ABSTRACTS

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Managing nitrogen to achieve low soil nitrate-N amounts before sugar beet production is important to grow high quality sugar beet. A majority of Southern Minnesota Beet Sugar Cooperative producers grow corn before sugar beet production in the rotation. The objective in this study was to determine the effect of nitrogen application rate for corn production on the soil nitrate-N before sugar beet production. The study involved five sites with a soybean/corn/sugar beet rotation. Because of weather conditions, only three of the sites were completed through the sugar beet production year. A split plot experimental design with five replications was utilized. The whole plots were N applications before corn production of 0, 134, and 224 kg N/ha. The 134 kg N/ha is the recommended application rate while the 224 kg N/ha is considered very aggressive. Before sugar beet was grown, the whole plots were divided into N application rates of 0, 45, 90, 134, 179, and 224 kg N/ha. Soil nitrate-N was measured to a depth of 120 cm after each crop in the rotation. Corn yields and sugar beet root yields and quality were measured. At four of the five sites, the use of 224 kg N/ha for corn production resulted in significant increases in residual soil nitrate-N when compared to the corn grown with 134 kg N/ha. These effects were reflected in the sugar beet yield and quality measured at the three sites where sugar beet was harvested.

The micro-rate of desmedipham or desmedipham + phenmedipham or desmedipham + phenmedipham + ethofumesate plus triflusulfuron plus clopyralid plus methylated seed oil at 0.08 plus 0.004 plus 0.03 lb/A plus 1.5% v/v has been used in experiments since 1996 and used commercially since 1998. The micro-rate was used an average of 2.4 to 3.1 times per acre from 2001 through 2005. The average weed control from the micro-rate has been declining recently suggesting that common...
weeds such as pigweed spp., common lambsquarters and kochia are developing increased tolerance to the herbicides.

ELISON, DAVID M., The Amalgamated Sugar Co. LLC, P.O. Box 700, Paul, Idaho 83347. Improvements and innovations in vented pile storage methodology and construction.

The process of ventilating outside stored sugar beet piles has seen many years of improvements and refinements and been worked on by many individuals. The basic approach is sound and productive. The labor intensiveness and cost of materials to achieve the proper results have always been key factors in deciding its usage as a storage approach. The development of new methodologies, and use of new materials and instrumentation have made the assembly, the operating and monitoring of ventilated storage more feasible. Some examples are: 1) The reconfiguration of vent holes in tarping to lesson billowing and wind sail, as well as facilitate removal. 2) The sewing of smaller sections of tarping material together to form an integral cover over the whole pile and securing it. 3) The construction of inexpensive plenum bladders to deliver air to multiple pipe runs from one fan assembly. 4) The use of thermal couples to not only monitor pile temperature but to also control the operation of fans during critical cool down period and regulate their operation. 5) The use of remote computer accessing software to monitor the conditions and operation of distant storage piles from the convenience of an overseers home or office and hence save time, fuel, and save materials in some instances. 6) Labor saving procedures for achieving construct of the vent pile etc. The ability to ventilate metabolic heat from beet piles effectively with minimal cost as well as provide a protective barrier from weathering of the “crust” of the pile is a well sought after goal which in most storage years can be achieved.


A study was conducted over two years examining the effect of amide herbicides on sugarbeet injury and weed control. S-metolachlor and dimethenamide-P were applied to sugarbeets preemergence and at the two-leaf stage of sugarbeet growth. S-metolachlor was applied at rates of 0.72 kg ai/ha, 1.0 kg ai/ha and 1.4 kg ai/ha. Dimethenamide-P was applied at rates of 0.42 kg ai/ha, 0.63 kg ai/ha and 0.84 kg ai/ha. Regardless of herbicide rate, dimethenamide-P applied preemergence resulted in sugarbeet injury each year. S-metolachlor applied preemergence at rates of 1.4 kg ai/ha and 1.0 kg ai/ha also caused sugarbeet
injury each year. In one of two years, s-metolachlor applied preemergence at 0.72 kg ai/ha resulted in sugarbeet injury. Sugarbeets were not injured when herbicides were applied at the two-leaf stage of growth. In one of two years, *Amaranthus retroflexus* control was similar between treatments when s-metolachlor and dimethenamide-P were applied preemergence regardless of herbicide rate. Emerged weeds were not controlled when s-metolachlor and dimethenamide-P were applied at the two-leaf stage timing.

**HUBBELL, LEE A.*, JAMES F. STEWART, and DAVID B. WISHOWSKI, Michigan Sugar Company, 341 Sugar Street, Carrollton, MI 48724.** Determine the ideal population in 30 inch row spacing.

Over the last 25 years the number of seeds planted per acre by our growers has increased significantly. This change came after we documented the advantages of thicker beets in research trials that compared populations up to 160 beets per 100 feet (27,878 beets per acre) and later up to 200 beets per 100 feet (34,848 beets per acre). The seed spacing used by our growers decreased over 34% from 6.54 inches in 1982 to 4.30 inches in 2006. In recent years, growers have become concerned about the beets being too thick. The trial we conducted compared thinned populations from 60 to 300 beets per 100 feet, (10,454 to 52,272 beets per acre). The tons per acre and the recoverable sugar per ton were both less at the thinner populations. Recoverable sugar per ton increased up to the thickest population of 300 beets per 100 feet. The yield, in tons per acre, decreased at the highest populations.

**JANSEN, RUDOLF, KWS SAAT AG, P. O. Box 1463, Einbeck, D-37555 Germany. Exploiting the genetic potential of sugarbeets.**

The world record of 21,140 pounds of sugar per acre, reached near Brawley, CA, USA is an indication of the genetic potential of marketed varieties grown under optimal conditions. The negative correlation between sugar content and yield as well as the impact of pests and diseases on the crop create the major bottlenecks for yield. With fewer and fewer sugarbeet specific agrochemicals being developed and with the increasing demand for environmentally friendly products, breeders have to invest more to keep this crop competitive. The recent development of Rhizomania and Nematode tolerant varieties are promising examples for breeding progress. Modern biotech tools enable breeders to exploit the genetic variation of genetic resources faster than in earlier times. Thus the gain from selection is increasing over time. After having achieved herbicide tolerant varieties breeders are now working hard on other objectives, one of which is to develop so called “winter-beet” varieties.
suitable for longer processing campaigns and for a much wider range of growing conditions; conditions which would cause 100% bolting along with frost damage to regular varieties. This type of winter-beets can only be achieved by transformation technology, which offers still additional opportunities with different priorities set by the individual breeding companies.

LAMB, JOHN A.1*, MARK W. BREDEHOEFT2, and STEVEN R. ROEHL2, 1University of Minnesota, 439 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108, and 2Southern Minnesota Beet Sugar Cooperative, P.O. Box 500, 83550 County Road 21, Renville, MN 56384. Are rhizomania resistant sugar beet varieties nitrogen hogs?

Nitrogen management is important for optimum yield and quality of sugarbeet. Rhizomania is a soil born disease that affects the quality and yield of sugarbeet. The disease has been reported to affect the nitrogen nutrition in the sugarbeet. New sugarbeet varieties have been developed that have different resistance to rhizomania. The question is if the new varieties require a change in the amount of nitrogen needed for optimum yield and quality. A study was conducted from 2003 to 2005 to determine if rhizomania resistant varieties require different N guidelines than the non-resistant varieties. A factorial of varieties and N rates were used as treatments on both small plot and field scale strips in nine locations. The varieties were non-resistant, resistant with low quality, and resistant with high quality. Soil nitrate-N was measured at the beginning of the study while root yield and quality and residual soil nitrate-N was measure at the end of the growing season. The study concluded that no adjustment in the N guideline was needed for rhizomania resistant varieties.

MORISHITA, DON W.1*, STANLEY R. GORTSEMA2, JERRY D. NEUFELD2, AND DALE L. BAKER2, 1University of Idaho, Twin Falls R&E Center, P.O. Box 1827, Twin Falls, ID 83303-1827 and 2University of Idaho, Power, Canyon, and Minidoka County Cooperative Extension. Two year in-field sprayer calibration survey of sugar beet growers.

Sugar beet growers in Idaho and eastern Oregon typically make three to five sequential postemergence herbicide applications for successful weed control. Objectives of this survey were: 1) check the calibration accuracy of sprayers in the field; 2) conduct sprayer calibration presentations at grower meetings; and 3) conduct a follow-up survey in 2006. Amalgamated Sugar Company agronomists and fieldmen were relied upon for their knowledge and connection to the growers. In the field, applicators were stopped to collect spray for 30 seconds. The applicator or grower provided their desired spray volume, sprayer
speed, and spray bandwidth. Actual sprayer speed was determined by measurement or with a GPS unit. Spray bandwidth also was measured in the field. Spray volume was calculated from the measured variables. Average bandwidth in 2005 was 5% too wide and 2% too narrow in 2006. Sprayer speed was very close to the desired rate in both years, averaging 1 and 0.1% too slow in 2005 and 2006, respectively. However, speed ranged from 33% too slow to 16% too fast over both years. Average spray volume was 5% below desired in 2005 and 3% above in 2006. However, spray volume had the widest range of all variables and ranged from 75% below to 31% above the desired spray volume. Using a 90% calibration accuracy as the benchmark, 54% were within the accepted range in 2005 and 59% were acceptable in 2006. Results from these two years show that growers need to check the calibration of their sprayers more frequently, since growers say they calibrate their sprayers at the beginning of the season. Further educational efforts are needed to increase the calibration accuracy of sprayers used for weed control in sugar beets.

MORISHITA, DON W.*, MICHAEL P. QUINN1, ROBYN J. WALTON1, AND MICHAEL A. BECERRA2, 1University of Idaho, Twin Falls R&E Center, P.O. Box 1827, Twin Falls, ID 83303-1827, and 2Idaho Food Quality Assurance Laboratory, Twin Falls, ID 83303.

Ethofumesate carryover potential in wheat and barley.

The ethofumesate label restricts planting only ryegrass or sugar beet less than 12 months after applying ethofumesate in sugar beet. Consequently, growers can be severely restricted the following year. A study was conducted from 2004 to 2006 at the University of Idaho Research and Extension Center near Kimberly to: 1) determine spring wheat and barley injury potential to various ethofumesate rates and application timings on sugar beet and; 2) determine ethofumesate dissipation rate. Sugar beet was planted in 2004 and 2005. Ethofumesate was applied preemergence and postemergence in an 11-inch band and broadcast in sugar beet. Ethofumesate was applied preemergence at 1.75, 2.25, and 3.0 lb/A. These treatments were followed by three sequential standard herbicide applications. In the postemergence only treatments, ethofumesate was added to the second application at 0.75 lb/A, and to the third and fourth applications at 1.38 lb/A at about 7 d intervals. Spring wheat and barley were planted in April the year following each sugar beet crop. An ethofumesate soil dissipation study also was conducted with pre- and postemergence ethofumesate applications. Wheat and barley injury for both years ranged from 0 to 9% for all herbicide treatments. In 2005, injury differences were observed among
herbicide treatments in both wheat evaluations and the first barley
evaluation. No injury differences were observed in 2006. There were no
differences in wheat or barley yield between the control and any of the
herbicide treatments in either year, indicating no injury potential using
high ethofumesate rates. Ethofumesate dissipation studies indicate that
ethofumesate reached non-detectable levels (<13 ppb) by the end of
September or October of the application year.

ODERO, DENNIS C.*, ABDELOUHAB MESBAH, and STEPHEN
D. MILLER, 1University of Wyoming, Department of Plant Sciences,
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Interference of broadleaf weeds in sugarbeets.
There has been increased infestation of Venice mallow (Hibiscus
trionum L.), lanceleaf sage (Salvia reflexa Hornem.), wild buckwheat
(Polygonum convolvulus L.), and redstem filaree [Erodium cicutarium (L.)
L’Hér. ex Ait.] in sugarbeet fields within the Bighorn Basin of Wyoming.
Field experiments were conducted in 2005 and 2006 at the Powell Research
and Extension Center near Powell, Wyoming to determine the effect of var-
isious densities and duration of competition of these weeds on sugarbeet. In
2005, the densities were comprised of 2, 4, 6, 8, and 10 plants/m of sugar-
beet, while the duration of competition was 2, 4, 6, 8, 10 and 12 weeks at a
density of 6 plants/m. Sugarbeet root yield decreased as densities of Venice
mallow increased. However, no significant effect was shown for densities
of wild buckwheat, and sucrose content for both Venice mallow and wild
buckwheat. There was poor establishment of lanceleaf sage and redstem
filaree in 2005; therefore, no data was collected. In 2006, the weed densi-

ties were increased to 6, 12, 18, 24, and 30 plants/m of sugarbeet row. The
duration of competition remained the same with a density of 18 plants/m of
sugarbeet row. Sugarbeet root yield decreased as weed densities increased.
Similarly, root yield decreased as duration of competition increased.

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University Extension Sugar Beet Educator / Sugarbeet Advancement,
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2,3,4,5Michigan Sugar Company, 2600 S. Euclid Avenue, Bay City, MI
48706. Impact of genetic resistance to sugarbeet cyst nematode on
yield and quality of sugarbeets.
Sugarbeet cyst nematode can cause significant yield loss in many sugarbeet producing areas of the United States. Field trials were conducted to compare the yield of a sugarbeet cyst nematode resistant variety to conventional varieties. Studies were conducted in multiple locations throughout Michigan in fields known to be infested with sugarbeet cyst nematode. The resistant variety planted in the study was B-5534N developed by BetaSeed. Compared to conventional varieties, sugarbeet yields were improved by up to ten tons per acre in the fields with high levels of sugarbeet cyst nematode. In trials with no sugarbeet cyst nematode, the resistant and conventional varieties produced a similar yield. Soil sampled from sugarbeet roots of the resistant variety, contained a lower population of sugarbeet cyst nematode compared to soil sampled from roots of the conventional varieties suggesting, sugarbeet cyst nematode reproduction may have been affected by planting the resistant variety.

REGITNIG, PETER J.*, and JENNIFER J. NITSCHELM, Rogers Sugar Ltd., 5405 – 64th Street, Taber, Alberta, T1G 2C4. Chemical and mechanical control of group 1 resistant wild oats.

Populations of group 1 herbicide resistant wild oats are regularly found in the sugar beet production area of southern Alberta. Soil-applied herbicides are commonly used for broadleaf weed control in Alberta, but current sugar beet products are not considered to be highly effective on wild oats when applied alone. Experiments conducted between 2002 and 2006 evaluated various soil-applied herbicide treatments as well as mechanical treatments for wild oat control and crop safety. In 2002 and 2003, preemergence applications of ethofumesate + triallate showed promise as a non-group 1 option for wild oat control; however, treatments with this tank-mix combination resulted in significant sugar beet injury and stand reduction in 2004. In 2005 and 2006, preplant incorporated applications of triallate combined with preemergence applications of ethofumesate resulted in excellent wild oat control and acceptable levels of sugar beet injury. Highly significant root yield increases for preplant incorporated + preemergence treatments ranged from 6.1 to 13.4 tonnes per acre over a weedy check. Mechanically clipped treatments had root yields up to 9.3 tonnes per acre higher than a weedy check, but increases were lower than for chemical treatments in a test which included both.
SIMS, ALBERT L. *1, CAROL E. WINDELS 1, and CARL A. BRADLEY 2. 1University of Minnesota, Northwest Research and Outreach Center, 2900 University Ave., Crookston, MN 56716, and 2North Dakota State University, Walster Hall, Box 5012, Fargo, ND 58105-5012. Field applications of sugar factory spent lime: Effects on soil phosphorus.

Spent lime generated during the purification process in sugar production has historically been stock piled near the factory of origin. Recent evidence indicates that field applications of spent lime may reduce Aphanomyces root rot, a disease increasing in prevalence in sugar beet producing regions. Chemical analysis of spent lime from seven sugar beet factories in Minnesota and North Dakota revealed variation in phosphorus (P) concentration ranging from 3500 to 7000 mg P kg⁻¹ spent lime. At these P concentrations, land application of 20 metric tons of spent lime ha⁻¹ would also apply 70 to 140 kg P ha⁻¹. Spent lime was applied at five rates in two experimental sites 150 km apart. One growing season after spent lime application, NaHCO₃ extractable P (Olsen P) increased about 0.4 mg P kg⁻¹ for each 1 metric ton spent lime applied ha⁻¹ at both locations. After two growing seasons, Olsen P increased 0.2 mg P kg⁻¹ for each 1 metric ton spent lime ha⁻¹ at one location. At the other location, Olsen P increased as spent lime rates increased, but the response was considerably different than previously observed.

SMITH, JOHN A. *, C. DEAN YONTS, ROBERT M. HARVESON, ROBERT G. WILSON and GARY L. HEIN, University of Nebraska, 4502 Ave. I, Scottsbluff, NE 69361. 30 inch vs. 18 inch row sugarbeet production — Nebraska research and grower experiences.

The predominate row spacing used for sugarbeet production in Nebraska is 30 inches. Significant research exists that shows narrower row spacing, 22 inches or 18 inches for example, would increase sugar yield. The University of Nebraska and the Nebraska sugarbeet industry conducted a three year replicated field strip comparison of 30 inch row and 18 inch row sugarbeet yields; and one year of large scale production of 18 inch row sugarbeets in fields of four growers. The three year, field strip research, using field scale equipment, indicated 18 inch rows increased sugar yields compared to 30 inch rows by 1.8 tons/A and 0.5% sugar content, when averaged over the three year study. When the four growers averaged their contract yields for 18 inch row production and compared to their conventional 30 inch row contract yields, there was no difference in sugarbeet yield between the two row spacings. The 18 inch rows presented several practical large scale field production issues that likely suppressed any potential yield advantage for the 18 inch rows.
for the four producers. These issues included early season weed control, guess rows, clearance between rows for tires and equipment components, and a high harvest loss. Three technology items, now available to producers, will address three of the major practical problems incurred by the Nebraska producers who tried 18 inch rows in 2003. Roundup Ready varieties will provide weed control in narrow rows; functional sub-inch auto-steer will assure accurate guess rows; and the European style self-propelled harvester with front mounted defoliator, scalper, and lifter will reduce harvest loss in 18 inch row production.

STEWART, JAMES F.*, COREY J. GUZA, LEE A. HUBBELL, DAVID B. WISHOWSKI, and MARK A. ANDERSON, Michigan Sugar Company, 2600 South Euclid Avenue, Bay City, MI 48706. 

Influence of a Cercospora tolerant sugarbeet variety on the BEETCAST prediction model.

Cercospora leafspot is a serious disease problem in Michigan. Damage to the sugarbeet plant can occur prior to visual symptoms of the disease. Cercospora leafspot development is closely linked to weather conditions so timing fungicide applications just prior to visual disease symptoms using a prediction model can improve sugarbeet yields. The objective of this study was to evaluate the efficacy of BeetCast, a disease forecasting model, utilizing sugarbeet varieties with varying degrees of resistance to Cercospora leaf spot. The trial was designed as a split plot design with spray timings as the main treatments and sugarbeet varieties as the secondary treatments. The fungicide application timings were: 55/55 DSV, 70/70 DSV, traditional scouting, reduced spray program and an untreated control. The sugarbeet varieties planted, ranging from a moderate to a high level of Cercospora resistance were: Beta 5451, HM 7172 and Crystal 355. Sugarbeets were evaluated for visual disease symptoms, root weight and quality. The 55/55 DSV treatment provided the greatest control of Cercospora leaf spot among all varieties tested. All of the fungicide treatments had lower levels of disease compared to the untreated control. Beta 5451 and HM 7172Rz showed a greater response to more intensive fungicide application timings compared to Crystal 355 indicating that varieties with high levels of Cercospora leafspot resistance can be treated less aggressively than varieties with lower levels of resistance.

TELCK, ALAN B., AgTerra Technologies, Inc., 1402 Sugarland Dr., PO Box 5083, Sheridan, WY 82801. 

Agriculture information systems for the beet sugar industry.

Today, collecting accurate information from growers and deliver-
ing meaningful reports is more important than ever for companies in the sugar industry. Near real-time data collection and reporting provides competitive advantage and improves value-added services for sugar companies and their growers. The challenge in the past has been collecting accurate information in a timely and complete fashion so analyses could be passed onward to growers. Newer computerized technologies and widespread use of the Internet now allows companies to produce agriculture information systems that quantifiably impact production and quality. Discussed and shown will be some of the technology employed by AgTerra Technologies, Inc. being used in the sugar industry including Internet based forms and reports, Geographic Information Systems (GIS), Pocket PC, and digital pen and paper applications.

WILSON, ROBERT G.*, JOHN A. SMITH, and C. DEAN YONTS, University of Nebraska, 4502 Avenue I, Scottsbluff, NE 69361. Late season weed control in sugarbeets by hand-weeding, mowing, or selective application of glyphosate.

Field experiments were conducted over a three-year period near Scottsbluff, Nebraska to evaluate weed control from hand-weeding, mowing, or applying glyphosate over the top of sugarbeet with a canvas applicator. Four weeds were evaluated in each plot by planting corn, sunflower, kochia, or common lambsquarters in a separate sugarbeet row, every 1.5 m, after the crop had emerged. Weed control treatments were initiated after weeds had emerged above the sugarbeet canopy in either early or mid-August. Treatments consisted of hand-weeding, removing the weed from the plot; mowing, removing the top of the weed protruding above the sugarbeet canopy; or applying glyphosate with a canvas covered applicator to the top of the weed protruding above the sugarbeet canopy. The three treatments were applied in either early-August, mid-August, or on both dates. These treatments were compared to non-treated plots where weeds were allowed to grow with the crop. Mowing the top off of kochia and common lambsquarters did not kill the plant but did cause the plant to regrow from stems below the sugarbeet canopy. Although weeds regrew, the plant height was reduced and more sunlight reached sugarbeet leaves. Corn and sunflower plants that were mowed either died or continued to grow slowly where the top of the plant was removed. Weeds treated with glyphosate either died or were injured by the herbicide. In some situations, glyphosate dripped from the applicator or from treated weeds and killed sugarbeets growing next to weeds. Corn and sunflower were suppressed more by glyphosate than kochia and common lambsquarters. On average weeds that were allowed to grow with sugarbeet all season reduced root yield 27%. If
weeds were mowed in early-August they caused a 5% reduction in sugarbeet root yield while weeds treated with glyphosate in early-August caused a 26% yield reduction. Mowing weeds that protrude above the sugarbeet canopy was more effective than treating with glyphosate for late season weed management.

WILSON, ROBERT G., University of Nebraska, 4502 Avenue I, Scottsbluff, NE 69361. Influence of ALS-resistant kochia control in corn on kochia control the following year in sugarbeet.

A field study was initiated near Scottsbluff, Nebraska to evaluate the efficacy of herbicides for controlling ALS-resistant kochia in sugarbeet following various degrees of kochia control in corn the previous year. Glyphosate-resistant corn was treated postemergence with four different weed control treatments in 2005. Kochia control of 50, 71, 85, and 99% was obtained from the four weed control treatments utilized in corn. The four levels of kochia control became main plots in 2006 when glyphosate-resistant sugarbeet were planted. Each of the main plots was divided into six sub-plots that were treated with a different sugarbeet weed control program. Kochia density in sugarbeet averaged 6, 3, 2, and 1 plant/m² in main plots where in the previous year kochia control had been 51, 71, 85, and 99%, respectively. A conventional treatment of phenmedipham plus desmedipham plus triflusulfuron plus clopyralid at 0.18 plus 0.18 plus 0.018 plus 0.10 kg/ha applied four times (Full-rate) provided acceptable kochia control in some main plots. When the Full-rate was applied to main plots where 50 and 99% kochia control had been obtained in 2005, kochia control in sugarbeet was 12 and 81%, respectively and demonstrates the benefit of investing in kochia control in the previous corn crop.

YONTS, C. DEAN, University of Nebraska, 4502 Ave. I, Scottsbluff, NE 69361. Impact of mid-season water stress on sugarbeet growth.

In much of the irrigated sugarbeet growing region of the central high plains, adequate water supply continues to be in question. Drought and lack of winter snow pack means reservoirs are at or near record low levels. In other areas declining ground water levels are resulting in pumping restrictions being placed on growers. In either case, less water is available for crop production and is subsequently forcing changes in production practices. Producers facing water shortages have several options, grow crops that require less water, allow water stress to occur with crops that require more water, convert a portion of their acres to dryland or develop a strategy to use a combination. The objective of this experiment is to determine the production potential of sugarbeets
when irrigation is withheld during the greatest water use period of July and August. During the experiment, irrigation was withheld starting on July 20. Irrigation was then applied at 1, 2, 3, 4 and 5 week intervals. For each treatment, irrigation was continued for the remainder of the season and was intended to meet the future needs of the sugarbeet crop. Soil water content and yield parameters were collected. Sugarbeet yield was similar for the irrigation treatments tested in both 2003 and 2004. Results from field studies conducted from 2003 to 2006 will be presented.
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 population on weeds and sugar beet yield and quality in Michigan.

The introduction of glyphosate-resistant sugar beet varieties, in combination with narrow row planting widths, has the potential to reduce labor and herbicide inputs for sugar beet production. The objective of this research was to evaluate the effects of row spacing, plant population, and weed removal timing on glyphosate-resistant sugar beet production in Michigan. A field trial was established in 2006 at the Michigan State University Saginaw Valley Bean and Beet Research Farm. Sugar beets were planted at two row widths, 38- and 76-cm, and stands were thinned at the 4-leaf stage to populations of 54,226, 77,467, and 100,707 plants/ha. For each row spacing and plant population combination, glyphosate was applied when weeds were either 10 cm or 20 cm tall. Additionally, there were weed-free and untreated control treatments. Sugar beets were mechanically harvested and root weight measured for the inner two rows. For both row widths, plant population had no significant effect on root yield; however, root yield was 29% greater for sugar beets planted in 38-cm rows compared with sugar beets planted in 76-cm rows, for the weed-free control. Within each row width, weed removal timing did not affect root yield. Canopy cover measurements were also taken throughout the growing season. Beets planted in 38-cm rows exhibited significantly greater canopy closure than beets planted in 76-cm rows at each sampling time and achieved at least 90% closure at 70 days after planting. Plant population did not have a significant effect on canopy closure.

BOLLMAN, SCOTT L.*, and CHRISTY L. SPRAGUE, Michigan State University, 478 Plant and Soil Sciences Bldg., East Lansing, MI 48824. Response of four commercial sugar beet varieties to s-metolachlor and dimethenamid-P.

Previous field research in Michigan has shown that sugarbeet varieties respond differently to s-metolachlor and dimethenamid-P applied preemergence (PRE) and to 2-leaf sugar beets. Greenhouse trials were conducted to evaluate the response of four commercial sugar beet varieties to s-metolachlor and dimethenamid-P and to determine if differences in tolerance were due to herbicide absorption through roots or
leaves of sugar beets. At the 2-leaf stage of sugar beets, s-metolachlor and dimethenamid-P were applied directly to the soil, to the sugar beet leaf surface (vermiculite covering the soil surface), or to both the leaf and soil surfaces. The greatest injury to sugar beets occurred from applications directly to the soil compared with applications to the leaf surface, indicating that herbicide absorption through the roots or the hypocotyl of the plant is what is primarily responsible for the injury that is observed from these applications. Applications of dimethenamid-P caused greater sugar beet injury than applications of s-metolachlor. Of the four sugar beet varieties tested, Beta 5833 was more tolerant to both herbicides compared with the other three varieties and HM 7172 was the most susceptible variety. Additional experiments were conducted in hydroponics to determine if differences in soil behavior of these two herbicides influenced sugar beet tolerance to these herbicides. Under hydroponic conditions, there were no differences in sugar beet tolerance between s-metolachlor and dimethenamid-P, indicating that differences in how these herbicides behave in the soil is a main contributor to why there are differences in the magnitudes of injury observed between these herbicides in the field.

ECKHOFF, J. L. A*, and C. R. FLYNN, Montana State University, Eastern Agricultural Research Center, 1501 N. Central Ave, Sidney, MT 59270. Fine-tuning nitrogen recommendations for sprinkler and flood irrigated sugarbeet.

Good nitrogen management is one of the most important aspects of a high-yielding, high-quality sugarbeet (Beta vulgaris) crop. Not enough N limits yield. Too much N reduces quality, can cause surface and ground water contamination and increases input costs. An irrigation management study showed that sugarbeet under sprinkler irrigation had higher impurity content and lower extraction than flood irrigated sugarbeet. The objective of this study was to fine-tune nitrogen recommendations for sugarbeet produced under sprinkler and flood irrigation. Plots with varying rates of nitrogen were set up under a linear overhead sprinkler irrigation system and under furrow flood irrigation. Test sites were located next to each other each year. Soil is Savage silty clay. Pesticides and irrigation water were applied as needed. Four wells that reached ground water were placed under each irrigation system and ground water was sampled for nitrate-N content throughout the growing season. Sugarbeet petioles were collected from each plot during the growing season and analyzed for nitrate-N content. When analyzed across 3 years, sugarbeet under flood irrigation had greatest root yield, sucrose yield, and extractable sucrose with 197 kg/ha available N.
Sugarbeet under sprinkler irrigation had greatest root yield, sucrose yield, and extractable sucrose with 141 kg/ha available N. Under flood irrigation, impurities and sucrose loss to molasses increased as applied N increased. Under sprinkler irrigation, impurities and sucrose loss to molasses were equally high with any rate of applied N. Sugarbeet petiole nitrate-N contents at all testing dates were slightly greater under sprinkler irrigation than under flood irrigation, although petiole nitrate-N contents under both irrigation regimes were less than 1000 µg/gm by the end of August. Nitrate-N content was greater in ground water under flood irrigated sugarbeet than under sprinkler irrigated sugarbeet throughout the growing season.

HEMB, RANDALL L. 1*, JAMES F. STEWART 2, LEE A. HUBBELL 2, RALPH FOGG 2, COREY J. GUZA 2, DAVID B. WISHOWSKI 2, and STEVEN S. POINDEXTER 3, 1Germains Technology Group, 8333 Swanston Lane, Gilroy, CA 95020, 2Michigan Sugar Company, 2600 South Euclid Ave. Bay City, MI 48706, and 3Michigan State University Extension, One Tuscola Street, Suite 100, Saginaw, MI 48607. Evaluation of XBEET™, an enhanced sugarbeet priming system.

Sugarbeet emergence in Michigan is often difficult to achieve due to soil crusting, cold soils and other factors. Primed seed is typically utilized in Michigan to ensure quicker seed germination and crop establishment. The objective of this study was to evaluate an enhanced sugarbeet priming system being developed by Germains Technology Group. The system is called XBEET. This system is possible because of technological breakthroughs in seed lot calibration, machinery and process control. The objectives of this trial were to compare XBEET treated sugarbeet seed with the standard PAT treatment and with non-primed seed. Six small plot replicated trials were established in 2006. XBEET provided a significant improvement in speed of emergence and final stand at each of the locations. Sugarbeet yield and quality measurements will be taken from these trials. Several replicated strip trials were also conducted which will be discussed.

KING, STEVEN R., Montana State University, Southern Agricultural Research Center, 748 Railroad Highway, Huntley, MT 59037. Weed control programs in glyphosate-resistant sugar beets.

In 2006, two postemergence (POST) weed control programs were evaluated for the control of kochia (Kochia scoparia KCHSC), common lambsquarters (Chenopodium album CHEAL), and wild buckwheat (Polygonum convolvulus POLCO) in glyphosate-resistant sugar
beets. The experiment consisted of 22 treatments with four replications in a split-plot randomized complete block design with either a glyphosate-based herbicide program (RR) or a conventional herbicide program (CONV) as the main plot factor. In the RR program, the first POST treatment was applied to sugar beets in the 2-leaf stage and subsequent applications were applied every 14 d. In the CONV program, the first POST treatment was applied to sugar beets in the cotyledon stage and subsequent applications were applied every 7 d. In the RR program, weed control did not increase when treatments were preceded by ethofumesate applied PRE compared to glyphosate applied alone. In the CONV program, PRE ethofumesate generally increased the control of KCHSC, CHEAL, and POLCO at 109 days after planting (DAP) when treatments were applied either twice or twice plus the layby. Glyphosate alone applied twice controlled KCHSC, CHEAL, and POLCO 90, 91, and 99%, respectively, at 109 DAP. Conventional treatments applied alone twice controlled KCHSC, CHEAL, and POLCO 39, 54, and 84%, respectively, at 109 DAP. In the CONV program, weed control increased as the number of applications increased. Greater KCHSC control was achieved with the RR program compared to the CONV program when the number of applications was equal. Equivalent CHEAL control between the two herbicide programs only occurred when treatments were applied three times followed by the layby treatment and preceded by the PRE application of ethofumesate.

ROEHL, STEVE R.*, RICHARD HORSLEY2, and OSTEN TVEDT1,
1Southern Minnesota Beet Sugar Cooperative, P.O. Box 500, Renville, MN. 56284-0500, and 2North Dakota State University, Plant Sciences Dept., Fargo, ND 58105-5051. Use of a randomized nested block design in genetically modified, non-selective herbicide resistant sugarbeet hybrid testing.

Small-plot research with experimental genetically modified, non-selective herbicide resistant sugar beet (GMNSR), such as glyphosate or glufosinate resistant cultivars can be problematic. Non-GMNSR commercial cultivars are typically required within a GMNSR trial as a means to facilitate comparisons of GMNSR cultivars to the currently approved commercial non-GMNSR cultivars. Non-Target movement of herbicides can easily occur and cause injury to non-resistant cultivars when non-GMNSR cultivars are randomized within a GMNSR experiment arranged in a typical experimental design such as a Lattice or Randomized Complete Block. This may prevent reliable comparisons of GMNSR cultivars to conventional commercial cultivars. Other statistical designs were explored that could facilitate more simple
herbicide application with less risk of non-target movement. In 2004, Southern Minnesota Beet Sugar Co-op implemented a Randomized Nested Block Design (RNBD) that grouped GMNSR and non-GMNSR cultivar replicates separately within the trial. Filler or buffer ranges were used between nests. The potential for non-target movement of herbicide application was greatly reduced. Less concern for drift ultimately allows more timely application of non-selective herbicides. Further, the GMNSR or non-GMNSR cultivar nests within replicates can be sprayed with the appropriate herbicide by traveling down alleys between plot ranges with a commercial size sprayer. This method is more similar to sprayers used in commercial applications rather than spraying individual experimental units with small-plot equipment. A standard experimental design necessitates additional GMNSR seed for unsprayed border rows in addition to hand weeding to remove weeds, so the RNBD also requires less GMNSR seed and hand labor.

SPRAGUE, CHRISTY L.*, and GARY E. POWELL, Michigan State University, Plant and Soil Sciences Building, East Lansing, MI 48824. Timing of postemergence standard-split applications based on growing degree days in sugar beet.

Growing degree day recommendations can be used to time standard-split herbicide applications. Typical recommendations call for the first application of a standard-split program to be made when weeds are 0.63 to 1.25-cm tall and the second application of a standard-split program 7 to 10 days after the first application. In 2005 and 2006, two separate field studies were established in April and May to compare standard-split programs based on different growing degree days (base temperature 34 F) with a typical standard-split program. The herbicides applied included desmedipham & phenmedipham (Betamix) at 374 g ai/ha + triflusulfuron (UpBeet) at 17 g ai + clopyralid (Stinger) at 105 g ai/ha + methylated seed oil at 1% v/v for the first application and the same herbicides with an increased rate of desmedipham & phenmedipham (Betamix) to 560 g ai/ha for the second application. In two of the four studies, several of the growing degree day application programs provided greater weed control than the typical standard-split program timing. However, growing degree day programs with applications that extend over 425 growing degree days on the first or second application resulted in reduced weed control. The optimum timing for a growing degree day standard split program appears to be between 300 and 425 growing degree days.
Identifying risk management zones for Cercospora leafspot control in Michigan.

After the original development of the BeetCast predictive model for managing Cercospora leafspot in a high pressure high inoculum area, observations were made indicating that not all growing regions may respond the same to the model. In areas with lower inoculum levels the disease first appeared at later Disease Severity Values (DSVs). The objective of this study was to validate and refine BeetCast in low inoculum areas and to develop risk management zones for Cercospora leafspot control. Seven locations were selected throughout Michigan; based on disease pressure in Fairgrove (high pressure), Schwab (Medium to High pressure), Croswell (Low pressure), Sandusky (Low to Medium pressure), Twining (Low pressure), Hope (Medium pressure) and Harbor Beach (Medium to High pressure). Fungicide applications were based on accumulated DSVs as well as field observations. Research indicated that in lower pressure areas starting at 70-80 DSVs compared to 55 DSVs followed by additional applications at 55 DSVs may be adequate for managing Cercospora leafspot. Visual ratings for control of Cercospora leafspot as well as sugarbeet root weight, sugar content, and quality were collected.
Sections B & E
Physiology, Biotechnology, Genetics and Germplasm
Oral Presentations

FENWICK, ANN¹, REBECCA L. LARSON², PATRICK A. REEVES³, CHRISTOPHER M. RICHARDS³, and LEE PANELLA²*, ¹Beet Sugar Development Foundation, ²USDA-ARS, SBRU, 1701 Centre Avenue, Fort Collins, CO 80526, and ³USDA-ARS National Center for Germplasm Preservation Fort Collins, CO. Virus induced gene silencing of a gene repressing flowering in sugar beet.

Exposure to a prolonged cold period during winter is necessary for flowering in the next spring in many biennial plants – a process termed vernalization. We have described BvFL1, a vernalization gene in sugar beet (Beta vulgaris), which is a repressor of flowering that is downregulated in response to cold. This gene is a homolog to the MADS-box gene FLOWERING LOCUS C (FLC) found in Arabidopsis thaliana. Flowering time is a trait of critical agronomic importance, and an assessment of function at this key regulatory locus may present an opportunity to study (and control) flowering time as a tool in applied plant breeding efforts. Virus induced gene silencing constructs were engineered into a Barley stripe mosaic virus (BSMV) vector for use in blocking expression of the BvFL1 gene in sugar beet. Four antisense constructs were designed to target sensitive regions of the BvFL1 gene. Engineered BSMV was passaged through Quinoa (Chenopodium quinoa) and applied to sugar beet plants of varied ages to see if flowering could be induced without vernalization.

LARSON, REBECCA¹*, AMY HILL¹, and ALBERTO NUNEZ², ¹USDA-ARS, 1701 Centre Ave., Fort Collins, CO 80526, and ²USDA-ARS, 600 E Mermaid Lane, Wyndmoor, PA 19038. Protein changes associated with sugar beet resistance to Fusarium oxysporum.

Fusarium oxysporum is serious threat to sugar beet production worldwide. Although certain sugar beet lines appear to have resistance against F. oxysporum, little is understood about the basis for that resistance. Examination of F. oxysporum-induced protein changes in the sugar beet will serve two purposes: to identify candidate genes for use in marker-assisted selection and to elucidate mechanisms responsible for resistance. Sugar beet genotype C1200.XH024, with resistance to F. oxysporum isolate F-19, was analyzed at 2- and 5-days post pathogen challenge and compared to mock-inoculated beets. These times correlate with initial infection and vascular tissue penetration, respectively.
A total of approximately 950 proteins were reproducibly detected in the sugar beet leaf and root protein extracts using multidimensional liquid chromatography. One hundred twenty-one proteins were differentially expressed during resistance to F-19. Fourteen were only expressed during initial infection, forty-three once the vascular system was penetrated and forty-nine were expressed at both points. Fifteen proteins were repressed in F-19 challenged tissue in comparison to the mock inoculated control. Seventy protein peaks were analyzed by matrix-assisted laser desorption ionization time-of-flight mass spectrometry, the remaining protein peaks were below the level of detection. This analysis lead to the identification of proteins associated with salicylic acid-dependent resistance, the oxidative burst, signal transduction, photosynthesis, respiration and gene expression and regulation.

LARSON, REBECCA L.1*, ALBERTO NUNEZ2, and WILLIAM M. WINTERMANTEL3, 1USDA-ARS, Sugarbeet Research Unit, Crops Research Laboratory, 1701 Centre Ave., Ft. Collins, CO 80526, 2USDA-ARS-ERRC, Wyndmoor, PA, and 3USDA-ARS, Salinas, CA.

Rhizomania as seen from inside the beet cell: Identifying proteome differences between sugarbeet infected with Beet necrotic yellow vein virus and healthy sugarbeet.

Rhizomania, caused by Beet necrotic yellow vein virus (BNYVV) is one of the most economically important diseases affecting sugarbeet. The disease is characterized by excessive growth of lateral roots and constriction of the taproot, the main sucrose storage site in sugarbeet, resulting in decreased sugar yield. The importance of this disease has been reemphasized by the emergence of new resistance breaking isolates in many areas where resistant sugarbeet is universally planted. This project focuses on identification of proteins induced or repressed during BNYVV infection, with a goal of determining key protein interactions between BNYVV and sugarbeet that contribute to disease. Near isogenic sugarbeet lines varying for the presence/absence of the Rz1 resistance allele were grown under identical environmental conditions in a growth chamber in noninfested soil or soil infested with BNYVV. At three and six weeks after planting, plant material was tested to confirm the presence/absence of BNYVV, and total plant protein was extracted from roots, quantified and fractionated using multidimensional liquid chromatography. Subtractive proteomics determined that only approximately 20 percent of the sugarbeet proteome was influenced during BNYVV infection compared with healthy sugarbeet. Protein identification using tandem MALDI-TOF-MS and sequence analysis has identified several major proteins influenced by infection that are known to be involved in
cellular defense, including polyphenol oxidase, germin-like proteins, polyubiquitin and chitinase among others. Downstream analysis will involve arrays for the identification of interactions between BNYVV and sugarbeet proteins in an effort to identify key interactions driving infection and symptom development.

McGRATH, J. MITCHELL, USDA-ARS Sugarbeet and Bean Research, 494 PSSB, Michigan State University, East Lansing, MI 48824-1325. Integration of genetic, physical, and expression mapping resources for gene discovery and beet improvement.

Expressed Sequence Tags (ESTs) provide an entry into the analyses of 'gene space' at the molecular level. As expression markers, they indicate particular biochemical process that operate in various tissue and organ tissues, and can help discover developmental or response-to-environment pathways that might not have been predicted, for instance as seen in expression of seedling vigor. Most ESTs recovered may not show such an expression 'polymorphism', and these can be used to guide the development of genetic and physical maps that focus on the gene-containing regions of the yet-to-be sequenced sugarbeet genome. These gene-rich regions would be expected to harbor most genes involved in trait expression, and delimiting their genome context could provide for better markers and easier entry into map-based cloning projects. However, generally lower polymorphism levels within EST sequences expected from gene function conservation limits the utility of existing ESTs to serving as templates for re-sequencing to discover SNPs, and only a fraction of these will be expected to be segregating in a population of interest. Converting non-polymorphic markers into ones that can be mapped requires additional sequence information cis-linked to the EST, and BAC library pools can be deployed readily for this task. Once EST-containing BACs are identified, they become physical map markers, and the BAC clone can be searched for polymorphisms appropriate to the population of interest, through inspection of pre-existing BAC end sequences or de novo sequencing of the BAC clone. Using prior knowledge from model plant genomes such as Arabidopsis, genes demonstrated to operate in specific interesting biochemical pathways such as for stress tolerance can be rapidly isolated and characterized once a successful PCR primer pair has been designed.

McGRATH, J. MITCHELL†, and DANIELE TREBBI, †USDA-ARS Sugarbeet and Bean Research, and ‡Department of Crop and Soil Sciences, 494 PSSB, Michigan State University, East Lansing, MI 48824-1325, ‡(current address) Keygene N.V., P.O. Box 216, 6700 AE
Wageningen, The Netherlands. **Genetics of water content in sugar-beet roots.**

Water contributes the greatest portion of harvested sugarbeet weight. Due to the convenience of measuring sucrose in solution, such as that extracted in beet juice, little information on the inheritance of water content in beets is available. Water content has a direct influence on the percent of sucrose determined on fresh beets, and the percent of sucrose as the proportion of total dry matter yield could have consequence for breeding beets with higher sucrose content. Sucrose, water, and dry matter estimates were obtained from a segregating population derived from a single Sugarbeet x Red Table Beet hybrid, and these estimates were used to approximate their inheritance relative to the segregation of molecular markers. Results demonstrated that sucrose content, expressed as the proportion of both fresh and dry weights, was heritable. Harvest yield expressed as beet weight was also heritable, and all yield components co-segregated with water content loci. Incorporation of water weight measures into the East Lansing breeding program have demonstrated that genetic variability for water content is available in tested sugarbeet germplasm, and that commercial hybrids tested have a small but statistically significant lower water content than most East Lansing germplasm under development for release. The proportion of sucrose reflected in dry matter is also heritable, however the range of differences is relatively small, and the most promising route to higher absolute sugar yields in the fields remains increasing total dry (bio)mass.

WINERMANTEL, WILLIAM M.*, AMY G. ANCHIETA, and PATRICIA A. NICELY, USDA-ARS, 1636 E. Alisal Street, Salinas, CA 93905. **Development of novel sources of resistance to Beet curly top virus through virus-induced gene silencing.**

Curly top disease in most areas of the western U.S. is caused by the related curtovirus species, *Beet severe curly top virus* (BSCTV) and *Beet mild curly top virus* (BMCTV). Curtoviruses are transmitted by the beet leafhopper (*Circulifer tenellus*) and cause problems for sugarbeet production in many areas of the western United States. The large number of weed hosts, limitations of curly top resistant sugarbeet varieties, and reduced funding and public acceptance for insecticide application in some areas is making curly top management increasingly difficult. In order to provide more reliable control in a wider array of germplasm, we are using new technologies to engender resistance to the primary curtovirus species affecting sugarbeet production. Virus encoded replicase gene sequences common to both BSCTV and BMCTV, were
designed to include structural features demonstrated to cause virus-induced gene silencing (VIGS), a natural process that causes selective, sequence-specific degradation of viral sequences. When effective, VIGS can prevent virus infection in a wide array of plant species. Short viral sequences were inserted into a \textit{Tobacco rattle virus} (TRV)-based vector in order to test effectiveness of the sequences in suppressing infection by BSCTV and BMCTV. Modified TRV constructs containing different curly top VIGS-inducer sequences were mechanically inoculated to the experimental host, \textit{Nicotiana benthamiana}. BSCTV and BMCTV were inoculated separately at various time points following treatment with the TRV/VIGS inducer constructs. Test plants were monitored for the development of curly top symptoms over time, and scored for disease severity, plant weight, height, and virus concentration. Results with two silencing constructs delayed and reduced curly top symptom development in infected plants and decreased virus concentration compared with plants that were not treated with silencing constructs.
Ethylene production and its effect on storage respiration rate in wounded and unwounded sugarbeet roots.

Ethylene is produced by all seed plants and stimulates respiration in most plant tissues and organs. To understand how this plant hormone may affect postharvest sugarbeet root respiration, a series of experiments were conducted to determine (1) the rate of ethylene production in wounded and unwounded roots, (2) the effect of exogenous ethylene on root respiration rate, and (3) the effect of ethylene synthesis and response inhibitors on the storage respiration rate of wounded and unwounded roots. All experiments were conducted at 10°C. For the wound treatment, roots were severely bruised and abraded by tumbling in a tare lab beet washer for 30 min. This injury caused a two to three-fold increase in respiration rate in the 48 to 96 h after the injury. Ethylene production by unwounded roots averaged 0.11 nmol kg\(^{-1}\) h\(^{-1}\). In wounded roots, ethylene production averaged 1.30 nmol kg\(^{-1}\) h\(^{-1}\) during the first four days after injury, an eleven-fold increase over unwound roots. Treatment with exogenous ethylene at concentrations of 0.02, 0.1, 1.4 and 14 ppm increased respiration in a dose-dependent manner with respiratory increases ranging from 60% at 0.02 ppm ethylene to 130% at 14 ppm ethylene. At 0.02 and 0.1 ppm ethylene, the increase in respiration was transient, lasting only 48 h. At 1.4 and 14 ppm ethylene, the increase in respiration persisted for at least four days. The ethylene response inhibitor, silver thiosulfate, and the ethylene synthesis inhibitor, aminoethoxyvinylglycine, reduced wound-induced respiration rate by approximately 50%, but did not significantly lower respiration rate in unwounded roots. No consistent effect on sugarbeet root respiration was achieved with the ethylene response inhibitor, 1-methylcyclopropene. These results demonstrate that unwounded sugarbeet roots produce low levels of ethylene, that ethylene synthesis is induced by injury, and that ethylene has a role in the increase in respiration that occurs following injury.
Syngenta has developed the first Affymetrix chip with sugar beet sequences. The chip includes sequences from more than 15,000 unigenes from public databases and more than 19,000 BAC end sequences from the BAC library developed by USDA. The total number of probes on the chip is 500,000. The chip can be used both for expression analyses (unigene sequences) and for marker development applications (all sequences). One of the first major applications will be the creation of an ultra-high density map. The chip is available for public research after agreement with Syngenta.

SMIGOCKI, A. C., D. P. PUTHOFF, S. D. IVIC-HAYMES and S. ZUZGA, USDA-ARS, Molecular Plant Pathology Laboratory, BARC-West B004, 10300 Baltimore Ave., Beltsville, MD 20705. A Beta vulgaris serine proteinase inhibitor gene (BvSTI) regulated by sugar beet root maggot feeding on moderately resistant F1016 roots.

Damage from the sugar beet root maggot (SBRM) is a serious problem and control of this devastating pest ultimately relies on environmentally damaging insecticides. To explore novel strategies for management of SBRM and gain knowledge of root defense response mechanisms, we examined root gene expression incited by SBRM in a moderately resistant F1016 and a susceptible parental F1010 line. A gene of particular interest, coding for a serine (trypsin) protease inhibitor (BvSTI), was identified in the F1016 EST library. In addition, BvSTI shares sequence similarity with a tomato gene (LeMir) that is primarily expressed in the maturing epidermis of the root, is induced by invading nematodes, and is secreted to the rhizosphere. Gene expression profiles of BvSTI revealed its regulation by exogenous methyl jasmonate but not mechanical wounding, salicylic acid or ethylene. Given serine proteases comprise the major digestive enzymes in root maggot midguts, our findings suggest that BvSTI may be involved in the resistance mechanism of F1016. To elucidate the functional role of BvSTI in insect resistance and root biology, the BvSTI coding region was fused to the CaMV 35S promoter for overexpression in sugar beet hairy root cultures. Trypsin inhibitory activity increased 2 to 4-fold in the transformed roots. Studies on the effects of the inhibitor on insect mortality and growth rates are in progress. Cloning of BvSTI suggests that the proteinase inhibitor may form a zone of protection surrounding the moderately resistant F1016 roots and act as a first line of defense in the peripheral cell layers.
Host and viral factors that promote the emergence of resistance breaking variants of Beet necrotic yellow vein virus (BNYVV).

The determination of conditions that facilitate the appearance of highly pathogenic viral strains is critical for the development of sustainable disease management strategies. These determinants might reside in the host, or in the infecting viral populations. Resistance breaking (RB) variants of BNYVV have emerged in the “Imperial Valley” of California possibly as a response to the selection pressure imposed by sugar beets (Beta vulgaris L.) carrying the resistant Rz1 gene. These new variants can be differentiated from the wild type virus by specific mutations in its RNA 3 p25 gene. Another characteristic of the pathosystem is that genetic diversity of infecting BNYVV populations apparently increases during the process of overcoming resistance. Thus, in order to test this hypothesis and explore the influence of the host, the genetic structure of a wild type BNYVV isolate was evaluated before and after serial passage through two resistant (Rz1, or Rz2) and one susceptible sugar beet genotypes. The relative virus titer was 1-2 × 10^4 and 2-6 × 10^4 times lower in Rz1- and Rz2-plants, respectively. However, consensus sequencing of single-plant isolates revealed that BNYVV accumulated mutations at least two times faster in resistant plants than in the susceptible control. Preliminary results also suggest that viral factors, such as variant-to-variant competition and virus-to-virus interactions, increase the size and heterogeneity of infecting populations.

A procedure for rapid detection of resistance breaking variants of Beet necrotic yellow vein virus (BNYVV) using real-time RT-PCR allelic discrimination assays.

Resistant varieties of sugar beets, grown in the Imperial Valley of California, have been increasingly damaged by a new strain of BNYVV. Total RNA was isolated from asymptomatic and symptomatic (severe rhizomania disease) resistant plants and a portion of viral RNA 3, including the p25 gene, was amplified by RT-PCR and sequenced. The analysis revealed two polymorphic sites, A67V and D135E, associated
with the capability of the virus to overcome resistance. Based on this data, a set of TaqMan probes was designed for each site to discriminate between wild type (WT) and resistant breaking (RB) variants of BNYVV. The specific fluorescence emitted by each probe was detected and analyzed by an ABI 7000 real-time PCR system and the predicted genotypes were corroborated by DNA sequencing. The capability of this technology to typify numerous isolates facilitated the analysis of the spatial distribution of virus genotypes in the field. Thus, RB variants were mostly baited from yellow strips with high incidence of rhizomania, whereas WT variants predominated in the surrounding green areas. Mixed infections were found mainly in green and transitional zones. The predominance of the RB isolates in yellow strips suggests that they have gained fitness in resistant cultivars and will eventually become the dominant population.

BOETEL, MARK A.*, ROBERT J. DREGSETH, ALLAN J. SCHROEDER, and AYANAVA MAJUMDAR, Department of Entomology, North Dakota State University, Fargo, ND 58105. Seed treatment insecticides to manage soil insect pests of sugarbeet.

Most North American sugarbeet growers are at some level of risk from yield losses due to one or more soil-dwelling arthropod pests that can cause plant stand losses and corresponding yield reductions. Conventional granular and liquid insecticide formulations have been used to manage these pests for decades. Insecticidal seed treatments, if proven efficacious against these pests, would be attractive alternatives to these materials because they are convenient and relatively safe to deploy. Trials were carried out in 2005 and 2006 to compare the efficacy of experimental seed treatments and conventional insecticides against the following: 1) sugarbeet root maggot (SBRM), *Tetanops myopaefomis* Röder; 2) wireworms (*Limonius* spp.); and 3) subterranean springtails (Collembola). Poncho+Cyfluthrin (60:16 g ai/unit [100,000 seeds]) provided similar levels of SBRM control to that of the conventional insecticide (Counter 15G at 11.9 lb product/ac). Excellent wireworm control was provided by Poncho+Betacyfluthrin at two rates (60:8 g and 30:4 g ai/unit), Cruiser 5FS (60 g ai/unit), and Poncho 600 (60 g ai/unit). Results from the springtail trials demonstrated that seed treatments (i.e., V-10170 at 75 g, V-10170+Danitol [60:15 g, respectively], and Poncho+Betacyfluthrin at 60:8 g ai/unit seed were comparable in performance to low and moderate rates (6 to 8 lb product/ac) of Counter 15G. Seed treatments appear to be less likely to cause stand losses due to phytotoxicity than conventional insecticides. Overall, these findings suggest that the experimental seed treatments evaluated are likely to pro-
vide similar levels of root protection from SBRM, wireworms, and subterranean springtails as currently labeled conventional soil insecticides.

BRANTNER, JASON R.*, and CAROL E. WINDELS, University of Minnesota, NW Research & Outreach Center, Crookston 56716. **Control of Aphanomyces damping-off of sugarbeet by hymexazol seed treatment when disease onset occurs at different plant ages and inoculum levels.**

Hymexazol (Tachigaren 70WP) on sugar beet seed decomposes after sowing, so there is a need to know duration of its activity when disease onset occurs at various plant ages and inoculum levels of *Aphanomyces cochlioides*. Seed of Beta 1305R coated with metalaxyl and thiram was treated with 0 (pelleted control), 14 g a.i. (= 20 g product, minimum build-up) or 31.5 g a.i. (= 45 g product, pelleted) of hymexazol per unit (100,000 seed). Seed was sown in soil from two fields naturally infested with *A. cochlioides* at a moderate and severe level and placed in a growth chamber at 18°C to minimize infection. Planting was staggered so plants were at 1, 2, 3, and 4 weeks after planting (WAP) when exposed to 25+1°C to favor disease for 4 days and then 22-23°C for 10 days; soil was kept moist. Under moderate disease, both rates of hymexazol were effective in protecting seedlings from damping-off when onset of favorable conditions occurred at 1, 2, 3 or 4 WAP compared to the control. Under severe disease, the 31.5 g a.i. rate provided better control at most plant ages compared to the 14 g a.i. rate; when disease-favorable conditions occurred 3 WAP, damping-off was statistically the same for both rates of hymexazol and the control. Overall, the 31.5 g a.i. rate of hymexazol was most consistent in controlling damping-off under different disease pressures and plant ages at time of disease onset, but the 14 and 31.5 g a.i. rates provided similar benefits under moderate disease pressure.

DANIELS, JEFFREY L., CHARLES HICKS, KELVEN LUFF, JOHN O. MARTIN, DEAN W. MARUSKA, GEORGE SIMKINS, MICHAEL SMITH, and KEVIN B. THORSNESS*, Bayer CropScience, 2 T.W. Alexander Drive, Research Triangle Park, NC 27709. **Crop protection innovations in sugarbeet - Bayer CropScience.**

Bayer CropScience has developed new innovations for crop protection in sugarbeet. Bayer is developing clothianidin as Poncho Beta seed-treatment, a new highly systemic insecticide with a wide margin of crop safety. Poncho Beta controls beet leaf hopper (*Circulifer tenellus* (Baker)), reducing the incidence of curly top virus, and sugarbeet root maggot (*Tetanops myopaeformis*), wireworm (*Limonius californicus* ...)
(Mannerheim), springtail (*Collembola* spp.), leaf miner (*Pegomya hysocyami*), black bean aphid (*Aphis fabae*) and other insect pests. Poncho Beta treatments have also resulted in significantly more harvestable sugar per acre versus untreated controls. Bayer will introduce in 2007 three new “Ultra” emulsifiable concentrate sugar beet herbicide formulations. The premix desmedipham and phenmedipham (153 & 153 g ai/L) will be sold as Betamix Ultra Herbicide. The premix of desmedipham, phenmedipham and ethofumesate (107 & 137 & 166 g ai/L) will be sold as Progress Ultra Herbicide. Desmedipham at 306 g ai/L will be sold as Betanex Ultra Herbicide. The new Ultra formulations provide equivalent weed control to the previous versions of these herbicides at approximately half the volume.

In 2007, Bayer CropScience will offer a new soluble concentrate formulation of Gem, a strobilurin fungicide for control of cercospora leaf spot (*Cercospora beticola*), powdery mildew (*Erysiphe polygoni*) and suppression of rhizoctonia stem canker (*Rhizoctonia solani*). During 2008, Bayer plans to introduce Proline into the sugar beet disease control market. Proline is a new dimension triazole fungicide which will control all three of the before mentioned diseases. When used in rotation with each other, Gem and Proline will provide growers with a season long disease control program offering sound resistance management practices.

DANIELS, JEFFREY L.*, and MICHAEL R. SCHWARZ, Bayer CropScience, 2 T.W. Alexander Drive, Research Triangle Park, NC 27709. **Relationship of clothianidin plus beta cyfluthrin, combined with build-up coating options, to germination and field emergence of *Beta vulgaris* seeds.**

Sugar beet seed is routinely treated with some level of build-up coating. Seed applied fungicides and insecticides may be a part of this application. It will be important to understand the role that the combination of clothianidin + beta cyfluthrin (Poncho Beta) and seed buildup options play on germination and field emergence. Seven seed sources were obtained from two sugar beet seed suppliers. Each seed source was treated with either fungicide-only (thiram + metalaxyl) or fungicide + Poncho Beta (68 g ai/unit of beet seed) and with one of three buildup options (approximately 10%, 35 % weight gain, or 4m pellet) for a total of six treatments. Field studies were planted near Prosper, ND and Redfield, IA. Germination testing was performed by Germain’s Technology Group (GTG) or Bayer Crop Science (BCS) laboratories. Stand count results show that there were significant differences (P < 0.05) between treatments and between varieties. Poncho Beta produced numerically, if not significantly, higher stand for each com-
comparison at both sites although the amount of buildup was not important. Germination testing also indicated that the level of buildup did not affect germination. Poncho Beta produced a slight, but significant germination delay at day 4 counts in the laboratory. By day 7, there were no significant differences between fungicide-only and fungicide plus Poncho Beta. This is true across results from both laboratories. Field emergence results, combined with laboratory germinations, suggest that the level of weight gain build-up is not important when Poncho Beta is applied to sugar beet seed. This finding does not take into consideration the amount of weight gain buildup necessary to achieve satisfactory plantability. It is quite possible that the lowest level of buildup, combined with Poncho Beta, would not provide acceptable plantability.

HANSON, LINDA E.*, AMY L. HILL, and LEE PANELLA, USDA-ARS, SBRU, 1701 Centre Avenue, Fort Collins, CO 80526. Interaction of varying *Fusarium oxysporum* isolates with different sugarbeet lines.

*Fusarium oxysporum* can cause a wilt or yellows, as well as a root rot of sugar beet. Isolates that cause yellows symptoms on sugar beet are classified as *F. oxysporum* f. sp. *betae* (FOB). While host resistance to FOB is available, growers have reported variable results when using resistant material in the field. Current research in our laboratory and previous research by others on variability in FOB demonstrated that isolates that are pathogenic on sugar beet can be highly variable. This variability could be associated with different host interactions. To examine this, twenty sugar beet lines were tested for their response to different FOB isolates in a greenhouse screen. While some sugar beet lines showed fairly broad spectrum resistance or susceptibility, others varied in their response to the FOB isolates. Tests for the presence of the pathogen in the host root indicate potential differences in the rate of spread through the root between resistant and susceptible beets.

HEIN, GARY L.*, ROSANA SERIKAWA2, JOHN E. FOSTER2, and JOHN THOMAS1, 1Panhandle Research and Extension Center, and 2Department of Entomology, University of Nebraska-Lincoln, 4502 Ave. I, Scottsbluff, NE 69361. Variability in varietal response for resistance to sugar beet root aphid and potential implications.

The sugar beet root aphid is a common pest seen throughout a number of sugar beet growing areas in North America. Varietal resistance is the primary tool to manage root aphid populations; however, not all growing areas have highly resistant adapted varieties. Because of the importance of resistant varieties in managing this destructive insect, it is critical to understand the mechanisms of resistance involved and how
insect populations respond to widespread deployment of these improved varieties. Our objectives were to monitor the response of root aphid populations to resistant varieties in a region where widespread deployment of resistant varieties has occurred, establish potential mechanisms of varietal resistance and begin to determine the genetic variability of root aphid populations in North America.

Data from several years of variety testing in the greenhouse indicate that the primary mechanism of resistance to the aphid has been the reduction in reproductive ability of aphids to survive on resistant plants. However, we have tested numerous resistant and susceptible sugar beet varieties through the last several years and have noticed a trend for increased survival of aphid populations on highly resistant varieties. These results suggest the possibility that the aphids are beginning to overcome the resistance found in beets. However, through several attempts in the greenhouse, we have not been able to positively show that this is the case.

In order to establish some baseline to compare aphid populations across regions, aphids from several growing regions in North America were collected and analyzed for genetic variability using RFLP techniques. Data from these preliminary studies will be presented.

JACOBSEN, BARRY J.*, JOHN C. ANSLEY¹, KEN KEPHART², NINA K. ZIDACK¹, ALAN DYER¹, and MAREIKE R. JOHNSTON¹, ¹Montana State University, Department of Plant Science and Plant Pathology, Bozeman, MT 59717, and ²Montana Agricultural Experiment Station – Southern Agricultural Research Center, Huntley, MT 59037.

Timing of azoxystrobin fungicide application for control of Rhizoctonia crown and root rot on sugarbeet.

Field experiments at the Southern Agricultural Research Center near Huntley, Montana were conducted in 2004, 2005 and 2006 to compare applications of azoxystrobin fungicide based on soil and air temperatures or plant growth stage for the control of Rhizoctonia crown and root rot on sugarbeet (Beta vulgaris L.) The basis for temperature based fungicide applications in the field were growth chamber experiments were carried out at 15°C, 20°C-22°C, 25°C, and 28°C. These experiments demonstrated that Rhizoctonia solani AG 2-2 IV, causes very little or no disease at 15°C and that significant disease development did not occur until temperatures were 20°C or greater. Optimal disease control and extractable sucrose per hectare was accomplished with azoxystrobin applications when soil temperatures at the 10 cm depth were 18.3°C-26.6°C in both 2004 and 2005. Fungicide application timing based on plant growth stage showed that applications at the 8-leaf
stage had a lower disease index and higher yield than applications at the 4-lea

JONES, DAVID C.*, FEKEDE WORKNEH, and CHARLIE M. RUSH, Texas Agricultural Experiment Station, Bushland, TX 79012. Incidence and spatial distribution of rhizomania in fields planted to rhizomania resistant cultivars.

Beet necrotic yellow vein virus (BNYVV) causes rhizomania in sugar beets, and resistant cultivars are the best available control method. However, during the growing season of 2003 in the California Imperial Valley (CIV), severe rhizomania symptoms were observed in resistant varieties. These appeared as chlorotic strips that ran the length of the field. Subsequent studies have indicated that a fundamental difference exists between the CIV and wild type isolates. In Minnesota, rhizomania symptoms have also begun to appear in fields planted to resistant cultivars. Initially, individual plants exhibiting rhizomania symptoms (blinkers) were observed in several fields. Some suggest that this was due to a mix of susceptible and resistant seeds at planting or a result of pollen drift. However, symptomatic plants now often appear in clusters, which are inconsistent with distributions resulting from seed mixtures. Therefore, spatial distribution and spatial dependence were measured using aerial photography and geostatistical analysis to determine the randomness of the blinkers. In 2005 and 2006, rhizomania resistant fields with typical rhizomania symptoms were selected for this study. Digital images were acquired using a standard digital camera from a fixed wing aircraft. The pixels in each image were classified into three categories (soil, healthy, blinker) using unsupervised classification. Geostatistical analysis was conducted on data classes to determine the randomness of the blinker pixels within an image. Preliminary results indicate some degree of aggregation and appear to be directionally related to soil movement, suggesting that blinkers are not due to random seed mixture or pollen drift, but rather to variation in soil edaphic factors, virus density, virus genotype, or other unrecognized factors causing resistance breakdown in rhizomania resistant varieties.
What is the best time to apply fungicides for effective and economical Cercospora leaf spot control?

Cercospora leaf spot is the most damaging foliar disease of sugarbeet in Minnesota and North Dakota. The objective of this study was to determine the best time to apply fungicides for effective and economical Cercospora leaf spot control. Studies were conducted in 2005 and 2006 at St. Thomas, ND and Foxhome, MN. Each plot comprised of six 22-inch wide rows, 30 feet in length. All experiments were arranged in a randomized complete block design with four replicates. Treatments were applied with four-nozzle boom sprayers that delivered 20 gal/acre of solution at 100 psi pressure to the middle four-rows of plots. Fungicide treatments were applied using the following regimes: first application at first symptoms, and subsequent applications based on daily infection values of two consecutive days (DIV) and symptoms; first application at first symptoms, a second application 14 d after, and subsequent applications based on DIV and symptoms; first application at first symptoms, and subsequent applications made at 14 d intervals. There were also untreated check plots. Cercospora leaf spot severity was assessed throughout the season. The middle two-rows of plots were harvested and root yield and quality were determined. At St. Thomas in 2005 and 2006, and at Foxhome in 2005, disease severity was low. There was no significant difference in recoverable sucrose between fungicide treated and untreated check plots. At Foxhome in 2006, disease severity was low early in the season and increased as the season progressed. Fungicide applications resulted in better disease control and higher recoverable sucrose. The results suggest that applying fungicides at first symptoms and subsequent applications based on DIV and disease severity resulted in effective and economical disease control.

Some like it straight, some like it mixed!

Cercospora leaf spot, caused by *Cercospora beticola*, is the most economically damaging foliar disease of sugarbeet in Minnesota and North Dakota. Timely application of fungicides results in effective disease control. The fungicides most widely used for Cercospora leaf spot control are Eminent (triazole), Headline (strobilurin), and triphenyltin hydroxide (TPTH). Tolerance of *C. beticola* to TPTH has already been documented, and pathogens can develop resistance to the strobilurin and triazole class of chemistries. Research was conducted at Foxhome, MN,
to evaluate different strategies for controlling Cercospora leaf spot and to manage fungicide resistance. Strategies involving alternations and mixtures of full and reduced rates will be discussed.

LARTEY, ROBERT T.*, THECAN CAESAR-TONTHAT, WILLIAM M. IVERSEN, SOPHIA HANSON, and ROBERT G. EVANS, USDA-ARS, Northern Plains Agricultural Laboratory, 1500 North Central Ave., Sidney, MT 59270. **Survey of field soils for *Cercospora beticola* by PCR and ELISA.**

We surveyed several fields in the Lower Yellowstone River Valley (Eastern Montana and Western North Dakota) for *Cercospora beticola*, the causal agent of Cercospora leaf spot of sugar beet. We used both PCR based technique and ELISA for detection of *C. beticola* in soil. Soils were sampled from several sugar beet growing fields. The fields were either under sugar beet cultivation or in rotation with other crops such as barley and safflower. These were compared with other fields consisted of fields with no previous history of sugar beet or have never been cultivated. A soil sample from Florida where sugar beet is not known to be grown the DNA from pure *C. beticola* culture also serves as a control. The DNA was purified from soil using PowerSoil DNA Kit (MO BIO, CA) as per manufactures instructions. The purified DNA was then subjected to PCR in Extract-N-Amp PCR mix (Sigma Aldrich, St Louis MO) using the *C. beticola* specific actin primed with CBACTIN915L (5’ GTAAGTGCTGCCACAATCAGAC 3’) and CBACTIN915R (5’ TACCATGACGATGTTTCCGTAG 3’). The amplified products were resolved by electrophoresis in 1% agarose gels. Additionally, the soil samples were subjected to ELISA using *C. beticola* specific antibody. Using the combination of the two techniques, we were able to identify locations which have *C. beticola* in the soil. The survey provides a tool for pre-planting identification of locations with potential problems for *C. beticola* and Cercospora Leaf Spot of sugar beet in following growing season.

LENNEFORS, BRITT-LOUISE†*, EUGENE I. SAVENKOV2, JAN BENSEFELT3, ELISABETH WREMERTH-WEICH1, PETRA VAN ROGEN1, STIG TUVESSON1, LISETTE LAURIN1, JARI P. T. VALKONEN3, and JAN GIELEN4, 1Syngenta Seeds AB, Box 302, SE-261 23 Landskrona, Sweden, 2Department of Plant Biology and Forest Genetics, Swedish University of Agricultural Sciences, P.O. Box 7080, SE-750 07 Uppsala, Sweden, 3Department of Applied Biology, P.O. Box 27, FIN-00014 University of Helsinki, Finland, and 4Syngenta Seeds, 12 chemin de l’Hobit, 31790 Saint-Sauveur, France. **Transgenic rhizo-
mania resistant hybrids of sugar beets, providing strong resistance against different strains of BNYVV. Transgenic rhizomania resistant sugar beets were produced by inserting an inverted repeat of a 0.4 kb fragment derived from the Beet necrotic yellow vein virus (BNYVV) replicase gene. The resistance to BNYVV, was evaluated in several green-house and field experiments in comparison to conventional sources of resistance to rhizomania. In the green-house tests the plants were grown in soils from Europe, USA and Asia. All soil samples were highly infected with rhizomania and included samples with deviating strains of BNYVV and soils containing Beet soil borne mosaic virus (BSBMV). Field trials were performed in Sweden and USA and the transgenic materials showed promising results. In all experiments, samples of the roots were collected and the BNYVV content in the root sap was measured by enzyme linked immunosorbent assay (ELISA). The transgenic rhizomania resistant hybrids compared very favourably in all tests to the conventional sources of resistance. In soils with deviating strains of BNYVV, the transgenic sugar beets showed an outstanding level of resistance. Therefore the transgenic rhizomania resistant sugar beet varieties will be of high importance in the future, especially in locations where the conventional varieties become highly infected by BNYVV.

LEWELLEN, ROBERT T.1*, HSING-YEH LIU1, ANNE M. GILLEN2, and CARL A. STRAUSBAUGH2, USDA, Agricultural Research Service, 11636 E. Alisal St., Salinas, CA 93905, and 23793 N. 3600 E., Kimberly, ID 83341. Performance of rhizomania resistant sugarbeet under normal and resistance-breaking strains of Beet necrotic yellow vein virus.

Rhizomania in sugarbeet (Beta vulgaris) is caused by Beet necrotic yellow vein virus (BNYVV). Resistance to BNYVV is conditioned primarily by the allele Rz1. Since 2003, it has been observed that Rz1 has been compromised by resistance-breaking strains of BNYVV. A second resistance gene Rz2 originally identified in B. vulgaris spp. maritima (WB42) appears to continue to provide partial resistance to the resistance–breaking strains. Sugarbeet cultivars with single and combinations of resistance genes were evaluated in baited plant greenhouse tests based on ELISA values. These cultivars and other experimental hybrids and breeding lines were evaluated in field trials at Salinas and Brawley, CA and Kimberly, ID under BNYVV noninfested and infested conditions. Infested conditions included both normal and resistance-breaking strains. The performance in the field substantiated the baited plant results. Significant interactions occurred for components of yield
between cultivars (source of resistance) and strains of BNYVV. The \( Rz1 \) allele appeared to continue to provide some protection to losses caused by the resistance-breaking strains. Quantitatively inherited resistance selected against normal strains also provided partial protection against losses to the resistance-breaking strain. Because of the demonstrated vulnerability of single, major genes, the search is being continued for additional sources of resistance. A promising source is from WB151 and other \( B. vulgaris \) spp. \emph{maritima} accessions and populations.

LIU, HSING-YEH*, and ROBERT T. LEWELLEN, USDA, Agricultural Research Service, 1636 East Alisal Street, Salinas, CA 93905. 

**Distribution and differentiation of resistance-breaking isolates of \emph{Beet necrotic yellow vein virus} in the United States.**

Rhizomania is one of the most economically important diseases of sugar beet. This disease is caused by \emph{Beet necrotic yellow vein virus} (BNYVV) and is vectored by the plasmodiophorid \emph{Polymyxa betae}. The disease can only be controlled effectively by the use of resistant cultivars. During 2003 and 2004 in the Imperial Valley of California, partially resistant sugar beet cultivars with \( Rz1 \) allele seemed to be compromised. Resistance-breaking BNYVV isolates have been identified from these plants. Rhizomania infested sugar beet fields throughout the United States were surveyed in 2004-2005. Our soil survey indicated that the resistance-breaking isolates not only existed in the Imperial Valley and San Joaquin Valley of California but also in Colorado, Idaho, Minnesota, Nebraska, and Oregon. Out of the soil samples tested by baited plant technique, 92.5% of ‘Beta 6600’ (\( rz1rz1rz1 \)), 77.5% of ‘Beta 4430R’ (\( Rz1rz1 \)), 45.0% of ‘Beta G017R’ (\( Rz2rz2 \)), and 15.0% of ‘KWS Angelina’ (\( Rz1rz1+Rz2rz2 \)) were infected with BNYVV. Analyses of the deduced amino acid sequence of coat protein and P-25 protein of resistance-breaking BNYVV isolates revealed the high percentage of identity with non-resistance-breaking BNYVV isolates (99.9% and >98.0% respectively). The variable amino acids in P-25 proteins were located at the residues of 67 and 68. In the U. S., the two amino acids found in the non-resistance-breaking isolates were conserved (AC). The resistance-breaking isolates were variable including AF, AL, SY, VC, VL, as well as AC. The change of these two amino acids cannot be depended upon to differentiate absolute resistance-breaking and non-resistance-breaking isolates of BNYVV.

McGRATH, J. MITCHELL1*, and SUBA NAGENDRAN2, 1USDA-ARS Sugarbeet and Bean Research, and 2Department of Plant Pathology, 494 PSSB, Michigan State University, East Lansing, MI 48824-1325.
Discovery of resistance to seedling disease caused by *Rhizoctonia solani* AG2-2, description of the host-pathogen interaction, and development of a seedling disease screening nursery.

Sugarbeet seedling mortality caused by the damping-off pathogen *Rhizoctonia solani* AG2-2 is perhaps the most serious biotic cause of stand failure in the Michigan growing regions, and is likely important worldwide. Resistance to the seedling disease has not been available. Resistance would be beneficial in establishing uniform stands of beets, and the resulting improved harvest quality of similarly sized beets delivered to the factory. An initial set of experiments to examine disease progression in susceptible hosts was conducted with high and low virulence isolates in order to identify targets of opportunity for biotechnology manipulation, and during this work, the crown-and-root-rot (CRR) resistant release EL51 was demonstrated to survive early challenge by the highly virulent isolate R1. Subsequently, the host-pathogen interaction was examined in detail using light and fluorescence microscopy. The resistance reaction was characterized by the failure of the pathogen to ramify the water-conducting stele tissues of the young hypocotyl, with an apparent barrier at the narrow endodermis. Field experiments were initiated to determine if resistance was expressed under agronomic conditions by a simple modification of traditional CRR screening to that of inoculating 3-week-old seedlings. Full stands of EL51 were present at the end of the season, and stands of the susceptible hybrid USH20 were decimated. In 2006, the entire East Lansing CRR nursery was inoculated at the seedling stage, and clear germplasm differences in disease reaction were seen. Interestingly, the disease continued to develop throughout the growing season, suggesting both seedling and CRR resistance can be selected simultaneously with a simple modification in the timing of inoculation.

PFERDMENGS, FRIEDERIKE, and MARK VARRELLENN*, Institute for Sugar Beet Research, Department of Phytopathology, Holtenser Landstr. 77, 37079 Göttingen, Germany. Characterisation of soils from different geographic origins containing *Beet necrotic yellow vein virus* (BNYVV) which overcomes *Rz1* resistance in sugar beet.

BNYVV, transmitted by soil-inhabiting *Polymyxa betae* possesses world-wide distribution in the main sugar beet growing areas and causes Rhizomania. Plant resistance represents the only effective measure to control the virus. A single dominant allele (*Rz1*) is mainly used in commercial cultivars to obtain partial resistance to infection. Another *Beta vulgaris* subsp. *maritima* (WB42) derived single resistance gene *Rz2* represents a different resistance mechanism. In the last decade
however several soils, containing different isolates belonging to A- and P-type of BNYVV have been described inducing severe rhizomania symptoms in the field or in greenhouse experiments on BNYVV partial resistant genotypes. Increased pathogenicity is attributed to high inoculum potential, genetic variability and additional soil-borne pathogens. Towards understanding of increased pathogenicity, we used BNYVV infested soils containing 5th RNA harbouring P-type (Phitiviers, France), A-type (Daimiel, Spain) and (Imperial Valley) together with conventional B- and A-type controls in a greenhouse resistance test using sugar beet hybrids (Rz1, Rz1+Rz2, susc. control). Root weight and BNYVV content in tap roots after 12 weeks showed that Pithiviers P-type as well as A-type Daimiel and Imperial Valley all were able to overcome Rz1 under these conditions. Determination of infective units of BNYVV transmitting P. betae displayed a higher BNYVV concentration in soils from Imperial Valley and Daimiel, but not in Pithiviers soil. Analysis of beets revealed infection with Pythium as well as Fusarium spec. in selected soils. Despite increased pathogenicity of BNYVV P-type might be related to the presence of RNA5 and those of Imperial Valley and Daimiel A-type to high inoculum potential, the final proof of resistance breaking BNYVV strains requires artificial infection methods excluding all other factors which might interfere with viral pathogenicity in a synergistic manner.

SECOR, GARY A., VIVIANA V. RIVERA, J. RENGIFO, and JOHN J. WEILAND, Department of Plant Pathology, North Dakota State University, and USDA-ARS, Northern Crop Science Laboratory, Fargo, ND 58105. Cercospora beticola mating types in the North Central USA.

Cercospora is an endemic disease of sugarbeets in the Red River Valley production area of North Dakota and Minnesota in the northcentral USA. Control is achieved mainly by crop rotation, resistant cultivars and timely fungicide application. A major concern of Cercospora leaf spot is the development of resistance by C. beticola to the fungicides used for control. All fungicides used have a history of resistance development in sugarbeets or other crops. Despite the fact that the perfect stage of C. beticola has not been found, C. beticola possesses a high degree of variability in morphological characteristics, cercosporin production and fungicide sensitivity. This suggests a sexual stage as a source of variability, and therefore the necessity of mating types in C. beticola as is present in other Cercospora spp. Primer sets for detecting presence of the two mating type alleles were used to test isolates of C. beticola for mating types. Based on a random sampling of C. beticola isolates from
past studies, it appears that we are able to detect both mating type alleles designated MAT1 and MAT2. Further studies are ongoing to determine the distribution of these mating types within populations of *C. beticola* from lesions, leaves, fields and production areas. The presence of mating types may provide an explanation of the apparent high degree of variability found in *C. beticola*.

STRAUSBAUGH, CARL A.*, and ANNE M. GILLEN, USDA-ARS NWISRL, 3793 N. 3600 E., Kimberly, ID 83341. **Sugarbeet root rot in the Intermountain West.**

Root rot in sugarbeets caused by fungi and bacteria is a considerable problem in the western United States. In October 2004 and 2005, a survey was conducted on recently harvested sugarbeet roots throughout southern Idaho and eastern Oregon to identify the fungi and bacteria associated with root rot. Isolations were made from 533 and 287 roots for fungi and bacteria, respectively. Fungal isolations were conducted on potato dextrose agar (PDA) and water agar supplemented with streptomycin sulfate (200 mg/L). All cultures were hyphal tipped onto PDA for identification. Isolates of *Fusarium* spp. were also placed onto carnation leaf agar. Bacterial and yeast isolations were conducted on yeast extract-dextrose-calcium carbonate agar (YDC) and King’s medium B at 30ºC. Representative colonies were restreaked onto YDC and grouped based on growth habit, color, gram stain, and cell shape. One third of the bacterial isolates from each group were then placed on GN2 MicroPlates (Biolog Inc.) for metabolic fingerprinting. Thirty bacterial and yeast isolates representative of the groups identified were submitted to Microbial ID (MIDI Labs) for 16S rRNA and 28S rRNA sequencing, respectively. A total of 362 potential pathogenic fungal isolates were obtained: *Fusarium oxysporum* (29% of isolates), *Rhizoctonia solani* (18%), *Fusarium acuminatum* (18%), *Rhizopus* spp. (16%), *Phoma betae* (7%), oomycetes (6%), *Fusarium culmorum* (3%), and *Fusarium equiseti* (3%). A 197 fungal isolates considered saprophytes were found. A total of 396 bacterial and yeast isolates were obtained: lactic acid bacteria (41% of isolates), acetic acid bacteria (29%), enteric bacteria (17%), and yeast (13%). The lactic acid bacterial group contained *Leuconostoc mesenteroides* (80%) and *Lactobacillus plantarum* (20%). *Gluconobacter asaii* comprised 92% of the isolates from the acetic acid group. Given the diversity of organisms isolated, controlling root rots in sugarbeets will continue to be a challenge.
WEILAND, JOHN J.*, REBECCA L. LARSON², THOMAS P. FREEMAN³, MICHAEL C. EDWARDS¹, and HSING-YEH LIU⁴, ¹USDA-ARS, Red River Valley Agricultural Research Center, Fargo, ND 58105, ²USDA-ARS, Sugarbeet Production Laboratory, Fort Collins, CO 80526, ³North Dakota State University, Fargo, ND, 58105, and ⁴USDA-ARS, Sugarbeet Production Laboratory, Salinas, CA 93905.

**Discovery of Beet Black Scorch Virus in the United States.**

Emerging diseases of sugarbeet in the U.S. caused by viruses, bacteria, and fungi have been observed in recent years that primarily are soilborne in nature. In October of 2005, sugarbeet roots exhibiting symptoms indicative of Rhizomania were processed to generate inoculum for the recovery of beet necrotic yellow vein virus (BNYVV), causal agent of that disease. *Chenopodium quinoa* plants treated with inoculum exhibited lesions indicative of a viral disease, but expanding rapidly and uncharacteristically for BNYVV or the related virus beet soilborne mosaic virus (BSBMV). Thin sections of infected *C. quinoa* leaves examined by electron microscopy revealed densely packed aggregates of icosahedral virus particles. A purified preparation of the virus was used for genome cloning and to prepare rabbit antiserum for diagnostic purposes. Cloning and sequence analysis of the solitary 3.6 kb single-stranded RNA purified from virus particles revealed a genome with an organization characteristic of the plant Necroviruses in the family Tombusviridae. Alignments of the nucleotide and encoded protein sequences indicated that the virus was Beet Black Scorch Virus (BBSV). A sensitive double antibody sandwich enzyme-linked immunosorbant assay (DAS-ELISA) for BBSV based on rabbit antiserum against the virus was produced. This constitutes the first report, to our knowledge, of the existence of BBSV outside of China.

WINDELS, CAROL E.*, JASON R. BRANTNER¹, ALBERT L. SIMS¹, and CARL A. BRADLEY², ¹University of Minnesota, NW Research & Outreach Center, Crookston, MN 56716, and ²Dept. of Plant Pathology, North Dakota State University, Fargo, ND 58105. **Spent lime effects on yield, quality, and Aphanomyces root rot of sugar beet.**

*Aphanomyces cochlioides* is an economic pathogen of sugar beet and infests over 50% of fields sown in Minnesota (MN) and North Dakota (ND). Lime (calcium carbonate) aids extraction of sugar by precipitating impurities from beet juice. The resulting “spent lime” (14% less acid-neutralizing power of fresh lime) contains impurities. To determine effects of spent lime on sugar beet and *Aphanomyces* root rot, trials were established by applying 0, 7, 15, 29 and 44 Mg dry wet ha⁻¹ at Hillsboro (ND) and 0, 6, 12, 18, and 24 Mg dry wt ha⁻¹ at
Breckenridge (MN); lime was incorporated by chisel plowing. To allow plots to stabilize, full-season crops of corn and spring wheat were grown at the ND and MN sites, respectively, in 2004. In 2005, sugar beet was sown 19 and 13 mos. after lime was applied at ND and MN, respectively. There were significant increases in yield in plots treated with all rates of lime compared to the non-limed control in both trials. Severity of Aphanomyces root rot (0-7 scale, 0 = healthy, 7 = more than 75% of root rotted) in the ND site was equally low in all limed (mean = 2) and non-limed plots (mean = 2.2). Aphanomyces root rot was active in MN, and ratings were significantly lower and equal in all limed plots (mean = 3.7) compared to the non-limed control (mean = 6). Overall, spent lime increased sugar beet yield and when *A. cochlioides* was active, significantly reduced root rot.
GALLIAN, JOHN J.1*, KELLY V. TINDALL1, DAVID M. ELISON2, and DALE L. BAKER3, 1University of Idaho, Twin Falls R&E Center, P.O. Box 1827, Twin Falls, ID 83303-1827, 2Amalgamated Sugar Co., P.O. Box 700, Paul, ID 83347, and 3University of Idaho, 85 E. Baseline, Rupert, ID 83350. The effect of seed treatment and post-emergence insecticides on emergence, phytotoxicity, sugarbeet root maggot damage and root yield.

Sugarbeet root maggot (Tetanops myopaeformis) is the most important insect pest of sugarbeet in Idaho. Although most growers apply an insecticide to prevent economic loss, control can be variable. In 2006, five seed treatment insecticides were tested with and without post-emergence insecticide application for emergence, phytotoxicity, root maggot damage and yield on a grower’s field near Paul, Idaho, in an area with historically high root maggot pressure. The experiment was a randomized complete block design with 18 treatments and six replications. All rates of Cruiser (20, 40, 60 and 80 g ai thiamethoxam/100,000 seed), Lannate (23.2 g ai methomyl/100,000 seed) and Vydate (19.2 g ai oxamyl/100,000 seed) significantly delayed emergence (Tukey-Kramer, p<0.05). Final emergence was lower only with the Cruiser 20 and 80 g ai and the Lannate 23.2 g ai seed treatments. Emergence was not affected by Poncho-Beta (60 g ai clothianidin + 8 g ai beta-cyfluthrin/100,000 seed). Percent injury compared with the control was higher with the Lannate treatment than all other seed treatments (43.3% injury). Ten roots/plot (60 roots/treatment) were rated for sugarbeet root maggot damage on July 19 and 20 using a 0 to 9 rating scale. Root maggot pressure was light and there were no differences among treatments. The split post-emergence application of aldicarb treatment and the Poncho-Beta seed treatment yields were higher than the Lannate seed treatment. Although no conclusions may be drawn regarding the efficacy of the seed treatments, Lannate and the high rates of Cruiser may not be suitable for treatment of sugarbeet seed.

HANSON, LINDA E.1*, GARY D. FRANC2, and LEE PANELLA1, 1USDA-ARS, SBRU, 1701 Centre Avenue, Fort Collins, CO 80526, and 2University of Wyoming, Laramie, WY. Characterization of genes associated with potential for fungicide resistance in Cercospora beticola.

The recent development and widespread use of fungicides with
highly specific modes of action has greatly increased the potential for
development of fungicide insensitivity in the pathogen population. Disease control failures have been reported with pathogens such as *Cercospora beticola* in sugar beet, and powdery mildews and leaf spots in other crops. Determining the modes of action of fungicides has enabled elucidating specific genetic mechanisms for resistance to several classes of fungicides. There have been ongoing efforts to determine the baseline sensitivity of sugar beet pathogens such as *C. beticola* to important fungicides. As the genetics of resistance to many of these fungicide classes is determined, there is the potential to determine the characteristics of important target genes in the population to obtain a better idea of some of the inherent risks for fungicide resistance development. Information on these gene sequences also can be used to develop improved and rapid screening methods. Information on important target genes for several classes of fungicides that are used or have been used for Cercospora leaf spot control is being collected.

HARVESON, ROBERT M., University of Nebraska, Panhandle REC, Scottsbluff, NE 69361. **Predicting disease severity for sugar beet root rots using a pre-plant soil disease assay.**

*Aphanomyces cochlioides* and *Rhizoctonia solani* are important soilborne pathogens responsible for significant root disease problems that are primary constraints to sugar beet production in Nebraska. These types of diseases are difficult to control because they are often not noticed until substantial damage has already occurred. Efforts to manage them would be more effective if predictive techniques were available for those affected by these pathogens, rather than reactive ones. Therefore, a new technique with the purpose of estimating relative pathogen populations in the soil and predicting potential for root disease problems later in the season is currently being tested from pre-plant soil samples collected from fields to be sown with sugar beets. Samples are planted with a susceptible cultivar and the test is conducted for one month. A disease index is developed based on the time period during the test that seedlings become infected and is calculated on a 0-100 scale. Pre-plant index values are then compared with yields obtained from the same fields after harvest. To obtain a better understanding of soil index values, we are additionally conducting tests in soils using known pathogen concentrations as standards. Data obtained to this point suggests that this technique provides promise for predicting potential root disease problems. For example, sugar yields obtained in 2004 from 21 low index fields averaged 2800 kg/ha more than 6 high index fields. This technique not only estimates pathogen concentrations, but additionally identifies
Specific pathogens involved, enhancing the grower’s disease management decisions.

HEIN, GARY L.*, RICK PATRICK, CHARLES K. FLINT, and JOHN A. SMITH, Panhandle Research and Extension Center, University of Nebraska-Lincoln, 4502 Ave. I, Scottsbluff, NE 69361. Effectiveness of a precision applicator in applying pesticide granules synchronously with sugar beet seed.

A precision granule applicator has been developed by Monosem for their Mecca planter units called the spot applicator. This applicator meters out granules and places them in synchrony with the seed. The advantage of this applicator is to apply an adequate amount of material directly with the seed and avoid application of material between the seeds. The intent of this applicator is to apply the material more precisely where it will be most effective, thus improving effectiveness and reducing costs. The objective of this study was to evaluate the effectiveness of this applicator on a grease belt at various speeds to determine the spatial distribution of granules released by the applicator.

The spot applicator was used on a grease belt modified for use in determining seed spacing of planter units running at various speeds. The grease belt was run at 2, 3, and 4 miles per hour and a series of photographs taken of the seed and granule placement on the belt. A digital counting procedure was used to estimate granule distribution. Synchronization of granules with the sugar beet seed could be obtained at all speeds, but the distribution around the seed also increased with increasing speed. The reduced popularity and usage of granule insecticides may reduce the need of this type of applicator; however, the applicator does have potential for more precise application of higher value pesticides or biocontrol products. Some of these products may need to be targeted directly at the seed but may not be appropriate for use as a seed treatment.

JARONSKI, STEFAN T.1*, CINDY FULLER-SCHAEFER1, BEN LARSON2, and BARRY J. JACOBSEN3, 1USDA-ARS, Northern Plains Agricultural Research Laboratory, Sidney, MT 59270, 2Montana State University Extension Service, Richland County Office, Sidney, MT 59270, and 3Department of Plant Sciences and Plant Pathology, Montana State University, Bozeman, MT 59717. Effect of three bacterial disease-control agents on the entomopathogenic fungi, *Metarhizium anisopliae* and *Beauveria bassiana*.

The rhizosphere is the primary arena for entomopathogenic fungi (EPF) deployed against soil-dwelling pests, and is also the site of action
of biological agents used against root pathogens. Interactions between EPF and soil microbes, much less biofungicidal agents, have been barely studied, however. USDA-ARS has been developing a biocontrol strategy using EPF against the sugarbeet root maggot, in parallel with Montana State University efforts to develop three microbial agents against the various sugarbeet pathogens: *Bacillus pumilis* LS201 (against *Pythium*, *Aphanomyces*), *B. mohaviensis* MSU127 (against *Rhizoctonia*), and *B. mycoides* BmJ (against *Cercospora beticola*). We examined the effect of the three biofungicidal agents on conidial germination and hyphal growth of three isolates of the EPF, *Metarhizium anisopliae* (MA1200, F52, TM109), and three isolates of *Beauveria bassiana* (GHA, TM28, TM86), on Plate Count Agar, Tryptic Soy Agar, and Potato Dextrose Agar. Conidial germination: there were considerable differences between the two fungal species and among isolates within each species in sensitivity to the bacteria. MSU127 had the strongest, most consistent inhibition with zones as wide as 16 mm, which persisted for at least several months. Hyphal growth: only *Beauveria* GHA was affected, by BmJ and LS201, on only TSA. The medium affected the message -- depending upon the medium used, very different inhibitory patterns were observed.

LARTEY, ROBERT E.*, THECAN CAESAR-TONTHAT, SOPHIA HANSON, WILLIAM M. IVERSEN, and ROBERT G. EVANS, USDA-ARS, Northern Plains Agricultural Laboratory, 1500 North Central Avenue, Sidney, MT 59270. **Detection of Cercospora beticola by PCR in amended and naturally infested field soil.**

The causal agent of Cercospora Leaf Spot of sugar beet (*Beta vulgaris* L), *Cercospora beticola*. Sacc. survives as stromata in beet leaf residues in the soil. Under optimal conditions, overwintering propagules germinate and produce conidia that are dispersed as primary inoculum to initiate infection in sugar beet. We developed and present here a PCR technique for detection of *C. beticola* in the soil. The DNA was purified from soil amended with *C. beticola* and naturally infested soil using PowerSoil DNA Kit (MO BIO, CA) as per manufactures instructions. The purified DNA was collected and subjected to PCR reaction in Extract-N-Amp PCR mix (Sigma Aldrich, St Louis MO) with CBACTIN and ITS based primers. Amplification was carried out over 35 cycles using a Mastercycler gradient thermocycler (Eppendorf Scientific Inc., Westbury, NY) at 94°C for 1 min denaturation, 52°C for 30 sec annealing, 72°C for 1 min extension and 5 min final extension at 72°C. The amplified products were resolved by electrophoresis in 1% agarose gels. The fragment sizes of *C. beticola* amended and the
infected field soil products correlated with the expected size of the control DNA extracts from *C. beticola* cultures. Amplicons were sequenced and compared to *C. beticola* actin sequence from gene bank. Alignment of sequences of the amplified products confirmed them to be that of *C. beticola*. The system will enable rapid post planting screening for inoculum potential of *C. beticola* in soil and determine effect of soil applied biocontrol agents on *C. beticola* and inoculum potential.

MAJUMDAR, AYANAVA1*, MARK A. BOETEL1, STEFAN T. JARONSKI2, ROBERT J. DREGSETH1, and ALLAN J. SCHROEDER1, 1Department of Entomology, North Dakota State University, Fargo, ND 58105, and 2USDA-ARS, Northern Plains Agricultural Research Laboratory, Sidney, MT 59270. **Bio-based management of sugarbeet root maggot by integrating an insect pathogenic fungus and cereal cover crops.**

The sugarbeet root maggot (SBRM), *Tetanops myopaeformis*, is the most damaging insect pest of sugarbeet in the Red River Valley. Field trials were conducted at two sites, St. Thomas and Minto, ND, to evaluate the efficacy of the insect-pathogenic fungus *Metarhizium anisopliae* (strain F52) as a stand-alone tool and as integrated with oat or rye cover crops for SBRM management. The fungus was applied as planting-time granules or as a postemergence spray. Cover crops were planted at 0, 187, or 374 seeds/m². The average root injury (RI) rating in untreated check plots at St. Thomas was 6.5 on a 0 to 9 scale (i.e., 0 = no injury and 9 = severe injury); plants in untreated control plots at Minto had an average root injury rating of 4.3. At St. Thomas, stand-alone oat or rye cover crop plots or those treated with *M. anisopliae* only incurred root injury levels of about 4.2. However, combining the rye cover crop at 374 seeds/m² with the *M. anisopliae* spray maintained root injury at only 3.2, which was significantly lower than the injury sustained in the rye-only plots (RI = 5.0). In general, plots established with an oat cover crop had RI levels below 4.0 indicating good potential of this cover crop; however, the spray formulation of the biocontrol fungus did not significantly improve SBRM control in those plots. At Minto, plots that received oat at 374 seeds/m² plus *M. anisopliae* spray had significantly lower SBRM feeding injury (RI = 2.2) than the corresponding integration with rye cover crop (RI = 3.7). It appears that the oat cover crop provided more consistent SRBM control than rye at the rates tested. Root protection provided by the spray formulation of *M. anisopliae* seems to be enhanced by an oat cover crop.
NITSCHELM, JENNIFER J., PETER J. REGITNIG*, and GREG W. NIKLES, Rogers Sugar Ltd., 5405 - 64th Street, Taber, Alberta, Canada T1G 2C4. Evaluation of Cruiser seed treatment for control of wireworm damage in sugar beet.

Counter 15G (terbufos) insecticide is the only option for controlling wireworm damage in sugar beet in Canada. Alternative treatments are being investigated for use in sugar beets in anticipation of Counter deregistration. Cruiser 5 FS (thiamethoxam) insecticide is registered in wheat, barley, corn and soybeans for control of wireworm and other insect pests. A commercial field seeded to barley in 2004 was observed to have areas of crop damage due to wireworm activity. One of these areas was planted to a replicated experiment in the sugar beet crop in 2005. Cruiser was applied to sugar beet seed at two rates and compared to Counter applied modified in-furrow. Potato bait traps were buried in the four untreated plots just after seeding; live wireworm were observed in soil around the bait traps upon removing the traps 3 weeks later. Sugar beet plant stands were significantly higher in the insecticide treatments than in the control treatment. Cruiser applied at 60 g ai/unit resulted in 25% higher extractable sugar per acre (ESA) and 22% higher beet yield compared to the control treatment. Counter provided comparable results to the Cruiser 60 g ai/unit treatment. Cruiser applied at 30 g ai/unit resulted in significantly improved beet yield over the control treatment, but the treatment yielded less than the Cruiser 60 g ai/unit and the Counter treatments.

STRAUSBAUGH, CARL A.1*, ANNE M. GILLEN1, JOHN J. GALLIAN2, KELLY TINDALL2, STACEY CAMP3, and J. R. STANDER4, 1USDA-ARS, NWISRL, 3793 N. 3600 E., Kimberly, ID 83341, 2University of Idaho, Twin Falls R&E Center, Twin Falls, ID 83303, 3Amalgamated Sugar Co., Paul, ID 83347, and 4Betaseed, Inc., Kimberly, ID 83341. Influence of host resistance and insecticide seed treatments on curly top in sugarbeets.

Curly top in sugarbeets caused by Beet severe curly top virus or closely related species is a considerable problem in the arid growing regions of the western United States. In an effort to develop improved and more environmentally friendly control measures, we conducted studies to evaluate the relative influence of host resistance and insecticide seed treatments on the control of curly top in sugarbeets. In 2005, two insecticide seed treatments, Poncho Beta (60 g ai clothianidin + 8 g ai beta-cyfluthrin/100,000 seed) and Gaucho (45 g ai imidacloprid/100,000 seed), and four sugarbeet hybrids varying in curly top resistance were evaluated for their influence on the control of curly top in comparison to
untreated checks. In 2006, similar studies were conducted except Cruiser (60 g ai thiamethoxam/100,000 seed) was substituted for Gaucho. Two studies were conducted each year and relied on natural inoculum except for Kimberly in 2006 where 0.5 viruliferous leafhoppers per plant were released. All insecticide treatments reduced curly top symptoms compared to the untreated check by September regardless of location and year. When comparing across varieties, contrasts indicate that Poncho Beta reduced curly top symptoms better than Gaucho and Cruiser by September. In 2005 when comparing across varieties with moderate disease pressure, Poncho Beta increased yield by 20.2 and 21.7% compared to the untreated checks at the two locations, respectively. At Kimberly, Poncho Beta also reduced the number of plants with leafminers in 2005 and black bean aphids in 2006 by at least 97%. Poncho Beta provided a level of control for curly top that would justify its application as a supplement to host resistance under Idaho conditions.

WINTERMANTEL, WILLIAM M.*, AMY G. ANCHIETA¹, and ROD CLARK², ¹USDA-ARS, 1636 E. Alisal Street, Salinas, CA 93905, and ²California Curly Top Control Board, 2895 N. Larkin, Suite A, Fresno, CA 93727. Mapping of curly top incidence and determination of genetic variation among viruses responsible for curly top in California.

Curly top disease is caused by Beet curly top virus (BCTV) and the related curtovirus species, Beet severe curly top virus (BSCTV) and Beet mild curly top virus (BMCTV). Curtoviruses are transmitted by the beet leafhopper (Circulifer tenellus) and are problematic in several large, but geographically separated regions of western North America, infecting sugarbeet, tomato, pepper, and bean as well as numerous native weeds. This study examined virus incidence and distribution among weed and crop hosts as well as genetic variability among curtovirus isolates to determine if specific weed hosts might be reservoirs for exceptionally severe virus species, such as BSCTV. Weed and crop hosts of the virus were collected from throughout California, and collection locations were mapped using a global positioning system (GPS). Sample collection was conducted from May through September over a 3 year period, and were scored as positive or negative for curtovirus infection using polymerase-chain reaction (PCR). The number of positive samples varied among years, but localized “hot-spots” were consistent from year-to-year. Results indicated that the highest incidence of curtovirus infection was in sugarbeet and wild mustard, followed by Russian thistle, tomato, and London Rocket, while other weed and crop hosts had considerably lower incidence. BSCTV and BMCTV were equally
prevalent, but no BCTV was identified from weeds or crop plants. No significant differences in host infection were observed between the 2 predominant curtovirus species. Some recombinant curtoviruses were identified with sections derived from both BSCTV and BMCTV, and two recombinants contained limited segments derived from BCTV, the older California species no longer found in the field. This demonstrates that exchange of viral genetic material can occur between curtovirus species. The abundance of BSCTV and BMCTV, along with the lack of BCTV indicated a clear transition between curtovirus species prevalent in California during the mid 1900s and those present today, suggesting changes in curtovirus population structure over time, virus evolutionary adaptation, and emergence of new curtovirus species with a selective advantage over older species such as BCTV.
DANG, XIAOJUN*, and DOLORES J. SOTO, Nalco Company, 1601 W. Diehl Road, Naperville, IL 60563. **Advances in fluorescence detection of sugar in water systems.**

Part of the sugar manufacturing process is the concentration of raw sugar or thin juice using multiple effect evaporators. Condensate from the multiple effect evaporators is commonly used as make-up water to a boiler. Occasionally, juice will mechanically carry over into the boiler condensate system, resulting in a “sugar shot.” Immediate detection and notification of a “sugar shot” and a sugar contamination of cooling water is critical because sugar juices break down forming organic acids in the boiler, which rapidly depress boiler water pH causing system damage. Acid corrosion in the boiler may occur, reducing equipment life. Severe “sugar shots” may require a plant shut down. A fluorescence method developed by Nalco is able to detect sugar contamination in an early stage. This technology measures naturally occurring non-sugars in the juice that have fluorescent properties. Lab tests and field evaluations have shown that the new sugar contamination detection technology using a low-cost, low-maintenance fluorometer can improve boiler corrosion and deposit control with continuous real-time monitoring and diagnostics, resulting in a safer operation, improved system reliability, and reduced operating costs.

DANG, XAIOJUN, DENNIS J. SAYE, DAVID LARSON, ANTHONY SOMMESE*, and KEVIN FINKENBINER, Nalco Company, 1601 W. Diehl Road, Naperville, IL 60563-1198. **Recent advances in Nalco’s juice purification system.**

Carbonation is the purification system for beet juice. In 2004, Nalco introduced its juice purification system to this audience. This system reduced juice color and enhanced juice purity of raw juice through a 2-stage system of air stripping and vacuum. During the past 2 years a considerable effort was put into developing an understanding of how the unit worked and what was actually being removed to effect the purity change. Interestingly, to gain a better understanding of the purification system and its effects, there needed to be a focus on carbonation. The purification system has found utility with all diffuser types and on beets from varying geographical locations. Using synthetic juice purities as a guide, purity enhancements have ranged from 0.2 to 1.8 purity points (raw juice before the unit vs. raw juice after the unit) in full
scale operation. Experimentation using a pilot unit, in conjunction with SAFAS’s pilot sugar line has proven that the purity improvement gained in the raw juice is carried through to thick juice.

GROOM, DAVID*, JIM HEGGENESS, and TERRY McGILLIVRAY, American Crystal Sugar Company, 1700 North 11th Street, Moorhead, MN 56560. **Controlling quality of MDS extract for long term storage.**

Changes in the quality and chemical parameters for extract and sugar produced from extract as well as the technique used for accelerating those changes are discussed. Accelerated storage techniques have been used to decrease the time needed to evaluate long term storage at 20°C. Conditions used include storage of samples at 55°C and 20°C followed by development of correlations between changes that occurred at the different temperatures. Relationships of storage time at the different temperatures are discussed as well as changes in color, invert, and pH in the sugar and the extract.

KAWLEWSKI, RON*, STEVE AAKRE, and JIM SCHUELLER, Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284. **Methods for automated particle size analysis.**

Southern Minnesota Beet Sugar Coop utilizes a particle size analyzer, Rotex’s Gradex 2000, to automate sieve analysis for shipped sugars. We have added an Ankersmid particle size analyzer that is used on our production sugar and a number of other materials. The unit has two modes of operation, laser time-of-transition and image analysis using a video camera. This paper will discuss the implementation of these two instruments and correlation of sieve data to the standard method hand sieving.

McGILLIVRAY, TERRY*, and BEVERLY JACOBSON, American Crystal Sugar Company, 1700 North 11th Street, Moorhead, MN 56560. **Determination of Betaine by NIR for Betaine recovery optimization.**

Recovery of betaine from a molasses desugarization separator is being more commonly done in the industry. Techniques for optimization of the recovery and purity of the recovered betaine stream involves sampling near the sample cut points, analyzing the samples by HPLC for betaine and adjusting the cut points to increase recovery and/or purity. The technique described in this paper involves sampling near the cut point followed by analysis using an NIR. Data showing the advantages of this system as well as precision and agreement with the HPLC method will be discussed.
REARICK, D. E.*, and CHERI McKAY, Amalgamated Research Inc., P.O. Box 228, Twin Falls, ID 83303. Amino acid elimination in chromatographic molasses separation systems.

During the recovery of sucrose from sugar beet molasses by chromatographic separation, the free amino acids originally present in beet juice exhibit a wide range of separation behaviors. Amino acids which are more strongly ionized, such as the dicarboxylic acids glutamic and aspartic acids, are efficiently removed in separator raffinate while those which exist as neutral molecules at separator pH are among the most difficult compounds to separate from sucrose. The more neutral amino acids, such as leucine, isoleucine, tyrosine, and others, tend to accumulate within the separator internal liquid inventory and co-elute with sucrose. For several of these amino acids, the conventional simulated moving bed (SMB) separator may remove as low as 10-20% of the incoming quantity. Modified separator designs, such as the ARi Coupled Loop System, lead to improved levels of amino acid elimination although elution of amino acids with sucrose is still at significant levels.

SAMARAWEERA, INDRANI*, DIANE RHEAULT, LYNN BUSCHETTE, TERRY McGILLIVRAY, and DAVID GROOM, American Crystal Sugar Company, 1700 North 11th Street, Moorhead, MN 56560. The relative stability of stored extract with and without inoculation with high levels of different microbial types.

Continued monitoring and testing of stored extract has demonstrated that long term storage of extract is possible when the extract is stored at the appropriate RDS, temperature, pH, and purity. This paper examines the conditions necessary for long term storage and changes that occur during long term storage. In addition, studies of the susceptibility of extract to degradation by the addition of high levels of inoculum were studied as a way of testing whether conditions specified for extract storage were sufficiently stringent. Changes in extract stored for over one year are discussed, points of microbial contamination when produced, and effects of contamination on stored extract are discussed.

THEISEN, KARL H., and IRMA GEYER*, pro-M-tec Theisen GmbH, Pforzheimer Str. 162, 76275 Ettlingen, Germany. Microwave technology: An ubiquitous in line measurement instrument for density, total solids, concentration, especially brix in a today sugar factory.

The microwave concentration measurement is one of the most modern technologies used in industry for process measurement and control. Measurement systems have been successfully employed for brix control on pans (batch and continuous) in the sugar making process.
Recent developments allow the technology to be applied to virtually all measurement points requiring the process variable determination and control of concentration, density, or total solids in sugar plants.

Over the last few months new applications, especially the concentration measurements in large pipelines and measurements in tanks, melters and mixers have shown that microwave technology thereby offers unique and new solutions to the sugar producing industry.

This paper discusses measurement experiences with microwave concentration measurement on large pipelines, in mixers, melters, vessels. Particular focus is on the concentration measurement of magma, molasses and mil of lime, with discussion of the technical aspects, considerations and advantages of the employment of microwave technology.
Comparative study of copper reduction, chromatographic, and enzymatic ICUMSA methods for reducing sugars in molasses.

Reducing sugars in six molasses samples from the USA, UK, Turkey, South Africa and Brazil were measured using copper reduction (Luff Schoorl and Lane & Eynon), chromatographic (HPLC and IC), and enzymatic ICUMSA (International Commission for Uniform Methods in Sugar Analysis) methods. The final molasses samples included two beet molasses, two sugarcane factory molasses, and two sugarcane refinery molasses. Precision and mean results were compared. The Lane & Eynon method had consistently the best precision. Precision was worst in the enzymatic and chromatography methods than both copper reduction methods and followed the order: Lane & Eynon > Luff Schoorl > HPLC = IC > Enzymatic. Lane & Eynon, and particularly Luff Schoorl, methods consistently over-estimated “apparent sucrose” in molasses, as compared to the more accurate chromatography results, because they measure all reducing substances present. HPLC generally gave slightly higher mean results than IC. The new ICUMSA enzymatic method (GS4-6; draft status) correlated well with both copper reduction and chromatographic methods, but tended to under-estimate apparent sucrose. However enzymatic results were close to IC results, which indicates that enzymatic method could be more accurate than copper reduction methods.

Microplate assay for rapid determination of sucrose, glucose, fructose and raffinose.

Current methods for the quantification of carbohydrates in sugarcane roots have limitations. Polarimetry and refractometry measure only sucrose content and are inaccurate with deteriorated roots. High performance liquid chromatography (HPLC) and gas chromatography (GC) quantify all simple carbohydrates regardless of root quality, but are
time-consuming, costly (HPLC) or require the use of noxious reagents (GC). Research was conducted to develop a rapid, high-throughput microtiter plate assay for accurate determination of sucrose, glucose, fructose and raffinose in sugarbeet roots. The assay modifies a previously described enzyme-based microtiter plate assay for quantification of sucrose, glucose, and fructose (J. Sci. Food Agric. 82:80, 2001) to decrease sample preparation and analysis time, and increase the range of sugar concentrations that can be accurately quantified. In addition, the assay was expanded to quantify raffinose in addition to sucrose, glucose and fructose. Using 15 minute, enzyme-coupled reactions and commercially available reagents, sucrose, glucose, fructose and raffinose were quantified with high reproducibility. The assay was linear for samples containing 2 to 100 mM sucrose, 0.2 to 10 mM glucose, 0.2 to 10 mM fructose, and 0.1 to 20 mM raffinose. Aluminum sulfate concentrations typically used to clarify beet extracts did not affect the assay indicating that sample preparation methods currently used for polarimetry measurements can be used with this assay. The assay was used to quantify sucrose, glucose, fructose and raffinose concentrations in clarified extracts from stored roots exhibiting varying degrees of rot. Comparison of these results with those obtained by HPLC was used to validate the assay.

McKEE, MARIANNE1*, SARA MOORE1, RON TRICHE1, CHARLEY RICHARD1, MARY AN GODSHALL1, and ROBERT HATCH1,1 Sugar Processing Research Institute, Inc., 1100 Robert E. Lee Blvd., New Orleans, LA 70124, and 2American Charcoal Company LLC, 403 Stampede Circle, Cheyenne, WY 82009. Laboratory studies on polyaluminum coagulants in sugarbeet juice and molasses.

There has been some interest in polyaluminum coagulants (PACs) currently used in water treatment as processing aids in sugar products. We have conducted several laboratory studies using these PACs in the clarification of sugarcane mixed juice, sugarbeet thick juice, and decolorization of beet molasses. Five polyaluminum coagulants were tested with two composed of only aluminum compounds while three were composed of a blend of cation aluminum polymers with polyquaternaryamine. All showed significant removal of color, polysaccharides, and turbidity when compared to control samples with no PAC added.

THEISEN, KARL H., and IRMA GEYER*, pro-M-tec Theisen GmbH, Pforzheimer Str. 162, 76275 Ettingen, Germany. Microwave technology: An ubiquitous in line measurement instrument for density, total solids, concentration, especially brix in a today sugar factory.
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Over the last few months new applications, especially the concentration measurements in large pipelines and measurements in tanks, melters and mixers have shown that microwave technology thereby offers unique and new solutions to the sugar producing industry.

This paper discusses measurement experiences with microwave concentration measurement on large pipelines, in mixers, melters, vessels. Particular focus is on the concentration measurement of magma, molasses and mil of lime, with discussion of the technical aspects, considerations and advantages of the employment of microwave technology.
BAURES, MARC A., Hydrite Chemical Co. 701 Sumner St. La Crosse, WI 54603. Rapid odor control for sugar plant process water and ponds.

Sulfide is commonly generated in significant concentrations within process water and associated water storage ponds at sugar processing plants. Sulfide is generated when bacteria utilize the oxygen within oxygenated sulfur compounds (e.g. sulfate, sulfite) under anaerobic conditions leaving sulfide as a bi-product. Resulting sulfide concentrations cause significant odor problems as well as corrosion to metal, concrete and electrical components. Health hazards from exposure to hydrogen sulfide gas can also be a significant danger to employees.

Hydrite Chemical used a new technology to demonstrate the efficacy for rapid sulfide treatment at a large sugar production facility in the mid west. The objective of the study was to rapidly destroy existing odors as well as prevent the formation of additional odors in inversion conditions using a patented two-part chemical addition process. The new process functions through the oxidation of target odor agents using hydroxyl radicals formed by the interaction of a catalyst and an oxidizer. Hydroxyl radicals are very potent oxidizing agents that exceed the potency of every commonly available oxidant commercially available today. They are also very selective within a complex wastestream for the destruction of compounds like sulfide.

Chemicals were metered via two separate feed pumps into selected wastewater streams based on wastewater flow rate and sulfide level. Sulfide was monitored using sulfide liquid and gas phase measuring instrumentation. Inversion prevention dosages were based primarily on flow rates with an assumption of the potential for sulfide generation.

A pond containing approximately 60 million gallons and 15 ppm sulfides was dosed through a portable water pump. Untreated water was pulled from one end of the pond, dosed, and returned to the pond on the opposite end continuously. Sulfide levels were reduced to < 5 ppm within the air above the pond. and the treated water had no discernable sulfide odor. Process water was treated by the addition of the two-part process to circulation plumbing within the plant, as well as within the plant wastewater system. Qualitative analysis was performed pre and post-treatment, with detectable odors being eliminated following treatment. Odors and sulfide levels in both applications were reduced or effectively eliminated.
Experiences with briquetting and burning boiler fly ash in a coal-fired beet pulp dryer.

Tests on boiler fly ash from Minn-Dak Farmers Cooperative’s boilers showed it contained from twenty to thirty percent fixed carbon with an energy content as high as 5800 BTU per pound. Fly ash briquettes made using three levels of molasses and hydrated lime as binding agent. Briquettes made with 15% molasses, 5% hydrated lime and 80% fly ash were deemed suitable for a full scale test. They crushed with 222 Lb (987 N) of force and broke when dropped from over nine feet (2.7 M). A mixture of 1:1.67 briquettes to sub bituminous coal was burned in the a full-scale burn test in the coal-fired pulp dryer. The briquettes held together well in the conveying and stoking equipment. After some initial problems the briquettes burned well and the energy recovery was high. A significant portion of the ash was unaccounted in a mass balance.

Experiences with processing sugarbeets frozen for long term storage.

Freezing piled sugarbeets through forced ventilation during the winter allows for storage and processing of sugar beets through the spring. However, processing frozen beets presents a number of problems in washing, slicing and diffusion. These include high energy consumption, frequent freezing in the washhouse and beet bunkers, high sugar loss to the flume water, difficulty in fighting sugar-consuming bacteria in the flume water, excess foam in the washhouse, difficulty in separating out stones, and frequent knife changes. This paper discusses these and other problems and the procedures employed at Minn-Dak to correct or compensate for them.

Reduction of washhouse sugar losses through water management at Minn-Dak Cooperative.

The primary causes of washhouse sugar loss identified at Minn-Dak Farmers Cooperative are leaching of sugar into the flume water with subsequent blowdown to the wastewater system, microbiological activity, and loss to skins from frozen beet. Loss to the wastewater system has been reduced by significantly increasing the recycling of water within the washhouse. The elimination of the mud settling pond and incorpo-
rating dirt-dewatering presses greatly helped. In addition, wash water streams for screens and presses were separated from the flume water and all water additions were minimized. Infection has been controlled with temperature, pH and effective dirt removal. To reduce sugar loss in the frozen beets peels, the peels were pressed and the juice was combined with raw juice. This combination of efforts resulted in a relatively high sugar concentration in the flume, which was beneficial overall but also increased sugar loss to the pressed mud.

GOVIND, RAKESH, University of Cincinnati, and PRD Tech, Inc., 1776 Mentor Ave., Mail Box Suite #107, Cincinnati, OH 45212. Eliminating hydrogen sulfide emissions from beet sugar wastewater.

Wastewater from the beet sugar industry are often released into a holding lagoon, wherein sulfate reducing bacteria convert the sulfate, naturally present in the water, to hydrogen sulfide, resulting in emissions of odorous hydrogen sulfide and generation of dissolved sulfide in the water. In addition, the dissolved metals in the water, such as iron, precipitate as black metal sulfides, requiring periodic dredging of the lagoon. Public health scientists now recognize that hydrogen sulfide is a potent neurotoxin, and that chronic exposure to even low ambient levels causes irreversible damage to the brain and central nervous system.

Methods to reduce hydrogen sulfide emissions include aeration of water, covers for lagoons and use of biocides. Aeration of water using air spargers and blowers, liquid mixing systems or entrainment of air into the water using venture results in major consumption of electric power. Even in aerated systems, such as activated sludge basins, hydrogen sulfide is produced in the anoxic zones of the basin. Further, aeration results in growth of aerobic organisms resulting in the generation of waste sludge, which has to be disposed. Covers are another strategy to eliminate air emissions, but are expensive to install and do not eliminate the formation of dissolved sulfide resulting in metal sulfide precipitates, which accumulate in the lagoon. Biocides are not only expensive but also kill all types of bacteria including aerobic and anaerobic organisms, which are needed to treat the dissolved organics in the wastewater. Further biocides are generally ineffective against sulfate reducing bacteria that exist in biofilms at the bottom and sides of the lagoon.

In this paper, a novel cost-effective strategy for eliminating hydrogen sulfide emissions is proposed using a novel enzyme formulation, which is not a biocide, but basically disrupts the biofilm forming capacity of sulfate reducing bacteria, thereby resulting in not only the sloughing-off of the existing biofilms but also incapacitating their sulfate reducing mechanism. This enzyme formulation is merely added to the
water as it flows into the lagoon and remains active in the wastewater. Further, application of this enzyme formulation at beet sugar plants has shown that the wastewater in the lagoon is clearer, and easier to recycle for reuse within the plant. Laboratory and field-scale results of the application of this enzyme formulation at beet sugar plants will be presented and its economics will be discussed.

GULA, FRANCIS1*, and XAVIER LANCRENON2, 1Novasep Inc., 23 Creek Circle, Boothwyn, PA 19061, and 2APPLEXION SAS, 264, avenue de la Mauldre, 78681 Epone Cedex, France. The use of ion exchange resins for beet sugar juice processing.

Ion exchange resins are widely used for beet sugar juice processing. The purpose of this article is to review most of their use and present the latest improvements regarding the exchangers. We will especially focus on strong acid cation resins which present the almost unique feature of salt conversion reactions and the thin juice softening. The salt conversion process is based on selective affinities for different ionic species. The decalcification of beet thin juice is nowadays a necessity in order to avoid the evaporators scaling by calcium carbonate, oxalate or silicate resulting in high energy consumption. Different techniques have been used to reduce the scaling. The most common ones are the use of anti scaling agents and more frequently cationic ion exchange resins. Originally they were regenerated with a brine solution however this has been progressively abandoned due to the waste handling cost. The industry has developed several alternatives more environmental friendly such as NRS, raffinate regeneration from molasses desugarization or Gryllus processes.

JENSEN, ARNE S.1*, and KENT QUINNEY2, 1EnerDry ApS, Moelleaparken 50, DK2800 Kongens Lyngby, Denmark, and 2Amalgamated Sugar Company, LLC, 138 West Karcher Avenue, Nampa, ID 83653. Steamdrying of beet pulp – larger units, more energy recovery, no VOC and large CO₂ reduction.

There are 5 large steam dryers installed and one under construction in USA. Since 2003 steam turbines have been used to drive the large fan in the dryer. The world largest dryer with a capacity of 78 metric tons water evaporated per hour is installed. It has 2 internal super heaters, whereby it has been possible almost to avoid a reduction of the power production and save all the fuel the drum driers use. The air pollution with dust and VOC is becoming more and more a serious problem. Steamdryers do not generate dust pollution or smell (VOC) at all. CO₂ reduction is worldwide becoming a demand. Introducing steamdrying
is a step in that direction. The next step can be to use the dried pulp as fuel, which can make the factory self-sufficient with CO\textsubscript{2} neutral fuel. It reduces the global warming, and it is cheaper than gas and oil. Furthermore it gives more CO\textsubscript{2} reduction per invested $ that other CO\textsubscript{2} reducing investments, e.g. ethanol plants.

KAULEWSKI, RON, PAUL RUSTAD, GARY CORNELIUS, and GLENN AUGUSTINE*, Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284. Managing operational challenges of pulp steam driers.

Installation of fluidized bed steam pulp driers are becoming more common place in the United States in response to energy and environmental interests. While the advantages of steam pulp driers are compelling, their operation raises several unique challenges in managing both the steam produced and additional water captured.

KAULEWSKI, RON\textsuperscript{1}* , DENNIS J. SAYE\textsuperscript{2}, and RON SANFORD\textsuperscript{1}, \textsuperscript{1}Southern Minnesota Beet Sugar Cooperative, 83550 County Road 21, Renville, MN 56284, and \textsuperscript{2}Nalco Company, 1601 West Diehl Road, Naperville IL 60563. Co-treatment of digester effluent and pond stored wastewaters during 2005-2006 campaign.

At the end of the 2004-2005 campaign an excessive quantity of wastewater had accumulated in the wastewater storage ponds. SMBSC needed to slow production and implement an emergency plan to permit the processing of the remaining stores of piled beets. In preparation for the 2005-2006 campaign, SMBSC and Nalco developed a wastewater management plan that permitted the discharge of up to 2MGD from the beginning of the campaign. The factory more than doubled the volume of water it discharged in 2005-2006, relative to the previous campaign. This paper describes the water management strategy that was implemented.

KOCHERGIN, VADIM\textsuperscript{1}* , WILLIAM JACOB\textsuperscript{2}, MICHAEL KEARNEY\textsuperscript{3}, and WILLIAM BORNAK\textsuperscript{3}, \textsuperscript{1}Audubon Sugar Institute, Baton Rouge, LA 70776, \textsuperscript{2}Amalgamated Research Inc. (ARI), Twin Falls, Idaho, 83301, and \textsuperscript{3}Recirculation Technologies Inc. (RTI), Richboro, PA. Ion exchange decolorization - possibility of resin rejuvenation.

Ion exchange decolorization technology has been used extensively in the sugar cane refineries. The technology was also tested in the beet sugar industry for color reduction in thin and thick juice in the mid-1980’s but was not considered feasible at that time. In the recent years the use of this technology in the beet industry, e.g., for decolorization of thick juice or chromatographic extracts, was revisited, and several
hurdles were identified. Expected lifetime and the modes of failure of ion exchange resin are among the important parameters that influence both process operating expenses and the risk level of technology implementation. Recently developed short-bed ion exchangers based on fractal fluid distribution technology are characterized by relatively low resin inventory, but also utilize shorter operating cycles. As it had been established that resin life is somewhat dependent on the total number of operating cycles, it was considered important to study the possibilities of resin rejuvenation. A technology developed by RTI has been tested for restoration of heavily fouled resins after continuous operation on both beet and cane derived syrups. Resin parameters and performance before and after rejuvenation procedure have been compared. It has been established that the performance of anion exchange decolorization resin could be restored to a great extent. Reduction in decolorization performance has been related to fouling, which resulted in decrease in moisture holding capacity. Actual ion exchange mechanisms appear to play a secondary role in adsorption of color bodies in the resin polymer matrix. Restoration of moisture holding capacity allowed increasing resin performance significantly. The results will be presented illustrating the differences between exhausted and treated resin samples. The feasibility of the implementation of the resin rejuvenation procedure will be discussed.

KRELL, LOTHAR, Braunschweigische Maschinenbauanstalt AG, Am Alten Bahnhof 5, D-38122 Braunschweig, Germany. Progressive steam dryer design enables highest capacities.

Steam dryers for drying beet pulp have been state of the art for some time, and they are operated with great success in a large number of beet sugar factories. One of the primary factors favouring the installation of this type of dryer is its considerable energy savings potential when compared with conventional drying systems. As primary energy costs are continuing their upward trend on a global scale, this savings potential is gaining additional significance. While steam dryers of higher and higher capacities are required to cope with the increasing capacities of modern sugar factories, overall investment costs are expected to remain at acceptable levels. The dryer itself with its surrounding steel structure (and building) is one of the major factors that contribute to these costs. BMA’s response to this situation is a new steam dryer concept. At the core of this concept are elements with special flow properties, which allow the dryer to be given a more cost-effective design. With the aid of computational fluid dynamics (CFD), the overall concept of integrated dust separation has been re-designed for optimized flow properties. The
feasibility of this new solution has in the meantime been demonstrated in a pilot plant with beet pulp. With its new concept, BMA offers its customers a dryer which achieves a maximum water evaporation rate of more than 75 t/h, while requiring less space and allowing investment costs to be cut. Another important feature is that the proven conditions for pressed-pulp fluidization in the fluidized bed have been retained. Advantages and special savings effects can be derived from the dryer installation and the arrangement of the dryer’s peripheral equipment for ease of access.

LANCRENON, XAVIER1*, TONY LEIGH2, NICK GARRET2, and HANNU PAANANEN3, 1APPLEXION SAS, 264, avenue de la Mauldre, 78681 Epone Cedex, France, 2British Sugar Plc, Wissington Sugar Factory, Stoke Ferry, King’s Lynn, Norfolk PE33 9QG, United Kingdom, and 3Danisco, Sokeritehtaantie 20, 02460 Kantvik, Finland. 

**Low green separation at Wissington Sugar Factory, the United Kingdom.**

Overview of a large chromatographic separation plant that was started in spring 2002 at the Wissington Sugar factory, UK. The authors show that the project was completed in schedule and the plant reached the expected performances in record time.


**Laboratory studies on the effect of enzymes on color, turbidity and total polysaccharides in sugarbeet and sugarcane juice.**

Control of color, turbidity and polysaccharides is important in sugarbeet and sugarcane processing. Controlling these parameters as early as possible in the process will provide benefits to the manufacturer in terms of lowered use of processing aids, improved filtration, better sugar recovery, and higher quality products. Twenty-eight commercial enzymes with targeted functionalities were examined for their ability to reduce color, turbidity and/or polysaccharides in raw beet and raw cane juice. Juices were treated with 500 ppm enzyme for 30 min at 50° C and monitored for reduction of color, turbidity and total polysaccharide content. For beet juice, enzymes with hemicellulase, pectinase, xylanase, and glucanase activity removed significant color or polysaccharide. For cane juice, enzymes with hemicellulase, cellulase, xylanase, and glucosidase activity were the most effective. Several enzymes also decreased turbidity.
RHOTEN, CHRISTOPHER D.,* and JEFFREY L. CARLSON, 1 Western Sugar Cooperative, 2100 East Overland Drive, Scottsbluff, NE 69361, and 2Minn-Dak Farmers Cooperative, 7525 Red River Road, Wahpeton, ND 58075-9698. A systematic approach to optimization of the BMA K-2300 continuous centrifugal.

The optimization of a continuous centrifugal station is factory specific and related directly to the brix, purity, crystal quality and crystal content of the massecuite being processed through the station. The massecuite brix, purity, crystal size and crystal content influence the required basket speed, the position and number of sugar washing spray nozzles, the machine loading (capacity) and the volume of wash water required to produce the desired sugar color and green syrup purity. A systematic approach to the centrifugal optimization requires: (1st) the determination of the correct basket speed for required mother liquor separation and optimization of machine loading, (2nd) the determination of the correct number of and best position for the location of sugar washing spray nozzles and (3rd) the determination of the correct wash water flow rate to achieve the required sugar produced color and green syrup purity. The correct optimization of the identified operating parameters will generally lead to increased machine capacity, reduced wash water consumption and reduced sugar color with minimal increase in green syrup purity.

SULLIVAN, SHAWN, Western Sugar Cooperative, 1302 - 1st Ave., Greeley, CO 80631. Impact of new SPCC regulations on sugar manufacturing.

Environmental regulations continue to be updated and expanded in the United States affecting all types of industries including sugar manufacturing facilities. Environmental Protection Agency (EPA) regulations requiring Spill Prevention, Control and Countermeasures (SPCC) plans at oil handling and storage facilities were authorized in Section 311 of the Federal Water Pollution Control Action of 1972 (Clean Water Act) and amended by the Oil Pollution Act of 1990. The SPCC regulations were originally promulgated in 1973 and apply to all 50 states with enforcement by the EPA. Major revisions were proposed to the Oil Pollution Prevention regulations found in 40 CFR 112 several times during the 1990s in response to some notable tank failures and spills. The final revisions were published on August 16, 2002 but the effective date has been extended multiple times with a current implementation date of 10/31/2007. The revisions to the SPCC requirements include eliminating the 660 gallon tank threshold while keeping the 1320 gallon threshold, allowing up to five years between professional engineer certifications.
and specifying that all oil containers of 55 gallons or greater are subject to the regulations. Additionally, more specific requirements have been included for fencing, security, secondary containment, substantial harm determination and facility inspections, evaluations and integrity testing. Although some suggest these revisions are mainly clarifications of the previous rule and related guidance, the practical effect will be that most sugar manufacturing facilities will be required to modify their oil handling facilities, practices and response mechanisms.

TAYLOR, MARK\textsuperscript{1}, and PASCAL DEDOLE\textsuperscript{2}, \textsuperscript{1}Fletcher Smith Ltd., Norman House, Friar Gate, Derby DE1 1NU, Great Britain, and \textsuperscript{2}Five Cail Group/Maguin S.A.S., 22 rue du Carrousel, Parc de la Cimaise, BP 374, 49 666 Villeneuve D’Ascq, France. \textbf{The New Bogazlyian Beet Sugar Factory: the new reference of most modern technology.}

A new beet sugar factory has been built in 2005/2006 in Bogazlyian (Turkey) after the contract was awarded to a consortium of 3 partners: Fives-Cail, Maguin, from France and OEP from Turkey. The turnkey completion in only 15 months of the highly modern factory enabled start up for the campaign starting November 2006. The presentation displays technologies selected and Preliminary production results are also presented.

ZIMMERMAN, ROBERT M.\textsuperscript{1*}, KEN BENNETT\textsuperscript{2} and E. JEREMY COSTER\textsuperscript{3}, The Western Sugar Cooperative, \textsuperscript{1}1302 - 1st Ave., Greeley, CO 80631, \textsuperscript{2}3020 State Ave., Billings, MT 59101, and \textsuperscript{3}7555 East Hampden Ave., Suite 600, Denver, CO 80231. \textbf{Billings BMA Tower 2000 installation and comparison to other Western Sugar BMA tower installations.}

The Billings Facility of the Western Sugar Cooperative installed a BMA 7000 by 19930 Tower 2000 for the 2004-05 campaign. The new diffuser replaced a nominal 4000-ton per day Silver Slope diffuser. An air permit change was required with new operational limits for this installation. Operationally, the new tower reduced pulp losses and draft from 0.45% OB and 140% OB with the slope diffuser to 0.35% OB and 110% OB. This is comparable to the other tower operations in Western Sugar. A qualitative and indirect analysis of microbiological activity in the tower shows lower activity in the newer tower as compared to the older towers. The factors influencing this include elimination of bottom screens, operating at nominal tower capacity and the control of activity in tower feed streams. The tower installation also improved downstream process activities including carbonation and evaporation.
ZIMMERMAN, ROBERT M.*, and SCOTT A WINN, The Western Sugar Cooperative, 1302 - 1st Ave., Greeley, CO 80631. **Fort Morgan evaporator failure.**

The Fort Morgan Facility of the Western Sugar Cooperative experienced a catastrophic evaporator failure during the 2004-05 campaign. The failure occurred when the joint between the upper shallow cone head and the side wall failed completely under less than 30 psig of pressure. Collateral damage included the destruction of 600 SF of roofing and other equipment damage. Injuries to personnel were limited, but factory operations ceased for several days. Limited operation was restored by bypassing the failed evaporator. Repairs were made to the evaporator for the following campaign and it was moved to a lower pressure service through the addition of another evaporator. Programs were put in place to examine all Western Sugar pressure vessels for this type of construction joint. A thorough review Western Sugar pressure vessels practices and testing was done and compared to applicable pressure vessel codes. Pictures of the damage and repairs are included.
RÖSNER, GERHARD¹, WALTER HEIN¹, GÜNTER POLLACH¹, PAUL DODD², and JASON GRECH²*, ¹Zuckerforschung Tulln GmbH, Reitherstraße 21-23, A-3430 Tulln, Austria, and ²BetaTec Hop Products GmbH, Freiligrathstr. 7/9, 90482 Nürnberg, Germany. **Reduction of processing aids – apparatus to reduce lime, antifoam and alkalizing medium.**

The production of sugar from sugar beet is increasingly under pressure to minimize costs. A significant share of these production costs come from processing aids. This work reports on developments at Zuckerforschung Tulln G.m.b.H/ AGRANA for savings of processing aids in three different areas. The first part deals with measures to minimize the demand of antifoaming agents. A so-called Anti Foam Optimizer (AFO) is discussed in detail. This device, which is installed within a bypass, calculates the optimal demand and dosage of antifoaming agents for various juices. The second apparatus labelled LISA (Lime Salts Analyser) determines the residual calcium content in juices in a very simple but robust and reliable way. This apparatus also performs within a bypass and its operational principle is based on the insolubility of calcium-soaps. It enables optimal dosages of alkalising medium as well as scale inhibitors. The third device was originally designed as a computer program called LIMOS (Lime Optimization System). It calculates the necessary minimum amount of milk of lime and performs its dosage on the basis of operational characteristics such as amount of raw juice and filter pressure. Besides detailed description of these apparatus and their operating mode, information on successful applications reported.