PREFACE

The following section contains abstracts of papers/posters presented at the 35th Biennial Meeting of the American Society of Sugar Beet Technologists.

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SECTION A – AGRONOMY
ORAL PRESENTATIONS

BREDEHOEFT, MARK W.*, MARK W. BLOOMQUIST, CHRIS C. DUNSMORE and CODY W. BAKKER, Southern Minnesota Beet Sugar Cooperative, 83550 County Rd 21, Renville, MN 56284. **Glyphosate influence on sugarbeet production and control of Abutilon theophrasti, Chenopodium album, and Amaranthus species using weed growth stage and growing degree days.**

Weed control in sugarbeets has been a challenge since the inception of sugarbeet production. Conventional sugarbeet weed control has seen many modifications to optimize the efficacy of these products. Weed control with conventional products has been managed by growth stage of sugarbeet and weeds and more recently by growing degree days. In 2008 a significant part of the sugarbeet growing regions in the United States seeded some percentage of their sugarbeet production acres to a biotech variety with the Glyphosate tolerant trait. Sugarbeet growers need to be given information to best manage Glyphosate for weed control in sugarbeet. A study was established in 2008 in Southern Minnesota to evaluate application of Glyphosate for control of Abutilon theophrasti, Chenopodium album and Amaranthus species using weed growth stage or growing degree days. A base of 34 degrees Fahrenheit was used to calculate GDD. One treatment with Glyphosate gave 54, 69 and 83 percent control of Abutilon theophrasti, Amaranthus species and Chenopodium album. All other Glyphosate treatments gave weed control with of 90% or greater. Sugarbeet production was best with Glyphosate applied at 200 and 400 GDD and one application prior to row closure. The application at 200 GDD tended to be the most important when an application one week prior to row closure was conducted. Glyphosate application at 1, 2, 4, and 6 inch weeds was best for weed control and sugarbeet production with Glyphosate applied at 32 oz. per acre compared to 22 oz. per acre.

DEAN, GREG A.[1]*, DAVID M. ELISON[1], DAVID L. SCANTLIN[1] and TIM PIERSON[2], [1]The Amalgamated Sugar Company, LLC and [2]Grower/Cooperator, P. O. Box 8787, Nampa, ID 83653. **Understanding the use of Glyphosate/Glyphosate- resistant technology and how it may change grower cultural practices.**

In the 2007 crop year we wanted to know the problems that commercial sugarbeet growers would face when they planted glyphosate resistant sugarbeets in crop year 2008. The objectives were to understand how using glyphosate on glyphosate resistant sugarbeets would impact commercial sugarbeet growers. First we wanted to understand the problems that growers would face associated with the actual applications of glyphosate. Secondly how this new technology would affect conventional tillage practices. We choose a commercial field in the Gooding, Idaho receiving area. No other herbicides were used on the field either pre or post-emergence and only Roundup® glyphosate was used to control weeds. The field was also divided into 3 tillage regimes, low, medium and high. We found that it was possible to control weeds in this field using only glyphosate. We also learned much about the glyphosate label, choice of rates, timing of application, and how dust affected glyphosate. When all inputs and yields were considered the low tillage regime had a greater return to the grower.

DOWNARD, ROBERT W.[1]* and DAVID ELISON[2], [1]The Amalgamated Sugar Company LLC, P.O. Box 127, Twin Falls, ID 83303-127 and [2]The Amalgamated Sugar Company LLC, P.O. Box 700, Paul, ID 83347. **Strip tillage in sugarbeets.**

Wind erosion is a major factor in sugarbeet stand loss in Idaho, Oregon and Washington. Strip tillage is a cultivation practice that can be used to properly prepare the soil while leaving enough crop residue to reduce the impact wind has on sugarbeet stand establishment. Our objective was to see how this practice worked in sugarbeet production on a large scale. Strip tillage was done in the spring on a field following corn. The row spacing was twenty two inches with a seed spacing of five inches. Several aspects of sugarbeet production were examined through out the growing season such as fertility, cultural practices, root yield and sugar content.

FELIX, JOEL* and JOEY ISHIDA, Oregon State University/Malheur Experiment Station, 595 Onion Avenue, Ontario, OR 97914. **Effect of Cuscuta spp parasitization on sugar beet root yield and sugar content.**

A survey of grower fields planted to sugar beets was conducted during October 2007 and 2008 to determine the effect of field dodder on harvestable root yield and sugar content of parasitized and non-parasitized plants in Eastern Oregon. Surveyed fields were chosen randomly, and were representative of dodder infestation in the area. Weed control in sampled fields was based on the micro-rate program in 2007 and glyphosate in 2008 on Roundup Ready® sugar beets. A total of 10 samples (with 8 sugar beets each) were randomly harvested in October from two rows covering approximately 1 m2 each in areas with and without dodder parasitization. Weight for each sample was recorded before transportation to the factory for commercial sugar content determination. Sugar beet root yield and percent sugar content were significantly reduced for parasitized roots compared to Cuscuta-free roots. The average root yield in 2007 was 65 T/ha and 95 T/ha for parasitized and non-parasitized samples, respectively. The average root yield in 2008 was 86 T/ha and 110 T/ha for parasitized and non-parasitized roots, respectively. The average sugar content for parasitized samples was 13% compared to 16% for non-parasitized roots. As a consequence, the amount of recoverable sugar ha-1 in 2007 was reduced 44% for parasitized roots. Grower loss from Cuscuta parasitization is measurably high since both root yield and percent sugar content are used to determine payments.

FRANZEN, D. W.*, L. F. OVERSTREET, N. R. CATTANACH and J. F. GILES, North Dakota State University, Department 7180, Fargo, ND 58108. **Phosphorus starter fertilizer studies in the southern Red River Valley.**

Use of 3 gal/acre of 10-34-0 as a row-placed starter has become a common practice for sugar beet growers in the Red River Valley of Minnesota and North Dakota. As a result, numerous other proprietary formulations of starter phosphate fertilizers and P availability enhancers have been marketed to growers. Three site-years of phosphate (P) fertilizer studies were conducted to examine the relative benefits of the use of several of these products compared to rates of 10-34-0. Results suggest that none of these materials were consistently superior to the 3 gal/acre rate of 10-34-0. Growers should continue to choose a starter fertilizer based on availability and cost.

GUZA, COREY J.*, DENNIS E. MONTEI and RICHARD R. LIST, Michigan Sugar Company, 2600 S. Euclid Avenue, Bay City, MI 48706. **Effect of forced air ventilation on sugarbeet storage in Michigan.**

Michigan Sugar Company has experienced sugarbeet pile storage losses due to changing weather patterns. Warmer than normal December and January temperatures have been common in Michigan, resulting in increased sugarbeet respiration loss and physical deterioration. Michigan Sugar Company has tested forced air pile ventilation for two years, the 2005–2006 campaign and the 2006–2007 campaign at both the Bay City and Sebewaing, MI locations. Sugar factory data along with captive samples placed in the pile were used to determine the success of the project. Despite challenging weather conditions in both years of the test, the ventilated sugarbeets continued to process well in the factory as indicated by a drop in lime salts and improvement in extraction and recoverable white sugar per ton (RWST). Cossette samples taken from the factory before, during and after the ventilated beets were processed indicated that ventilation improved RWST. This was due to the higher sugar content and clear juice purity in the ventilated beets compared to the non-ventilated beets. The results from the captive samples in which the variety Beta 5451 was used, indicated an improvement in percent clear juice purity and percent sugar with ventilation, particularly at the Bay City location. A visual evaluation also indicated an improvement in sugarbeet storage with ventilation compared to no ventilation. The first year of testing proved that ventilating piles was a success, resulting in an average of 18 lbs of sugar per ton increase in the ventilated piles vs. the non-ventilated check. In the second year of the study, ventilation improved sugar recovery by 39 lbs of sugar per ton.

HARRIGAN, TIMOTHY M.[1], STEVE POINDEXTER[2]*, KURT EWALD[3] and TOM WENZEL[2], [1]Biosystems and Agricultural Engineering Dept., Michigan State University, East Lansing, MI 48824, [2]Michigan State University Extension, Sugarbeet Advancement, One Tuscola Street, Suite 100, Saginaw, MI 48607 and [3]Lakke-Ewald Farms Inc., 4949 N. Unionville Road, Unionville, MI 48767. **Reclaiming beet ground soil quality and productivity with low-intensity tillage, biosuppressive covers and organic inputs.**

Economic pressures have led to shorter rotations with more frequent planting of sugarbeets. Intense tillage and trafficking has damaged soil structure. Many beet growers have seen yields stagnate or decline in recent years. Specific causes are often difficult to identify and often seem to arise from multiple sources including diseases, insects and nematodes. Managing cropping systems for soil quality can improve stand establishment and crop growth, improve water infiltration, drainage and aeration, maintain a balance of pests and pathogens, and create

a low-stress environment for the crop. This project evaluated a soil quality management approach designed to reclaim the productivity of unproductive beet ground by including dairy manure, oilseed radish and oriental mustard in the crop rotation. The cover crops were seeded by direct drilling or by a new process, manure slurry-enriched seeding whereby the manure and seed were applied in one operation with little soil disturbance. The slurry seeded cover crop stands counts were 40% to 60% of drilled stands, but the slurry-seeded crop biomass was equal to or greater than the drilled crop because Individual plant biomass was two to six times greater with slurry seeding. Based on sugarbeet cyst nematode (SBCN) counts the sugar beet crop was considered to be at 'low' or 'no' risk, but an oilseed radish cover crop lead to a significant decrease in SBCN, and SBCN resistant beet varieties yielded significantly greater than susceptible varieties. Across treatments the resistant variety averaged nearly 1,100 lb/ac greater in recoverable sugar in 2007, and 3,457 lbs/ac greater in recoverable sugar in 2008.

HENNINGSEN, J. DANIEL*, DON W. MORISHITA and DONALD L. SHOUSE, University of Idaho, Twin Falls R&E Center, P.O. Box 1827, Twin Falls, ID 83303. **Herbicide, insecticide and fungicide tank mixtures with glyphosate in glyphosate-tolerant sugar beet.**

Weed control in other glyphosate-tolerant crops has shown little or no interaction when glyphosate is tank mixed with other herbicides, insecticides or fungicides. 2008 marked the first year of full-scale glyphosate tolerant sugar beet production in the US. Currently, the glyphosate label does not list any approved tank mixtures with any pesticides used in sugar beet. It does offer this precaution: tank mixtures of this product with herbicides, insecticides or fungicides may result in crop injury or reduced weed control. Based on this label information, we determined there was need for information on the compatibility of glyphosate with other pesticides for use on glyphosate-tolerant sugar beets. Field studies were conducted from 2003 to 2008 to evaluate herbicide tank mixtures and to begin investigating potential interactions with insecticides and fungicides tank mixed with glyphosate for use on glyphosate-tolerant sugar beet. Several studies examined glyphosate tank mixtures with other herbicides while another two year study evaluated three insecticides and two fungicides tank mixed with glyphosate applied to glyphosate-tolerant sugar beets. No crop injury, reduced weed control, or reduced sugar beet yield was observed with any of the herbicide tank mixtures, with the exception of pyrazon. Common lambsquarters control was reduced with glyphosate pyrazon, although sugar

beet yield was not affected. With limited evaluations of insecticide and fungicide tank mixtures with glyphosate, very little negative effect was observed. The only exception was early season common lambsquarters control with trifloxystrobin and azoxystrobin, in 2007. However, common lambsquarters control was equal to glyphosate alone at the later evaluation date. There was no difference in root yield or recoverable sugar among any of the pesticide tank mixtures indicating no negative interaction between glyphosate and the herbicides, insecticides, or fungicides. Growers and crop advisors however, are anxious for the pesticide manufacturers to label these tank mixtures to help assure them no potential problems exist with glyphosate tank mixtures.

HERGERT, GARY W.* and REX A. NIELSEN, University of Nebraska Panhandle Research and Extension Center, 4502 Avenue I, Scottsbluff, NE 69361. **Comparison of strip tillage versus broadcast N application for sugar beets.**

Strip-till placement of fertilizer is a fairly recent application option for sugar beets and producers have asked whether it might be more efficient than conventional broadcast N. Strip-till placement of N was compared to broadcast N application for sugar beets during 2006, 2007 and 2008 (not harvested at abstract writing) near Scottsbluff, NE. Effects on sugar beet stand, yield, sugar content and sucrose production and sugar loss to molasses (SLM) were evaluated. N rates of 0 to 210 lbs N/acre in 35 pound increments replicated five times were compared. No significant N application method effects or N rate by method interactions were shown. N rate significantly increased yield. Based on plot soil tests, the current University of Nebraska N algorithm would have recommended 140 lb N/acre in 2006 and 60 lbs N/acre in 2007 for 26 ton beets. In 2006, beet yield was maximized near 27 tons per acre and near 26 tons in 2007. The N response curves showed 105 to 115 pounds of N maximized tonnage and recoverable sugar in 2006 and 60 to 80 pounds of N in 2007. The research shows that the UNL algorithm, although considered conservative, is still an excellent guide to N application. It also confirms much of our past N rate research: increasing N rate increases tonnage up to a point, but with declining sugar content and increasing SLM and maximum recoverable sugar occurs at optimum N. The research showed the importance of testing for residual nitrate and that current University of Nebraska N recommendations are adequate for high sugar beet yields and quality. Soil sampling following sugar beet showed good recovery of residual nitrate whether N was broadcast or strip-till applied.

HUBBELL, LEE A.[1]*, JAMES F. STEWART[1] and DAVID B. WISHOWSKI[2], [1]Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Drive, Bay City, MI 48706 and [2]Hilleshog, 5146 Rogers Road, Akron, MI 48701. **Effect of Headline (pyraclostrobin) as a yield enhancer for sugarbeets in Michigan.**

Headline fungicide has been promoted as a yield enhancer for sugarbeets beyond any effect as a fungicide. Replicated trials were conducted in Michigan at six locations over four years comparing Headline to other strobilurin fungicides, Eminent, and a check. The plan was to control Cercospora Leafspot in the check plots with fungicides not included as treatments in the trial. In 2005 and 2006 we did not control Cercospora well in the check treatment. Only in these two years was any fungicide treatment significantly better than the check but Cercospora had not been controlled. Cercospora was controlled in all plots where one of the fungicide treatment applications was made. The only time one fungicide application was significantly better than another fungicide was Headline applied 51 days before harvest compared to Quadris applied 27 days before harvest. This was at one location in 2006. There was no other trial where a Headline application was significantly better in Recoverable Sugar per Acre than any other fungicide treatment including Eminent. There was no fungicide treatment better than the check at the three test locations in 2007 and 2008 when Cercospora leafspot was controlled in the check treatment. We do not see a yield enhancement effect from an extra Headline application whether close to harvest or earlier.

HUBBELL, LEE A.[1]*, JAMES F. STEWART[1], DAVID B. WISHOWSKI[2], COREY J. GUZA[3] and RALPH FOGG[3], [1]Michigan Sugar Company, Agricultural Research Center, 1459 S. Valley Center Drive, Bay City, MI 48706, [2]Hilleshog, 5146 Rogers Road, Akron, MI 48701 and [3]Michigan Sugar Company, 2600 S. Euclid Avenue, Bay City, MI 48706. **Construction and development of facility and protocol for sugarbeet storage trial(s).**

The key question when conducting research on sugarbeet storage is how to develop a test that will be reliable and replicable. Formerly Michigan Sugar Company has conducted a trial in a facility that relied on out side temperatures and did not have a method of humidity control; therefore it was difficult to conduct a replicable trial. Data accumulated from year to year was also difficult to compare due to varying storage conditions making the trial less reliable. Previously samples have been placed in plastic bags and tied with a one and one fourth inch PVC tied

in the opening to allowing air to vent from the bag. The storage room is cooled as much as possible relying on outside temperatures for approximately 120 days. Twice throughout the storage period the temperature in the room will be increased and then cooled again in order to stress the storage conditions. This in essence will cause some varieties to begin to rot. In 2007 a decision was made to investigate a new protocol that will produce a reliable and replicable trial. A new storage facility was constructed that incorporates temperature and humidity sensors, a Humicell to create humidity, an air intake/ mixing system, and computer software to monitor and control conditions within the storage room. Samples will also be stored in three quarter bushel vegetable boxes allowing free air circulation in and around each sample. The first trial will begin with the harvest of the 2008 sugarbeet crop. Although the final protocol and procedures are yet to be determined, having more control over the sample(s) environment will surely help to improve the reliability of the test.

KAFFKA, STEPHEN R.[1]* and SCOTT SHEPARD[2], [1]University of California - Davis, Department of Plant Sciences, One Shields Avenue, Mail Stop [1], Davis, CA 95616 and [2]University of California Cooperative Extension, Merced, CA 95340. **Evaluating best management practices for *Cercospora* leaf spot control in over-wintered beets.**

Cercospora beticola Sacc. (CLS) is widely distributed in most sugarbeet growing regions, but in California has been only a minor disease, damaging only crops sown in spring and harvested in autumn in the southern San Joaquin Valley (SJV). University recommendations for chemical control of CLS were developed based on spring-fall production. In the last several years CLS began to occur at increasingly damaging levels in the spring planted-spring harvested cropping area in the northern SJV. Average winter temperatures allow sugarbeets to grow and the pathogen to develop. The control of CLS on over-wintered crops has not been evaluated elsewhere. Two on-farm trials were carried out in 2006-07 and again in 2007-08 at locations spanning the range of conditions in the over-wintered region in areas that had previously experienced high levels of CLS infection. Two varieties will be grown in randomized plots with 4 replications of each variety (B4430-susceptible, and Alpine---partially resistant). Five different levels of control were compared: No control, minimal control (2 treatments 2X), intermediate control (3-4X), aggressive control (> 4X) based on first observation in the field, and preventative (6-7X) through the late summer-winter period. A series of fungicides were used based on mode of action to help avoid the development of resistance. In order of use

these were: tetraconazole, a strobularin, dithiocarbamate, and a second strobularin. If more than 4 sprays were applied, the sequence was repeated. CLS infection levels were quantified throughout the season and yields compared at harvest. At the site near Merced, a weather station monitoring temperature, relative humidity, and leaf wetness was installed. CLS occurred severely at the eastern site, but not the western site in each year. Infection levels were greater on the B4430 cultivar than Alpine. CLS levels were significantly reduced by 2 to 3 fungicide treatments over the September –March period. Even though CLS levels were reduced by greater numbers of treatments, yields were not significantly increased.

KALSO, KEITH W., Michigan Sugar Company, 159 S. Howard Avenue, Croswell, MI 48422. **Ontario sugarbeet pile recovery innovation project.**

An innovative approach to sugarbeet pile recovery was developed by the unique partnership between Michigan Sugar Company and Ropa North America in the summer of 2007. The partnership utilized a Ropa Maus loading and cleaning beet machine with a locally fabricated header built for recovery of large long-term beet storage piles. The typical wheel loader used industry wide was replaced with this new system. The unique design not only direct loads trucks but also has a cleaning capacity similar to a conventional sugarbeet piler as used in the United States. The two primary objectives for this systems use was to reduce freight costs by removing soil at the loading site and removal of pile shoulders before beet deterioration occurs. The Ropa Maus used by Michigan Sugar Company in the 2007-2008 campaign loaded and cleaned 176,821 tons of beets at the Dover, Ontario beet storage site. Over 8664 tons of soil and plant material were segregated from the beet pile equating to over $97,905 savings in freight costs. Beets were recovered in a circular path around each pile. As pile shoulders were continually being loaded out, much improved quality was observed at the factory with the new system. Also when compared to typically managed beet piles, factory diffusion juice sugar percent increased and factory lime salt concentration decreased. Other results observed were less soil contamination at the factory, less soil in factory settling ponds, less piling yard damage, removal of frozen chunks, faster and safer truck loading and safer truck unloading when compared to using a wheel loader.

KHAN, MOHAMED F. R., North Dakota State University and University of Minnesota, Department of Plant Pathology, 227 Walster Hall, P.O. Box 5758, Fargo, ND 58108-6050. **Advantages and challenges of commercial production of Roundup Ready® sugarbeet in the US.**

Roundup Ready® sugarbeet became available for commercial production in 2008 and was quickly adopted in all the major sugarbeet growing regions. 'Weeds' is considered as the most important problem for most sugar beet growers and weed control costs is usually higher in states such as Nebraska and Idaho compared to Minnesota and North Dakota. Roundup Ready® sugarbeet is easily produced using two to three timely applications of glyphosate that results in excellent weed control but growers have to pay a technology fee. Effective weed control may also be obtained using three to four timely applications of herbicides in tank mixes on conventional sugarbeet more economically than using Roundup Ready® technology. Some growers were willing to incur a higher production cost for the convenience of the new technology. Adoption of the Round Ready® technology was highest in states such as Idaho (98%) and Wyoming (90 to 95%) where weed control cost is generally higher. Yield of Roundup Ready® and conventional sugarbeet appear to be similar in Minnesota, Michigan and North Dakota where about 50% of the acreage was planted to conventional sugarbeet and 50% to Roundup Ready® sugarbeet. There were some concerns that some of the Roundup Ready sugarbeet may not have as good a disease resistance package as some of the conventional varieties. There were also concerns about increase selection pressure for resistance to glyphosate in areas where only glyphosate tolerant crops such as soybean, corn and sugarbeet will be used in the rotation. If growers are to maximize the benefits of using Roundup Ready® technology, varieties with improved disease resistance will be needed and more research should be done to determine compatibility of glyphosate with other pesticides to improve pest control and simultaneously reduce production costs.

KHAN, MOHAMED F. R.[1]*, LARRY CAMPBELL[2], NORMAN CATTANACH[3] and AARON CARLSON[3], [1]North Dakota State University and University of Minnesota, Department of Plant Pathology, 227 Walster Hall, P.O. Box 5758, Fargo, ND 58108, [2]USDA, Agricultural Research Service, Northern Crop Science Laboratory, 1307 – 18th Street North, Fargo, North Dakota 58105 and [3]North Dakota State University, Soil Science Department, 249 Walster Hall, P.O. Box 5638, Fargo, ND 58105. **Impact of fungicides on sugarbeet yield, quality, and storage respiration rate in**

the absence of disease.

Researchers in the United Kingdom reported that triazole and/or strobilurin fungicides increased sugarbeet, *Beta vulgaris*,, yield by 5%, even when disease pressure was moderate to low. The objective of this research was to determine the effect of fungicides on sugarbeet yield, quality, and postharvest respiration rate, in the absence of disease in the Red River Valley. Sugarbeet was planted at Prosper, North Dakota in 2005 through 2008. The variety selected was tolerant to *Aphanomyces cochlioides* and seeds were treated with Tachigaren to provide additional protection from Aphanomyces. Five fungicides commonly used for Cercospora leaf spot control - Eminent, Headline, Gem, Super Tin and Topsin - were each applied three times at about 14 days intervals beginning in late July. There was also an untreated control. These six treatments were arranged in a randomized complete block design with four replicates. Sucrose concentration and loss to molasses were determined at American Crystal's laboratory at East Grand Forks, MN. Differences in root yield, sucrose concentration, or recoverable sucrose between the untreated control and any of the fungicide treatments were not significant. In 2007, root samples were collected, washed, and placed in perforated polyethylene bags and stored at 4ºC and high relative humidity. Postharvest storage respiration rates were determined 30 and 90 days after harvest. There was no significant difference in respiration rates between the untreated control and any of the fungicide treatments. Storage respiration rate will be measured again in 2008. In these trials, there was no apparent benefit in applying fungicides to healthy sugarbeet.

KNISS, ANDREW R., University of Wyoming, Department of Plant Sciences, 1000 East University Avenue, Laramie, WY 82071.
Volunteer glyphosate-resistant corn interference in glyphosate-resistant sugarbeet.

With the introduction of glyphosate-resistant sugarbeet, the herbicide glyphosate will be heavily relied upon for weed management in the crop. If glyphosate-resistant sugarbeet is grown in rotation with glyphosate-resistant corn, volunteer corn will not be adequately controlled if glyphosate is used exclusively for weed control. A field study was conducted in 2008 at the Sustainable Agriculture Research and Extension Center near Lingle, Wyoming to determine the effect of volunteer corn density on sugarbeet yield reduction. Corn was planted into the sugarbeet crop at densities of 0.03, 0.07, 0.13,0.27, and 0.53 plants per foot of crop row (1 corn plant per 33, 14, 8, 4, and 2 feet of

row, respectively). Glyphosate was applied to the entire trial as needed throughout the growing season for weed control. The experiment was set in a randomized complete block design with 3 replications. The log-logistic model was fit to root yield data to determine yield loss due to corn plant density. One corn plant per 12 feet of row (in 30-inch rows) caused a reduction in root yield of 10%. Yield losses increased rapidly as corn density increased beyond this level.

MÄRLÄNDER, BERNWARD*, JULIA FUCHS, HEINRICH REINEKE and NICOL STOCKFISCH, Institute of Sugar Beet Research, Holtenser Landstr. 77, 37079 Göttingen, Germany. **Environmental impact of sugar beet production in Germany.**

Environmentally sound cultivation methods for crop production in general and sugar beet cultivation in particular are recurrently discussed within the EU. The debate is going on between society, politicians and the agricultural community and focuses on protection of the environmental goods soil, water, air, and biodiversity. Thus, there is an urgent need for reliable data about sugarbeet cultivation. Results are needed about performance, environmental effects, efficiency, cost structures of farms and flows of material and energy. Objective of the joint project on environmental effects of sugar beet cultivation was to provide information about the diversity of cultivation systems in Germany and to evaluate cultivation exemplarily on a nationwide level. For that purpose, interviews in 109 farms about business economics and about sugarbeet production on 285 field sites in 2004 were performed. This data base was analysed in four projects which comprise indicators for environmental effects, eco-efficiency and profitability of sugar beet cultivation. The results are valuable in order to deduce scale, frequency and data contents of future surveys as well as characteristics of surveyed fields and farms. Furthermore it is possible to identify objectives for sustainable development in sugarbeet cultivation.

MORISHITA, DON W.[1], JOEL FELIX[2], DONALD L. SHOUSE[1]* and J. DANIEL HENNINGSEN[1], [1]University of Idaho, Twin Falls R&E Center, P.O. Box 1827, Twin Falls, ID 83303 and [2]Oregon State University, Malheur Experiment Station, Ontario, OR 97914. **Volunteer potato timing of removal with and without glyphosate in sugar beet.**

Sugar beet often follows potato in southern Idaho and eastern Oregon crop rotations. Depending on post-harvest environmental con-

ditions and management practices, volunteer potato can be a serious problem in sugar beet production. Field experiments were conducted at the University of Idaho Research and Extension Center near Kimberly and Oregon State University Malheur Experiment Station near Ontario to determine the timing of volunteer potato removal on sugar beet yield with and without glyphosate. Experiments were conducted from 2006 to 2008. Whole potato tubers averaging 2 oz were planted within each row at a density of 2.4 plants/yd^2 in all years. Critical timing of removal was determined by manually removing emerged potato when potato growth attained the following growth stages: 1) 10-cm rosette, 2) hooking (pre-tuber initiation), 3) tuber initiation, 4) early tuber bulking, and 5) mid-tuber bulking. Additional potato removal treatments were included to anticipate shoot re-growth and these treatments included: 6) remove as-needed at 10-cm rosette, 7) remove as-needed at tuber hooking, 8) remove as-needed at tuber initiation, 9) potato not removed and 10) potato-free treatments were included. Volunteer potato shoots were cut 1 cm below soil surface when removed manually. Glyphosate applications were made at identical growth stages in a separate experiment. Glyphosate was applied at 0.75 lb ae/A at the desired growth stages. In the remove as-needed treatments, shoots were cut or sprayed each time potato plants had re-grown to 10-cm rosettes. Tubers in the 'not removed' treatment had the highest average tuber yield at 7.8 ton/A. The optimum removal time for volunteer potato may be at tuber initiation. Sugar beet root and sucrose yield of remove once and remove as-needed at tuber initiation were equal. Removing above-ground plant biomass one time at earlier growth stages was apparently too soon because volunteer potato recovered and produced more tubers. Volunteer potato removal at early or mid-tuber bulking was apparently too late because sugar beet root and sucrose yield was reduced.

REGITNIG, PETER J.* and BRYAN AVISON, Lantic Inc., 5405 – 64th Street, Taber, Alberta, Canada T1G 2C4. **Evaluation of zone tillage for sugar beet production in Alberta.**

In southern Alberta, reduced tillage in sugar beets has contributed to improved control of wind erosion. In 2004, zone tillage experiments were initiated to evaluate managing crop residue and erosion using an implement that tilled a narrow strip where sugar beets are seeded while leaving the inter-row area undisturbed. With recent increases in fuel prices there is further incentive to reduce the number of tillage operations for seedbed preparation using a zone tillage system. Early season soil temperature and sugar beet production were evaluated for zone

tillage in comparison with conventional tillage over a 4 year period. In 2004 and 2005 soil temperatures and speed of sugar beet emergence were evaluated in a commercial field where conventional tillage was compared to tillage using a commercial 24-row zone tillage implement. In 2005 through 2007 small plot experiments that evaluated soil temperature, speed of sugar beet emergence and sugar beet production were conducted using a 6-row research zone tillage implement. Results over 4 years indicate that in most cases it was possible to achieve emergence stands with zone tillage that were comparable to conventional tillage stands. Temperature data suggests that zone tillage did not have a substantial impact on above or below ground in-row early season temperature compared to a conventional system. Visual evaluations of plant vigour in June indicated the leaf canopy was more robust for conventionally tilled treatments and there was also a trend for slightly higher extractable sugar per acre for these treatments. The zone tillage system studied in these trials appears to be a viable option for consideration by Alberta sugar beet producers interested in reducing tillage operations and improving control of wind erosion. Further investigation is continuing through larger scale strip trials being conducted in southern Alberta.

SEARLE, DENNIS W.[1]*, DON W. MORISHITA[2] and TAMIE KEETH[2], [1]The Amalgamated Sugar Company LLC, P. O. Box 8787, Nampa, ID 83653 and [2]University of Idaho, Twin Falls R&E Center, Twin Falls, ID 83301. **A study of the control of powdery mildew using nine commercially available fungicides and three experimentals.**

In the production year of 2008 at the University of Idaho R&E Station Parma Idaho, a powdery mildew study was conducted to compare the control capabilities of nine of the current commercially available fungicides. There were also three experimental fungicides in the trial. Since 1973 powdery mildew, if left untreated, has caused an economic loss in the commercial fields grown in Southwestern Idaho. In the last few years, there have been several fungicide products introduced for use in controlling this disease. It is important that our industry understands the effectiveness of each of these products so that we can assist the producer in making an educated decision as to which product best meets his needs. There were 25 treatments, replicated 6 different times. The plots were 11'x30' encompassing 6/22' rows. The 4 center rows of the plot were treated. The two center rows 25' long were evaluated and harvested. There were two applications made three weeks apart during the growing season. The plots were evaluated before each application

and thirty days after the last application. The border rows of the entire trial were not treated. The powdery mildew measure was severe. The border rows were 100% infected by the end of the season. The results from the plots show that there is a definite advantage to using a fungicide to control powdery mildew. There is also an indication that there is a difference in performance between fungicides.

SHOUSE, DONALD L.[1], DON W. MORISHITA[1]*, J. DANIEL HENNINGSEN[1], ROBYN C. WALTON[2] and MICHAEL P. QUINN[3], [1]University of Idaho, Twin Falls R&E Center, P.O. Box 1827, Twin Falls, ID 83303, [2]Seminis Seed Company, 21120 Hwy 30, Filer, ID 83328 and [3]Oregon State University, Crop and Soil Science, 109 Crop Science Building, Corvallis, OR 97331. **Volunteer potato density interference in sugar beet.**

Sugar beet often follows potato in southern Idaho and eastern Oregon crop rotations. Depending on post-harvest environmental conditions and management practices, volunteer potato can be a serious problem in sugar beet production. Field experiments were conducted at the University of Idaho Research and Extension Center near Kimberly to determine the effect of volunteer potato densities and timing of volunteer potato removal on sugar beet yield. Experiments were conducted in 2005 and 2006. Whole potato tubers averaging 2 oz were planted within each row. Tubers were planted at seven densities ranging from 2,723 to 16,335 tubers/A in addition to a potato-free control. At the highest potato plant density, potato tuber yield averaged 10.4 ton/A. These tuber yields equated to >223,000 tubers/A. With no volunteer potato, sugar beet root and extractable sucrose yield averaged 33 and 4.3 ton/A, respectively. At the lowest potato density, sugar beet root yield was reduced 25% in 2005 and 21% in 2006 and at the highest density; root yield was reduced 61% in 2005 and 58% in 2006. This study clearly shows the competitiveness of volunteer potato in sugar beet.

STACHLER, JEFF M.*, ALAN G. DEXTER and JOHN L. LUECKE, Dept. of Plant Sciences, North Dakota State University and University of Minnesota, Dept. 7670, PO Box 6050, Fargo, ND 58108-6050. **Weed control in glyphosate-resistant sugar beets.**

Certain weed species can be difficult to control with glyphosate applied alone. Volunteer glyphosate-resistant crops are frequently observed in glyphosate-resistant sugar beet. Small-plot field research

was established without sugar beet in 2008. Triflusulfuron plus glyphosate applied twice improved Powell amaranth and wild buckwheat control compared to two applications of glyphosate. Glyphosate plus desmedipham plus phenmedipham plus ethofumesate plus triflusulfuron plus AMS plus MSO provided the greatest control of glyphosate-resistant canola. Glyphosate plus clopyralid at 0.067 kg ai/ha provided 100% control of glyphosate-resistant soybean. Herbicide combinations with glyphosate will be necessary for control of certain weed species and volunteer glyphosate-resistant crops.

STACHLER, JEFF M.* and JOHN L. LUECKE, Dept. of Plant Sciences, North Dakota State University and University of Minnesota, Dept. 7670, P.O. Box 6050, Fargo, ND 58108-6050. **Weed control challenges in glyphosate-resistant sugar beets in Minnesota and eastern North Dakota.**

Glyphosate-resistant sugar beets were commercially available for the first time in Minnesota and eastern North Dakota for the 2008 growing season. With this introduction emerging weed control issues were observed. Weed control failures were observed in southern and central Minnesota where glyphosate is relied upon for weed control in glyphosate-resistant corn and soybeans. Control of waterhemp, Powell amaranth, common and giant ragweed, lambsquarters, kochia, and wild buckwheat will need to be closely monitored throughout the area. Volunteer glyphosate-resistant corn, soybeans, and canola were observed at harvest in some glyphosate-resistant sugar beet fields. Herbicide combinations with glyphosate in glyphosate-resistant sugar beets will need to be managed differently compared to herbicide combinations in conventional sugar beets. Application timing, herbicide rates, and adjuvants will all impact the performance of herbicide combinations with glyphosate. Glyphosate-resistant sugar beet varieties will need to be subjected to conventional herbicides to maintain current tolerance levels.

STEWART, JAMES F.*, COREY J. GUZA and LEE A. HUBBELL, Michigan Sugar Company, 1459 S. Valley Center Drive, Bay City, MI 48706. **Timing of glyphosate applications for optimum weed control and sugarbeet yield in a Roundup Ready® sugarbeet production system.**

Trials were conducted over a three year period in Michigan to evaluate the effectiveness of glyphosate for weed control in glyphosate-

tolerant sugarbeets. Weed population was lower in 2006 and 2007 with two to four weeds per ft^2 compared to 2008 with over ten weeds per ft2. Weed species present during the 2006 and 2007 seasons were common lambsquarters (*Chenopodium* album) and pigweed species (*Amaranthus retroflexus* and Powell Amaranth). In 2008 wild mustard (*Brassica kaber*) and common lambsquarters were present. A single glyphosate application at 4-leaf stage sugarbeets resulted in poor weed control and reduced sugarbeet yield. A single glyphosate application at 10-leaf stage sugarbeets was more effective than the single application at 4-leaf stage sugarbeets. Both application timings were less effective than two or three well timed glyphosate applications. Glyphosate applied to sugarbeets at the 2-leaf, 6-leaf and 10 leaf stage provided excellent weed control. Good weed control was also achieved with glyphosate applied to 2-leaf and 6-leaf or 2-leaf and 10-leaf stage sugarbeets. Sugarbeet yield was similar between the two and three glyphosate application treatments. None of the glyphosate applications caused sugarbeet injury. All of the glyphosate treatments were applied at a rate of 22 fl oz/acre and included ammonium sulfate at 17 lb/100 gallons of spray solution.

WILSON, ROBERT G., University of Nebraska, 4502 Avenue I, Scottsbluff, NE 69361. **Strategies for controlling glyphosate-tolerant weeds in glyphosate-tolerant sugarbeets.**

Common lambsquarters (*Chenopodium album* L.) and toothed spurge (*Euphorbia dentata* Michx) are two weeds on the increase in Nebraska, Colorado, and Wyoming and have been shown to be more difficult to control with glyphosate. Therefore experiments were conducted in 2007 and 2008 to examine various strategies for controlling both weeds in glyphosate-tolerant sugarbeets. Strategy one examined the influence of weed control in glyphosate-tolerant corn on weed populations in the succeeding glyphosate-tolerant sugarbeet crop. The second strategy explored the benefits of adding ethofumesate at planting and tank-mix partners to postemergence applications of glyphosate. While strategy three examined the benefits of glyphosate rate and timing for improving efficacy on common lambsquarters and toothed spurge. Increasing the herbicide input in corn resulted in a dramatic reduction in common lambsquarters density in the following sugarbeet crop. Adding ethofumesate at planting in conjunction with glyphosate applied postemergence resulted in 99% toothed spurge control compared to 62% control when only glyphosate was applied postemergence. Toothed spurge control in sugarbeets improved when glyphosate rate was increased from 0.84 to 1.26 kg/ha. However glyphosate control of toothed spurge declined dramatically when spurge reached 25 cm in height.

YONTS, C. D., University of Nebraska, Panhandle Research and Extension Center, 4502 Avenue I, Scottsbluff, NE 69361. **Development of season long deficit irrigation strategies for sugarbeets.**

For most of the last ten years the Western Sugar Cooperative growing region has experienced drought. For surface water users, it means irrigating with an inadequate water supply to meet crop demand. For ground water users the drought means there is a need to pump more water at a time when pumping restrictions are being implemented to sustain ground water levels. In either case, irrigation water is limited and growing sugarbeets means water stress may likely occur. The objective of this experiment is to develop deficit irrigation strategies that producers can use to minimize the impact of water stress on sugarbeet production. An experiment was designed to evaluate season long deficit irrigation on sugarbeets. Sprinkler irrigation was used to establish nine water treatment levels ranging from full irrigation to no irrigation applied during the growing season. During 2007 only 2.3 inches of rainfall was recorded during the growing season. Sucrose content was similar for all treatments tested with the exception of the no irrigation treatment. No irrigation resulted in a sucrose content that was 3% greater than any irrigated treatment. The reverse was true for tons per acre. In this case, the no irrigation treatment produced about half of the yield compared to most other treatments. Greatest sugar yield was normally recorded with irrigation treatments that applied 75% of full irrigation requirements. Numerically full irrigation did not produce the greatest yield. Results from 2007 and 2008 will be presented.

SECTION A – AGRONOMY
POSTER PRESENTATIONS

ARMSTRONG, JON-JOSEPH Q. and CHRISTY L. SPRAGUE*, Michigan State University, Plant and Soil Sciences Building, East Lansing, MI 48824. **Effect of row width and plant population on weeds and yields in glyphosate-resistant sugar beet.**

The adoption of glyphosate-resistant varieties will greatly impact how Michigan growers manage weeds and produce sugar beets. Planting sugar beets in narrow rows is one option for making the sugar beet crop more competitive relative to weeds to improve weed control, yield, and quality. To evaluate weed management and potential yield improvements in narrow row glyphosate-resistant sugar beet, field trials were conducted at one site in 2006 and three sites each year in 2007 and 2008. Three row widths (38-, 51-, and 76-cm rows) and four plant populations (54,000; 78,000; 101,000; and 124,000 plants/ha) were investigated in these trials. In untreated plots, weed biomass was not different among row widths. However, a trend of slightly reduced biomass in narrower rows was observed at two of three sites in 2007. In plots which received a single glyphosate application when weeds were 10 cm tall, subsequent weed biomass was significantly reduced in the 38- and 51-cm rows compared with 76-cm rows at all sites in 2008. Though producers will not be able to achieve season-long weed control with only one application of glyphosate, reduced weed biomass following an initial glyphosate application indicates increased competitiveness of sugar beet in narrow rows. In addition to the benefits of weed control, planting sugar beet in narrow rows also led to higher root and sugar yield. Among all plant populations, root yield was higher in 38- or 51-cm rows compared with 76-cm rows in five of seven site-years.

DEAN, GREG A.* and CLARK W. MILLARD, The Amalgamated Sugar Company LLC, P. O. Box 8787, Nampa, ID 83653. **Sugar beet tops help insulate roots from heat in the daytime and nighttime freezing temperatures.**

Sugarbeets received during periods of extreme heat and cold that have been defoliated more than 1 or 2 rounds in advance of harvesting lose more sugar than is necessary due excess respiration in storage. During the fall of 2003, we used Hobo® data loggers to collect temperature information near Mountain Home, Idaho at the Reverse growing area. We collected ambient air temperatures and a temperature 2 inches

below the crown of topped and untopped sugarbeets at 30-minute intervals from late September until mid-November. A Hobo weather station was used to collect ambient air temperatures and the 2 inches below the crown temperatures were achieved by boring a hole into the sugarbeet, and placing the thermocouple so that it was located approximately in the center. The resulting changes in daytime highs to nighttime lows were notable. During one 24 hour period on October 31- November 1, 2003 there was a 38° swing in ambient air temperatures, a 40° swing of the 2 inch beet temp of topped beets and a 13.5° swing in the sugarbeets with the tops still intact.

HONGO, CHIHARU[1]*, KATSUHISA NIWA[2], JUN YOKOBORI[2], RYUTARO YAMADA[3], and MASATO KUWAHARA[4], [1]Chiba University, Center for Environmental Remote Sensing, 1-33 Yayoi-cho, Inage-ku, Chiba, Japan 263-8522, [2]Zukosha Co. Ltd., Hokkaido, Japan, [3]National Agriculture and Food Research Organization, Ibaraki, Japan and [4]Green Techno Bank, Hokkaido, Japan. **Development of an efficient sugar beet cultivation support system using the agricultural spatial information - Prediction of root yield using meteorological data and satellite data.**

The production of the beet sugar in Hokkaido, Japan, is about 640,000 tons, that is 3/4 the total domestic production amount. The government is recommending a cost reduction of the production and manufacturing process, because the price of domestic beet sugar is 2.8 times higher than the imported sugar. The objective of this study is to assess the feasibility of development of an efficient sugar beet cultivation support system effective to reduce the cost for beet cultivation and also for the beet collection and sugar production, using the agricultural spatial information data. In this study for predicting the root yield of sugar beet, the analysis of the satellite data and meteorological data were conducted in the Memuro Town, Hokkaido, Japan. The accumulated temperature(T), cumulative rain fall amount(P) and accumulated solar radiation(R) from the end of April to the middle of July were selected as the predictors of the root yield(RY) prediction formula, RY=0.043675R+0.02783T-1.09513P-39.634(r2=0.87**). The predictive error was 3.6t/ha, that was the result calculated by the farmers group, after weighted to the predicted root yield using NDVI which was derived from SPOT5 satellite data. The results suggest that it was possible to predict the root yield before three months of harvesting season. By providing such results to sugar companies much earlier, before harvesting, the sugar beet collection and sugar production efficiency will be increased.

KALSO, KEITH W.* and WAYNE MARTIN, Michigan Sugar Company, 159 S. Howard Avenue, Croswell, MI 48422. **Ontario sugarbeet pile recovery innovation project.**

An innovative approach to sugarbeet pile recovery was developed by the unique partnership between Michigan Sugar Company and Ropa North America in the summer of 2007. The partnership utilized a Ropa Maus loading and cleaning beet machine with a locally fabricated header built for recovery of large long-term beet storage piles. The typical wheel loader used industry wide was replaced with this new system. The unique design not only direct loads trucks but also has a cleaning capacity similar to a conventional sugarbeet piler as used in the United States. The two primary objectives for this systems use was to reduce freight costs by removing soil at the loading site and removal of pile shoulders before beet deterioration occurs. The Ropa Maus used by Michigan Sugar Company in the 2007-2008 campaign loaded and cleaned 176,821 tons of beets at the Dover, Ontario beet storage site. Over 8664 tons of soil and plant material were segregated from the beet pile equating to over $97,905 savings in freight costs. Beets were recovered in a circular path around each pile. As pile shoulders were continually being loaded out, much improved quality was observed at the factory with the new system. Also when compared to typically managed beet piles, factory diffusion juice sugar percent increased and factory lime salt concentration decreased. Other results observed were less soil contamination at the factory, less soil in factory settling ponds, less piling yard damage, removal of frozen chunks, faster and safer truck loading and safer truck unloading when compared to using a wheel loader.

KHAN, MOHAMED F. R.[1]* and RANDY NELSON[2], [1]North Dakota State University and University of Minnesota, Department of Plant Pathology, 227 Walster Hall, P.O. Box 5758, Fargo, ND 58108-6050, [2]University of Minnesota, Clay County, 715 – 11th Street North, Moorhead, MN 56561. **Comparing fungicide use with defoliation as management strategies for economic control of Cercospora leaf spot in sugarbeet.**

Cercospora leaf spot, caused by *Cercospora beticola*, is the most destructive foliar disease of sugarbeet in Minnesota and North Dakota in warm and humid conditions. Fungicide usage and defoliation as management strategies were evaluated in 2006 and 2007 at Foxhome, MN. Fungicides were applied when required in a rotation program starting at initial symptoms. Plants were defoliated in July in 2006, and July and August in 2007, to avoid the disease. There were also untreated check

plots. In both years, the use of fungicides provided acceptable disease control and resulted in the highest recoverable sucrose because of higher root yields with significantly higher sucrose concentrations. Defoliated plants had the least amount of Cercospora leaf spot. However, defoliation adversely impacted the photosynthetic capacity of plants resulting in reduced yield. In 2006, defoliation resulted in similar root yield and recoverable sucrose as the untreated check. However, in 2007, defoliation resulted in lower root yield, sucrose concentration and recoverable sucrose than the untreated check. Lower yield of defoliated plots in 2007 was probably a result of slow re-growth of leaves because there was 45% less rainfall in July through September in 2007 compared to 2006. Defoliation was effective in controlling Cercospora leaf spot but resulted in significantly lower sucrose yields compared to fungicide usage which makes it an uneconomical management tool for growers.

LAMB, JOHN A.[1]*, MARK W. BREDEHOEFT[2] and CHRIS DUNSMORE[2], [1]Department of Soil, Water and Climate, University of Minnesota, 1991 Upper Buford Circle, St. Paul, MN 55108 and [2]Southern Minnesota Beet Sugar Coop., 83550 County Rd 21, Renville, MN 56284. **Sugar beet production following corn, BtRR corn, sweet corn, spring wheat, and soybean in Southern Minnesota.**

Information about the effect of previous crops grown on nitrogen recommendations for optimum sugar beet quality and yield is limited in south central Minnesota. Corn is grown as a previous crop on about 75% of the sugar beet acreage. The next popular previous crop is soybean at 15%. A study was established to determine the effect of previous crops of conventional corn, genetically modified corn for Bt and roundup ready, sweet corn, soybean, and spring wheat on N required for optimum sugar beet yield and quality. This study was conducted at three locations from 2006 to 2008. The previous crops were grown in year one and fertilized using University of Minnesota fertilizer recommendations. Sugar beet was grown in year 2 where each previous crop was grown in year. The previous crop plots were split and six nitrogen rates (0, 33, 67, 101, 134, and 168 kg ha^{-1}) were applied. In 2006 and 2007, root yield and extractable sucrose per acre was affected by the previous crop and nitrogen application. Corn and genetically modified corn had the lowest root yield and extractable sucrose. Spring wheat had the greatest root yield and extractable sucrose per acre in each year. The previous crop did not affect the optimum nitrogen application rate.

OLSSON, ÅSA*, LARS PERSSON and ROBERT OLSSON, NBR (Nordic Beet Research Foundation), Borgeby Slottsväg 11, 237 91 Bjärred, Sweden. **Damage to sugar beet roots caused by harvesters; influence on rots and sugar losses during storage**

Storage of sugar beets with a minimum of sugar losses requires that only undamaged, clean and healthy beets are harvested and put in the piles. The objectives of this study were to determine the influence of beet damages caused by harvesters, on rots and sugar losses during storage in Sweden. Winter temperatures in the south of Sweden are variable and range from -10ºC to + 10ºC. Sugar beets were harvested with two different types of harvesters to create two classes of damaged beets: gently harvested beets and roughly harvested beets. Hand harvested (more or less undamaged beets) were used as control. After harvest, tip breakage, surface damage and cracks were evaluated on approximately 25 roots in each of eight replicates per damage level. For the majority of the gently harvested beets (90%), the diameter of the broken off root tips were less than 2 cm which can be compared to 11% for the roughly harvested beets. The beets were then stored in two temperatures, 5ºC and 15ºC. After storage for 63 days, all roots were evaluated for fungal growth and rots on surface and on root tips. Sugar loss/day was also determined. The results show that provided that the temperature is low during storage, around 5ºC, sugar loss/day are similar for both gently and roughly harvested beets. If the temperature is increased to 15ºC, the sugar loss/day for roughly harvested beets (0.26% sugar/day) is almost triple that of the gently harvested beets (0.10% sugar/day). The root tip was the most sensitive part of the root and wounded tips provided direct entrance for fungal attacks by e. g. Botrytis. Other fungi that were isolated from rotted tissue were *Penicillium*, *Sclerotinia* and *Fusarium* spp.

OVERSTREET, LAURA F.*, NORMAN R. CATTANACH, SARAH GEGNER and DAVID FRANZEN, North Dakota State University, Soil Science Department 7680, P.O. Box 6050, Fargo, ND 58108-6050. **Use of strip tillage in a sugarbeet rotation in the Red River Valley of North Dakota and Minnesota**

Strip tillage was used to produce sugarbeet and sugarbeet rotation crops (corn and soybean) on two soil types in the Red River Valley of the North in 2007 and 2008. The objective of the study was to determine if strip tillage can be modified to create a suitable, cost-effective means of producing sugarbeet and associated rotation crops in this region. A randomized split plot design was employed to test the effect

of strip tillage versus conventional chisel plowing for the three crops being studied plus wheat as a residue crop preceding sugarbeet. Strips were applied and fertilizer was placed in the fall of 2006 and 2007 for the following growing seasons. Wheat, sugarbeet, soybean, and corn were planted in the spring. In 2007, May and June received 50% greater rainfall than average. In 2008, June rainfall was 78% greater than average; September rainfall was 3.3 times greater than average and the first half of October was 3.6 times greater than average. Despite wet conditions of early spring in 2007, there were no significant differences between strip tillage and conventional tillage for tonnage or recoverable sugar per acre. Sugarbeet root yield averaged 29.6 ton/a in strip tillage treatments and 30.0 ton/a for conventional tillage; net sugar averaged 14.5% for both treatments in 2007. In 2008, there was not a significant difference for root yield or recoverable sugar per acre between tillage treatments. Average yield was 27.4 ton/a for strip till and 28.5 ton/a for conventional chisel plow; net sugar averaged 14.4% for strip till and 14.7% for chisel plow in 2008. Corn yield did not differ between locations or tillage treatments in 2007 and averaged 155 bu/a in strip till compared to 160 bu/a in the chisel plow treatment. Average soybean yield in 2007 was significantly different between locations but did not differ between tillage treatments.

SIMS, ALBERT L.[1]*, JOHN A. LAMB[2], MARK W. BREDEHOEFT[3], KIM R. HOFF[1] and CHRIS DUNSMORE[3], [1]Northwest Research and Outreach Center, University of Minnesota, 2900 University Avenue, Crookston, MN 56716, [2]Department of Soil, Water, and Climate, University of Minnesota, 1991 Upper Buford Circle, St. Paul, MN 55108 and [3]Southern Minnesota Beet Sugar Coop., 83550 County Rd. 21, Renville, MN 56284. **Nitrogen mineralized during the Minnesota sugar beet growing season as affected by previous crops.**

In sugar beet, too little N during the growing season reduces root yield and too much N late in the growing season reduces root quality (recoverable sucrose per ton). The impact of crops grown prior to sugar beet on soil mineralized N during the sugar beet growing season needs to be assessed. Two sugar beet experiments were established in Minnesota; the Red River Valley (RRV) near Crookston with corn, soybean, and spring wheat as previous crops, and south central Minnesota (SCM) with BtRRcorn and sweet corn as previous crops. Soil cores plus

anion/cation exchange resin were isolated within acetate liners, placed within the sugar beet plant row, and harvested periodically throughout the growing season. Both were analyzed for inorganic N accumulation, which was assumed to be the result of mineralization. In 2006 in RRV, 34-38 kg N ha^{-1} mineralized following wheat and corn and 56 kg N ha^{-1} following soybean. Following wheat, most N mineralization occurred during the first 6-wks of the growing season, but accumulated throughout the growing season following corn and soybean. In 2007, about 62 kg N ha^{-1} mineralized following wheat and soybean and 18 kg N ha^{-1} following corn; mineralization occurred throughout the growing season following all crops. In 2007 in SCM, approximately 84 and 135 kg N ha^{-1} mineralized during the sugar beet growing season following BtRRcorn and sweet corn, respectively. Most of the mineralized N occurred during the first 6-wks, but mineralization throughout the growing season was apparent.

SIMS, ALBERT L., Northwest Research and Outreach Center, University of Minnesota, 2900 University Avenue, Crookston, MN 56716. **Sugar beet production following wheat, corn, and soybean in the Red River Valley.**

Sugar beet production in the Red River Valley of the North has traditionally followed small grains in the crop rotation sequence. However, in recent years the production of corn and soybean has increased two to five times while small grain production has declined. Currently, recommendations discourage growing sugar beet after soybean, but it is acceptable after spring wheat and corn. Previous research showed a negative effect of corn residue on sugar beet production that was not corrected with additional nitrogen (N). Field experiments were conducted to examine the effects of previous crops of spring wheat, corn, and soybean on sugar beet production. A second objective was to determine if primary tillage (moldboard plow or chisel plow) of the previous crop or N applied to the sugar beet would alter previous crop effects. Regardless of previous crop, primary tillage had no effect on sugar beet production. Nitrogen rates affected sugar beet root yield and quality, but this effect varied with previous crop. Sugar beet root yields were greater following wheat and least following corn. Additional N did not overcome the negative effects of following corn. Soybean as a previous crop had intermediate effects on sugar beet root yield at all N rates. Some N fertilizer was required to maximize sugar beet root quality (recoverable sucrose per ton) following corn and, to a lesser extent, following soybean, but not following wheat. However, excess

N application reduced root quality more following soybean than any other previous crop. Sugar beet performed best following spring wheat. Sugar beet performance after soybean was not as great as following wheat, but was greater than following corn. Growers should still use caution growing sugar beet after soybean because of potential root rot disease issues.

STEVENS, W. BART*, ROBERT G. EVANS, WILLIAM M. IVERSEN and JAY D. JABRO, USDA, Agricultural Research Service, 1500 N. Central Avenue, Sidney MT 59270. **Strip tillage and high-efficiency spray irrigation method in a sugarbeet-malting barley cropping system.**

Strip tillage and high-efficiency spray irrigation methods reduce fuel and water inputs compared to conventional practices, but have not been extensively evaluated in sugarbeet (*Beta vulgaris* L.)-malting barley (*Hordeum vulgare* L.) cropping systems. A field study comparing conventional and strip tillage systems and two sprinkler irrigation methods (mid-elevation spray application, MESA; low-energy precision application, LEPA) was conducted near Sidney, MT from 2004 to 2008. Strip tillage (ST) was performed (for sugarbeet only) using a single operation that left alternating 30-cm wide strips of tilled and untilled soil. Fertilizer was banded 10 cm deep during the tillage operation. Conventional tillage for sugarbeet consisted of six separate operations using different tillage implements, all performed following a broadcast application of fertilizer. Tillage preceding barley consisted of a single pass with a field cultivator following a broadcast application of fertilizer. Sugarbeet grown with ST yielded as well or better than when grown with conventional tillage (CT) in all five years. In two of five years, ST resulted in root sucrose content that was about 5 g kg^{-1} higher than with CT. Irrigation method did not affect sugarbeet yield. Barley yield was not affected by irrigation method but in three of five years was from 5 to 15% lower following ST sugarbeet than when following CT sugarbeet. It was concluded that sugarbeet yield with ST is equal to or better than with CT regardless of irrigation method. Barley was unaffected by irrigation method but yielded an average of 6% less following ST-sugarbeet than following CT-sugarbeet.

WILSON, ROBERT G., University of Nebraska, 4502 Avenue I, Scottsbluff, NE 69361. **When and what herbicides to apply for layby weed control in sugarbeets.**

Field experiments were conducted in 2006 through 2008 to examine the efficacy of S-metolachlor or dimethenamid-P alone and in combination with ethofumesate for late-season weed control in glyphosate-tolerant sugarbeet. All weed control treatments were kept weed-free until the end of June. Beginning in July weeds were allowed to grow so that the residual benefit from herbicides applied from late April through mid June could be evaluated. Weed density was measured in late July and again in late August. Ethofumesate was applied at planting while S-metolachlor and dimethenamid-P were applied at either the 2, 4, 6, or 8 true-leaf sugarbeet growth stage. Late-season weed suppression from both S-metolachlor and dimethenamid-P benefitted from an application of ethofumesate at planting. Applying S-metolachlor or dimethenamid at the 6 to 8 true-leaf growth stage provided better late-season weed control than earlier applications.

SECTIONS B & E
PHYSIOLOGY, BIOTECHNOLOGY, GENETICS AND GERMPLASM
ORAL PRESENTATIONS

FUGATE, KAREN KLOTZ* and ABBAS M. LAFTA, USDA-ARS, Northern Crop Science Laboratory, 1307 - 18th Street North, Fargo, ND 58105. **What controls respiration rate in stored sugarbeet roots?**

Although respiration is estimated to be responsible for 60 to 80% of the sucrose lost during storage, the mechanisms by which sugarbeet roots regulate their respiration rate are unknown. In plants, respiration rate is regulated by (1) available respiratory capacity, (2) cellular energy status, (3) or the availability of respiratory substrates. Previous research found no relationship between respiration rate, respiratory capacity (due to the combined capacity of the terminal oxidases of the electron transport pathway), and cellular energy status (measured as the ratio of ATP to ADP) in roots whose respiration rate was altered by abiotic stresses, suggesting that sugarbeet root respiration rate is not regulated by respiratory capacity or cellular energy status. Determination of tissue respiration rates in response to potential effectors of respiration demonstrated that respiratory capacity was 2.4-fold greater than that utilized by respiring root tissues and that respiration rate did not increase when respiration was uncoupled from energy production or when cellular ATP or ADP concentrations were altered. These results support the hypothesis that respiratory capacity and cellular energy status do not regulate sugarbeet root respiration and imply that sugarbeet root respiration is likely to be regulated by the availability of respiratory substrates. Respiratory substrates in sugarbeet root are synthesized from sucrose by the action of sucrose-degrading enzymes and the enzymes of glycolysis, the oxidative pentose phosphate pathway and the tricarboxylic acid cycle. To identify possible restrictions in these pathways that may limit the availability of respiratory substrates, compounds that are substrates, intermediates or cofactors of these pathways were profiled in roots whose respiration was altered by abiotic stresses.

GIELEN, JAN[1], ELISABETH WREMERTH-WEICH[2], PIERRE PIN[2], PETRA VAN ROGGEN[2], THOMAS KRAFT[2]*, KARSTEN HARMS[3] and GERHARD STEINRUCKEN[2], [1]Syngenta Seeds, P.O. Box 27, 31790 Saint-Sauveur, France, [2]Syngenta Seeds, P.O. Box 302, 261 23 Landskrona, Sweden, [3]Südzucker Mannheim/Ochsenfurt, ZAFES,

Wormser Straße 11, 67283 Obbrigheim/Pfalz, Germany. **Bolting control in sugar beet.**

Sugar beet (*Beta vulgaris*) is a biennial crop species that is essentially grown for the production of white sugar. One of the key parameters in the breeding of sugar beet concerns the susceptibility to vernalization and subsequent bolting. Apart from the apparent change in plant morphology, the source-sink status in bolting plants has shifted thereby preventing the accumulation of sucrose in the taproot and thus causing substantial losses. Resistance to bolting is a polygenic or quantitative trait, subject to environmental conditions including temperature and day length, and therefore difficult and time-consuming to assess for breeders. Consequently, the use of molecular markers for bolting resistance may substantially facilitate the breeding process. Based on the current understanding of the flowering-time control in *Arabidopsis thaliana*, the combination of forward and reverse genetics allowed for the partial dissection of the bolting response in sugar beet and has resulted in the identification of QTLs and candidate genes for marker development. In addition to marker applications, the dissection of the flowering time control in both sugar beet and *Arabidopsis* opened avenues for engineering bolting resistance in sugar beet. By suppressing the vernalization response the growing season of sugar beet may be prolonged which is predicted to increase yield. Ideally, the growing practice of sugar beet would shift from a spring into a winter crop leading to substantial gains in the profitability of the sugar beet crop and its competitive position with respect to sugar cane. One obvious candidate gene for engineering bolting resistance in a biennial crop like sugar beet is FLC. Constitutive expression of the FLC gene from *Arabidopsis* delivered substantial delays in bolting depending on the phenotypic screens applied, but did not overrule the vernalization response under simulated field conditions in the greenhouse. Data obtained on FLC and other genes for bolting control will be presented and discussed.

JANSSEN, GEERT[1]*, ROY MARTENS[2], REBECCA LARSON[2], MARIA NIHLGARD[1] and THOMAS KRAFT[1], [1]Syngenta Seeds, P.O. Box 302, 261 23 Landskrona, Sweden and [2]Syngenta Seeds, 1020 Sugarmill Road, Longmont, CO 80501. **Acceleration of *Rhizoctonia* resistance breeding.**

Rhizoctonia solani Kühn is one of the major sugar beet diseases and can cause severe yield losses due to root rot. Partial genetic resistance (tolerance) has been identified and is available in commercial varieties for effective control of the disease. Syngenta Seeds has developed

several different molecular mapping populations to study the genetic inheritance of the disease resistance through a combination of phenotypic characterization and detailed genetic analysis. Phenotyping of relative resistance was performed using field observations performed in Longmont, Colorado, using artificial inoculation of the disease to obtain a severe and homogeneous infection level. Genetic analysis has revealed the presence of various quantitative trait loci (QTL's) spread over different linkage groups. QTL's were only partially overlapping between populations and years, indicating the complexity of the inheritance as well as confounding influence based on environmental variation. Molecular markers have been identified and implemented into the *Rhizoctonia* resistance programs within Syngenta Seeds to accelerate the breeding efforts towards higher yielding varieties maintaining the highest resistance levels possible.

KOZAK, ROBERT[1]* and CRAIG S. LAUFER[1,2], [1]Atlantic Biomass Conversions, 507 N. Bentz Street, Frederick, MD 21701 and [2]Hood College, Dept. of Biology, Frederick, MD 21701. **Addition of a thermostabilized pectin methylesterase significantly enhances the rate of saccharification of sugar beet pulp by the commercial pectinase preparation Pectinex® Ultra SPL.**

The first stage in the production of cellulosic biofuels is the release of sugars from the biomass. Sugar beet pulp (SBP) offers a potential source of sugars provided they can be released within the parameters of the sucrose production campaign. For SBP it will be advantageous to utilize the diffuser processing temperature to speed up the enzymatic degradation. We have engineered thermostabilizing mutations into the *Pectobacterium chrysanthemi* pectin methylesterase (PME). A version with four amino acid substitutions raised the stability over the wild-type by close to 12 C to 62 C. In addition to contributing to temperature stability, three of the four mutations resulted in minor improvements in the enzyme's catalytic constant (kcat). The initial velocities catalyzed by the wild-type and thermostabilized enzymes are comparable at the temperature optimum (50 C) of the wild-type enzyme. However, at 60 C the initial velocities are approximately 140% of those of the wild-type at its optimum temperature. Pectinex® Ultra SPL (Novozymes) is a mixture of enzymes derived from *Aspergillus aculeatus*. With the addition of our engineered PME to the Pectinex®, and without further chemical or heating pre-treatments, we solubolized approximately 50-60% of the theoretically available sugars. This included over 90% of the arabinose and galacturonic acid. Further, at 55 C the rate of sugar production

from beet pulp was approximately 50% greater in the PME-added vs Pectinex® alone. These results provide a pathway to the development of a low capital process that can be integrated into existing sugar beet processing facilities.

McGRATH, J. MITCHELL*, LINDA HANSON and RACHEL NAEGELE[1], USDA-ARS, Sugarbeet and Bean Research Unit, and [1]Plant Breeding and Genetics Program; Department of Crop and Soil Sciences, 494 Plant and Soil Sciences Building, Michigan State University, East Lansing, MI 48824-1325. **Breeding perspectives and programs at East Lansing.**

USDA-ARS sugar beet breeding activities at East Lansing reach back to the 1940's, with activities of Michigan State University reaching back to circa 1911. Many of those contributions are well known in the sugar beet breeding community, and this talk will serve to update this community on the current breeding at East Lansing. The overall goal is to produce germplasm enhanced in one or more traits for release to the seed industry for ultimate incorporation into modern hybrids. Along this trajectory, germplasm is being developed for genetic analyses of traits important to the Great Lakes and Eastern U.S. growing regions. Two broad breeding methods are being deployed, each with multiple components. Open pollinated methods are being used to recombine existing germplasm releases to effect genetic progress through selection in the Eastern agro-environment. Selfing is being employed to create inbreds for genetic analyses. Both sets of germplasm result in populations as one of the three essential legs for modern sugar beet breeding. The other two legs, phenotyping and markers, are also being developed. The relative efforts applied to these three legs needs to be balanced against available resources.

NAEGELE, RACHEL P.[1] and J. MITCHELL MCGRATH[2]*, [1]Plant Breeding and Genetics Program, Michigan State University and [2]USDA-ARS, SBRU, 494 PSSB, Michigan State University, East Lansing, MI 48824-1325. **Seedling vigor in Beta vulgaris: The artistry of germination.**

Emergence and stand establishment through the first 10 weeks after planting continue to be primary concerns of sugar beet growers. Our goal is to understand the genes and genetics of seedling vigor in order to overcome beet's inherent disadvantages of small seed size and encap-

sulation in a corky fruit. Vigor is defined here as the ability of seedlings to tolerate adverse environments. Previous work showed an apparent induction of vigor via hydrogen peroxide that results in mobilization of stored lipid reserves for heterotrophic growth in good emergers. That work only examined 4-day old seedlings that had erupted from the seedball. Events that contribute to this vigor certain precede this stage of growth, while the germinating seed is still encapsulated. In this work we seek to examine these early events via a number of methods in order to define critical transitions between physiological stages of dormant seed, imbibition, resumption of biochemical activity, and growth. Problems of accessing the true seed within the intact seedball needed to be surmounted prior to analyses of physiological stages, and a simple method was developed. Using this and similar methods, the activity of specific genes was measured via quantitative PCR, including hormone responsive and signal transduction candidates. Results show that marked changes occur during the development of the seedling prior to germination.

PANELLA, LEE[1]*, LANA WHEELER[2] and MARY McCLINTOCK[1], [1]USDA-ARS, Sugarbeet Research Unit, 1701 Centre Avenue, Fort Collins, CO 80526 and [2]USDA-ARS, National Center for Genetic Resources Preservation, 1111 South Mason Street, Fort Collins, CO 80521. **Long-term survival of cryopreserved sugarbeet pollen.**

R. J. Hecker and coworkers demonstrated that sugarbeet (Beta vulgaris L.) pollen could be stored in liquid nitrogen vapor phase (-160°C) (LN) for 1 yr and remain viable. In this study we demonstrate that similar pollen, stored for 17 years in LN was able to successfully pollinate sugarbeet and produce viable seed. There were significant differences in the moisture contents of the stored and fresh pollen, but two viability staining tests showed no significant differences between stored and fresh pollen, and differences in pollen tube germination were small. Long-term storage of pollen provides opportunities for many uses both in sugarbeet genetic resources preservation and plant breeding (which have considerable overlap). In a heterozygous crop such as sugarbeet, collected pollen would be a way to preserve superior, individual genotypes. Pollen from high value inbred parental lines needed for recurrent backcrossing could be preserved. This would have applied plant breeding applications and be useful in developing populations to facilitate genetic analyses. Collection and storage of pollen could be a way to obtain a more representative sample of the genetic diversity in wild populations. With restrictions on the international transport of seed

becoming increasingly stringent, pollen could be an alternate way to distribute genetic resources or cultivated beet germplasm internationally.

SMIGOCKI, ANN C.[1]*, SNEZANA D. IVIC-HAYMES[1], SABINA ZUZGA[2] and JELENA SAVIC[3], [1]USDA-ARS, Molecular Plant Pathology Laboratory, 10300 Baltimore Avenue, Beltsville, MD 20705, [2]Polish Academy of Sciences, Warsaw, Poland and [3]Institute for Biological Research "Siniša Stanković", Department of Plant Physiology, Belgrade, Serbia. **Insect resistance to sugar beet pests mediated by a Beta vulgaris proteinase inhibitor transgene.**

Assimilation of dietary proteins is critical to insect survival; therefore, inhibition of digestive proteolytic enzymes is an effective insect control strategy. To specifically target serine classes of digestive proteases associated with several insect pests of sugar beet, we cloned a Beta vulgaris root gene (BvSTI) that codes for a serine (trypsin) proteinase inhibitor. BvSTI is a root gene transcript profiled from sugar beet with moderate resistance to the root maggot (Tetanops myopaeformis). Root maggot damage deforms roots and predisposes them to pathogen diseases that reduce yield and quality. To determine the functional role of BvSTI in insect resistance, we over-expressed the gene in sugar beet hairy roots and Nicotiana benthamiana plants. Transformants had high levels of BvSTI gene transcripts driven by the constitutive 35S promoter. Clear zones corresponding to proteinase inhibitor (PI) activities were observed at ~24, 26 and 28 kDa on PAGE zymograms. Western blot analysis using BvSTI polyclonal antibodies revealed one major protein of approximately 26 kDa. Because the root maggot cannot be reared in vitro, we chose several other insect pests of sugar beet and tobacco to bioassay the BvSTI-transgenic plant materials. Spodoptera frugiperda (fall armyworm), Spodoptera exigua (beet armyworm), Manduca sexta (tobacco hornworm) and Heliothis virescens (tobacco budworm) larvae that ingested tobacco leaves or sugar beet roots containing the recombinant BvSTI protein exhibited higher mortality or were delayed in growth and development relative to control larvae. Since serine proteases comprise the major digestive enzymes in root maggot midguts, we speculate based on our findings that the BvSTI gene is involved in root maggot resistance mechanisms.

WINTERMANTEL, W. M.[1]*, A. GULATI-SAKHUJA[1], R. L. LARSON[2], L. L. HLADKY[1], A. NUNEZ[3] and A. HILL[4], [1]USDA-ARS, 1636 East Alisal Street, Salinas, CA 93905, [2]Syngenta Seeds, 1020 Sugarmill

Road, Longmont, CO 80501, [3]USDA-ARS-ERRC, 600 East Mermaid Lane, Wyndmoor, PA 19038 and [4]USDA-ARS, 1701 Centre Avenue, Fort Collins, CO 80526. **Proteome changes in sugarbeet in response to *Beet necrotic yellow vein virus* infection.**

Rhizomania, caused by *Beet necrotic yellow vein virus* (BNYVV), is characterized by excessive growth of lateral roots and constriction of the taproot, resulting in decreased sugar yield. There are limited sources of resistance against the virus and resistance-breaking isolates are becoming increasingly problematic worldwide. Developing more effective disease control strategies starts with gaining a better understanding of the basis for resistance and the mechanism of disease. Multidimensional liquid chromatography was employed to examine proteins differentially expressed in nearly isogenic lines of sugar beet either resistant or susceptible to BNYVV infection. More than 1,000 protein peaks were reproducibly detected in the root extracts from each treatment. Differential protein expression in response to viral inoculation was determined by comparing healthy and BNYVV-challenged chromatogram protein profiles for each sugarbeet genotype. Protein expression was temporally regulated, and in total, 7.4 and 11% of the detected proteome was affected by BNYVV-challenge in the resistant and susceptible genotypes, respectively. Sixty-five of the proteins induced or repressed by the virus were identified by tandem MALDI-TOF mass spectrometry and expression of key defense- and disease-related proteins was further verified using qualitative reverse transcriptase polymerase chain reaction. Results suggest involvement of classic systemic resistance components in *Rz*1-mediated resistance and phytohormones in hairy root symptom development. Follow-up studies seek to identify key virus-sugarbeet protein interactions driving infection and symptom development, and to utilize this information to develop novel methods for rhizomania resistance.

WINTERMANTEL, WILLIAM M.* and LAURA L. HLADKY, USDA-ARS, 1636 East Alisal Street, Salinas, CA 93905. **Resistance to curly top viruses through virus induced gene silencing.**

Curly top disease, caused by viruses of the genus Curtovirus, and transmitted by the beet leafhopper (*Circulifer tenellus*), has resulted in losses for western U.S. agriculture for over a century. No control methods have been developed that economically, effectively and reliably prevent losses in tomato, sugarbeet and many other crops, and sources of host resistance are incomplete and difficult to transfer among cultivars. In order to provide more reliable control in a wider array of hosts, we are

developing methods to engender resistance to the two primary curtovirus species in the United States. Partial replication gene (C1) sequences of *Beet severe curly top virus* (BSCTV) and *Beet mild curly top virus* (BMCTV) were inserted into a *Tobacco rattle virus* (TRV)-based vector to test the effectiveness of the sequences in suppressing infection of BSCTV and BMCTV through virus-induced gene silencing (VIGS). TRV containing curtovirus VIGS-inducer constructs were agroinoculated into *Nicotiana benthamiana* seedlings. BSCTV and BMCTV were inoculated separately at various time points following treatment with TRV/VIGS inducers. Test plants were monitored for the development of curly top symptoms over time and scored for disease severity, plant weight and virus concentration. Results with two silencing constructs delayed and reduced curly top symptom development in infected plants and decreased virus concentration compared to plants not treated with silencing constructs. Confirmation of control is in progress through plant transformation with optimized constructs. Continuing studies are examining application of these constructs for large-scale induction of resistance to curtoviruses in the absence of plant transformation.

SECTIONS B & E
PHYSIOLOGY, BIOTECHNOLOGY, GENETICS AND GERMPLASM
POSTER PRESENTATIONS

EUJAYL, IMAD A.[1]*, IVAN SIMKO[2] and CARL A. STRAUSBAUGH[1], [1]USDA-ARS, NWISRL, 3793 North 3600 East, Kimberly, ID 83341 and [2]USDA-ARS, Crop Improvement and Protection Unit, 1636 E. Alisal Street, Salinas, CA 93905. **Association Analysis of Beet Curly Top Disease Resistance Genes in Sugarbeet.**

Association mapping is a novel approach to overcome common bi-parental genetic linkage mapping limitations. This linkage-disequilibrium based approach was successfully applied in other crops, thus allowing for detection of markers linked to genes of resistance. The objectives of this study were to analyze population structure (estimate K) of a large collection of experimental and commercial varieties from six seed companies and elite germplasm from USDA-ARS, and to use this population to identify markers associated with resistance to curly top. A pool of 168 diploid hybrids and germplasm were genotyped with 39 polymorphic SNP and 30 SSR markers and phenotyped for curly top reaction in the field and the greenhouse for two seasons. To compare performance of the two marker systems, the population structure analysis was performed on a subset of 62 genotypes that were analyzed with both SSR and SNP makers. The estimated number of subpopulations was affected by marker system, and varied from K=2 to 4. Analysis of population structure based on *K*=3 indicated clustering of varieties from Betaseed and American Crystal, while varieties from Hilleshog and Seedex formed a different cluster. Varieties from Holly Hybrids were distinctly separated from other clusters with a notable exception of accession HH06. Analysis of the complete population of 168 accessions, confirmed clustering detected on a subset of individuals. The USDA-ARS germplasm showed similarity to the Hilleshog – Seedex cluster, while a population from KWS clustered separately. The association analysis revealed several genomic regions associated to the disease reaction and putative alleles associated with SNP markers located on chromosomes 2, 5, 7, and 9.

FENWICK, ANN[1], REBECCA L. LARSON[2], PATRICK A. REEVES[3], AMY L. HILL[1] and LEE PANELLA[1]*, [1]USDA-ARS, Sugarbeet Research Unit, 1701 Centre Avenue, Fort Collins, CO 80526, [2]Syngenta

Seeds, Inc., 1020 Sugar Mill Road, Longmont, CO 80501 and [3]USDA-ARS, National Center for Genetic Resources Preservation, 1111 South Mason Street, Fort Collins, CO 80521. **Efficacy of *Barley stripe mosaic virus* to induce gene silencing of a gene repressing flowering in sugar beet.**

Exposure to a prolonged cold period during winter is necessary to induce flowering in the following spring for many biennial plants – a process termed vernalization. This 3 to 4 month period of vernalization is a major limitation in producing multiple generations annually in breeding sugar beet. *BvFL1*, a vernalization gene in sugar beet, has been shown to be a repressor of flowering that is downregulated in response to cold. With the virus induced gene silencing system using *Barley stripe mosaic virus* (BSMV), a construct was designed that would target all four alleles of *BvFl1*. The virus was passaged through quinoa (*Chenopodium quinoa*), which is a local lesion host, to confirm infectivity. The quinoa leaves with lesions were ground and applied to sugar beet leaves from plants at different growth stages. Plants were grown in 24 hr light at 20°C to eliminate photoperiod effects. Presence of the virus in sugar beet leaves was confirmed by RT PCR, however, sugar beet plants that had infected leaves did not flower. The RNA from the infected leaves was analyzed using real time (qRT) PCR to monitor expression levels of *BvFl1*.

HU, JINGUO* and BARBARA HELLIER, US Department of Agriculture, Agriculture Research Service, Western Regional Plant Introduction Station, Washington State University, Pullman, WA 99164. **Sugar beet germplasm collection in the National Plant Germplasm System.**

The National Plant Germplasm System (NPGS) holds more than 500,000 accessions of crop plant and related species that are being maintained, characterized, regenerated and distributed by four major Plant Introduction Stations and an additional 21 special clonal and seed germplasm repositories. The Western Regional Plant Introduction Station (WRPIS) is responsible for managing approximately 80,000 accessions including the collection of sugar beet and related species. As of October 20, 2008, there were 2,525 accessions with 2,336 belonging to *Beta vulgaris* (29), *B. vulgaris* subsp. *vulgaris* (1,726) and *B. vulgaris* subsp. *maritima* (571). The remaining 199 accessions belong to a dozen species with the number of accessions in each species varing from one to 48. The whole collection is maintained in seed form in Pullman, WA and 1,926 accessions are backed up at the National Center for Genetic

Resources Preservation in Fort Collins, CO. The data associated with each accession are stored in the Germplasm Resource Information Network (GRIN) database which can be accessed worldwide through the Internet for browsing the data or ordering seed samples. The purposes of maintaining the collection include preserving viable seeds harboring genetic diversity of Beta species, collecting information on biological and agronomic characteristics and finally, supplying seed samples to the sugar beet research community for genetic improvement of the crop. During regeneration great emphasis has been put on retaining the genetic integrity of the original seed samples. Together with our collaborators, we have collected and entered into GRIN 28,903 descriptor and evaluation records. We have distributed 6,050 seed samples to requesters worldwide with 5,119 to addresses in USA and 931 outside the USA since 1996. WRPIS welcomes suggestions, support, and collaborative efforts to achieve our goal of maintaining a healthy and available sugar beet germplasm collection.

KUYKENDALL, L. DAVID*, JONATHAN SHAO, KATE BURDEKIN and TATSIANA KURUSHKO, Molecular Plant Pathology Laboratory, USDA-ARS, 10300 Baltimore Avenue, Beltsville, MD 20705. **Molecular genetics and genomics of effective pathogen response in *B. vulgaris L.***

Cercospora-induced leaf spot disease, or CLS, a serious problem for sugar beet farmers, can cause as much as a 40% reduction in sugar yield. Unlike CLS, *Erwinia betavasculorum* does not cause significant damage to a resistant genotype, C69 for example. First, we completely annotated a Bacterial Artificial Chromosome (BAC) carrying a key disease resistance control gene, *NPR1*. Comparative genomics and functional analysis led to the discovery of an evolutionarily conserved microsyntenic cluster of core genes *HSF, NPR1, CaMP* and *CK1PK* in poplar, tomato, grapes, *Medicago truncatula* and *Beta vulgaris*. *CaMP* gene encodes a chloroplast-targeted, signal peptide-led, calmodulin-binding protein whose RNA transcript was found to be enriched by either abiotic or biotic stress. Protein products of *NPR1* (pathogen response), *HSF* (heat shock factor) and CK1PK (casein kinase 1-class protein kinase), localized in the nucleus, serve to promote expression of genes controlling either pathogen defense, embryogenesis or partitioning of chromosomes between daughter cells, respectively. Highly conserved clustering of orthologous genes (COG) in five diverse eudicot species likely reflects positive selection for coordinating expression of genes whose products are necessary in managing biotic and other environmental stresses. Increasing understanding of molecular mechanisms underlying effec-

tive, genetically-programmed response to pathogens will be helpful to plant molecular geneticists for extension and realization of the plant genome's full potential for effectively resisting microbial invasion.

LAFTA, ABBAS M. and KAREN KLOTZ FUGATE*, USDA-ARS, Northern Crop Science Laboratory, 1307 - 18th Street North, Fargo, ND 58105. **Dehydration accelerates root respiration and impacts sugarbeet raffinose metabolism.**

Sugarbeet roots lose water during storage and often become severely dehydrated after prolonged storage and at the outer portions of piles which have greater wind and sun exposure. Sucrose loss is known to be elevated in dehydrated roots, although the metabolic processes responsible for this loss are unknown. To identify processes that contribute to sucrose loss in dehydrated roots, respiration rate and raffinose oligosaccharides (raffinose and stachyose) and their precursors (*myo*-inositol and galactinol) were determined in sugarbeet roots during four weeks of 10°C storage at high (85%) and low (40%) relative humidities. Roots stored at 40% relative humidity dehydrated significantly and their respiration rate was accelerated during 28 days of storage. The increase in root respiration during storage at low relative humidity was closely associated with weight loss. Raffinose concentrations increased significantly during storage at high relative humidity but decreased in dehydrated roots. There was an increase in *myo*-inositol and a decrease in galactinol levels during storage at both high and low relative humidity. A slight decrease in stachyose level was found in stored roots. The observed decrease in raffinose levels in dehydrated roots could be due to its degradation to melibiose and myo-inositol, as they increased in dehydrated roots. The results suggest that low storage relative humidity can alter the postharvest physiology of sugarbeet roots by increasing weight loss, accelerating root respiration rate, and influencing raffinose metabolism. Roots also became soft and visibly wilted upon dehydration, which could affect root processing and sucrose yield.

LARSON, REBECCA L.[1], MARY E. MCCLINTOCK[2], ROBERT A. CRAMER[3], AMY L. HILL[2], ANN FENWICK[2], PATRICK A. REEVES[4], KIMBERLY M. WEBB[2]* and LEE PANELLA[2], [1]Syngenta Seeds, Inc., 1020 Sugar Mill Road, Longmont, CO 80501, [2]USDA-ARS, Sugarbeet Research Unit, 1701 Centre Avenue, Fort Collins, CO 80526, [3]Montana State University, Bozeman, MT 59717 and [4]USDA-ARS, National Center for Genetic Resources Preservation, 1111 South Mason Street,

Fort Collins, CO 80521. **Differential sugar beet gene expression during the defense response to challenge by *Cercospora beticola.***

Cercospora leaf spot (CLS), caused by the fungus *Cercospora beticola* Sacc., is a widespread foliar disease of sugar beet that causes reduced sugar and root yield. It can become a problem in many production areas in the U.S. and world-wide. The study of host resistance is important for the understanding of host-pathogen interaction, the development of more effective disease control strategies, and ultimately marker assisted selection utilizing implicated defense response genes. In the current study, a modified suppressive subtractive hybridization (SSH) was utilized to identify host plant genes involved in the defense response of sugar beet resistant to CLS. A CLS-resistant sugar beet germplasm, (FC504CMS X FC502/2)] X SP6322-0 (LSR), was inoculated with *C. beticola* or mock inoculated, RNA extracted and a subtracted library created for the identification of highly expressed and low abundance defense related genes. Semi-quantitative reverse transcriptase polymerase chain reaction (RT-PCR) was then used to quantify and verify expression level over time, after challenge by *C. beticola*, of a few potential defense related genes identified from the subtractive library. RNA was extracted from mock inoculated and *C. beticola* inoculated susceptible (FC403) and resistant (LSR) sugar beet plants at 0 h, 48 h, 72 h, and 5 day. Expression of CP5, GST, SOD, P450, PR-10, and UVB were quantified over the time course. ANOVA analysis shows significant expression differences between resistant and susceptible cultivars for some of the selected genes.

TAKAHASHI, HIROYUKI[1]*, YOSHIYA SHIMAMOTO[2], KAZUYUKI OKAZAKI[1], KAZUNORI TAGUCHI[1], YOSUKE KURODA[1] and HIDEYUKI ABE[1], [1]National Agricultural Research Center for Hokkaido Region, Shinsei Memuro Hokkaido 082-0081 Japan and [2]Tokyo University of Agriculture, Yasaka Abashiri Hokkaido 099-2493 Japan. **Flow distance and crossing ability of dispersed pollen in sugar beet.**

Sugar beet is wind-pollination plants, and when different pollen parents are used for seeds production, it is necessary to isolate between each seeds production fields. It needs 2km isolation distance to avoid cross contamination in Japan, but there is not so much data that proves it. Then, in this study, the pollen dispersal characteristic and the crossing rate were investigated. Dispersed pollen was measured using Durham pollen samplers, which set from the pollen source in several isolation distances (0m, 20m, 50m 100, 460m, 840m, 1220m, 1555m). And CMS

plants were planted in the same isolation distance to observe crossing rate with the dispersed pollen from the pollen source was investigated. Dispersed pollen was observed up to 1555m, and very small amount F1 seed which considered that pollinated with dispersal pollen was observed in 1555m. From the result showed that fertile pollen of sugar beet dispersed at least 1500m. However, it is thought that the isolation distance can be shortened a little more, because this trial was carried out under the condition there existed no competing pollen, and the shield of the windbreaker etc. is arranged in actual seed production field.

SECTION C – ENTOMOLOGY AND PLANT PATHOLOGY ORAL PRESENTATIONS

ACOSTA-LEAL, RODOLFO*, BECKY K. BRYAN and CHARLES M. RUSH, Texas AgriLife Research (Texas A&M University System), Amarillo, TX 79106. **Generation and dispersion of resistance breaking variants of *Beet necrotic yellow vein virus* in the field.**

A few years after the deployment of commercial sugarbeet varieties encoding the *Rz*1 allele, which confers partial dominant resistance to BNYVV infection, the emergence of resistant breaking variants of BNYVV was verified in the Imperial Valley of California. Preliminary data suggest that breakdown of *Rz*l-mediated resistance is also occurring in other production regions of North America. Genetic sequencing of the viral RNA 3, encoding the pathogenic determinant p25 gene, revealed a strong correlation between its amino acid motifs and type of plant virus interaction (i.e., in this case, compatible = disease and incompatible = asymptomatic infection) in the Imperial Valley pathosystem. Thus, most plants from yellow spots in the field and with severe symptoms of rhizomania were infected by virus haplotypes encoding the VLE p25 motif. By contrast, most asymptomatic plants outside the yellow spots were infected by virus haplotypes encoding the ALD or less frequently by the nationwide wild type ACD motifs. This specific evolutionary trajectory of BNYVV from wild type to resistance breaking genotypes (i.e., from ACD to ALD to VLD to VLE) apparently occurred only under the Imperial Valley conditions. Symptomatic and asymptomatic root samples from Minnesota were indistinctly infected by ACD and/or AHD p25 motifs. Therefore, an alternative evolutionary trajectory of BNYVV to overcome *Rz*l might have taken place under the conditions of Minnesota. To test this hypothesis, sequencing other regions of the virus genome is in process.

ACOSTA-LEAL, RODOLFO*, BECKY K. BRYAN and CHARLES M. RUSH, Texas AgriLife Research (Texas A&M University System), Amarillo, TX 79106. **In search of predictors of sugarbeet resistance durability to *Beet necrotic yellow vein virus*.**

A natural trend of pathogens is to evolve into new forms that allow them to overcome host resistance. The relatively recent emergence of resistance breaking strains of *Beet necrotic yellow vein virus* (BNYVV) in the USA offers the opportunity to understand this event at the eco-

logical and molecular levels. We have monitored the genetic response of an original wild type BNYVV strain to different host constraints. Analyses of field and greenhouse samples indicate that virus populations infecting susceptible cultivars were composed of a predominant master haplotype immersed in a background of haplotypes exhibiting minimal nucleotide diversity (π = 0.0006 to 0.0017, for greenhouse and field samples, respectively). The same master haplotype and populational genetic structure was found in every field isolate collected from susceptible plants in North America since 1991. Surprisingly, this highly stable virus population structure dramatically changed during passage through resistant sugarbeet cultivars. In plants carrying the Rz1 resistant allele, most virus populations contained two master haplotypes and were highly heterogeneous (π = 0.0010 to 0.0036). Furthermore, deviation from the wild type BNYVV was even more dramatic in plants with *Rz*2-mediated resistance (π = 0.0015 to 0.0038). In this case, every single plant was infected by a different master haplotype, which gave place to virus genomes with two or more mutations. Because many of the mutant virus genomes generated in resistant plants might be nonviable, vector transmissibility, genetic composition of vector-acquired populations, and changes of virus fitness after passage through resistant plants are under analyses.

BOETEL, MARK A.[1], AYANAVA MAJUMDAR[2]*, ROBERT J. DREGSETH[1] and ALLEN J. SCHROEDER[1], [1]Department of Entomology, North Dakota State University, Dept. 7650, P.O. Box 6050, Fargo, ND 58108 and [2]Gulf Coast Research and Extension Center, Alabama Extension Service, Fairhope, AL 36532. **Seed treatment insecticides for managing soil insect pests of sugarbeet .**

North American sugarbeet fields are often at risk of infestation by one or more soil-dwelling insect pests that can cause major yield losses. Granular and liquid insecticide formulations have been used to manage soil insect pests for decades. Insecticidal seed treatments, if efficacious against these pests, would be attractive control alternatives because they are simple and relatively safe to deploy. Four years of field trials (2004 to 2007) were carried out to compare experimental seed treatments and conventional insecticides for efficacy against the following: 1) sugarbeet root maggot (SBRM), *Tetanops myopaeformis* Röder; 2) wireworms (*Limonius* spp.); and 3) subterranean springtails (Collembola). Poncho (clothianidin) + cyfluthrin at 60:16 g active ingredient (a.i.) per unit (100,000 seeds) provided similar levels of SBRM control to the conventional insecticide (terbufos 15G applied at 2 kg a.i./ha]). Excellent wire-

worm control was provided by Poncho+betacyfluthrin (60:8 g a.i./unit seed), Cruiser 5FS (thiamethoxam; 60 g a.i./unit), and terbufos 15G (1.7 kg a.i./ha). Springtail trials demonstrated that seed treatments (V-10170, V-10170+danitol, and Poncho+betacyfluthrin) were comparable in performance to low and moderate rates (1 to 1.7 kg a.i./ha) of terbufos 15G. Seed treatments appear to be less likely than conventional insecticides to cause phytotoxicity and associated yield losses. The experimental seed treatments we evaluated are likely to provide similar efficacy as moderate rates of currently labeled conventional soil insecticides for controlling SBRM, wireworms, and subterranean springtails; however, they should not be relied on as the sole control tactic in areas heavily infested by SBRM.

CATTANACH, ALLAN[1]*, JEFF DANIELS[2], MARK A. BOETEL[3] and ROBERT J. DREGSETH[3], [1]American Crystal Sugar Company, 101 North Third Street, Moorhead, MN 56560, [2]Bayer CropScience, 5421 Boulder Drive, West Des Moines, IA 50266 and [3]Department of Entomology, North Dakota State University, 1300 Albrecht Boulevard, Fargo, ND 58105. **Strip trial evaluation of Poncho Beta insecticide in the RRV.**

The sugarbeet root maggot (SBRM), Tetanops myopaeformis, is the most serious insect pest of sugarbeet in the Red River Valley. Comparisons of Poncho Beta (clothianidan + beta-cyfluthrin) to other commonly used insecticide treatments for control of the SBRM and other insect pests were conducted at nine locations during 2008. The Poncho Beta insecticide was applied by GTG Inc. at 60 g a.i. clothianidin and 8 g a.i. beta cyfluthrin per 100,000 seeds. Stand counts after 100 % emergence indicated no phytotoxicity from Poncho Beta insecticide with stands equal to Mustang Max treatments and properly applied granular insecticides. Improved stand establishment was observed if granular insecticides were improperly applied. SBRM ratings were always reduced with Poncho Beta (RI = 2.5) compared to the untreated control (RI = 3.1). Damage ratings at locations with high SBRM infestations were not as effectively reduced as ratings with granular insecticide at maximum label rates. Under severe SBRM pressure a second application of insecticide near peak fly activity must be used to prevent yield loss. Poncho Beta has been determined to be comparable to 8 to 10 lbs per acre of Counter in North Dakota State University trials. Yield with Poncho-B was equal to or greater than yields with other insecticides at locations with low to moderate SBRM pressure. Poncho Beta followed by an application of Lorsban 4E resulted in the highest

recoverable sugar per acre at one location with severe SBRM pressure. Yield data was not available from all locations at the time of preparation of this abstract. Poncho Beta gave very good control of springtails at two locations with that insect present. Wireworm control was observed to be very good and similar to Mustang Max and Counter insecticides. Impact of Poncho Beta on storage is being evaluated.

CHRIST, DANIELA and MARK VARRELMANN*, Institute of Sugar Beet Research, Department of Phytopathology, Holtenser Landstr. 77, 37079 Göttingen, Germany. **Occurrence of different Fusarium species in sugar beet.**

Phytopathological studies in the United States have revealed an infection of sugar beet with different *Fusarium* species also pathogenic to wheat and related to Fusarium Head Blight (FHB). For Europe this relationship between the *Fusarium* infection of wheat and sugar beet has not been described yet. However, in a German field survey comparison of mycotoxin content of wheat from different rotations with different precrops (rapeseed, maize and sugar beet) resulted in elevated mycotoxin contents also when sugar beet was grown as a precrop. Based on two field trials with winter wheat – sugar beet crop rotations in Germany (Lower Saxony) in 2006/07 we isolated different *Fusarium* specs. from sugar beet. The isolates were identified based on morphological criteria and EF1_-PCR-RFLP. F. *redolens* was the most frequently isolated species from freshly harvested beets. During storage we observed a shift in the most frequent isolated species from *F. redolens* to *F. culmorum* plus *F. cerealis*. Remarkably, *F. graminearum*, one of the major components of the FHB-complex in wheat, was only rarely isolated. All Fusarium species isolated from sugar beet were additionally inoculated back to wheat and their known pathogenicity and ability to produce systemic infections on wheat confirmed. Due to these results obtained, it is suggested, that sugar beet residues left in the field after harvest might represent another source for saprophytic survival of *Fusarium* species.

FRANC, GARY D.*, ANDREW R. KNISS and WILLIAM L. STUMP, University of Wyoming, Plant Sciences-3354, Laramie, WY 82071. **Rhizoctonia root and crown rot interactions with fungicide and glyphosate in glyphosate-tolerant sugar beet.**

Sugar beet cultivars tolerant to glyphosate are increasingly popular in the Great Plains due to economics of weed control. Anecdotal reports suggest RRCR tolerant cultivars may have altered host-plant resistance

following application of glyphosate. In one year, application of glyphosate to the nontreated inoculated check significantly increased RRCR incidence, but this early-season effect was not detected later in the season when all plants became infected (P=0.05). Season-long RRCR disease severity values revealed that when glyphosate was applied to plots receiving azoxystrobin significantly less disease resulted than when azoxystrobin was applied in the absence of glyphosate ($P3$0.05). Field studies revealed that the RRCR disease reaction in the host plant could be affected by glyphosate application.

HANSON, LINDA E., USDA-ARS, SBRU, 494 PSSB, Michigan State University, East Lansing, MI 48824-1325. **_Fusarium_ seed stalk blight and rot in sugar beet.**

Fusarium stalk blight of sugar beet can cause reductions or complete loss of seed production. The causal agent is *Fusarium oxysporum*, and may be *Fusarium oxysporum* f.sp. betae (FOB), the cause of Fusarium yellows. In addition, *Fusarium solani* has recently been demonstrated to cause a rot of sugar beet seed stalk, and other species have been reported associated with sugar beet seed or fruit, but their effect on seed production is not known. We sampled diseased seed stalks and examined isolates for their pathogenicity and virulence on sugar beet seed stalks in greenhouse tests and in the laboratory on detached seed stalk sections. Isolates of FOB representing three different genetic groups also were examined for their effect on seed stalks. Seed stalk tissue of sugar beet germplasm that had been found to vary in response to FOB or in response to stalk blight in field screening were inoculated by three different methods. The same germplasm also were tested for their response using the standard test for yellows. *Fusarium oxysporum* was the most commonly isolated species from seed stalks, but two other species also were isolated from stalk lesions, and both caused rot of seed stalk when inoculated into either intact seed stalks, or detached seed stalks. Isolates from at least two of the three genetic groups of yellows isolates caused similar symptoms on seed stalks with all inoculation methods tested. Disease response correlated well between yellows tests and seed stalk blight tests for several germplasm.

HANSON, LINDA E., USDA-ARS, SBRU, 494 PSSB, Michigan State University, East Lansing, MI 48824-1325. **Potential interaction between _Rhizoctonia_ and _Rhizopus_ causing root rot in sugarbeet.**

Rhizoctonia crown and root rot is one of the most important soil-

borne fungal diseases of sugarbeet. One important factor in managing this disease is host resistance. However, losses of control with resistance, as well as other management methods, are being increasingly reported. In 2005, we observed sugarbeets in greenhouse pathogenicity tests with moderate resistance to Rhizoctonia crown and root rot that showed symptoms faster than expected following inoculation. Root rotting also was more severe than expected. Isolations revealed a second fungus was also present and was morphologically identified as *Rhizopus*. When inoculated alone onto sugar beet, this fungus caused only some minor discoloration under greenhouse conditions. However, when co-inoculated with *Rhizoctonia solani,* moderately Rhizoctonia-resistant beets showed more severe root rot than was observed with *Rhizoctonia solani* alone. In 2007, samples were received from some fields with root rot problems that also contained both pathogens. Isolates of *Rhizopus* from these samples produced little damage on their own, but rot was increased when they were applied in combination with *R. solani*. These data may provide an additional factor of concern when using Rhizoctonia-resistant material in fields where both fungi are present.

HILL, AMY L.[1], KIMBERLY M. WEBB[1]*, JULIE LAUFMANN[2], LINDA E. HANSON[3] and LEE PANELLA[1], [1]USDA-ARS, Sugarbeet Research Unit, 1701 Centre Avenue, Fort Collins, CO 80526, [2]US Forest Service, 1409 Westfield Drive, Fort Collins, CO 80526 and [3]USDA-ARS, Sugarbeet and Bean Research, 494 PSSB, East Lansing, MI 48824. **Long term preservation of a collection of Rhizoctonia solani, using cryogenic storage.**

The fungus *Rhizoctonia solani* Kühn is an important plant pathogen on a number of crops and maintaining an extensive collection of reference isolates is important in understanding relationships of this pathogen with multiple hosts. While a number of long-term storage methods have been developed, most of these require frequent transfer, require the entire sample to be removed from storage, and can cause changes to morphological or pathogenic characteristics after several years. One hundred nine isolates of *R. solani* representing nine anastomosis groups were colonized onto barley grains which then were placed into individual cryotubes and stored at –160°C in liquid nitrogen vapor phase. At 60 days, 5, and 10 years, all isolates were removed from storage, placed on PDA plates and examined at 2 and 5 days after plating. Percentage of barley grains from which *R. solani* germinated and notations on morphological characteristics were recorded, and compared to

data collected from the original cultures prior to storage. At each time period, a subset of isolates was inoculated to a susceptible (FC901) and a resistant (FC703) sugar beet cultivar. Roots were rated for symptoms on a scale of 0 (no visible symptoms) to 7 (plant dead and root completely rotted through). All isolates tested that were stored using the cryogenic method had no changes to either morphologic or pathogenic characteristics. This indicates that for permanent storage, cryogenic methods are well suited for the preservation of *R. solani* culture collections.

KAFFKA, STEPHEN R., University of California - Davis, Department of Plant Sciences, One Shields Avenue, Mail Stop 1, Davis, CA 95616. **Fertilizer N effects on yield and root quality for high-yielding, fall-planted sugarbeets in the Imperial Valley**.

The highest average sugarbeet yields in the world are achieved in the Imperial Valley (IV) in California, an irrigated dessert region. Three trials were carried out over the 2004-08 period to evaluate optimal fertilizer levels for both gross and recoverable sugar yields. N fertilizer rates ranging from 0 to 290 lb/ac were compared. Beets were harvested three or four times from April to July and fresh weight and dry matter accumulation and root and sugar yields. Plant N uptake was evaluated at each harvest. Fertilizer responses were similar in all three years with highest root and gross sugar yields achieved at approximately 220 lb N ac^{-1} in both June and July harvests (65 t ac^{-1} /22,000 lb ac^{-1}). Fertilizer optima were lower for April and May harvests, respectively. Current sugarbeet varieties did not require greatly increased amounts of N fertilizer to achieve root and gross sugar yield levels nearly three times as great as those achieved in the 1950's at approximately similar N levels. We surmise that irrigation rates and primary tillage practices have not changed greatly over that time period, so current yields represent a significant improvement in efficiency over the last 50 years. Recoverable sugar yields were greatest at slightly lower rates, based on the use of the Carruthers formula. Between the second and third trials, a purity index was introduced, and crown removal emphasized by the industry. To address these changes, detailed analyses of whole root and crown quality were carried out as part of the third trial (2007-08) in this series, and economic returns calculated for different levels of crown removal. The crown fraction increased on average as a % of total root FW during the April to late June period from 11.9 to 12.9 to 13.7 %. Sucrose concentration differences in crown portions compared to whole roots were 5.0, 4.6 and 3.6 % lower and purity differences were 2.3 to 4.4 to 5.6 % lower over the three successive harvests. Despite these differences,

economic returns were improved by crown removal only in the earliest harvest (mid-April). At mid May and late June harvests, conventional topping was more profitable than more severe crown removal calculated using the purity based formula established for the IV. Complete crown removal resulted in losses greater than $150/ac at optimal fertilizer rates, but losses were lower at higher fertilizer N rates.

LIU, HSING-YEH* and ROBERT T. LEWELLEN, USDA-Agricultural Research Service, 1636 E. Alisal Street, Salinas, CA 93905. **Interactions between resistance-breaking *Beet necrotic yellow vein virus* and Beet oak-leaf virus in sugar beet.**

Rhizomania, a serious disease of sugar beet (*Beta vulgaris*), is caused by *Beet necrotic yellow vein virus* (BNYVV) and vectored by the plasmodiophorid *Polymyxa betae*. Resistance allele Rz1 has been widely incorporated into commercial cultivars. Recently, resistance-breaking isolates of BNYVV (RB-BNYVV) were identified and characterized. When the occurrence of RB-BNYVV was surveyed throughout the sugar beet growing areas in the United States, most soil samples contained Beet oak-leaf virus (BOLV) as well. BNYVV and BOLV often occurred in the same field and sometimes in the same sugar beet plant. The possibility of interactions between these two *P. betae*-transmitted sugar beet viruses was tested. Plants grown in soils infested with aviruliferous *P. betae* or carrying RB-BNYVV and BOLV, alone and in combination, were compared with plants grown in non-infested soil for differences in plant fresh weight and virus content as measured by enzyme-linked immunosorbent assay (ELISA). *Rz*1 and *Rz*2 resistance genes that condition resistance to BNYVV did not confer resistance to BOLV. BNYVV ELISA values were significantly higher in single infections than in mixed infections with BOLV in both the rhizomania-resistant and -susceptible cultivars. In contrast, ELISA values of BOLV were not significantly different between single and mixed infections in both the rhizomania-resistant and -susceptible cultivars. Results indicate that BOLV may suppress BNYVV in mixed infections. Soils infested with *P. betae* significantly reduced fresh weight of sugar beet seedlings regardless of whether they were with or without one or both viruses or resistance genes.

MARTIN, JOHN O.*, KEVIN THORSNESS, KELVEN LUFF, CHARLES HICKS, DEAN MARUSKA, GEORGE SIMKINS and JAMES BLOOMBERG, Bayer CropScience, 2 T.W. Alexander Drive,

Research Triangle Park, NC 27709. **Evaluation of program approaches for foliar disease control in sugar beets with prothioconazole.**

Damage from Cercospora leaf spot & Powdery mildew has been a serious issue for sugar beet producers in the United States. With the introduction of prothioconazole into the market in 2008, Bayer CropScience has been exploring different approaches with prothioconazole (Proline) and trifloxystrobin (Gem) to maximize control of these foliar diseases. Included in these approaches are different adjuvant systems as well as variations in treatment programs.

NIHLGÅRD, MARIA[1]*, MATS LEVALL[1], RICKARD JONSSON[1], BRITT-LOUISE LENNEFORS[1], REBECCA LARSON[2] and GERHARD STEINRUCKEN[1], [1]Syngenta Seeds, P. O. Box 302, 261 23 Landskrona, Sweden and [2]Syngenta Seeds, 1020 Sugarmill Road, Longmont, CO USA 80501. **Storage diseases – assessment and implications for breeding.**

For farmers and the sugar industry it is essential to store sugar beets for various periods of time. An extended storage time can secure the beet supply, stretch the campaign and allow for flexibility. It is critical that the sugar beets retain sugar yield during storage. Sugar losses can depend on different factors including the health status of the beets when put into storage, the degree of injury, the amount of soil attached to roots and on the pathogenic microorganisms present in the pile. It is known that different diseases such as *Fusarium spp*., *Rhizoctonia solani,* rhizomania, and Curly top can influence storage capacity. Consequently, it is important to use varieties with the appropriate disease resistance packages to combat different diseases in the production areas to not only maintain optimal yield in field, but also prevent sugar losses during storage. During storage trials performed by Syngenta Seeds different factors influencing the storability have been investigated. It has been clearly shown in the storage trials that mechanical and freeze damage in beets leads to increased fungal attack. The major fungal microorganisms colonizing the roots in storage are *Fusarium* spp., *Penicillium claviforme* Bainier and *Botrytis cinerea* Pers. Beet health in storage also depends on the degree of dirt attached to the beet. Less soil reduces the amount of pathogens and humidity, both of which cause damage, so root architecture, specifically root groove depth, has a significant impact on storability. In the trials many genetically different sugar beet materials with significant differences in storability have been identified.

POINDEXTER, STEVEN S.[1]* and JAMES F. STEWART[2], [1]Michigan State University Extension, Sugarbeet Advancement, One Tuscola Street, #100, Saginaw, MI 48607 and [2]Michigan Sugar Company, 1549 Valley Center Drive, Bay City, MI 48706. **Impact of Quadris and Proline fungicides on yields of sugarbeets with natural infection of Rhizoctonia crown rot.**

Rhizoctonia solani of sugarbeets is a significant problem in many sugarbeet producing areas of the United States. The objective of this study is to determine the effectiveness of the fungicides Quadris from Syngenta Crop Protection and Proline from Bayer Crop Science on control of Rhizoctonia solani rot. The research was conducted in fields with a known history and potential for naturally high levels of inoculums. Most current research is or has been utilizing artificial inoculation techniques. Susceptible Rhizoctonia beet varieties were planted at each location in 2008. Two trials were conducted in large strip trials and two in small research trials. Each location provided different levels of actual Rhizoctonia infections. Significant differences occurred in infection levels between the untreated check and the Quadris and Proline treatments. Two to six leaf treatments in a 7 inch band of both Quadris and Proline helped control early season Crown Rot infections but did not eliminate mid/late season below ground Rhizoctonia infections. Yield data from 2008 trials is forthcoming.

REGITNIG, PETER J.* and BRYAN AVISON, Lantic Inc., 5405 – 64th Street, Taber, Alberta, Canada T1G 2C4. **Suppression of Aphanomyces root rot in Alberta.**

Root disease has been a very minor production issue in southern Alberta in the past; however, in recent years some fields have exhibited disease symptoms that are associated with *Aphanomyces cochlioides*. Soil samples taken from suspected problem areas produced Aphanomyces soil disease index (SDI) values as high as 99 (0-100 scale). The sugar beet production area of Alberta is primarily sprinkler irrigated and has relatively high pH calcareous soils. Five field trials were conducted between 2005 and 2007 in soil with SDI values between 86 and 97, to evaluate the effect of precipitated calcium carbonate (PCC) and resistant varieties on suppression of Aphanomyces root rot. PCC, a byproduct of the sugar beet purification process, was applied at rates of 0, 4 and 8 tonnes wet weight/acre. Moisture content of the PCC averaged 33%. The resistant varieties evaluated were commercially approved in various U.S. growing regions. The application of PCC significantly reduced late season visual root rot ratings and significantly increased

sugar beet root yield in all five trials, including one trial where PCC was applied 2 years prior to planting sugar beets. PCC application did not have a significant effect on sugar beet quality. In four trials where Aphanomyces susceptible and resistant varieties were compared, the root yield of susceptible varieties always showed a significant increase when PCC was applied. Root yield of resistant varieties only responded significantly to PCC application in the trial which exhibited the highest level of visual root disease symptoms. Results suggested that the root yield of the selected Aphanomyces resistant varieties was comparable to commercially approved susceptible Alberta varieties when no PCC was applied. In three trials where SDI values were determined before and after PCC application, PCC appeared to have minimal influence on this value. The application of PCC appears to be a viable control measure to mitigate Aphanomyces root rot in the southern Alberta growing region.

STRAUSBAUGH, CARL A.[1]*, IMAD A. EUJAYL[1], EUGENE REARICK[2], PAUL FOOTE[3] and DAVE ELISON[3], [1]USDA-ARS, NWISRL, 3793 North 3600 East, Kimberly, ID 83341, [2]Amalgamated Research Inc., 2531 Orchard Drive E., Twin Falls, ID 83301 and [3]Amalgamated Sugar Company LLC, 50 South 500 West, Paul, ID 83347. **Sugarbeet cultivar evaluation for storability and rhizomania resistance.**

Sugarbeet production worldwide is hindered by sucrose loss in storage and yield loss associated with rhizomania caused by *Beet necrotic yellow vein virus* (BNYVV). To reduce storage losses and improve resistance to rhizomania, studies were initiated to establish a storage cultivar selection program for sugarbeet. In 2006 and 2007, 30 or more commercial sugarbeet cultivars were grown in soil naturally infested with BNYVV. At harvest, two 8-beet root samples from each plot were collected and used to establish percent sugar. Additional samples were placed on top of an indoor pile (set point 1.7°C) and inside an outdoor pile in a randomized complete block design with four replications. After 142 and 159 days in indoor storage, sucrose reduction ranged from 13 to 90% in 2007 and 57 to 100% in 2008. Outdoor storage sucrose reduction ranged from 13 to 32% in 2007 and 28 to 60% in 2008. An average of 31 and 45% of the root surface was covered with fungal growth in 2007 and 2008, respectively. Cultivars that retained the most sucrose had resistance to BNYVV and less fungal growth and weight loss. Indoor storage with BNYVV infested roots allowed for the most consistent cultivar separation and will potentially lead to cultivars being selected for improved storability and rhizomania resistance.

STRAUSBAUGH, CARL A.[1]*, IMAD A. EUJAYL[1], LEE W. PANELLA[2] and LINDA E. HANSON[3], [1]USDA-ARS, NWISRL, 3793 North 3600 East, Kimberly, ID 83341, [2]USDA-ARS, 1701 Center Avenue, Fort Collins, CO 80526 and [3]USDA-ARS, 494 PSSB, Michigan State University, East Lansing, MI 48824. **Genetic diversity and pathogenicity of Rhizoctonia on sugarbeet.**

Rhizoctonia root rot causes serious losses on sugarbeet worldwide. To explain why Rhizoctonia root rot resistant sugarbeet cultivars have not performed well in some areas of the Intermountain West (IMW), 97 *Rhizoctonia* isolates were collected from sugarbeet roots produced in commercial fields from 2004 to 2006. These field isolates were compared with 19 tester isolates for genetic diversity based on sequencing of the internal transcribed spacer (ITS) region using primers ITS1 and ITS4. Greenhouse pathogenicity tests were conducted on the cultivar Monohikari. Plants were rated for foliar discoloration, root rot, crown size, and top fresh weight. From these 4 parameters, disease severity index was calculated. Based on disease severity, 34 field isolates were more pathogenic than tester F203 (also known as R9), which is the isolate used by the industry to establish resistance in sugarbeet. Thirty of the 34 pathogenic isolates came from the following Idaho counties: Canyon (11 isolates), Jerome (8), Owyhee (6), and Elmore (5). Based on the phylogenetic analysis, the four AG 2-2IIIB testers fell into different clades. To ensure sugarbeet remains resistant to *Rhizoctonia*, additional studies with isolates from various clades and cultivars varying for resistance should be conducted.

TEDFORD, ERIC C.*, DAVID LAIRD, BRETT MILLER and GARY PASTUSHOK, Syngenta Crop Protection, P. O. Box 18300, Greensboro, NC 27419. **Inspire XT, a new triazole mixture fungicide for sugarbeet disease control.**

Inspire™ XT fungicide is a new fungicide for control of Cercospora leaf spot and powdery mildew on sugar beets. The formulation contains 2.08 pounds each of the active ingredients difenoconazole and propiconazole per gallon of product. Over the past 3 years, Inspire XT has been evaluated in field trials across the sugar beet growing states of the U. S. for efficacy and potential effects on yield and sugar content. Difenoconazole and propiconazole are excellent partners in this mixture as they are both efficacious against *Cercospora beticola* and *Erysiphe polygoni,* and they are both systemic. Although Inspire XT has protective, curative and eradicative properties, it is best to begin applications prior to the onset of disease. The first application should go on pre-

ventatively or based on a forecast system. For resistance management purposes, Inspire XT must be used in alternation with any non-triazole fungicide that is registered for use on sugar beets. Alternation programs with Inspire XT and either Headline® or Super Tin® provided excellent control of Cercospora leaf spot and powdery mildew. In addition, yields and sugar content generally increased in fungicide treated beets relative to the untreated controls.

THIEL, HEIKE and MARK VARRELMANN*, Institute of Sugar Beet Research, Department of Phytopathology, Holtenser Landstr. 77, 37079 Göttingen, Germany. **The P25 pathogenicity factor of *Beet necrotic yellow vein virus* physically interacts with several sugar beet proteins possibly involved in virus pathogenicity or plant resistance.**

Beet necrotic yellow vein virus (BNYVV), causal agent of rhizomania is transmitted by the soil-borne plasmodiophorid *Polymyxa betae* and induces severe lateral root proliferation, necrosis and strong root yield reduction. The growth of partially (*Rz*1, *Rz*2) resistant hybrids stabilizes yield but does not prevent virus infection and replication entirely. P25 encoded by viral RNA3 is responsible for symptom development and yield reduction and suggested to function as an avirulence (Avr) gene product in resistant and pathogenicity factor in susceptible genotypes. In addition previous studies have shown that recently occurring resistance breaking isolates possess increased P25 variability. To better understand P25 functions and the molecular basis of the virus-host interactions, the BNYVV encoded P25 was applied in a yeast two-hybrid screen of an *Rz*2 resistant sugar beet cDNA library. This screen identified several candidate proteins, which orthologues from other plant species are well-known to be expressed following pathogen infection and involved in plant defense response. Some interactions may be necessary for the virus life cycle or might serve to suppress the sugar beet defense. Among the candidates are members of the plant ubiquitin/proteasome system and proteins involved in phytohormone signalling, cell cycle and structure as well as stress and pathogen response. The interaction of several of the candidate genes with P25 was confirmed in *Nicotiana benthamiana* leaf cells by transient agrobacterium-mediated expression applying the bimolecular fluorescence complementation (BiFC) technique.

WINDELS, CAROL E.[1]*, JASON R. BRANTNER[1], ALBERT L. SIMS[1] and CARL A. BRADLEY[2], [1]University of Minnesota, Northwest Research and Outreach Center, Crookston, MN 56716 and [2]University

of Illinois, Crop Sciences Department, Urbana, IL 61801. **Long-term effect of a single soil application of factory lime on Aphanomyces root rot and sugar beet yield.**

Aphanomyces cochliodes infests over 50% of sugar beet fields in Minnesota (MN) and North Dakota (ND). Factory lime is a by-product of the beet sugar purification process where calcium carbonate aids extraction of sucrose from beet juice by precipitating impurities containing inorganic and organic compounds. Long-term trials, in fields naturally infested with *A. cochlioides*, were established to determine the effect of one soil application of factory lime on Aphanomyces root rot and sugar beet yield. Applications of 0, 3.3, 6.5, 13, and 19.5 ton dry lime A^{-1} were made at Hillsboro, ND (October, 2003) and 0, 2.7, 5.3, 8, and 10.6 ton dry lime A^{-1} at Breckenridge, MN (April, 2004). All rates of lime increased soil pH within a few months after application and have remained constant; e.g, at Hillsboro, rates of 0, 6.5, and 13 ton lime A^{-1} resulted in pH values of 7, 7.7, and 7.8, respectively and at Breckenridge, rates of 0, 5.3, and 10.6 ton lime A^{-1} resulted in pH values of 6.3, 7.6, and 7.7, respectively. At Hillsboro, there was low disease pressure from *A. cochlioides* in replicated sugar beet experiments in 2005 through 2007, but lime increased stand and root and sucrose yields compared to the non-limed control. At Breckenridge, *A. cochliodes* was active in 2005 to 2007 and all rates of lime reduced Aphanomyces root rot and increased root and sucrose yields (optimal at 5.3 to 8 ton dry weight A^{-1}). Overall, amendment of soil with factory lime has had a long-term, positive effect on sugar beet yield (to date, through the fourth year after application), whether *A. cochlioides* was active or inactive. When *A. cochlioides* was active, factory lime significantly reduced Aphanomyces root rot.

WINDELS, CAROL E.* and JASON R. BRANTNER, University of Minnesota, Northwest Research and Outreach Center, 2900 University Avenue, Crookston, MN 56716. **Intraspecific group of *Rhizoctonia solani* AG 2-2 and rotation with corn affect sugar beet.**

Rhizoctonia crown and root rot (RCRR) of sugar beet is caused by *R. solani* AG 2-2 intraspecfic groups (ISG) IV and IIIB. The disease is increasing in prevalence on sugar beet in Minnesota and North Dakota and is attributed in part, to close rotation of susceptible crops (beans). Thus, rotation of non-host crops (cereals) is recommended. In 2005 and 2006, plots were inoculated with *R. solani* 2-2 IV, 2-2 IIIB, and not infested (control) and then sown to spring wheat, soybean, and corn. At harvest, isolation of *R. solani* from roots of wheat, soybean, and corn in the control averaged 1, 4, and 2%, respectively; 2-2 IV plots averaged

2, 12, and 5%, respectively; and 2-2 IIIB plots averaged 5, 16, and 33%, respectively. No aboveground or root rot symptoms were observed, except for lesions on corn roots from plots inoculated with *R. solani* AG 2-2 IIIB. When sugar beet was sown in 2006 and 2007, Rhizoctonia damping-off occurred 3 weeks later; stands were highest in the control regardless of previous crop, lowest in 2-2 IIIB plots sown with soybean or corn, and intermediate and equal in plots with 2-2 IV following all crops and in soil with 2-2 IIIB after wheat. At harvest, RCRR was more severe in 2006 than in 2007 and overall, was highest in plots inoculated with *R. solani* AG 2-2 IIIB, lowest in the control, and intermediate in plots with AG 2-2 IV. RCRR ratings were highest after corn, lowest after wheat, and intermediate after soybean. In 2006, root and sucrose yields (averaged across all plots) were significantly higher following wheat and equally low following soybean and corn. In 2007, sugar beet yields tended to be highest after wheat and soybean and lowest after corn. Thus, sowing corn in fields infested with *R. solani* AG 2-2 IIIB can increase RCRR and decrease yield of a subsequent sugar beet crop.

SECTION C – ENTOMOLOGY AND PLANT PATHOLOGY POSTER PRESENTATIONS

DE TEMMERMAN, NELE[1], MARK ANFINRUD[2], MARC MEULEMANS[1], ALEXANDRA BURKHOLZ[1], ERIK DE BRUYNE[1], GUY WEYENS[1], STEVE BARNES[1], STEFAAN HOREMANS[1], MARC LEFEBVRE[1] and MELVIN D. BOLTON[3]*, [1]SESVanderHave, Soldatenplein 15, 3300 Tienen, Belgium, [2]SESVanderHave, 5908 - 52nd Avenue South, Fargo, ND 58104 and [3]USDA, Agricultural Research Service, Northern Crop Science Laboratory, Fargo, ND 58105.
Rhizomania resistance in the Tandem® sugar beet variety.

Rhizomania, caused by *Beet necrotic yellow vein virus* (BNYVV), is a major disease of sugarbeets world-wide. The 'Holly' resistance gene (Rz1) confers strong resistance to several BNYVV isolates and has been incorporated into most major sugarbeet breeding lines. However, the threat presented by resistance-breaking isolates of BNYVV, to which the Holly gene does not confer adequate resistance, underscores the need for novel sources of Rhizomania-resistant germplasm. The Tandem® sugarbeet variety combines resistances to BNYVV from two sources: the *Rz*1 (Holly) gene and a proprietary *Beta maritima*-derived source. Beets from Tandem®, Holly-mediated resistant, and susceptible non-*Rz* lines were harvested from replicated microplots with heavy Rhizomania disease pressure in the Red River Valley (North Dakota), and were analyzed for virus accumulation, root yield, sugar content and juice purity parameters. BNYVV titers were significantly and uniformly lower in samples from Tandem® or "Holly" than those from the susceptible controls.

HANSON, LINDA E.* and J. MITCHELL McGRATH, USDA-ARS, SBRU, 494 PSSB, Michigan State University, East Lansing, MI 48824-1325. **Seedling disease resistance screening assays.**

A number of pathogens can cause early season stand loss in sugar beet. Fungi such as *Rhizoctonia solani* AG-2-2 and AG-4 and *Fusarium oxysporum* are able to cause post-emergence damping-off in sugar beet. Recent work has identified some sugar beet germplasms which show reduced damage from isolates of *Rhizoctonia solani* AG-2-2 IIIB at early growth stages compared with the majority of beet germplasm tested. These and other USDA-ARS germplasm are being screened for response to additional isolates of AG-2-2 IIIB as well as AG-2-2 IV

originally collected from both seedling damping-off and mature plant crown and root rot samples. Testing for response to *F. oxysporum* also showed evidence for differences in the level of susceptibility to damping-off in different germplasm. Testing of plants at different ages and growth conditions may be useful to determine optimal conditions for plant screening and allow for identification of germplasm with improved resistance to early season losses.

HARVESON, ROBERT M., University of Nebraska, Panhandle Research and Extension Center, 4502 Avenue I, Scottsbluff, NE 69361. **Strobilurin applications for managing Rhizoctonia root and crown rot in Nebraska based on soil temperature measurements.**

Rhizoctonia root and crown rot, caused by *Rhizoctonia solani*, is the most widespread, consistently damaging sugar beet disease in Nebraska, and causes both seedling disease and two different phases of root rot later in season. These two phases include a crown rot, and a tip rot of the tap root beneath the soil surface. Because of the diversity of pathogen forms observed, making fungicide recommendations based on plant growth stage or chronological time of the season is difficult and impractical. Therefore, a study was begun in 2006 with the purpose of evaluating optimal timing for making fungicide applications based on measurement of soil temperature. The study consisted of 3 treatments: 1) untreated control; 2) fungicide applications based on soil temperatures averaging 75F (24C) for 3 consecutive days, 3) fungicide applications after severe symptoms appeared. Pathogen growth and activity is optimal at 78-90F (26-32C), thus 75F was chosen as the cardinal temperature for testing. Data collected included multiple disease counts, disease severity ratings assigned at harvest, and sucrose and root yield determinations. Sugar yields and numbers of diseased plants were significantly improved with the use of azoxystrobin when soil temperature reached 75 F, compared to controls and spraying after symptom development. Therefore the general concept appears to work adequately for Nebraska conditions; however improvements may still be realized with some further modifications. This concept will be continued and expanded in 2008 to test spray treatments based on varying temperatures with the purpose of determining optimal temperature for making applications.

HARVESON, ROBERT M., University of Nebraska, Panhandle Research and Extension Center, 4502 Avenue I, Scottsbluff, NE 69361. **Unknown sterile fungi used as biological control agents for managing multiple**

root pathogens of sugar beets under field conditions.

Several common root diseases routinely damage sugar beets in Nebraska and other areas of the Central High Plains, and it is becoming more common to find fields infested simultaneously with multiple pathogens. Root diseases induced by these pathogens often cause more devastating losses than with foliar diseases because they are difficult to detect before serious damage occurs. Due to the lack of available chemicals for economic control of soilborne diseases, other alternative techniques, such as biological control are increasingly being sought for disease management. Over the last several years, unidentified, sterile fungi have been isolated in conjunction with infected sugar beet roots and seedlings. Several promising candidates have been identified from in vitro assays that inhibit numerous sugar beet root pathogens, including *Rhizoctonia solani*, *Aphanomyces cochlioides*, *Phoma betae*, and *Pythium* and *Fusarium* spp. Those selected isolates were tested as biological control seed treatments in a field naturally

infested with multiple root diseases. Results obtained from 2006 are very promising and suggest that these fungi are providing some level of protection for the entire season against a complex of soilborne diseases. For example, plots planted with a root rot susceptible cultivar treated with the "Hall" isolate resulted in sucrose yields almost 1800 lb/a higher than untreated plots of the same cultivar, which was compatible with other cultivars possessing various combinations of disease tolerances grown under the same conditions.

KHAN, MOHAMED F. R.[1], ISSA QANDAH[1] and MELVIN D. BOLTON[2]*, [1]Department of Plant Pathology, Walster Hall 306, North Dakota State University, Fargo, ND 58105 and [2]USDA, Agricultural Research Service, Northern Crop Science Laboratory, Fargo, ND 58105.

The effect of temperature on Rhizoctonia disease development and fungicide efficacy in controlling Rhizoctonia root rot on sugarbeet.

Rhizoctonia solani AG 2-2 is the causal agent of Rhizoctonia root and crown rot in sugarbeet. This disease has recently been increasing in occurrence and severity in sugarbeet production areas in the Red River Valley of Minnesota and North Dakota. Since the intraspecific groups AG 2-2 IIIB and AG 2-2 IV both cause Rhizoctonia root and crown rot and are both prevalent in the Red River Valley, our objectives were to compare disease development of these intraspecific groups at four different soil temperatures under controlled climate conditions. A second objective was to determine the efficacy of several fungicides at the temperature determined to be optimal for disease development. Trials were conducted

using growth chambers set at four different temperature regimes (10, 15.6, 21.1 and 26.7°C). No disease development occurred at 10 and 15.6°C. However, AG 2-2 IIIB, but not AG 2-2 IV, showed significant disease development at both 21.1 and 26.7°C during the two-week post inoculation evaluation period. Efficacy of several classes of fungicides was tested at 26.7°C since this was the temperature most conducive to disease development. Application of azoxystrobin completely controlled the disease down to 0.336 L ha^{-1} (half the label rate) but not at 0.168 L ha^{-1} (quarter label rate) while prothioconazole controlled the disease only at 0.365 L ha^{-1} (full label rate). Difenoconazole at 0.512 L ha^{-1} (full label rate) was not effective at controlling Rhizoctonia root rot.

KIRK, WILLIAM W.[1]*, LINDA E. HANSON[1&2] and CHRISTY L. SPRAGUE[3], [1]Michigan State University, Department of Plant Pathology, East Lansing, MI 48824, [2]USDA-ARS, SBRU, 494 PSSB, East Lansing, MI 48824 and [3]Michigan State University, Department of Crop and Soil Sciences, East Lansing, MI 48824. **Glyphosate and fungicide effects on Cercospora leaf spot in four glyphosate-resistant sugar beet (Beta vulgaris) varieties.**

Glyphosate has been shown to reduce foliar diseases in soybean and wheat. In fact, currently there is a patent application for a synergistic combination of glyphosate and a fungicide for disease management. Cercospora leaf spot (*Cercospora beticola*) is one of the most significant disease problems in Michigan sugar beet production. The recent commercialization of glyphosate-resistant sugar beet allows for the testing of glyphosate and glyphosate-fungicide combinations for the management of Cercospora leaf spot. The glyphosate-resistant sugar beet varieties, ACH 827RR, Hilleshog 9027, Hilleshog 9028, and Hilleshog 9029 were inoculated with *Cercospora beticola* for the development of Cercospora leaf spot. Four different herbicide treatments: 1) no herbicide (hand-weeded control), 2) a standard-split herbicide program (two applications of desmedipham & phenmedipham + triflusulfuron + clopyralid + non-ionic surfactant), 3) three applications of glyphosate, and 4) four applications of glyphosate were evaluated alone and in combination with a standard Cercospora fungicide program. Variety and fungicide main effects were significant for Cercospora leaf spot severity. However, regardless of the herbicide program Cercospora leaf spot severity was not affected. Therefore, results from the first year of this research indicate that glyphosate and glyphosate-fungicide combinations do not significantly contribute to Cercospora leaf spot control.

LARTEY, ROBERT T.[1]*, ANDREW LENSSEN[1], THECAN CAESAR-TONTHAT[1], JOYCE ECKHOFF[2], SOPHIA HANSON[1] and ROBERT G. EVANS[1], [1]USDA-ARS, Northern Plains Agricultural Laboratory, 1500 North Central Avenue, Sidney, MT 59270 and [2]Montana State University, Eastern Agricultural Research Center, 1501 North Central, Sidney, MT 59270. **Preliminary evaluation of Laetisaria arvalis as chemical seed treatment alternative in sugarbeet.**

Like several other crops, application of protective fungicides as seed treatment is a common and effective practice to manage seedling diseases of sugar beet. Sugarbeet seeds from commercial sources are pretreated with one or more of the available fungicide. Occasionally, some of the fungicides are combined to pretreat sugarbeet seed to enhance the spectrum of activity against targeted pathogens. Chemicals used to pretreat sugarbeet seeds include Tachigaren (hymexazol), Apron (metalaxyl) and Thiram (tetramethylthiuram disulfide; TMTD). In the Lower Yellowstone River Valley sugarbeet growing region (eastern Montana and Western North Dakota), a combination of Apron and Thiram is a commonly offered as seed treatment to commercial sugarbeet growers. We present in this paper the result of a preliminary evaluation of *Laetisaria arvalis* as a biological alternate to commercial fungicide treatment of sugarbeet seed. Ground dried culture of *L. arvalis* was applied to sugarbeet seed using methyl cellulose. In other treatments, *L. arvalis* was cultured in barley or peat (American Peat Tech, LLC, Aitkin MN.) substrates and incorporated in soil prior to planting of untreated seed. Controls consisted of untreated or commercially treated seeds. After planting, the crops were maintained under controlled environment and subsequently assessed for emergence and growth over a period of six weeks. Emergence and growth of all the *L. avails* treatments were comparable to the chemical treatment. The *Laetisaria* cultures on substrates enhanced growth of the sugarbeet seedlings. Our results support the need for expanded investigation of *L. arvalis* as an alternate to chemical seed treatment of sugarbeet seed.

MAJUMDAR, AYANAVA[1]*, MARK A. BOETEL[2], STEFAN T. JARONSKI[3] and RICHARD D. HORSLEY[4], [1]Alabama Cooperative Extension System, Gulf Coast Research and Extension Center, Fairhope, AL 36532, [2]Entomology Department, North Dakota State University, Fargo, ND 58108, [3]USDA, Agricultural Research Services, Northern Plains Agricultural Research Laboratory, 1500 N. Central Avenue, Sidney, MT 59270 and [4]Plant Sciences Department, North Dakota State University, Fargo, ND 58108. **Soil persistence of *Metarhizium***

***anisopliae* applied to manage sugarbeet root maggot in a cover crop microenvironment.**

The sugarbeet root maggot, *Tetanops myopaeformis* (Röder), is a major insect pest of sugarbeet in North Dakota and Minnesota. Three biocontrol field trials using *Metarhizium anisopliae* (Metch.) Sorok. Strain F52 as an insect pathogen in conjunction with cover crops were conducted from 2002 to 2004. Granular and aqueous spray formulations of F52 were applied in furrow to replicated plots at 8 x 10^{12} viable conidia/ha. Oat and rye cover crops were planted prior to sugarbeet at three rates to create different microenvironments for the fungus. Soil samples were collected at 0, 30 or 60 d after treatment (DAT). Significantly higher numbers of conidia were detected in soil samples collected immediately after application in F52 spray plots compared to the granule plots. This suggested delayed activation of *M. anisopliae* granules and proliferation of conidia on them, which has also been observed in the laboratory. Soil sampling and dilution plating results indicated a 90% decline in conidial viability for the aqueous formulation of F52 within 30 DAT. In 2002, a 1.5 to 7.7-fold increase in conidial density per gram of soil occurred between 0 and 60 DAT in plots treated with F52 granules. This increase was numerically higher in cover crop plots compared to no cover plots. Soil moisture tension in cover crop plots was higher (i.e., average of 27 kPa) compared to no cover plots (17 kPa). It appears that F52 granular formulations can persist in low soil moisture microenvironments that occur under a cover crop canopy. To our knowledge, this is the first report on the field persistence of F52 formulations when integrated with summer cover crops.

OKAZAKI, KAZUYUKI*, HIROYUKI TAKAHASHI, KAZUNORI TAGUCHI, YOUSUKE KURODA and HIDEYUKI ABE, National Agricultural Research Organization, Shinsei, Memuro, Hokkaido, 082-0071, Japan. **Evaluation of sugar beet lines bred in Japan to examine resistance to damping-off caused by *Aphanomyces cochlioides*.**

Damping–off, caused by *Aphanomyces cochlioides* Dreshsler, is an important disease in direct sowing culture of sugar beet. Although transplanting culture is a general cultivation style of sugar beet in Japan, it is expected that the field by direct sowing increase to reduce cultivation cost in the future. Our objective in this study was (1) to develop a handy inoculation method to classify the resistance to damping-off, and (2) to evaluate the resistance of our breeding lines by using developed method. 108 seeds (3 replications of 36 seeds) were sown into a peat moss pot (8 cm diameter, 10cm depth) containing 250g sterilized field soil and pots

were placed in a controlled room (16hr daytime-25degree C, 8hr night-time-20 degree C). 2 weeks after sowing, seedlings were inoculated with zoospore suspension. 4-5 weeks after sowing, seedlings were assessed for infection by 6 stages (0 = healthy, 5 = death). As the result, in case seedlings were inoculated with 12,500 zoospores per a pot, seedlings shows sever disease symptom and lines were clearly and stably classified by their disease severity. 100 breeding lines (12 pollinator lines and 88 O-type lines) were evaluated for their resistance with this developed method. As the result, breeding lines were classified clearly from resistance to susceptible. O-type lines exhibited various degree of resistance and 11 lines were selected as promising lines. On the other hand, all pollinator lines were grouped as susceptible. Form these result, it would be concluded that the improvement of resistance in the pollinator lines is necessary to breed a resistant variety for *Aphanomyces* damping-off disease.

SPRAGUE, CHRISTY L.[1]*, KELLY A. BARNETT[1], LINDA E. HANSON[2&3] and WILLIAM W. KIRK[3], [1]Michigan State University, Department of Crop and Soil Sciences, East Lansing, MI 48824, [2]USDA-ARS, SBRU, 494 PSSB, East Lansing, MI 48824 and [3]Michigan State University, East Lansing, MI 48824. **Impact of glyphosate and fungicides on the disease severity of Rhizoctonia crown and root rot in four glyphosate-resistant sugar beet (*Beta vulgaris*) varieties.**

Previous greenhouse research with an experimental glyphosate-resistant sugar beet variety indicated that host resistance to Rhizoctonia crown and root rot could be compromised when plants were exposed to glyphosate. In order to improve disease management recommendations, field research was initiated in Michigan to investigate the interaction between weed and disease management strategies on the severity of Rhizoctonia crown and root rot in four commercial glyphosate-resistant sugar beet varieties. The glyphosate-resistant sugar beet varieties investigated were ACH 827RR, Hilleshog 9027, Hilleshog 9028, and Hilleshog 9029. Each of these varieties were treated with three different weed management programs: 1) no herbicide (hand-weeded control), 2) a standard-split herbicide program (two applications of desmedipham & phenmedipham + triflusulfuron + clopyralid + non-ionic surfactant), and 3) three applications of glyphosate. Uninoculated and plots inoculated with *Rhizoctonia solani* AG-2-2 IIIB were compared for each variety by weed management combination. Additional treatments included inoculated plots treated with the fungicide azoxystrobin in-furrow or postemergence to 6-leaf sugar beets. Significant main effects included

the presence of the disease, fungicide treatment, and variety. Herbicides and interactions with herbicide programs were not significant. Results from this first year of field research indicate that weed management strategy had little impact on Rhizoctonia disease severity. However, a combination of host plant resistance and fungicide applications were important in reducing Rhizoctonia disease severity.

SECTION D – CHEMISTRY & INSTRUMENTATION
ORAL PRESENTATIONS

HELGE, JOHN M.*, THOMAS D. CHARBONEAU, SCOTT A. NISWANDER, XIAOJUN DANG and DENNIS J. SAYE, Nalco Company, 1601 W. Diehl Road, Naperville, IL 60563. **Continuous real-time monitoring of factory water systems identifies opportunities for process and operating cost improvements.**

Environmental restrictions and an ever-increasing emphasis on water resource management have created a need for improved monitoring and control of beet factory utility water. Fluorescence-based technologies have been developed to provide data that enables factory operations staff to more effectively monitor and control cooling water, condensate and boiler applications while driving down operating costs. Factories operating more complex non-contact surface condensers with open recirculating cooling towers need to be concerned with monitoring and controlling bacteria, corrosion, and mineral deposition in these systems. Data gathered by the 3D TRASAR® system provides timely information to minimize the impact of these factors. When condensate from the multiple effect evaporators is used as boiler make-up water, operators need immediate detection and notification of a "sugar shot." Sugar juices carried over into the boiler condensate system, break down forming organic acids in the boiler, which rapidly depress boiler water pH causing acid corrosion in the boiler and reducing equipment life. A severe "sugar shot" may require a plant shutdown. The fluorescence method developed by Nalco measures naturally occurring, fluorescent, non-sugars in the juice. This sugar detection technology uses a low-cost, low-maintenance fluorometer that can detect contamination early enough to allow operators to divert the contaminated feed water before damage occurs. A boiler application using this fluorescence technology has been developed, tested and is currently being commercialized to address water-related challenges, such as scale and corrosion. An updated monitor/controller protects the boiler from scale and deposits by detecting system variations and then delivering the correct program dosage. It improves boiler corrosion and deposit control with continuous real-time monitoring and diagnostics, resulting in safer operation, improved system reliability, and reduced operating costs.

JARSKI, HEATHER R.*, DAVID R. GROOM and TERRY D. McGILLIVRAY, American Crystal Sugar Company, 1700 N. 11th

Street, Moorhead, MN 56561. **Use of NIR spectroscopy for on-site betaine measurement in the ACS Hillsboro molasses desugarization plant.**

The betaine-rich fraction from the Hillsboro molasses desugarization plant had previously been analyzed at ACS only with high performance liquid chromatography performed by a skilled operator and only at the Technical Services location. A Foss NIRSystems Series 5000 near-infrared spectrophotometer was calibrated to measure betaine concentration in dilute MDS separator train samples (0-20% betaine, 0-40% RDS). The betaine calibration is a multiple linear regression based on two wavelengths with an R2 value of 0.9990. The NIR spectrophotometer was installed at the ACS Hillsboro molasses desugarization plant in February 2008. Routine analysis of betaine content is performed. Daily measurements assist in separator train optimization and when combined with dry substance measurements, are used to calculate an estimate of final product betaine concentration, which is checked against customer specifications.

McGILLIVRAY, TERRY*, DIANE RHEAULT, JIM HEGGENESS, INDRANI SAMARAWEERA and JOE WALLEVAND, American Crystal Sugar Company, Technical Services Center, 1700 North 11th Street, Moorhead, MN 56560. **Chemical markers or signals for determination of storability of chromatographic separator extract.**

Storage of extract from a molasses desugarization plant does not typically present difficulties unless the proper storage parameters are not followed. In some cases there may be deterioration of the extract with negative consequences for the processing of the degraded extract. This study involved inoculating extract with high levels of microbial material and following the changes in the extract over an extended period of time. Extract was stored at two different dry substance contents and at two different temperatures with the experimental. Microbial and chemical changes in the extract were followed through for a period of more that six months. The results of the tests show that changes in purity, color, pH, and volatile acid production occur without any significant change and in many cases, a decrease in the mesophilic microbial counts. The simple laboratory tests such as color, pH, and purity appear to be sufficient for determining how well extract has or is storing.

McKEE, MARIANNE*, RONNIE TRICHE, MARY AN GODSHALL and CHARLEY RICHARD, Sugar Processing Research Institute, Inc.,

1100 Robert E. Lee Boulevard, New Orleans, LA 70124. **Color increase during laboratory storage of sugarbeet processing streams.**

Color increase of beet thick juice and molasses desugarization extract during storage can lead to difficulties in processing when products are returned to the beet sugar factory for crystallization. Recently Sugar Processing Research Institute has studied the effect of storage under laboratory conditions on beet thick juice and extract. Samples of thick juice and extract were placed on the bench top and aliquots removed at specific intervals for analysis. The analyses performed on these samples included pH, brix, color, turbidity, and organic acids such as lactic acid and acetic acid. Based on the samples analyzed, pH and brix remain constant over time and a very slight upward trend in turbidity was observed. A strong correlation between color and storage time was found. For thick juice, a 5.21 ICUMSA color unit increase per day was noted and for extract, the color increase per day was found to be 6.98 ICUMSA units per day. These results along with the organic acids analysis will be discussed.

NIELSEN, BJARNE CHRISTIAN, Neltec Denmark, Egegaardsvej 2, 6541 Bevtoft, Denmark. **Increase sugar house throughput by measurement and automation.**

The recent increase in on-line measurements in the sugar house has shown that the process in most sugar factories is much more volatile than previously anticipated. First of all, the performance of the centrifugals is not uniform. It varies with the quality of the massecuite, it varies between the centrifugals, and it varies within each single charge. Further, the massecuite varies from batch to batch from the same crystallizer, it varies between the crystallizers, and it varies with the quality of the juice. Measurements show, that deviations of + and - 50% in the colour of the sugar leaving the centrifugals happens quite frequently and sometimes within 10 seconds. Many of the larger variations are averaged out in the drier and thereby hidden for the operators - unless an instrument displays the variations. With the right instrumentation, the operators can see what happens and adjust the equipment causing many of the variations. As a result, sugar with a much lower colour is produced - with the same effort. Naturally, the immediate reaction to this is to start a process of cost reductions, where the colour is gradually increased toward the upper limit, but still at a safe margin. This paper explains how an on-line colorimeter can display the process variations and assist in obtaining significant cost reductions.

REARICK, D. E.*, CHERI McKAY and DIANE PATTERSON, Amalgamated Research Inc., P. O. Box 228, Twin Falls, ID 83303. **Sugar beet processing applications of the determination of fermentation products by liquid chromatography.**

High performance liquid chromatography (HPLC) and the closely-related technique of ion chromatography (IC) are widely applied in the sweetener industry for the determination of carbohydrates such as glucose, fructose, and sucrose. However, in addition to analyses for these principal components, liquid chromatographic (LC) techniques can be very useful for a variety of other applications including process troubleshooting and emission testing. One area of particular interest is the determination of fermentation products, which may be used to diagnose specific factory problems. For example, the presence of butyrate in diffusion juice has been used as an indicator of the carryover with beets of beet wash water components.[1,2] This report discusses several other specific examples of the use of LC to detect the products of microbiological activity in factory streams and by-products.

SECTION D – CHEMISTRY & INSTRUMENTATION
POSTER PRESENTATIONS

None Submitted

SECTION F – FACTORY OPERATIONS
ORAL PRESENTATIONS

BAURES, MARC A., Hydrite Chemical Co., 701 Sumner Street, La Crosse, WI 54603. **Successful odor control in flume water, ponds, and mud presses in sugar beet processing plants.**

Rapid formation of various odor compounds results from poor water quality at many sugar beet processing plants. The presence of elevated hydrogen sulfide outside of plant boundaries has led to the intervention of regulatory agencies, while employee safety has been compromised in confined areas such as tare labs and screen houses. Successful control of these odors was accomplished utilizing the proprietary Hydritreat HS process at seven different sugar plants with four different beet sugar companies. The process utilizes a strong oxidation source together with an activator to form potent hydroxyl radicals. The elevated oxidation potential of these hydroxyl radicals is able to efficiently destroy hydrogen sulfide odors as well as odors associated with mercaptans, amines, and volatile fatty acids. The sheer number of hydroxyl radicals formed allows for overcoming COD levels in excess of 30,000 ppm where normal oxidation processes would fail. The process has demonstrated the ability to reduce atmospheric hydrogen sulfide levels as high as 400 ppm atmospheric to near zero, while hydrosulfide levels as high as 40 ppm were reduced to near zero in solution. The ability to eliminate hydrogen sulfide results in increased employee safety, decreased regulatory agency involvement, and infrastructure preservation.

BIERBAUM, MARIO* and JOACHIM BRAASCH, GEA Ecoflex GmbH, Schifferstraße 20-22, D - 47059 Duisburg, Germany. **Experiences of plate falling film evaporators at the back end of the evaporator station.**

For more than ten years Plate Falling Film Evaporators have been employed successfully in the beet and cane sugar industry worldwide. For the first time in Europe two Plate Falling Film Evaporators were installed in the last effects of a seven-effect evaporator station for the campaign 2008/09. Their installation and performance have caught broad interest and will be presented in this paper. The existing Robert-Evaporators in 6th and 7th effect were retrofitted with plate packs and commissioned mid of September 2008. Significant operating and performance data such as u-values, pressure drop and the change in juice colorization have been recorded during the whole beet sugar campaign.

This paper further highlights the condition of the plate packs at the end of the campaign, the chemical cleaning procedure and the control arrangement of the evaporator station which handles the evaporation of thick juice close to saturation within plate packs.

BLOOM, KEVIN, American Crystal Sugar Company, Box 357, 1020 Business Highway 2, East Grand Forks, MN 56721. **Results and experiences with the Putsch Jet Wash Roller Table.**

Review the operating success and problems of the spray table. The economic justification of the spray table was because of reduced sugar loss from lower residence time. Intangible benefits include better separation of flume water from beets. Problems were identified with clarified water supply and the impact that it has on beet washing.

BRAUN, ROBERT L., The Amalgamated Sugar Company LLC, 3184 Elder Street, Boise, ID 83705. **Greenhouse gas reporting – meeting customer expectations.**

Although there is still no regulatory basis for green house gas reporting in the U.S., the regulatory pundits are predicting the new administration is likely to sponsor or adopt measures that will provide a regulatory basis for green house gas reporting and control. In the meantime, concern about climate change is driving corporate leaders to address green house gas in sustainability initiatives. With intent to fully account for and disclose their carbon foot print, global corporations are requiring their suppliers to document green house gas. There are several non-governmental organizations (NGO) that have developed protocols and tools for counting and reporting green house gas emissions. One of the NGO's that facilitates green house gas documentation is the Carbon Disclosure Project. As requested by a major customer, TASCO prepared an online report of green house gas emissions for 2004 through 2007. This presentation will present background about the green house gas reporting process, details about TASCO emissions and implications of regulatory and supply-side drivers for green house gas disclosure.

BURRIS, BRIAN[1]*, YVAN BATHANY[2] and HANNU PAANANEN[3]. [1]Novasep Inc., 23 Creek Circle, Boothwyn, PA 19061, [2]Novasep Process, Site de Saint-Maurice de Beynost, 5 chemin du Pilot, 01798 Miribel, France and [3]Danisco, Sokeritehtaantie 20, 02460 Kantvik, Finland. **Improved betaine recovery during molasses desugarization**

using the NS2P chromatography process.

This paper shows how the NS2P (New Sequential, 2-Profile) chromatography system improves betaine recovery compared to traditional SMB (Simulated Moving Bed) systems. The NS2P is a three-fraction chromatography system and also yields improved sugar recoveries in addition to the enriched betaine product stream. It is possible to convert a traditional two-component molasses desugarization plant that produces only sucrose via SMB (and a by-product 'salt' stream) into a NS2P system that yields the additional betaine revenue stream. Typical results show that on a molasses containing 60% sucrose and ~5% betaine purity on dry solids that the extract fraction will contain 91.5-95% sucrose purity at 90.5-93% recovery and that a separate betaine product stream can be recovered at 67-78% purity and 90-98% betaine recovery.

CARLSON, JEFFREY L.* and UPASIRI SAMARAWEERA, Minn-Dak Farmers Cooperative, 7527 Red River Road, Wahpeton, ND 58075. **Improvement in first carbonation sludge settling by selection of a better flocculent addition point and the addition of starch as a second flocculent.**

Improvement in first carbonation sludge settling was sought to increase factory throughput. The addition point for flocculent was changed from the distributor tank to the separate lines feeding the individual trays of the BMA sludge thickener. The change prevented the floc from forming in the distributor, breaking apart then having to reform in the individual settling trays. The change also allowed operators to adjust polymer flow to individual trays to compensate for operational and physical differences. The addition of a starch solution adjusted to pH 11 improved the settling of first carbonation sludge. Starch together with anionic polyacrylamide provides faster settling and a clearer supernatant than either flocculent does individually. Unlike synthetic polymers, the amount of starch used can be determined by need and economics, not regulation.

DeLOREY, DEAN C., The Amalgamated Sugar Company LLC, 3184 Elder Street, Boise, ID 83705. **Water fooprinting – sugar beet processing.**

The total volume amount of fresh water utilized by a business is referred to as the "water footprint". Freshwater is typically supplied by either groundwater wells and/or pumped from rivers. Sugar beet processing facilities are net importers of water since sugar beets contain

approximately 75% water. The amount of supplemental freshwater varies significantly at The Amalgamated Sugar Company LLC facilities. Usage rates are dependent on several variables including the design of the cooling water systems outside of the facilities, available heat sinks within the facilities and the ability to store and reuse excess condensate. Minimizing or eliminating freshwater usage is a goal for all Amalgamated sugar beet processing facilities.

EKERN, ERIC P., Michigan Sugar Company, 2600 South Euclid Avenue, Bay City, MI 48706. **Wedge-wire screens for continuous centrifugals.**

Continuous centrifugals provide very reliable performance for high raw and low raw service except for the relatively short life of their screens. The standard chrome plated nickel screens typically show wear in 30 to 60 days that can result in increased sugar losses. The Michigan Sugar factory in Bay City has been working with Johnson Screens in testing and developing wedge-wire screens for continuous centrifugals. Side-by-side comparison with conventional screens showed equal performance on sugar and syrup quality. Screens tested to date have provided from three to as many as five campaigns of service. They have proven to be a durable, long lasting alternative to the standard screens.

GOVIND, RAKESH[1] and DAVE FERGUSON[2], [1]University of Cincinnati, Cincinnati, OH 45221 and [2]LCP Tech, Inc., 8120 Indian Hill Road, Cincinnati, OH 45243. **Reducing Generation of Biogenic Hydrogen Sulfide in Sugar Wastewaters.**

Sulfate reducing bacteria (SRB), as the name implies, are a group of microorganisms that are capable of reducing sulfate ion to sulfide. Microbial sulfate reduction is a widely distributed process of great ecological importance, but with significant undesirable characteristics and effects. For example, biogenic sulfide generation can induce weakening and decomposition of concrete structures in water collection and treatment systems, and emission of noxious and toxic hydrogen sulfide gas, which has a characteristic “rotten egg” odor, from lagoons, ponds, water tanks, and other bodies of water. Enzymes are non-toxic and are capable of increasing the bioenergetics of sulfide formation. Application of these enzymes to the lagoon influent eliminates the formation of hydrogen sulfide at the source. It should be emphasized that the majority of hydrogen sulfide is formed in the anoxic sediment of the lagoon and the remarkable robustness of SRBs to aqueous biocides is their ability to

form biofilms. Extensive laboratory and field testing of an enzyme mixture has shown reductions of more than 98% in hydrogen sulfide production from typical wastewaters with no increases in aquatic toxicity. This allows the water to be released to a local creek or river or filtered for recycling. In comparison, untreated lagoons accumulated significant amounts of insoluble black metal sulfide precipitates that had to be periodically dredged and landfilled. Also, in untreated lagoons, there was a significant dissolved sulfide concentration which made water re-use unacceptable without significant water treatment costs. The enzyme mixture is typically supplied as a concentrated aqueous solution that is mixed with process water to remove active biofilms and reduce sulfide formation. Application of this enzyme product is a very cost-effective way of reducing hydrogen sulfide emissions from lagoons and rendering the wastewater recyclable for re-use within the plant.

GROOM, DAVID*, HEATHER JARSKI and TERRY McGILLIVRAY, American Crystal Sugar Company, 1700 North 11th Street, Moorhead, MN 56560. **Optimization of betaine recovery in a coupled loop molasses desugarization separator.**

Betaine recovered during the molasses desugarization (MDS) has increased in value over the past few years. Maintaining product quality while maximizing recovery of the betaine-rich fraction has a higher rate of return than in the past. Techniques for optimization of the recovery and quality of the betaine fraction involve the use of a NIR on site at the factory lab. Data from the NIR has proven useful in monitoring the quality of the betaine-rich fraction on a daily basis. In addition, the NIR has proven to be a useful tool in troubleshooting analyzing samples taken to fine tune control valve cut points. Data from the NIR has proven to be a very useful adjunct to the RDS and apparent purity data used to determine operating parameters. With the rapid availability of betaine data, adjustments are made to the MDS train to account for changes feedstock. Data from comprehensive sampling around valve cut points can used to enhance recovery while maintaining product quality. This paper reviews the application of NIR betaine data in optimizing the operation of a coupled-loop separator.

KAWLEWSKI, RON[1], DENNIS J. SAYE[2]* and DAVID W. SCHEIMANN[2], [1]Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284 and [2]Nalco Company, 1601 West Diehl Road, Naperville, IL 60563. **Separation and removal of prelimer suspended solids.**

In preliming, a substantial portion of non-sugars is aggregated as the juice passes through a pH gradient. In a typical process, these aggregated non-sugars pass through subsequent liming and carbonation steps, where some of these solids are returned to the prelimer and may re-dissolve into the juice. Consequently, this may decrease the purity of the clarified "thin juice." The cost of downstream processes increase with the amount of contaminating non-sugars that need to be removed. Previous research conducted by the beet sugar industry has indicated that the purity of thin juice may increase by 0.5% to 0.6% if the solids generated during preliming are removed prior to carbonation. There have been numerous attempts to adopt this practice, and there has been general agreement that this practice could be extremely beneficial. Primarily, solids handling issues have hampered successful implementation. Among these was the fragile nature of prelimer solids and sugar loss resulting from problems in filtering these solids. Previous studies by other investigators have indicated that the physical separation of prelimer solids could be greatly improved by cationic polymer application. In the present research, we have identified and tested two effective anionic flocculants that permit the removal of suspended prelimer solids. During the 2007-2008 campaign, polymer was introduced to the influent of an Enviroclear rapid settler (clarifier) that received a portion of the prelimer effluent. The flocculants that were tested included a food grade anionic flocculent and a new anionic flocculent of very high molecular weight and high mole charge. Both polymers were effective in the capture of prelimer solids in the side stream system receiving approximately 10% to 25% of the factory flow. The resulting floc was found to be robust and amenable to co-filtration with the first carbonation underflow. Filtration of prelimer solids mixed with first carbonation solids did not impact the performance of the Putsch filter presses.

KOCHERGIN, VADIM, Audubon Sugar Institute, LSU AgCenter, 3845 Hwy. 75, St. Gabriel, LA 70776. **Low raw crystallization – is there room for improvement?**

Low raw crystallization is arguably the most important step in a beet sugar factory. Sugar loss with molasses is the largest single loss, and both non-sugar and sugar recycle with low raw sugars leads to increased energy consumption and reduced throughput. Additionally, every sugar boiling increases the fillmass color by 10-20 %. Therefore, every step directed to minimization of recycle and improved centrifuge performance makes significant impact to the bottom line. Growing uniform sugar crystals with correct particle size to assure maximum rate

of crystal growth as well as molasses exhaustion still remains much of an art due to the multiple factors affecting the crystallization and centrifugation processes. A crystal population should be grown allowing for sufficient surface area, however, providing large enough crystals to insure proper surging and minimizing non-sugar recycle with low raw sugars. Procedures will be discussed for evaluation of crystal size distribution in the industrial low raw fillmass and seed slurries. Experimental results showing the variation of crystal size and coefficients of variation of as fillmass is subjected to crystallization and centrifugation will be presented.

PULLAMMANAPPALLIL, PRATAP[1]*, PAUL LANE[1], ABHAY KOPPAR[1], DOUG RENK[1], IOANNIS POLEMATIDIS[1], DAVID CHYNOWETH[1] and ROBERT LEGRAND[2], [1]Department of Agricultural and Biological Engineering, University of Florida, Gainesville, FL 32611 and [2]URS Corporation, Austin, TX 78729. **Demonstration of biogasification of sugarbeet tailings.**

Nearly forty percent of all refined sugar consumed in the USA is made from sugar beets grown in the north central and north western regions of the United States. Beet sugar processing generates significant quantities of solid organic waste called tailings. Raw sugar beets are first washed and separated from "tailings" which mainly consist of sugar beets, weeds, sugar beet tops, debris and soils held by sugar beets when harvested. Usually, these tailings are stockpiled outside the factory and hauled away for disposal into landfills or applied on nearby farmland at a significant cost to the factory. American Crystal Sugar Company operates five processing plants along the Red River Valley in Minnesota and North Dakota. It spends close to $1 million per year disposing 400 tons of tailings that are generated daily just at its East Grand Forks plant.

Sugar production from sugar-beets is an energy intensive operation due to the need for drying and evaporation. The East Grand Forks plant for example spends about $1 million per year for natural gas. Anaerobic digestion (or biogasification) of tailings would generate biogas fuel that could potentially reduce the fossil fuel requirements and moreover fuel would be produced on site guaranteeing a fuel supply that is not subject to price fluctuations.

In this paper we will present the development of a biogasification system to anaerobically digest tailings. A demonstration scale high solids anaerobic digestion system to biogasify 2 tons per day of tailings was constructed and is being operated at the American Crystal Sugar Company, Moorhead. The design was based on laboratory scale

and pilot scale studies at the University of Florida. The design, implementation, construction and start-up of the system will be presented. In addition, the process performance in terms of organic loading rate, methane production rate, methane yield, methane composition in gas phase, effluent soluble COD, residual volatile organic acids and pH will be presented. The design of a full-scale system and a techno-economic feasibility analysis of such a system will also be presented.

ROGERS, GALAN M.*, KAREN CUMMINGS and TOM DOLECHECK, The Amalgamated Sugar Company, 50 South 500 West, Paul, ID 83347. **Mini-cassia mud pond settling problems and the solutions in new separation technology.**

The Mini-Cassia Factory of the Amalgamated Sugar Co. experienced an infection in the mud pond that prevented settling of fine solids. Foam and fine solids returning from the mud pond contaminated the beet tailings transported in the flume water. The remedy involved the removal of vegetable matter from the flume water, then separating the dirt from the flume water economically. A series of screens, hydroclones, and belt filters presses were used to accomplish this task. The majority of the coarse dirt was mechanically removed with hydroclones before the use of polymers to coagulate fine particles fed to belt filter presses. This method of dirt removal uses minimal amounts of polymer, will eliminate the mud pond, and reduce overall maintenance costs.

SAMARAWEERA, INDRANI S.[1]*, TERRY D. McGILLIVRAY[1], DIANE L. RHEAULT[1] and DENNIS BURTHWICK[2], [1]American Crystal Sugar Company, 1700 North 11th Street and [2]2500 North 11th Street, Moorhead, MN 56560. **Microbial issues encountered in wastewater treatment at Moorhead factory and remedial measures.**

Wastewater treatment is an integral part of slicing and processing of sugar beets in the sugar industry. American Crystal Sugar Company has 5 factories. Three of these factories have a 6.7 million gallon anaerobic contactor, aerobic basin and ponds for processing of wastewater while the other two factories have lagoons and wetlands for the treatment of their wastewater. During the 2007/2008 campaign our efforts were focused on microbial issues in wastewater treatment at the Moorhead factory. Therefore this paper will discuss problems encountered with filamentous bacteria, chlorination studies, nutrient addition, heat treatment of anaerobic influent and differences in the Moorhead and Hillsboro anaerobic systems. The remedial measures taken at Moorhead factory

allowed us to finish processing of wastewater about three weeks ahead of the previous campaign.

TZSCHAETZSCH, OLIVER[1]*, BILL JACOB[2] and TIM PRYOR[2], [1]ESCON, D-12165 Berlin, Germany and [2]ARI, Twin Falls, ID 83303.
Fractal applications for sugar factory decolorization processes.

Ion exchange decolorization to date plays no significant role in white sugar production from sugar beet. An increasing demand for high performance decolorization equipment in the refining and liquid sugar industry has pushed ion exchange resin manufacturers to improve selectivity, kinetics, color uptake capacity and cycle lifetime of their products. Fractal processing equipment allows for the best possible utilization of the advantages of the enhanced resins resulting in extremely effective and compact systems. In conjunction with nanofiltration systems the demand for water and salt as well as the waste water production are significantly reduced. Thick juice or molasses desugarisation extract are disposing of very high colors in comparison to typical cane liquors. Trials to decolorize these products in fractal decolorizing systems have proved successful thus representing a backup or alternative for existing unit operations. The flow turndown ratios of fractals allow for the combination of high throughput thin juice softeners and comparably low flow syrup decolorization applications in one dual-use installation helping to further improve economics.

SECTION F – FACTORY OPERATIONS
POSTER PRESENTATIONS

None Submitted