Look to the Future

ABSTRACTS

AMERICAN SOCIETY OF SUGAR BEET TECHNOLOGISTS

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AMES, RICHARD W., P. W. CAULKINS, B. A. MUEHLBERG and G. W. GOLOVANOFF, Minn-Dak Farmers Cooperative, Route 1, Box 10, Wahpeton, ND 58075. Laboratory information management, data acquisition, and computer applications in the sugar factory.

A multi-user computer database system for sugarbeet factory operations has been developed. The system uses an IBM 5364 as the central processing unit (CPU). The CPU has one million bytes of main storage, and 135 million bytes of disk storage. RPG II and Fortran programs are used to calculate and store the process control information. This information is generated by routine laboratory analysis and factory data logging. During normal operation, raw data is acquired directly from an automatic titrator, or entered by a lab technician, or a factory operator. All calculations and reports are handled by the computer. The time needed to generate daily and weekly operating reports has been reduced from hours or days; to seconds. The laboratory results are immediately displayed on any system terminal with a board sheet type inquiry program. The automated, immediate display of process control information is a dramatic improvement over the manual method it replaced. With this system, factory operators are able to retrieve information quicker, and react faster to process changes. Also, special inquiries can be made on the database by using packaged programs. These programs are available for either the CPU or personal computers - which can be interfaced to the CPU. Personal computers allow the use of an enormous amount of statistical quality control software, and other data analysis packages. These packages are excellent tools in the search for operating trends, and finding relationships between operating parameters.

ANDERSEN, JYTTE MOLLERUP, P. ULVSKOV and J. MARCUSSEN. 1) Biotechnology Section, A/S De Danske Sukkerfabrikker, 1, Langebrogade, DK-1001 Copenhagen K, Denmark, 2) Institute of Plant Physiology, Royal Veterinary and Agricultural University, 40, Thorvaldsensvej, DK-1871 Copenhagen F, Denmark - Regeneration capacity in Sugar Beet Tissue Culture as related to Exogenously added and Endogenously synthesized Cytokinins.

Manipulation with growth hormones in the substrate for plant tissue culture is considered to be the most important factor controlling the differentiation from undifferentiated cells in whole plants. It is known that the cells in culture also do synthesize plant hormones. However, the influence of exogenously added hormones on the level of endogenously synthesized hormones is poorly understood as well as the influence of this interaction on the differentiation process in tissue culture.

Using a zeatin kit consisting of an immunosorbent column based on monoclonal antibodies and an ELISA assay based on polyclonal antibodies towards zeatin, the endogenous level of zeatin and N-9 derivatives of zeatin has been analysed in regenerating and non-regenerating callus cultures of sugar beet. Variation in zeatin levels of callus isolated from different portions of seedlings has been observed. Correlation between origin of callus, exogenous and endogenous cytokinin levels as related to regeneration capacity will be discussed.

AUTH, MARGARET, and D. EUGENE REARICK. The Amalgamated Sugar Company, P.O. Box 127, Twin Falls, ID 83301. - Clarification of sugar factory process samples with zinc salts.

Beet sugar factory process samples have traditionally been clarified, for polarimetric sucrose determination, by means of lead salts. However, due to the difficulty and cost now associated with disposal of lead-containing solutions as toxic wastes, many laboratories have sought alternatives to lead clarification. The addition of zinc chloride solution and a base (aqueous ammonium hydroxide or potassium hydroxide) to a factory sample forms a precipitate of zinc hydroxide which removes suspended solids and much of the dark colored components. Resulting solutions are darker than basic lead acetate clarified samples but, even for molasses, are light-colored enough to allow pol determination in a normal saccharimeter with a 100 mm cell. Initial paired comparisons showed no statistically significant differences between molasses pol values determined using basic lead acetate or zinc chloride and base.

BABB, THOMAS, A. JAMES P. MUELLER and CAROL A. FRATE. Spreckels Sugar Co., Inc., 29400 W. Whitesbridge, Mendota, Ca 93640; Dow Chemical U.S.A., Route 1, Box 1313, Davis, Ca 95616; U.C. Cooperative Extension, Agricultural Building, County Civic Center, Visalia, Ca 93291 - An integrated approach for the control of rhizomania.

Rhizomania has affected more than 50,000 acres of sugar beets in California since 1983. Polymyxa betae, the fungus vector of this viral disease, is known to move from field to field in irrigation water. Further spread of the disease is probable in irrigated agriculture as practiced in California. Trials conducted in commercial sugar beet fields tested various rates of 1,3-dichloropropene soil fumigant in combination with tolerant and susceptible varieties. The objective was to determine whether economic yields could be obtained in fields known to be infested with the virus and its fungus vector. Yield increases were obtained.
Baker, Ellen H. and C. M. Rush. Texas A&M University, Texas Agricultural Experiment Station, P.O. Drawer 10, Bushland, Texas 79012. - Preliminary studies on seed priming of sugarbeet.

Studies were conducted with primed and unprimed sugarbeet seed (cv. Mono Hy TX 18) under field and laboratory conditions to compare rates of emergence, damping off, and final stand. In field tests at five separate locations, seed were planted in thirty-foot, two-row plots and replicated five times. Stand counts were made approximately three and ten days after the first seedlings emerged. Primed seed consistently emerged faster than unprimed seed, and the difference was statistically significant in three of the five fields. After one week, stand counts were not significantly different in any field. In a second study, primed and unprimed seed were evaluated for resistance to infection by two pathogenic Pythium spp. Seed were planted in artificially infested soil and incubated in the laboratory for two weeks in lighted growth chambers at 25°C. Emergence counts were taken after one week and final stand counts were taken at two weeks. Primed seed had significantly higher rates of emergence and better final stands in both treatments.

Baker, Ellen H., and C. M. Rush. Texas A&M University, Texas Agricultural Experiment Station, P.O. Drawer 10, Bushland, Texas 79012. - Reaction of selected sugarbeet varieties exposed to two pathogenic Pythium spp.

In the Texas Panhandle, two Pythium spp. designated P2 and P3 have been consistently isolated from diseased sugarbeet seedlings. The isolates do not form sexual structures and may be heterothallic species or sterile strains of P. ultimum. P34 is more virulent and causes more pre-emergence damping off than P2. Thirty cultivars were evaluated for their reaction to the two Pythium isolates. Seed were planted in artificially infested soil and incubated in a greenhouse for two weeks. The cultivars were evaluated for emergence and stand. Four varieties, American Crystal 146, USDA-USH 23, Holly 1434-03 and American Crystal CB6, showed significant tolerance to the two pathogens. Mono-Hy varieties RH 83, D2, TX9 and TX10 also showed some tolerance.

Bosse, Dietrich. SMA, Braunschweigische Maschinenbauanstalt AG, Braunschweig, Germany. - The increase of crystal yield by application of the MET flash cooling crystallizer for intermediate and white sugar masscuites.

The main objects of cooling crystallizers downstream of pans are: - increased crystal yield; - reduced sucrose and non-sucrose circulation; - higher quality sugar; - reduced energy consumption. Magma cooling to increase crystal yield is a fundamental operation in sugar production and is not new. Every sugar factory cools low-raw masscuites to lower the mother syrup purity for increased crystal yield. The sugar industry has always been seeking to subject even high or medium purity magmas to such cooling crystallization which, however, cannot be accomplished with conventional equipment because of inevitable incrustations on the cooling surfaces. The new MET flash cooling crystallizer is an apparatus that can handle these magmas as well. It is a unit where, after crystallization, the magma is cooled down in three steps by way of pressure reduction which results in two effects: - cooling of the magma promotes further desugarization of the mother syrup and, consequently, crystal growth; - flash evaporation associated with temperature reduction means more water is extracted from the mother syrup, thus providing for further desugarization. The resultant advantages are: - crystal mass increased by up to 45% for white sugar and by up to 20% for intermediate product; - sugar house energy consumption reduced by up to 10%; - sugar quality improved by the fact that in a cooling crystallizer, i.e. at low temperatures, the formation of color is substantially less than in pans; and - continuous operation.

Bowers, Don*, Dennis Searle, Agronomists for Amalgamated Sugar Company. Craig Baid, Richard L. Johnston and Robert L. Stoltz, Entomologists, University of Idaho. P.O. Box 1766 Nyssa, Oregon 97913. The Sugarbeet Crown Borer of Idaho. The sugarbeet crown borer (Hulstria undulatella) is a relatively new pest insect in the sugarbeet fields of Idaho. Several fields near Parma were found with 30 to 40 percent infestation in 1985. Since then several areas have been infested in Fruitland, Lewistown, Payette, and Weiser. Across the Snake River in Oregon they have been found in large numbers near Adrian, Nyssa, Ontario, and Vale. Heavy infestations have also been found during 1987 and 1988 in Twin Falls and Cassia Counties. The most critical time is during seedling establishment and thinning. The crown borer will
attack the plant and clip the leaf at the base of the petiole. In large numbers it will completely encircle the crown of the beet and will chew through the crown of the sugar beet. Registration for an insecticide, Counter, has just been received for the control of crown borer.

BRAUN, ALEXINE. American Crystal Sugar Company, Research Center, 1700 North 11th Street, Moorhead, MN 56560. - Cryopreservation of sugar beet germplasm.

Conserved germplasm ensures the availability of genetic material at a later date. Of several means of germplasm preservation, only freezing at ultra-low temperatures (in LN) can ensure long-term storage of material under conditions of genetic stability. Cryopreservation has been successfully applied to meristems of several species in recent years. Sugar beet meristems were aseptically isolated from shoots developed on sugar beet (Beta vulgaris L.) inflorescences precultured on modified MS agar medium containing 19.4 μM 6-benzyl-aminopurine, 6 μM trifludobenzoic acid, and supplemented with 5% DMSO. After two days the meristems were transferred to liquid, modified MS medium and the cryoprotectants sorbitol and DMSO added in varying concentrations. The meristems were frozen to -40°C and stored in liquid nitrogen. Growth resumed when the meristems were quick-thawed at 39°C and cultured on modified MS medium.

BRAVO, SIMON, G.S. LEE and W.R. SCHMEHL*. Department of Agronomy, Colorado State Univ., Ft. Collins, CO 80523. - Effect of planting date and nitrogen fertilization on the seasonal concentration and total content of six micronutrients in sugar beet. Concentrations and total contents of six micronutrients (Fe, Zn, Cu, Mn, B, Mo) were determined in the leaves, petioles, crowns and roots of sugar beet (Beta vulgaris) grown under field conditions in Colorado. Three levels of N fertilizer (0, 100 and 300 lb/A) and two planting dates (April 22 and May 27) were imposed. Plants were harvested at approximately two-week intervals from July 12 through September 27, then a final harvest October 18. Increasing the rate of N increased the average seasonal concentration of B in the plant, decreased concentrations of Fe and Mn, but had little affect on Cu, Zn and Mo. The early planting increased the average concentration of Mn, B and Mo in the plant but decreased concentrations of Fe, Zn, and Cu. Concentrations of Fe, Zn, Cu and Mo in all plant parts, B in the blades, and Mn in the crowns and roots decreased as the season advanced. Concentrations of B and Mo in the four plant parts decreased in the order: leaves, petioles, crowns, roots. Fe, Zn, Mn decreased in the order: leaves, crowns, petioles, roots. The highest concentration of Cu was in the crowns. The maximum total plant content and the date for each micronutrient are: Fe (1.80 lb/A, August 9); Zn (0.10 lb/A, July 29); Cu (0.07 lb/A, August 23 and October 18); Mn (0.68 lb/A, August 23 and October 18); B (0.31 lb/A, September 27); Mo (1.3 g/A, August 9).

BRIMHALL, PHIL B.*, and R. C. ZIELKE. Chief Agronomist and Director of Research respectively, Michigan Sugar Company, P.O. Box 107, Caro, MI 48723. - Determination and effect of beet population on beet quality and yield.

Field tests were conducted in Ohio and Michigan to determine the effect of various, uniform and random beet populations. In addition, the best population of all grower contracts was determined by counting beets in tare samples, calculating the average weight per beet and dividing that number into the average pounds of beets per acre. The number of beets per acre at harvest time had a marked effect on beet quality and yield. Harvested beet populations were considerably less than spring or fall beet counts.

BROPHY, ROBIN M., American Crystal Sugar Company, Research Center, 1700 North 11th Street, Moorhead, MN 56560. - Evaluation of laser particle sizing technology for incorporation into online pan control.

Laser based particle analysis techniques will be studied to determine if the technique is valuable in providing real-time crystal size measurement, size variation, number of crystals (6 crystalization), and growth rate information. Whether this instrumentation can be incorporated into pan control as primary sensing replacing inferential measurements like: conductivity, bulk dielectric constant, radiometric density, and techniques which derive supersaturation will be explored.
BUGGEE, WILLIAM M. *, and L. G. Campbell. USDA, Agricultural Research Service, P.O. Box 5677 - Univ. Stn., Fargo, ND 58105 - Dual resistance in sugar beet to Rhizoctonia solani and Phoma betae.  

R. solani is a soil-borne fungus that causes crown and root rot of sugar beet. Phoma betae is a seed and soil-borne fungus that causes storage rot of sugar beet. Genetic resistance to each pathogen has been independently developed in two separate programs. Three replicated greenhouse trials revealed sugar beet germplasm lines that had been developed for resistance to R. betae also possessed resistance to R. solani. This dual resistance was confirmed in a field test where a known amount of inoculum of R. solani was applied to crowns in early July. The root-rot resistant germplasm FC-712 was most resistant with a disease index (DI) of 0.98 (scale 0, dead - 7, healthy) followed by the storage-rot-resistant lines F1002 (DI, 2.68) and F1004 (DI, 2.8) and the R. solani-resistant cultivar ACH 139 (DI, 3.47). The susceptible cultivar Momohikari had a DI of 6.28. The same ranking held with respect to stand loss. F1002 is a selection from root-rot resistant FC-701/4 and F1004 is a selection from a storage-rot-resistant Soviet introduction.

BURA, MANFRED, Institute for Plant Breeding, KWS Kleinwanzlebener Saatzucht AG, P.O. Box 146, D-3352 Einbeck, FRG. - Genetic Manipulation with Sugarbeet. Genetic engineering is expected to become a powerful tool to manipulate plants in plant breeding. This new technique should be particularly successful in improving breeding characters which are determined by single genes. This is true among others for resistance to several diseases and agrochemicals. As far as sugarbeets are concerned projects for virus resistance (e. g. Beet Necrotic Yellow Vein Virus = BNYVV/Rhizomania) and herbicide resistance are actually in progress. In the case of herbicide resistance, transgenic sugarbeet plants have already been obtained from transformed callus lines in the greenhouse. These plants contain a bacterial gene whose translation product detoxifies the herbicide BASTA (Phosphinothricin) by acetylation. The most promising strategy to control BNYVV follows the “coat protein (CP) concept” which has been recently shown to function against Tobacco Mosaic Virus and some other plant viruses. At present a series of expression vectors are available for transformation experiments with sugar-beet tissue. These advanced constructs are T*-plasmid-derived binary vector systems with plant specific promoters (e. g. P 35S from CMV), a selectable marker gene (e. g. for kanamycin), and the CP-gene from the BNYVV RNA-2, respectively. As a final result of all our efforts in plant genetic engineering we hope to develop complete resistance to BNYVV in commercial sugarbeet varieties.


Populations of the southern garden leafhopper, Empoasca solana DeLong, have become more prevalent in sugarbeets during the past four years. Studies were initiated in 1986 to: 1) Determine the impact of leafhopper populations on sugar beet production; 2) Develop a practical population sampling method for use in the field; 3) Evaluate seasonal activity of the leafhopper; 4) Determine what leafhopper population level represents a control threshold; and 5) Determine what insecticides provide effective reduction of leafhopper populations. Leafhopper populations were monitored using a suction sampling device and by leaf sampling. These evaluations provided data on seasonal activity of leafhopper populations, the development of leaf sampling method for use in the field, and the use of a treatment threshold based upon the number of leafhopper nymphs found per leaf. It was found that sugarbeet, and sugar yields were increased where leafhopper populations were reduced. Several insecticides were found to provide effective reduction of the leafhopper population.

CAMPBELL, LARRY G.*, and W. M. Bugbee. USDA, Agricultural Research Service, P.O. Box 5677 - Univ. Stn., Fargo, ND 58105. - Inheritance of storage-rot resistance.  

Lines resistant to prevalent storage-rot fungi are available; however, little is known about the inheritance of storage-rot resistance in sugar beet (Beta vulgaris L.). The storage-rot resistant lines F1004, F1005, and F1006 were crossed with seven genetically diverse CMS lines. The resultant hybrids exhibited higher levels of resistance to Phoma betae (Oud.) Frank and Botrytis cinerea Pers. than their CMS parents but were not as resistant as the rot-resistant pollinators. Hybrids with SP 69550-01 and FC 708 CMS were more resistant than hybrids involving the other CMS lines. Sucrose concentration of the susceptible/resistant hybrids was equal to the commercial hybrids and clear juice purity was slightly below that of the commercial hybrids. No negative association between storage-rot resistance and yield was detected.
CATTANACH, ALLAN W.* and L. J. SMITH. Extension Sugarbeet Specialist, N.D. and U. of Mn. Extension Services, 203 Waldron Hall, Fargo, ND 58105 and Superintendent, Northwest Experiment Station, University of Minnesota, Crookston, MN 56716. - Influence of uniformity of in-row plant spacing and plant population on sugarbeet yield and quality. Part I - Objectives, materials and methods. Sugarbeet yield and quality is directly affected by plant population at thinning and harvest. Many growers desire to reduce production costs by planting to a final stand thus eliminating the need for a mechanical or hand thinning operation. Due to limitations of sugarbeet planters, seed variability and unpredictable environmental conditions, planting to a final stand often results in very non-uniform plantings in the sugarbeet row. Controversy exists about the impact of non-uniform in-row plant spacing on sugarbeet crop harvestability, yield, quality and storability of beet roots. Populations of 23,760, 29,700, 35,640, 41,580 and 47,520 plants per acre were established at Fargo, ND and Crookston, MN in 1986, 1987 and 1988. At each plant population four computer generated in-row spacing arrangements were established. In-row spacings included doubles and triples and in-row skips up to three feet in length. Parameters measured included root yield and quality, post thinning stand loss, % harvestable roots and root size. Only minor significant yield differences were observed between the uniform and non-uniform in row spacing comparisons at populations of 41,580 plants per acre or less.

CHRISTENSON, DONALD R. Crop and Soil Sciences Department, Michigan State University, East Lansing, MI 48824. - Sugar beet yield trends as affected by cropping systems.
A cropping systems study involving corn (Zea mays L.), oats (Avena sativa L.), dry beans (Phaseolus vulgaris L.), and sugar beets (Beta vulgaris L.) was established in 1972. Relative yield (annual system mean/annual experimental mean) was compared with year using linear regression to evaluate yield trends from 1975-1985. A slope significantly different from zero was used to indicate a significant trend. Significant yield trends for sugar beets were 1.00% per year for the corn-dry bean-sugar beet system, a negative 0.89% per year for the corn-sugar beet system and a negative 1.36% for the corn-corn-sugar beet system. The negative trend for sugar beets following corn appears to be caused by an antagonistic effect between the carryover of the herbicide cyanazine from corn and pyrozon plus TCA applied to sugar beets.

CLUFF, JOHN R. The Amalgamated Sugar Company, P.O. Box 127, Twin Falls, ID 83301. - Statistical process control in the sugar factory.
The principles of statistical process control (SPC) and its related statistical quality control (SQC) are already commonly practiced in the food industry. Major industrial sugar users are now requiring their suppliers to implement SPC. The Amalgamated Sugar Company has implemented an SPC program that has proven beneficial to its operation and has been accepted by all customers to whom presented. Microcomputer data are manipulated by microcomputer and are used to produce run charts, control charts, X-bar and R charts and certificates of analysis. This has been accomplished without resorting to expensive hardware, commercial software or outside consultants. Further implementation of SPC to the operator level is underway.

The control of microbiological organisms in the processing of sugar beets continues to be an elusive goal for the beet processor. This paper presents the best, current recommendations based on the authors observations for such control, using several biocides in combination. It alters and brings up to date suggestions originally presented by Mazer Chemicals to the ASSBT in San Diego in 1985 and at Phoenix in 1987.

The quality aspects: care, sugar content, sodium, potassium, and amino-nitrogen and frost damage have been studied and quantified. The economical significance of the parameters will be different for different countries and companies, but the philosophy (and the method) has a general applicability. A payment system, based on the parameters mentioned, has been developed and put
into practice in the campaign 1988. Because better feed stock for a factory means cheaper production, the calculated economical value is paid for on a bonus/malus basis.

Provided that the grower can improve the quality at a lower expense than the factory can afford to pay as premium for better quality, both grower and factory can benefit from the payment system.

Dexter, Alan G.*. Department of Crop and Weed Sciences, North Dakota State University and the University of Minnesota, Fargo, ND 58105. - Stinger (clopyralid) on sugar beets in North Dakota and Minnesota.

Stinger (clopyralid) is a postemergence herbicide recently registered for weed control in sugarbeets in the United States. Stinger controls only a few weed species but has been effectively controlled by Stinger often can not be selectively controlled by other herbicides in sugarbeets. Problem weeds in Eastern North Dakota and Minnesota controlled by Stinger include Canada thistle, common cocklebur, marshelder, and wild buckwheat. Wild buckwheat control by Stinger in 1988 was less than in previous years, perhaps due to the droughty conditions in 1988. Tank-mixtures of stinger with B-273 (endothall) gave wild buckwheat control superior to Stinger alone. Poast (sethoxydim) and Betanex (desmedipham) also were tank mixed with Stinger to give more broad spectrum weed control. Stinger plus Poast plus Dash (adjuvant from BASF) gave grass control similar to Poast plus Dash. Thus, Stinger is one of the few broadleaf control herbicides which does not antagonize grass control from Poast when applied as a tank mixture. Stinger plus Betanex gave sugar beet injury similar to Betanex alone and additive annual weed control. Stinger at 0.25 lb/A or Poast plus Dash at 0.25 lb/A plus 1 qt/A applied to hand weeded sugar beets caused no loss of extractable sucrose per acre compared to untreated, hand weeded sugarbeets. However, Stinger plus Poast plus Dash at 0.25 lb/A plus 0.25 lb/A plus 0.25 lb/A caused a significant reduction in extractable sucrose per acre compared to the untreated, hand weeded check. Stinger plus Poast plus Dash gave, or tended to give, broadleaf annual weed control superior to Stinger alone.


Extensive variation was measured within and between 16 sugar beet populations for frequencies of callus initiation and shoot regeneration, time to callus initiation and time between callus initiation and shoot regeneration. When tested on MS medium with 1 mg/L benzyladenine (BA), leaf discs from expanding leaves of 59 of 78 plants, representing all 16 populations, initiated callus. Of these, 35 plants from 11 populations regenerated shoots on that callus without transfer. Significant variation among plants within populations should allow identification of individuals capable of shoot regeneration in generally unresponsive but otherwise elite populations. Genotype x medium interaction was evaluated in an effort to increase the range of sugar beet germplasm capable of shoot regeneration. Increased levels of BA, as well as inclusion of certain concentrations of gibberellic acid or napthaleneacetic acid, increased the frequency of callus and shoot production in some genotypes. Some genotypes produced buds on callus appearing on hormone-free medium. In some cases, it has also been possible to reduce the time to callus initiation. Clustering germplasm sources into response types is proposed as an aid to efficiently increasing the range of sugar beet germplasm which can be regenerated from callus. Each response type may require a different medium for optimum regeneration.

Doney, Devon L.* and E. D. Whitney. USDA, Agricultural Research Service, P. O. Box 5677 - Univ. Str., Fargo, ND 58105 and 1636 E. Alisal Str., Salinas, CA 93905 - Beta maritima (sea beet) germplasm in England, Wales and Ireland.

The collection and evaluation of exotic germplasm has received increased attention in recent years due to the gradual elimination of natural habitats and the need for new stress resistant genes. This is particularly true of Beta maritima (sea beet). This report reviews the 1987 exploration of Beta maritima along the sea coast of England, Wales and Ireland. Areas of distribution are compared to previous sitings. Most plants occur in a narrow band between high tide and 10 to 20 meters inland. Plants were most prevalent on shingle (gravel) beaches. In general, the distribution of sites in 1987 was similar to previously reported distributions. In areas of large populations, no extinction is threatened; however, areas of small populations are threatened and some have already been eliminated. Extinction factors include livestock grazing, particularly sheep, slippage of mud cliffs, industrialization, sea ports, and recreation activities such as cement sea walls, parks and beaches. Other factors such as high tide, wind, animals and man are operating as dispersal agents.
FORD-LLOYD, BRIAN V., I. GODWIN, G. TODD, T. NAGAMINE and H.J. NEWBURY. School of Biological Sciences, University of Birmingham, P.O. Box 363, Birmingham B15 2TT, U.K. - Genetic variation in sugar beet and its consequences in tissue culture and genetic transformation.

Sugar beet breeding material, and that of other cultivated beets, is highly genetically variable. This can be demonstrated most clearly by RFLP analysis using cDNA probes and also by employing a range of isoenzyme markers. Response in tissue culture is also apparently genetically variable both within and between varieties and this includes protoplast yield, callus initiation, adventitious regeneration from callus and somatic embryogenesis in suspension cultures. Different strains of wild type Agrobacterium show differing levels of virulence when interacting with a range of beet genotypes. No beet genotype tested so far has proved resistant to every bacterial strain. Consequently, most programmes involving the manipulation of sugar beet varieties in culture require an initial screening of individuals to select genotypes most responsive to the treatments applied.

FORSSTROM, K. JAMES, and STEPHEN D. MILLER. University of Wyoming, Univ. Station Box 3295, Laramie, WY 82071. - Comparison of sugar beet planters and planting depth with two sugar beet varieties.

Planting sugar beets to stand requires a uniform, predictable and preferably high emergence rate. The objective of this study was to compare emergence rates of two varieties of sugar beets planted with four planters operated at two planting depths. The study was conducted in 1987 and 1988 at Torrington, WY. Sugar beets planted with a John Deere MaxiMerge planter or with a Milton planter with depth bands had 10 percent higher emergence than when planted with a John Deere 71 planter or a Milton planter with depth wheels. Plant spacing uniformity was poorest with the John Deere MaxiMerge planter. Sugar beets planted at the shallower depth (3/4 inch) had 8 percent higher emergence when compared to those planted at the deeper depth (1 1/4 inch) in 1988 but depth had no influence in 1987. Monochikari variety had 9 percent better emergence than Holly Hybrid 30 variety for the two years of the study.

FORSSTROM, K. JAMES, STEPHEN D. MILLER and JAMES M. KRALL. University of Wyoming, Univ. Station Box 3295, Laramie WY 82071. - Transplanted and seeded sugar beets with reduced tillage.

Reduced energy requirements and wind and water erosion control are the principle advantages of reduced tillage. However stand establishment, weed control and furrow irrigation are sometimes a problem when employing reduced tillage systems for sugar beets. The objective of these studies is to compare transplanted sugar beets with sugar beets planted to stand using chisel and no-till reduced tillage systems. Studies with sprinkler and furrow irrigation are being conducted at Torrington, WY. The systems have evolved to include preplant herbicide application (ethofumesate plus diethanil), shallow strip tillage, postemergence herbicide application (demon then plus phemethal) as needed, and cultivation and ditching. Agritech Corporation establishes the transplants. They have modified their transplanters to handle residue and establishment success equals that obtained in conventional tillage. Direct seeding has been successful since the initiation of strip tillage, resulting in plant populations of 24-35,000 plants/A. No sugar beet yield differences have been found between the two tillage systems. In 1987 transplanted sugar beets yielded 7 tons/A more than seeded sugar beets. In 1986 transplants were frozen with a 12°F freeze four days after establishment. Yields of the re-transplanted sugar beets were the same as for the sugar beets seeded six weeks earlier.

FOwers, MICHAEL J. The Amalgamated Sugar Company, P.O. Box 127, Twin Falls, ID 83301. - Observations on control of microorganisms in the diffuser loop.

Efforts to reduce process losses due to bacterial degradation of sucrose within the diffuser loop have been evaluated. Several operating schemes were examined with variables including temperatures, use of a single biocide and combinations of biocides, and dosage frequencies. 35% formalin, carbamates, chlorine dioxide, liquid sulfur dioxide, and ammonium bisulfite were evaluated as microbiocidal agents. Evaluation methods included determination of nitrates, dextran, lactic acid, invert, and standard plate counts. It was observed that invert levels are appreciably higher at 45°C to 60°C. This indicates that the majority of invertase present is that produced by bacterial infections since those invertases are more heat stable than beet derived invertases as described by Bucholz et al (Zuckerind, 112: 792-795, 1987). It was also observed that, excluding CH₂O, liquid sulfur dioxide is the most effective, alternate biocide when added to pulp press water and the cossette mixer. Additional microbiocidal benefits may be obtained by manipulation of press water and diffuser supply water temperatures.
Sugar and Beet Shrink are a major expense to the processor and growers in Eastern Wyoming. Extremes in the weather pattern and harvesting during warm weather have been a concern. During the summer of 1988, a pile ventilation experiment was approved with the goal of comparing a 20,000 ton ventilated pile with a non-ventilated pile of equal tonnage. The experiment was conducted during the recently completed harvest. Forced air through duct work has cooled the ventilated pile to 33 degrees. The piles are being monitored daily and processed results of the piles will be calculated when the piles are processed in January with the ultimate goal of reducing sugar shrink.

GALLIAN, JOHN J., S. K. KOBER, R. R. REASONER, and C. E. BURT. University of Idaho, 1330 Filer Ave. East, Twin Falls, ID 83301, and West Coast Beet Seed, P. O. Box 717, Salem, OR 97308. - Spatial occurrence of *Polymyxa betae* and *beet necrotic yellow vein virus* in California sugarbeet fields.

The use of doubled haploids in the beet breeding program.

GERIK J. S.*, and J. E. DUFFUS. USDA, Agricultural Research Service, 1636 E. Alisal St., Salinas, California 93905. - Spatial occurrence of *Polymyxa betae* and beet necrotic yellow vein virus in California sugarbeet fields.

The spatial occurrence of beet necrotic yellow vein virus (BNYVV) and *Polymyxa betae* in sugarbeet fields located in the San Joaquin Valley and Imperial Valley of California was investigated. Fields thought to be recently infested were chosen for the study. Soil samples were collected from one acre sectors using a stratified random sampling method. Seeds of sugarbeet were planted in these soil samples and grown for 8 weeks. The occurrence of BNYVV in roots of seedlings was determined by ELISA and that of *P. betae* microscopically. Ordinary runs analyses were performed on the data to determine if the distributions were clustered either down or across the rows. The occurrence of BNYVV was variable; some fields were totally infested, others were only slightly infested. Clustered patterns were more frequent down rather than across the rows indicating movement of the virus with irrigation water. One field in which no known symptoms of rhizomania on beets had ever occurred was totally infested with BNYVV, indicating the possible association of soil differences between the infested and non-infested areas. Rhizoplane microflora were found to differ between these areas.

GILL, NIELS H., Maribo Seed, P.O.Box 29, DK-4960 Holeby, Denmark. - The use of doubled haploids in the beet breeding program.

The inbreeding in terms of selfings or continued paircrossings is used in the breeding program of most companies. Since the sugar beet, *Beta vulgaris* L., is a cross pollinated species with a two year life cycle, this inbreeding procedure takes several years and the material often suffers from severe inbreeding depression. One way to cut down the time consumption in inbreeding is by means of doubled haploids. The Maribo Seed company uses unfertilized ovules from the seed plants of sugarbeet to produce the haploid plantlets, which then later are chromosome doubled with colchicine. Out of 1,000 ovules taken from seed plants about 200 will turn into haploid plantlets in the tubes. Out of those 200 plantlets, about 100 will respond to colchicine treatment and become doubled haploid beets in the greenhouse. The doubled haploid plants are then selfed, but the amount of plants with sufficient seed setting is very much depending on the degree of seed fertility in the material. From yield trials the results so far show that the selected doubled haploids, of diploid monogerm, have root weights varying from 30 percent to 87 percent of normal varieties, whereas testhybrids from the same doubled haploids yields between 95 percent and 99 percent.

GERIK J. S.*, and J. E. DUFFUS. USDA, Agricultural Research Service, 1636 E. Alisal St., Salinas, California 93905. - Spatial occurrence of *Polymyxa betae* and beet necrotic yellow vein virus in California sugarbeet fields.

The spatial occurrence of beet necrotic yellow vein virus (BNYVV) and *Polymyxa betae* in sugarbeet fields located in the San Joaquin Valley and Imperial Valley of California was investigated. Fields thought to be recently infested were chosen for the study. Soil samples were collected from one acre sectors using a stratified random sampling method. Seeds of sugarbeet were planted in these soil samples and grown for 8 weeks. The occurrence of BNYVV in roots of seedlings was determined by ELISA and that of *P. betae* microscopically. Ordinary runs analyses were performed on the data to determine if the distributions were clustered either down or across the rows. The occurrence of BNYVV was variable; some fields were totally infested, others were only slightly infested. Clustered patterns were more frequent down rather than across the rows indicating movement of the virus with irrigation water. One field in which no known symptoms of rhizomania on beets had ever occurred was totally infested with BNYVV, indicating the possible association of soil differences between the infested and non-infested areas. Rhizoplane microflora were found to differ between these areas.
GILES, JOSEPH F., and N. R. CATTANACH. Department of Soil Science, North Dakota State University, Fargo, ND 58105. - Evaluation of commercial sugarbeet planter units in the Minnesota and North Dakota.

Seed metering performance of individual sugarbeet planter units was evaluated on a planter test stand in 1987 and 1988. Approximately 300 growers participated each year with 95 percent testing all 12 of their planter units. The majority of the units tested were John Deere (Flex, Maximerge and Maximerge II) and Milton. Additional types evaluated were International (100, 200, 800 and 900 series), Heath and Nodet Gouquis. Seed spacing and ground speed were set according to individual preference. Seed was metered on to a revolving grease belt. Uniformity of seed spacing and amount of seed damage were evaluated. If results were unsatisfactory to the grower, the planter unit was examined for worn or defective parts and improper adjustment and corrections were made. Inferior units were found among almost every set of twelve tested. Increasing ground speed resulted in non uniform seed spacing with all planter types. Improved planter performance was observed with proper grower maintenance.

GILES, JOSEPH F., A. W. CATTANACH, L. J. SMITH and N. R. CATTANACH. Department of Soil Science, North Dakota State University, Fargo, ND 58105 and University of Minnesota-Crookston, Crookston, MN 56716. - Effect of planter ground speed and seed spacing on sugarbeet production.

A major problem in sugarbeet (Beta vulgaris L.) production is the establishment of an adequate number of evenly spaced plants. Sugarbeet plant spacing is determined by the performance of the sugarbeet planter, quality of sugarbeet seed and the environment. Performance of different types of sugarbeet planter units was evaluated on a planter test stand. Increasing ground speed reduced the seeding percentage of each planter type. Field studies were established in seedbeds of different soil texture at different moisture levels using a John Deere 71 Flex planter operated at two ground speeds and two seed spacings. Seed emergence percentage was affected by ground speed in the lighter texture soils, particularly with low soil moisture. A slower ground speed resulted in a significant increase in root yield, sugar percentage and recoverable sugar. Sugar production was significantly reduced by increasing the seed spacing in late plantings.

GODSHALL, Mary An*, M. A. CLARKE, C. D. DOOLEY, and R. S. BLANCO. Sugar Processing Research, Inc., P. O. Box 19687, New Orleans, LA 70179. - Progress in beet sugar colorant research at S.P.R.I.

Beet sugar colorant is composed of a mixture of colorant types, distributed between the surface of the crystal and the inner crystal structure. This study describes the distribution of phenolic, amine and high molecular weight (MW) components of colorant in U.S. white beet sugars and the changes that can occur on storage. High MW colorant (greater than 12,000 daltons) represents 12-30% of the total color, and in some sugars can be much higher. Determination of this type of colorant by gel permeation chromatography (GPC) is described.

Observations that indicate that color development on storage is related to reactions occurring on the surface of the sugar crystal are reported.


The population dynamics of Heterodera schachtii on sugarbeet was affected by differences in chemical control and plant growth. Microplot studies involving nematicides showed 1,3-D, at 168 kg/ha, reduced nematode P1 of 344, 766, and 1126 eggs and 32/100 cm² soil by 90, 92, and 93%. There were 1, 3, and 3%, and 6, 6, and 7%, of the P1 recovered from 1,3-D treated plots, 5 and 15 cm from the center of the row, 28 days after planting. This compared to 31, 34, and 36%, and 52, 53, and 56% for aldicarb (5.6 kg a.i./ha); and 34, 37, and 38%, and 66, 67, and 68% for untreated plots. Nematode population densities were significantly less in the 1,3-D treated than in the aldicarb treated plots until after 3 nematode generations and 1212 degree-days with a base of 8 °C (DB). The greatest sugarbeet yield and nematode P1 after 1364 DB degree-days were recovered from 1,3-D plots at a P1 of 344 eggs and 32/100 cm² soil. Lowest sugarbeet yield and P1 were recovered from untreated control plots at a P1 of 1126 eggs and 32/100 cm² soil.
HAFEZ, SAAD L. and K. HARA. University of Idaho, SW Idaho Research and Extension Center, Parma, ID 83660. - *Heterodera schachtii* populations can be reduced by planting a trap crop or applying low rates of Temik to rotation crops.

It is known that host root exudates or a low concentration of carbamate nematicides can stimulate hatching of the cyst nematode. If the larvae hatch and there is no susceptible host for them to feed on, they will die from starvation. In these studies, low rates of Temik (1.7 and 2.2 kg ai/ha) were applied to fields of dry beans and sweet corn heavily infested with sugarbeet cyst nematode. Also, the German radish variety RS01841, which is used in Germany for animal feed, was grown for 10 weeks in sugarbeet fields heavily infested with the sugarbeet nematode. Results suggest that treating with low rates of Temik in the rotation crops (beans and corn) or planting the German radish variety RS01841 reduced the cyst nematode population more than 50% when beets were again planted in the rotation.

HALLON, JOHN M. USDA, Agricultural Research Service, P. O. Box 1633, East Lansing, MI 48826-6633. - Interactions between Rhizoctonia solani and temperature influence the localization of phenolic compounds within infected sugarbeet roots. Most infections of sugarbeet roots by *Rhizoctonia solani* (AG 2-1) develop during the warmest part of summer. As temperatures moderate, infection sites become surrounded by a brown layer of phenolic materials. In this study the relationships between temperature, infection by *R. solani*, and the formation of phenolic materials within sugarbeet roots were examined. Infections established rapidly at 30°C, whereas there was little evidence of root infection at 15°C. Inoculated roots were first incubated at 30°C for 2 weeks, then were transferred to 15°C. Fungal advance through tissues ceased after transfer to the cooler temperature. Next, roots were incubated first at 15°C for 2 weeks, then were transferred to 30°C; there was no evidence of infection. Roots that were incubated first at 30°C for 2 weeks, followed by 3 weeks at 15°C, then returned to 30°C, had few (2 of 8) infections that were able to reestablish within 2 weeks. Inoculated roots incubated at 30°C had deposits of oxidized phenolics (condensed tannins) within necrotic tissues, but there was no histochemical evidence for the presence of reduced phenolics. In contrast, the roots with no successful colonization or the roots in which disease progress had ceased, had heavy deposits of both oxidized and reduced phenolic materials at the boundary between healthy tissue and diseased or inoculated tissue. Phenolic compounds in the reduced state may constitute an antimicrobial barrier to the fungus.

HALLON, J. M.*, USDA, Agricultural Research Service, P. O. Box 1633, East Lansing, MI 48826-6633; and E. J. POTCHEN and R. A. MILLER, Dept. of Radiology, Michigan State Univ., E. Lansing, MI 48824. - Nuclear magnetic resonance imaging as a tool for anatomical and developmental studies of sugarbeet roots. Methods used to study structure and developmental changes within roots normally are destructive, thereby precluding study of developmental processes within individual roots. Proton nuclear magnetic resonance (NMR) imaging may offer the potential for nondestructive study of roots. We studied the utility of NMR for imaging internal structure of healthy and *Rhizoctonia solani*-infected sugarbeet roots. Healthy roots showed extremely high contrast between the vascular and the parenchyma layers of rings within roots. Parenchyma layers appear very light, whereas vascular layers are dark. Similar NMR images of table beets are grey with low contrast between tissues. NMR images of sucrose gradients in test tubes reveal obvious signal intensity differences between concentrations. Higher sucrose concentrations gave more intense signals. Overall, relative NMR image intensities agree closely with previous reports on the distribution of sucrose in sugarbeet roots. Images of *Rhizoctonia*-infected roots have a very dark area at the advancing front of an infection. However, infected tissues behind that front have the high contrast within rings that is typical of healthy tissue. NMR imaging is useful for the nondestructive study of sugarbeet root anatomy, development, and disease development; and may prove valuable for monitoring some chemical changes within sugarbeet roots.

HECKER, R. J.*, and M. E. MCCCLINTOCK. USDA, Agricultural Research Service, 1701 Center Ave., Fort Collins CO 80526. - Pollen as a tissue for assay and selection in sugarbeet. Pollen is a tissue that needs to be tested for potential for genetic assay and selection in vitro. We used sugarbeet pollen as an assay tissue by exposing pollen to off-the-shelf enzymes known to be produced by *Rhizoctonia solani*. Pectinase, pectolyase, and cellulase each enhanced in vitro germination of pollen from
Rhizoctonia root rot susceptible plants compared to pollen from resistant plants. Pollen tube growth rates and tube lengths were not different. There was less ion leakage from pollen of susceptible plants than from pollen of resistant plants into media augmented with low concentrations of pectolase, as measured by conductivity. When explanted on auxin-free media, explants from resistant plants showed differences for leakage of potassium and magnesium ions. In the case of pectolase, there was more potassium leakage from resistant pollen as measured by ICP, as well as by emission spectroscopy, but conductivity was lower than that from susceptible pollen. The discriminatory power of these tests for resistance is not completely known. Selection in sugarbeet pollen was attempted for cold tolerance (4 cycles) and salt tolerance (1 cycle). We have some evidence that low temperature challenge of the gametophyte resulted in faster emergence of progeny seedlings in 10° soil. One cycle of salinity challenge of pollen (about LD 95) is being evaluated for change of salinity tolerance of the resulting progeny.

Helge, John M. Nalco Chemical Company One Nalco Center Naperville, IL 60566

Practical application of SPC and quality improvement.

Presentation will consist of a general discussion of the concept of quality as defined by the widely accepted Crosby principles. Using slides we will discuss how these concepts are used to create an environment in the workplace to conform to requirements and foster a zero-defect mentality. The tool used to measure progress in quality is Statistical Process Control. We will discuss how to best utilize this tool to achieve a total quality system. Using a unique computer software and actual data from operating beet sugar factories we will illustrate some techniques to use to reduce and control process variability.


Ceecoza & L. Connection is the single most important disease affecting sugarbeet production in the Red River Valley. The intensity and spread of the disease is strongly influenced by warm temperatures and high humidity. Usually several fungicide applications are needed to control the disease. In the past, fungicide spraying was started in early July and continued on a regular 10-14 day schedule throughout the growing season. The "calenad" spray program was effective in disease control but was expensive and inefficient. In an effort to reduce grower production costs while still providing effective disease control, American Crystal developed a Ceecoza advisory system. Initially, the system involves field monitoring and the use of automated remote weather stations located in each factory district. A central computer at the Research Center acquires the 24 hour temperature and humidity data and calculates the daily infection value based on the University of Minnesota Ceecoza production model. The computer transmits the data to each factory office via a facsimile machine at 8:00 A.M. daily. The Factory Agricultural staff issues a Ceecoza advisory to area growers via telephone records. The advisory includes the 2 day infection value, progress of disease development and whether or not a fungicide application is recommended at that time. The Ceecoza advisory system has been proven to be an effective and economic method of disease control. The Company's Agriculture Department records show that the number of fungicide applications has been reduced by 1.5 since the program has been in effect. This represents a $2.2 million annual saving to Red River Valley beet sugar growers.


Habituation is the phenomenon by which plant cells acquire the ability to grow without exogenously supplemented growth substances. The autonomous growth of habituated tissue is believed to result from enhanced endogenous levels of cytokinins and auxins. The physiological basis of autotrophic growth was studied by quantifying the internal physiological levels of cytokinin and auxin in habituated sugarbeet tissue (line 3). IAA was analysed by HPLC equipped with an on-line spectrophotometer. Cytokinins were quantified by means of RIA. The endogenous cytokinin concentration enhanced during callus induction (from 5 to 55 pmol/g fr. wt.) but decreased and remained low in the course of the habituation process. Likewise, auxin concentrations were low during this process except for the fully habituated tissues (from 6 to 200 pmol/g fr. wt.). Gradual decrease of auxins induces, habituation while direct omission causes cell death. These results seem to indicate that auxins are important for maintaining the growth of sugarbeet callus.
Rhizomania continues to spread among sugarbeet fields in California. More than 75,000 acres of farmland in California are now known to be infested with rhizomania. In 1988 the pathogens were detected for the first time in soil from the Imperial Valley. One of the best methods of rhizomania control has been avoidance of the disease through soil tests. During the last 6 years growers' soil samples have been assayed for beet necrotic yellow vein virus (BNYVV). BNYVV is detected in the samples with a bioassay. Beet seed is planted in the soil samples and allowed to grow for 8 weeks, in which time they may become infected with BNYVV. The virus is detected in the root tissue by ELISA. During the years 1986-1988, 4284 soil and tissue samples, representing 1435 fields and 102,800 acres have been assayed; 40% of these samples representing over 43000 acres were positive for BNYVV, while 75% of these samples were positive for the vector, Polymyxa betae. By avoiding infested fields growers are able to reduce yield losses due to rhizomania. Yield data from 1986 indicate disease losses were reduced by 25%, or by an average of 1.5 tons of sugar per acre. This translates to more than a $600 per acre additional gross value compared to diseased fields. The assay produced false positive results at a rate of 12% and 0 - 18% false negative results. New testing procedures have been implemented to minimize the false results.

KEARNEY, MICHAEL. The Amalgamated Sugar Company, P.O. Box 127, Twin Falls, ID 83301. - A technique for fitting the equation Z=f(x,Y) linear in x, nonlinear in y and some interesting applications.

Ordinary tools for curve fitting experimental data include linear, polynomial, logarithmic, exponential and multilinear methods. A procedure for fitting functions linear in one variable and nonlinear in another has been developed by TASCO and has been used frequently in our research work. Extensive sucrose density tables can be represented with relatively simple functions using this method. Certain mixtures of carbohydrates can be evaluated for percent composition using these types of functions based on polarimeter and refractometer measurements.

KERR, ERIC D.* and J. G. ROBB. University of Nebraska, Panhandle Research and Extension Center, 4502 Ave. I, Scottsbluff, NE 69361. - Comparison of Heterodera schachtii egg populations to yield of sugar beet in commercial fields of Nebraska.

Threshold population levels of Heterodera schachtii Schmidt on sugar beet, Beta vulgaris L., vary among geographic areas of sugar beet production. Decisions to utilize nematode control practices based on the use of egg and larva counts from soil samples in the western Nebraska production area is limited by lack of an established threshold level for that region. Nematode PI were determined from soil samples collected at planting time at 15 m intervals along two strips in two commercial sugar beet fields located near Bayard and Mitchell, about 50 km apart. Both fields were Trip very fine sandy loam and furrow irrigated with surface water. The regression of yield (Y) in metric tons as a function of eggs and larvae/cm 3 of soil (X) was Y = 66.49 - 6.47X and Y = 67.26 - 2.40X at Bayard and Mitchell, respectively. The r coefficients were -.67 and -.77 at Mitchell and Bayard, respectively. No significant relationship between egg and larva counts and percent sugar was found. Economic thresholds for each location were estimated based on the current contract and costs for representative sugar beet growers in the area. Threshold estimates were 1.15 and 2.65 eggs and larvae/cm 3 of soil for Bayard and Mitchell, respectively.

Kienzle, William B. and Chadwick, Thomas C. Holly Sugar Corporation, Betteravia Plant, 2820 W. Betteravia Road, Santa Maria, CA 93455. - Spot test to confirm the presence of potassium imidodisulphonate.

Imodisulphonate (IDS) is formed in beet sugar processing factories by the reaction of nitrites with sulfur dioxide. Potential cost factors associated with IDS formation are: High white sugar ash content, deactivation of added SO2, and sucrose destruction associated with the microbial activity. IDS is usually isolated from suspected sugar or filter ashes by dissolution in potassium chloride solution and recovery of the undissolved crystals. The recovered crystals are frequently of a nondescript shape and not readily identifiable. If, however, the crystals are reacted with a solution of 2,4,6-triphenylpyrylium chloride, the presence of IDS can be confirmed by the formation of a definitive, feathery shaped product.
KIRK, MARYELYN, S.R. TEMPLE, J. KRAWETZ. Department of Agronomy Extension, University of California at Davis, Davis, CA 95616. Movement of the beet yellows virus through the sugarbeet plant.

Movement of the beet yellows virus through the sugarbeet plant was studied over a 5 week period following inoculation to provide information useful to sampling programs comprised of leaf collection and testing for beet yellows using Enzyme Linked Immuno-sorbent Assay (ELISA). Fifty plants, six weeks old (8 leaf stage), were inoculated by allowing viruliferous aphids to feed on recently expanded leaves, and numbered leaves of ten plants were harvested at weekly intervals. A distinct separation existed between ELISA values corresponding to healthy and infected plants. This study showed that one week after inoculation, beet yellows virus was detectable in 40% of the inoculated plants using ELISA, between the 3rd and 5th weeks the newest leaves consistently represented the virus status of the entire plant, and five weeks after inoculation the virus was detectable in leaves older than the inoculated leaf. These results support the utility of ELISA as an epidemiological tool by facilitating an optimum leaf sampling technique which best represents beet yellows incidence in the field, especially when infection dates can be anticipated.

KNIGHTON, RAYMOND E.* and M. D. SWEENY. Department of Soil Science, North Dakota State University, Fargo ND 58105. Spatial variability of salt accumulation on a field basis caused by irrigation with sugarbeet processing wastewater.

Irrigation has been used as a viable tool to dispose of processing effluent. To ascertain the spatial variability of salt accumulation after irrigation with sugarbeet processing wastewater, two field sites were sampled for electrical conductivity and sodium adsorption ratio on a 100 m regular grid. The dominant cations in these soils are Ca$^2+$ and Mg$^2+$, while the dominant anion is SO$_4^{2-}$. Measured electrical conductivity and sodium adsorption ratio were shown to be highly correlated in space with these ions. A dramatic increase in potassium at the surface of the soil appears to be due to irrigation. The distribution of salts, spatially, was found to be higher than expected under a uniformly irrigated field. The variability in some species appears to be related to inherent variability in the field before irrigation and accentuated by several transport processes due to irrigation. The study illustrates potential problems associated with soil sampling when identifying salt buildup in the presence of highly variable soils.

KOBER, STEVEN K., and J. J. GALLIAN. University of Idaho, 1330 Filer Avenue East, Twin Falls, ID 83301. Evaluation of seedborne fungi as seed and seedling pathogens of sugarbeet.

Thirty isolates in three fungal genera were isolated from sugarbeet (Beta vulgaris L.) seeds produced near Salem, OR, and tested for pathogenicity in growth chambers. Diurnal temperatures fluctuating through the 30 day test period began at 10/2 C (day/night) and gradually increased to 20/6 C. Seedling emergence from previously disinfested seed which was individually inoculated by vacuum infiltration with one Alternaria and two Fusarium isolates was 30 and 17-20% lower, respectively, than the water inoculated controls. Seed inoculated with 11 Phoma isolates resulted in emergence reductions of 25-92% compared to the control. These results suggest that cool temperatures at planting contribute to the ability of seedborne microorganisms to be pathogenic to sugarbeet seedlings, resulting in reduced plant stands.

LAMB, JOHN A.*, and JOHN T. MORAGHAN. University of Minnesota, Northwest Experiment Station, Crookston, MN 56716, and Department of Soil Science, North Dakota State University, Fargo, ND 58105. Foliar Nitrogen Application on Sugarbeet. A cooperative study was started with the objective of determining the effects of foliar N application on sugarbeet yield and quality under conditions of inadequate N supply and optimum fertilizer application. The experiment was conducted from 1986 to 1988 at the Northwest Experiment Station, Crookston, MN on a Wheatville loam (Aeric Calcicxeroll). The residual NO$_3^-$-N soil test 0 to 2 ft was 40 lb N/A in 1986 and 1987 and 70 lb N/A in 1988. The treatments were 2 levels of preplant N, nonfertlized and fertilized with urea to a soil test NO$_3^-$-N 0 to 2 ft + fertilizer content of 140 lb N/A, and 4 foliar N treatments applied as UAN solution. The foliar treatments were 0, 20, 40, and 60 lb N/A. The 20 lb N/A treatment was applied Aug. 1; 40 lb N/A as 20 lb N/A on July 15 and Aug. 1; and 60 lb N/A treatment as 20 lb N/A on July 1, July 15, and Aug. 1. Petiole and blade samples for total N and NO$_3^-$-N analyses were taken 7 to 10 days after each foliar N application date. Root and top yield were taken and quality data collected at harvest the third week of September. The amount of recoverable sugar per acre was only affected by the soil N treatment. In 1986 and 1988, recoverable sugar was not affected but in 1987 it was increased 824 lb/A by the soil treatment. These results indicate late season foliar applications of N are not beneficial for maximum sugar production.
LAW, MARK E.*, and M.D. SCHLOMANN. Southern Minnesota Sugar Cooperative, Renville MN 56284. - Electronic Temperature Acquisition on Sugarbeet Storage Piles.
The dynamic nature of sugarbeets in a storage pile system presents many problems in temperature control and measurement. The objective of this project was to incorporate an efficient and effective means to evaluate temperature throughout a grid network within the piled sugarbeets. To effectively measure temperatures, grids of thermister probes were placed on the angle of repose as the sugarbeets were piled. After a sufficient amount of sugarbeets were piled to hold the probes in place, the leads were linked to channel multiplexers. The multiplexers were then connected to a data logger which logged individual data points on six-hour intervals during a 24-hour period. The data logger stored the data until retrieval via a phone line. The retrieved data was then summarized into a graphical representation and used to evaluate proper fan operation for control of ventilated sugarbeets. A recovery rate of 80% of the hardware used in this installation can be expected. The only material lost are the wires and thermisters in the pile itself. The remaining hardware can be collected to be used the following year.

LEEDS, DANIEL L., and JOHNs, DAVID F., Holly Sugar Corporation, P.O. Box 517, Hamilton City, California 95651.
REDC I ng L IM E W ASTE
At our Hamilton City, California factory we have had high lime waste in the past years. This has included discard from the slaker, spalls, and limerock left in the kiln at the end of campaign. For financial as well as environmental reasons, it was imperative to reduce waste. By reducing the percentage of coke to the kiln and deliberately underburning the rock and reintroducing the fines to the kiln, we were able to significantly reduce lime waste as well as optimize lime production.

Genetic variability for reaction to rhizomania has been identified in diverse Beta germplasm. Response to selection for resistance was measured within representative sources. Sources included types of variability that fit patterns for either qualitative or quantitative inheritance. Selections and evaluations were made and compared in field plots with high disease pressure at Salinas. Root symptomology and yield were used as the criteria of selection and evaluation. Four cycles of selection have been completed and evaluated within punitively quantitatively inherited sources. Progress was made in each cycle of selection. After three cycles of phenotypic recurrent selection, synthetics derived from diverse sources (C39, Y47, FC-Rhizoc., etc.) had reached the level of protection provided by the Rz allele. However, unlike the Rz, hybrids between these synthetics and susceptible parents had mid-parental values for resistance. Empirical evidence showed that reaction to rhizomania is highly heritable and that field tests and selections based upon symptomology/yield were sufficiently critical for discriminating differential disease reactions. Near-isogenic lines differentiated by Rz were significantly different for resistance and yield when tested under rhizomania conditions. Although root traits were confounded by their B. maritima sources of resistance, resistance to rhizomania has been transferred from B. maritima to sugarbeet. High resistance was identified in one plant from accession PI206407 (Turkey vulgaris type) and appears to be inherited in a dominant manner.

LEWELLEN, R. T.*, and I. O. SKOYEN. USDA-ARS, U.S. Agric. Research Station, 1636 E. Alisal St., Salinas, CA 93905. - S$_1$ progeny recurrent selection to improve yield of sugarbeet.
Recurrent selection may be useful to increase the frequency of favorable alleles for yield. Four cycles of S$_1$ progeny recurrent selection have been completed in sugarbeet population-790. Sugar yield was used as the criterion of selection. Performance of synthetics from each cycle were compared in field tests. Compared to the unimproved population (CO), the C4 synthetic was improved by 10.22, and 7% for gross sugar yield, root yield, and sucrose concentration, respectively. Most improvement for root yield and gross sugar yield was from C1 and C4, whereas most improvement for sucrose concentration was from C2. Thus, S$_1$ progeny recurrent selection discriminated S$_1$ genotypes for yield and was an effective method of population improvement in sugarbeet. However, the rate of progress per year (3 years/cycle) and rigid design may not justify such a long term program when populations need improvement for many factors (genetic structure, resistance to diseases, pests, and stresses, etc.) in addition to components of yield. Based on experimental results, a population improvement program will be outlined that has greater flexibility and reduced intervals per cycle of selection but still
encompasses the efficacy of S₁ and S₂ progeny evaluation as pivotal steps to isolate and discriminate superior genotypes.

LEWELLEN, R. T.*, and I. O. SKOYEN. USDA-ARS, U.S. Agric. Research Station, 1636 E. Alisal St., Salinas, CA 93905. - Screening sugarbeet genotypes for nonbolting tendency using an annual tester. The most common procedure to evaluate genotypes of sugarbeet for resistance to bolting is exposure to extended periods of cold induction followed by long day conditions in overwintered or winter plantings in the field. This method is effective but subject to extremes in environmental conditions, costly in time, and may be inconvenient. A procedure to evaluate genotypes for bolting under more controlled conditions within a shorter period would be advantageous. A procedure involving an annual tester to evaluate biennial genotypes is being investigated. When an easy bolting annual was used as a common tester, all F₁ hybrids bolted quickly and synchronously under long day conditions in the field or greenhouse. However, when a nonbolting (hard bolting) annual tester was crossed to biennial plants, the F₁ testcrosses bolted over an extended period. The association between the known bolting tendency of biennials and that of their annual testcrosses was high. Also, a high association occurred between the rate or timing of bolting in tests under lighted greenhouse and spring planted field tests without cold induction. Preliminary evidence suggests that specific biennial genotypes can be categorized and sorted for their bolting tendency with the aid of a hard bolting annual tester. Line C600CMS was released in 1988 for this purpose.

LIU, HSING-YEH*, and JAMES E. DUFFUS. USDA, Agricultural Research Service, 1636 E. Alisal St., Salinas, CA 93905. - New soil-borne viruses of sugarbeet. In studies in California and Texas three distinct viral pathogens similar in particle morphology to beet necrotic yellow vein virus (BNYVV), the causal agent of rhizomania of sugarbeet, have been isolated from rhizomania infested fields. These BNYVV-like viruses are mechanically transmissible and vectored by the soil fungus Polymyxa betae Keskin. However, these isolates are distinct from BNYVV in symptom expression, host range, and serology. Because these viruses have particles similar to those of BNYVV there is confusion in electron microscopic based routine tests for BNYVV. Therefore, host range and serological tests also should be used. The distribution of these viruses in the field, their economic importance, and the relationship of these entities to the rhizomania disease of sugarbeet are not yet known.

LOGIE, JAMES R. and WOLF MUSOW. Manitoba Sugar Company, 555 Hervo St., Winnipeg, MB R3T 3L6. - Foxboro, Plymouth, MA 02360. - Conductivity Control in First Carbonation. The measurement of pH has been the traditional means of 1st carbonation control in the sugar beet industry. Industrial probes must operate in a hot, alkaline environment containing variable quantities of mud and beet impurities. The probes react directly with the solution which gradually leads to a loss in sensitivity response. As this occurs, alkalinity control becomes more difficult and filtration problems arise. The potential replacement of pH with conductivity was discussed with Foxboro in early 1987 after it was learned that they had developed a new conductivity probe coupled with intelligent automation technology. Two probes were used to monitor the process for 28 days during the 1987-88 processing season while pH was used for control. Once the comparative data was evaluated, conductivity was used for effective control during the final 69 process days. The probes were inert to the hot juice environment, gave better statistical correlation to alkalinity than pH and the new technology was readily accepted by the operating staff.

MADSEN, MARK R., Western Sugar Company, 400 Great Western Avenue, Lovell, WY 82431. - Recirculation Juice system in Silver Slope Diffuser. In the sugarbeet industry the goal is to reduce the cost per hundred weight of sugar or (therms/bag). Studies and energy balances around the diffuser found this area to be inefficient and expensive to operate. Slope diffusers around the world are generally supplied with heat through the condensing of steam in an external jacket. Studying design considerations, a direct contact heat exchange was chosen. The method used was to recirculate juice pulled from the diffuser, heated, and return it to the diffuser in the approximate area where it was removed. The results of this modification to the Silver Slope diffuser were encouraging. The energy that was required to operate the diffuser was reduced significantly. There were other benefits involving a constant temperature profile throughout the diffuser, lower pulp losses, and improved diffuser operation. Exact data is still being compiled at the time of this abstract.
MAGGI, GARY. The Western Sugar Company, 555 17th St., Denver, CO 80202. - Micronized coal firing of sugar beet pulp drying operations. This paper examines the equipment and modifications to existing equipment necessary to achieve the conversion of pulp drying operations from natural gas to subbituminous coal. The use of micronized coal (325 mesh) makes it possible to change fuels without major changes to existing equipment.

MANTOVANI, GIORGIO, and G. VACCARI. University of Ferrara, Ferrara 44100, Italy. - The beet technological value and storage conditions. The beet technological value is valued on the grounds of non traditional parameters which relate better to the problems concerning processing. In particular the dry substance determination and the composition of the juice extracted at diffusion temperature are considered. These evaluation criteria are particularly interesting in the case of damaged roots which are stored in unfavourable conditions due to high temperatures. Storage of sound and damaged beets either in piles in the fields or in the factory silos for a maximum of four days with temperatures between 20 and 35°C, is taken into consideration. The results as a whole point out the big problems arising also from a short storage in particular climatic conditions. With the purpose of having a more complete view of the consequences of storage on the technological value of beet it is necessary to extend the field of investigation to non-traditional parameters.

MARTIN, SUSAN S. USDA, Agricultural Research Service, 1701 Center Ave., Fort Collins CO 80523. - The phytoalexin response of diverse Beta lines infected by Cercospora beticola. The flavonoid phytoalexins betagarin (B) and betavulgarin (BV) accumulate in sugarbeet, Beta vulgaris L., in response to infection by Cercospora beticola Sacc. HPLC (C-18 column, 4.6 mm x 25 cm; gradient elution with mixtures of acetonitrile and 3% aq. acetic acid; UV detection) was used to determine the presence and concentrations of these compounds in ether extracts of leaf lesions. BV were identified by their ultraviolet spectra, obtained online from the photodiode array HPLC detector. Lesions were sampled from fifteen diverse Beta lines, field-grown and inoculated with C. beticola. These USDA Plant Introduction lines were collected in countries around the world. BV accumulated in lesions of each of the lines examined, which included the conspecific but phenotypically distinct chard, red and yellow table beet, fodder beet, annual beet, and the presumed ancestral Beta maritima. B was present in most lines, but was below detectable limits in a few cases. The generality of the phytoalexin response in these diverse genotypes supports the hypothesis that these compounds are involved in resistance to the pathogen. B and BV also were elicited in sugarbeet leaf blades and petioles by several abiotic agents; thus, in addition to their classification as phytoalexins, B and BV are included in the more general class of "stress metabolites."

MARTIN, SUSAN S. USDA, Agricultural Research Service, 1701 Center Ave., Fort Collins CO 80526. - Separation of constitutive and induced phenolics of Beta vulgaris by high performance liquid chromatography. The sugarbeet, Beta vulgaris L., responds to infection by the fungus Cercospora beticola by accumulating two flavonoids that are toxic to the pathogen, and thus are considered phytoalexins. Study of the accumulation of these compounds in the leaf lesions that are symptomatic of the disease has been limited by lack of a sufficiently sensitive analytical procedure. The flavonoid compounds were separated by high performance liquid chromatography on reverse phase (ODS) columns by gradient elution with mixtures of 3% (aq.) acetic acid and acetonitrile. The use of a photodiode array detector (PDAD), with its output of full ultraviolet spectral data (200-360 nm) at intervals of about one second directed to a computer, facilitated development of an optimal separation. The procedure can determine quantitatively the phytoalexin content of a single lesion. Modifications of the gradient and use of the PDAD permitted recognition of the constitutive simple phenolic acids and aldehydes found in sugarbeet leaves, and of the simple phenolics and ferulic amides described by Chiji et al. (Agric. Biol. Chem. 48: 1653-1654, 1984) in sugarbeet seeds.

MARTYN, RAY D. 1, C. M. RUSH2, E. H. BAKER2, and C. L. BILES1. 1Department of Plant Pathology and Microbiology, Texas A&M University, College Station 77843; and 2Texas Agricultural Experiment Station, Bushland 79012. - Etiology of root rot of sugar beet in Texas. Approximately 16,000 ha of sugar beets (Beta vulgaris L.) are grown in a four-county area in
the panhandle of Texas and constitute a significant proportion of the agricultural economy in that region. A disease characteristic of interveinal chlorosis of the leaves, wilting, vascular discoloration, and root rot has increased over the past 8 years to the point that it limits production in some fields. Symptomatically, the disease is similar to Fusarium yellows, caused by Fusarium oxysporum f. sp. betae; however, the severe root rot which occurs is not associated with Fusarium yellows. The rot typically begins at the distal end of the root, with black streaks radiating upward. In extreme instances, the infected portion of the root completely rots, leaving only remnants of the vascular bundles. Fusarium oxysporum was isolated consistently from internal root tissue of affected plants. Two separate tests with two isolates of F. oxysporum from diseased, field-grown sugar beets confirmed their pathogenicity and reproduced all disease symptoms on cultivar TX-9 in the greenhouse. Inoculations with two known isolates of F. o. f. sp. betae from California and one from Oregon did not cause root rot. Electron microscopy of infected root tissue revealed that both F. o. f. sp. betae and the Texas isolate readily colonized the vascular tissue.

MARTYN, RAY D.1, C. M. RUSH2, C. L. BILES1, and E. H. BAKER2. 1Department of Plant Pathology and Microbiology, Texas A&M University, College Station 77845; and 2Texas Agricultural Experiment Station, Bushland 79015. - Isozymic variation of the Texas isolate of Fusarium oxysporum, causal agent of root rot of sugar beet.

A sugar beet disease (Beta vulgaris L.) occurs in Texas that symptomatically resembles Fusarium yellows, but which also is characterized by a root rot. The causal agent has been identified as Fusarium oxysporum. Native polyacrylamide gel electrophoresis (PAGE) was used to examine isozyme variability of three enzymes (cinnamyl alcohol dehydrogenase, esterase, and glucose-6-phosphate dehydrogenase) in both the Fusarium yellows fungus and the Fusarium root rot fungus. Three isolates of F. o. f. sp. betae (two from California and one from Oregon) were compared with two sugar beet isolates of F. oxysporum from Texas using Native-PAGE 10-15 gradient gels with the Pharmacia PhastSystem®. In addition, one isolate each of F. solani and F. graminearum was included. Isozymes resolved for each isolate were subjected to a binomial hierarchical cluster analysis using the statistical program (BIOSTAT II). Matching distances (relatedness) between isolates were calculated and used to construct phenograms. Matching distances for all isolates of F. o. f. sp. betae were either identical or very similar, indicating they were the same or closely related to each other. Similarly, the matching distance for each Texas isolate was the same, but distinct from those of F. o. f. sp. betae from Texas and the Texas isolate is unique. Matching distances of F. solani and F. graminearum were quite distinct from all isolates of F. oxysporum. Phenotypic variation in isozymes of the Texas sugar beet isolates, together with differences in disease symptoms, may justify a new race designation of F. o. f. sp. betae or a new formae speciales.

MCFARLAND, DAVID L. Western Sugar Co., West 8th St., Bayard NE 69334. - Experiences with low raw affination at Bayard factory. In the summer of 1987, the Bayard factory of The Western Sugar Company installed Low Raw affination to improve molasses exhaustion and to reduce non-sugar recirculation to the white side which has given this factory specific problems. In the summer of 1988, an additional affinator was installed after our second low raw centrifugals so that we may grain our high raw pan with this second affination magma. This affination process increased molasses exhaustion by lowering molasses apparent purity from 60.9 to 58.3 and lowered low raw sugar color from 2873 RBU to 1346 RBU.

MELIN, DAVID C.*; DONALD W. LIND and DONALD E. MURDOCK. Holly Sugar Corporation, P. O. Box 1168, Sidney, MT 59270 - Effect of Quality Improvement at Sidney, Montana. The development of a thorough beet quality improvement program at the Holly Sugar Corporation factory in Sidney, Montana has resulted in sugar content increased to over 18% on sugarbeets purchased with yields averaging more than 21 tons per acre. A continuing program of evaluation of each grower's production performance by a grading system where points are awarded on a weighted basis against factory averages each year of yield per acre, sucrose content, brei nitrate and beet tare is used to influence each grower to maximize income from the sugarbeet crop and to increase the quality of the sugarbeet for maximum extraction of refined sugar. The selection criteria for sugarbeets has been modified to allow more rapid approval of varieties developed and tested in appropriate regions outside of the Sidney growing area. In 1987 and 1988 the highest 10% of sugarbeet growers at Sidney averaged 24.0 tons per acre at a 19.25% sugar content. The economic impact of the sugarbeet crop in the Sidney growing area has created a stable supply of sugar which justifies investment in the necessary equipment for refining operations. Diffusion juice purity at Sidney has increased more than 1% in the past three years along with increased daily alice and sugar production.
MILLER, STEPHEN D. M. and K. J. FORNSTROM. University of Wyoming, Laramie, WY 82071. - Labor requirements in sugarbeets with preplant, postemergence and complementary preplant/postemergence treatments.

Weed control accounts for a large proportion of the expense incurred by growers in raising sugarbeets (Beta vulgaris L.). In Wyoming, herbicides are applied to over 70% of the sugarbeets prior to planting, 35% sprayed postemergence and over 6% treated after thinning. In addition, sugarbeets are cultivated one to three times during the season and weed escapes controlled by one to three hand hoeings.

A field experiment was conducted at Torrington, WY during 1987 and 1988 to determine weed control and labor requirements with preplant, postemergence and complementary preplant/postemergence herbicide applications in sugarbeets. Early season weed populations averaged over 60,000 and mid season weed populations over 27,000 plants/A in the untreated check. Early season weed populations were reduced 91 to 97% and mid season weed populations 87 to 97% with all complementary preplant incorporated and postemergence desmedipham plus phenmedipham treatments. Lowest total hoeing time (5.1 to 9.7 hr/A) were obtained with these treatments.

Based on linear regression analysis of hoeing time (total of 1st and 2nd hoeing) and weed population, 4.4 hr/A were required to walk through a sugarbeet field when no weeds were present and an additional 0.5 hr/A required for every 1000 weeds/A ($r^2=0.92$).

MOLLER, GUNTHER R. DDS-Engineering, 1 Langebrogade, DK-1001 Copenhagen - Essential parameters in automation of the pan floor.

During these years the 3rd generation of automation products, the computerized control equipment, is on its way into our factories. Much time and much money will be spent, and hopefully the results will meet the promises that have been made. Experience from DDS-factories and experience gained by commissioning pan control equipment all over the world has shown that only projects where the basic problems on and around the pan floor have been analyzed and taken into account, e.g. capacity, quality, heat economy and labor ended up satisfactorily. The essential parameters discussed are pan design, measuring methods, seeding technique, control philosophy and automation degree.

MOORE, STEPHEN M., and ROBIN M. BROPHY. American Crystal Sugar Company, Research Center, 1700 North 11th Street, Moorhead, MN 56560. - Quality lab data acquisition implemented with inexpensive networked PCs.

American Crystal Sugar's Commercial Beet Quality Lab operates with inexpensive "PC compatible" computers on a local area network. This paper describes the success of this approach and compares it to other more traditional approaches. A complete description of the current system including required hardware, software, and technical support are discussed.

MORAGHAN, J. T., and K. HORSAGER. North Dakota State University, Department of Soil Science, Fargo, ND 58105 - EUF-extractable soil nitrogen and sugarbeet nitrogen nutrition in the Red River Valley

Twenty two nitrogen (N) fertilizer trials were conducted in the Red River Valley to determine whether EUF-extractable soil organic N could be used to predict N mineralization in dryland sugarbeet (Beta vulgaris L.) fields. EUF-extractable organic N levels ranged from 0.71 to 2.68 mg N/100g. EUF-organic N levels were poorly related to the N-fertilizer-response patterns for recoverable sugar found at the various sites. End-of-the-season N accumulation in tops and storage roots from unfertilized plots was determined in 16 of the experiments. N accumulation was significantly correlated with preplant levels of soil nitrate-N in the upper 60 cm ($r = 0.51$), in the upper 120 cm ($r = 0.89$), and in the upper 180 cm ($r = 0.89$), but was not correlated with EUF-organic N ($r = 0.19$) and total N ($r = 0.33$) levels in the upper 12.5 cm. EUF-extractable N levels in the topsoil were not as efficacious as profile soil nitrate-N measurements for determining the N-supplying power of Red River Valley soils.

NARUM, JUDY A. 1* and SUSAN S. MARTIN2. 1Beet Sugar Development Foundation and USDA-ARS, 1701 Center Ave., Fort Collins CO 80526. - Impurities and sucrose in the root, peel, and interior of diverse sugarbeet lines.

Quantities of selected impurities in the near-surface layers ("peel") of the sugarbeet were compared to those of the root interior (the peeled beet) and the whole root. Amino-N (ninhydrin), sodium and potassium (flame photometer), percent sucrose (polarimeter) and dry weight were determined. To explore the range of these characters in beets of varied genetic backgrounds, we examined ten diverse sugarbeet types, including commercial sugarbeets, smooth-root types, other experimental inbred lines, and a sugarbeet-fodder beet hybrid. In
general, peels contained significantly higher concentrations of impurities and lower concentrations of sucrose than did either the whole root or the interior; significant differences existed among cultivars. Ultimately, these data will be useful, together with those of others, in assessing the feasibility of improvement in beet processing quality by peel removal.


The possibilities in molecular markers in a wide range of research branches is well known. Unfortunately the knowledge of these markers remains very small in beet. The aim of this work is to characterise molecular markers genetically (in particular isozymes and storage proteins) and to study their applicability. The possibilities of the use of electrophoresis of enzymes and storage proteins for line and chromosome identification were tested. Different extraction and fractionation methods of storage proteins were used on single seed as well as on bulk samples. The variation within the lines was as large as the variation between lines allowing no simple classification. Activity stainings of isozymes was a more interesting tool for the identification of sugarbeet lines. On the basis of the isozyme patterns similarity coefficients between cultivars could be calculated. A cluster analysis of these coefficients allowed a correct classification of the different varieties. Interspecific hybrids are very useful to study the behaviour of enzymatical activity in a non parental plant. (Olôo et al. TAG.73:261-266 1986) No silencing of genes or genomes was observed, interspecific heteropolymers could be detected. Chrome identification was tested on addition lines. Eleven isozymesystems were used to identify the extra chromosome in Beta vulgaris, carrying an extra chromosome of Beta procumbens. The nine chromosomes could be distinguished. (Van Geyt et al. TAG.76:577-586 1998)

OWENS, LOWELL D. USDA, Agricultural Research Service, Plant Sciences Institute, Plant Molecular Biology Laboratory, Beltsville, MD 20705. - Sugarbeet leaf-disc culture: improved conditions for inducing regenerative wound callus.

A potential route to obtaining transgenic sugarbeet plants is via Agrobacterium transformation of regenerative tissue. Because transformation is likely a low-frequency occurrence we have sought to increase the production of regenerative callus per plate of cultured tissue. We have tested leaf discs of the highly regenerative genotype REL-l (supplied by J. W. Saunders) on several media and plating densities. Best results were obtained by culturing five 7-mm discs/plate on a modified RV medium (consisting of Murashige & Skoog [MS] inorganic salts, 10 vitamins, 5 amino acids and 1 g/l benzyladenine) and transferring the discs biweekly during the first month. With this method callus that developed on the leaf disc edge produced more than 40 embryos or shoots/plate in 7 weeks of culture.

RUSH, CHARLES M., T. H. MAREK, and E. H. BAKER. Texas Agricultural Experiment Station, F.O. Drawer 10, Bushland, Texas 79012. - Relationship between sugarbeet root rot severity and percent reduction in sugar content.

A sugarbeet root disease rating system was developed to explore the relationship between root rot severity and sugar content. At harvest in 1987, 15-20 sugarbeet samples were taken at random from each of 13 selected fields with varying levels of disease. Beets from individual fields were bulked and grouped according to a disease rating of 0-4. Subsamples (7-11 Kg) were collected from each rated group and analysed for sugar content. Correlation coefficients of disease rating versus sugar content ranged from 0.60 to 0.96. Using mean sugar values of each disease category from the 13 fields, the percent sugar reduction in each category 1-4 compared to category 0 was determined. Regression analysis of 1st through 4th order polynomials and several logarithmic and semi-logarithmic models were used to evaluate the relationship between percent sugar loss and disease rating. The model of best fit was a 1st order polynomial with an ordinate intercept of zero. The coefficient of determination $r^2$ of this model was 0.88. The model was sugarloss = 9.32 times the rating.

RUSH, CHARLES M., and S. R. WINTER. Texas Agricultural Experiment Station, F.O. Drawer 10, Bushland, Texas 79012. - Influence of previous crop on Rhizoctonia root rot.

A field study was conducted to determine if previous crops affect disease development in the subsequent sugarbeet crop. Alfalfa, cotton, sorghum, sunflower, or wheat, grown in monoculture for 2-3 years, or fallow ground, preceded the beet crop. Disease incidence and progression in the sugarbeet crop were monitored by
taking bimonthly counts of the number of dead plants in two 7.6-m lengths of row in each plot. The was half of the area in 1987 and half in 1988. Even after five years out of beets high levels of disease developed in some plots. At the end of the season in 1987, beets following alfalfa had the highest incidence of disease, losing 47% of the crop to root rot. Beets on sorghum and wheat ground followed with losses of 41% and 38%, respectively. Plots on cotton, fallow, and sunflower ground all had significantly less disease with 22, 22, and 22% losses. Differences in these three were not significant. In 1988, similar trends were observed. As of August 2, beets on ground preceded by wheat or sorghum had 66% or 64% stand loss, respectively. Thirty-five percent of the stand was lost on alfalfa ground. Cotton, fallow, and sunflower once again proved to be the best for preceding beets with only 16% and 18% stand loss, respectively. Rhizoctonia solani was the predominant pathogen both years.

It is hypothesized that beets on cotton, fallow, or sunflower ground had less disease because of lower levels of crop residue in the soil compared with wheat, sorghum, and alfalfa.

SAMARAWEERA, INDRANI S.R.* American Crystal Sugar Company, Research Center, 1700 North 11th Street, Moorhead, MN 56560. - Technique used in assessing the efficacy of biocides and sanitizers for microorganism control in factory diffusers.

Sugar losses in factory diffusers due to microbial action have been curtailed by the use of various biocides in the United States. Different sanitizers are used in factories to keep microbes in constant check. Therefore to evaluate the biocides and sanitizers that give best results, a preliminary study was conducted at American Crystal Sugar Company Research Center. A "disc diffusion assay-modified Kirby Bauer technique" was used for assessment and will be discussed.


A number of fungicides are used for control of different fungi affecting sugar beets in the United States. Some work better than others in different parts of the country depending on climatic conditions, soil types, and microbial populations in various ecological niches. Our experience in the Red River Valley is limited. Therefore a new approach to evaluation of the efficacy of FDA/EPA approved fungicides was carried out at American Crystal Sugar Research Center. All assessments were carried out in four parts through a period of 5-6 weeks. The first three stages of assessment were carried out in the laboratory, and all data obtained was reinforced with a fourth stage of assessment in the greenhouse. Techniques and methods of testing used will be discussed.


A reproducible method for regeneration of plants from petiole and thin layer explants of 25 cultivars/breeding lines of sugar beet encompassing haploid, diploid, triploid and tetraploid has been developed. High frequency bud regeneration was mainly observed in the blade-petiole transition zone. Organogenesis resulted when petiole explants excised from 18-day-old seedlings grown on half-strength MS containing 3 mg/l NAA, 3 mg/l BAP and 1 mg/l TIBA were cultured on MS with 3 mg/l NAA and 3 mg/l BAP. Bud formation was observed after 15 days. Using the above sequence, the maximum number of organogenic explants (in the best case 80% of petiole explants forming buds) were obtained, with 10 to 30 buds per explant (5.0 mm length). Thin cell-layer strips isolated from shoot apices cultured on MS medium supplemented with 0.9 mg/l BAP or 1 mg/l IBA formed adventitious buds on MS medium containing 0.5 mg/l NAA or 5 mg/l BAP. About 90% of normal shoots were easily rooted on MS medium with 1 mg/l IBA and could be transferred to the greenhouse where they continued normal growth. No chromosomal variation was observed in the regenerants. Thus, with the system described above, interesting sugar beet genotypes can be clonally propagated, and unlimited material can be made available to breeders.


Injury to sugarbeets from herbicide residues left from the preceding cropping year has kindled interest in more herbicide resistant cultivars. Because simply inherited herbicide resistance has been obtained in other crops through
tissue culture selection schemes, we pursued this in sugarbeet. Using the annual self-fertile diploid released clone, REL-I, with its superior shoot regeneration and suspension cultures, we produced dispersed suspension cultures from callus induced on leaf discs by MS medium + 1 mg/L benzyladenine (BA). Suspensions were subcultured twice in liquid MS + 1 mg/L BA before plating of unmutagenized cell clusters on 2.8 nM chlorsulfuron on MS + 1 mg/L BA with agar. A single colony arose which quickly sent up a shoot. Additional shoots were extracted and treated as separate isolates. Shoots and callus were resistant to chlorsulfuron concentrations that killed similar tissues of REL-I. Initial tests in greenhouse and field indicated that resistance segregates in the F1 generation. Unique somaclonal variation was observed in plants of many of the isolates or their S1 progeny. This included tumorigenesis, variegation, partial and complete sterility, and aberrant plant morphology.

SAUNDERS, JOSEPH W.*, J. CLAIR THEURER, and GEORGE ACQUAAH. USDA-Agricultural Research Service, P. O. Box 1633, E. Lansing, MI 48826-6633, and Dept. Crop and Soil Sciences, Michigan State Univ., E. Lansing, MI 48824. - Progress with isoenzyme investigations. Isoenzymes are multiple functional forms of enzymes that are easily studied using relatively common laboratory procedures. They are useful in fingerprinting clones, populations, and cultivars, as well as for developing linkage maps that are currently being used in selection schemes for quantitative traits in several crops. We have continued investigations using isoenzymes to learn more about isoenzyme structure and expression as well as to develop a linkage map. Continued screening of breeding populations and chard and table beet cultivars has been conducted to identify sources of genetic variability for isoenzyme mobility. Enzymes studied have been malic enzyme, glutamate-oxaloacetate transaminase, glutamate dehydrogenase, aconitase, diaphorase, shikimate dehydrogenase, isocitrate dehydrogenase, malic dehydrogenase, phosphoglucomutase, and phosphoglucoisomerase. Aberrant segregation ratios have been encountered with glutamate dehydrogenase and phosphoglucoisomerase. Isozyme patterns from pollen extracts have been used to assist in determining enzyme structure and the relationships among electrophoretic bands. Zymograms from pollen show fewer bands than from leaves, due to differential gene expression and the absence of heterodimeric proteins of monogenic origin.

SCHENKEN, MICHAEL A'! and H.E. EITEL. Southern Minnesota Sugar Cooperative, Renville MN 56284. - Use of a Variable Speed Frequency Drive on a Sugarbeet Piler Cleaning Screen. Sugarbeet root condition can vary greatly throughout the harvest period which directly affects how the roots flow through the piler. There is no simple and effective way to control the speed of screen rollers during variations in root condition. The objective of this study was to determine the effectiveness of adjusting the screen roller speed to the condition of the beets. A variable speed frequency drive was installed on one of two near identical Silver Super Pilers at the Bird Island receiving station. The beets were weighed at the point of 19 feet with random growers unloading at both machines. Records were kept to determine grower loads and piler number. Sugar percent, tare dirt and first
dirt were recorded for each pile. Visual evaluations during operation showed a reduction in root damage at slower roller speeds. An adjustable drive could result in reduced machine wear, less root damage, and higher quality roots for long-term storage.

SCHMALZ, CHARLES L. The Amalgamated Sugar Company, Box 700, Paul 10 83437. A simple method to monitor and evaluate sugar moisture. Sugar exiting the centrifugals is coated with a thin film of supersaturated syrup. The behavior of this film during subsequent drying, conditioning, and storage is of great interest to the industry. Unfortunately, the small amount of moisture involved and the nature of sugar-water equilibria has made previous investigations difficult. This paper describes a simple, yet accurate means of measuring the amount of water present in surface films. The procedure permits evaluation of rates of moisture absorption and desorption. A brief study using the technique will be discussed. The changes brought about by sugar conditioning and storage were investigated, as was the subject of moisture migration within a bulk sugar site.

SCHENROCK, KARLHEINZ W.R., 5335 Fillmore, Ogden UT 84403. - Ion exclusion - Saviour or Imposter. An illumination of the application of ion exclusion in the beet sugar industry and its impact on the economical well being of the industry. Initial commercialization of ion exclusion failed because its recovery cost for sugar from impure sugar solutions was higher than the recovery cost of sugar from sugar beets. This relationship can now be reversed with developments from an increased understanding of this technique. The pseudo-moving bed process for the enrichment of fructose can now be fully utilized for the separation of sucrose from native sugar beet nonsugars. At least four such plants, including two in the cane industry are now fully operational with others in the planning stage. With the correct preparation of the syrups to be treated by such technique, due consideration for the most effective integration into the existing operation and improvements in the properties of the separation medium already witnessed ion exclusion will become a standard unit operation in most sugar beet factories.

SCHWEIZER, E. E.*, USDA, Agricultural Research Service, Fort Collins, CO 80526, J. M. SHRIBBS, ICI Americas, Inc., Mt. View, CA 94042, and L. HERGERT, Western Sugar Co., Alliance, NE 69301. - Validation of a bioeconomic weed management model for sugarbeet production. Few bioeconomic weed-crop models have been developed or field tested. In 1987, low and high risk models were compared to standard practice and consultant advisement at two locations to determine whether annual weeds can be controlled economically by employing weed actions based on bioeconomic modeling. These models combined data on weed species, weed and crop growth, weed management options, costs and benefits of each option, and risk acceptance by growers. Herbicide selection of preplant, postemergence, and layby treatments differed considerably among the four weed management strategies. The low risk model was herbicide intensive and the high risk model was labor intensive. Total weed control costs, number of escaped weeds at harvest, yield of recoverable sucrose, and net return above weed costs were not different among the four weed management strategies at either location. Thus, weeds can be controlled in sugarbeets by employing weed actions based on bioeconomic modeling.

SKOYEN, I. O.*, R. T. LEWELLEN, and E. D. WHITNEY. USDA-ARS, U.S. Agri. Res. Station, 1636 E. Alisal St., Salinas, CA 93905. Comparison of resistance to rhizomania from diverse sources. Sources of resistance or tolerance to rhizomania have been independently identified. It is unknown how much protection against rhizomania these sources provide and their relative magnitude of control. Tests were grown at Salinas under various combinations of infested and noninfested and fumigated and nonfumigated treatments to measure differential damage to rhizomania. Varieties used were 'US H11' (susceptible check), 'Rhizosen' (Holly hybrid that segregates for the gene Rz), 'Rizor-3' (SES variety from Europe), and R39 (source of C39/R4). Under nondiseased conditions, the relative sugar yield for these four varieties was 100, 112, 106, and 98%, where as under severe rhizomania, the sugar yield was 100, 370, 400, and 440%, respectively. The results suggested that resistance from the three sources was nearly equal but did not provide complete protection. Under severe rhizomania conditions, all roots of Rhizosen, Rizor-3, and R39 showed damage and the high risk model was labor intensive. Total weed control costs, number of escaped weeds at harvest, yield of recoverable sucrose, and net return above weed costs were not different among the four weed management strategies at either location. Thus, weeds can be controlled in sugarbeets by employing weed actions based on bioeconomic modeling.
SMITH, DAVID *, and RICHMOND, JOHN A. Holly Sugar Corporation, P.O. Box 581, Brawley, CA 92227. Observations on Color Development in Stored Sugar.

Storage of beet sugar for sale and distribution throughout the year at Holly Sugar's processing facility in Brawley, California poses some unique problems as a result of unfavorably high ambient temperatures throughout a significant portion of the year. Observations comparing data from 1983 through 1988 suggest process strategies aimed at less color development of sugar during long-term storage. Dependence of final color was investigated as a multiple linear function of color, moisture, ash, crystal size and crystal size distribution. Using regression techniques ash had the most predictive value. Sugar Processing Research, Inc. has reported that 84 percent of the color and 60 percent of the ash was located in the surface film of the sugar. These findings indicate that the amount of centrifugal wash water should be controlled primarily by ash content instead of by color.

SMITH, GARRY A.* USDA, Agricultural Research Service, P.O. Box 5677 - Univ. Stn., Fargo, ND 58105. Research at the new Northern Crop Science Laboratory. Located on the campus of North Dakota State University, the NCSL was dedicated September 2, 1988. The laboratory is one of two federal laboratories, both on the NDSU campus, which together have been designated the Red River Valley Agricultural Research Center. The new NCSL houses three ARS research units: sugarbeet, cereals and oilseeds (sunflower and flax). In addition the laboratory contains an electron microscope operated by NDSU which currently operates two transmission and one scanning scope. The new laboratory contains 71,000 square feet distributed on two floors. The laboratory was built at a cost of $8.3 million through a special congressional appropriation. Twenty scientists (15 ARS and 5 NDSU) occupy the new facility. Sugarbeet research in progress and to be conducted at the new facility includes identification of physiological and biological properties responsible for growth and sucrose accumulation, characterization of the biochemical mechanism of sugarbeet root rot caused by the soil-borne fungus Rhizoctonia solani, development of germplasm resistant to Cercospora leaf spot, development of a biological method to control Tetanops myopaeformis and release of germplasm with low storage respiration and resistance to storage rot.


Sugarbeet yield and quality is directly affected by plant population at thinning and harvest. Many growers desire to reduce production costs by planting to a final stand thus eliminating the need for a mechanical or hand thinning operation. Due to variability of sugarbeet planters, seed variability and unpredictable environmental conditions, planting to a final stand often results in very non-uniform plant spacings in the sugarbeet row. Controversy exists about the impact of non-uniform in-row planting on sugarbeet crop harvestability, yield, quality and storability of beet roots. Populations of 23,760, 29,700, 35,540, 41,580 and 47,520 plants per acre were established at Fargo, ND and Crookston, MN in 1986, 1987 and 1988. At each plant population four computer generated in-row spacing arrangements were established. In-row spacings included doubles and triples and in-row skips up to three feet in length. Parameters measured included root yield and quality, post thinning stand loss, % harvestable roots and root size. Only minor significant yield differences were observed between the uniform and non-uniform in row spacing comparisons at populations of 41,580 plants per acre or less.

Smith, Larry J. and Alan G. Dexter*. Northwest Experiment Station, University of Minnesota, Crookston, MN 56716 and Dept. of Crop and Weed Sciences, North Dakota State University, Fargo, ND 58105 - Sugar beets following soybeans in a crop rotation.

Sugar beet grower production practice records from American Crystal Sugar Company and Minn-Dak Farmers Cooperative in Eastern North Dakota and Minnesota have indicated that the average yield of sugar beets following sugar beets in a crop rotation was less than from sugar beets following other crops. This study was initiated in 1985 to determine a) comparative yield of sugar beets following soybeans following sugar beets in a crop rotation, b) influence of soybean herbicide carryover on sugar beet yield, and c) influence of soybeans on sugar beet plant populations. The data was averaged over sugar beet yields in 1986 and 1987 following soybeans and barley seeded in 1985 and 1986.
Hand weeded sugarbeets following soybeans yielded 1072 lb/A less extractable sucrose than sugarbeets following barley when soybeans were not treated with herbicides. Sonalan (ethalfluralin) at 0.94, 1.12, and 1.31 lb/A and Treflan (trifluralin) at 0.75 and 1.0 lb/A, applied to soybeans preceding sugarbeets, reduced extractable sucrose per acre by 144, 601, 1010, 317, and 1003 lb/A, respectively, compared to sugarbeets following non-treated soybeans. The 5% LSD was 421 lb/A. Sugarbeets following soybeans treated with Treflan at 1 lb/A yielded 2075 lb/A less extractable sucrose than sugarbeets following barley. Sugarbeets following non-herbicide-treated soybeans had plant populations similar to sugarbeets following barley. Sonalan and Treflan carryover caused reductions in sugarbeet plant populations.


An enzyme immunoassay system was developed to measure raffinose in foodstuffs. A rabbit was immunized with a raffinose-protein conjugate, and serum containing antibodies to raffinose was collected and was used in a 96-well plate-based immunoassay. The method has a 2.5 hour analysis time, a minimum detectable level for raffinose of 0.1 ppm, and a useful dynamic range of 0.1-3 ppm. The antibody does not cross-react with glucose, fructose, galactose, maltotriose, citric acid, ascorbic acid, quinic acid, or malic acid at 0.1 M. Cross-reactivity with melibiose and sucrose is 0.8% and 0.008%, respectively.

Comparison of the immunoassay to a galactose oxidase procedure indicated that the immunoassay was a more accurate indicator of raffinose concentration. The method was also used to measure the raffinose content of cane sugar, beet sugar, honey, cranberry juice, orange juice, and apple juice samples. Raffinose concentrations of the samples varied from 0.3 ppm to ca. 2000 ppm. The results suggest that the immunoassay can rapidly determine raffinose concentrations in a variety of foodstuffs. A more field usable assay is being considered for development which will provide results in 15 minutes with similar specificity and sensitivity.

SPITIOLO*, PACIO, A. CURIONI, A. CRAPISI (University of Padova, 35100 Padova, Italy), G. VACCARI, G. MANTOVANI (University of Ferrara, 44100 Ferrara, Italy). - Enzymatic and total amino acid changes at different storing conditions for damaged and undamaged beets.

Damage to beet roots is a source of sugar loss, either by the formation of fragments which cannot be recovered or by metabolic and enzymatic processes particularly active during the first hours following the harvest. Since the sucrose decomposition and its regulation within practical beet storage conditions are still not completely understood (Sugar Technology Reviews 12: 143-265, 1985) acid and neutral invertase and sucrose synthetase, key enzymes of carbon metabolism in plants, aminopeptidase, splitting off an N-terminal residue with a free amino group, and total amino acid content in damaged and undamaged sugarbeets were evaluated. Enzymatic and amino acid investigation on the cold and hot extraction juice of the brei respectively were carried out. Beet samples of damaged vs. undamaged, interior vs. surface of pile, silos factory vs. field pile, T2 vs. T4, and T1 vs. T2 days by a one way analysis of variance and orthogonal contrasts showed significantly higher specific enzyme activity values (p<0.01). The total amino acid content, determined by Amino Acid Analyzer, was subject to slight variations. The same trend in aspartic and glutamic acid, serine and glycine levels was monitored.

TEMPLE, STEVEN R., V. E. BURTON, C. A. SUMMERS and M. KIRK. Agronomy and Range Science and Entomology, University of California, Davis, CA 95616 and Kearney Agricultural Center, 9240 South Riverbank Road, Parlier, CA 93648. - Epidemiological Studies of Beet Yellows Virus in California.

Several biological and cultural considerations have contributed to a resurgence of heavy beet yellows virus infection and serious losses to the California sugarbeet crop during the last four seasons. Studies were initiated in 1986 to determine the relative importance of the following: 1) The occurrence of other potential BYV vectors not reported earlier; 2) The relative importance of beet residues vs. alternate hosts as sources of primary BYV infection; and 3) The proximity of fall harvest and spring harvest areas. Sequential sampling of fields for BYV incidence has used ELISA methods and documented disease buildup reliably and efficiently. Aphid populations have been monitored by leaf sampling and by capture in water pan traps. New information on the importance of timing of infection has been obtained, and processors have cooperated in documenting the relationships between timing, incidence, and yield. Newsletters report BYV developments during key parts of the disease cycle, and the industry is studying
proposed changes in the existing disease-free program that would increase confidence in more stable sugarbeet yields. Integrated and multifaceted approaches to disease management are being emphasized.

TEMPLE, STEVEN R., MARY KIRK and ROBERT LEWELLEN. Agronomy and Range Science, University of California, Davis, CA 95616 and USDA/ARS, 1636 East Aisle Street, Salinas, CA 93905. - Field inoculation and screening of sugarbeet varieties and experimental lines for resistance to beet yellow virus.

The past four California sugarbeet crops have suffered substantial losses caused by infection with beet yellow virus, in spite of emphasis on disease-free programs established by the industry since 1965. Serological testing for BYV has been employed to 1) update our knowledge of BYV epidemiology, and 2) improve the efficiency of artificially inoculating varieties and experimental lines with BYV in an effort to improve levels of genetic resistance. Forty-seven hybrid varieties and 100 half sib families were planted at Davis in a replicated, split plot experiment in which paired rows represented inoculated and noninoculated treatments. Green peach aphids were reared under controlled conditions on plants inoculated and serologically validated for systemic BYV infection, then "harvested" for inoculating five-week old seedlings in the field in early June. ELISA results indicated an efficiency of 80-100% BYV infection among inoculated rows, and 27-40% in the noninoculated rows. Harvest data for sugar yield showed very highly significant differences among varieties and between the inoculated and noninoculated treatments. Results are being used by the California Seed Evaluation Committee to identify and recommend more resistant hybrids for growers in chronic BYV areas, and by sugarbeet breeders to further improve levels of genetic resistance in future varieties.

TERRY, NORMAN* and I. MADHUSUDANA RAO. Department of Plant and Soil Biology, 108 Hilgard Hall, University of California, Berkeley, CA 94720. - Role of phosphate in the carbon fixation, partitioning and export of Beta vulgaris.

Sugar beets (Beta vulgaris L.) were cultured hydroponically in growth chambers with normal and low levels of orthophosphate (P\textsubscript{o}) supplied in half-Hoagland's solution (low-P plants were supplied with 1/20th of the P\textsubscript{o} supplied to the control plants). Low-P treatment substantially increased the levels of starch and sugars (sucrose and glucose) in leaves with more of the fixed carbon being partitioned to starch than to sucrose. Low-P decreased the rate of photosynthetic CO\textsubscript{2} fixation by 25% and the rate of export of fixed carbon from leaves to other growing regions by 15%. The increased levels of sucrose in low-P plants were associated with fairly high rates of growth of fibrous roots but with relatively low rates of growth of storage roots. Low-P increased the amounts of certain enzymes including the phosphatases, and enzymes involved in starch and sucrose metabolism. We propose that low-P treatment decreased carbon fixation by decreasing stromal levels of ribulose bisphosphate, an effect attributable to an increased diversion of sugar phosphates towards the synthesis of starch, sugars and other non-P carbon compounds.


Smooth root sugarbeets, which would have the advantages of easier harvestability, less soil to transport, less bruising and breaking of roots resulting in lower storage losses, and a potentially greater efficiency in processing, are being developed at East Lansing, Michigan. Progress has been made: the percentage remains as the commercial cultivars MHE4 and USH23. However, they were one percentage point lower in sucrose with between 20-30 pounds less recoverable sugar per ton. At present, the most promising smooth root progenies have 30-40% soil reduction at harvest, 1 to 3 tons/acre less root yield, and a sucrose percentage almost equal to that of commercial cultivars. The growth characteristics of a smooth root line was compared to those of MHE4 and ACH176 cultivars in a 50-day sand culture greenhouse experiment. Results demonstrate that smooth root types and standard varieties partition assimilate similarly to plant parts. There was a tendency for smooth root types to produce fibrous roots lower on the taproot. Approximately 15% of the smooth roots had growth cracks. The use of smooth root lines as components of hybrids will be discussed.
With the entry of Britain into the E.E.C., British Sugar received a beet quota which allowed a substantial expansion of production. This was quickly carried out in the seventies and for the last few years effort has been spent in optimising the factories and reducing operating costs. British Sugar is the lowest cost producer in the E.E.C. and this is achieved by long operating runs, improved control and mechanisation to reduce labour and the installation of...
modern plant and processes to reduce production costs, particularly in fuel,
lime usage and sugar and operations. This paper seeks to highlight the latest
technical methods adopted by British Sugar to achieve these aims.

UNGAR, JOHN. Dianex Systems, 231 South Transit Street, Lockport, NY 14094. - Raw sugar decolorizing
"no activated carbon or bone char.
Many sugar refineries are using ion exchange resins as a polishing stage for the thick juice, following
bone char or activated carbon as the primary (gross) decolorizing step. In such cases, a higher color
level can be tolerated in the effluent from the primary decolorizers, which results in the following
advantages:
I) Longer service cycles of the primary decolorizers between thermal rejuvenations.
II) Longer useful life of the ion exchange resin, which is protected by the bone char, or activated
carbon from excessive fouling by very large molecules, and finely divided suspended solids.
III) Improved quality of the final product, due to the ion exchange absorbent removing certain color
bodies, and colorless organics, which are not absorbed by bone char, or activated carbon.
With proper care being taken in operating the ion exchange polishing units, the resin can be used for
several hundred, and in some cases thousands, of cycles before it has to be replaced completely. The
usual make-up (addition) rate is only 10-20% per annum, depending upon the individual plant conditions.
With the development of second generation macroporous ion exchange resins, such as DIAION PA-308, it is
possible to dispense with the use of bone char, or activated carbon. Thus refineries and factories where
no decolorizing has been practiced before, or where the bone char or activated carbon units require
replacement, may find the use of this ion exchange absorbent as both primary and secondary thick juice
(or remelt) decolorizer, a very efficient and economical solution. Experience has shown that DIAION PA-
308 can also be operated at temperatures up to 90 degrees C, and still meet the stability and other
requirements of health authority regulations (e.g., USDA Food Additives Reg. #173.25).

VACCARI, GIUSEPPE, G. NANTOVANI, F. ERDEM, and G. SGUALDINO. University of Fer-
rara, Ferrara 44100, Italy. - Beet dry substance and raw sugar moisture determi-
ned by near infrared spectroscopy.
The near infrared spectroscopy technique has already shown good results for the
determination of beet polarization and brix, and factory juices polarization.
Thanks to the rapidity of analysis, and the simplicity of the sample treatment,
this technique can be used for the determination of the beet dry substance and
raw sugar moisture. As far as the beet dry substance is concerned, whose determi-
nation is judged important for a better evaluation of the root quality, it is in-
dispensable to have at disposal a method of analysis that is as rapid as possible
and which does not need sample handling. Concerning raw sugar, the determina-
tion of moisture by means of a rapid and reliable method is extremely important mainly
for evaluating its storability for refining. The methods employed and results
obtained are shown and discussed.

VANHOOK, ANDREW. Chemistry Department, Holy Cross College, Worcester, MA.
01610. - Nucleation Revisited.
Updated review of nucleation in sucrose syrups and glasses. Raffinose, stachyose,
gelatin and agar at low concentrations are outstanding in inhibiting growth
formation in 73 and 90% syrups. This correlates with their influence on growth
rate. Very high concentrations of invert, etc. are required to match this
behavior and this is likely due to high viscosity rather than growth site
poisoning.

WANG, S., A. HANG, AND T. TSUCHIYA*. Department of Agronomy, Colorado State
University, Fort Collins, CO 80523. Chromosome studies of callus tissues and re-
generated plants from unfertilized ovule culture of sugarbeet (Beta vulgaris).
Cytological investigations were conducted on both callus tissues and regenerated
plants which were derived from unfertilized ovule culture of diploid and tetra-
ploid sugarbeet. Eleven regenerated plants from the ovule culture of diploid sugar-
beet showed varied ploidy levels (haploid 2n=9, diploid 2n=18 and tetraploid 2n=36).
Many plants showed chimerisms for their ploidy. Four plants from tetraploid sugar-
beet ovule culture were studied with the following results: two diploids (2n=18)
and two tetraploids (2n=36). Calli with different morphology showed different
chromosome constitutions and cell size. Dark green calli without morphogenesis
showed no dividing cells. Calli with yellow or brown color showed many giant
cells and different high ploidy numbers of chromosomes (2n=36, 72 and others),
including some giant chromosomes. Morphogenetic tissues showed mostly euploid
chromosome numbers and no high ploidy cells were found. (Supported by CSU Agri-
cultural Experiment Station Hatch project and donation by Seedex, Inc., Longmont,
Colorado.)

Sugar factories must respond to changing operating conditions during a campaign that affect the sugar yield and steam consumption of the factory. Computer simulation of different process alternatives and operating conditions affords the opportunity to optimize the process for maximum sugar yield and minimum steam consumption. A versatile computer program for sugar factory analysis called "SUGARS" can be used to evaluate sugar factory processes at different operating conditions by doing the material and heat balances. The results from SUGARS can be used to help determine the optimum process to maximize the operating margin (excess of product revenues over steam production expenses). A computer model of a typical sugar process is shown and different process alternatives are evaluated by SUGARS to predict the sugar yield, molasses purity and steam consumption with the corresponding operating margin.

WHITNEY, E. D.*. USDA, Agricultural Research Service, 1636 E. Alisal St., Salinas, CA 93905. - The enzyme-linked immunosorbent assay (ELISA) as a tool for resistance breeding for rhizomania control.

Rhizomania is a serious fungal transmitted virus disease of sugar beet in many sugar beet production areas of the world. Resistance to this necrotic yellow vein virus has been identified in sugar beet and in Beta maritima, a close relative of sugar beet. Procedures have been developed for field and greenhouse testing to evaluate sugar beet, B. maritima and their interspecific hybrids. ELISA values within a test may vary from 0.001 to 1.999 in greenhouse and field grown plants and from 0.034 to 1.999 within a cultivar. The values for noninoculated sugar beet ranged from 0.001 to 0.072. The difficulty that arises is the inability to identify a definitive point between whether the virus is present or absent in the test plant. The ELISA is not the panacea one might hope in resistance testing but does have a place in confirming the reaction of a field or greenhouse tested plant.

WHITNEY, E. D.*, D. C. ERWIN., and S. R. TEMPLE. USDA, Agricultural Research Service, 1636 E. Alisal St., Salinas, CA 93905, University of California, Riverside and Davis California. - Biology, inoculum production, and testing for resistance to Phytophthora drechsleri in sugar beet.

P. drechsleri causes a serious root rot of sugar beet during hot weather when the soil is saturated with water. We have studied factors that may influence inoculum production and testing for resistance. Corn meal agar and V-8 agar were equally good for mycelial growth and better than lima bean agar. The optimum temperature for growth was between 28 & 30C with no growth at 5 and 40C. The fungus grew better at a pH of 7.5 than at 4.2. Soil extract stimulated sporangial production more than sterile soil extract, tap water or distilled water. Zoospores and infested milo seed were effective as inoculum in greenhouse tests. Cultivar SP 85303-0 was highly resistant in greenhouse tests and in a field test when compared to seven other cultivars.

WINDELS, CAROL E.*, and DONNA J. NABBEN. Northwest Experiment Station, University of Minnesota, Crookston, MN 56716 - Characterization and pathogenicity of anastomosis groups of Rhizoctonia solani isolated from field-collected sugarbeet.

During 1985-88, diseased sugarbeet (Beta vulgaris) seedlings and plants > 6-wk-old with crown and root rot were collected from fields throughout the Red River Valley of Minnesota and North Dakota. Of 158 isolates of Rhizoctonia cultured from seedlings, 13 were binucleate. The remaining 145 isolates were multi-nucleate with characteristics typical of R. solani and were identified to anastomosis group (AG): AG-4 predominated and infected 63% of the seedlings, followed by AG-5 (23%), AG2-2 (4%), and AG-1 (4%). 5% of the isolates did not anastomose with the tester isolates (AG-1 through AG-9, and AG-B1). Of the 206 isolates from rotted roots of older plants, 97% were AG-2-2, 3% were AG-4, and <1% were AG-5. Pathogenicity tests on seedlings showed that 3 wk after planting, isolates of AG-1, 2-2, and 4, severely reduced stands, whereas AG-5 and the unidentified isolates were less pathogenic; the binucleate Rhizoctonia isolates were most pathogenic. When the same isolates were inoculated on 8- to 9-wk-old roots, all isolates of AG-2-2 were highly pathogenic; AG-4 isolates produced superficial lesions near the point of inoculation; and isolates of the other anastomosis groups and binucleate isolates were nonpathogenic.
Winter, Stephen R.* Texas Agricultural Experiment Station, Texas A&M University System, P. O. Drawer 10, Bushland, TX 79012. - Responses and interactions of irrigation and nitrogen in sugarbeet production.

Understanding nitrogen (N) responses at low irrigation (I) levels should improve our ability to grow high quality sugarbeets with limited irrigation. Sugarbeets planted 4 yrs in March were irrigated uniformly for emergence then grown at three I levels (0, 19, and 39 cm mean seasonal I) and four N rates (0 to 300 kg/ha). Root yield, sucrose content, and brei impurities were measured at final harvest in November. Root yield increased 5.3 kg/m² of I (0.6 tons/acre-inch). Increased I slightly lowered fresh weight sucrose content 2 yrs with no effect the other 2 yrs and reduced sucrose loss to molasses because both amino-N and K in brei decreased 41 kg/ha/cm of I. Applied N increased I root yield 2 yrs when residual N (0-2.4 cm) was 120 to 128 kg/ha but not when residual N was 258 kg/ha, reduced sucrose content only when residual + fertilizer N exceeded 300 kg/ha, increased brei Na 0.38 ppm/kg N but increased brei K only when residual + fertilizer N exceeded 300 kg/ha, and increased amino-N in brei and sucrose loss to molasses slightly below and greatly above 300 kg/ha residual + fertilizer N. Two yrs there was more root yield response to N at high I than at low I (7.8, 16.8, and 22.4 t/ha increase for November. Root yield increased 5.3 kg/m² of I (0.6 tons/acre-inch). Increased I slightly lowered fresh weight sucrose content 2 yrs with no effect the other 2 yrs and reduced sucrose loss to molasses because both amino-N and K in brei decreased 41 kg/ha/cm of I. Applied N increased I root yield 2 yrs when residual N (0-2.4 cm) was 120 to 128 kg/ha but not when residual N was 258 kg/ha, reduced sucrose content only when residual + fertilizer N exceeded 300 kg/ha, increased brei Na 0.38 ppm/kg N but increased brei K only when residual + fertilizer N exceeded 300 kg/ha, and increased amino-N in brei and sucrose loss to molasses slightly below and greatly above 300 kg/ha residual + fertilizer N. Two yrs there was more root yield response to N at high I than at low I (7.8, 16.8, and 22.4 t/ha increase for highest N rate at 0, 19, and 79 cm I). High N was more detrimental to sucrose content and impurities at low I then at high I. In conclusion, applied N should likely increase as I is reduced but even with reduced N, sucrose loss to molasses will likely increase as I is reduced.

Wozniak, Chris A. and Lowell D. Owens. USDA, Agricultural Research Service, Plant Molecular Biology Laboratory, Room 118, Building 005, BARC-West, Beltsville MD 20705. - Agrobacterium-mediated sugarbeet cell transformation.

A morphogenic cell suspension culture of line E1-1 was cocultivated with A. tumefaciens strain LBA4404 containing the binary vector system pAL4404 and pBI121. From one to twelve days following cocultivation, cells were assayed for the expression of beta-glucuronidase, a transformation marker which produces a blue intracellular precipitate following incubation of cells in the appropriate substrate solution. Transformation was observed as a low-frequency event, yielding 0.1 - 1% transformed (expressing) cells. Methods for enhancing this frequency are under study and include effects of bacterial concentration, virulence gene induction, length of cocultivation period, and other sugarbeet/A. tumefaciens genotype interactions. Transformed cells are currently undergoing selection for resistance to geneticin and will be regenerated.

Yeh, Y.1 C. M. Rush2, and S. D. Lyda1. Texas Agricultural Experiment Station, 1Amarillo, TX 79106, and 2College Station, TX 77843. - Inter- and Intraspecific Restriction Fragment Length Polymorphisms in the Genus Aphanomyces. Aphanomyces cochlioides Dresch. is a water mold that causes sugar beet black root. A comparative analysis of mycelial DNA was made from two isolates of the fungus from Texas, two isolates from Minnesota, and one isolate each from Michigan, California, The Netherlands and Sweden. DNA was isolated from mycelium using a modified procedure of Garber and Yoder (Anal. Biochem. 135:416-422). Restriction endonuclease enzymes were used to examine intraspecific variation of the fungal DNA. Fragment patterns were compared on agarose gels following electrophoresis of digested DNA. DNA from other species of Aphanomyces was studied by this technique to determine phylogenetic relationships based upon restriction fragment length polymorphisms.

Yu, Ming H. USDA, Agricultural Research Service, 1636 East Alisal St., Salinas, CA 93956. - Assessment of resistance to root-knot nematode in sugarbeet.

Root-knot nematodes, Meloidogyne spp. can be a serious problem to sugarbeet (Beta vulgaris) crops. However, some nematodes are parasitic to more than 90 host crops in addition to sugarbeet. The three Patellares species, i.e., B. potatorum, B. procumbens, and B. webbiana, that have high resistance to Heterodera schachtii were susceptible to Meloidogyne spp. Therefore, it was important to investigate the possible existence of tolerance or resistance to this nematode complex within sugarbeet germplasm. A wide variety of sugarbeet genotypes that were derived from domestic and foreign sources were used in this study. Assessment was conducted in the laboratory and greenhouse. Early infection by larvae of this nematode species was characterized by the formation of small galls or exudation of egg matrices on the root system of sugarbeet seedlings. However, gall formation does not necessarily indicate susceptibility of a plant. The preliminary observations from this study showed that approximately 9% of the inoculated seedlings had detectable galls on their root system. At the present, classification of susceptibility or resistance of a plant is pending on the fate of gall size, gall number, and nematode reproductivity during the subsequent growth of the plant.
Reactions and derivatives from beet leaf tissue culture.

Plant tissue culture has become an important tool in exploration of the biological characterization of plants. Leaf explants from selected beet genotypes of various germplasm sources were cultured on modified Murashige and Skoog media plus N6-benzyladenine and 1-Naphthaleneacetic acid. Callus formation was most prolific on leaf samples excised from accessions of Beta vulgaris and B. maritima of section Vulgares. However, little or no callus was induced from explants of B. patula of Vulgares, and B. patellaris and B. procumbens of Patellares. Although roots and root-like structures occasionally appeared on calli that formed on the auxin-free medium, none of those roots developed into useful root systems in the established regenerants. The upper threshold temperature for beet in vitro regeneration was about 33°C. At this temperature and above explants from accessions of more than 75% of Beta species examined did not survive or survived but did not differentiate. It seems that in the genus of Beta the further the species were morphologically from B. vulgaris the less was their ability to regenerate under investigated conditions. Somaclonal variation in sugar beet regenerants involved leaf morphology and chromosome complements.

Applications of porous ceramics to hot gas clean up.

The EPA’s New Source Performance Standards (NSPS) say that particulate emissions must not exceed 0.015 grains per standard cubic foot (gr/SCF) of stack gas. This is a relatively difficult requirement to meet. Porous ceramic, both as a rigid matrix and in the form of woven cloth, has proved to be equal to the task. Further, by utilizing high performance particulate removal (HPPR), it is possible to use filtered hot gas for a secondary purpose—driving a turbine for example. Dry hot gas clean up can also avoid scrubbing and the co-current wet waste problem associated with scrubbing. The paper discusses a number of specific applications and the results obtained.