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ABSTRACTS

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ANDERSON, PETE A., American Crystal Sugar Company, Route 2 Box 42, Hillsboro, ND 58045. **Constructed wetland treatment of sugar beet wastewater.**

The original wastewater treatment system at American Crystal Sugar Company's (ACSC's) Hillsboro, North Dakota sugar beet refinery consisted of primary sedimentation, wastewater storage in anaerobic lagoons, and aerobic treatment by activated sludge. This system alone was incapable of reducing the 5 day Biochemical Oxygen Demand (BOD_5) of the wastewater to meet the refinery's National Pollutant Discharge Elimination System (NPDES) 25 mg/L limit. Analysis of the aerobic plant effluent had also exhibited toxicity to aquatic organisms due to high levels of ammonia. Construction of the 157 acre (63.6 hectare) CW for supplementary wastewater treatment began in 1988 and was completed in 1993. During 1994 and 1995 removal efficiencies for BOD_5, Total Kjeldahl Nitrogen (TKN), and Total Phosphorous (TP) were 95%, 87% and 44%, respectively. Data collected from 1996-1998 indicated similar removal rates for BOD_5 and TKN. A net export of TP apparently occurred from the CW during these years. Except for one failure in 1998, quarterly Whole Effluent Toxicity (WET) testing of the CW effluent has routinely shown no toxicity to Pimeprhales promelas (Fathead minnow) or Ceriodaphnia dubia (Daphnia) and the discharged effluent has met all other NPDES water quality parameters. Constructed wetland treament has proven to be an efficient system for the advanced treatment of sugar beet process wastewater while simultaneously providing valuable waterfowl habitat.

ANDERSSON, VISTI, Niro A/S, 305 Gladsaxevej, DK 2860 Soeborg, Denmark. **Drying of beet pulp in pressurized superheated steam - Further developments.**

At the ASSBT meeting in Monterey, 1991 the Niro steam dryer for beet pulp was presented. Since then a number of units for beet pulp and wood based biofuel have been put in operation in Europe and two units for beet pulp are to day under construction in the States. Since 1991 a number of developments and design improvements have been tested and proved on the units as they were delivered and commissioned, such as increased capacity by installing additional heating surfaces in the cells, improved control of the retention time by installation of special designed hole and gill plates in the fluidized bed, new proven generation of the intake and discharge rotary valves with hydraulic automatic instrumentation and new design of the rotors.

ARMSTRONG, J. SCOTT, ROBERT J. DREGSETH*, and ALBIN W. ANDERSON, North Dakota State University, Department of Entomology, Fargo, ND 58105. **Lethal dose values for neonate sugar beet root maggot *Tetanops myopaeformis* (Roder) larvae exposed to terbufos, chlorpyrifos and aldicarb.**

Sugar Beet Root Maggot (SBRM) *Tetanops myopaeformis* (Roder) larvae were exposed to varying levels of technical aldicarb, chlorpyrifos and terbufos in a mortality experiment that established LD_{50} and LD_{90} values over a period of seven years (1987 - 1994). The results of these assays show that SBRM did not developed resistance to carbamate or organophosphate insecticides within the years tested, even when larvae used in the assays were from adults that were collected from fields that had control failures. SBRM larvae had very consistent LD_{50} and LD_{90} values, indicating that control failures were due to the fate of insecticide in the environmental (i.e. excessive rain, aggressive soils) rather than true resistance. The larval mortality data is important as base-line information that will be used in future assays that check for resistance.

BEHROUZ, EHSANI M. and NASRIN YAVARI, Sugar Beet Seed Ins., P.O.Box 31585-4114, Karaj, Iran. **The effect of TIBA/proline treatment on sugar beet somatic embryo formation.**

The effect of TIBA on sugarbeet in vitro seedlings (inplanta) and cell culture along with proline was investigated. Sugarbeet sterilized seeds were grown in vitro on 1/2 MS medium supplemented with 0 and 3 mg/l TIBA. Calli obtained from young leaves cultured on MS medium containing 1.0 mg/l BAP, were used for the initiation of cell suspension culture which was MS containing 0 and 50 mM proline. Aliquots of 1 ml from cell suspension culture were inoculated onto the somatic embryo induction medium containing TIBA 0.5 mg/l , BAP 1.0 mg/l and proline 0 and 50 mM concentration. After three weeks of culture, embryogenic calli were transferred to the regeneration medium supplemented with NAA and BAP at 0.2 and 0.5 mg/l respectively. The frequency of somatic embryo formation in calli obtained through TIBA/proline treatment was 10 times higher than in the control.

BENSON, SCOTT and JEFFREY L. CARLSON*, Minn-Dak Farmers Cooperative, 7525 Red River Road, Wahpeton, ND 58075-9698. **Effectiveness of available biocides on microbes present in the diffusions system at Minn-Dak Farmers Cooperative.**

Since OSHA regulations have made the use of formaldehyde practically impossible in the United States, beet-sugar processors are having difficulty in fighting infections in diffusion systems. Several types of anti-microbial agents are available but gave inconclusive results at Minn-Dak when used in the BMA Diffusion system. Minn-Dak undertook this study to determine the efficacy of several available biocides on microbes present in the diffusion juice. Minn-Dak researchers selected hydrogen peroxide, gluteraldehyde, dithiocarbamates, and ammonium bisulfite at different concentrations and combinations. They examined the counts of lactic-acid producing bacteria, mesophiles, yeasts and molds, and thermopiles in diffusion juice samples before and after adding the biocides. Hydrogen peroxide had the greatest affect followed by gluteraldehyde, and dithiocarbamates. Ammonium bisulfite was the least effective as a biocide.

BIANCARDI, ENRICO[1]*, WALTER BOSCHETTI[1], GIANCARLO BELTRAMI[2], MATTEO CECCHINI[3], and ROBERTO GHEDINI[4], [1]Istituto Sperimentale per le Colture Industriali, viale Amendola 82, 45100 Rovigo; [2]Consorzio Nazionale Bieticoltori, via Moro 16, 40127 Bologna; [3]Società Fondiaria Industriale Romagnola, via Croce 7, 47023 Cesena; and [4]Associazione Bieticoltori Italiani, via Hirsch 19, 40100 Ferrara, Italy. **Effects of integrated controls against *Cercospora beticola* in sugar beet.**

The negative effects of cercospora leaf spot (CLS) on sugar beet production are firstly due to the reduction of the active leaf surface. Either moderate or severe attacks promote a rapid re-growth of new leaves during the second half of the harvest, altering the source-sink relations . The influence of both factors on production traits is variable because it depends on: 1) the intensity of the attack; 2) the CLS genetic resistance of the variety; 3) the fungicide treatment efficiency; 4) the climatic conditions; 5) the harvest date. While the loss of leaf surface causes a decrease of root yield, the regrowth in the late season influences mainly the decrease of both sugar content and processing quality. To understand the still open questions concerning the interactions among production, disease, genotype, and fungicide treatments, seven field trials were carried out in 1997 and 1998. The results indicate that the characterization of varieties as either resistant or susceptible based on the visual evaluation of the disease is not indicative of their sugar production. A method is proposed for a more reliable estimate of the CLS resistance. The effects of genetically determined resistance and chemical protection on yield are equally important in conditions of low or moderate attack. The effect of fungicide treatments is more important in case of severe disease levels. The leaves regrowth rate in different genotypes appears to be not correlated to CLS resistance.

BOSSE, DIETRICH, and REINHOLD HEMPELMANN*, BMA AG, P.O. Box 3325, 38022 Braunschweig, Germany. **Tower 2000: A new tower extraction concept**.

One of the characteristics of the BMA extraction tower is that the tower juice is withdrawn through bottom and side screens. The maximum load on the bottom screens is approximately 65 $m^3/m^2/h$, the limit being the cossette packet on the screen influencing the flow. Series of tests have shown that the specific throughput of the side screens, unlike that of the bottom screens, can be increased up to 200 $m^3/m^2/h$. For the new "Tower 2000" concept, the circulation juice is withdrawn only through novel side screens. Essential advantages are: (1) no bottom screen and subjacent juice chambers, (2) simpler design of extraction tower base, minimizing the danger of infections, (3) the whole screen area made in corrosion-resistant steel, (4) absence of bottom screens evades damage of screens, (5) minimized maintenance as screens need not be removed after the campaign. In addition, the driving system was redesigned. A smaller number of pinion teeth allows to reduce the number of drive units which are now of the central planetary gear type. A safety coupling protects the drives from extraordinary loads. All the measures taken to achieve technical improvements also entailed a reduction of manufacturing costs. The first plant practising the new concept was successfully put into operation in the 1998 campaign.

BREDEHOEFT, MARK, Southern Minnesota Beet Sugar Cooperative, P.O Box 500 East Highway 212, Renville, MN 56284. **Dual II Magnum, fall and spring applied in sugar beets.**

Weed control in suagr beets is a challenge for producers and processers. Effective control of weeds in sugar beets starts with early season weed control. The objective of this research was to evaluate Dual II Magnum for weed control in sugar beets applied in fall, spring and layby alone and with post emergence herbicides. Control of yellow foxtail, redroot pigweed, and common lambsquarters was increased by the use of Dual II Magnum compared to Eptam, Roneet, and Nortron. Although Dual II Magnum and Nortron gave similar weed control at early season evaluations, late season evaluations showed an advantage to Dual II Magnum longer season control. The use of Dual II Magnum also resulted in increased sugar production in comparison to above mentioned herbicides.

BREWTON, RANDOLPH G.*, and CHARLES M. RUSH, Texas A & M Agricultura Research Center, 6500 Amarillo Blvd W., Amarillo, TX 79106. **Detection of genetic diversity in beet soilborne mosaic virus (BSBMV) in the central United States; identification of single-strand conformation polymorphisms (SSCP).**

The furoviruses are a distinct taxonomic group of *fu*ngal-transmitted, *ro*d-shaped single stranded RNA viruses with divided genomes. Beet necrotic yellow vein virus (BNYVV) and beet soilborne mosaic virus (BSBMV) are two furoviruses that infect sugar beet (*Beta vulgaris L.*). Some sugar beet cultivars that are resistant to BNYVV-induced rhizomania are suceptible to infection by BSBMV, resulting in leaf and hairy root lesions. Our objectives in this study were: 1) determine the degree of genetic diversity in BSBMV isolates taken from a wide geographic area, and 2) identify genetic markers that link to disease phenotypes; particularly those which include the roots. Sugar beets exhibiting foliar symptoms consistent with BSBMV infection were collected from fields in Minnesota, Nebraska, Wyoming, Colorado and Texas. Total RNA was isolated from symptomatic leaf tissue and used to produce first-strand cDNA. We utilized unique oligonucleotide primers and the polymerase chain reaction (PCR) to specifically amplify overlapping PCR products on BSBMV RNA's 2, 3, and 4. The products, which ranged in size from 166-742 base pairs, were heat denatured to separate the double-standed DNA into stable single-stranded structures. The samples were separated overnight on 10% polyacrylamide gels and silver stained to visualize the DNA bands. We have utilized SSCP to successfully identify informative PCR products on RNA's 2, 3 and 4 that indicate the presence of multiple genetic groups (genotypes) of BSBMV. One informative product was found on RNA's 2 and 4 indicating three and two genotypes respectively. Two informative products on RNA 3 indicate a minimum of four genotypes and the potential for as many as eight genotypes.

BURT, GEORGE[1]*, CALVIN WELTY[1], JAMES ENYART[1], and DR.GERALD SIMANTEL[2], [1]West Coast Beet Seed Company, P. O. Box 7717, Salem, OR 97303, and [2]Novartis Seeds, Inc., 11939 Sugarmill Road, Longmont, CO 80501. **Production techniques being utilized to ensure purity of transgenic characteristics.**

Transgenic traits are incorporated into breeding lines under tight control measures in the lab and green houses. The challenge and objective in the seed production and processing is to ensure that these characteristics are maintained at the same level for both the current production and future production. Every grower and their fields were carefully selected for cleanliness and isolation from other sugarbeet fields. Movement of transgenic material was carefully monitored. Every piece of equipment was carefully inspected both before and after it came in contact with transgenic seed or pollen carrying transgenic characteristics. Planters, swathers, and cleaning equipment underwent thorough inspection prior to entering the field or the introduction of seed. Combines had to meet both a thorough inspection and a requirement of combining specific acres of another crop before use. Separators were washed with high pressure water along with other agents to remove and destroy pollen. Specific tote boxes were modified to accept only transgenic seed and shipping containers were also chosen to ensure no contamination. The cleaning and processing facilities were scheduled to handle only transgenic material. Sampling and testing of seed at different intervals in the program was used to ensure the purity of the transgenic character. To protect future productions as well as the environment, inspections and control of escapes in nurseries and fields were and will be made. GPS, detailed maps, and specific record keeping programs are being used to monitor past fields and to help growers select control measures of plants from shattered seed. This information system will also be used for selection of future productions.

CAMPBELL, L. G.[1]*, G. A. SMITH[1], J. D. EIDE[1], and L. J. SMITH[2], [1]USDA, Agricultural Research Service, Northern Crop Science Laboratory, Fargo, ND 58105-5677, and [2]Northwest Experiment Station, University of Minnesota, Crookston, MN 56716. ***Metarhizium anisopliae*** **as a biocontrol agent for sugarbeet root maggot.**

Only a few insecticides are available for controlling the sugarbeet root maggot (*Tetanops myopaeformis*). These could become less effective because of the development of resistant root maggot strains or become unavailable because of environmental concerns. An effective biocontrol agent would provide an alternative and, perhaps, more consistent control method. Laboratory results and a 1995 field trial prompted further testing of the entomopathogenic fungus *Metarhizuim anisoplaie* (Metschn.). *Metarhizium* inoculum was prepared by culturing the fungus on heat-killed barley. The inoculated barley was spread evenly over field plots in the fall proceeding the sugarbeet crop, in the spring prior to planting, or both in the fall and spring. Root yields ranged from 49.5 Mg ha^{-1} when no insecticide was applied to 59.2 Mg ha^{-1} when Lorsban (chlorpyrifos) was used to control maggots. The fall, spring, and fall plus spring applications of *Metarhizium* yielded 51.5, 50.9, and 58.9 Mg ha^{-1}, respectively, at Crookston in 1996. The 1997 trials included the same three *Metarhizium* treatments with an additional application of *Metarhizium* in the spring of 1996 (prior to planting barley). Root yields for the *Metarhizium* treatments ranged from 51.4 to 57.5 Mg ha^{-1}, compared to 57.6 Mg ha^{-1} when Lorsban was applied and 48.7 Mg ha^{-1} in the absence of maggot control in 1997. Yield differences between treatments were not significant in 1998 because of reduced root maggot pressure, but appeared to follow the pattern observed in the 1996 and 1997 trials. Results, to date, have been encouraging; however, additional information on application rates and timing, formulations, and the effectiveness of *Metarhizium* in more environments will be required before commercialization is feasible.

CARLSON, JEFFREY L., PETE JENSEN, and DENNIS KALLSTROM, Minn-Dak Farmers Cooperative, 7525 Red River Road, Wahpeton, ND 58075-9698. **Ammonia and nitrate removal from wastewater at Minn-Dak Farmers Cooperative with a nitrification-denitrification system.**

Ammonia and nitrates in water discharges can have a detrimental affect on the environment. Beet processors are required to report releases of these compounds on their toxic release inventory forms which are published by the EPA. In addition, ammonia can cause failure of whole effluent toxicity tests required by the EPA. In 1997, Minn-Dak Farmers Cooperative installed a Infilco Degremont, Inc. designed nitrification-denitrification wastewater treatment. It is installed in series with anaerobic wastewater treatment and removes ammonia, nitrate and residual carbonaceous biological oxygen demand. In its campaign of operation, it converted 99 % of the ammonia-nitrogen, to nitrate and removed over 90 % of that nitrate-nitrogen.

CARLSON, JEFFREY L., UPASIRI SAMARAWEERA, and KEN A. KUBAT, Minn-Dak Farmers Cooperative, 7525 Red River Road, Wahpeton, ND 58075-9698. **Increases in pH during beet-juice evaporation: causes and cures.**

In evaporating sugar beet juices with a high natural alkalinity, pH increases are sometimes seen in the evaporators and pans. These high pH's can change the heat-transfer and crystallization properties of the syrups. Use of gypsum, sulfuric acid or sulfur dioxide for increased pulp pressing adds to the natural alkalinity of the diffusion juice, thus magnifying this problem. Also, adding sodium hydroxide or soda ash to the beet end can cause similar increases in pH. Since the problem is an excess of sodium and potassium ions in the second carbonation juice, beet processors can solve the problem by balancing the excess with anions in a number of ways. The most common method is adding SO_2 to thin juice but other more economical and effective solutions include the following: 1) Use calcium chloride instead of calcium sulfate for a pressing aid, 2) add calcium chloride or some other soluble calcium salt to the raw juice, and 3) Use an acid whose anion forms a soluble calcium-salt in first and/or second carbonation in addition to carbon dioxide.

CARLSON, HARRY L.[1*], KENNETH A. RYKBOST[2], DONALD W. KIRBY[1], and RANDY L. DOVEL [2], [1]University of California Intermountain Research and Extension Center, P.O. Box 850, Tulelake, CA 96134, and [2]Oregon State University Klamath Experiment Station, 6941 Washburn Way, Klamath Falls, OR 97603. **Effects of sugarbeet planting date and plant population on sugar yield in the Klamath Basin.**

Date of planting studies were conducted over a six year period, 1991 to 1996, to determine the optimum dates for sugarbeet planting in the Klamath Basin. These field studies were conducted at the Klamath Experiment Station in Klamath Falls, Oregon and at the Intermountain Research and Extension Center in Tulelake, California. During the first three years of study, it was determined that planting in early April resulted in significantly higher beet yields than later planting. Planting date did not have a marked affect on the sugar content of harvested beets; although, early planting did result in greater sugar production per acre because of higher beet yields. On average, each week delay in planting date after May 1 resulted in a 600 lb per acre loss in sugar production. Because plant stand establishment can be difficult under Klamath Basin's typically cold, wet spring conditions, follow-up studies were conducted in 1994, 1995 and 1996. These studies included a wide range of plant populations in addition to varied planting dates to determine adequacy of plant stands in early-planted fields and critical plant stand thresholds for replant decisions. This second set of experiments confirmed the rapid yield decline with delayed planting. Beet yields also declined with reduced plant populations. Averaged over all planting dates, the yield of plots with 8000 plants per acre was approximately 20 percent lower than the yield of plots with adequate plant stands (20,000 plants per acre). Still, because of the dramatic effect of delayed planting date on yield, plots established early with poor plant stands generally out yielded plots with adequate stands planted a few weeks later. A multi-variant regression yield model using plant population and planting date was developed to help guide growers in making decisions on the benefits and liabilities of replanting sugarbeet fields with poor initial stands.

CATTANACH, ALLAN W.[1*], LARRY J. SMITH[2] and MARK W. BREDEHOEFT[3], American Crystal Sugar Co. 101 No. 3rd St. Moorhead, MN 56560, University of Minnesota, NWES, Crookston, MN 56716, and Southern Minnesota Beet Sugar Cooperative, P.O. Box 500, Renville, MN 562843. **New fungicides for Cercospora leafspot control in Minnesota and North Dakota.**

Sugarbeet (Beta Vulgaris L.) was planted on over 700,000 acres in eastern ND and MN in 1998. Leafspot caused by Cercospora beticola Sacc. has been the most serious disease of sugarbeet in the region for over two decades. Incidence and severity of the disease was at or near epidemic levels in southern growing areas in 1995 and throughout the region in 1998. In spite of up to 10 fungicide applications by some growers in 1998 yield and quality losses were in excess of $50,000,000. Thirty six fungicide treatments were applied at 20 gpa and 120 psi, then evaluated for cercospora leafspot control at two RRV and two southern MN locations. Efficacy of fungicides in use now is greatly influenced by fungal tolerance to TPTH and resistance to benzimidazole products. Yield, quality and cercospora leafspot rating were determined at harvest. Some presently registered fungicides increased recoverable sugar per acre by more than 1,500 lbs. compared to untreated controls. Selected Experimental fungicides increased recoverable sugar per acre by more than 3,000 lbs. compared to untreated controls.

CHIOU, TZYY-JEN [1], MATT VAUGHN [1]and DANIEL R. BUSH [1,2*]. [1]Department of Plant Biology & [2]USDA-ARS. 190 ERML, University of Illinois, Urbana, IL 61801. **Sucrose is a signal molecule in a new signal-transduction pathway that modulates sucrose transport activity and assimilate partitioning.**

One of the defining features of multicellular growth is the need to partition resources and information between organ systems that specialize in divergent biological processes. The leaf is the principle site of energy and material acquisition while other organs specialize in additional requisite activities, such as water and ion uptake (root) or reproduction (flowers and seeds). Assimilate partitioning is the physiological process in higher plants that mediates the transport and allocation of organic nutrients via the phloem cells of the plant's vascular system. In the results reported here, we identify sucrose as a signaling molecule in a new signal-transduction pathway that regulates assimilate partitioning by controlling the sucrose transporter that loads the phloem. Transporter activity declined in plasma membrane vesicles isolated from leaves fed exogenous sucrose via the xylem transpiration stream. In contrast, alanine and glucose transporter activities did not change in response to sucrose treatments. Kinetic analysis of transport activity showed a decrease in Vmax. RNA gel blot analysis documented a decrease in symporter message levels, suggesting a drop in transcriptional activity or a decrease in mRNA stability. Taken together, these results suggest that a complex interplay between symporter gene expression and protein turnover regulates sucrose export to the beet root. Sucrose-dependent changes in the sucrose transporter were reversible, suggesting this sucrose-sensing pathway can modulate transport activity as a function of changing sucrose concentrations in the leaf phloem. This is the first report of a signaling pathway that can control assimilate partitioning at the level of phloem translocation.

COLONNA, WILLIAM J., and C. GARY FISCHER*, American Crystal Sugar Company Research Center, 1700 N. Eleventh Street, Moorhead, MN 56560. **Modification of the procedure for measuring amino-N in brei extracts in the beet quality lab.**

Amino-N content, a parameter used in determining beet quality, is quantitated fluorimetrically with o-phthaldialdehyde (OPA) + βmercaptoethanol (βME). The toxicity of the latter prompted us to explore the use of an alternate thiol, namely, N-acetyl-cysteine (NAc). NAc is a crystalline solid that is stable in aqueous or alcoholic solutions, and is much less malodorous and markedly safer than βME. Substitution of NAc in the amino-N reagent system reduces its sensitivity, but only slightly. Since the thiol partakes in the reaction between OPA and amino acids, and becomes incorporated in the fluorescent reaction product, the decrease in sensitivity may result from slower reaction kinetics when NAc vs βME is present. In parallel trials with 240 identical samples, filtrate amino-N levels averaged ~23% higher when NAc vs. βME was used in the reagent. This is attributable to a difference in reactivity between NAc vs. βME and the glutamine standard used for calibrating the fluorometer. Glutamine, at ~35% of total, was found to be the predominant amino acid in brei; however, significant levels of 5-6 other amino acids are also present. With a standard containing amino acids representative of those in brei, NAc gave amino-N values ~38% higher than when the βME/glutamine combination was used. These higher amino-N levels may explain the spread between predicted and actual SLTM in the sugar mill. Our data suggest that more accurate amino-N values would be obtained with standards containing a mixture of the predominant amino acids found in brei, and in the representative proportions, rather than glutamine alone. It is proposed that NAc be adopted for use in amino-N determinations in the Quality Lab.

CROOK, TERESA M*., Michigan Sugar Company, P.O. Box 247, Carrollton, MI 48724. **The effect of sugar beet root aphid (Pemphigus betae Doane) on sugar beet yield and quality in Michigan.**

Sugar beet root aphid had a significant impact on both sugar beet yield and quality in some areas of Michigan in 1995. This pest has continued to be prevalent at differing levels including 1998. The objective of this study was to compare sugar beet quality consisting of sugar content, clarified juice, amino-nitrogen of the same varieties in both the presence and absence of the sugarbeet root aphid.

DEXTER, ALAN G., INES ROTHE and JOHN L. LUECKE, North Dakota State University-University of Minnesota, Plant Sciences Department, Fargo, ND 58105. **Weed control in Roundup Ready™ and Liberty Link™ sugarbeet.**

Roundup (glyphosate) and Liberty (glufosinate) were used for weed control in Roundup Ready and Liberty Link sugarbeet in 1997 and 1998. The objectives of the experiments were 1) determine weed control and sugarbeet yield after Roundup or Liberty treatment, hand weeding or conventional herbicide treatment, 2) determine the optimum time of first treatment with Roundup or Liberty and 3) determine the influence of row-crop cultivation on yield of sugarbeet when weeds were controlled by Roundup or Liberty. The following results are from 1997, data from 1998 will be analyzed and presented at the meeting. In 1997, sugarbeet treated with Roundup or Liberty yielded more than hand weeded sugarbeet even though the first hand weeding was at the same time as the first herbicide treatment. Sugarbeet treated with conventional herbicides yielded similar to the hand weeded sugarbeet. Sugarbeet yield was reduced if the first application of herbicide was delayed until two weeks or later after the cotyledon growth stage of the sugarbeet. Sugarbeet cultivated two or five times yielded less or tended to yield less than non-cultivated sugarbeet when Roundup or Liberty were used to provide nearly total weed control. Two to three applications of Roundup or Liberty were needed for complete weed control.

DEXTER ALAN G.[1], TREVOR M. DALE[1], JOHN L. LUECKE[1] and MARK W. BREDEHOEFT[2], [1]North Dakota State University - University of Minnesota, Plant Sciences Department, Fargo, ND 58105 and [2]Southern Minnesota Beet Sugar Cooperative, Renville, MN. 56284. **Micro rates of postemergence herbicides in North Dakota and Minnesota.**

The micro rate system of postemergence herbicides in sugarbeet included desmedipham (Betanex) or desmedipham & phenmedipham (Betamix) or desmedipham & phenmedipham & ethofumesate (Betamix Progress) at 0.08 lb/A plus triflusulfuron (UpBeet) at 0.004 lb/A plus clopyralid (Stinger) at 0.03 lb/A plus methylated seed oil adjuvant at 1.5% v/v. Clethodim (Select) at 0.03 lb/A or quizalofop (Assure II) at 0.0275 lb/A or sethoxydim (Poast) at 0.063 lb/A sometimes was included for improved grass control. All herbicide rates are 66 to 75% lower than conventional rates. The micro rate should be applied three or more times at 5 to 7 day intervals starting at the cotyledon to early two-leaf sugarbeet stage. A survey of sugarbeet grower usage of the micro rate system indicated that about 98% of the growers who used the micro rate system in 1998 intended to use it again in 1999. Research results in 1997 and 1998 indicated that three applications of the micro rate gave better weed control than two applications of conventional rates and generally gave weed control similar to three applications of conventional rates. In some cases, three applications of conventional rates gave better broadleaf weed control than three applications of the micro rate but the differences were 5% or less. In some cases, the micro rate, with no grass herbicide, gave better grass control than conventional rates probably because the methylated seed oil adjuvant in the micro rate greatly increased grass control from triflusulfuron.

DOLE, KEVIN A.* and JON R. MURNIK , Murnco Inc. P.O. Box 1707, Winter Haven, FL. 33882. **Comparison of the effectiveness of biotechnology products for the reduction of biochemical oxygen demand (BOD) and odor in sugarbeet wastewater.**

Classically, processing sugarbeet wastewater has involved a series of holding ponds to reduce Biochemical Oxygen Demand (BOD) over time. The disadvantages to this sort of scheme are large amounts of land are required, and the water may need to be stored for long periods. Additionally these systems usually suffer from severe odor problems. Even after long treatment times, there are no guarantees that the water will be at acceptable levels for discharge. More modern approaches involve anaerobic digestion followed by aerobic contact and clarification. These methods can be effective, but they require large amounts of capital and may not be feasible for small operations. An emerging alternative for operations that cannot afford an expensive treatment system is the use of biotechnology products to enhance degradation, and reduce odors. Through experimentation we hoped to gauge the effectiveness of commercially available products for the reduction of BOD and odor of typical sugarbeet wastewater. Sugarbeet wastewater having a BOD of 26,100 mg O_2/L was aliquoted in triplicate into earthen reaction chambers for a total of 8 treatments (7 variables and 1 untreated control).Standardized amounts of 7 commercially available products were aliquoted in triplicate into their appropriate vessels and incubated at 20^0 C. Samples were taken at two week intervals for a total of 8 weeks, and analyzed for BOD and odor. Odor was tested by a 10 person smell panel that rated odor on a scale from one (slight odor) to ten (offensive odor). All ten people's scores were added and the overall score is used to indicate the strength of the odor. After the eight week trial, the untreated sample had a BOD(mg O_2/L) of 16, 720 with an overall smell score of 73. Treatments 3,4, 5, and 6 had BOD of 8400, 7600, 6800, and 6750 respectively with respective odor scores of 64, 56,53,and 49. Treatments 1,2 and 7 exhibited the largest reductions, their respective values were 3520, 2720, and 2400 with odor scores of 33, 22, and 19 respectively.

DORAN, JOY B.*, JENNIFER CRIPE, MISTY SUTTON, and BRIAN FOSTER, Central Michigan Univ., Dept. of Biology, Mt. Pleasant, MI 48859. **Conversion of sugar beet pulp to ethanol using engineered bacteria.**

There is a critical need to develop alternative fuel sources that are renewable and less detrimental to the environment. Data show that sugar beet pulp is easily degraded by enzymes, does not need physical pretreatment, does not appear to produce any compounds that are strongly inhibitory, and is currently undervalued, making it an attractive substrate for a bioconversion process for generation of fuel ethanol. For the past 20 years annual production of sugar beets (U. S.) has fluctuated between 20 and 30 million wet tons with over 1.6 x 106 tons (dry wt.) of beet pulp remaining after sucrose removal. Production of feed from pulp is an economically marginal part of processing due to low feed value and relatively high costs of drying. Fermentations with pressed pulp (75% moisture) yielded slightly higher ethanol concentrations than pellets (10% moisture). To determine whether enzymatic hydrolysis of beet pulp alone is sufficient to generate carbohydrates, experiments were performed with varying loads of commercially available enzymes. Presently, there are several sugar beet processing plants that each generate over 60,000 tons of pulp, an amount adequate for an in-line conversion facility. Using our methods, each facility could produce approximately 6 million gallons of fuel ethanol, a yield similar to corn based fermentations in U.S. processes. Approximately 25 g ethanol/liter was obtained using Celluclast Ultra at 0.57% v/v and Pectinex at 0.28% v/v. When the enzyme load was increased to 0.89% v/v of each enzyme preparation, fermentations reached approximately 40 g ethanol/liter.

DRAYCOTT, A. PHILIP[1]* and MICHAEL J. ARMSTRONG[2], [1]Sugar Beet Specialist, Newmarket, Suffolk, CB8 8UZ, [2]Head of Agricultural Research and Development, British Sugar, Holmewood Hall, Holme, Peterborough, Cambridgeshire, PE7 3PG, United Kingdom. **Amount and fate of NPK fertiliser applied to sugar beet crops in the European Union.**

Throughout the EU, attention is increasingly being focused on environmental implications of use of fertilisers. The authors recently surveyed the application rates of NPK used in member countries. Such values are used to estimate total NPK applied to the 2.1 million hectares (5.2m acres) of sugar beet grown each year. Average yields and nutrient concentrations in sugar beet storage roots and tops are then used to calculate the amount taken up from the soil. Hence the amount left in the soil, and returned to it if tops are ploughed in, is examined in relation to leaching into ground waters and build up in soil concentrations. Finally the amount of NPK taken to the factories and its eventual export in lime and by-products is estimated. It is concluded, that if recommended rates of NPK are not exceeded, sugar beet production leaves little residue of NPK in soil and ground water to pollute the environment.

DUNCAN, CHARLES L., and RAY HAASE*, and GARY GARCIA, Imperial Holly Sugar, Worland, WY 82401. **Lime covering on beet piles.**

The mummification of exposed beets on the sides of beet piles has been a concern to sugar companies. Our objective in this demonstration was to use a factory-produced by-product as a covering. Many different coverings, such as straw and plastics have been tried. The initial experiment was dried waste lime blended with water and sprayed on piles. It was difficult to blend and spray so this was abandoned. Next, some years later, lime mud from the settling pond was vacuumed into a Vac-Truck and pumped onto piles. It was too labor intensive to vacuum the lime mud into the truck so this practice was abandoned. It was then discovered that the lime mud produced in the factory could be thickened and pumped into Vac-Trucks. Using the truck pump the lime mud was blown over the sides of the pile. A Brix of 85 to 90 made the mud stick best. Approximately 75 feet of pile can be covered with a ton of lime mud. Later a trailer with it's own 4 cylinder diesel engine, a 4 speed transmission with a positive 'on or off' hand clutch, a Roper steel impellered 3 inch pump, and an easily aimed 3/4 inch nozzle mounted by a stand for an operator was built to pump the mud on the pile. It is connected to the truck with a 3 inch hose. The lime covers each individual beet and lets the air ventilate the pile. It dries an off white and has a good reflective quality. Beets under lime shrink less than those with no lime or covered with straw. There was no need to blend and the factory was not inundated with straw. This covering reduced the man hours in the factory.

ECKHOFF, J.L.A., and J.W. BERGMAN, Montana State University, Eastern Agricultural Research Center, 1501 N. Central Ave., Sidney, MT 59270. **Sugarbeet *(Beta vulgaris)* production under sprinkler and flood irrigation.**

Sugarbeets in the lower Yellowstone River valley are irrigated, mostly by furrow flood irrigation. Irrigated sugarbeet acres in this area are increasing, and the potential for additional irrigated acres is great. Some acres now under flood irrigation are being converted to sprinkler irrigation, and newly developed irrigated acres are under mostly under pivot sprinkler because of efficiency of this system. This study, now in its second year, compared yield and quality of sugarbeets under furrow-flood irrigation and under low-pressure sprinkler irrigation. Sugarbeets were planted to stand in a commercial field. Half of the field was irrigated using furrow flood irrigation and the other half was irrigated using a low-pressure overhead linear sprinkler system. Wells that reached the ground water were placed at the upper and lower ends of each irrigation system and groundwater was sampled regularly for nitrate content. Soil was sampled from each well site for nitrogen content before planting and following harvest. Sugarbeet samples were harvested from the upper and lower ends of each irrigation system for yield and quality determinations. Sugarbeet populations were statistically compared using a single factor ANOVA. No significant differences in plant population were detected between the two irrigation systems, although the population under the sprinkler was slightly greater in both years. Irrigation system did not affect sucrose content, root yield, or sucrose yield in either year. Irrigation did not affect sugarbeet quality in 1997, but the sugarbeets in the upper end of the field, especially under the sprinkler, had lower sucrose and higher impurities than sugarbeets elsewhere in the field, resulting in significantly greater loss to molasses and lower extraction. Impurity data for 1998 are not available at this time.

EGGLESTON, GILLIAN[1]. [1]SRRC-USDA, Agricultural Research Service, 1100 Robert E. Lee Blvd, New Orleans, LA 70179. **Removal of interfering amino acids for the improved quantitation of sugars in beet sugar samples using ion chromatography.**

The effect of interfering amino acids on the accurate and precise quantitation of sugars in industrial beet sugar samples, using ion chromatography with integrated pulsed amperometric detection (IC-IPAD), was investigated. Industrial beet samples included a beet evaporator syrup, juices from a sweet water tank and molasses samples. Using sugar and amino acid standard mixtures, and industrial beet samples, proline was found to co-elute with fructose and serine with sucrose, and both co-elutions were Aadditive@, which caused both fructose and sucrose to be overestimated. Conversely, the co-elution of arginine with myo-inositol, and glutamine with glucose had a marked Asuppressive@ effect on sugar quantitation and both myo-inositol and glucose were underestimated. Various methods were investigated for their efficiency to remove interfering amino acids, but not remove sugars: prefiltering of dilute samples through cation exchange syringe filters proved the most efficient method. Using sugar and amino acid standard mixtures, within experimental error, the cation exchange filter restored the mean concentrations of myo-inositol, glucose and sucrose to expected values, and standard deviations for all sugars were reduced markedly. Removal of interfering amino acids in a beet juice from a sweet water tank caused increases in mean concentrations for myo-inositol (+4.2%) and particularly for glucose (+62.5%), and a decrease for fructose (-7.3%).

EIDE, JOHN D.*, GARRY A. SMITH and JOHN J. WEILAND, USDA, Agricultural Research Service, 1307 North 18th St., Northern Crop Science Laboratory, Fargo, ND 58105-5677. **Use of PCR to detect the sugarbeet root maggot biocontrol fungus *Metarhizium anisopliae*.**

Current methods for detection and identification of entomopathogenic fungi are laborious and time consuming, and identification of different strains of the same fungal species is even more difficult. The objective of this study was to prepare PCR (polymerase chain reaction) primers specific for the detection of the sugarbeet root maggot entomopathogen *Metarhizium anisopliae* (Metschnikoff) Sorokin. PCR primers specific for the 5' end and 3' of the actin gene coding sequence were synthesized. These primers were used in the PCR to amplify a 1.3-kb DNA fragment in *M. anisopliae* ARS-T1 and five other *M. anisopliae* strains. These same primers detected a 1.2-kb fragment in the entomopathogenic fungi *Beauveria bassiana*, *Cordyceps militaris*, *Hirsutella thompsonii* and *Verticillium lecanii*. The *M. anisopliae* fragments were cloned and both strands sequenced. Some differences between *M. anisopliae* strains were detected in the intervening sequences. Two primers internal to the 1.3-kb actin fragment were synthesized. These primers were used in the PCR with *M. anisopliae* DNA amplified a 450-bp fragment which was cloned and sequenced. The intron sequences are being examined for unique sequences specific for *M. anisopliae*. The rRNA genes of these fungi also are being examined for the presence of distinguishing sequence characteristics. Two primers, ITS1 and ITS4 specific for the ITS (Internal transcribed spacers) region of the nuclear rRNA gene were synthesized. Use of these primers in the PCR with *M. anisopliae* DNA produced a 600-bp fragment. We have also synthesized two primers E24 and PN29 for use in amplification of the 28S rDNA. These primers amplified a 1.1-kb fragment from DNA of *M. anisopliae*. This fragment contains group I introns which have been useful for differentiating between strains of entomopathogenic fungi.

EPSTEIN, GREGG P., Perry Machinery Corporation, 25 Mt. Laurel Rd., Hainesport, NJ 08036. **The secondary market for process equipment and technology in the beet sugar industry.**

More money is spent, as a percentage of total capital, on used machinery and equipment today than ever before. In recent years, used equipment markets have become increasingly international, growing rapidly in both developed and emerging nations. Major advantages of used equipment include pricing from roughly 20% to 70% of new replacement costs and delivery item which is a fraction of new. The four basic ways to purchase used machinery include as is, as is on approval, cleaned and tested, and rebuilt and guaranteed. The equipment is most often described in great detail, but it is critical for prospective purchasers to inspect equipment prior to placing an order. Initial appearances sometimes belie the fact that the equipment is actually in fine operating condition. At the same time, one cannot rely entirely on first impressions as it is not hard to clean and paint a machine which is essentially dysfunctional. Selling surplus equipment from ones own site is a cash generator which cleans up headaches or storage, insurance, maintenance, and property taxes. What may be obsolete in one process may not be so in another. Used equipment is not limited to individual machines, but also includes the sale and relocation of entire factories.

FOWERS, MIKE[1]* and LAWRENCE E. LLOYD[2], [1]The Amalgamated Sugar Company LLC, P.O. Box 127, Twin Falls, ID 83303, and [2]The Amalgamated Sugar Company LLC, P.O. Box 700, Paul, ID 83347. **Biocide synergy: reducing costs and losses through physical and chemical interactions.**

During the last several years different biocide and process schemes have been utilized in an effort to reduce costs while maintaining losses as low as possible. Biocide treatments include the use of peracetic acid, ammonium bisulfite, carbamates, and gluteraldehyde. The synergistic effect of various biocide schemes will be discussed and correlated with sugar losses. Gluteraldehyde has been very successfully used as a sterilant in medical applications. Its cost has made it prohibitive for use in the sugar industry until recently. Careful selection of proper addition points and dosages makes gluteraldehyde a viable alternative to more corrosive and less effective biocides.

GALLIAN, JOHN J.[1]*, RONALD L. ROEMER and DEL J. TRAVELLER[2], [1]University of Idaho, Twin Falls Research and Extension Center, P.O. Box 1827, Twin Falls, ID 83303-1827, and [2]Amalgamated Sugar Company LLC, P.O. Box 127, Twin Falls, ID 83301. **Effect of rotation on severity of rhizomania using susceptible and resistant varieties.**

Since the formation of the Snake River Sugar Company Cooperative, there has been increased pressure on land for sugarbeet culture, and many growers have shortened the rotation. In some cases sugarbeets have been grown following sugarbeets, and severe losses from rhizomania have been observed. A rotation study was initiated in 1995 in a field severely infested with rhizomania. Following a potato-bean-barley rotation, rhizomania resistant Beta 4035R yielded 24.7 T/A and susceptible WS-91 yielded 17.1 T/A. In a sugarbeet/sugarbeet rotation, all combinations of resistant and susceptible were tested. Yield of resistant sugarbeet following resistant sugarbeet was 21.2 T/A; resistant following susceptible was 19.6 T/A; susceptible following resistant was 15.81 T/A and susceptible following susceptible was 13.38 T/A. Good crop management along with planting resistant varieties will be necessary for control of rhizomania.

GILES, J.F., Dept. of Soil Science, North Dakota State Univ., Fargo, ND 58105. **Remote telecommunication access of sugarbeet research and extension reports and bulletins on the Internet**.

An opportunity to provide the information generated by the research funds of the Sugarbeet Research and Education Board of Minnesota and North Dakota to a broad audience through the Internet was initiated in 1996 through the Agri-industries telecommunications and information technologies project of the USDA funded Red River Trade Corridor. This media provides for an in-depth regular update on recommendations (herbicide, root maggot, cercospora, etc.). The database available is keyword searchable on any topic included. This project provides the design and installation of a "gateway" which serves as an entry point to global and regional networks. This sugarbeet project was the first of its kind on the Internet, allowing the Sugarbeet Research and Education Board to 'lead out' in implementing such a resource in the sugarbeet industry.

GILES, J.F.[1]*, A.W. CATTANACH[2], and N.R. CATTANACH[1], [1]Dept.of Soil Science, North Dakota State Univ., Fargo, ND 58105, and [2]American Crystal Sugar Co., Moorhead, MN 56560. **Effect of sodium chloride application on sugarbeet production in the Red River Valley**.

Sodium chloride application for sugarbeet is a common recommendation on the high potassium testing soils in Europe. Objective of this study was to evaluate the possibility of a similar increased sugar production in the soils of the Red River Valley. Fall and spring application rates of 100, 200 and 400 pounds of sodium chloride and 200 pounds of slow release (sulfur coated) sodium chloride were applied to three soil types during the 1997 and 1998 growing seasons. Plant establishment, root yield and extractable sucrose were measured at each location each year. Residual salt effects from the first year application were identified in the soil profile and on subsequent crops (spring wheat and dry beans) in the rotation.

GILES, J.F. [1], A.W. CATTANACH[2], and N.R. CATTANACH[1]*, [1]Dept.of Soil Science, North Dakota State Univ., Fargo, ND 58105 and [2]American Crystal Sugar Co., Moorhead, MN 56560. **Sugarbeet stand establishment and sugar production using John Deere MaxEmerge 2 planter attachments.**

Placement of sugarbeet seed within the row can be a factor in sugar production. In recent years, numerous modifications and attachments for the Deere MaxEmerge 2 planter have appeared in the market. A two-year field study was conducted with the primary objective of determining the performance from these modifications and attachments in seed placement accuracy and the effect on sugarbeet stand establishment and sugar production. Seed tube configuration, seed furrow attachment and closing wheel design had a significant effect on stand establishment, root yield and extractable sucrose.

GRIGUS, MICHAEL E.*, Niro Inc. – Filtration Division, 1600 O'Keefe Road, Hudson, WI 54016. **Review of the two year operational history of a reverse osmosis system concentrating beet molasses chromatographic separator effluent.**

Beet molasses chromatographic separators generate dilute streams that require concentration to high solids (50% - 80% total dry solids). Typically these dilute streams are concentrated to high solids only with evaporation. In January 1997, a Niro Filtration reverse osmosis ("RO") system was commissioned in a beet sugar processor's factory (Southern Minnesota Beet Sugar Cooperative, Renville, MN) to pre-concentrate the raffinate fraction prior to final concentration with evaporation. The system was designed to concentrate a 5 Brix raffinate fraction to 15 Brix, reducing the evaporative loading by more than two thirds. This paper reviews the pilot and development results which formed the basis for the system's design and also its two year operational and performance history. In particular, the operating and performance parameters of the process generated during the pilot testing and in the commissioned system will be presented and discussed.

GRIMWOOD, G. C. and P. D. THOMPSON, Process Engineering. **Process performance of high capacity centrifugals.**

The process performance of two distinct types of centrifugal are described, the high grade continuous (HGCC) and the large batch centrifugal. The HGCC was developed for cane raw suar production but has been succesfully applied to beet high raw assecuite in Europe. The process performance of a machine capable of processing 950 ft³/h of massecuite with a 75 hp motor will be described and illustrated. Large batch centrifugals of 4000 lbs per charge and over are becoming commonplace. The performance of these machines will be shown along with the custom designed drive system used to produce more than 20 cycles per hour, giving an output of more than 8,800 cwt/day of white sugar per machine. The improvement in centrifugal yield is sufficient to justify replacement of existing smaller machines, giving additional savings in maintenance and electrical power demand.

GODSHALL, MARY A.[1]*, JOHN R. VERCELLOTTI [1], EUGENE REARICK [2]*, and REBECA S. BLANCO [1], [1]Sugar Processing Research Institute, Inc., 1100 Robert E. Lee Boulevard, New Orleans, Louisiana 70124; [2]Amalgamated Research, Inc., P.O. Box 228, TwinFalls, ID 83303-0228, **Characterization of raffinates from chromatographic separation.**

The use of chromatographic separation to recover sugar from molasses has become a well established process in many beet sugar companies. Besides the fraction enriched in sucrose (extract), a series of cuts may be produced, such as a betaine-enriched fraction. However, the major by-product of the process is a dilute, highly colored raffinate, low in sugar, but otherwise not well characterized. It is of interest to examine the components of this product with a view to better understanding its make-up and a consideration to finding added value. Several raffinates from a chromatographic separation system have been characterized as to their polymeric content, alkali-labile constituents, and extractable components. Phenolic acids, flavor compounds and colorant polymers are included in the complex mix that makes up the raffinate.

GÖRAN HYOKY[1], HANNU PAANANEN[2], GARY CORNELIUS[3], and MICHEL COTILLON[4], [1]Finnsugar Bioproducts, 1101 Perimeter Drive, Suite 475, Schaumburg, IL 60173, [2]Cultor Ltd. Finnfeeds, 02460 Kantvik, Finland, [3]Pacific Northwest Sugar Co, P.O. Box 1939, Moses Lake, WA 98837 and [4]Applexion S.A., 264 Avenue de la Mauldre, 78680 Epone, France. **Presentation of the FAST separation technology.**

This is the first public presentation of the new FAST Separation Technology. It is a further development of the sequential SMB chromatographic separation process, and it is suitable for all existing industrial separations in sugar and other sweetener production for recovering two or more products. It was developed in pilot scale in 1996, and has so far, since 1997, been successfully applied in industrial scale at five plants in six different applications, beet molasses separation being one of them. The FAST technology offers superior column capacity to any other technology (150 to 200% higher), maintaining comparable or better product purity and recovery. Considerably lower investment cost, and recovery of multiple products, make the the FAST process more economical than other chromatographic separation technologies. It also enables extraordinarily profitable upgrading of existing plants, since capacity can be inreased without new columns and more products can be recovered, e.g. betaine from beet molasses. Improved product purity and recovery is obtained if capacity is maintained. Operation principle and data as well as economical comparisons are presented.

GUZA, COREY J.[3] *, COREY V. RANSOM[1], DON MORISHITA[2], AND CAROL MALLORY-SMITH[3], Oregon State University, Malheur Experiment Station, 595 Onion Ave., Ontario, OR 97914, Twin Falls R&E, Center P.O. Box 1827, Twin Falls, ID 83303, Oregon State University, 107 Crop Science Bldg., Corvallis, OR 97330. **Effectiveness of glyphosate and glufosinate for weed control in transgenic *Beta vulgaris* varieties.**

Five studies were conducted involving the effect of herbicide application timing, rates and additives for weed control in sugar beets (Beta vulgaris). Glufosinate applications began at 2.5 cm weeds and 7.6 cm weeds with 2 weekly applications thereafter. Rates for glufosinate were 0.30 kg ai/ha and 0.40 kg ai/ha with and without 1.4 kg/ha of ammonium sulfate (AMS). Glyphosate timing treatments were initiated at 2 stages, cotyledon and 2-4 leaf sugar beets with successive treatments at weekly intervals. Glyphosate treatments with the addition of AMS or residual herbicides were applied at 2-4 leaf sugar beets. Glyphosate rates were 0.90 kg ai/ha. All five studies included conventional herbicide programs which consisted of various herbicide combinations including ethofumasate, ethofumasate + desmedipham - phenmedipham, triflusulfuron, and sethoxydim. Weed control ratings were taken 7 days and 28 days after the final herbicide applications. At one location glyphosate + S-dimethenamid provided slightly lower weed control for common lambsquarters *(Chenopodium album)* 28 DAT (97%) compared to the other treatments (98-100%). All glyphosate timing treatments provided greater control of redroot pigweed *(Amaranthus retroflexus)* and hairy nightshade *(Solanum sarrachoides)* than the standard. Glufosinate applied 3 times at 0.30 kg ai/ha beginning at 7.6 cm weeds demonstrated lower control of common lambsquarters at 28 DAT (75%) compared to the standard (98%). Common lambsquarters control also was lower for glufosinate at 0.40 kg ai/ha + AMS at 28 DAT (68%). The glyphosate and the glufosinate treatments showed no sugar beet injury whereas the standard treatments showed between 5 and 16% sugar beet injury.

HALLOIN, JOHN M.[1]*, and CHARLES A. PETTY[2]. [1]USDA, Agricultural Research Service, Sugarbeet and Bean Research Unit, and Department of Botany and Plant Pathology, Michigan State University, East Lansing, MI 48824; and [2]Department of Chemical Engineering, Michigan State University, East Lansing, MI 48824. **Alternative methods for density grading of sugarbeet seeds: a proposal.**

Sugarbeet seeds are selected on "gravity tables" to provide high density seeds that exhibit superior germination and emergence to non-selected seeds. Use of gravity tables allows separation under dry conditions, thus, the seeds do not require drying before treatment and packaging. However, the advent and increased use of seed priming and other preconditioning treatments obviate the need for keeping seeds dry, and opens alternative, and possibly more useful methods of gravity grading that involve moistening of seeds. We propose two methods of achieving gravity-based seed separation with moist seeds. 1) Premoistened seeds could be dispensed into a stream of flowing water. Seeds with densities less than 1.0 (that of water) would float, whereas those with greater densities would sink in the flowing water, with the velocity of sinking being dependant upon their relative densities. Passage of the moving stream of seeds and water through a set of baffles would allow separation of seeds into discrete, preselected density classes. 2) Alternatively, mixtures of seeds and water could be pumped into hydrocyclones. The flow of material into these devices produces a cyclonic flow within them that causes centrifugal separations of materials that then can be drawn off in a binary separation. Either of these proposed grading methods seems likely to provide improved gravity-based separations that may provide planting seed of improved quality.

HAMLIN, GARY[1], KEITH GARWICK[2], JEFFERY VALMUS[2] and GARY WEIN[2]*, [1]Spreckles Imperial Holly Sugar, 395 Keystone Avenue, Brawley, CA 92227, [2]ChemTreat, Inc., P.O. Box 27207, Richmond, VA 23261. **Developing compatible cooling water treatment program for sugar mill operations.**

Controlling corrosion, scale, fouling, and microbiological activity in sugar mill cooling water operations can be challenging. With proper field monitoring technique for corrosion, fouling, and microbiological activity, utilizing both field instrumentation, field microbio tests, and field chemical tests, cooling water chemical treatment program can be quantified as to their performance relative to observed scenarios. The results of these field studies were marked reduction of system corrosion and foulings, as well as more effective management of process upsets resulting from sugar incursions. Example: Observed field corrosion rates were reduced from 100+ mils/year for mild steel and copper corrosion rates in excess of 20 mils/year to mild steel corrosion rates of less than 10 mils/year and copper corrosion rates less than 2 mils/year. Various treatment scenarios were observed and their effects.

HAWKINS, DAVE[1], KLAUS NIEPOTH[2] and BORIS MORGENROTH[2], [1]U.S. BritAm Engineering Services Inc. 7800 113th Street North Suite 202, Seminole, FL 33772, [2]Balcke-Dürr Energietechnik D-40882 Ratingen, Germany, Homberger Str. 2. **Experiences with a Balcke-Dürr falling film plate evaporators - System EVAP$_{plus}$**

The new Balcke-Dürr plate type falling film evaporator was introduced the first time in 1992. Since then the Balcke-Dürr evaporator has become the product of choice in the beet sugar industry in Europe and USA. The key advantage of the Balcke-Dürr evaporators is their superior heat transfer performance. The k-values are about 1.2 to 1.5 times higher than falling film tube evaporators and 1.5 to 5.0 times higher than Robert evaporators. Small residence times and the self cleaning effect minimize scale formation allowing for long operation periods without cleaning. Falling film principle, plate design, and recirculation provide stable operation even in case of problems such as stopped juice flow. The Balcke-Dürr concept is particularly suited for modernizing the evaporation station of existing sugar plants since the investment cost of a Balcke-Dürr modernization is very low when compared with Robert, falling film tube or rising film plate evaporators. For the sugar industry bring this system an optimal improvement of the production capacities with other advantages to the alternatives which were used in the past.

HEIDEL, GRETCHEN B.*, and CHARLES M. RUSH, Texas Agricultural Experiment Station, P.O. Drawer 10, Bushland, TX 79012. **Comparison of serological tests for the detection of two soilborne sugar beet viruses.**

Beet necrotic yellow vein virus (BNYVV) and beet soilborne mosaic virus (BSBMV) are closely-related and often found to infest the same field. Cross reaction in serological tests used to identify the viruses is a concern when determining which virus is present. Sugar beets from seven fields in Texas and one field in Minnesota were tested for BNYVV and BSBMV by DAS ELISA, F(ab')$_2$ indirect ELISA, and a commercially-available BNYVV ELISA kit to determine consistency of results among tests. DAS and F(ab')$_2$ ELISAs used antisera developed to purified virus (BNYVV-whl, BSBMV-whl) or denatured capsid (BNYVV-den, BSBMV-den). Results of Western blot assays were used as comparison standards for BNYVV and BSBMV assay results, respectively. Among BSBMV tests, results from DAS ELISAs more closely matched those of Western blots than those obtained from the F(ab')$_2$ test using BSBMV-den antiserum. Results from the BNYVV kit test matched those of Western blots more closely than those of the DAS ELISA using BNYVV-den IgG. BNYVV and BSBMV test results, including Western results, were ranked, respectively, according to the percentage of positive results for each test for all fields. No differences were indicated among BSBMV tests. The BNYVV kit test detected more positive samples than DAS or F(ab')$_2$ ELISAs using BNYVV-den antiserum.

HOFMAN, VERNON L.[1] and SURANJAN PANIGRAHI[2] [1] Extension Ag Engineer and [2] Associate Professor, Ag and Biosystems Engineering, North Dakota State University, Box 5626, Fargo, ND 58105. **Measuring spray coverage on sugarbeets.**

Spray coverage of sugarbeet plants with fungicide usually provides the best protection from foliar diseases such as cercospora. A technique has been developed to measure the spray coverage on plant leaves with the use of fluorescent dye, a CCD camera interfaced with a computer which is programmed with software designed to determine area of spray coverage on the plant leaf. This method is used to compare the coverage efficiency of various types of spray equipment. Several types of applicators have been studied including conventional sprayers, air-assist sprayers and spray planes. After spraying on a fluorescent dye, leaf samples were taken and analyzed for coverage. In 1996 tests, conventional sprayers provided a total plant coverage of 17.7%, 57.1% and 59.2% in 3 trials with different applicators. Air-assist applicators produced a total plant coverage of 14.4% and 79.1%. Spray planes provided a total plant coverage of 47.2% and 47.9%. In 1997 tests, conventional sprayers provided total plant coverage of 39.9% and 65.5%. Air-assist sprayers provided total plant coverage of 46.9% and 53.9%. Spray planes provided total plant coverage of 47.9% and 25.3%.

HOFMAN, VERNON L.[1] , THOMAS HALL[2], LESLIE BACKER[3], and LARRY SMITH[4], [1]Extension Ag Engineer, [2]Graduate Student, [3]Associate Professor, Ag and Biosystems Engineering, North Dakota State University, Box 5626, Fargo, ND 58105 and, [4]Director, NW Experiment Station, University of Minnesota, Crookston, MN 56716. **Evaluation of sugarbeet yield sensing systems operating concurrently on a harvester.**

A torque sensor and two sets of load cells were mounted on a sugarbeet harvester. The torque sensor was mounted in the scrub chain driveline. One set of load cells was mounted at the discharge of the scrub chain. A second set of load cells was mounted at the end of the elevator (outlet conveyor). For comparison, the three systems were operated simultaneously, and three sets of parallel yield data were generated. Raw voltage signals were gathered from each of the three systems using a Cr-10 data acquisition device. The three signals were very similar, and the lag time between each system's measurement was very apparent. The raw data were manually converted into flow rate values for comparison. Raw data were also gathered and converted into accumulated weight with the harvester operating empty. The torque sensor accumulated the largest magnitude (-250 pounds over 90 seconds). The accuracy and precision of the systems were determined by comparing yield monitor measured truckload weights to actual truckload weights obtained from piling station scale tickets. The outlet conveyor weight sensing system gave the highest precision with a standard deviation of 10.28%. The scrub chain weight sensing system gave the next highest precision with a standard deviation of 10.58%. The torque sensor weight sensing system gave the lowest precision with a standard deviation of 16.97%. No significant differences were found between the standard deviations of the outlet conveyor and the scrub chain weight sensing systems. The standard deviations for the outlet conveyor and the scrub chain weight sensing systems were significantly lower at 95% confidence than the torque sensor system. Three yield maps were generated (one for each weight sensing system) for each of four fields monitored; totaling approximately 200 acres. Due to high truckload errors, the yield data were corrected using actual truckload information. The three maps generated for each field appeared very similar, but no statistical analysis has been completed to determine significant differences. The site-specific data in the three yield maps for each field were subtracted from each other to determine how one system functioned differently than another depending on location

HSING-YEH LIU*, GAIL C. WISLER, JOHN L. SEARS, AND JAMES E. DUFFUS. USDA-ARS, 1636 East Alisal Street, Salinas, CA 93905. **Beet chlorosis virus - A new luteovirus affecting sugarbeet.**

A yellowing disease of sugarbeet has been frequently observed in Colorado, Nebraska, Texas, and California sugar beet fields since early 1990s. Symptoms of this disease are identical to those caused by beet western yellows virus (BWYV) including interveinal yellowing, thickening and brittleness of older leaves and necrotic lesions caused by Alternaria sp. BWYV has a wide host range and is readily distinguished by systemic infection of shepherd's purse (Capsella bursa-pastorus) and lack of infection of Chenopodium capitatum. These newly described isolates have a narrow host range and show interveinal reddening on C. capitatum but do not infect shepherd's purse. This disease is readily transmitted in a persistent manner by the green peach aphid (Myzus persicae), but is not mechanically transmissible. The virus has been purified and the isometric virus particles are 26 nm in diameter. The coat protein from purified preparations is ca. 23 kDa. Serological analysis and biological properties indicate that the virus is distantly related to, but distinct from BWYV. We proposed to name this virus beet chlorosis virus.

HUBBELL, LEE*, and RICHARD LIST, Monitor Sugar Company, P.O. Box 39, Bay City, MI 48707 - **Cold sand germination as an indicator of actual field emergence.**

Emergence is the first concern each year and one of our largest problems. All seed that is sold has a high guaranteed percent germination from a pleated paper test at room temperature , but our growers average only about 56 percent of the seeds planted producing beets at harvest time. In 1997, different varieties and lot numbers of seed commercially prepared for sale were tested, and the field emergence varied from 91.8 percent down to 60.1 percent. The object of this test was to find a germination method that better indicates actual field germination. We used packed silica sand and cold temperatures. The temperatures used were 40°F for three days and 50° for the balance of the test. Over three years of testing, there was a much better correlation with this cold sand test than with the blotter test.

IVIC*, SNEZANA[1], IRIS MCCANNA[1], RICHARD SICHER[2] and ANN SMIGOCKI[1], [1]Molecular Plant Pathology Laboratory, [2]Climate Stress Laboratory, ARS, USDA, Beltsville, MD. **Carbohydrate content of sugarbeet (*Beta vulgaris* L.) transformed with a cytokinin biosynthesis gene.**

To study the role of cytokinins in carbon partitioning, sugarbeet clone Rel-1 was transformed with the isopentenyl transferase *ipt* gene fused to a wound-inducible proteinase inhibitor II (Pin2) or a tuber-specific patatin (Pa) gene promotor. Two transformation methods were used, *Agrobacterium*-mediated cotyledon transformation and particle bombardment of embryogenic hypocotyl callus. For root initiation, transformed shoots had to be exposed to high auxin concentrations (50 mg IBA/l) for 24 hours as compared to normal shoots that were maintained on 3 mg IBA/l. *Ipt* shoots rooted in 4-8 weeks and the controls in 2 weeks. All *ipt*-transformed plants exhibited phenotypic characteristics associated with elevated cytokinin levels. Some showed increased adventitious shoot formation while others had reduced apical dominance, a large, proliferative crown and a very small root mass. Others exhibited slower growth and an overall reduction in the number and size of leaves. Leaf and taproot cytokinin levels were up to 17 and 2 times higher, respectively, than in normal plants. In one transformant, about a 9 fold increase in leaf sucrose levels was observed while the glucose content was 18 times higher. No corresponding increase in sucrose and glucose levels was observed in the taproots of this plant.

JACOBSEN, BARRY J.[1]*, S. KIEWNICK[1], J. BERGMAN[2] and JOYCE ECKHOFF[2]. [1]Department of Plant Sciences, Montana State University, P.O. Box 173140, Bozeman, MT 59717-3140 and Eastern Agricultural Research Center, Sidney, MT 59270. **Integrated control of soilborne diseases of sugar beet with antagonistic bacteria and fungicide seed treatments.**

In two years of field studies, 4 Bacillus sp. either used alone or in combination with seeds either treated with Apron-Thiram or with Apron-Thiram-Tachigaren provided increased stands, root yield and sucrose yields by controlling Pythium damping-off or Aphanomyces black root. In 1998, 3 field trials were done in Montana using commercial formulations on seed pelleted by Seed Systems Inc. Stands where bacteria were combined with the seed treatment fungicides were increased over either Apron-Thiram or Apron-Thiram-Tachigaren in all locations at 4 and 8 weeks after planting and at harvest. In 1998 yield of untreated plots averaged 8067, Apron-Thiram 8250, Apron-Thiram-Tachigaren 8616, bacteria plus Apron-Thiram 8994 and bacteria plus Apron-Thiram-Tachigaren 9089 lbs of sucrose/A. Percentage sucrose content was not influenced by seed treatment.

JENSEN, ARNE S.*, M. Sc. EnerDry ApS, Moellaaparken 50, DK2800 Lyngby, Denmark. **Dewatering of beet pulp.**

A new generation of steamdryers is now available. It has about 40% more capacity for the same price than the so far known steamdryers. The steamdryer for pulp acts as one extra effect put in front of the juice evaporators. Instead of juice is pulp kept moving in a kind of fluid bed. The vapour arising form the pulp leaves the dryer sufficiently clean to be used in the first step of juice evaporators. In this way the drying is done without consuming energy. Near 100% of the energy used for an alternative drum drying of pulp is saved. As the drying has no outlet to the atmosphere all air pollution with dust and smell is avoided. Furthermore does no oxidation of the product take place. That means that there is no loss of dry matter in opposition to drum drying, where the loss is between 5% and 12%. A sugar factory can save energy in the factory itself and/or by introducing steamdrying instead of drum drying. A comparison of the two possibilities is done, and by diagrams it is shown, that a sugar factory having drum drying and a reasonably energy consumption in the factory itself should rather consider steamdrying of beet pulp than try to reduce the energy consumption in the sugar factory itself. The now lower capital cost for a steamdryer and almost no energy consumption means, that the optimal dry substance in the pressed pulp is lower than before. It is known, that pressing the pulp to more than 30% DS is possible in twin screw presses. By diagrams it is shown, that this is no more interesting with the new generation of steamdryers.

JOHNSON, DAVID J.*, and JOHN M. HALLOIN. USDA, Agricultural Research Service, Sugarbeet and Bean Research Unit, and Department of Botany and Plant Pathology, Michigan State University, East Lansing, MI 48824. **Progress in development of a sugarbeet seedling assay for resistance to *Aphanomyces cochlioides*.**

The pathogen *Aphanomyces cochlioides* Dresch. causes extensive damping-off of seedlings and root rot on surviving sugarbeets (*Beta vulgaris* L. in warm, wet soils. Within the United States, development of germplasm resistant to this pathogen relies on a naturally infested field nursery in Minnesota, a situation that provides time limitations on researchers, and inherent variability of the disease environment. Past efforts to minimize these problems through use of greenhouse assays have provided inconsistent results. This inconsistency of results was likely due to a lack of understanding of natural infection in the field, coupled with a lack of understanding of the modes of resistance to A. cochlioides already present in some sugarbeet varieties. We are developing a soil-less assay for resistance to Aphanomyces seedling disease using rolled germination paper in growth chambers and zoospore inoculum. In this system, resistance to damping-off is strongly temperature dependent: high at 15°C, intermediate at 20 and 25°C, and low at 30°C. Under conditions of intermediate resistance (25°C), attempts to find significant differences in disease severity between susceptible (eg. Edda) and resistant (eg. USH20, ACH 555, and 68-22) varieties have yielded inconsistent results, apparently due to variability of factors in the system. Work is underway to refine the system: further reducing variability in the host, the environment, and the inoculum.

JOHNSON, MARK[1], VADIM KOCHERGIN[2]*, [1]Amalgamated Sugar Co. LLC, P.O. Box 87, Nampa, ID 83651, [2]Amalgamated Research Inc., P.O. Box 228, Twin Falls, ID 83303. **Experience with slow conditioning of white sugar in the concrete silos.**

A novel concept of slow sugar conditioning has been tested in a 40-ft. diameter concrete silo at Nampa factory. Unlike in conventional conditioning systems sugar retention time has been extended to the entire storage period, which allowed use of relatively inexpensive equipment to accomplish conditioning goals. Although the silo did not have any additional insulation, sugar flowability improved drastically and the crust on the walls was eliminated almost completely. Because of better flowability the level of sugar remaining in the silo before cleaning was significantly reduced. The latter results are extremely important from a safety standpoint. Based on the obtained results a cluster of twelve concrete silos will be retrofitted to allow for all Nampa sugar to be maintained at optimal storage conditions.

KAFFKA, STEPHEN R.*[1], DAXUE, DONG[1], PETERSON, GARY[1], and THOMAS A. BABB[2]. [1] Department of Agronomy and Range Science, University of California, Davis, CA 95616, and [2]Spreckels Sugar, Inc., Box 2240, Woodland, CA 95776. **Sugarbeet (*Beta vulgaris*) seedling emergence in response to varying soil, irrigation, and seed treatments in California.**

Sugarbeet seeds from a single seed lot were treated with different combinations of seed coating materials (film coating and pelleting), fungicides (metalaxyl, chloroneb, and hymexazol) and an insecticide (imidicloprid). Some also were primed. These differing seed treatments were compared in three emergence trials, two at Davis in California's Sacramento Valley in 1997 and 1998, and one at Holtville, in the Imperial Valley in 1997. Seeds were planted in plots that had been treated with a soil fumigant (metam sodium), a pre-plant incorporated herbicide (cycloate), or no soil treatment. Sprinkler irrigation and furrow irrigation methods also were compared. Emergence rates, cumulative emergence, seedling populations at the six leaf stage, and the causes of post emergence seedling mortality were evaluated for each seed *x* soil *x* irrigation treatment combination. Soil fumigation had no significant effect on emergence in any of the three trials, while the use of cycloate significantly reduced final plant populations. Emergence rates and cumulative emergence were comparable in furrow and sprinkler irrigated treatments in both Davis and Holtville, despite a five fold increase in surface soil salinity in Holtville with furrow irrigation (2 to 10 dS m^{-1}). Emergence rates were highest for primed and untreated seeds and lowest for film coated seed at all locations. Both cumulative emergence and plant populations at the six leaf stage were significantly greater for both primed and film coated seeds treated with imidicloprid, compared to seeds without imidicloprid. Post emergence mortality was due primarily to pathogens in all the trials, though the amount of predation by insects varied among the trials. Pre-emergence mortality varied more than post emergence mortality among the treatment combinations, and the largest seedling populations were correlated with the lowest pre-emergence mortality.

KAFFKA, STEPHEN R.*, DAXUE, DONG, and GARY R. PETERSON. Department of Agronomy and Range Science, University of California, Davis, CA 95616-8515. **The response of sugarbeets (*Beta vulgaris*) to saline soils and irrigation water.**

Saline water from tile drains or shallow wells can be used for the production of sugarbeets. Sugarbeet was grown in a trial in western Fresno County in plots that differed in the amount of salt, nitrogen and boron present. EC_e averaged over 0 to 2.5 m varied from 1.5 to 7.0 dS m^{-1}, depending on the prior irrigation history of the plots. Plots were irrigated with different rates and times of application of saline well water (EC_w . 6.7 dS m^{-1}) that also contained nitrate (NO_3-N: 25.6 mg kg^{-1}) and boron (5.9 mg kg^{-1}). Control plots were irrigated with low salinity water (0.4 dS m^{-1}) that had little nitrate or boron. Crop growth, yield, and root quality characteristics were evaluated and compared based on irrigation treatments and differences in residual soil salinity and N content. Cumulative water use (ET_c) over the growing season was equal among the different irrigation treatments and averaged 860 mm. Sugarbeet clean root yields averaged 70 Mg ha^{-1} and were unaffected by the application of saline irrigation water. Sugarbeet tolerated the range of salinity and boron of the soils and water observed, but were adversely affected by the nitrogen present in soils and irrigation water. Sugar concentration in roots and gross sugar yield declined from 134 g kg^{-1} and 9.6 Mg ha^{-1} to 110 g kg^{-1} and 8.0 Mg ha^{-1} with increasing amounts of saline irrigation water. Different application patterns and rates of saline irrigation had little effect on sugar yield because of large amounts of N present in irrigation water and in soils as residual N from previous saline irrigation treatments. In reusing drainage water or applying shallow well water, farmers must take account of both salinity and N. For sugarbeet, N accounting is necessary to assure larger sugar concentrations when saline water is used in a cyclic reuse program or to extend irrigation water supplies for other crops.

KEARNEY, MICHAEL*, VADIM KOCHERGIN, KEN PETERSEN, MIKE MUMM, LARRY VELASQUEZ and WILLIAM JACOB, Amalgamated Research Inc., P.O. Box 228, Twin Falls, ID 83303. **Novel characteristics of the ARi coupled loop chromatography process.**

A key feature of the ARi coupled loop process has been the invention of a novel chromatographic mechanism for the separation of sucrose syrups. Prior art sucrose separation has relied upon the use of elution chromatography. The elution mechanism has been applied in the use of batch systems since the early 1960's and in simulated moving bed systems since the mid 1980's. Unlike elution chromatography, the new mechanism performs better at very low water use, very high system loading and very low pressure drop. The process exhibits a number of equally unexpected operating characteristics. The contradictory mechanism allows the ARi coupled loop separator to be implemented without an increase in total resin or water use compared with a conventional system and provide significantly higher product purity and recovery. Implementation on a 500 ton/day molasses separator has demonstrated that the process is transferable to full scale operation.

KEARNEY, MICHAEL*, VADIM KOCHERGIN, KEN PETERSEN, MIKE MUMM, WILLIAM JACOB and LARRY VELASQUEZ, Amalgamated Research Inc., P.O. Box 228, Twin Falls, ID 83303. **Applications of engineered fractals in the sugar industry.**

Amalgamated Research Inc. has recently proposed the use of engineered fluid transporting fractals as functional alternatives to turbulence. The purpose is to eliminate the uncontrollable geometry associated with the scaling and distribution of fluids. Because of the ubiquity of turbulence, a large number of applications are envisioned. Present applications include rapid low turbulence mixing, controlled formation of specified fluid geometry and low energy fluid distribution. Practically any fluid handling step is a candidate for the use of fractals. "Fractalization" of an overall fluid process can lead to a number of benefits. A single factory at Amalgamated Sugar Co. has so far implemented fractals for distributing fluid in the molasses chromatography process, for controlling exhaustion/regeneration in thin juice ion exchange and to provide uniform air circulation in a sugar silo.

KEMP, NATHAN J.[1]*, KAREN A. RENNER[1], TERESA CROOK[2], and LEE HUBBLE[3], [1] Michigan State University, East Lansing, MI 48824, [2] Michigan Sugar Company, Caro, MI 48723, [3] Monitor Sugar Company, Bay City, MI 48706. **Weed competitiveness in glyphosate- and glufosinate- resistant sugarbeet.**

Field trials were conducted in 1998 by Michigan State University, Michigan Sugar, and Monitor Sugar Companies to determine the effect of annual weeds on sugarbeet yield and quality. Trials were located at three sites in Michigan. Plots were arranged in a randomized complete block design with four replications. Glyphosate or glufosinate were applied postemergence to the appropriate transgenic beet variety when weeds were 0.5, 1, 2, 4, and 8 inches tall and then plots kept weed free until harvest. Alternatively, herbicides were applied to 1 inch weeds and then plots kept weed free for varying lengths of the growing season. Yields were taken by harvesting two of the four rows in mid-October. Weeds did not reduce sugarbeet yield when treated at 1 or 2 inches in height. Weeds reduced yield at all sites when herbicide applications ceased in early June. Sugarbeets treated with two applications of glyphosate or glufosinate, initially applied to 1 inch weeds and then applied 3 weeks later, had yields comparable to plots receiving three or more applications, if the second application was made in mid-June.

KLOTZ, KAREN L., USDA, ARS, Northern Crop Science Laboratory, 1307 North 18th Street, P.O. Box 5677-University Station, Fargo, ND 58105-5677. **Contribution of invertase and sucrose synthase isoenzymes to sucrose losses in sugarbeet.**

It has long been known that the major enzymes involved in sucrose catabolism in plants are the invertases and sucrose synthases. The role of these enzymes in sucrose losses in sugarbeets during growth and development and postharvest storage, however, is unclear. Past studies have provided conflicting results as to the relative importance of these two enzymes in sucrose loss in sugarbeet. These conflicts may arise from the nature of the enzymes involved. In most plants, invertase and sucrose synthase are not single enzymes, but families of enzymes, consisting of several isoforms. It is likely that the different isoenzymes of an enzyme family perform different functions and are important at different developmental stages. Enzyme activity assays, however, typically measure total activity for the family, not the individual isoenzymes. My objective is to determine the relative role of the individual isoenzymes for sucrose catabolism by comparing their activity relative to sucrose content and respiration. Total sucrose synthase activity, soluble and insoluble acid invertase activity, and alkaline invertase activity will be measured in relation to carbohydrate content and root respiration. Activity of the individual isoenzymes will then be determined using activity staining of isoelectric focusing or nondenaturing protein gels and RT-PCR. This approach will be used to examine the role of sucrose synthase and invertase isoenzymes during growth and development and postharvest storage. This paper will present the research goals, research plan and preliminary results of this work.

KOCH, DAVID W.[1*], FRED A. GRAY[1], and JAMES M. KRALL[2], [1]Plant Sciences Dept., Box 3354, Univ. of Wyoming, Laramie, WY 82071, and [2]Torrington Research & Extension Center, Box 374, Torrington, WY 82240. **Trap cropping for sugar beet nematode control.**

Trap crops provide sugar beet growers an alternative to nematicides. The sugar beet nematode (SBN) is the most destructive and difficult to control pest of sugar beets. Nematode-resistant radish was grown on 8 SBN-infested producer fields as a second crop after either malt barley, silage corn or dry bean. Sugar beet was grown the following year. Ammonium nitrate was applied at 56 kg ha^{-1}. Radish was seeded at 24 kg ha^{-1} and furrow irrigated. Radish growth varied from 101 to 2518 kg ha^{-1} and was most closely related to planting date, which was influenced by harvest date of the previous crop. Following malt barley, average sugar beet yield increase with radish was 7.1 Mg ha-1, compared with 1.4 Mg ha^{-1} with full-label rate of aldicarb. There was no significant increase in sugar beet yield with radish following corn or dry bean. There was no additive effect of radish and aldicarb. Radish grown after malt barley was more effective than aldicarb and was less costly than applying full-label rate of aldicarb.

KOCHERGIN, VADIM* and WILLIAM JACOB, Amalgamated Research Inc., P.O. Box 228, Twin Falls, ID 83303. **Economic aspects of raw juice chromatographic purification.**

The current status of the raw juice chromatographic process developed by Amalgamated Research Inc. is reviewed. While sugar technologists are comfortable with most of the major steps of the process, the search for the best techniques to separate suspended solids from the feed raw juice stream is still in progress. It appears from our economic analysis that the lime kiln replacement with membrane filtration may be feasible only if the overall process includes chromatographic separation. The feasibility of the new process is affected by many factors, such as location, environmental regulations, capacity and configuration of sugar end, presence of juice storage, etc. Various approaches are discussed allowing for gradual implementation of chromatographic purification of raw beet juice into existing plants.

KRALL, JAMES M.*, DAVID W. KOCH, FRED A. GRAY and JAMES R. GILL, University of Wyoming, Plant Science Department and Cooperative Extension Service, Laramie, WY 82071. **Cultural management of trap crops for sugar beet nematode (*Heterodera schachtii*) control in Wyoming.**

A promising alternative to nematicides for control of sugar beet nematode (*Heterodera schachtii*) is trap crops, which are specially developed varieties of fodder radish (*Raphanus sativa*) and yellow mustard (*Sinapsis alba*). There is a need to determine the most effective use of trap crops in Wyoming. The objective was to compare the effect of cultural management practices on production of traps. A series of replicated research/demonstration field trials were conducted from 1992 to 1997. Trap crop dry matter was 3 times higher following cereals compared to corn and dry beans. This is attributed to a much longer growth period (1430 compared to 645 growing degree days). Application of 44.8-56 kg ha^{-1} actual N fertilizer increased dry matter by one third across seven trials. Higher levels of N input did not appreciably increase dry matter production. Broadcast seeding onto corn and before knifing of dry beans as well as application of N to late plantings, did not make up for the lateness of establishment as fertilized trap crop yields were still less than half that of plantings made15 days earlier. Re-cropping immediately following cereal harvest and N application is advisable.

KUYKENDALL, L. DAVID* and ANN C. SMIGOCKI, Molecular Plant Pathology Lab, USDA, ARS, 10300 Baltimore Ave., Beltsville, MD 20705. **Cercospora beticola interactions with axenic sugar beet shoot cultures.**

Sugar beet leaf spot disease caused by Cercospora beticola often has a significant impact on both sugar beet yield and quality in some areas of the United States including the Red River Valley and Michigan. Our lab had previously produced some transgenic sugar beets possessing novel pathogen-defense genes specifying antimicrobial proteins. This study was conducted to examine the ability of these new genotypes to inhibit the growth of Cercospora. However growth stimulation was observed. Axenic sugar beet leaflets evidently supply the fungal pathogen with required growth factors not found in chemically defined media and thus are an excellent substrate for the in vitro growth of Cercospora. These growth factors are being determined. Greenhouse plant tests will be used to screen new germplasm.

LAMB, JOHN A.[1*], GEORGE W. REHM[1] and MARK BREDEHOEFT[2], [1]Department of Soil, Water, and Climate, University of Minnesota, 439 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108, and [2]Southern Minnesota Beet Sugar Cooperative, P.O. Box 500, Renville, MN 56284. **Grid cell size needed for sugar beet nitrogen recommendations in Southern Minnesota.**

High quality sugar beets require precise nitrogen fertilizer management with N recommendations based on a measurement of residual nitrate-N to 120 cm (4 ft). The use of grid soil sampling may be a good tool to improve nitrogen management. The objective of this study was to determine the agronomic and economic aspects of using different grid cell sizes for sampling soil nitrate-N. Nitrogen application maps were developed from soil samples taken on four different grid cell sizes, 18 m (60 ft), 55 m (180 ft), 91 m (300 ft), 128 m (420 ft), and a conventional average for the field. The treatments were applied with a fertilizer truck equipped with a variable rate applicator. Sugar beet root yield was determined with a harvester equipped with a state of the art yield monitor. Root quality was also evaluated. The nitrogen fertilizer application maps based on the 55, 91, and 128 m soil sampling grids were similar in 1997. The application map for 18 m grid cell size was different. In 1997, there were no differences in root yield and quality as affected by grid cell size. Also no differences occurred for 1998 root quality.

LEWELLEN, R. T.[1]*, G. C. WISLER[1], H.-Y. LIU[1], S. R. KAFFKA[2], J. L. SEARS[1], and J. E. DUFFUS[1], [1]USDA, Agricultural Research Service, 1636 E. Alisal Street, Salinas, CA 93905, and [2]University of California, Department of Agronomy and Range Science, Davis, CA 95616. **Reaction of sugarbeet breeding lines and hybrids to beet chlorosis luteovirus.**

Virus yellows is a complex of aphid vectored viruses that may include beet yellows, beet western yellows (BWYV), beet mosaic, and in Europe, beet mild yellows (BMYV) viruses. Recently, a new luteovirus of sugarbeet was recognized in California, Texas, Colorado, and Nebraska that is similar to BWYV and BMYV. It has been named beet chlorosis virus (BChV). BChV has a different host range than BWYV or BMYV. The host range of BChV includes *Chenopodium capitatum* causing leaves to turn red which led to the virus affectionately being called "capitatum red." On sugarbeet, foliar symptoms are similar to BWYV but with a tendency for greater interveinal yellowing with distinct green veins. BChV was used in 1997 to inoculate sugarbeet variety trials at Salinas and Davis, California to determine its effects on yield and the occurrence of differential host-plant reactions. The yield reduction caused by BChV was similar but probably more severe than that caused by BWYV. Sugar yield losses ranged from about 5 to 40%. In general, the reactions fit the loss pattern known for BWYV and BMYV. Lines and hybrids from the virus yellows resistance breeding program at Salinas tended to show the most resistance. The most susceptible commercial hybrids tested were those that have been grown in Colorado and Nebraska where BChV has caused significant damage in several recent years.

LEWELLEN, R. T.*, and JULIA K. SCHRANDT, USDA, Agricultural Research Service, 1636 E. Alisal Street, Salinas, CA 93905. **Inheritance of resistance to powdery mildew in sugarbeet derived from *Beta maritima*.**

Powdery mildew of sugarbeet (*Beta vulgaris* L.) caused by *Erysiphe polygoni* DC. was introduced into N. America in 1974. Since, it has remained a persistent problem. Traditional American germplasm, e.g., curly top resistant breeding lines, were largely susceptible. Chemical control and partial resistance are used to help control losses. High resistance was observed at Salinas in *B. vulgaris* spp. *maritima* accessions WB 97 and WB 242. In a preliminary investigation, this wild beet resistance was backcrossed into sugarbeet where reaction to *E. polygoni* among individual plants was expressed in more-or-less discrete resistant:susceptible classes. Plants from these backcross derived lines were used in controlled crossing designs to obtain testcross and selfed families for genetic analysis. In 1997 these families were scored for reaction to powdery mildew under natural field conditions at Salinas. Their segregation fit the pattern expected for a single, dominant gene for resistance to powdery mildew. The gene symbol *Pm* is proposed for this resistance factor. In field tests in 1998, the identical testcross families showed different segregation patterns. The possible reasons for these differences will be discussed.

MAHMOOD, T*., and RUSH, C. M. Texas A&M University, Texas Agricultural Experiment Station, PO Drawer 10, Bushland, TX 79012. **Cross-protection between beet soil borne mosaic virus and beet necrotic yellow vein virus in sugar beet.** Phytopathology 88: XXX

ELISA, Western blotting, and reverse transcription-polymerase chain reaction (RT-PCR) were used to investigate the occurrence and degree of cross-protection produced in sugar beet in greenhouse by protecting plants with beet soil borne mosaic virus (BSBMV) and challenging with beet necrotic yellow vein virus (BNYVV). Sugar beet seedlings were inoculated mechanically by vortexing in the absence of the fungus vector *Polymyxa betae*. A high degree of cross-protection occurred between BSBMV and BNYVV. The persistence of cross-protection dependents on the interval between inoculations with protecting and challenging virus; longer inoculation intervals enhanced the persistence of cross-protection. Cross-protection was most effective when inoculation interval was between 5 and 10 days, a period during which virus accumulated to a maximum level in plants singly infected with BSBMV or BNYVV. Results obtained by ELISA and Western blotting were consistent indicate that cross-protection affected viral capsid protein accumulation. RNA of both protected and challenging viruses was detected in doubly infected plants by using RT-PCR indicating that RNA of the challenge virus was present in the protected plants.

MARTIN, SUSAN S.* and JOHNNY M. THOMAS II, USDA-ARS Crops Research Laboratory, 1701 Center Avenue, Fort Collins CO 80526. **Glucosinolate composition of trap crop mustard is influenced by nutrient availability and photoperiod.**

Some cultivars of white mustard, *Sinapis alba* L., function as "trap crops" for the sugarbeet cyst nematode [SBCN], *Heterodera schachtii* Schm., because they stimulate cyst hatching but do not allow the nematode to reproduce normally. We have shown that cultivars of white mustard known to be "susceptible" (i.e., allow nematode reproduction) or "resistant" to SBCN do not differ greatly in glucosinolate [GSL] composition. To test whether nutrient deficiency might differentially affect GSL composition of resistant [R] or susceptible [S] cultivars, we grew one S and 2 R cultivars in nutrient solution to the 4- to 6-leaf stage. We then assigned plants from each cultivar to one of five treatments: (1) no change in nutrient regime (control); (2, 3, 4) similar medium except modified to be severely deficient in S, N, or P, respectively; or (5) distilled water with no supplied nutrients. After 7d roots were harvested and analyzed for GSLs by HPLC. N, S, or P deficiency differentially affected root GSL composition of the four *S. alba* cultivars. Total root GSLs were greatly diminished in resistant cvs. after 7d of N or S deprivation, but only slightly reduced in the susceptible cv. A new minor glucosinolate, epiprogoitrin, was identified as a component of trap crop mustard. Two new compounds were observed in extracts of nutrient deficient plants; these were isolated and identified as benzoic acid and goitrin (5-vinyl-2-oxazolidinethione), decomposition products of GSLs. We also examined the effect of photoperiod on white mustard cultivars (1 S and 2 R) and again found differential effects on GSL composition. However, differences did not appear to be sufficient in magnitude or consistency to appear related to the cultivars' relative resistance or susceptibility to SBCN.

McGRATH, J. MITCHELL. USDA-ARS, 494D PSSB, Crop and Soil Sci, Michigan State University, East Lansing, MI 48824-1325. **Sugarbeet seed germination and emergence in the laboratory and field: new approach to an old problem.**

Establishment of sugarbeet field stands is a recurring problem for growers. Predicting field emergence using laboratory testing would be advantageous, particularly if the factors governing sugar beet seed germination related to the process of stand establishment were targeted. We developed a strategy examine germination under a set of easily reproduced conditions where moisture was not limiting. Thirty-nine seedlots of 25 commercial seed, breeding lines, experimental hybrids and related germplasm were germination tested using a pleated paper test, germination in water and germination in hydrogen peroxide. Germination in water showed marked differences among seedlots with high germination under standard (paper or peroxide) conditions. Relative germination percentages in water corresponded with relative field emergence, although absolute values were different.

McGRATH, J. MITCHELL. USDA-ARS, 494D PSSB, Crop and Soil Sci, Michigan State University, East Lansing, MI 48824-1325. **Genetic diversity in selected, historical USDA sugarbeet germplasm releases and *Beta vulgaris* ssp. *maritima*.**

Diversity among older USDA sugarbeet germplasm releases was examined to gain insight on genetic diversity and the effect of breeding on the loss or gain of diversity over time. Accessions were chosen from the major breeding stations contributing to the U.S. germplasm pool and their presumed ancestors from Europe, including representatives for the wild forms *Beta vulgaris* ssp. *Maritima*. Using 69 polymorphic RAPD fragments for gene frequency analysis, heterozygosity was determined within and among groups of accessions related either by release date, breeding station or simply-inherited agronomic characters for monogerm seed and restoration of fertility in a cytoplasmic male sterile background. In general, heterozygosity within releases declined with time but total genetic diversity in the U.S. germplasm pool remained constant. Breeding for the agronomic characters had a marked influence in reducing diversity.

McGRATH, J. MITCHELL. USDA-ARS, 494D PSSB, Crop and Soil Sci, Michigan State University, East Lansing, MI 48824-1325. **Genetic diversity in selected, historical USDA sugarbeet germplasm releases and *Beta vulgaris* ssp. *maritima*.**

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MESBAH, ABDEL O.[1], and STEPHEN D. MILLER[2], [1]Northwest Research and Extension Center, 747 Road 9, Powell, WY 82435, and [2]Dept. of Plant Sciences, P.O. Box 3354, University of Wyoming, Laramie, WY 82071. **Weed control in Roundup Ready™ and Liberty Link™ sugarbeets.**

Field experiments were conducted in 1997 and 1998 at two locations; the Powell and Torrington Research and Extension Centers, Wyoming, to evaluate weed control efficacy in transgenic sugarbeets. The glufosinate sugarbeet trials consisted of two herbicide rates (0.27 with or without ammonium sulfate and 0.36 lb, ai/ac.) and two treatment stages (cotyledon and 4 leaves). Each stage contained three applications 10 days apart. At the cotyledon stage, weed control was moderate to good. However, at the four leaf stage weed control was excellent. The glyphosate trials consisted of one rate 0.75 lb, ai/ac. and two treatment stages (cotyledon and four leaves). Each stage consisted of one, two or three applications 14 days apart. At the cotyledon stage weed control was good with the three applications. However, at the four leaf stage, weed control was excellent with both the two and three application treatments.

MILLER, STEPHEN D.[1]* and K. James Fornstrom[2]. Dept. of Plant Sciences[1] and Civil Engineering[2], University of Wyoming, Laramie, WY 82071. **Weed control and sugarbeet response with dimethenamid and CGA-77102.**

Weed control and sugarbeet response with preplant incorporated, preemergence, postemergence or layby applications of dimethenamid and CGA-77102 (the active isomer of metolachlor) were evaluated on light textured, low organic matter (< 1.1%) soils under both furrow and sprinkler irrigation. Sugarbeet injury and stand reductions were substantial (15 to 35%) with preplant incorporated or preemergence applications of both compounds. Further, sugarbeet injury and stand reductions were greater with dimethenamid compared to CGA-77102. Broadspectrum weed control with dimethenamid or CGA-77102 ranged from fair (kochia) to excellent (green foxtail) and was best with preplant incorporated treatments.

MILLER, STEPHEN D.* and Abdel Mesbah. Dept. of Plant Sciences, University of Wyoming, Laramie, WY 82071. **Weed control and sugarbeet response with micro-rates of postemergence herbicides.**

Plots were established under furrow and sprinkler irrigation at the Powell and Torrington Research and Extension Centers; respectively, in 1997 and 1998 to compare weed control and sugarbeet response with standard and micro-rate postemergence herbicide programs. Herbicide rates in the micro-rate program were reduced 50 to 75% compared to the standard program. In addition, all micro-rate treatments were applied with a methylated seed oil additive. Broadleaf weed control was similar and grassy weed control slightly better with micro-rate compared to the standard program. Further, sugarbeet injury was 5 to 10% less in the micro-rate compared to the standard program.

MILLER, JAY P., ARTHUR A. QUINN, and MARGARET M. REKOSKE, Betaseed Inc., 1788 Marschall Rd., Shakopee, MN 55379. **The evaluation of several sugarbeet genotypes over four years in the root rot nursery at the Shakopee Research Station.**

Aphanomyces cochlioides is an important pest problem in some of the midwestern sugarbeet growing areas. One of our plant breeding objectives at Betaseed Inc., is to develop Aphanomyces tolerant varieties. An effective breeding program relies upon an effective disease nursery in which to evaluate and select genotypes.

In 1994, an Aphanomyces nursery was initiated at Betaseed's Shakopee, MN, research station. A methodical trial consisting of five diverse genotypes was conducted from 1995 to 1998 to determine the level of disease and consistency of the nursery. A rating scale of 1-9 was used where 1=healthiest and 9=dead. Over the four year period, the most susceptible genotype had disease ratings of 6.5, 7.5, 7.8, and 8.2, respectively, while the most tolerant genotype had scores of 2.2, 1.4, 2.8, and 1.8, respectively. The American Crystal Sugar Aphanomyces Official Trial has also been conducted in this nursery. From 1995 to 1998 the susceptible official trial check variety had an average disease score of 6.0; while, the tolerant check had an average disease score of 3.8.

MIRANOWSKY, AL and JEFFREY L. CARLSON, Minn-Dak Farmers Cooperative, 7525 Red River Road, Wahpeton, ND 58075-9698. **Design improvements in Minn-Dak Farmers Cooperative's beet quality laboratory increases sample throughput and lowered construction costs.**

Beet-sugar processing companies are looking for ways to hold down beet quality lab construction and operation costs. The new quality lab at Minn-Dak Farmers Cooperative was designed as a multi-use facility that lowered both construction and processing costs. Improvements included incorporating belt conveyors, bar code usage, computer integrated instrumentation, elimination of the red-beet method of tacking samples and increasing from one to two analytical lines. These improvements resulted in 372 samples per day as compared to 167 samples per day. In addition, it now takes only two, instead of three days from the time the growers deliver the beets until they have the results back from the quality laboratory.

MORAGHAN, JOHN T., Soil Science Department, North Dakota State University, Fargo, ND 58105. **Was application of a new precision farming concept after a sugarbeet crop efficacious?**

A new precision farming technique was used to reduce N-fertilizer use in a 1998 65-ha commercial wheat field following a 1997 sugarbeet crop. Based on a late-season, colored aerial photograph of a Crookston sugarbeet field, the farmer, Mr. Gary Wagner, reduced his 1998 recommended N-fertilizer rate by 67 kg N/ha in areas with a "green" antecedent sugarbeet canopy. Was this reduction justified? No N fertilizer was applied by Mr. Wagner to four antecedent "green" and to four "yellow" canopy areas, each 10m x 10m in size. The sugarbeet canopies contained an average of 243 and 93 kg N/ha in the "green" and "yellow" areas, respectively. The areas were divided into two and either 0 or 134 kg urea-N/ha was applied to the subplots. Nitrogen fertilizer increased wheat grain yields from 3,500 to 4,480 kg/ha (60 to 77 bu/acre) at the "yellow" canopy sites. The non-significant increase was only 10 kg/ha, from 4420 to 4430 kg/ha, at the "green" canopy sites. Nitrogen fertilizer increased grain-crude protein only at the antecedent "yellow" canopy sites. The new precision farming procedure was an economic success in a practical farming situation.

MORISHITA, DON W.[1]*, COREY V. RANSOM[2], MICHAEL J. WILLE[1], and JOEY ISHIDA[2], [1]University of Idaho, Plant Science Division, P.O. Box 1827, Twin Falls, ID 83303 and [2]Oregon State University, Malheuer Experiment Station, 595 Onion Ave., Ontario, OR 97914. **Evaluation of metolachlor for weed control in irrigated sugar beet.**

Metolachlor was evaluated for crop tolerance and weed control in irrigated sugar beet (*Beta vulgaris*). Experiments were conducted near Twin Falls, Idaho in 1997 and 1998 and near Ontario, OR in 1998. Metolachlor was applied preplant incorporated (PPI), preemergence (PRE), and postemergence (POST) followed by sequential POST herbicide applications. Crop injury of metolachlor treatments ranged from 0 to 16% in 1997, but was not greater than registered herbicide treatments. In 1998, injury ranged from 6 to 18% at Idaho and 0 to 63% at Oregon with treatments including metolachlor. Injury at Oregon was higher than standard treatments. In 1997, PRE metolachlor applications controlled common lambsquarters better than PPI applications. Kochia was not effectively controlled. Redroot pigweed and common lambsquarters control with PPI and PRE metolachlor applications ranged from 88 to 100% at both locations in 1998. Kochia control was variable and not different among metolachlor treatments. Late season hairy nightshade and annual sowthistle control at Oregon averaged 95% among metolachlor treatments followed by two POST herbicide applications. Due to high kochia populations in 1997, root yields were best when kochia control was 76% or higher. In 1998, all metolachlor treatments at Idaho had root yields ranging from 24 to 29 tons/A and were not different from the standard herbicide treatments. At Oregon, metolachlor treatments applied PPI had root yields greater than the untreated check. These data indicate that metolachlor can injure sugar beet under some circumstances, but injury was not always reflected in root yields. Weed control with metolachlor followed by POST herbicide applications appears to be comparable to ethofumesate and cycloate for common lambsquarters, redroot pigweed, annual sowthistle, and hairy nightshade control.

MORRISON, CHRIS D.*, and ROBERT W. STRICKLAND, Nalco and Imperial Holly Sugar Co. (respectively), One Nalco Center, Naperville, IL 60563; P.O. Box 9, Sugar Land, TX 77487. **A new era in sugar factory supplier alliances.**

Sugar factories have long relied on chemical vendors not only to supply materials to reduce foaming, minimize corrosion/scale/biological growth problems, but also to provide onsite technical services. These services include: product testing, training, program optimization, and troubleshooting. Although many suppliers could provide most/all of the chemical requirements, most(all) U.S. factories would use many different vendors(up to 5) for a variety of reasons. Most of these reasons are historic. The new Pacific Northwest Sugar Co. (PNSC) factory, (jointly owned by the local growers and Imperial Holly Sugar Co.), started slicing/operations in Sept. of 1998. As a major start-up, an obvious need was extra technical support, coordination throughout the factory, and technical innovation. PNSC's goal is to become the 'low-cost producer of sugar.' After a lengthy review of types of supply agreements and choices for suppliers, qualified suppliers were asked to make presentations to become PNSC's alliance partner. One firm(Nalco) was chosen to supply all the process/water chemicals and corresponding technical services. The results of the alliance are impressive and have allowed the factory personnel more time to focus on 'making sugar.' The alliance has also allowed the factory to get more service and technical assistance on areas affecting the entire factory. In addition, lower cost of chemicals through volume purchasing, outsourcing of all the associated problems/feed systems in these areas, new monitoring innovations, and daily on-site service have improved operations at PNSC. For the supplier, they now have a dedicated long-term client, a larger revenue stream and an opportunity to add a great deal of value/accountability for the success. Benchmarks for the factory fall '98/winter '99 campaign will be included in the presentation/paper detailing the metrics of the alliance's success comparing it to other factories using numerous suppliers.

NITSCHELM, JENNIFER J.* and PETER J. REGITNIG, Rogers Sugar Ltd, 5405-64th Street, Taber, Alberta, Canada, T1G 2C4. **Grid sampling to determine soil and plant variability in an irrigated sugar beet field.**

In Alberta, fertilizer recommendations for sugar beet crops remain largely based on conventional soil sampling. A grid sampling scheme was utilized in a commercial sugar beet field to demonstrate the variability of soil nitrogen and sugar beet production. Sixteen grid points located at 300 by 300 ft intervals (2.1-acre grids) were established in May 1997 in a field with a history of manure application and high soil nitrate. Soil samples collected in July from the 0-48" profile revealed a range of 55 to 330 lbs/acre available soil nitrate-N. By October, the available soil nitrate-N in the profile had decreased to an average of 35 lbs/acre. Nitrogen contained in the beet tops was estimated at 135 lbs/acre, with a correlation of 74% between soil nitrate-N and leaf % N. Sugar beet yield ranged from 22.1 to 30.2 tons/acre among the sixteen grid points. Sugar beet quality and sugar production were lower at grid points where July soil nitrate-N levels were above 200 lbs/acre. Late season leaf color, determined by a visual rating, served as a good indicator of sugar beet quality and soil nitrate-N levels. The field was uniformly fertilized and seeded to a spring wheat crop in 1998. Following the grain harvest, soil samples were again collected from the grid points. On average, 130 lbs/acre of available soil nitrate remained in the 0-48" soil profile. However, variability of soil nitrate-N had persisted, as the range among the grid points was from 70 to 230 lbs/acre.

NORMAN, LLOYD[1], GARY GARCIA[2], VINCE SALZMAN[2], FABIEN CABRERA[3], THOMAS CHARBONEAU[4], and KENNETH STEWART[4], [1]Brose Chemical Co., 2309 Lockhaven Dr., Colorado Springs, CO 80909, [2]Imperial Holly, P. O. Box 468, Worland, WY 82401, [3]Appplexion, 264, avenue de Mauldre, 78680 Epone (France), [4]Brose Chemical Co., P. O. Box 1506, Twin Falls, ID 83303. **Prelimer suspended solids can be separated.**

For many years it has been generally believed that superior final juice quality could be realized if the solids generated by the preliming process could be eliminated. However, because of the fragile, bulky, sticky nature of the precipitates formed, the task of separation, particularly at the plant scale level, has been formidable. Sedimentation to concentrate the suspended solids in normal prelimer operation is generally either very slow or non existent, and even when reasonable settling has been achieved, the filter media blinds and filtration is poor. Our work started several years ago when we discovered that a cationic polymer, Mafloc 2009, was found useful in helping plants to filter 2nd Carb juice when dextran was present. It was deduced that, since the 2009 rendered the sticky dextran filterable, perhaps it might be useful in coagulating the multiplicity of colloids in the prelimer and making them filterable. Many tests have shown that the polymer does just that, but when used alone, still falls short of success at the plant level. It was then discovered that certain anionic polymers give a synergistic boost and that a particular polymer, Applexion Flo Cap 3, (along with Mafloc 2009) gave excellent results. Our most recent testing has been on the full plant stream of prelimer effluent at Worland, Wyoming. In some respects the results have been very good, with the plant personnel really liking the way the rest of the plant runs. Still, anomalous data on filtration results, color, and other juice quality criteria leave us at this moment teetering on the brink of commercial application.

OPELKA, MICHAEL J., JAMES S. RAUH, and JAMES A. CUDDIHY, Jr.*, Midland Research Laboratories Inc., 10850 Mid America Ave., Lenexa, KS 66219. **Flume water clarification: An integrated systems analysis.**

Beet sugar mills have traditionally treated flume water systems with a chemical treatment program consisting of defoamers, polymers for clarification, and biocides. Each of these products has merit for usage in a flume system, however, if the right combination of treatment programs with appropriate feedpoints is not implemented, the economic justification and resulting performance of these chemicals will fall short of treatment goals. In other words if not properly treated, organics will continue to recirculate through the system causing reinoculation of the beets and possible surose loss. If an appropriate polymer is fed upstream of the clarifier there will be better retention time for the polymer to work, and more organics will be settled at the clarifier. By lowering the organic load in the flume water coming back to the incoming beets, an oxidizing biocide, such as chlorine dioxide will work extremely well at lower than normal dosages. Chlorine dioxide will not react with ammonia and when fed prior to and after the beet washer it will insure clean beets going to the slicers with little potential for microbiological contamination of the slicer system. Defoamers will still be needed in several feedpoints, however, the usage rate will be much lower due to less organics recirulating which naturally create foam. Turbidity levels or NTU values, with the use of a polymer, were seen to be reduced in flume clarifier effluent by as much as 50%-70%. Biocide usage and defoamer usage could drop as much as 25% with a cleaner system. The synergy of use with these three treatment components will save money on chemicals as well as keep the flume system cleaner to provide a cleaner beet with less spoilage potential.

OPELKA, MICHAEL J., JAMES S. RAUH*, and JAMES A. CUDDIHY, Jr., Midland Research Laboratories, Inc., 10850 Mid America Avenue, Lenexa, KS 66219. **Analyzing dextran in the sugar industry: A review of dextran in the factory and a new analytical technique.**

The formation of dextran as a result of microbiological activity is well documented. Dextran is currently recognized as having significant financial impact in cane sugar more than in beet sugar as penalties are often levied by cane sugar refiners. The presence of dextran in the factory is known to cause multiple processing problems, each having financial impact beyond merely sucrose loss. The processing and financial impact of dextran on the total factory operation is significant. However, the ability to measure the presence of dextran may be a limiting factor in recognizing its true impact on sugar beet operations. It is known that losses in sucrose may occur in beets in storage even under favorable conditions. The adaptation of dextran testing in beet sugar processing can identify at any stage of the process where sucrose losses are occurring and to what extent. A recently developed test method using a monoclonal antibody procedure has just been introduced into the cane industry. The new test method eliminates the time consuming and labor intensive methods currently practiced for measuring haze formation. It also has the advantage of being able to test dextran in juice and syrup as well as on the final sugar, while the currently used methods test only the final sugar. Using the test in the factory will allow operations to be adjusted accordingly to prevent slowdowns and loss of sucrose. Comparison of test methods by procedure, precision and accuracy show that the monoclonal test procedure is clearly superior.

PANELLA, LEE[1], IVICA LIOVIĆ[2], EARL G. RUPPEL[1], and ANDRIJA KRISTEK[2], [1] USDA-ARS Crops Research Lab, 1701 Centre Ave., Fort Collins, CO 80526-2083, and [2]Institute for Sugarbeet Breeding, Divaltova 320, Osijek, Croatia. **Varied response of *Beta vulgaris* L. Plant Introductions to *Cercospora beticola* in different environments.**

Thirty-five Plant Introductions (PIs) from the USDA-ARS National Plant Germplasm System *Beta* collection were screened for resistance to *Cercospora beticola* Sacc. at three locations: 1) an artificially produced epiphytotic in Windsor, CO.; 2) an artificially produced epiphytotic in Osijek, Croatia; and 3) a naturally occurring epiphytotic in Osijek, Croatia. These accessions included sugarbeet, leaf beet, garden beet, fodder beet accessions(*Beta vulgaris* subspecies *vulgaris*), as well as wild sea beet accessions (*Beta vulgaris* subspecies *maritima*). Randomized complete-block designs, with two replications were used to evaluate germplasm. Internal controls included a highly susceptible synthetic check and a resistant hybrid check, (FC504 X FC502/2) X SP6322-0. The artificially inoculated nurseries were inoculated twice. The PIs were visually evaluated on a scale from 0 (no disease) to 10 (plant dead). In Colorado, the leaf spot epidemic progressed rather slowly at first, but rapidly became quite severe by late August to early September. The growing season in Croatia is about one month ahead of Colorado, therefore the trials in Croatia were evaluated earlier. The inoculated nursery in Croatia also had severe disease symptoms. Because some of the annual *B. v.* subsp. *maritima* accessions flowered very early in Croatia, they could not be evaluated, and there are complete data (all three locations) available on only 19 of the accessions. An analysis of variance (PROC ANOVA - SAS) on the disease indices (visual evaluation scores) determined that there were significant differences among entries (P=0.05) on all three dates at all three locations. An LSD was generated for mean separations. Although the variation was higher in Osijek, susceptible and resistant controls preformed similarly. Some entries, however, which showed resistance in Croatia, were moderately to highly susceptible in Colorado.

PICCINNI, GIOVANNI *, MELISSA L. FAHNERT and CHARLES M. RUSH, Texas A&M University, Texas Agricultural Experiment Station, P.O. Drawer 10, Bushland, TX 79012. **Management of soilborne pathogens by managing irrigation of sugar beet.**

Two experiments were conducted to evaluate the effect of several irrigation regimes on disease development in sugar beet. The first experiment included four furrow-irrigation regimes (every two, three, four and five weeks) and four inoculation treatments (BNYVV, BSBMV, BNYVV+BSBMV and non-inoculated control). The treatment irrigated every four weeks showed the lowest disease incidence and a yield that was not significantly different from the treatment irrigated every two weeks. Also, sucrose content was significantly higher in the four-week irrigation treatment than in treatments irrigated every two and three weeks. Plots inoculated with BNYVV had a significantly higher disease incidence than BSBMV and BNYVV+BSBMV treatments. Yields were also significantly affected by inoculation treatments. Beets in the BNYVV+BSBMV treatment had a significantly higher yield than beets in the BNYVV treatment. The second experiment included three frequencies, three amounts and two methods of irrigation under a center pivot system. There were two main irrigation regimes: a Low Energy Precision Application (LEPA) system with 100%, 75%, and 50% the full rate of the pivot system, and a LEPA system with on/off valves where plots were irrigated at different frequencies. Measurements taken during the season included: top fresh weight, top dry weight, root fresh weight and number of beets per meter. Soil moisture was measured by use of a neutron probe. At harvest, root yield, number of beets per meter, disease index, percent sucrose, and stand counts were determined. Highest disease index and lowest percent sucrose occurred in plots irrigated at the full rate. Also, treatments irrigated the least had a significantly higher percent sucrose than in full rate plots. Sugar beets irrigated every other time the grower applied irrigation had the highest yield and the lowest disease incidence. These results indicate that disease losses can be reduced and yields increased with improved irrigation management.

PICCINNI, GIOVANNI *, AND CHARLES M. RUSH, Texas A&M University, Texas Agricultural Experiment Station, P.O. Drawer 10, Bushland, TX 79012. **Water use efficiency and disease severity of sugar beet grown in pathogen-infested soil.**

An experiment was conducted in a controlled environment to evaluate the effect of three irrigation amounts on disease development and water use efficiency in sugar beet. Three pathogen treatments, beet necrotic yellow vein virus (BNYVV), beet soilborne mosaic virus (BSBMV), BNYVV+BSBMV, a non-inoculated control and three irrigation amounts, pot capacity (PC), 75% PC and 50% PC, were arranged in a split plot design and replicated five times. Pots of each treatment were weighed every other day to determine evapotranspiration. Evaporation was determined from unplanted pots, and plant transpiration was calculated by the difference. The treatment irrigated at 75% pot capacity showed minimal disease incidence and a root weight comparable to the fully irrigated healthy control. Plants from BNYVV-infested seed had a significantly higher disease incidence than BSBMV and BNYVV+BSBMV treatments. Root weights and plant water use were significantly affected by the inoculation treatments. Beets in the BNYVV+BSBMV treatment had a significantly higher root weight and water use than beets in the BNYVV treatment suggesting competition between the two viruses.

PINGEL, RANDALL L.*, GARRY A. SMITH, LARRY G. CAMPBELL, and JOHN D. EIDE, Northern Crop Science Laboratory, USDA-ARS, 1307 N. 18th St., Fargo ND 58105. **Persistence and movement of fungal conidia applied in soil for the management of the sugarbeet root maggot, *Tetanops myopaeformis* (Röder).**

The fungus, *Metarhizium anisopliae* (Metschnikoff), has potential as an alternative to chemical soil insecticides for the management of the sugarbeet root maggot. For 3 years (1996-98) in the same field, soil applications of an isolate of the fungus (ARS-T1) were made over rotations (wheat, barley, and sugarbeets) and seasons (fall and spring) to evaluate the effectiveness of management strategies. There is a need to better understand what happens to the fungus in the soil after applications (i.e., what concentration of conidia is present, do conidia persist throughout the season, does the fungal concentration build-up with repeated applications or timing of applications, and do conidia move within the soil profile). From May 27 to Aug 19 of 1998, soil samples within the top 22.5 cm (in increments of 7.5 cm) of the soil profile were taken every 2 weeks and analyzed for the presence and quantity of conidia. Concentrations of conidia for all the fungal treatments ranged from 40-160 x 10^3 conidia/g of soil throughout the sampling period. The number of conidia did not increase with more applications, nor did timing of applications (fall vs. spring) affect the levels of conidia present in the soil. 57-89% of the conidia were present in the top 7.5 cm of the soil profile, and there were significantly fewer conidia present in the middle and bottom 7.5 cm of the soil profile when applications were made for only 2 years. The data suggest the fungus persists during the period of maggot activity with no appreciable reduction in conidial concentration, there is minimal buildup of innoculum over the years or with timing of applications, and there is more downward movement of conidia with more years of applications.

POPE, JAMES D.[1]*, and JOHN K. MANNO[2], [1]PSI Process Systems, Inc., 1790 Kirby Parkway, Suite 300, Memphis, TN 38138, and [2]Dedert Corporation, 20000 Governors Drive, Olympia Fields, IL 60461-1074. **Preparation for an actual application of mechanical vapor recompression evaporation in the sugar beet industry.**

Use of evaporation on process streams is well known in the sugar beet processing factory. Multiple-effect evaporator systems operating at low pressures have worked successfully and economically in the traditional factory process, energy balance, and steam generation scheme. However, recent additions to the factory steam load caused by new facilities such as molasses desugarization (MDS) and factory capacity expansions are taking existing boilers to maximum capacities. Mechanical recompression evaporators have been successfully applied in other industries, such as corn wet milling, as a solution to these problems. At one sugar beet factory in the Red River valley, mechanical vapor recompression (MVR) evaporators are being installed in a new MDS facility. By using these MVRs, the potential steam consumption was reduced by approximately 30%. The electrical requirement used instead is consumed by two 1250 horsepower motors and one 900 horsepower motor on turbo-fan recompressors. In this application, the additional capital cost for the MVRs versus a multiple-effect system is economically feasible compared to the additional capital cost of new steam boilers and requirements of air emissions permitting. The application of MVRs requires an in depth analysis of the nature and volume of the evaporative loads as well as an understanding of the configuration alternatives available.

RANSOM, COREY V.[1]*, JOEY ISHIDA[1] and DON MORISHITA[2], [1] Malheur Experiment Station, Oregon State University, Ontario, OR 97914, and [2] Twin Falls R&E Center, P.O. Box 1827, Twin Falls, ID 83303. **Sugar beet tolerance and weed control with BAS 65607.**

BAS 65607 is a soil-active herbicide that has potential for weed control in sugar beets. Trials were conducted at two locations to evaluate BAS 65607 for sugar beet tolerance and weed control efficacy. For the tolerance trials, weeds were controlled with standard herbicides and by hand labor. Sugar beet injury and yield was evaluated in response to postemergence applications of BAS 65607 at a typical use rate (0.72 kg ai/ha) and at rates 2 and 4 times the typical use rate. Combinations of BAS 65607 with phenmedipham/desmedipham (phen./desm.) and phen./desm. plus triflusulfuron were also evaluated. In Ontario, the combinations were with the 1X rate applied to 4-5 leaf sugar beets, while at Kimberly they were applied with the 2X rate to 2 leaf beets. The weed control trials consisted of treatments of BAS 65607, phen./desm., and phen./desm. plus triflusulfuron alone and in combinations applied to 2 leaf sugar beets. In the tolerance trial, BAS 65607 injured sugar beets at the 2 and 4X rates in Kimberly, but only at the 4X rate in Ontario. At Kimberly, the combination of BAS 65607 (2X) with phen./desm. plus triflusulfuron reduced sugar beet yield by 25% compared to BAS 65607 alone at the 1X rate. At Ontario, BAS 65607 at the 4X rate reduced yield 9% compared to the hand-weeded check. At Kimberly, all treatments provided greater than 91% control of redroot pigweed, common lambsquarters, and hairy nightshade, and at least doubled the yield of the untreated. At Ontario, addition of BAS 65607 to phen./desm. increased control of redroot pigweed, common lambsquarters, and hairy nightshade. BAS 65607 and dimethenamid alone on 2 leaf sugar beets were not effective in Ontario, but were in Kimberly. This may have been due to differences in weed emergence at the two sites. All treatments in Ontario increased yields compared to the untreated plots, but yields with BAS 65607 and dimethenamid alone were lower than the other treatments due to poor weed control.

REARICK, D. E.[1]*, D. PATTERSON[1], and M. AUTH[2], [1]Amalgamated Research Inc., P.O. Box 228, Twin Falls, ID 83303 and [2]formerly of The Amalgamated Sugar Company, P.O. Box 127, Twin Falls, ID 83303. **Evaluating the condition of ion exchange resins used for molasses desugarization.**

Ion exchange resins used as the separation medium in the chromatographic separation of sucrose from sugarbeet molasses are a major portion of the cost in any process-scale system and are expected to perform efficiently for years. Testing of a resin over its lifetime can provide information on potential problems with the resin as well as verify that it is still effective in separating sucrose. Tests to be discussed include those for resin capacity, acid-form water content, heavy metal fouling, organic fouling, and separation efficiency.

REITMEIER, L.J.*., J.F. GILES, D.W. FRANZEN and N.R. CATTANACH. North Dakota State University, Soils Dept., Walster Hall, Fargo, ND 58105. **Use of remote imagery to reveal high levels of deep soil N and direct N application.**

Soil sampling by sugarbeet producers in a sugarbeet-wheat-potato rotation find lower sugar content and higher impurity levels than producers in other rotations, despite following generally accepted soil testing following each crop. High soil N can contribute to lower quality in sugarbeets. Our objective was to determine if high N was present in the field, and modify detection and recommended practices to growers if high N was found. Aerial photography and satellite imagery were both found to delineate areas of high or low sugarbeet top N, which might lead to directed sampling for sugarbeet top analyis and deep soil sampling following potatoes to 180 cm to reveal N levels to growers. Soil sampling was not a good indicator of N available to the subsequent crop. A sugarbeet crop was grown using no supplemental N, based on N found at the 120-180 cm level and with N credits from potato tops, while a wheat crop was grown, reducing supplemental N by as much as 100 kg/ha in parts of the field directed by sugarbeet top analysis. Using traditional methods alone, N recommendations would have been substantially higher for both sugarbeet and spring wheat.

RENNER, KAREN A.[1], and JOHN P. BURK [2*], [1] Michigan State University, East Lansing 48823, and [2] Michigan State University Extension, 515 Center Ave., Bay City, MI 48708. **Strip crop rotations influence weed density and sugar beet yield.**

Sugar beet seedlings must be protected from winds in the spring because wind and soil particles can abrade young seedlings, stunt, and kill the crop. Planting corn and soybeans in strips followed by fall mulch tillage may reduce wind erosion and protect sugar beet seedlings. Trials were conducted in 1996 and 1997 on a commercial farm in Bay County, Michigan. Sugar beets were planted following two years of strip-cropping corn and soybeans. Crop residue, weed densities, and sugar beet populations, yield, and percent sugar were evaluated. Residue cover in the spring after sugar beet planting was 12 and 35% following soybeans and corn, respectively. Weed densities in sugar beets were greater in soybean residue. Sugar beets planted in soybean residue had lower populations, yields, and percent sugar compared with sugar beets planted in corn residue.

ROEMER, RONALD L.* and JOHN G. GALLIAN, University of Idaho, Twin Falls R&E Center, P.O. Box 1827, Twin Falls, ID 83303-0127. **Field emergence testing of commercial sugarbeet varieties.**

In 1995 a continuing program was started to determine the field emergence of commercial sugarbeet varieties. The objective was to determine (1) if a significant difference exists in seedling vigor, (2) the variability in vigor among locations and (3) the percent of seeds that become established plants. Seed was randomly sampled for each variety from commercial seed lots available to growers that were used in our standard variety trials. Fifty seeds were planted in single-row plots twenty-five feet long with four replications at several locations each year. Seeds were planted one inch deep using a cone planter with Milton disk openers. Plant counts were started as soon as the first seedlings were observed to be emerging, and final counts were taken when emergence was complete. The results of these tests have shown significant differences among varieties throughout the four years of testing. These data provide growers with realistic emergence information and has become as important in their variety selection as yield and sugar percentage.

ROSSITER, GORDON J.[1], ROHAN U. SENEVIRATNE[2]*, and RONALD M. SCARBOROUGH[3], Advanced Separation Technologies, 5305, Great Oak Dr., Lakeland, FL 33815. **ISEP® ion exchange technology in *Thin Juice* softening; commercial plant experience.**

Concentration of thin juice is one of the most expensive steps in beet sugar processing due to it's large steam consumption. To reduce this, scale formation in the evaporator must be inhibited. This is achieved by reducing hardness, typically by 80-90%. This can be done by ion exchange. However, large expense of conventional ion exchange equipment has hindered the implementation of softening by ion exchange. Advanced Separation Technologies commissioned it's first ISEP® moving bed contactor in thin juice softening in 1997 and operated successfully during the 1997 beet campaign. In this process, weak acid cation resin in Na form is used with dilute H2SO4 acid (<0.4%) as the regenerant. After regeneration, the resin is converted to the Na form by treating with a dilute stream of NaOH, under controlled conditions. ISEP® technology demonstrated lower steam consumption, elimination of evaporator downtime as well as a two third reduction in resin charge and lower operating costs compared to conventional ion exchange technologies. The ISEP®s consistent product quality and it's flexibility to accomodate feed variations were a major high point of the campaign.

RUSH, CHARLES M. *, GIOVANNI PICCINNI, and KEDEN BURK, Texas Agricultural Experiment Station, P. O. Drawer 10, Bushland, TX 79012. **Development of a disease management system using precision agriculture technology.**

The majority of sugar beets produced in the Western United States are irrigated and in most instances, sugar beet yields are positively correlated with the amount of irrigation water applied. However, when beets are grown in pathogen infested soils, increased irrigation often leads to increased disease and lower root yields and quality. Irrigation amount and frequency can also impact foliar disease development and nematode populations. Therefore, irrigation scheduling is of paramount importance to production of a high yielding high quality crop. Recently, remote sensing with infrared thermometers (IRT) has been used to monitor crop water requirements and to schedule irrigations. However, because plants infected by soilborne pathogens may exhibit the same symptoms as drought stressed plants, IRT based irrigation scheduling may not work in pathogen infested soils. In order to determine whether IRTs or other techniques of remote sensing are able to distinguish between biotic and abiotic stresses, a study was initiated in which IRTs were mounted directly to a center pivot. The crop was scanned twice weekly the day before irrigation. One scan was performed in the middle of the day and the second scan later in the evening after plants had begun to regain turgor. Preliminary results indicate that midday readings with IRTs will not be able to distinguish between biotic and abiotic induced stresses. However, because healthy plants regain turgor more rapidly than plants with root disease, the difference between midday and evening readings may provide a method of differentiating between biotic and abiotic stresses. If this holds true, diseased areas can be mapped and less water can be applied with the use of variable rate nozzling systems.

SAUNDERS, JOSEPH, W., USDA/ARS Sugarbeet and Bean Research Unit, Michigan State University, Department of Crop and Soil Science, East Lansing MI 48824-1325. **Sugarbeet tissue culture media differentially support the growth of sugarbeet pathogens *Rhizoctonia solani, Pythium ultimum, Cercospora beticola,* and *Aphanomyces cochlioides.***

Co-culture of pathogen and host plant tissue in viltro offers prospects for studying host defense gene expression, and opportunities for identification and cell selection of resistant genotypes. Sugarbeet pathogens Rhizoctonia solani and Pythium ultimum grew well (about 2 cm/day) from mycelial plugs on Murashige-Skoog agar medium with standard 60 mM nitrogen from nitrate and ammonium. Cercospora beticola grew more slowly (about a tenth as fast), and Aphanomyces cochlioides grew rapidly but very sparsely. All pathogens grew to, over and into sugarbeet isssue cultured on the same plate, leading to host tissue death. Cercospora (due to slow extensiøn growth) and Aphanomyces (due to sparse growth) should be suitable for future co-culture research with sugarbeet tissue cultures.

SELLE, STANLEY J.[1], MICHAEL HOHL[2], F.A. (TONY) HEINBAUGH[3], BRAD CARLSON[4], and OLIVIER DEUR[5], [1]Northwest Research, Inc., P.O. Box 5156, Grand Forks, ND 58206-5156, [2]Dakota Machine, Inc., 420 East Main Avenue, West Fargo, ND 58078, [3]American Crystal Sugar Company, 101 North Third Street, Moorhead, MN 56560, [4]American Crystal Sugar Company, RR2, Box 42, Hillsboro, ND 58045, and [5]Maquin-Promill, B.P. 239, F-28104 Dreux Cedex, France. **Wet scrubber stack emission test results from the new triple-pass pulp dryer at the Hillsboro factory of American Crystal Sugar Company.**

American Crystal Sugar Company installed a Promill triple-pass dryer during expansion of its Hillsboro, ND, factory. This was the first application of this technology to sugar beet pulp in the USA. Pulp dryer components are described, along with a brief discussion of system performance. A key feature of the Promill design is provision for controlled emergency shutdown, utilizing a refractory guillotine to isolate the furnace exit from the dryer drum. Heat for drying is provided by means of an overfeed stoker, moving grate furnace firing a low-sulfur Montana subbituminous coal. Particulate emissions are controlled using a wet scrubber. The wet scrubber achieves zero discharge to wastewater systems by recirculating blowdown to the inlet of the dryer drum. The results of stack gas and particulate emission testing are presented.

SIMS, ALBERT L.[1*], JOHN T. MORAGHAN[2], and LARRY J. SMITH[1], Univ. of Minn., ARC Bldg, 2900 University Ave., Crookston, MN 56716, and North Dakota State Univ., Walster Hall, P.O. Box 5638, Fargo, ND 58105. **Sugar beet canopy influences on spring wheat response to fertilizer nitrogen.**

Sugar beet canopies can vary in color within a field indicating differences in canopy nitrogen (N) content. Fertilizer N recommendations, based soley on soil nitrate-N tests, for a crop following sugar beet will not take into consideration N returned to the soil in the sugar beet canopy. The objective of this experiment was to quantify spring wheat response to fertilizer N following sugar beet at sites selected for visual sugar beet canopy color differences. Six sites were selected within a field based on sugar beet canopy color in an aerial photograph taken just prior to sugar beet harvest. Five N rates (0 – 180 kg N ha^{-1}) were established at each site with 4-5 replications then planted to hard red spring wheat the following spring. Canopy N returned to the soil was 264-369 kg ha^{-1}, 72 kg ha^{-1}, and 124 kg ha^{-1} in three green, two yellow, and one yellow-green canopy sites, respectively. Soil nitrate-N in the top 60 cm of soil was 35-462 kg ha^{-1}, 17 kg ha^{-1}, and 20 kg ha^{-1} in the same respective canopy sites. Fertilizer N would have been recommended for a 3.4 Mg ha^{-1} yield goal on all but one green canopy site using soil tests alone. Wheat grain yields and protein content were not different over the range of fertilizer N rates at the green canopy sites. At yellow and yellow-green canopy sites, wheat yields and protein content were significantly increased with the application of fertilizer N. Wheat did not respond to fertilizer N where green sugar beet canopies were located the previous year regardless of residual soil nitrate-N levels. Wheat response to fertilizer N was significant in areas where sugar beet canopies were not green the previous year. Nitrogen management of crops following sugar beet should consider N returned to the soil in the sugar beet canopy.

SMIGOCKI*, ANN[1], STEPHEN WILHITE[2], TOM ELDEN[2], SCOTT ARMSTRONG[3] and CHRIS WOZNIAK[1,4], [1]Molecular Plant Pathology Laboratory, [2]Soybean and Alfalfa Research Laboratory, ARS, USDA, Beltsville, MD 20705, [3]Department of Entomology, North Dakota State University, Fargo, ND 58105 and [4]Biopesticide and Pollution Prevention Division, US Environmental Protection Agency, Washington, D.C. 20460
Biotechnological strategies for effective control of the sugarbeet root maggot (*Tetanops myopaeformis* Roder).

Two approaches are being undertaken for management of the most devastating pest of sugarbeet in the US, the sugarbeet root maggot (SBRM). One approach involves the expression in transgenic sugarbeet plants of proteinase inhibitor genes which have specific activity against the root maggot's digestive proteases. These enzymes are essential for the release of nutrients for normal growth and development. Extracts of midguts excised from feeding second instar larvae were analyzed for specific protease classes using an inhibition assay. More than 86% of the gut protease activity was inhibited by 2 mM phenyl methyl sulfonyl fluoride, a serine protease inhibitor. Less than 3% inhibition was observed with 50 μM E-64, a cysteine protease inhibitor, and no inhibition with Pepstatin A, an aspartyl protease inhibitor. Using azocasein as a substrate, maximum protease activity was detected at pH 8.5, consistent with the serine class of proteases. Another approach being evaluated is the effect of cytokinin-induced insecticidal compounds on the SBRM larvae. A 1% suspension of leaf surface extracts from *Nicotiana plumbaginifolia* plants transformed with a cytokinin biosynthesis gene induced a twitching response and death of 30% of the first instar SBRM larvae at 72 hr. After 120 hr, 92% of the larvae were dead as compared to about 25% of the controls. Sugarbeet plants transformed with the cytokinin biosynthesis gene fused to a wound-inducible or a tuber-specific promoter have been regenerated for further analysis of the effect of cytokinins on defense responses.

SMITH, JOHN A.* and KAREN L. PALM, University of Nebraska, 4502 Ave. I, Scottsbluff, NE 69361. **Effect of uniformity of within-row plant spacing on sugarbeet yield.**

The number of plants per unit area of a field will influence both root yield and sugar yield of sugarbeets. Optimum plant populations have been well documented for various growing areas and production practices. The influence on yield by the uniformity of plant spacing within the row for a given plant population is not as well documented. This issue is important when considering planter model, planter operation, seedbed, percent emergence, and other factors that affect the uniformity of spacing between plants within the row. The objective of this project was to determine how non-uniformity of plant spacing within the row for a given plant population affects sugarbeet yield. Six plant spacing configurations within the row were planted to stand in two plant populations and evaluated for yield during three growing seasons. Root yield decreased when plant spacing was sufficiently variable, including large gaps and closely spaced plants. Although not measured, observations suggest that harvestability and weed control could be more important issues than sugarbeet yield when plants are not uniformly spaced within the row.

SMITH, LARRY J.[1],* and DOUGLAS W. RAINS[2], [1]Northwest Experiment Station, University of Minnesota, Crookston, MN 56716 and [2] American Crystal Sugar Company, Drayton, ND 58225. **Effect of variable rate nitrogen fertilization based on grid, topography and conventional soil testing on sugarbeet yield, quality and profitability.**

In 1996, over 125,000 acres of sugarbeet production in MN and ND was variable rate fertilized based on grid soil testing. A major drawback of grid soil testing is the cost associated with sampling and analysis. In 1995, Hollands showed a relationship between soil topography and soil nitrogen (N) levels, which could significantly reduce these costs. A trial initiated in 1997 compared N application based on these two methods of soil sampling and variable rate application versus the conventional random soil sample and single rate N application. The conventional random soil test showed 83 NO_3-N in the 4 ft soil profile on the test field. The grid method (2.5A/grids) showed a variation of 14-153 lbs. The three topography zones in the study had an average of 24, 78 and 152 lb NO_3-N in the low, intermediate and high elevations of the field respectively. Variable rate N application based on the grid system increased yield, net sucrose % and gross return 1.53T, 0.30% and $91 per acre respectively over the conventional test. Based on topography, an increase in yield and net return of 1.17T and $46 per acre was realized.

STAEL VON HOLSTEIN, CARL[1]*, ROBERT WILSON[2], CORY RANSOM[3], COREY GUZA[3], JOEY ISHIDA[3], JOSEPH F. GILES[4] and ALLAN W. CATTANACH[5], [1]Novartis Seeds, P. O. Box 7, Glyndon, MN 56547, [2]University of Nebraska, Panhandle Research & Experiment Center, 4502 Ave., Scottsbluff, NE 69361, [3]Oregon State University, Malheur Experiment Station, [4]North Dakota State University, 133 Walster Hall, Fargo ND 58105, and [5]American Crystal Sugar Company, 101 North Third St. Moorhead, MN 56560. **Row width and plant population study with transgenic Glyfosate resistant sugarbeets.**

This experiment was designed to take a look at the different plant populations per acre, using transgenic glyfosate resistant sugarbeets, to determine if the recoverable sugar per acre can be increased with this new growing technique. The trials were conducted at three different locations in the US. We have not yet received the results so they can't be submitted at this time.

TELCK, ALAN B., Holly Sugar Corporation, 1967 West Fifth Street, Sheridan, Wyoming 82801. **GIS/GPS applications in sugar beet production.**

Geographic Information System (GIS) technology is designed to help analyze relationships and patterns not recognized by viewing lists or paper maps. By incorporating Global Positioning Satellite (GPS) technology with GIS, an entirely new strategy for sugar beet production is being developed at Imperial Holly Corporation. Digital maps are generated showing highly detailed geographic information and linked with information in the Agricultural Information System database. These spatial data make it possible to relate numerous input and environmental factors to sugar beet yield and have sufficient statistical power to build robust agronomic models and decision support systems. Imperial Holly Corporation is incorporating GIS as the backbone to a new AgTrac agricultural information system. Discussed are the current status of Imperial Holly's GIS programs, perceived and realized benefits, and the future direction of these programs.

THOMPSON, P. D., Process Engineering. **Reducing energy consumption in beet factories: The European experience and its application to North America.**

Energy efficiency levels in North America are traditionally some years behind those in Europe. This paper explores why this is the case and focusses on the technologies and methods used in Europe to push steam demand to 20 %beet and below. A comparison of the economics of the two situations is made.

THORSNESS, KEVIN B., THOMAS W. KLEVEN, CHARLES P. HICKS, and D. PATRICK DWYER, AgrEvo USA Company, Wilmington, DE 19808. **Use of Liberty in transgenic sugar beet.**

Weed control is a critical aspect of sugar beet production. Herbicides that are labeled for use in sugar beet are limited by their weed spectrum and/or the window of application. Liberty® Herbicide is a non-selective postemergence herbicide with no soil residual and is being developed by AgrEvo USA Company for use on transgenic sugar beet (LibertyLink® sugar beet). LibertyLink® sugar beet have been genetically altered by insertion of the phosphinothricin-acetyltransferase (pat) gene and are tolerant to Liberty® Herbicide. The pat gene encodes for an enzyme that detoxifies Liberty® Herbicide in the LibertyLink® sugar beet plant. Field experiments were conducted in 1996-1998 at various locations to evaluate weed efficacy, band applications, cultivation influence, and tolerance of LibertyLink® sugar beet to Liberty® Herbicide applications. Liberty® Herbicide at 14-28 oz/a was broadcast applied to 1 and 3" weeds and applications were repeated 1-2 more times when newly germinated weeds reached the original application stage. Weeds present in the trials were redroot pigweed, common lambsquarters, kochia, hairy nightshade, wild buckwheat, common purselane, wild oat, green and yellow foxtail, and barnyardgrass. The plots were not hand-weeded. Weed control with Liberty® Herbicide was better when applied to 1" weeds compared to 3" weeds. Liberty® Herbicide at 14 and 28 oz/a gave 82 and 97% overall control of 1" weeds, respectively. Liberty® Herbicide applied in a 7-11" band provided similar weed control to broadcast applications. Liberty® Herbicide applied 2 times and alternated with 2 cultivation passes gave similar weed control to Liberty® Herbicide applied 3 times without cultivation. Liberty® Herbicide applications to LibertyLink® sugar beet from emergence to the 10-leaf stage of growth did not cause visible injury. Liberty® Herbicide will provide sugar beet growers with a tool to produce sugar beet with less hand labor and cultivation.

TUNGLAND, LEE, and ROY MARTENS, Novartis Seeds,1020 Sugarmill Road, Longmont, CO 80501.**Sugar yield gains from testcross recurrent selection.**

Testcross recurrent selection is a half-sib family selection procedure based on topcrossing with a tester (Hallauer and Miranda, 1981). Pseudo self-incompatible sugarbeet populations are uniquely adapted to this breeding procedure, since both self and outcrossed seed may be produced on a single plant. The objective of this research was to determine the applicability of this procedure to "typical" breeding populations. Four populations representing diverse germplasm groups were used as the test material: Population 1 (M6RE) was derived from 10, 4*x*, curly top resistant lines released by Dr. Helen Savitsky; Population 2 (I6HB) was derived from 4, 2*x*, rhizoctonia resistant releases of Dr. Richard Hecker and 2, 2*x*, elite proprietary sources; Populations 3 (I6G4) and 4 (LD2Q) were composed of 8 and 7, 2*x*, elite proprietary populations, respectively. Selection in M6RE, I6G4, and LD2Q, was imposed for sugar content (minimum of 100% of the population mean) and gross sugar yield. In I6HB, similar selection criteria for sugar content and sugar yield were used in tandem with selection for rhizoctonia resistance. Two breeding cycles from each population were evaluated in replicated yield trials at Glyndon, MN and Longmont, CO in 1998 to measure gain from selection. All populations showed improvement for root yield and gross sugar yield, ranging from 0.45% to 11.4% gain per cycle. I6HB showed zero (0%) gain for sugar content while the other populations ranged from 2.1% to 5.7% gain per cycle. Measured gain was significant ($p<0.05$) for sugar content and sugar yield in M6RE and I6G4. Although no significant gain was found for root yield, certainly the numerical gain found contributed greatly to gross sugar yield. The significant gain in sugar content, with only modest selection pressure, demonstrates the higher heritability of this trait. The results of this research shows that testcross selection can improve both yield and quality traits simultaneously. With the diverse origins of the populations evaluated, we conclude that this procedure could be applied to any heterogeneous pseudo self-incompatible sugarbeet population with high probability of sugar yield gain.

VAN WERT, SALLY L., AgrEvo USA Company, 2711 Centerville Rd., Wilmington, Delaware, 19808. **An overview of the regulation of biotechnology enhanced plants in the United States.**

With the advent of biotechnology enhanced plants there has been the development of regulations and policies in the United States and other countries. In the United States the safety review system for such plants began to be elucidated in 1986 and its development is ongoing. In the United States the framework is based upon the existing laws of the United States Department of Agriculture (USDA), the United States Environmental Protection Agency (EPA) and the Food and Drug Administration Agency (FDA). The regulations and policies are based in science, are generally transparent and have some flexibility. The USDA has authority from the time that a genetically enhanced plant or seed is moved into or within the United States until a commercial submission to the Agency is approved (determination of nonregulated status). If the plant is expressing a pesticidal compound, such as is the case for "Bt plants", then the EPA also has jurisdiction once the acreage for field testing is above 10 acres. A plant pesticide must also be registered with the EPA and either a tolerance or exemption from the requirement of a tolerance granted for the introduced pesticidal compound and genetic material. The EPA regulations are currently proposed, however, applicants are complying as though they were final. The FDA has provided a policy to guide the applicant in evaluation of the food and feed safety aspects of the genetically enhanced plant. A submission to the FDA is voluntary. A summary of every biotechnology enhanced plant product commercially available in the United States has been provided to the FDA. To date more field trial and commercial approvals have been granted for genetically enhanced crops in the United States than in any other country.

WEILAND, JOHN J.* Sugarbeet and Potato Research, USDA-ARS-Northern Crop Science Laboratory, Fargo, N.D. 58105. **Discrimination of sugarbeet fungal pathogens using amplified DNA from regions of the actin and rRNA genes.**

Determination of the causal agents of seedling damping-off and adult root rot can be confounded by misclassification of the disease-causing organism and by the presence of co-colonizing saprophytes. The actin and nuclear ribosomal RNA (rRNA) genes were used as targets in the development of polymerase chain reaction (PCR) protocols that permitted discrimination of common sugarbeet fungal pathogens without the need for phytopathological expertise. Using DNA primers (5FWDACT and MIDREVACT) directed to conserved regions in the actin gene, amplified DNA was generated from genomic DNA prepared from *Aphanomyces cochlioides*, *Pythium ultimum*, *Rhizoctonia solani*, *Fusarium oxysporium*, *Phoma betae*, and *Cercospora beticola* that was of a size consistent with the amplification of actin gene sequences. Use of primers ITS1 and ITS4 in the amplification of the internal transcribed spacer (ITS) region of the nuclear rRNA gene of these fungi also yielded products consistent with the amplification of this gene region. Size polymorphisms in the DNA amplified with the actin and rRNA primer pairs observed between pathogens in different genera also were consistent with the known sequence diversity that exists within these two genes. Where amplified product DNA size was indistinguishable between any two members of differing fungal genera, restriction fragment length polymorphisms (RFLPs) observed after restriction endonuclese digestion of the amplified DNA permitted discrimination of the pathogens. Use of the assay in the detection of *A. cochlioides* in infected sugarbeet seedlings is presented.

WEILAND, JOHN J.[1]*, GARRY A. SMITH[1], and LEE PANELLA[2]. [1]Sugarbeet and Potato Research, USDA-ARS-Northern Crop Science Laboratory, Fargo, ND. 58105-5677 and [2]Sugarbeet Research, Crops Research Laboratory, USDA-ARS, Fort Collins, CO, 80526. **Greenhouse assay for the evaluation of sugarbeet resistance to Rhizoctonia root rot.**

Evaluation of sugarbeet for resistance to Rhizoctonia root rot using field nurseries can be costly and subject to environmental variables that restrict disease development. A rapid method for the detection of resistance to Rhizoctonia root rot in sugarbeet in the greenhouse was developed. Sterile barley grain inoculated with an isolate of *Rhizoctonia solani* AG2-2 (R9 isolate) known to cause root rot in sugarbeet is the basic inoculum. Infested grain is used to inoculate 5 week-old sugarbeet plants in the greenhouse and evaluation of root rot severity is determined at 2-3 weeks post-inoculation. Sugarbeet germplasm from the USDA Fort Collins breeding program and one commercial hybrid were used to validate the method and included highly resistant material (FC709-2 and FC718) and highly susceptible material (FC403 and Maribo >Ultramono=). Ranking of the germplasm accessions for percent healthy roots after inoculation in the greenhouse was similar to the ranking of the same germplasm in the Rhizoctonia root rot nursery in Fort Collins over several years of testing. The method can be used for the selection of individuals exhibiting superior root rot resistance from a segregating population. Evaluation of progeny in a segregating population using the assay can improve the accuracy of root rot resistance scoring for use in molecular marker mapping programs. A preliminary characterization of resistance gene candidates (RGCs) amplified by the polymerase chain reaction that differ between plants exhibiting root rot resistance and root rot susceptibility is presented.

WEISS, L. WARNER*, Sugars International LLC, 30 Glenmoor Drive, Englewood, CO 80110. **Sugars™ program update for Windows - beet sugar.**

New development for the Sugars computer program has resulted in a completely new version for use with Windows 95/98/NT. This new version has a full graphical interface. Models are built with a drag-and-drop technique to draw the flow diagram for the process using shapes from the shape stencils that are provided with the program. Connections are made between shapes using a connector tool with automatic line routing and crossovers. Clicking on each shape gives a dialog screen for entering performance data to control each station. Clicking on each external flow going into the model gives a dialog screen for entering data to define the characteristics of the external flow. Details of all internal flow streams (flows between stations) are available by clicking on the flow stream. Flow streams between stations can be revised by simply clicking on the flow stream and dragging it to a new connection on another station; for example, to change the vapor used by a pan, or heat exchanger. Data for each model is stored in an Microsoft Access database. A revenue screen is provided to show the net process revenues generated by the process. Many other new enhancements are also provided. The new Sugars for Windows program is fast, flexible and very user-friendly.

WILSON, ROBERT G., University of Nebraska, 4502 Avenue I, Scottsbluff, NE 69361. **Glyphosate and glufosinate for weed control in herbicide tolerant sugarbeet.**

Experiments were initiated near Scottsbluff, NE in 1997 and 1998 to evaluate the sucrose yield of glyphosate and glufosinate tolerant sugarbeet varieties and to examine the efficacy of both herbicides for selective weed control in the crop. In 1997 two sugarbeet varieties tolerant to glufosinate and one variety tolerant to glyphosate were compared to the same varieties without the herbicide tolerant gene and three standard varieties at two locations. In 1998 four sugarbeet varieties tolerant to glufosinate and three varieties tolerant to glyphosate were compared to varieties without the herbicide tolerant gene and three standard varieties at two locations. Sucrose yields were similar between varieties with or without herbicide tolerance and standard varieties. Two applications of glyphosate at 0.84 kg/ha or two applications of glufosinate at 0.3 kg/ha applied when the crop was in the 2 to 4-leaf growth stage and again 10 to 14 days later controlled 99% of the weed population. Both glyphosate and glufosinate provided similar weed control and less early season crop injury than a conventional weed program which consisted of phenmedipham plus desmedipham plus triflusulfuron.

WILSON, ROBERT G. and JOHN A. SMITH, University of Nebraska, 4502 Avenue I, Scottsbluff, NE 69361. **Crop production with glyphosate tolerant sugarbeet.**

Approval of glyphosate tolerant sugarbeet has the potential to change the direction of U.S. sugarbeet production during the next century. Weed control with postemergence glyphosate treatments is as effective or in some cases more effective than conventional weed control programs. Glyphosate tolerant sugarbeet exhibit minimal crop injury, particularly during early season growth periods. Reduction in crop injury from currently used postemergence herbicides enhances early season crop vigor and the ability of the plant to capture sunlight and compete with weeds. Improved weed control diminishes the need for cultivation which allows the spacing of sugarbeet in narrower rows. Narrow row planting coupled with enhanced crop vigor means earlier row closure, a crop more competitive with weeds, and the potential for enhancement of sucrose yield.

WISLER, G. C.*, R. T. LEWELLEN, J. L. SEARS, H.-Y. LIU, and J. E. DUFFUS. USDA-ARS, 1636 E. Alisal St., Salinas, California. **Differences in beet necrotic yellow vein virus (BNYVV) levels among susceptible and resistant sugar beet cultivars grown in the United States.**

The content of BNYVV in sugar beet roots from representative commercial and experimental cultivars developed for production in the United States was measured by a triple antibody sandwich ELISA (TAS-ELISA). A monoclonal antibody to BNYVV was used as the trapping antibody and a polyclonal antibody made from an in vitro expressed capsid protein of BNYVV for the detecting antibody. Differences in absorbance (A405 nm) values measured among the eight cultivars closely corresponded to a dosage effect and to the frequency of the Rz allele that conditions resistance to BNYVV. A diploid (Rzrz) hybrid had a significantly lower value than a similar triploid (Rzrzrz) hybrid. Cultivars that segregated (Rzrz:rzrz) had higher absorbance values than uniformly resistant (Rzrz) hybrids. For all cultivars, differences were observed among the three harvest dates, with progressively lower absorbance values obtained as the season progressed. A strong positive correlation was observed between absorbance values and the rhizomania disease index scores, whereas a negative correlation was observed between absorbance and individual root weight, plot root weight, and sugar yield. These results are important in plant breeding, varietal development, and cultivar evaluation. They show that the breeder or agronomist can be fairly confident of measuring varietal reactions to rhizomania by either scoring or weighing field grown material. This information is useful in resistance breeding and evaluation programs and for the sugar industry in consideration of cultivar choice, inoculum production, and rotations for future cropping.

WOZNIAK*, CHRIS A., and JOHN L. KOUGH, U.S. Environmental Protection Agency, Biopesticides and Pollution Prevention Division, 401 M Street, S.W., Washington, D.C. 20460. **Regulation and oversight of plant-pesticides by the U.S. EPA.**

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food Drug and Cosmetic Act (FFDCA), the Environmental Protection Agency registers all pesticides sold in the U.S. The advent of plant transformation technology has led to the production of transgenic plants with new pesticidal properties. These biopesticides are termed Plant-pesticides. This category includes plants produced by introduction of traits that would not normally be available by traditional plant breeding methods with sexually compatible relatives. An example would be the integration of bacterial gene sequences into sugarbeet for insect resistance. Prior to registration, each plant pesticide is examined to decide what data are needed to ensure that a reasonable certainty of no harm to man and the environment will result from its use. In general, details of the gene construct and expression levels of the introduced pesticidal substance, as well as information on the digestibility and allergenicity of proteins produced and toxicity profiles for humans and non-target species are requested from the registrant. To date seven plant pesticides (products) have been registered which represent six active ingredients (genotypes) expressed within three species: cotton, potato and corn. Resistance management is being developed for at least some of the crops expressing Bt-based insecticidal traits by incorporating non-treated refuges into planting design. Plants with herbicide tolerance traits are not regulated under the Plant-pesticide rule since the trait itself does not meet the definition of a pesticide under FIFRA. The herbicide, however, may need a new label and assessment for increased residues. All genetically modified plants are subject to oversight by the USDA's Animal and Plant Health Inspection Service under the terms of the Plant Pest Act and Plant Quarantine Act.

WOZNIAK*, CHRIS A, USDA, Agricultural Research Service, Molecular Plant Pathology Lab, BARC-West, Beltsville, MD 20705. **A novel fungus pathogenic to the sugarbeet root maggot.**

A new hyphomycetous fungal species, *Synglíocladium tetanopsis*, was discovered in the Red River Valley following an epizootic on third instar sugarbeet root maggots (SBRM). Larvae were selected from field plots based upon discoloration (yellow to orange-brown) and sclerotization of the cuticle. The fungus sporulated upon surface mycelium following incubation of SBRM cadavers in a moist chamber with subsequent production of synnemata. Plating of hyphal fragments and culture on modified oatmeal and potato dextrose agars yielded a pure isolate which produced synnemata after approximately three weeks at 24 □C. Ameroconidia were produced upon short, monoverticillate conidiophores borne directly upon prostrate hyphae or the surfaces of aerial synnemata. Spores were subcylindric, non-ornamented and often produced in copious slime. Koch's postulates were demonstrated by inoculation of first and third instars with conidiospores of *S. tetanopsis*, observation of disease etiology, and reisolation of the fungus in pure culture. A higher infection rate and shorter time to mortality were recorded for first instar SBRM as compared to third instars with sporulation occurring on the cadavers in as little as 8 days versus 28 days for third instars. Analysis of disease progression by scanning electron microscopy indicated that infection is by cuticular penetration and not by ingestion of spores. No sexual state is currently known for this imperfect fungus, however, the anamorph is consistent with those known from the genus *Cordyceps*. At least three other species of *Synglíocladium* have been documented and associated with insects and other arthropods. Evaluation of ladybird beetles, green lacewing larvae and adults, and tobacco hornworm larvae suggest that there was no pathogenic effect of *S. tetanopsis* on these species. This represents the first known pathogen of the SBRM, *Tetanops myopaeformis*, from a natural epizootic. Cultures of *S. tetanopsis* have been deposited in the ARS Entomopathogenic Fungal Cultures (ARSEF) and Northern Regional Research Lab (NRRL) collections.

YONTS, C. DEAN, JOHN A. SMITH and ROBERT G. WILSON, University of Nebraska, Panhandle Research and Extension Center, 4502 Avenue I, Scottsbluff, Nebraska 69361. **Design and evaluation of cover crop systems for sugarbeet production under furrow irrigation.**

Establishing sugarbeet in areas prone to wind erosion can often result in reduced plant stand due to small seedlings being damaged or cut off by wind and moving soil. The result in stand loss is the need to reseed sugarbeet or if it is too late in the growing season, to establish a different crop. The use of a cover crop can reduce the impact of wind erosion by providing protection for small sugarbeet plants during early stages of growth. Seeding sugarbeet in a growing cover crop has been practiced in areas using sprinkler irrigation. For sugarbeet production using furrow irrigation, the cover crop that provides plant protection, can also interfere with establishing furrows for irrigation. The objective in this study was to design spring and fall planted cover crop systems for seeding sugarbeet in furrow irrigated fields. Five cover crop treatments were established over a three year period in field strips approximately 800 feet long. The cover crop treatments included conventional plow, fall cover crop seeded both on beds and broadcasted and spring cover crop seeded both on beds and broadcasted. A three-pass system was developed to prepare the soil, construct furrows and seed the cover crop in preparation for seeding sugarbeet in the spring. Root yield and sugar content were determined for each of the cover crop treatments. During the first two years of study yield of sugarbeet was not affected by the different cover crop treatments.

YONTS, C. DEAN, KAREN L. PALM and DAVID L. REICHERT, University of Nebraska, Panhandle Research and Extension Center, 4502 Avenue I, Scottsbluff, Nebraska 69361. **Late season irrigation management for sugarbeet.**

Irrigated agriculture will be required to use less water for crop production in the future due to increased demand on available water supplies by nonagricultural uses, such as the environment and urban growth. Reducing the amount of irrigation water applied to sugarbeet will increase the level of crop water stress during the growing season. Irrigation management methods throughout the growing season must be evaluated to minimize the impact of reduced water supplies for irrigation. The objective in this study was to determine the effect of limiting irrigation late in the growing season for sugarbeet. Sugarbeet plots were established each year during 1995-1998, in both furrow and sprinkler irrigation systems. Soils were a Tripp very fine sandy loam with a water holding capacity of approximately 1.8 in/ft. Irrigation treatments included full irrigation through harvest, limited irrigation after August 15 through harvest and no irrigation after August 15 through harvest. Root yield and sugar content were determined for each of the different irrigation treatments. For the full irrigation treatment, total irrigation water requirements from August 15 through harvest ranged from approximately 4-8 in. over the four-year study period. Results indicate that root yield, sugar content, and sugar production were not affected by limiting or stopping irrigation after August 15.

YU, M. H., USDA, ARS, U. S. Agricultural Research Station, 1636 East Alisal St., Salinas, CA 93905. **An observation of root-knot nematodes in California and development of resistant sugarbeet.**

The status of root-knot nematode distribution in California sugarbeet field was investigated. Samples of the infected plants and infested soil were collected from various major production areas. To identify the specificity of Meloidogyne spp., nematodes were initially recovered with the use of susceptible hosts. For nematodes from infected plants, matured females were extracted and inoculated to tomato seedlings that were growing in containers; and for those from infested soil, seedlings were germinated directly in the field soil containers. Isolates recovered from these procedures were multiplied and inoculated to groups of index plants from different species to conduct a differential host assay. The results demonstrated that the four most common species of root-knot nematode, i.e., M. incognita, M. javanica, M. arenaria, and M. hapla, were currently existent in California sugarbeet growing areas. Genetic sources of resistance to root-knot nematode has been recently identified. Due to its multi-species resistant capability, sugarbeet production may be protected from serious root-knot nematode damages when the resistance factor(s) is eventually incorporated into a commercial variety.

ZAGERS, PIET, and DIRK P. VERMEULEN*, Suiker Unie, P.O. Box 100, 4650 AC Oud-Gastel, The Netherlands. **Expansion of the existing graining system to a 3-stage batch process as an optimal solution to produce coarse sugar (MA : 1.0 – 1.5 mm) without loss of production capacity.**

All three Suiker Unie factories in The Netherlands operate with a 2-stage graining system with two batch pans which produce grain for all three strikes. The second grain pan and second and third strike production pans are seeded with first-stage grain with MA 125-150 μm. In the second grain pan the crystals grow to MA 0.30-0.35 mm has been reached. This grain is used only in the first strike pans for the production of white sugar with MA 0.65-0.70 mm and CV 28-35%. The grain is produced starting from slurry (e.g. SCF; MA ca. 10 μm) using production pans which were no longer required. The graining system has also led to a better sugar quality.

Until 1996, when it was closed, the Roosendaal factory produced coarse sugar with MA of about 1.5 mm by splitting the masse cuite during the boiling process and pumping about half of it into a second pan and continuing the crystallization to the final crystal size with both pans. A major disadvantages of such operation was a significant reduction of beet processing capacity.

Last year, the Dinteloord factory studied how the beet processing and sugar production capacity could be maintained with minimal investments, when during 2-3 weeks in the campaign coarse sugar with MA 1.0 to 1.3 mm was to be produced. Expansion of the graining system to three pans (producing grain with MA 0.6 mm) made such operation feasible. One of the nine first strike production pans was sacrificed to operate as third-stage grain pan. In order to maintain white sugar production with the remaining eight pans, the average grain size was also increased during standard boiling and the batch time was further optimized (shortened). In fact it was possible to increase production capacity by 10% during standard boiling. The background and experience with the new system during the campaign of 1998 are discussed.