# ABSTRACTS

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# Section A, Agronomy
# Oral Presentations

ALFORD*, C. M., NELSON, K. K., and MILLER, S. D., Department of Plant Sciences, Univeristy of Wyoming, Laramie, WY 82071. **Plant population, row spacing and herbicide effects on weeds and yields in sugarbeets.**

Todays agricultural economy dictates that producers fine-tune their farming practices to maximize yields and minimize production costs. To help identify practices that might benefit sugarbeet producers, the University of Wyoming is conducting a two year study on the role that row spacing, sugarbeet population and herbicide treatments play in weed control and sugarbeet yield. The study was conducted on a Mitchell sandy loam soil at the University of Wyoming Agricultural Experiment Station at Torrington, WY with glyphosate tolerant sugarbeet. The experiment was conducted as a split plot with three to six replications. Main plots were three sugarbeet row spacings and subplots a factorial arrangement of five plant populations and weed management level (2 applications of glyphosate at 0.42, and 0.84 kg $ha^{-1}$, 4 micro-rate applications of desmedipham-phenmedipham plus triflusulfuron plus clopyralid and methylated seed oil (MSO) at 90 + 4.5 + 25 g $ha^{-1}$ + 1.5% v/v, 3 applications of a conventional rate of desmedipham-phenmedipham-ethofumesate at 290 and 370 g ai $ha^{-1}$, a hand weeded and a weedy check plot. In year 1, the 38 cm row spacing produced the highest yields, least weeds and highest sucrose. Weed control and yields were best in the hand weeded and 2 glyphosate application treatments.

DALE*, T. M. and RENNER, K. A., Michigan State University, Plant and Soil Sciences Building, East Lansing, MI 48824. **Timing of postemergence micro-rate applications based on growing degree days in sugarbeets (*Beta vulgaris*).**

In 2000 the "micro-rate", a combination of desmedipham & phenmedipham at 0.09 kg/ha or desmedipham & phenmedipham & ethofumesate at 0.09 kg a.i./ha + triflusulfuron at 0.004 kg/ha + clopyralid at 0.023 kg/ha + 1.5% methylated seed oil (MSO), received registration in Michigan. The micro-rate provides good to excellent annual weed control and allows the grower to apply POST herbicides throughout the day and not just in the evening. The herbicide label states that micro-rate treatments should be applied every 5 to 7 days. Frequent micro-rate applications can result in excessive sugarbeet injury and greater herbicide/application costs. However, too few applications can result in poor weed control which can reduce sugarbeet yield and quality. Weed growth is dependent on temperature and moisture rather than calendar days. In 2001, an experiment was conducted to determine the micro-rate application timing that controlled weeds with the least sugarbeet injury. Treatments included applications every 7 days, as needed, every leaf pair, or every 175 and 275 GDD (base 1.1 C). Sugarbeet was planted April 5, Arpil 17, and May 3 in 2001. The three planting dates were considered an early, normal, and late planting date. Sugarbeet injury was similar across all treatments and planting dates with HM "E-17. However, differences in injury were observed with Beta "5400" for April 5 and May 3 planting dates. Overall week control was greater with the 175 GDD treatment compared to other treatments when averaged over the three planting dates. Redroot pigweed was not controlled as well when micro-rates were applied every 275 GDD. However, recoverable sucrose in the 275 GDD treatment was equal to or greater than in other treatments, and the number of micro-rate applications was reduced by 2 or 3 compared to the 7 day or 175 GDD timing. This research was repeated in 2002.

DÜRR, C, BEAUDOIN, N, GUÉRIF, M, MACHET, JM, DAMAY, N, CARIOLLE, M, and DUVAL, R. **Some useful functions to the growth analysis and development of sugar beet.**

PRESENTATION CANCELLED

GUÉRIF, M. and LAUNAY M. **Spatial calibration of a sugar beet growth model by assimilation of remote sensing data. Application to the yield forecast at the scale of sugar beet area around a factory and precision farming.**

The models that simulate the growth and the development of the crops are privileged tools in decision making to help in crop management as well as for the yields estimation. In the case of precision farming, the target is to establish a diagnostic of the growth stages and of the yield potentials at the inter-plot scale in order to spatially adapt the cropping technique. When estimating the production at a regional level, one will seek to take into account the spatial variability of the environment and the techniques used at the entire production area scale to better forecast the yield variability. In both cases, it is necessary to use a spatialized application of a crop model that will raise the problem of the knowledge of the entry variables and of the non stationarity of some parameters in the relevant area. The use of a remote sensing data, which gives repeated access in the course of the crop cycle to growths stages of the canopy helps control the simulations induced by the crop model. The assimilation of remote sensing data in the model allows to re-estimate certain input variables as well as the parameters which vary in space and which are hard to measure accurately, and considerably help the prediction ability of the model.
Two examples of the implementation of this method are developed, using the growth model SUCROS as well as airborne and satellite remote sensing date (SPOT). The first method concerns yield estimations on sugar industry feeding ponds level and is based on approximately fifty plots. It is demonstrated that the applied method, in combination with rules derived from the analyses, enables a 20% reduction of the wrong yield estimations (when this model is being used solely) to 11% (when this model is used in combination with the remote sensing date). It further allows to estimate parameters (factors expressing the crop establishment, the maximum rooting depth, ...) which are most relevant for the diagnoses of growth conditions of the crop. The second example consists in the diagnosis of growth stages at the inter-plot scale, for two plots of an experimental site in "precision agriculture". It is again demonstrated that the integration of remote sensing data enables the model to better restore the spatial variability of the growth stages of the crop and of the yield, as well as the hydric situation of the soil inside the plots. The model thus spatially calibrated constitutes an effective tool for the spatialized management of cultural techniques pertaining to the growth and soil status (irrigation, fungicide, ...)

KNISS, A. R., WILSON, R. G., BURGENER, P. A., and FEUZ, D. M., University of Nebraska, 4502 Avenue I, Scottsbluff NE 69361. **Economic analysis of herbicide tolerant sugarbeet.**

Agronomic and production aspects of herbicide tolerant sugarbeet have been well documented in recent years. However, few studies have compared the economic impact of herbicide tolerant sugarbeet with conventional weed management strategies. Previously generated agronomic data from major US sugarbeet growing regions were assembled, and an economic analysis was conducted. The purpose of the analysis was to compare the profitability of herbicide tolerant sugarbeet to conventional weed control systems used in each of the growing regions. As herbicide tolerant sugarbeets have not yet been sold commercially, it is unclear how costly the anticipated technology fee will be. The amount a producer could afford to pay for the new technology was estimated from net economic returns. With several widely-used sugarbeet herbicide patents set to expire, a reduction in conventional herbicide costs is expected. Breakeven values for the tech-

nology fee were calculated incorporating this change.

KOCH, H. J., CHRISTODULOS, P., and MILLER, H. **Conservation tillage for a sustainable sugar beet production in Germany – Environmental and Phytopathological Aspects.**

Soil compaction and soil erosion can be severe environmental hazards which are closely related to agricultural land use. In arable cropping conservation tillage can be an effective means to protect the environment against these hazards. In Germany, ecological and economical benefits have resulted in a substantial increase of the beet crop area cultivated with conservation tillage systems during the past years (about 25 % of the national beet crop in year 2002). These tillage systems require less agricultural inputs in terms of energy (minus 8 %) and are characterized by plant residues remaining on the soil surface (10 to 50 % soil cover) to prevent soil erosion (up to minus 95 % of soil loss). Additionally, stable soil aggregates generated by conservation tillage increase the machine bearing capacity and protect against subsoil compaction. On the other hand, the development of pests and diseases (slugs, DTR and Fusarium sp. in wheat) can be promoted by surface plant residues. These aspects are reviewed with reference to long term results from German field experiments.

LAMB[1], J. A., SCHMITT[1], M. A., BREDEHOEFT[2], M. W., and ROEHL[2], S. R., [1]Dept. of Soil, Water, and Climate, Univ. of Minn., 1991 Upper Buford Circle, St. Paul, MN 55108, and [2]Southern Minnesota Beet Sugar Cooperative, 83550 Cty. Rd. 21, P.O. Box 500, Renville, MN 56284. **Management of turkey and swine manure derived nitrogen in sugar beet cropping system.**

Livestock operations, mainly poultry and swine, are increasing in size and impact in the Southern Minnesota sugar beet growing area. Manure research data concludes that manure has a positive effect on crop production from its effects on soil nutrient availability and soil physical properties. A concern has been raised about the effect of late season nitrogen mineralized from the manure on sugar beet quality. The implications of the manure-N release are critical, especially to sugar beet growers. This research project has been designed to: 1) measure manure application effects on sugar beet root yield and quality compared to fertilizer N applications and 2) determine the effect of turkey and swine manure mineralization difference on sugar beet root yield and quality. A three year study was conducted to measure the effects of manure application directly before sugar beet production. The treatments include fertilizer nitrogen, turkey manure, and swine manure. The manure applications occurred early November in the year before sugar beet production. Fertilizer nitrogen was applied in a series of rates to determine the equivalent of the N supplied by manure. The results from the three sites of this study indicate that the use of manure on field with no prior manure application may not be as detrimental to sugar beet quality as originally thought. If manure is applied at reasonable rates equivalent to the N fertilizer recommendation, it does not negatively affect sugar beet recoverable sucrose per acre on fields with no manure application history. Excessive application rates of manure will reduce quality.

MALNOU, C., JAGGARD, K. W., and SPARKES, D. L. **Nitrogen fertilizer recommendations for sugar beet: a canopy approach.**

Few UK soils have the capacity to supply adequate nitrogen (N) in an available form at the rate and duration required by the beet crop. Consequently, for most soils, the supply of N has to be supplemented with fertilizer. The current N recommendation system used in the UK produces recommendations which are within 15 kg N/ha of the optimum for maximum sugar yield in only 30% of cases - as determined in

experiments chosen to represent the UK sugar beet crop. A mineral N system based on results of soil analyses offers almost no improvements. In an attempt to make recommendations more field specific, we have studied the physiology of N fertilizer use on the expansion and subsequent activity of the foliage canopy. Five experiments were carried out at four sites within the UK to determine the smallest N fertilizer rate which is the first to produce 85% cover and to compare this with the optimum rate for maximum sugar yield. The field experiments were grown under conditions of optimum husbandry, except for N fertilizer treatments, which ranged from 0 to 160 kg N/ha. Canopy cover was assessed throughout the season and sugar yield determined. The yield response to N fertilizer was not a linear plus exponential curve but a split line response. Both the current UK N recommendations and the smallest amount of N to reach 85% cover were within 20 kg N/ha of the optimum for maximum sugar yield in only 43% of cases. Agreement between the recommended N dose and the optimum N for maximum sugar yield showed possibilities for improvement. The canopy approach emphasized the relationship between N, canopy expansion and sugar yield.

MAY, M. J., CHAMPION, G. T., and QI, A. **Novel weed management options in GM herbicide tolerant sugar beet.**

Methods of producing effective weed control with environmental benefits are limited with current selective herbicides and/or inter-row tillage; in most countries, weed control commences pre-emergence or at the cotyledon stage of weeds (and crop). GM herbicide tolerant (GMHT) sugar beet would allow treatment at later growth stages with glyphosate and offers opportunities to manage and manipulate weeds for environmental benefit. In order to enhance this advantage, we have developed a simple over-the-row band spraying technique using a conventional overall sprayer to control in-row weeds first and those between the rows, if and when necessary, with a later overall spray application. In 1999 and 2000, five experiments investigated the effect of weed management strategies on yield of glyphosate tolerant GM sugar beet. Glyphosate was applied at timings between 207 and 864 day degrees above 3oC (°Cd) after sowing and followed by a second application between 698 and 1022°Cd. In other treatments, glyphosate was applied in approximately 20 cm bands over the sugar beet rows at similar but fewer timings up to only 586°Cd. These were followed by a second but overall application between 401 and 811°Cd. Treatments were compared to untreated controls and programmes of current commercial herbicides commencing between 79 and 222°Cd. Yield reductions occurred if spraying was delayed after the critical period for weed competition, but the band spray technique allowed non-competitive weeds to remain between the rows until later in the season.

MILLER, H., KOCH, H. J. and BÜRCKY K. **Conservation tillage for a sustainable sugar beet production in Germany – Yield and economic effects.**

In Germany sugar beets are mainly grown on loamy soils that are well suited for ploughless tillage and drilling into mulch residues. Thereby the growing is risky due to water erosion. Since 1989 the agricultural department of Südzucker AG carries out long term trials with 4 tillage systems at 9 sites in Southern Germany. The following tillage systems are tested: Conventional (P – Ploughing): After harvest of cereal crops, usually single or double stubble tilling is carried out. Depending on the soil type an autumn, winter or spring furrow follows. Conservation (I – intensive loosening, M – flat loosening). On the contrary, in the case of reduced tillage using implements not turning the soil around, a mulch layer from the harvest residues of the previous and/or catch crop covers the soil surface. Direct drilling ( D ): The cultivation of cereals and sugar beets without any form of soil preparation in the rotation is called direct drilling (Zero-Till, No-till). In summary, the sowing of sugar beets into mulch makes it possible

to obtain yields that are both, high and stable, if tillage is adopted to the local conditions. The introduction of these systems resulted in a considerable reduction of erosion damages in row cultures such as sugar beet or maize. Lower yields are compensated by positive effects such as lower surface- and ground water pollution.

SIMS*, A. L. and SMITH, L. J., University of Minnesota, Northwest Research and Outreach Center, 2900 University Ave., Crookston, MN 56716. **Sugar beet root yield response to band and broadcast applications of phosphorus fertilizer in low P testing soils.**

Concerns about phosphorus (P) in the environment will lead to more scrutiny of excess P fertilizers being applied in agriculture, encouraging growers to improve P fertilizer utilization efficiency. In many crops, optimum yields have been obtained when P fertilizers were banded at rates considerable less than would be required for a broadcast application. Our objective was to examine sugar beet yield response to P fertilizer when that fertilizer was banded with the seed at planting or broadcast prior to planting. Phosphorus fertilizer was broadcasted at rates of 0 to 44.4 kg P $ha^{-1}$ in 7.4 kg P $ha^{-1}$ increments, prior to sugar beet planting with or without additional liquid fertilizer applied at planting in a band with the seed (28 L $ha^{-1}$ of 10-34-0). Phosphorus fertilizer application, whether broadcasted or banded, did not affect the sucrose concentration in the sugar beet roots. The greatest yielding broadcast rate of P fertilizer produced 5.6 to 18.0 Mg $ha^{-1}$ more sugar beet roots than the control (no P fertilizer) in 3 site-years. However, when 28 L $ha^{-1}$ of 10-34-0 was banded with the seed at planting and no P fertilizer was broadcast prior to planting, similar root yield increases over the control were observed. When P fertilizer was banded with the seed there was no further yield increase from broadcast applications of P fertilizer. Phosphorus fertilizer utilization can be increased in a sugar beet crop by banding it was the seed compared to broadcast applications prior to planting.

SMITH*, J. A., GATCH, R. E., and PALM, K. L., University of Nebraska, 4502 Ave. I, Scottsbluff, NE 69361. **Plant spacing accuracy of sugarbeet planter models and of options within planter model.**

Most sugarbeet production in the U.S. is currently planted-to-stand with no subsequent adjustment of plant spacing or plant population. Incorrect plant population, or inconsistent spacing between plants can suppress sugarbeet yield potential, increase weed pressure, reduce harvest efficiency, and increase harvest loss. To achieve good plant spacing accuracy, growers need to know how planter models compare, which planter options are best, and how field performance is influenced by field speed and seed coating. A field study was conducted at Scottsbluff, NE to compare three current U.S. planter models (Deere MaxEmerge, Case-IH ASM, and Monosem NG Plus II) and two European sugarbeet planter models (Kleine Unicorn 3 and Monosem Meca 2000) for accuracy of spacing between plants. Several options were compared within each of the three U.S. planter models. All planters were compared at two field speeds (5 km/h and 8 km/h), with two seed coating types (full pellet and minimal coating build-up), and within two planting dates in 2001. Six hundred spacings between plants were measured for each combination of planter configuration, field speed, seed coating type, and planting date. When compared as a single factor averaged over other factors, seed spacing accuracy was better for 5 km/h field speed than 8 km/h; and full pelleted seed was better than minimal seed coating. Averaged over both field speeds for pelleted seed and comparing the most accurate option tested, the Kleine Unicorn 3 had better plant spacing accuracy than all other planter models; the Case-IH, Monosem NG Plus II and Monosem Meca 2000 were similar and also better than the Deere MaxEmerge. Field speed, seed coating, and planter options, particularly the seed tube options with the Deere MaxEmerge model, were often

more important than basic planter model for accuracy of spacing between plants.

VANDERGETEN, J.-P. **Impact of the position of silos, the engines and the loading techniques on the quality of the sugar beets.**

In Belgium, the majority of the sugar beets is stored in the fields during variable periods. The beets are loaded by cranes in articulated trucks. In the beginning of the harvest campaign the storage period is generally very short. At the end of the campaign, 1/3 of the production is stored for a longer period. Currently, 10% of the beets undergo a complementary cleaning at the time of loading. Since two years some steps have been undertaken in order to optimize these different operations. The objective is to improve the external quality of the beets by reducing the tare and the root breakage and damage.

To reach this objective, different steps have been undertaken:

- inventory and follow-up of the material used by the enterprises for the loading of the beet piles. A particular attention has been granted to the crane equipment, to the shape of the grab, to their size and to the types of teeth that equip them. The association of the grab and the cleaner loader has also been analyzed. Some measures have been done of the damages that they caused to the roots;
- inventory of the sites where beets are stored. The elements that influence the quality of the production have been analyzed without forgetting other aspects like accessibility and security;
- analysis of the loading techniques. The operator of the crane plays a primordial role in the quality of work. This survey permits to clear the positive and negative points;
- impact of a permanent control by a supervising person during the loading on the production quality;
- attempts to improve the grabs by suppression of the sharp edges of some elements. Some comparative measures have been done on the beets;
- contacts with the intervening parties in order to analyze the results and to confront the different opinions.

This work has been done in collaboration with the Project Group Agricultural Engineering that is composed of agronomists representing all Belgian sugar factories. A booklet of synthesis should be published in 2003.

WILSON, R. G., University of Nebraska, 4502 Avenue I, Scottsbluff, NE 69361. **Improving weed control with a new micro rate formula.**

Field studies were conducted near Scottsbluff, Nebraska in 2001 and 2002 to compare weed control, crop injury, and crop yield from a series of phenmedipham plus desmedipham plus triflusulfuron plus clopyralid treatments applied either broadcast or as a 18 cm wide band over the sugarbeet row. The full rate of phenmedipham plus desmedipham plus triflusulfuron plus clopyralid was 185 plus 185 plus 101 g $ha^{-1}$ and was reduced by 25, 50, or 75% to achieve four rates, these four rates were combined with 1.5 or 3% methylated sunflower oil to achieve a total of eight treatments. Each of these treatments plus the full rate of phenmedipham plus desmedipham plus triflusulfuron plus clopyralid applied without methylated sunflower oil, were applied three times starting when the crop was in the cotyledon stage of growth.

# Section A, Agronomy
## Poster Presentations

ABDOLLAHIAN-NOGHABI, M. and SHAHBAZI, H. A. **Critical period of weed control in sugar beet in Mashhad.**
ABSTRACT NOT SUBMITTED

ABDOLLAHIAN-NEGHABI, M. **Presentation of Iranian Sugar Industry, Sugar Beet Production and Research.**
ABSTRACT NOT SUBMITTED

MASOUD[1], H. and ALIMORADI[1]*, I., [1] Islamic Azad University, Science and Research Branch, P. O. Box 19395-1775, Tehran, Iran. **Factors affecting quality of sugar beet at semi-arid area of Isfahan.**

One of the main reasons for sugar loss especially in the central part of Iran is the quality of sugar beet. Sugar beets produced in semi-arid areas have lower quality in comparison with those in temperate climates. To determine the role of different quality parameters in such conditions, 7820 samples were taken from 14 locations, in which 8 were located in semi-arid areas and 6 were located in temperate climate, during the years of 1997-98 and 1998-99. All the samples were carried to Isfahan Research and Laboratory Services and analyzed with a Betalyzer for sugar content (S.C.), Sodium (Na), Potassium (K) and amino nitrogen (amino N). The results showed that samples from semi-arid locations have a lower S.C. and higher impurities. The average of S.C. and Na in Lenjan were 14.31% and 6.01% (meq/100 gr. beet) whereas in Semirom were 19.51% and 1.94 (meq/100 gr. beet) respectively. Lenjam is located in a semi-arid area and Semirom is located in a temperate climate. The lowest amino-N was observed in Lar (average of 1.82 meq/100 gr. beet) and the highest was in Ghohab (average of 5.09 meq/100 gr. beet). The highest K content observed was 7.28 (meq/100 gr. beet) in Khanmirza and the lowest was 5.71 (meq/100 gr. beet) in Lar. Among all different impurity parameters Na had a more important role in sugar beet quality in all of the semi-arid locations studied. The correlation coefficient of Na with S.C. was -0.876 in Lenjan and -0.14 in Ghandoman. Amino-N showed a positive correlation in most of the locations.

ALIMORADI*, I., Tahavol Design & Engineering Co, No 121, Hamsian Alley between Kargar & Jamalzadeh, Keshavarz Blvd., Tehran, Iran. **Sugar beet production in Iran - A study on production restricting factors.**

Sugar beet production has a history of one century in Iran. The first sugar factory was established in south of Tehran in 1895. Now there are 34 beet factories operational in Iran with a total capacity of more than 70000 tons per day. According to the 2001 sugar syndicate record, the total sugar beet production has reached to 4.6 million ton, about 65% of the nominal capacity of sugar factories. Iran is located in a semi-arid area with 250 mm annual precipitation, which is varied from 50 mm in desert to 1000 mm near Caspian Sea. Therefore all the sugar beet cultivation should be irrigated. The sources of water for irrigation could be wells, rivers, spring or Qanat. Another important factor is different climatic conditions in the country, which varies from cold temperate in mountainous areas of Zagros chain to semi-tropical climate near Persian Gulf. For this reason the vegetation period is varied from 150 to 210 days. There are 90000 farmers for 170000 ha of sugar beet cultivation so the average

of a beet field is less than 2 ha. On the other hand only a few farmers have college education and most of them are uneducated. Sugar beet is growing in a very light to very heavy soils, very salty to normal soils. Most of the farms are in clay soil with very low organic matter. 60% of the total sugar beet cultivation are mechanized or semi-mechanized whereas the 40% of the rest is still cultivated by traditional methods. As a consequence, low plant population in these fields produces low yield and low quality. This paper is an overview of these restricting factors on sugar beet production in Iran.

ANFINRUD[1], M. N. and KHAN[2], M. F. R., [1]Interstate Seed Company, Box 338, West Fargo, ND 58078, and [2] North Dakota State University- University of Minnesota, Plant Sciences Department, Fargo, ND 58105. **Seed size fractions among various Beta vulgaris genotypes were evaluated for embryo size, germination, and reaction to environmental stress.**

The sugarbeet industry in the USA utilizes a range of seed sizes to plant the sugarbeet crop ranging from Small to X-Large. Diverse genetics exist that carries disease tolerance, sugar content, sugar yield etc. The diversity of agronomic traits found in the seed is also expressed in the size of the seed that is produced and processed for sale. Some varieties produce predominatly small to medium sized seed and some varieties typically produce Large and Extra Large seed based on seed diameter and thickness. The purpose of this study is to evaluate seed size differences of three diverse commercial varieties representing genetics sold in the Red River Valley by Syngenta, Beta Seed and Vanderhave. Parameters measured are embryo weight, hull weight, germination, germination rate, emergence under various stress tests, and greenhouse depth of planting evaluation. Significant differences were found in germination and emergence among seed sizes but interactions existed among varieties. Small seeded varieties tended to have better quality indicators in the small fraction rather than the large. Conversely, a larger seeded variety had better quality in the large compared to its corresponding small fraction.

ASHLEY[1], R. O., BERGMAN[2], J. W., and ECKHOFF[2*], J. L. A., [1]NDSU Dickinson Research Extension Center, Dickinson, ND 58601, and [2]MSU Eastern Agricultural Research Center, 1501 N. Central Ave, Sidney, MT 59270. **Sugarbeet (*Beta vulgaris*) grown on fumigated soils.**

Sugarbeet is a high value crop and producers want to include it in the crop rotation as often as possible. However, disease and nematode problems can be caused by shorter rotation and may reduce yield and quality of sugarbeet, making the crop less profitable for both producer and processor. A field study was conducted for two years at three locations in northwest North Dakota and northeast Montana to study yield and quality losses of sugarbeet grown in several rotations. Methyl bromide, a soil fumigant, was used to reduce disease, nematode and insect populations in replicated plots. After fumigation, producers seeded the plots along with the rest of the field. In cases with three or more years of rotation, plant stand appeared to be injured by methyl bromide treatment, although yield and quality were not always affected. In fields with a two year rotation, fumigation usually improved stand, yield and quality. These data demonstrate that three or more years between sugarbeet crops in a rotation can improve yield and quality of the sugarbeet crop.

AYALA GARCIA, J. M. **Evolution in the efficacy of Metamitrone in the control of weed in spring sugar beet in Spain.**
**Abstract not received**

BARTOCCI, F. , SADAM, Italy, **The Use of GIS for Mapping Fertility**

Since 1999 the agronomical service of SADAM sugar industry is collecting data on sugar beets growing in Marche, a region in the middle of Italy. These data are about:

- Field Morphology Property (size, slope, exposure)
- Chemical and Physical properties of soil (Texture, pH, Carbonates, Organic Matter, Total Nitrogen, C/N, Cationic Exchange Capacity)
- Nutritional properties (N-CaCl2, P, K, Na, Ca, Mg, Fe, Mn, Cu Zn, B)
- Agronomical practices (Irrigation, kind of tilling, Rotation of crops, fertilization).
- Phyto-pathologic conditions of soils and crops (Nematodes e Rhizomania, cercospora etc )
- Leafs nutritional conditions (N and microelements)
- Technological properties of sugar beets (°Z, Na, K, α-N; Inverted Sugar)

Until now we collected data of more than 9000 fields; each of them is geographically identifiable trough latitude and longitude co-ordinates. All the information were inserted in a electronic database and were used for the construction of a GIS (Geographical Information System). This instrument makes the consultation of data collected simpler, also because it allows to obtain thematic maps of Marche territory about each kind of information. In the paper we show the more significant thematic maps obtained with data of the last 4 years. These maps help field's operators to know in a very simple way information about the fertility of soils and their nutritional and phyto-pathologic conditions and allow to choose the best agronomical practice to improve the productivity of sugar beets and other crops.

BIANCARDI[1], E., MARCHETTI[2], R., STEVANATO[1*], P., BENEDETTI[3], A., and DE BIAGGI[1], M., [1]Istituto Sperimentale per le Colture Industriali, Sezione di Rovigo, viale Amendola 82, 45100 Rovigo, Italy, [2]Istituto Sperimentale Agronomico, Sezione di Modena, viale Caduti in Guerra 133, 44100 Modena, Italy, and [3]Istituto Sperimentale per la Nutrizione delle Piante, via della Navicella 3, 00184 Rome, Italy. **Uptake of nitrogen by sugar beet from deep layers of the soil.**

The dynamic of nitrogen in the soil is one of the most complex among the main nutrients. Therefore, it is still very difficult to establish the optimal quantity of nitrogen needed by cultivated plants. This element influences greatly the sugar beet crop: its shortage limits sugar production, while excess causes a lowering of processing quality. The matter is problematic because there is a fine line between shortage and excess. Moreover, excessive use of nitrogen fertilisers causes pollution of ground and surface water. To establish with sufficient accuracy the amount of applied nitrogen, it is necessary to know exactly the quantity of the element available in the whole profile of soil explored by the root system. In several countries, sugar beet root system was observed to be capable of reaching a depth of 2.50-3.00 metres. Thirty-two soil profiles were sampled during 3 years in areas of intense sugar beet cultivation in northern Italy. Soil samples were taken from fields where variety tests were in progress, thus ensuring data regarding the climate and yield, all of which are necessary for the correlation of the different sets of data. Twelve soil samples per soil profile were taken every 0.25 m, down to a depth of 3.00 m. To detect the moment when the crop begins the nitrogen uptake at a given depth, a test was set up with $^{15}N$ injected into the soil at 2.00, 2.50 and 3.00 m from the surface. About 30% of the profiles displayed relatively high concentration of available nitrogen in the deep layers. This means that the nitrogen fertilization based on analysis of samples collected at insufficient deep can lead to underestimate the availability of nitrogen in the soil.

BREDEHOEFT[1*], M. W. and LAMB[2], J. A., [1]Southern Minnesota Beet Sugar Cooperative, 83550 Cty. Rd. 21, P.O. Box 500, Renville, MN 56284 and [2]Dept. of Soil, Water, and Climate, Univ. of Minn., 1991 Upper Buford Circle, St. Paul, MN 55108. **Validation and implementation of new nitrogen fertilizer recommendations.**

Nitrogen management is paramount to high quality sugar beet production. Development, updating, validation, and adoption by the sugar grower of nitrogen fertilizer recommendations are part of this process. New N fertilizer recommendations were developed for the Southern Minnesota Beet Sugar Cooperative growing area over a period of 1998 to 2000. To validate and encourage adoption by the growers a series of small plot and strip trails were conducted in 2000. The strip trails in three production fields were intensively soil sampled before the strips of fertilizer N rates were applied. In the zero N strip or check, a small plot with replicated N rates was established. In the fall, sugar beet yield and quality were determined for the replicated small plots at each site. The results verified the findings of the initial N fertilizer research. Optimum root yield and quality were obtained when the soil nitrate-N in the four foot depth plus fertilizer N was 130 pounds per acre. Root yield did not increase when greater quantities of N were applied and root quality decreased.

CROOK[1], T. M., JAMES F.[2], S., and RADER, T., Michigan Sugar Company, [2]725 South Almer Street, Caro, MI 48723, 320 Sugar Street, Carrollton, MI 48724. **Foliar feed fertilizers on sugarbeets in Michigan.**

Many producers in Michigan apply "complete foliar feeds" beginning in the sugarbeet's 6 to 8 leaf stage continuing to row closure. Little data is available to determine the benefit of these products in large scale replicated trials. Foliar feed products were applied according to their respective labels for 6 to 8 rows in long strip trials (1000 feet to ½ mile long fields) in 2001 and 2002. Both yield and quality data were collected.

DALE[1*], T. M., RENNER[1], K. A., STEWART[2], J., and HUBBELL[3], L., [1]Michigan State University, Plant and Soil Sciences Building, East Lansing, MI 48824, [2]Michigan Sugar Company, Carrollton, MI 48724, and [3]Monitor Sugar Company, Bay City, MI 48707. **Effect of preemergence and postemergence herbicides on sugarbeet *(Beta vulgaris)* yield and quality.**

Pervious research reported interactions amount PRE and POST herbicide treatments resulting in increased sugarbeet injury, and a decrease in sugar yield. The objective of this study was to evaluate weed control, sugarbeet injury, yield, and quality following various herbicide programs. Herbicide treatments consisted of a factorial arrangement of five PRE herbicides, including no PRE, cycloate at 3.36 kg a.i./ha, pyrazon at 4.48 kg a.i./ha, ethofumesate at 1.68 kg a.i./ha, S-metolachlor at 1.42 kg a.i./ha, and five POST herbicides, including no POST, desmedipham & phenmedipham at 0.56 kg/ha + triflusulfuron at 0.017 kg/ha, desmedipham & phenmedipham & ethofumesate at 0.56 kg/ha + triflusulfuron at 0.017 kg/ha, desmedipham & phenmedipham at 0.09 kg/ha + triflusulfuron at 0.004 kg/ha + clopyralid at 0.023 kg/ha + 1.5% MOS, desmedipham & phenmedipham & ethofumesate at 0.09 kg/ha + triflusulfuron at 0.004 kg/ha + clopyrail at 0.023 kg/ha + 1.5% MOS. The experimental design was a RCB in a factorial arrangement with 4 replicates. Common lambsquarters control at one location in 2001 increased significantly from 95% with POST herbicides to 99% when PRE herbicides were followed by POST herbicides. Redroot pigweed control was excellent with all treatments at two locations in 2001. At the site with the highest pigweed density, redroot pigweed control with the standard split application provided 91% control, while the micro-rate provided 99% control when combined over PRE herbicides. Sugarbeet injury did not differ due to herbicide treatment when combined over locations in 2001. Sugarbeet stand and

yield were reduced at one site from cycloate PRE compared to the no PRE treatment when combined over all POST treatments. This research was repeated at three locations in 2002.

DEXTER*[1], A. G., VICENT III[2], D. L., and LUECKE[1], J. L., [1]North Dakota State University – University of Minnesota, Plant Sciences Department, Fargo, ND 58105 and [2]former NDSU graduate student, presently with BASF Corporation, 407 Parkers Drive, Portland, MI 48875. **Control of kochia resistant ALS-inhibiting herbicides in sugarbeet.**

Kochia resistant to ALS-inhibiting herbicides has become very common in eastern North Dakota and Minnesota. Nearly all kochia populations are primarily composed of plants resistant to ALS-inhibiting herbicides. The micro-rate was applied 2.65 times per acre averaged over the 723,000 sugarbeet acres in eastern North Dakota and Minnesota in 2001. The most common micro-rate tratment for kochia infested fields was desmedipham & phenmedipham & ethofumesate (Progress) at 0.09 kg/ha plus triflusulfuron (UpBeet) at 0.0045 ka/ha plus clopyralid (Stinger) at 0.034 ka/ha plus clethodim (Select) at 0.034 kg/ha plus methylated seed oil adjuvant at 1.5% v/v. The triflusulfuron in the micro-rate gave excellent control of non-resistant kochia but the micro-rate generally did not provide adequate control of kochia resistant to ALS-inhibiting herbicides. Fluroxypyr (Starane) added to the micro-rate at 0.017 to 0.13 kg/ha improved kochia control but also caused sugarbeet yield loss. In one experiment averaged over three locations, the micro-rate alone applied four times gave 58% kochia control while the micro-rate plus ethofumesate at 0.14 kg/ha applied twice followed by the micro-rate along applied twice gave 71% control Premergence ethofumesate at 3.4 kg/ha followed by micro-rate applied four times gave 83% kochia control. Three applications of a conventional rate of desmedipham & phenmedipham & ethofumesate (Progress) at 0.28 (first), 0.34 (second), 0.56 (third) kg/ha plus clopyralid (Stinger) at 0.052 kg/ha plue clethodim (Select) at 0.046 kg/ha gave 80% kochia control. Preemergence ethofumesate at 3.4 kg/ha followed by three applications of desmedipham & phenmedipham & ethofumesate at 0.28 kg/ha plus trifusulfuron at 0.009 kg/ha plus clethodim at 0.046 kg/ha gave 90% kochia control.

EL ANTRI, M., EL KAHAYARI, M., GABOUNE, R., and HILALI H. **Determination of position and duration of sugar beet life cycle according to varieties type at Doukkala Region, Morocco.**

Sugar beet cultivated area has been increased since the introduction of the crop at Doukkala region in 1970. The occupied area varied from 3,900 ha in 1970 to 18,400 ha in 2001. Moreover, sugar beet irrigated fields will attain 25,000 ha in 2002 after current management of the region. Root yield has also been increased 30 to 65 t/ha. Thus, potential production will be about 1,625,000 tonnes in 2003 compared to 1,125,000 t at the present time. Since factories capacity is limited, the only possibility is to extend the machining campaign. However, because of deterioration of sugar beet quality at the end of the season (July-august) due to high temperature, diseases etc..., the machining period should start early. Therefore, three experiments were conducted at COSUMAR station at Sidi Bennour and at INRA experimental station at Khémis Zemamra. The objectives were to determine seeding and harvesting dates per varieties type in order to extend the machining period while maintaining good sugar beet quality. Six varieties of each sugar beet type (Z. N. E) were planted at five seeding dates starting from September 22 to January 17, and harvested at two different dates (Standard life cycle for each type and 15 days before). Results showed that root and extractable sugar yield were significantly reduced when harvested 15 days before the end of the standard life cycle. October and November were the best seeding dates. To start harvesting early

in the season (April-may), Z type should be seeded in October, N type during November and E type at the beginning of October-November.

ESCRIOU, H. **BETSY: Internet information system for advise on weed control in sugar beet.**
ABSTRACTS NOT RECEIVED

K. FARES (1), C. DURR (3), P. POSTEL (4), R. DUVAL(4), N. DAMAY (2), CARRERA (4), Y. LEMOINE (4), JL. JULIEN (2), B. MARY (3), JM. MACHET (2), M.CARIOLLE (4) ET M. RICHARD-MOLARD (4),1 : UNIVERSITÉ CADI AYYAD, FACULTÉ DES SCIENCES SEMLA, MAROC,2 : LABORATOIRE DÉPARTEMENTAL D'ANALYSES ET DE RECHERCHE, LAON , FRANCE, 3: INRA, UNITÉ D'AGRONOMIE DE LAON – REIMS-MONS, LAON, FRANCE, 4 : INSTITUT TECHNIQUE FRANÇAIS DE LA BETTERAVE INDUSTRIELLE, PARIS, FRANCE. **Study of early sugar beet nitrogen uptake**

Although much work has been carried out on nitrogen absorption by sugar beet during the advanced stages of vegetation, very few studies have focused on early absorption of nitrogen by the crop. Field plots were carried out during two years in France to better characterize early nitrogen absorption. Nitrogen was brought at rates of 100, 200 and 300 kg/ha in irrigated (drop by drop) and non-irrigated plots, three weeks before sowing. It was also added at a rate of 100 kg/ha just before sowing in localized and generalized modes. Seedling emergence was observed and leaf areas were measured from emergence to the 16 leaf stage. Growth curves were established by sampling beets at different stages during the crop. Time was calculated as thermal time (base 3.5 °C) from 80% emergence. Nitrogen concentrations in the 0-60 cm layers in the ground and the roots of the beets were also measured. The results showed early differentiation between the various nitrogen treatments regarding the level of fresh and dry matter and regarding the level of the quantity of nitrogen in the leaves and roots. The drop by drop irrigated beets showed faster growth and higher absorption of nitrogen. These results could be used to define nitrogen application methods, making it possible to reduce the nitrogen amount brought before sowing without decreasing growth and productivity.

FURSTENFELD, R. and HORN, D. **Nutrient management in quality sugar beet cultivation – 20 years soil testing and fertilization advice.**

Poor sugar content and juice quality of sugar beets required an adaptation of N fertiliser. After testing of different N fertiliser recommendation systems the EUF method (electro-ultrafiltration) for soil analysis was introduced in South Germany in 1982. During 20 years about 1 million soil samples have been analysed. The most important nutrients like nitrogen, phosphorous, potassium, calcium, magnesium, sodium, boron and sulphur have been analysed simultaneously from the same extract. Based on the results of the soil analysis fertiliser recommendations are given for sugar beets in respect to high sugar beets production. Especially the N fertilisation has been decreased for sugar beets from more than 200 kg N ha-1 in 1980 to an average of less than 100 kg N ha-1 today. The reduction of N fertilisation resulted in better quality and increased sugar yield. The introduction of the soil testing system decreased the α-amino-N concentration of sugar beets by about 30%, which resulted in less N import into sugar factories. Lowering the N fertiliser rates the residual nitrate in soils at harvest are also decreased.
High practicability and less costs of the soil testing system led to great acceptance in sugar beets growers practice. More than 60% of sugar beet growers in southern Germany use site specific recommendations before cultivation of sugar beets. This is of much economical and ecological importance for a sustainable sugar beet production.

GEUZE, M. C. **Sugar quota exchange between farmers**

To avoid unlimited sugar production, the European Union set quota on EU member states and sugar factories. As a consequence the factories divided up their production quota amongst their sugar beet farmers. In the Netherlands this was carried out in 1987 when the average beet acreage was between 4 and 6 hectares.
After a long period of stand still in scaling-up, the Netherlands sugar industry and beet growers jointly decided to open up the market for beet quota. As of January 1, 2002 beet growers can buy or sell their production quota. High interest was shown in quota prices and effects on farm structure.
As a novelty in Europe, sugar beet growers in the south-east province of Limburg successfully started a sugar quota exchange. Its purpose was to bring together supply and demand, thereby reaching an equilibrium price. Questions arose if this system was in accordance with economic law.
The sugar exchange operates periodically, carries out financial transfers and publishes the sugar quota price in order to increase market transparency.
Presently a study is carried out on the economics of beet growing, quota price development, scale of production, farmers leaving or joining the market and other effects of more or less free trade in sugar quota between farmers.
In the paper the results of this study will be made available for other participants in the worldwide sugar beet industry. Similar developments could take place in other countries.

GILES*, J. F. and CATTANACH, N. R., Department of Soil Science, North Dakota State University, Fargo, ND 58105. **Effect of sugarbeet plant spacing uniformity on sugar production in the Red River Valley of the North.**

Increasing ground speed of a MaxEmerge 2 planter results in non-uniform plant spacing. Field studies were conducted in 2001 and 2002 to evaluate the effect of sugarbeet within-row space uniformity on sugar production in the soils of the Red River Valley. Minimum buildup and pellet seed types planted at ground speeds of 4, 5, 6 and 7 mph were used to establish non-uniform plant spacing in these studies. Plant space distribution was determined at the 2 to 4 leaf stage and root yield and extractable sucrose were measured at harvest. Uniformity of plant spacing decreased with increasing ground speed, regardless of seed type. Recoverable sugar production in 2001 was reduced with increasing ground speed. These data will be combined and analyzed with harvest data from 2002 and presented at the meeting.

HOFFMANN, C. and BLOMBERG, M. **Linking remote sensing with leaf area index of sugar beet.**

Remote sensing and vegetation indices can be used to describe and characterize the canopy of plant stands with a non-destructive method in a large scale. Leaf area formation of sugar beet in spring and early summer is a good parameter to describe for the developmental stage of the plants. For yield formation the early closure of the canopy is very important. However, there are many factors which influence the leaf area development of sugar beet.
This study aimed at testing, whether differences in leaf area development of sugar beet could be estimated with remote sensing and the calculation of the NDVI (Normalized Differential Vegetation Index, ratio between red and NIR radiation). For this purpose sugar beet field trials were carried out in 2001 and 2002 with different treatments (N application, sowing date, weeds, plant population, damage due to herbicide application, soil compaction, varieties, boron deficiency, Cercospora - leaf spot disease, Rhizoctonia). The leaf area of sugar beet varied from 0.5 to 8 m2 m-2 as affected by the treatments und season. The NDVI gave a good impression of differences in leaf devel-

opment in the sugar beet field, although it did not respond as distinctly to treatments as the leaf area index. Therefore, the relationship between leaf area index and NDVI was not linear.

HUBBELL*, L. A., WISHOWSKI[1], D. B., [1]Monitor Sugar Company, 2600 Euclid Ave., Bay City, MI 48706. **Rhizoctonia control with Quadris in Michigan.**

Rhizoctonia causes significant loss in the Michigan growing area. A few specialty varieties have been available that contain some tolerance but usually have lower production potential. The promise of a fungicide to help control rhizoctonia lead to this research. The objective was to confirm benefit, if any, and evaluate application timings. There was a significant benefit from Quadris application in various levels of natural disease infestation.

JONES, P. D., LISTER, D. H., JAGGARD, K. W., and PIDGEON, J. D. **Future climate impact on the productivity of sugar beet**

The impact of future climate change on sugar beet yields is assessed over western Europe using future (2021-50) climate scenario data from a General Circulation Model (GCM) and the Broom's Barn simulation model of rain-fed crop growth and yield. GCM output for the 1961-90 period is first compared with observed climate data and shown to be reliable for regions west of 24°E. Comparisons east of this meridian were less reliable with this GCM (HadCM2) and so were omitted from simulations of crop yield. Yield increases due to future climate change are expected in northern Europe of around 1 t/ha of sugar for 2021-50 but decreases of similar magnitude in northern France, Belgium and west/central Poland. Averaged for the study area, weighted by current production, yields show no overall change due to climate. However, this figure masks significant increases in yield potential (due to accelerated growth in warmer springs) and in losses due to drought stress. Drought losses are predicted to approximately double in areas with an existing problem and to become a serious new problem in NE France and Belgium. Overall west and central Europe simulated average drought losses rise from 7% (1961-90) to 18% (2021-2050). The annual variability of yield (as measured by the coefficient of variation) will increase by half, from 10% to 15% compared to 1961-90, again with potentially serious consequences for the sugar industry. These changes are independent of the 10% yield increase, which Demmers-Derks et al. (1998) showed was the likely direct effect of the increase in atmospheric CO2 concentration by 2021-2050. The importance of crop breeding for drought tolerance is further emphasised.

KAFFKA[1*], S. R. and BABB[2], T., [1]Agronomy and Range Science, University of California, Davis 95616, [2]California Department of Pesticide Regulation, Sacramento, CA 95814 **Insecticide use during sugarbeet stand establishment in the Imperial Valley can be reduced.**

Insect predation on emerging seedlings is considered a serious problem in fall-planted fields in the Imperial Valley. Growers rely on the use of carbamate and organophosphate pesticides to control insect pests of seedlings, but these chemicals will become restricted in the future because of environmental concerns. To quantify losses and to evaluate new plant protection methods, different ways of protecting emerging sugarbeet seedlings were compared over three years. Treatments included current practices and alternative seed treatments using imidicloprid at 45 and 20 g a.i. per unit. Seedlings were labeled and counted weekly until thinning. Spacing of established seedlings was measured in fall and again at harvest. Yields were collected and root quality determined. Pre-

emergence insecticide applications, applied either to the soil or the seed, resulted in significantly more seedlings emerging and surviving compared to treatments without insecticides in all three years. Seed treatments were as effective as the soil and post-emergence aerial insecticide treatments. When fields were pre-irrigated, establishment rates with insecticides were 65 % or greater. In all three years, much less post-emergence loss was observed than growers anticipated, ranging from 1% to 15% of the emerged seedlings. Over-wintered plant losses in the last two years ranged from 0% to 15%. There were no significant differences in any year among treatments in root and gross sugar yields.

KOCH, H.-J.[1], BRANDHUBER, R.[2], STOCKFISCH, N.,[1]SCHÄFER-LANDEFELD, L.[2]
[1]Institut für Zuckerrübenforschung (IfZ) and [2]Bayerische Landesanstalt für Bodenkultur und Pflanzenbau **Soil physical effects of sugar beet harvest and slurry spreading on regularly managed fields.**

In a field study, conducted on ten conventionally managed field sites in Germany, the effects of high axle loads (15 to 25 t) on soil physical properties were investigated. Soil texture classes ranged from loamy sand to silty clay loam. All sites were annually ploughed, one site was additionally subsoiled to 40 cm depth. In the context of common field operations either a sugar beet harvester (45 t total mass, 1.13 bar average contact pressure) or a slurry spreader (30 t total mass, 0.77 bar average contact pressure) was driven over the soils. Soil moisture conditions varied from 3.2 kPa to 32 kPa water tension during this pass. Penetration resistance was measured before the pass. Soil cores were collected in a grid scheme at each site before and after the machine was driven over the site. Bulk density, aggregate density, air filled porosity and air permeability at seven distinct soil water tensions ranging from 0.1 kPa to 32 kPa were determined in these cores at three layers (topsoil, plough pan and subsoil).
At most sites, a machine pass strongly affected topsoil properties. Bulk density and aggregate density increased while air filled porosity and air permeability decreased. The plough pan was already severely compacted before wheeling; therefore changes were small. The subsoil showed no changes or only minor signs of compaction. Only at the deeply fissured site, significant signs of compaction (i.e. changes in bulk density, air filled porosity and air permeability) were detected in subsoil layers.
Our results show that using present-day heavy agricultural equipment does not necessarily lead to severe subsoil compaction. However, deeply fissured soils with an unstable subsoil structure are in serious danger of becoming severely compacted.

KÖHLER. R. **Care and cleaning of silos at Südzucker.**
ABSTRACTS NOT RECEIVED

KONIG. H.-P. **Effects of long term conservation tillage on the nitrogen balance of a sugar beet – winter wheat – winter barley crop.**

This study displays the effects of conservation tillage on N-availability and the N-balance of crops. Since 1992 mouldboard ploughing to each main crop and mulching (shallow tillage to a maximum depth of 10 cm) are compared in a sugar beet - winter wheat - winter barley - mustard (catch crop) crop rotation in the Harste tillage trial near Göttingen (North-West-Germany). Besides, N-fertilization is varied in four levels respectively to the crop. All crops are grown each year on three neighbouring fields. The experimental fields are organized in split-plot designs with four replications each. N-uptake of all three main crops increased with increasing N-fertilization. In sugar beet N-uptake was influenced by the tillage system. In average of all N-levels the sugar beets of the ploughed treatment took up more N (181 kg N ha-1) than those of the mulched

treatment (149 kg N ha-1). N-uptake of the cereals was not affected by tillage. Only 42 % of the total N incorporated by sugar beet plants was withdrawn from the field by the roots, i.e. more than half of the incorporated N remained in the field by tops and leaves. In cereals 77 % of the incorporated N (average N-uptake: wheat 205 kg N ha-1, barley 143 kg N ha-1) was withdrawn from the field by the grain. The tillage effects on N-uptake of sugar beet affected the N-balance of the entire crop rotation. Almost settled balances were achieved in the high fertilization levels of the cereals (210 and 180 kg N ha-1) whereas in high fertilization levels of sugar beet (170 kg N ha-1) large balance surpluses occurred. Settled balances can be achieved without significant yield losses if N-fertilization of sugar beets is reduced to an amount necessary for maximum white sugar yield (in this case 50 kg N ha-1). During the course of the experiment the absolute height of the balances of the rotations decreased slightly which was due to an increasing yield level.

LABOSKI[1*], C. A. M., LAMB[2], J. A., and SIMS[3], A. L., Department of Crop and Soil Sciences, Michigan State University, 286 Plant and Soil Sciences Building, East Lansing, MI 48824, [2]Department of Soil, Water, and Climate, University of Minnesota, 1991 Upper Buford Circle, St. Paul, MN 55108, and [3]Northwest Outreach and Research Center, University of Minnesota, 2900 University Ave, Crookston, MN 56716. **Can the Illinois N test improve nitrogen management in sugar beet?**

Managing soil nitrogen is essential to optimize sugar beet quality. Nitrogen fertilizer recommendations for sugar beet in the North Central States varies by growing region. In Michigan the recommended rate is four pound of nitrogen per acre for each ton of expected yield. In Minnesota and North Dakota, 100 lb N/acre-2' or 130 lb N/acre-4' soil nitrate-N plus fertilizer N is recommended. Regional differences in methods of determining nitrogen fertilizer recommendations can be attributed to differences in climate, soil organic matter, soil texture, and payment formulas. The Illinois N test (INT) is new soil nitrogen test that measures a fraction of organic nitrogen that may mineralize during the growing season. Potentially the INT can account for differences in climate, organic matter, and texture. The INT has been able to predict sites where no additional fertilizer nitrogen was needed and has been correlated to the optimum nitrogen rate for corn in Illinois; it has not been tested on other field crops. The objective, of this first year of research, is to determine whether or not the INT can improve nitrogen fertilizer recommendations by taking into consideration mineralizable organic nitrogen. Results from multiple locations in Michigan and Minnesota will be discussed.

LEGRAND, GUY, IRBAB/KBIVB **Computerised data base of the "International Sugar Beet Library" in 2003 : more than 22,000 bibliographical references on the sugar beet since 1990.**

Since 1965, the "International Sugar Beet Library" ("BIB" - "BibliothŠque Internationale de la Betterave") is collecting reprints of research publications (currently 150 references/month) related to the sugar beet crop as well as to the related agronomic or industrial topics. These references correspond to scientific publications, technical papers or extension documents. They also correspond to proceeding reports, annual reports, working notes and various published works. These references are presented according to the following themes : A) Cropping techniques of the sugar beet, B) Genetics, biotechnology and breeding, C) Biology and physiology, D) Crop protection, E) Soil and fertilisation, F) Economy and sugar policy, G) By-products of the sugar industry and environmental aspects of the beet and sugar production. The BIB contains about 20,000 (old) entries for the period 1965-1989. Since 1990, the collected references are introduced in the computerised database of the "International Sugar Beet Library" which

allows doing all kind of selection on those references. Since 1990, the computerised BIB database contains more than 22.000 new entries. Selections can be done according to a specific keywords list containing more than 3.000 keywords (in English only), or by the author's name (more than 15.000 more often with their address), by the year of publication, by the language (mostly English, German, French and some other European languages) and/or on the basis of different combinations. This database is only available by annual subscription and can be easily installed on computers of the subscribing institutions/companies. Updating of the database is then monthly made by an e-mail sent file. In the same way, the BIB database will be soon available (restricted to the subscribers having a password) on the IRBAB/KBIVB Internet website. A well lower cost annual subscription to the "Beet Information Bulletin" corresponds to a monthly sent printed issue presenting the last 150 items introduced in the database. All the items presented in the BIB database or in the "Beet Information Bulletin" can be consulted at the library of the IRBAB/KBIVB (restricted to the two kind of subscribers). The BIB database will be presented during the Poster session.

LEGRAND, GUY1, IGNACE DEWAELE2, PAUL SCOLAS3 and BRUNO VAN DER JEUGD4, 1IRBAB/KBIVB, 2Raffinerie Tirlemontoise, 3 Sucrerie de Fontenoy, 4 Suikergroep. **Sugar beet pulp production under GMP (Good Manufacturing Practice) conditions in Belgium.**

Following the more and more strict requirements asked for the agro-food industries, the partners of both sugar beet and sugar Belgian sectors, and in particular the Confederation of the Belgian Beet Growers (CBB) and the Association of Belgian Sugar Manufacturers (SUBEL) decided, on October 5th 1999, to develop a system of "Integral Chain Quality Management" (ICQM). The general principals are self-control and certification. The ICQM system will be applied to all the links of the production chain from the sugar beet farmers and their suppliers, to trade, transport and transformers of plant raw materials. All fluxes of inputs are concerned. On its side, as a first step, the sugar industry has spread its existing quality assurance (ISO/HACCP) to the by-products by developing a descriptive card system for each by-product guaranteeing the quality of its various by-products. The integration between the descriptive by-product card and the ISO/HACCP procedure is also stated as GMP-equal (Good Manufacturing Practice). The descriptive by-product card relative to the sugar beet pulp (wet, pressed and dried beet pulp) is common to all sugar factories of Belgium. The GMP card consists of two parts : a general part recalls the legal, interprofessional and inside factory requirements, the indicative composition, the guarantees of transport and delivery, the instructions for storage and use. A second part presents a detailed description of the production process and the risk analysis. Inventoried risks include security, quality and environment. Minimal monitoring and control measures are described. The second step in the quality system is to have a full GMP certificate for the animal feed production (Good Manufacturing/Managing Practice). Some sugar factories in Belgium already obtained a full GMP certification of the animal feed products beet pulp and beet molasses. These GMP certified producers can use the GMP quality label.

LORENZ*, B. L., MILLER, S. D., Dept. of Plant Sciences, University of Wyoming, Laramie WY, 82070. **Investigating the possible presence of ALS resistant *Kochia scoparia* in the Big Horn Basin of Wyoming.**

The purpose of this research was to collect data on the presence and distribution of acetolactate synthase resistant (ALS) (*Kochia scoparia* L.) in the Big Horn Basin of Wyoming. The Big Horn Basin is contained within Big Horn, Fremont, Hot Springs, Park and Washakie counties. Proper weed control is critical to production of food and fiber crops. The loss of effective weed control due to herbicide resistance is well known.

*Kochia scoparia* is a serious weed in many parts of Wyoming's crop and rangeland. With repeated applications of ALS herbicides to crops, roadsides and other areas in the Big Horn Basin, there is a strong likelihood of ALS resistant kochia. Kochia seed samples from 10 sites in the Basin were germinated for 10 days at 25°C using the STS soybean protocol. For each site 10 replicates with 15 seeds per replicate were treated with an ALS herbicide, with similar but untreated controls. 47.1% of the treated seed and 57.2% of the control seed germinated. 4.2% of all ALS treated seed showed resistance for the 10 sites sampled. 7 of the 10 sites showed ALS resistance with 11.8% of these germinated seeds being resistance. This infers herbicide resistant kochia in the Big Horn Basin of Wyoming. Additional sites will be collected and tested to further delineate the extent of ALS resistant kochia in the Basin. Results will be distributed to Weed Coordinators and interested parties from the Big Horn Basin counties to promote integrated control of kochia in crop and rangeland settings.

MESBAH[1*], A. O. and MILLER[2], S. D., [1]Powell Research and Extension Center, 747 Road 9, Powell, WY 82435, and [2]Department of Plant Sciences, University of Wyoming, Laramie, WY 82071-3354. **Redstem filaree *(Erodium cicutarium L.)* control in sugarbeets.**

Field experiments were conducted at the Powell Research and Extension Center, WY to evaluate redstem filaree control in sugarbeets. Preplant treatments consisted of ethofumesate (Nortron) and/or pyrazon (Pyramin). Postemergence treatments consisted of full rate or micro-rate of desmedipham/phenmedipham/ethofumesate (Betamix Progress) + triflusulfuron (Upbeet) + stinger (Colpyralid). Micro-rate system included 1.5% methylated seed oil with or without nortron at 0.04 lb ai/A or pyramin at 0.008 lb ai/A. Each treatment consisted of three or four applications made at 7 day intervals starting at cotyledon stage. Sugarbeet injuries were slightly higher with full rate than with micro-rate. Redstem filaree control with three applications was moderate with both full and micro-rate systems. Best control was achieved with Norton as preplant followed by four applications of micro-rate in combination with nortron. Sugarbeet root yields were higher in herbicide treated compared to the check and yield increases were closely related to redstem filaree control. Sugar contents among all treatments including the check were similar.

MILLER*, S. D., ALFORD, C., M., and MESBAH, A. O., Plant Sciences, University of Wyoming, Laramie, WY 82071. **ALS resistant kochia control in sugarbeets.**

ALS resistant kochia populations have increased markedly in the Big Horn Basin of Wyoming the last three years due to extensive use of sulfonyl-urea herbicides in barley and sugarbeets. Studies were conducted under sprinkler and furrow irrigation at the Research and Extension Centers at Torrington and Powell; respectively, from 1999 to 2002 to evaluate potential treatments for management of ALS resistant kochia in sugarbeets. Preemergence applications of ethofumesate at half or full labeled rates in comination with postemergence applications of desmedipham/phenmedipham/ ethodumesate provided the most consistent kochia control. Conventional rate treatments of desmediphan/phenmedipham/ethofumesate were generally more effective than micro-rate treatments at both locations. Spiking desmedipham/phenmedipham/ethofumesate with additional ethofumesate increased kochia control at both sites; however, the spiked treated were less effective than the complementary pre/postmergence treatment program. Several experimental herbicide treatments including fluroxypyr, carfentrazone and flumioxisan provided fair to excellent kochia control but were injurious to sugarbeets.

MORISHITA, D. W. and WILLE, M. J., University of Idaho, Twin Falls R&E Center, P.O. Box 1827, Twin Falls, ID 83303. **Volunteer potato control in sugar beet.**

Volunteer potato (*Solanum* tuberosum) can be a significant weed problem in sugar beet production. A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to determine the most effective method of controlling volunteer potato in sugar beet. The experiment was a split block design with four replications. Main plots were the presence or absence of volunteer potato, and subplots were herbicide treatment. Individual subplots were 4 rows by 6 m in 2001 and 4 rows by 9 m in 2002. Sugar beet was planted on 56-cm rows at a seeding rate of 140,800 seed/ha. Plots were kept weed-free except for volunteer potato. Crop injury and weed control was evaluated visually 30 days after the last herbicide treatment (DALT). Tuber biomass from three volunteer potato plants in each plot was measured prior to harvest. The two center rows of each plot were harvested mechanically October 1 to determine sugar beet yield. None of the herbicide treatments injured the crop except glyphosate, which caused 28% injury. Glyphosate wick-applied when volunteer potato was taller than the sugar beet controlled volunteer potato 81% and reduced tube biomass >99%. All other herbicide treatments controlled volunteer potato 21 to 34% and reduced tuber biomass more than the check. Sugar beet root yield ranged from 49 to 52 MT/ha and did not differ among volunteer potato control treatments. Sugar beet yields averaged 45 MT/ha over all herbicides when volunteer potato was present compared to 60 MT/ha in its absence. Only wick-applied glyphosate effectively controlled volunteer potato but was no more effective than other herbicides tested in increasing sugar beet yield.

MULLER, R. and CORELL, G. **Documentation – An argument in favour of environmentally friendly and sustainable sugar beet production.**

Sugar is a high quality and reliable food. Today, consumers and the public are not only interested in the quality of a product but also in the quality of its production. There is a demand for transparency of the production process. Today, processes within the sugar factory are fully documented and certified, but only a few of the beet growers provide records that create transparency of the sugar beet production. Apart from the demands of the public and clients (for sugar and animal feed), future legal guidelines will demand such documentation.

In relation to sustainability and environmental protection, sugar beet production is progressive. Selective post-emergence weed control, damage-threshold-oriented foliar disease control and demand-driven fertilization based on soil analysis: all these systems minimize adverse impacts on the environment. The environmental compatibility and sustainability of sugar beet production are strong arguments for the continuation of the sugar market regulations and sugar beet cultivation in Europe.

SÜDZUCKER AG, in collaboration with the farmer associations, has developed a "Field documentation for sugar beet" in which the farmers will document the seeds, fertilizers and pesticides which are used. These data are obligatory. In addition, field specific data, such as the preceding crops and their yields, can be documented on this sheet. In 2002 the "Field documentation for sugar beet" was tested for its practicability with a group of about 1000 growers and it will be available, on paper or via the internet, to all SÜDZUCKER related growers in 2003.

NEWCOMB*, T. L., CATTANACH, A. W., LESHUK, T. M., JOHNSON, K. K., and BERNHARDSON, D. R., [1]American Crystal Sugar Company, 101 No. 3rd St., Moorhead, MN 56560. **Variable rate nitrogen application on wheat after sugarbeet – putting research into practice.**

American Crystal Sugar Company has been promoting variable rate nitrogen

application using satellite imagery of beet canopies since 1999. However, grower skepticism surfaced concerning potential adverse effects of reduced N use on wheat yield and test quality. The Precision Farming Team devised a plan to provide answers to shareholder concerns. Objectives were to: 1) determine if a variable rate application of nitrogen using beet top imagery adversely affect wheat yield following sugarbeets. 2) maximize field uniformity in all crops. 3) increase quality in subsequent beet crops. 4) lower nitrogen costs and 5) reduce lodging of small grains. Wheat sampling was conducted on 24 fields in all five factory districts. Prior to planting spring wheat, urea was variable rate applied according to management zones set up with the use of satellite images of the nitrogen management zones, 80, 40, and 0 lbs./acre N credit. Each sample was tagged according to zone, area, sample number and marked with GPS coordinates. A total of 36 samples were taken from each field. Each sample was processed to determine yield and quality. Data was statistically analyzed to determine treatment differences with the experimental design being a RCBD with locations as blocks. This research indicated proper nitrogen credits are presently used to maintain a high yielding quality wheat crop. Beet tops mineralize nitrogen rapidly, it becomes available in early spring for wheat. Two other benefits of this program are the environmental impact and economic savings to the grower. ACSC growers reduced actual nitrogen application by 2,500 tons over 70,000 acres, in 2001. These benefits reward growers who continue good stewardship of the land and reduced their input costs by over $500,000.

OUSSIBLE, M. and HILALI, H. **Low plant population: a serious constraint to beet and sugar yields in Morocco.**

Sugarbeet is planted in Morocco on an average acreage of 60.000 Ha, most of it is under irrigation. A total of approximately 3 million tons, are produced every year. Since it's introduction in early 60's, sugarbeet production has increased due to a significant increase in both yield and acreage. However, the achieved beet and sugar yields are still far below the potential of the irrigated environment. The undertaken numerous field surveys showed that the principal yield -limiting component is plant popuplation, which is highly determined by stand establishment. This study is aimed at 1) describing the present situation of beet and sugar produced in Morocco, 2) identifying cultural constrains that limit plant population and 3) adapting new tillage and planting systems for successful stand establishment. Our results showed : a) the weakness of the mostly used system, made of one pass by disk plow, at least 3 passes by the V-shaped disk harrow, one pass by furrow making implement and hand planting (placing and burying the seeds at very high seeding rates), this system is used in all soil, climate and croping system situations; and b) the high agronomic, ecological and economical performance of the tillage and planting systems that combine the use of the chisel plow or disk plow for deep tillage, the use of one pass by the roto-tiller for seedbed preparation instead of the multiple passes by the disk harrow. Planting is done by a seeder. New developed tillage and planting systems combining these tools showed good adaptation to most sugarbeet producing environments in Morocco and higher performance in terms of sustainable production, profit-earning, time and energy saving.

PIDGEON, J. D. **Drought effects on the productivity of sugar beet across Europe.**

Drought has a major impact (£28m/year) on beet production in the UK. Irrigation is not a viable solution. Therefore we studied the impact of drought on European production to establish if a breeding programme for drought tolerance is economically viable. We used the Broom's Barn beet growth model, adapted for brighter environments and conditions when drought would affect canopy growth. Disaggregated monthly weather data for a 0.5° x 0.5° grid across Europe was used to run the model for 1960-1995. In three independent tests in the UK and Germany, there was reasonable

agreement between simulated and observed yields. The model was then run to simulate water stress-free and rainfed commercial yields of a modern variety across Europe for 1960-1995. Potential yields increased from north to south and west to east due to increased radiation receipts and temperatures. Simulated rainfed yields were largest in north and central Ukraine, eastern Poland and southern Germany. Drought losses were the greatest in east Ukraine and southern Russia (>40% : 5 t/ha worth £1000 at the world sugar price). Parts of the UK and central Europe, with sandy soils, suffered intermediate losses while the low countries and a large area of western Ukraine suffered virtually no drought losses. Our results demonstrate, on a Europe-wide basis, the importance of breeding for drought tolerance.

POGGIOLINI, S. and BARBANTI, L. **Yield response of sugar beet in cropping systems at different input levels.**

Two crop managements were compared on a 4-year rotation: sugar beet, grain sorghum, soybean and wheat. The trial, still under way, was carried out on a farm scale over 10 years (1993 to 2002). Traditional husbandry involved high input of energy (soil tillage, fertilisers) and of chemicals (weed and disease control); integrated husbandry involved lower input levels (48% less energy for tillage, 32% less N-P input, 50% less chemical input). Since 1997, two cross-combinations were added to the basic scheme: traditional husbandry x low N-rate and integrated one x high N-rate.

In terms of yield, low input level in sugar beet could hardly match the performance of high input level, while the remaining crops proved more responsive to integrated farming. In terms of net income, integrated husbandry in sugar beet filled the gap to traditional one, thanks to considerable cost savings.

The split scheme adopted since 1997 highlighted that, by simply applying high N-rate to integrated husbandry, sugar yield was restored to high level.

The gain in beet quality associated with low input turned out to be quite moderate, in the very good-quality farm where the trial was carried out.

Over the whole rotation, input reductions allowed significative direct cost savings, which in turn gave a 7% increase in net income. Energy savings were more substantial, and the corresponding output/input ratios greatly improved.

It is perceived that in sugar beet rotations a sensible decrease in input level is possible, while at the same time assuring profitability and improving the cropping system efficiency to convert subsidiary energy into valuable vegetable productions.

PRINGAS, C., KOCH, H.-J. and MILLER, H. **Influence of long term conservation tillage on fungal disease appearance in winter wheat.**

When non inverting conservation tillage is applied the development of pests and diseases can be promoted by plant residues left on the soil surface. For winter wheat this hypothesis needs to be tested for important fungal diseases like Fusarium sp. and Drechslera tritici-repentis.

Since 1994 four tillage systems are compared at 9 sites in southern and eastern Germany. The tillage treatments (ploughed = mouldboard ploughing 30 cm deep, loosened = non inverting loosening 30 cm deep, mulched = only shallow tillage 10 cm deep, direct drilled = no tillage except for sugar beets with 1-2 passes of shallow tillage) are applied to all main crops of the crop rotation which includes sugar beet followed by winter wheat and one more cereal crop (mainly winter wheat).

Stubble wheat leaf infestation with Drechslera tritici-repentis did not differ between tillage treatments if a triazole or strobilurine fungicide was applied once during shooting. To investigate tillage effects on Fusarium sp. infestation the Deoxynivalenol (DON) concentration in the cereal grain was measured. Compared to the ploughed treatment this toxic metabolite of Fusarium sp. increased slightly with loosening, mulching and direct

drilling on several sites (2001). Only on one stubble wheat site grown with a variety susceptible to Fusarium sp. infestation DON concentration in the grain from the mulched and direct drilled treatments exceeded the critical value of 0.5 ppm clearly.

QI, A. and JAGGARD, K. W. **Using a crop/soil model and GIS techniques to estimate sugar beet yield in the UK.**

Sugar beet yield forecasting has been always important in the UK for campaign planning and marketing. The existing forecasting method relies on two or three helicopter over-flights in the middle of the crop growing season to measure foliage cover. This cover index is then used to calculate the crop canopy intercepted radiation. From late June onwards this is used to produce a national yield forecast. This method does not distinguish the spatial variations caused by different soil types, sowing dates and rainfall patterns. A more informative and versatile alternative is therefore needed. During the past five years, a process-based sugar beet growth and yield model has been developed incorporating water-limiting factor which depends on the soil texture type, rainfall and crop canopy development. This model was tested against sugar yields from both irrigated and rain-fed crops grown on sandy loam soil from 1976-2001 at Broom's Barn. The yields from irrigated crops ranged from 8.1 to 15.8t/ha and those from rain-fed crops from 5.1 to 15.3t/ha. The model simulated yields accounted for 80% of the variance in the observed yields. This model was further tested in 2001 and is being tested in 2002 using a range of soil texture types at five sites. Results from 2001 were satisfactory at four sites but the fifth site produced a much higher yield than predicted. The reasons for this discrepancy are being investigated. A geographic database for soil texture types has been built at a resolution of 5km x 5km in the UK sugar beet growing areas. Other spatial databases for sugar beet fields and weather data are being developed. The Broom's Barn sugar beet growth and yield model will be coupled with these geographic information databases to estimate the sugar yield for management and factory areas.

RAJIC, M., SKLENAR, P., and CACIC, N. **Effect of sugar beet seed plant defoliation on seed quality.**

ABSTRACTS NOT RECEIVED

REGITNIG, P. J., and NITSCHELM, J. J., Rogers Sugar Ltd, 5405 - 64th Street, Taber, AB, T1G 2C4. **Sugar beet injury with early and late day applications of conventional rate and micro-rate herbicides.**

Conventional rates of sugar beet herbicides that include Betamix are generally applied in late afternoon, once temperatures start to decrease, so as to reduce the risk of sugar beet injury. Micro-rate applications contain lower amounts of Betamix and are considered safer than conventional rates for the sugar beet crop. In Alberta, postemergence Betamix applications are often applied in the presence of a preemergence herbicide. Our objective was to assess sugar beet injury and yield with early and late day applications of conventional rate and micro-rate sugar beet herbicides in the absence or presence of a preemergence herbicide. Field experiments were conducted in 1999, 2000 and 2001 under weed-free conditions. Early day treatments were applied before 10:30 a.m., while late day treatments were applied after 4:30 p.m. In each of the three study years, visual sugar beet injury ratings were within commercially acceptable limits. Sugar beet injury ratings were similar for conventional and micro-rate treatments in 1999 and 2000, and higher for conventional treatments in 2001. The presence of a preemergence herbicide generally resulted in increased visual sugar beet injury from subsequent postemergence herbicide applications. Extractable sugar per acre did not differ among herbicide treatments in any of the three study years, with one exception; in 2001, the early day conventional herbicide

treatment applied in the presence of a preemergence herbicide yielded less extractable sugar per acre than other herbicide treatments.

RUPPAL[1*], D. A. and POINDEXTER[2], S., [1]Eastern District Sales Manager, Hilleshog Sugarbeet Seed, and [2]Michigan State Sugar Beet Extension Agent / Sugar Beet Advancement, [1]5146 Rogers Rd., Akron, MI 48701. [2]MSU Extension 1 Tuscola St., Saginaw, MI 48607. **Effect of cultivation on yield and quality of sugar beets.**

With the introduction of micro rate herbicide programs and pending introduction of Roundup Ready / Liberty Link sugar beet technologies, the need for cultivation is being questioned in the absence of weeds. A three-year study was set up to look at the impact of no cultivation compared to different timing of cultivation on yield and quality of sugar beets. Field experiments were established in 1999, 2000, and 2001 at different locations in the Great Lakes growing region. In an effort to mimic more closely to grower conditions, row length was increased on average to 300 feet. The different treatments were planted in six row strips and only the center four rows were harvested to eliminate any border effects. Four treatments were used in 1999: 1) No cultivation, 2) One time early cultivation, 3) One time late cultivation (prior to row closure), 4) Grower special (cultivate 3 times similar to grower). Starting in 2000 a fifth treatment was added 5) Over cultivation same as treatment #4 with additional dirt deliberately thrown into crown of the plants. This treatment was added to determine its effects on Rhizoctonia incidence. Combined over multiple years, locations, and environments produced no significant differences in yield or quality of sugar beets when comparing all treatments. Conditions involving early season packing rains, a one time early cultivation may be beneficial in some instances. A late cultivation (row closure) with soil thrown into crown may reduce RWSA primarily from increased Rhizoctonia Crown Rot. Overall, in three years and nine locations, a single or multiple cultivation has not shown any significant yield or quality enhancements when compared to no cultivation when weeds are not a concern.

SCHLINKER, G. **First experiences of sugar beet cultivation on ridges in Germany**
ABSTRACTS NOT RECEIVED

STEENSEN, D. K. **Influence of topping technique on yield and quality in different sugar beet varieties.**

The influence of different topping techniques on yield, quality, and processing of sugar beet has been the subject of several investigations. In relatively few of these investigations however, the influence of different varieties has been involved. Rightly it can be argued that by rubber flail topping and non-scalping, i.e. the crown remaining intact, a more true expression of the potential yield is achieved than by conventional topping and scalping, which to a higher extent provides an expression of the technically achievable yield. Measurement of the potential yield versus the technical yield in different variety material can be of great interest to breeding. Whether interaction between topping technique and variety can be detected was tested in a series of investigations during 1999-2002. Six varieties from three different breeders were tested. Flail topping and non-scalping generally resulted in significantly higher root and sugar yield, without sugar content or juice purity being affected significantly at the same time. However, as for interaction between topping technique and variety no significant difference were detected, although morphological differences between varieties, such as crown height above the ground surface, were observed.

TALEGHANI, D., HASHEM, A., MADJIDI, E., and SADEGHYAN, Y. **Nitrogen use efficiency in sugar beet as affected by irrigation and nitrogen level.**
ABSTRACTS NOT RECEIVED

TITS, M. and MISONNE, J-F. **Environmental aspects of the sugar beet crop in Belgium.**
ABSTRACTS NOT RECEIVED

TUGNOLI, V. **Nitrogen metering in dry cultivation and in fertigation**

The years of experience ANB has acquired in nitrogen metering in sugar beet cultivation—both experimental and more recently in the open field—have made it possible to improve both production and quality. Autumn and winter soil testing enables one to determine the necessary nitrogen content before sowing. Subsequent checking of the cultivation (4-6 true leaves) with the N-tester allows one to fine-tune fertilization coverage, advising different treatments for each individual area of cultivation. The results of 9 years of ANB experiments adopting such metering in dry crops indicate a 17% increase in production (sugar content) as compared to unfertilized crops and an 8% increase over those fertilized in the traditional manner; the quality of the dense juice (PSD) appeared on the average 2% higher than obtained with crops more heavily fertilized but not using the metering method. When low-volume drip or microirrigation systems are available, it is possible to apply nitrogen throughout the various stages of plant development, when the crop needs it the most. ANB tests, performed since 1999, indicate that the nitrogen doses can be reduced by as much as 20%. The sugar yields were more significant: in Northern Italy there was a 40-50% increase in the southern Po River Valley and 20-30% in the northern Po area; in central Italy the increase was more than 100% over crops obtained with traditional dry crop fertilizer application. Recently large-scale use of these methods in the open-field are producing encouraging results both regarding means of administration and quantities obtained. Further tests conducted by ANB since 1990 have shown that mineral nitrogen is best applied with the sowing of radishes and mustard in the autumn (prior to sowing sugar beets in the spring) in rows set 45 cm apart (so that in the spring sugar beets or another crop can be sown between the rows, the advantage of this is improved soil health and fertility). These plants have a significant biocide effect on nematodes. Moreover, thanks to their particular ability to store nitrogen, they prevent the leaching of nitrogen and enhance soil fertility.

TUGNOLI, V. and BETTINI, G. **The use of foliar fertilizer application in sugar beet growing.**

The experience of ANB Technical Services has demonstrated that the use of foliar fertilizers can resolve late (at approximately the 16-leaf stage) deficiencies in macro and microelements. Foliar application of nitrogen is particularly useful as it provides the most immediate assimilation and avoids the need for late application of granular mineral fertilizers that penalize polarization and qualitative crop yield. Moreover it has been shown that the increasingly evident deficiencies of boron and manganese in Italian fields are resolved with the application of specific foliar fertilizers. The application of such fertilizers is also useful in post-emergence weed control mixtures, improving the effectiveness of the active principles vs. the weeds and helping the crop overcome the effect of chemical treatments, particularly with the least selective products. The foliar application of amino acids, seaweeds and bio-stimulants has proved effective in attenuating crop stress resulting from soil subsidence, a lack or excess of water, low temperatures and other weather conditions. The present work reports the results of field trials and programs of treatments at various stages of crop growth. Several years experi-

mentation by ANB Technical Services indicate a 12-15% improvement in sugar production in Northern Italy and a 15-18% improvement in Central Italy. Therefore, it appears evident that the use of foliar fertilizers makes it possible to quickly overcome the nutritional and environmental deficiencies that arise during the crop growth cycle.

VANDERGETEN, J-P. **Measures of carrying capacity of soil with the electronic penetrometer according to the cultural techniques applied to the sugarbeet.**

In 2002, the IRBAB made a high number of measures in order to evaluate the physical state of the soil profile of sugar beet fields. The measures have been made for different situations. The measures have been made with an electronic penetrometer "penetrologger" of the company Eijkelkamp Agrisearch Equipment. It measures the soil resistance to penetration down to a depth of 80 cm. The device gives 1 measure of resistance by every cm of depth. The soil resistance is expressed in MPa or in $N/m^2$. The environmental regulations don't permit applications of organic matter during the winter period. The limited storage capacities require applications of organic matters in the spring. These applications are done just before the soil preparation and the sowing of the beets. Some comparative measures have been done in the wheels tracks of slurry spreaders with small tyres (400 to 500 mm), and of heavier self-propelled slurry tankers equipped with large tyres (1005 mm) to lower pressure. Some comparative measures have been made in fields where sugar beet growers practice spring ploughing and the winter ploughing. In some regions the two techniques coast themselves and present advantages and inconveniences. One pass seedbed preparation with a combined machine has been compared with seed preparations in several passes with simple machines. The objective of the one pass preparation with the combined machine is the improvement of the financial balance of the crop and the limitation of packed layers in the soil profile. Several farms practice no tillage and reduced soil tillage. The objective is to reduce the costs and the time spent for soil preparations. Currently these costs represent approximately 50% of the mechanisation cost. The time spent for the tillage (stubble cleaning, ploughing, seedbed preparation,...) represents more than 50% of the total time dedicated to the parcels. Some measures have been made in different situations. The harvest machines have a higher weight and increased capacities. A first set of measures has been made in order to better surround their impact on soil.

WAUTERS, A. and TITS, M. **Evolution of cropping techniques in Belgium from 1974 to 2002 through the data of the variety trials.**

Abstracts not received

WEVERS, J. D. A. **Weed control with low dosages in Europe; the Dutch approach.**

Many active ingredients are available for the control of dicotyledonous weeds in Europe, but there are differences in availability between countries. In the future a common EU-list with active ingredients will be the basis for products to be registered in the member countries. Weeds are controlled during three main periods: pre-planting, pre-emergence and post-emergence. Except for specific weed problems, the pre-plant applications are seldom used anymore, because of the availability of very effective post-emergence herbicides. Some examples will be presented. To a much lesser extent this also applies to the pre-emergence treatments as main emphasis is on post-emergence treatments. The general tendency is to control weeds several times during the growing season with tank mixes. The ingredients in the tank mixes are chosen according to the weed flora present and the dosage is set according to the stage of the weeds, and only in some cases of stage of the beet. To reduce costs, efforts are made to find the minimal dose needed for a given situation of weed flora, weed stage and weather conditions. Several examples will be presented. In some countries efforts are made to reduce the

environmental impact of herbicides by special actions. In those cases mechanical hoeing is an integral part of weed control. In general, however, weed control is carried out by overall herbicide applications.
For monocotyledonous weeds several products are also available. In most cases they are applied separately, but in some situations low dosages of a graminicide are added to tank mixes for the control of dicots and monocots simultaneously. A list of available products will be presented.

WILSON[1*], R. G., BLUMENTHAL[1], J. M., BURGENER[1], P. A., HARVENSON[1], R. M., HEIN[1], G. L., PALM[1], K. L., SMITH[1], J. A., YONTS[1], C. D., FRANC[2], G. D., MILLER[2], S. D., FORNSTROM[2], K. J., JACOBSEN[3], B. J., JOHNSON[3], G. D., NESSEN[4], S. L., MARTIN[5], S. S., and PANELLA[5], L. W., [1]University of Nebraska, 4502 Avenue I, Scottsbluff, NE 69361, [2]University of Wyoming, P.O. Box 3354, Laramie, WY 82071, [3]Montana State University, Plant Science and Pathology, AB 205, Bozeman, MT 59717, [4]Colorado State University, 115 Weed Research Lab, Ft. Collins, CO 80523, [5]USDA, Agricultural Research Service, 1701 Center Avenue, Ft. Collins, CO 80526. **Sugarbeet Production Guide.**

The Sugarbeet Production Guide is a rich resource of information, recommendations and reference materials for growing sugarbeet in the Central High Plains. Agricultural scientists from a four-state area discuss a range of sugarbeet production issues from seed selection and successful planting to pest management and a bountiful harvest. Using clear explanations to support their recommendations, the authors address the specifics of production as well as the importance of integrating cultural practices, pest management, farm equipment, and crop production into sustainable systems. The information is augmented with more than 40 illustrations, 25 tables and 185 color photographs, including diagnostic photos of weed seedlings, insects, disease, and plant and field damage.

YONTS*, C. D., University of Nebraska, Panhandle Research and Extension Center, 4502 Ave. I, Scottsbluff, NE 69361. **Sugarbeet emergence as influenced by irrigation method and polyacrylamide placed in seed furrow.**

Furrow or sprinkler irrigation is often used to assist in sugarbeet plant establishment, yet little information is available to compare the two methods. Furrow irrigation saturates seed from below and leaves the soil undisturbed. Sprinkler irrigation saturates the seed from above and breaks down and consolidates soil particles near the surface. Adding synthetic compounds, such as polyacrylamide to the soil, is another method being tried to enhance plant emergence and/or reduce soil crusting. The use of polyacrylamide for this purpose has had mixed results. The objective of this study is to determine the most effective method(s) of irrigating sugarbeet at planting time to enhance emergence. Sugarbeet was planted on two different dates during the spring of 2001 and 2002. Irrigation methods included no irrigation, furrow irrigation after planting, sprinkler irrigation after planting and sprinkler irrigation before and after planting. Polyacrylamide was added to the seed furrow at planting time at a rate of 2 lb/ac. This treatment was compared to no polyacrylamide added to the seed furrow at planting time. For 2001, polyacrylamide did not influence the final emergence for any of the irrigation treatments tested. Multiple irrigations after planting gave the greatest final emergence for the first date of planting in 2001. For the second planting date both sprinkler irrigation before and after planting and sprinkler irrigation after planting had the greatest emergence. Emergence for furrow irrigation after planting was similar to sprinkler irrigation after planting. The no irrigation treatment resulted in the slowest rate of emergence and least final emergence. Results for 2001-02 will be presented.

# Section B, Genetics and Germplasm Enhancement Oral Presentations

DE BIAGGI[1*], M., ERICHSEN[2], A. W., LEWELLEN[3], R. T., and BIANCARDI[1], E., [1]Istituto Sperimentale per le Colture Industriali, Sezione di Rovigo, viale Amendola 82, 45100 Rovigo, Italy, [2]Formerly, Holly Sugar Company, P.O. Box 764, Sheridan, Wyoming, USA 82801, and [3]USDA, Agricultural Research Station, 1636 East Alisal Street, Salinas, California, USA 93905. **The discovery of the rhizomania resistance traits in sugar beet.**

Previously recognised as soil sickness or confused with other sugar beet diseases, the symptoms of rhizomania (in its current meaning) were known in several European countries well before the Second World War. Its rapid spreading was noticed in Italy after 1946, and few years later sporadic symptoms of the disease were observed over 10,000 hectares in areas of intense cultivation. Without knowing the true pathogenic factor, some prophylactic measures were adopted: (1) avoid excess water; (2) avoid spreading of contamination trough machinery and tare soil; (3) early harvesting in diseased fields; (4) sowing Italian variety with high sugar content. The last advice was established after a number of field trials that included different commercial varieties. Later became evident that the best entries carried the quantitative resistance named "Alba type". Around 1965, the pathologists involved in such researches could establish that the rhizomania was caused by an atypical fungus-virus symbiosis. With this discovery, the disease was correctly explained, and the word rhizomania became used over many important sugar beet production countries. In the 1970's, both the rapid diffusion of the disease and the worsening of the damages on sugar yield pushed many research institutes and seed companies to find more efficient control measures. After years of searching, two monogenetic traits now known as "Rizor type" and "Holly type" were identified and commercially exploited in Italy (1983) and in U.S.A. (1986), respectively. For both countries, the full and particular background of the discovery of the different rhizomania resistances is given by the breeders involved.

FAUCHÈRE, J. **The influence of temperatures on bolting in France**

In France, in some years bolters can represent a considerable financial prejudice because of the labour needed to remove them. They are also one of the main causes that limit, with the sensitivity to frost, early or autumn drilling in some regions. Sensitivity to bolting also limits the use of several specific varieties to the geographic areas where conditions favouring the bolting phenomenon are rare. The increased use of this type of genetic material therefore requires good knowledge of the conditions in which these varieties are grown.

The phenomenon of vernalisation by the cold observed in the spring is a criterion which, if not important, is well-known for the determinism of bolting. Nevertheless, in France, the regions with the coldest springs are also those where the most sensitive varieties present little or no bolting. Therefore the vernalisation phenomenon is reversible in some conditions, especially when temperatures late spring are high. This study was conducted in collaboration with the French weather station and the SES France company. The data from 30 varieties tested over 3 years have, thanks to 7 trial sites, made it possible to constitute different 21 sites/years in terms of weather conditions.

The sites/years were classed in 4 different categories:

- cold spring/cold summer
- cold spring/hot summer
- hot spring/cold summer
- hot spring/hot summer

This classification tries to find the best compromise between the number of days determining vernalisation and the number of days determining de-vernalisation compared with the bolting percentages observed and several minimum temperature thresholds between drilling and the 90th day for vernalisation and several maximum temperatures for the devernalisation period included between the 60th and 120th day. Thanks to the weather data obtained from the different French weather stations, the results obtained helped to establish a network to determine the areas sensitive to bolting depending on the drilling dates practised. This precious tool enables targeted research into the different specific varieties and allows the judicious implementation of trials to determine the different varieties' degree of sensitivity to bolting, which is an element that the breeder has to know.

JANSSEN, G., NIHLGARD, M. A. E., and KRAFT, T. , Syngenta Seeds , **Mapping of resistance genes to powdery mildew (Erysiphe betae) in sugar beet.**

Powdery mildew (*Erysiphe betae*) is a fungal foliar disease on sugar beet which can cause yield losses up to 30 %. Genetic resistance is a powerful tool to control the disease and limit any economic damage. Within the germplasm of cultivated sugar beet considerable variation is present which is oligogenic based. Subsequently, various sources of resistance have been identified in wild *Beta vulgaris* and *Beta* spp., of which one has been identified as a monogenic source of resistance.

Syngenta seeds developed mapping populations in which either the oligogenic or the monogenic based resistance is segregating. Phenotypic evaluations were carried out in greenhouse as well as under field conditions with natural exposure to the disease. Numerous QTL's were identified for the oligogenic based resistance which explained up to 35 % of the phenotypic variation. The monogenic resistance was mapped to a single locus confirming that a single gene is responsible for the resistance. Fine mapping of the gene is ongoing. The relation of the two types of resistance is discussed.

KOCH, G. **GABI-BEET : the German Sugar Beet Genome Initiative**

GABI-BEET will provide new technologies for the molecular breeding of sugar beet. Marker technology (RFLPs, RAPDs, SSRs, AFLPs) has already been employed successfully in practical beet breeding. Here, we aim to introduce new markers based on single nucleotide polymorphism markers (SNPs) from expressed genes and anonymous markers in combination with a high throughput system for marker analysis as a new tool for molecular breeding and research.

GABI-BEET is divided into four major projects: project A (sequencing of ESTs and bioinformatics) which is the requirement for project B (high density mapping and allelic variation detected by SNP technologies) with the integration of conventional and functional markers. This approach is complemented by the comparative mapping and genome analysis by in situ hybridization (project C) and the construction of representative large insert libraries (project D).

The GABI-BEET project is focussing the following milestones:

A) Supply of extensive sequence information of transcribed regions (expressed sequence tags, ESTs) of the sugar beet genome.

B) Establishment of an integrated data base for molecular and genetic information and the development of new marker systems based on single nucleotide polymorphism (SNP).

C) Comparison of the genome structure of wild and cultivated beet with respect to repetitive and mapped low-copy sequences,

D) Construction of a bacterial artificial chromosome (BAC) library from sugar beet genome.

The presentation will give an overview of the network of partners in the project, the goals and current status of the project.

LEWELLEN, R. T., LIU, H-Y, WINTERMANTEL, W. M., and SEARS, J. L., USDA, U.S. Agric. Res. Station, 1636 E. Alisal St., Salinas, CA 93905. **Inheritance of BNYVV systemic infection in crosses between sugarbeet and *Beta macrocarpa*.**

*Beet necrotic yellow vein virus* (BNYVV), the cause of rhizomania, rarely infects sugarbeet (*Beta vulgaris* L.) systemically. Conversely, from mechanical inoculation BNYVV almost always systemically infects *B. vulgaris* subsp. *macrocarpa* (*B. mac*) line that grows as a weedy annual in the Imperial Valley of California. This *B. mac* has been used for many years in the virology programs at Salinas as an indicator host for virus assays. *B. mac* shows other reactions to viruses that are of interest. When infected young, *Beet yellows*, *Beet mosaic*, and *Beet curly top viruses* kill *B. mac*. Other "nonbeet" viruses, e.g., *Lettuce mosaic virus*, readily produce systemic infection in *B. mac* but not in sugarbeet. It was of interest to determine the genetic basis of these different host-plant reactions. *B. mac* is a very easy bolting annual and highly self-fertile and successful crosses were achieved only when sugarbeet was used as the female. Color patterns and annualism were used as markers to positively identify $F_1$ hybrids. The very limited number of $F_1$ plants tested had the virus reaction of sugarbeet or were intermediate. The $F_2$ suggested that BNYVV systemic infection was conditioned by a homozygous recessive factor but the lack of fit may have been caused by escapes and lethal and sublethal mutant plants and to incomplete expressivity. $F_3$ population and $F_3$ line patterns also suggested recessive inheritance, but again ratios appeared disturbed. Most $F_3$ plants produced from $F_2$ plants with systemic infection to BNYVV were susceptible to systemic infection and there was no evidence for seed transmission. Evaluation of segregating populations is continuing with the intent to produce a biennial line with the virus reactions of *B. mac* and to determine if different genes for host reaction are involved for each virus or if one recessive factor is predisposing *B. mac* to be widely susceptible to systemic infection by numerous viruses.

MCGRATH*, J. M., USDA-ARS, 494 PSSB, Michigan State University, East Lansing, MI 48824-1325. **Alphabet soup for beets: status of ESTs, BACs, RILs and other genomic sundries.**

Dogma holds that phenotype = genotype + environment; DNA makes RNA makes protein; and form follows function. Translation? The beet's work is accomplished in large part by proteins, these proteins (i.e. genes) are inherited from the parents, and expression of genes is influenced by environment (and also development). By understanding what beet proteins are active when and where, and these can be deduced from beet gene sequences whose function can be inferred from other well-characterized proteins, we can begin to build a conceptual framework for the types of work that the beet's proteins must accomplish in order to be profitable to growers and industry. This report considers the progress in building the tools that will enable such a framework. These prerequisites encompass everything you wanted to know about the inner workings of beets but were afraid to ask. For instance, as of June 2002, over 2,800 Expressed Sequence Tags (ca. 10% of genes) are available, building a 5X genome coverage Bacterial Artificial

Chromosome library is underway, and thousands of Recombinant Inbred Lines are being developed. These efforts have and will continue to require close cooperation among ARS scientists as well as colleagues in industry and academia. These tools are freely available as they are built, and will likely remain so in the future. Already, problems previously considered intractable are beginning to yield insight upon application of these tools. Progress is likely to accelerate in the future, as these genomic investments are leveraged with scientific expertise inside and outside of the sugar beet community.

MEULEMANS M., MOREMANS, S., and JANSSENS, L. **Interaction between different major genes and influence of the genetic background in the expression of Rhizomania resistance.**

Interactions between different major genes of rhizomania resistance were studied in B.N.Y.V.V. bioassays.
The virus content (ELISA value) and the gene dose effect were analyzed.
Genes of different origin do differ in their gene action; moreover expression of resistance is also strongly dependant of the genetic background.
Some of these differences are measurable as differences in yield components under conditions of strong natural infection.
The implications for practical breeding and hybrid allocation will be discussed.
Key words: Beet Necrotic Yellow Vein Virus, Rhizomania resistance, major genes.

OBER, E. S., JAGGARD, K. W., CLARK, C. J. A., and PIDGEON, J.D. **Progress towards improving the drought tolerance of sugar beet.**

Insufficient soil moisture during summer months is now the major cause of sugar beet yield losses in the UK and parts of Europe where the crop is not normally irrigated. However, selection for increased drought tolerance has not been a breeding priority until recently. With this aim, the objectives of the project over the past 4 years were to 1) assess the degree of genotypic diversity for drought tolerance; 2) identify sources of germplasm with increased drought tolerance over current commercial varieties; 3) identify key morpho-physiological traits associated with high or low drought tolerance. A total of 51 beet genotypes have been tested in the field under large polythene covers to impose a terminal drought beginning approximately 40 d after emergence. There were more than two-fold differences in drought susceptibility index between genotypes at the extremes, and some lines showed consistently better performance than a benchmark variety. Under drought conditions there was significant gentoypic variation for wilting score, rates of water use, leaf expansion rates, osmotic adjustment, and stomatal conductance. The percentage loss in biomass production due to drought was significantly correlated with specific leaf weight, leaf succulence index, water use, and percentage green crop cover. Divergent lines showing consistent, contrasting responses will be crossed to create mapping populations. Using another approach, yield data from official variety testing trials were comsbined with a drought stress index computed using historical weather data and trial site soil profile information. Varieties were identified that showed significantly different responses to increasing water deficit.

OGATA*, N., TAGUCHI, K., and TANAKA, M., National Agricultural Research Center for Hokkaido Region, Shinsei Memuro Kasaigun Hokkaido 082-0052, Japan. **Half diallel analysis for yield components and top traits in self fertilized O-types of sugarbeet.**

In three way top cross hybrids of sugarbeet (*Beta vulgaris* L.), the seed parent to be used is $F_1$ crossed CMS with O-type, but no clear genetic information of seed par-

ent from the diallel analysis for yield components and top traits has so far been known. In present study genetic model of sugar yielding traits, namely root weight, sugar content, harmful non-sugar content (K, Na and amino-N), and tops, namely top weight, leaf number and plant height in direct sowing condition were analyzed in $F_1$ of half diallel cross using 5 self fertilized O-types as parent. Results were as follows. Firstly for root weight, top weight, plant height and amino-N, since the dominance variances (H1) were higher than the additive variances (D), and the average degree of dominances (?H1/D) of them were over 1.0, heterosis effect were clearly shown in $F_1$. Narrow sense heritability of root weight and top weight were 42.0% and 15.4%, respectively. On the other hand, for sugar content, Na, K and leaf number, the additive variances were higher than the dominance variances, especially narrow sense heriatbilty of sugar content and K were 92.1% and 90.4%, respectively. Secondly from the correlation analysis between all traits in parent and $F_1$, respectively, there were negative correlations between sugar content and Na, and also top weight and K. The correlation coefficient between root weight and root circumference was positive and higher than the case of root weight - length. In concluding, sugar content, K and leaf number could be improved efficiently by individual selection based on the phenotypes in parent. However, for another traits in which heterosis were shown prominently, line selection based on the combining ability test in $F_1$ may help fulfill the goal.

PANELLA, L., USDA, Agricultural Research Service, 1701 Centre Ave., Fort Collins, CO 80526. ***Beta* germplasm evaluation and the GRIN database.**

Since it was established in 1983, the Sugarbeet Crop Germplasm Committee (CGC) has aggressively managed the evaluation of the accessions of *Beta* germplasm held the USDA-ARS National Plant Germplasm System (NPGS). Currently, the NPGS holds 2,441 accessions ranging from wild sugarbeet relatives to heritage open-pollinated varieties and released germplasm registered in *Crop Science*. There are more than 4,100 records of evaluations of accessions for twelve major pests and diseases of sugarbeet. These data and more information are contained in the Genetic Resources Information Network (GRIN) database that can be publically accessed through the World Wide Web at http://www.arsgrin.gov/npgs. The GRIN database is much more that an NPGS "inventory" of seed on hand. There also are botanical, morphological, and agronomic evaluation data; more than 200 photographs of accessions; *Beta* taxonomic information; contact information for the Sugarbeet CGC; pedigrees of registered germplasm; photographs illustrating disease scale ratings; and descriptions and citations of evaluation trials. The Sugarbeet CGC has also been working with the GRIN programers develop the capacity to enter molecular marker and accession level population data to this database. This information makes the GRIN database an extremely valuable tool for public and private beet breeders who have learned how to access GRIN. In this presentation the available data on *Beta* accessions are detailed and instructions on how to access this information are presented.

SOUVRÉ, A. ** , ALIBERT, B, * , SELLIER, H., * **Gene Flow from GM sugar beets to wild relatives in the conditions of seed production.**

In prior studies, the compatibility of GM beet pollen, (expressing EPSP and uidA genes), and the environmental wild relatives (ruderals) have been measured and analytical techniques optimized. We report here, results concerning a three-year open field trial in South West of France, a well-known area for beet seed production.

The first year allowed to: i) to measure the level of GM hybrids in germinated seedlings and in non-germinated embryos issued from 60 ruderals and 20 male sterile (MS) plants,

which were planted in micro-plots located at 10m, 50m, 100m and 200m from the GM pollen source and ii) to study the fertilisation potential of the GM pollen at 1000m from the source by using MS plots.
The second year experiments were conceived to measure transgene flow with respect to the distance (up to 1000m) and to the density of ruderals in micro-plots (1, 5, 50 ruderals + 20 MS) and to evaluate pollen dispersal for distances reaching 1500m from the GM source by using the pollen trap technique*.
During the third year, we measured the transfer of transgenes between GM hybrids of ruderals with non transgenic ruderals of the same generation.

SRIVASTAVA, H. M. and GAUCH, H. G. JR. **Genotype x environment interactions in sugarcrops : Comparison of different stability models and efficiency and usefulness AMMI Matmodel in sugarbeet (*Beta vulgaris* L.).**
**Abstract not received**

WEVERS, J.D.A. **Variety testing in Europe.**
Variety testing in almost all EU-countries is done in two stages. The first part is called a study on the DUS (distinctness, uniformity and stability) of the varieties. For this, field and or greenhouse trials are carried out in which several parameters are measured such as root yield, sugar content and the contents of sodium, potassium and amino nitrogen. In some cases also special parameters are taken into account: colour of hypocotyls, length of leaf petioles, relation between length and width of the leaves, crown heights and others. The latter parameters vary between countries. If these parameters prove to be different from other existing varieties, uniform within the variety and stable during the two years that DUS tests normally last; a breeder's product is regarded as a new variety. At that stage the variety is given a name by the breeder and is entered on the national and or European list of varieties. In most countries a governmental body is responsible for this stage of variety testing. For the nomenclature an agreement is needed from the authorities of the other European countries. In most cases the same genetics get the same name over all countries. The costs of this stage of variety testing in most countries is charged to breeders.
The second stage of variety testing is the study of the cultural value of the varieties. In most cases the period of testing of this stage lasts three years. In some countries both stages are combined into two years of testing of DUS and cultural value and a third year of cultural value testing only. In other countries both stages are done in succession so that a complete cycle lasts five years. For cultural value again root yield, sugar content, and the contents of sodium, potassium and amino nitrogen are measured. In some countries also soil tare, completion of ground cover and susceptibility to diseases are measured separately. If this is claimed, special tests can be made to determine the rate of resistance to pests of diseases or variety tests are carried out in presence of the relevant pest or disease.
The number of trials, number of replications, plot size, drilling, harvesting and sampling method can vary from country to country. Some examples will be presented. In almost all countries the results are expressed relative to the existing varieties. If new varieties prove to be better than these existing varieties they are admitted to a recommended list. The criteria for a decision on being better than the existing varieties can also vary between countries. Also for this some examples will be presented.
In most countries also the second stage of variety testing is a responsibility of a governmental body. Discussions are on going as to whether this stage should be the responsibility of the market parties involved: breeders, sugar industry and beet growers. In most countries they are paying for the tests on the cultural value of varieties.
Examples of recommended lists for different countries will be shown.

# Section B, Genetics and Germplasm Enhancement Poster Presentations

AMIRI, R., MOGHADDAN, M., MESBAH, M., SADEGHIAN, S. Y., and IZADPANAH, K. **Genetic investigation of resistance to beet necrotic yellow vein virus (BNYVV) in *B. vulgaris* subsp. *maritima*, accession WB42.**
**Abstract not received**

DALE[1*], T. M., RENNER[1], K. A., and MCGRATH[2], J. M., [1]Michigan State University, and [2]USDA, Agricultural Research Service, Sugarbeet and Been Research Unit, Michigan State University, Plant and Soil Sciences Building, East Lansing, MI 48824. **Response of sugarbeet (*Beta vulgaris)* varieties and populations to postemergence herbicide treatments.**

Previous research has shown a differential response of sugarbeet varieties to herbicide treatments. Increased sugarbeet injury may result in reduced yield, sugar content, or both. Preliminary research indicated a differential response of sugarbeet varieties to postemergence herbicides. Our objective was to evaluate the growth response of fourteen sugarbeet varieties, and four USDA sugarbeet populations, to postemergence herbicides applied three times at the micro-rate. Commercial sugarbeet varieties, and USDA populations were grown in growth chambers with a photoperiod of 16:8 h (light:dark) and thermoperiod of 14:24 C (day:night). Sugarbeet was treated with the micro-rate of desmedipham plus phenmedipham plus triflusulfuron plus clopyralid plus methylated seed oil at 0.045, 0.045, 0.004, 0.023 kg a.i./ha and 1.5% v/v, respectively, at weekly intervals beginning at the cotyledon growth stage. The experiment was arranged in a CRD with three replicates and was repeated. Treatments consisted of either treated or untreated sugarbeet. Leaf area and dry weights were recorded one week after the third micro-rate treatment. Sugarbeet varieties varied in their response to micro-rate treatments. Micro-rate treatments resulted in leaf area reduction from 5 to 43%, and dry weight reduction from 22 to 58% among the fourteen sugarbeet varieties. The micro-rate reduced leaf area by 33 to 45% and dry weights by 44 to 54% among the USDA populations. The commercial variety "HM E-17" and USDA population "607XHS' were the most tolerant with a 5 and 33% reduction in leaf area, and 22 and 44% reduction in dry weight, respectively.

KOCH, G. **Mapping leaf spot disease resistance genes in sugar beet.**

Leaf spot disease is one of the most important foliar diseases of sugar beet (Beta vulgaris L.) caused by the fungal agent Cercospora beticola Sacc. Disease is controlled by fungicide applications and use of resistant cultivars. Disease resistance is inherited as a complex trait with medium to low heritability. Consequently, molecular mapping and identification of disease resistance genes is hard to achieve. Different approaches for genetic mapping will be described and results will be discussed.
Based on a F2 AFLP marker mapping, single plants with known quantitative trait loci (QTLs) for resistance were selfed (F3), mass selected, selfed again (F4) and in parallel crossed to a male sterile line (MS x F3). F4 lines and F3 hybrids were rated for disease severity in replicated observation trials. Results will be presented with respect to (1) the achievement of a dissection of the complex inherited disease resistance trait into simple segregating disease resistance genes, (2) a preliminary conclusion on the efficacy of the QTL based selection to leaf spot disease resistance, and (3) discussion of alternative approaches to facilitate marker assisted breeding for Cercospora leaf spot resistance.

KORNIENKO, A. **New methods of sugar beet starting material development.**
Abstract not received

KORNIENKO, A. **Perspectives of molecular markers using in sugar beet breeding.**
ABSTRACT NOT RECEIVED

KORNIENKO, A. **Use of biotechnological methods in sugar beet breeding.**
ABSTRACT NOT RECEIVED

SKLENAR, P., KOVACEV, L., CACIC, N., RAJIC, M., and MEZEI, S. **General and specific combining ability for root traits in sugar beet.**
ABSTRACT NOT RECEIVED

SRIVASTAVA, H. M. **Sugarbeet cultivation in India - Current status and future prospects – An overview.**
ABSTRACT NOT RECEIVED

SVIRSHCHEVSKAYA, A. and LAVI, U. **Genetic relationships in sugar beet gynogenetic lines revealed by AFLP.**

A collection of sugar beet (Beta vulgaris L.) doubled haploid lines was created through gynogenesis. Gynogenetic lines originated from in vitro cultured unfertilized ovules of diploid plants from commercial Belarusian cultivars.The haploid nature of beet regenerants was proved by flow cytometric analysis and microscopy. The AFLP (Amplified Fragment Length Polymorphism) technology was applied to 31 sugar beet accessions, including parental plants and gynogenetic "progeny". The technique is based on selective amplification of limited number (50-100) of DNA restriction fragments out of total genomic EcoR1/Mse1 DNA digests. Band patterns of 50-300 bp fragments were generated. AFLP was applied for assessment of heterozygosity in three parents originated from Belorusskaya 69 and Ganusovskaya 55 diploid cultivars. According to our preliminary estimation the highest rate of heterozygosity in these parental lines was about 50%. One hundred and eighty eight segregating AFLP amplified products were generated by four primer combinations in the gynogenetic progeny (13 lines). The method was also used for evaluation of polymorphism and the genetic relationships within and between groups of sugar beet lines. A phylogenetic tree was constructed by the Neighbour joining method (PHYLIP package), revealing the relationships between six groups of sugar beet gynogenetic accessions derived from various cultivars. It was shown that specific identification of three groups out of six could be achieved by one (E + ACC/M + CTA) primer combination. This study is in progress.

VILLANUEVA, F., and RUSH, C. M., Department of Plant Pathology, Texas Agricultural Experiment Station, Bushland, TX 79012. **Genetic Variability Among Isolates of Beet Soilborne Mosaic Virus.**

Beet soilborne mosaic virus (BSBMV), a member of the genus *Benyvirus*, is a rigid, rod-shaped virus with a divided genome consisting of four polyadenylated single-stranded RNAs. BSBMV has been identified in the central and western sugar beet growing regions of the United States and is a close relative of beet necrotic yellow vein virus (BNYVV), which causes the disease rhizomania. Our objective in this study was to deter-

mine whether genetic diversity exists among BSBMV isolates collected from different sugar beet growing areas in the United States. Virus isolates were collected from fields in Colorado, Minnesota, Nebraska, North Dakota, Texas and Wyoming. Based on previously determined nucleotide sequence of BSBMV, 18-mer oligonucleotide primers were developed for six regions of RNA2 and six regions of RNA3. Three regions of RNA2 were tested: those coding for the 21 kDa capsid and the 74 kDa readthrough protein and the 42 kilobase ORF of the triple gene block. Three regions of RNA3 were also tested. The greatest genetic variability among isolates was detected in the region coding for the 74 kDa readthrough protein. This region is presumably related to virus transmission. Variability was also found within RNA3. RNA3 is associated with the virus infection process. No variability was found in the coat protein region, suggesting that there are no serological differences among isolates. No variability was found in the sequence coding for the 42 kDa protein from the triple gene block region. Ecological implications of the variations that were identified are unclear at this moment.

YU*, M. H., USDA, Agricultural Research Service, 1636 East Alisal St., Salinas, CA 93905-3018. **Progress in development of sugarbeet with resistance to root-knot nematode.**

Sugarbeet is an important source of sucrose for commercial processing and is a favored host of root-knot nematode. Host resistance to *Meloidogyne* spp. was not found in the cultivated sugarbeet, but was identified from wild *maritima* beets. The resistance has been successfully introgressed into sugarbeet genotypes. Observations on several breeding populations were conducted in infested and noninfested field plots. Under nematode infested and high temperature conditions, all susceptible control plants were heavily infected, more than 66% of them had gall symptoms, and the rest were dead. In comparison, an average of 77% of plants in resistant families produced healthy roots while the rest were infected. In backcrossed populations, approximately 44% of plants exhibited resistance, and over one-half of infected plants died. These studies confirmed the strength and inheritance of root-knot nematode resistance in sugarbeet. Positive results were demonstrated by the improved taproot conformation and root weights. Further development of marker-assisted selection protocols for efficient identification of resistant genotypes will facilitate sugarbeet breeding. Additional improvements on these breeding materials are needed to develop an elite sugarbeet line.

# Section C, Entomology and Plant Pathology
## Oral Presentations

AYALA-GARCIA, J. **Control of *Cercospora beticola* by applying fungicides and using double-tolerant varieties (Rhizomania and cercospora).**

Chemical control with 21-day application intervals turns out to be insufficient under severe Cercospora beticola attacks. Varieties with double tolerance to Rizomania and Cercospora were used some years before: they revealed deficient tolerance to Rizomania under Spanish conditions.

At present, this aspect has been improved and there is some material, which is both more tolerant to Rizomania and less sensitive to Cercospora.

Due to the social concern asking for restriction in the use of pesticides, there may be a reduction in the number of applications using fungicides, which might endanger the control achieved up to now.

Therefore, in view of the present day circumstances, the aim of this work is to assess, under Cercospora and Rizomania high-pressure conditions, the tolerance level and productive potential of varieties presenting double tolerance to these diseases.

BOETEL[1*], M. A., DREGSETH[1], R. J., SCHROEDER[1], A. J., and MACRAE[2], I. V., [1]Department of Entomology, North Dakota State University, Fargo, ND 58105, and [2]University of Minnesota, Northwest Research & Outreach Center, Crookston, MN 56716. **Integration of Trap Cropping and Reduced Area Insecticide Treatment to Manage Sugarbeet Root Maggot.**

The sugarbeet root maggot, *Tetanops myopaeformis* (Röder), is a major economic pest of sugarbeet production the Red River Valley growing area of North Dakota and Minnesota. Larvae cause injury to the plant by scraping the root surface with oral hooks. Heavy larval feeding pressure can predispose the plant to severe yield losses and can result in plant mortality if feeding causes the tap root to become severed. Control of this insect is typically achieved via planting-time and/or postemergence soil insecticide applications. Well over 90% of all products applied used for protection of Red River Valley sugarbeets from *T. myopaeformis* are organophosphate insecticides. Thus, populations in areas that typically receive more than one application of an organophosphate per year are under a substantial amount of selection pressure for the development of resistance to this valuable insecticide class. This is a grave concern among area pest managers and it is exacerbated by the fact that few efficacious chemical alternatives exist. The overall goal of this investigation was to assess the viability of integrating trap cropping with reduced area insecticide applications as a management option for this important pest. The primary objective in meeting this goal was to determine if strips of sugarbeet seedlings ("trap beets") along the edge of *T. myopaeformis* source (previous-year sugarbeet) fields would arrest females from dispersing to mate or search for oviposition sites in current-year beet fields. A secondary objective was to measure the management potential of concentrating emerged *T. myopaeformis* adults in the trap beet zone and treating the area with a foliar insecticide, thus, leading toward reducing the overall insecticide load necessary to protect localized fields. Our experiment was carried out on a total of seven commercial sugarbeet field sites during the 2001 and 2002 growing seasons. Study sites were located in the northern portion of the Red River Valley near St. Thomas, ND due to consistently high population levels in the area. All source fields were planted to spring wheat during the evaluation year, and were located immediately adjacent to current-year sugarbeet fields. In the first year of the study, a strip of sugarbeet seedlings (26.8 m wide x 805 m long) was sown into the newly planted spring wheat along ½ of the length of each source field. The remaining length (805 m) was planted to spring wheat without trap

beets. Width of the trap and non-trap zones was increased to 53.6 m during the 2002 season. Flies were monitored throughout the fly activity cycle in the trap and non-trap zones in source fields as well as adjacently in the current-year sugarbeet field at each site. Data from 2001 indicate that the trap crop reduced female movement into current-year beets during two weeks of high fly activity that included the peak oviposition period. Similar trends were observed with males, although significance was restricted to the third week of high fly activity. A slight trend toward lower feeding injury in current-year sugarbeets adjacent to the trap crop was observed, but the difference was not significant. Findings from both seasons will be presented and implications regarding the pest management potential of trap cropping and reduced area insecticide treatment for protecting sugarbeet fields from *T. myopaeformis* injury will be discussed.

BOUDON-PADIEU, E., GATINEAU, F. LARRUE, J., and RICHARD-MOLARD, M.
**The role of phloem-restricted bacteria in the Low Sugar Content Syndrom (LSCS). Biology of bacteria transmission by a Cixiid (*Hemiptera fulgoromorpha*). Prospects for the control of the disease.**

The syndrome "basses richesses" of sugar beet (SBR), occurring in Burgundy and Franche-Comté (France) since 1991, causes a sudden drop of sugar content of taproot. Etiological investigations were based on the observation of an insect vector candidate, a Cixiid (*Pentastiridius beieri*, Wagner, 1970) not previously reported in sugar beet crops and described in this French region for the first time. Wild insects trapped in sugar beet fields were fed on sugar beet seedlings which further developed all of the symptoms characteristic of SBR on leaves and taproot, demonstrating that *P. beieri* was involved in the transmission and diffusion of SBR. The biological cycle of the insect species in the cropping system was elucidated.

Molecular and cytological observations on SBR-affected sugar beets from the field and on symptomatic sugar beets inoculated by *P. beieri*, showed that one or the other of two phloem-restricted bacteria could be associated to the syndrome : a stolbur phytoplasma and a Bacterium-like organism (BLO), hence shown both to be transmitted by wild specimens of *P. beieri*. Along with three-year observations, the BLO appeared to be the main etiological agent of the disease. On the basis of 16S rDNA analysis, the BLO was identified as a new phytopathogenic γ-3 *Proteobacteria* .

The biology of *P. beieri* and the biology of the vection of the two etiological agents associated with SBR, specified in sugar beet cropping system, now provide clues towards control methods.

Key-words : Basses richesses – Cixiid – *Pentastiridius beieri* – phytoplasma – BLO – epidemiology.

DEWAR, A. M., HAYLOCK, L. A., BAKER, P., GARNER, B. H., and SANDS, R. J. N.
**Effects of delayed weed control in genetically modified herbicide-tolerant sugar beet on the abundance and diversity of arthropods.**

The proposed introduction of genetically modified herbicide tolerant (GMHT) crops has prompted fears about possible adverse environmental impacts of their widespread adoption, particularly on arable weeds, insects and associated farmland birds. In two of four field trials with glyphosate-tolerant sugar beet, in which the first overall applications of glyphosate in a two spray programme were delayed, or where first applications were applied in a band with the second applied overall, there was no consistent effect of treatments on the cumulative numbers of carabids, staphylinids or spiders trapped in pitfall traps. This was almost certainly due to the low weed populations at these sites (circa 11-12 /m2 in untreated plots), which did not alter the structure of the habitat sufficiently to influence the populations of these arthropods. At the other two sites, where weed numbers in untreated plots were three to five times greater (27 and

61/m2 respectively), there were significant correlations between weed biomass (including dead and dying weeds) in late July and the cumulative numbers of staphylinid beetles during the sampling period June-August. The correlations were much weaker, although still significant, for carabids, but non-significant for spiders. There was no difference for any species of carabid or staphylinid, or their combined totals, between the conventional treatments and the early overall glyphosate treatment. This suggests that the response of the beetles was to the removal of weeds, and not to the chemicals used. Within any site there was no significant difference in the ? index of biodiversity between any treatment on any one sampling date, or when the cumulative catch over all sampling dates was considered.

HEIN*, G. L. and THOMAS, J. A., University of Nebraska, Panhandle Research and Extension Center, 4502 Ave. I, Scottsbluff, NE 69361. **Impact of sugar beet root aphids on sugar beet yield and response of resistant varieties.**

Sugar beet variety trials in the region have shown that sugar beet varieties vary greatly in the level of resistance to sugar beet root aphid feeding. Data from these trials also indicate that the mechanisms of root aphid resistance may also vary between varieties. The objectives of this study were to quantify the impact of root aphids on sugar beet yields and to determine if multiple components of resistance are functioning in these varieties. Plots established in the summers of 2000 and 2001 were used to compare six varieties with varying levels of resistance and determine the impact of sugar beet root aphids on the yield of these varieties. A split-plot experimental design was used with varieties being the main plots and aphid infestation (infested vs uninfested) being the split plot. All plots were replicated five times. Sugar beet root aphids were reared in the greenhouse and infested into the 'infested' plots in late June. The 'uninfested' plots were treated with Aphistar in mid and late August to eliminate all aphid populations. Yield impact was determined by harvesting the center two rows of the plot, weighing the plot yield and taking tare samples for percent sugar analysis and purity.

Root aphid infestations developed to a significant level in both years with infestations in 2001 being somewhat greater than 2000. The highly susceptible varieties showed significantly reduced sugars for the infested plots as compared to the uninfested with an average reduction of 1.8 percentage points. Reductions in percent sugar correlate well to the root ratings (aphid presence). For each of the highly susceptible varieties, aphid-infested plots yielded at least 1500 pounds per acre less than the aphid uninfested plots. These data demonstrate the severity of the impact of this insect pest and the great potential that resistant varieties have in reducing that damage. Also, it appears that multiple resistant factors may be involved in aphid resistance for some varieties.

KAFFKA[1*], S.R., LEWELLEN[2], R. T., and WINTERMANTEL, W. M.,[2], [1]Agronomy and Range Science, University of California, Davis, 95616 and [2]USDA/ARS, 1636 E. Alisal, Salinas, CA 93905. **Beet curly top virus, insecticides and plant resistance.**

*Beet curly top virus* (BCTV), a gemini virus, remains a problem for farmers in the San Joaquin Valley of California. It is spread by the beet leaf hopper (*Circulifer tenellus* Baker), which has become naturalized. Recent dependence on non-tolerant sugar beet cultivars has led to increased concern about the potential for a BCTV epidemic, particularly in overwintered crops, which are planted when conditions for infection are greatest. Three trials were carried out in successive years in the western San Joaquin Valley to test the effects of alternative insecticides for control of BCTV on susceptible and tolerant sugar beet cultivars. Two rates of imidicloprid applied as a seed treatment (45 g and 90 g a.i. per 100,000 seeds) were compared to the current standard treatment of phorate applied to soil at 83.8 g a. i. per 1000 m of row, and an untreated control. In the third trial,

clothianidan was also used at the rate of 15 g a.i per 100,000 seeds. Cultivars ranged in tolerance from the most tolerant line available to the most susceptible cultivar ever observed. In the the third trial, different planting dates were also compared. Natural BCTV infection occurred in all three years. Sugar beet root and sugar yields declined linearly with increasing rates of infection. Yields declined because roots were significantly smaller with the non-tolerant cultivar and root populations were reduced by plant loss. Sugar percentage was unaffected by treatments, but differed by cultivar. Imidicloprid and phorate provided similar levels of protection to plants, but where not able to prevent large yield losses among susceptible cultivars when infection occurred early in crop development. Plant resistance provided more effective protection than systemic insecticides.

KHAN[1*], M. F. R. and KHAN [2], J., [1]North Dakota State University & University of Minnesota, Fargo, ND 58105, and [2] North Dakota State University, Fargo, ND 58105.
**Using the prediction model to manage Cercospora leaf spot in sugarbeet.**

Cercospora leaf spot is the most damaging foliar disease of sugarbeet in North Dakota and Minnesota. Research was conducted to determine the most effective and economical method for controlling Cercospora in sugarbeet. Research was conducted in 2001 using susceptible HH Agate and tolerant Crystal 222 sugarbeet varieties at Breckenridge, MN, and St. Thomas, ND. Fungicide applications were made using the Cercospora prediction model, where daily infection values (DIVs) were calculated at RH > 86% and > 90%, and compared with calendar spraying and common growers practice. The prediction model consists of two integrally related components: percent disease severity based on field monitoring and a Cercospora Advisory (CA) based on weather information. The CA describes the potential for infection by *Cercospora beticola* that exists the previous 48 h as a whole number between 0 and 14 based on the DIV. The DIV ranges from 0 to 7 and is calculated from the number of hours per day with RH > 90% [but the Sugar Cooperatives use RH > 86%] and the average temperature during those hours. If the sum of two adjacent days were less than six, the potential for infection was low; a sum of six was marginal; and a sum of 7 to 14 indicated conditions favorable for infection. At Breckenridge, DIVs and disease severity were low and it was not economical to apply fungicides in most of the treatments. At St. Thomas, disease severity was higher compared to Breckenridge. Significantly lower recoverable sugar per acre (RSA) occurred in untreated compared to treated HH Agate. No significant difference in RSA occurred between untreated and treated Crystal 222. It was economical to apply fungicides to HH Agate but not always economical for Crystal 222. The DIVs calculated at RH > 86% and at RH > 90% at both locations were not significantly different and thus did not impact on spray decisions.

LEMAIRE, O., BEUVE, M., LINK, D., PFEFFER, S., and GILMER, D. **Etiology and molecular epidemiology of a severe "Rhizomania-like" disease occurring in confined locations in Europe; hypothesis for the implication of the BNYVV "P" pathotype.**

A fifth *Beet necrotic yellow vein virus* (BNYVV) RNA (RNA5) component has been identified (Koenig *et al*, 1997) in sugar beets grown in the Pithiviers area, where more severe symptoms of rhizomania including foliar systemic symptoms were observed. Molecular and epidemiological studies have been carried out to verify if this BNYVV "P" type or variants of this strain could have led to such symptomatology and yield losses. To monitor the spread of the P pathotype, a European survey has been conducted in 2002. Experiments of immunocapture followed by multiplex RT-PCR were performed to detect BNYVV P type. We compared sequences from the PCR products of RNA2 (coat protein and P14, a suppressor of post transcriptional gene silencing-PTGS), RNA3 (P25, putatively involved in symptom expression) and RNA 5 (P26, putatively involved in symptom

severity) from susceptible (Roberta) and partially resistant (Parade) sugar beet genotypes. Sequence alignments showed only minor amino acid changes with the previously RNA5 and RNA3 sequences from the Pithiviers area. More deleted forms of RNA3 have been observed for the P type infecting tolerant varieties, compared to the A or B type on the same genotype. Phylogeny of P25 encoded by RNA3, reveals that P25 from P type are grouped in a distinct cluster compared to the A and B P25 proteins. Preliminary molecular epidemiological data showed that BNYVV P type is restricted to the French Pithiviers area and in a confined location of East Anglia (UK), with a very slow extension in space and time. RNA5 from France and UK belong to the formerly described Kazakstan RNA5 cluster and exhibit nucleotides subsitutions and deletions when compared to the chinese-japanese RNA5 sequences.

MERIGGI, P., ROSSI, V., and PAGANINI, U. **Cercospora leaf spot: integrated control in Northern Italy.**

Cercospora leaf spot (CLS) is the major disease of sugar beet in Northern Italy; it seriously affects about 160.000 hectares. Losses due to the fungus are generally very severe even if they depend on the year, the environmental conditions, the harvesting period and the cultural practices. To control the disease and minimize the losses for both growers and industries, strategies based on an integrated use of resistant sugar beet varieties and fungicide sprays were developed in the last ten years.

The aim of integrated control is to increase both sugar yield and quality of beets, to reduce the number of treatments and to decrease the risk of resistance of the fungal strains to the active ingredients. The sugar beet varieties performing high yields in Italy show a weak or medium level of resistance to CLS; this resistance level guarantees a sufficient disease control for the first harvesting period, while it must be integrated with a suitable scheduling of fungicide sprays in the late period of harvesting.

Several protection guidelines based on the start of treatments, number of sprays and alternate use of active ingredients were developed. Two main types of integrated strategies are actually in use: a) a CLS management developed by the National Technical Committee and b) a disease management strategy based on CLS forecasting, proposed by the Emilia-Romagna Region for the farms following the protocols for integrated crop productions, aimed at reducing the environmental impact of defense practices.

SCHNEIDER, J. H. M., and HEIJBROEK, W. **Towards an integrated control of *Rhizoctonia solani* in sugar beet.**

The soil-borne fungus Rhizoctonia solani causes increasing losses to sugar beet in Europe in general and in the Netherlands in particular. R. solani AG 2-2IIIB causes black root of seedlings and root and crown rot of mature beets. However, other AGs such as AG 1, AG 2-1, AG 2-2IV, 3, 4, 5, 11 and some undesignated isolates occur in sugar beets grown in Europe. In the Netherlands, R. solani AG 2-2IIIB has been isolated from maize, rye grass, field grown vegetable crops and lily. Fodder radish and white mustard, however, reduce the damage in a following sugar beet crop when applied as a fallow crop. Resistant varieties are only partial resistant to the disease and not immune. Seedlings are still susceptible. Seed treatment with a fungicide controlled R. solani in glass house tests, but was less effective in field trials. Management practices should aim to decrease the rhizoctonia population in soil by the use of resistant varieties, a balanced crop rotation and seed treatment. In addition, the grower should provide optimal growth conditions for the sugar beet. In this way rhizoctonia resistant varieties will perform optimally. A bio-assay to predict disease forecast system would provide the farmer a management tool to decide whether to grow a resistant or a non resistant variety, or to postpone the sugar beet crop when a soil is highly infested with rhizoctonia. In order to develop such a management tool a precise characterisation and geneti-

cal (molecular) analysis of the causal AG is essential. In collaboration with McGill university in Montreal, Canada, IRS has developed molecular methods to detect R. solani in plant and in soil. But again, the presence of the pathogen by itself in soil does not imply disease. Analysis of factors causing disease decline and soil suppressiveness may yield antagonists which could be used as a seed treatment and provide the farmers tools to optimise integrated management practices.

STEWART[1*], J. F., CROOK[2], T. M., and RADER[3], T., Michigan Sugar Company, [1]320 Sugar Street, Carrollton, MI 48724, [2]725 South Almer Street, Caro, MI 48723, [3]1459 South Valley Center Drive, Bay City, MI 48706. **Control of Cercospora leaf spot in Michigan with experimental fungicides.**

Cercospora leaf spot is the most damaging foliar disease of sugarbeets in Michigan. Yield losses of one to two tons per acre have been documented with only low to moderate disease infestations. The disease also reduces sucrose content and increases the level of impurities in the beet. Cercospora leaf spot is controlled by a combination of cultural practices and with timely fungicide applications. The fungicides which have been used for controlling Cercospora leaf spot in sugarbeets are only moderately effective. In addition, resistance is developing to the more effective systemic fungicides. Michigan Sugar Company has been evaluating several new fungicides for Cercorpora leaf spot control including azoxystrobin, trifloxystrobin, pyraclostrobin and tetraconazole. It appears that pyraclostrobin is the most effective of this group for controlling cercospora leaf spot followed by tetraconazole, trifloxystrobin and azoxystrobin. In two years of trials, pyraclostrobin treated plots outyielded the untreated check and a standard fungicide treatment by approximately 40% and 15%, respectively.

STUMP, W. L. and FRANC*, G. D., University of Wyoming, P.O. Box 3354, Laramie, WY 82071. **The efficacy of banded fungicide applications for Rhizoctonia root and crown rot management in sugarbeet.**

Fungicides are effective for suppressing Rhizoctonia root and crown rot of sugarbeet. Our objectives were to determine the optimal timing of fungicide applications relative to tillage operations that introduce inoculum onto sugarbeet crowns and to determine the relative efficacy of currently available fungicides. Field trials were conducted at the University of Wyoming Research and Extension Center near Torrington, WY. Depending on treatment, foliar band applications (7-inch width) were made on 30 May, 6, 13, 28 June, and 4 July. Immediately following the 13 June application, all plots were cultivated and *Rhizoctonia solani* (AG2-2) inoculum was applied to the crown of each plant. Rhizoctonia crown rot incidence was rated until harvest. On 25 September, beets were harvested to determine total root yields and the percentage of total sucrose. The most effective azoxystrobin and trifloxystrobin fungicide treatments were those made at the time of inoculation or when a half-rate split application of fungicide was made at inoculation and 2 weeks later. Disease incidence decreased 64-84% and total root yields increased 72-872% compared to the nontreated control ($P \leq 0.05$). Azoxystrobin treatments overall were 25% more effective than trifloxystrobin treatments for reducing disease incidence (linear contrast, $P \leq 0.05$). However, trifloxystrobin treatments applied at the time of inoculation or as a split application were equivalent to the best azoxystrobin treatments ($P=0.05$). In another study, kresoxim-methyl was less effective than azoxystrobin or trifloxystrobin at similar use rates ($P \leq 0.05$).

WINTERMANTEL*, W. M., CORTEZ, A. A., and ANCHIETA, A. G., USDA, Agricultural Research Service, 1636 E. Alisal St., Salinas, CA 93905. ***Beet curly top virus* revisited: factors contributing to recent severe outbreaks in California.**

*Beet curly top virus* (BCTV), transmitted by the beet leafhopper (*Circulifer tenellus)* has caused significant problems to irrigated agriculture in the western United States since the late 1800s. Although managed annually through an intensive leafhopper eradication program, BCTV re-emerged in 2001 as a serious threat to agriculture in California's San Joachin Valley. BCTV infects a broad range of crop hosts including sugarbeet, pepper, tomato, bean, spinach, and cucurbits, as well as numerous weeds. Although many strains of BCTV have been identified over the years, molecular characterization of BCTV in sugarbeet has demonstrated that the virus primarily exists as genetic variants of three strains, CFH, Worland, and California/Logan. Studies conducted in the early 1990s determined that most sugarbeets were infected with either CFH or Worland strains, but little information exists on strain distribution among weed hosts. Data collected over the past 2 years in California and other states has focused on molecular characterization of BCTV isolated from weed hosts present in the overwintering grounds of the beet leafhopper, as well as sugarbeet and selected other crops. PCR using BCTV universal primers, as well as strain specific primers have been used to amplify viral DNA from infected crop and weed hosts from both fields and overwintering grounds of the beet leafhopper. Strain identification coupled with sequence analysis provides insight into variability in virus population structure over broad areas, as well as over time.

# C, Entomology and Plant Pathology
# Poster Presentations

BRANTNER*, J. R. and WINDELS, C. E., University of Minnesota, Northwest Research and Outreach Center, Crookston, MN 56716. **Band and broadcast applications of azoxystrobin for control of *Rhizoctonia solani* on sugar beet.**

Rhizoctonia root and crown rot, caused by *R. solani*, often occurs between row closure through harvest in the Red River Valley. The disease has increased in recent years and producers want to know the optimal time to apply azoxystrobin (Quadris) for maximum disease control. Our objectives were to evaluate control of *R. solani* by azoxystrobin 1.) when infection begins at the 7- to 8-leaf stage or at canopy closure and 2.) after initial aboveground symptoms of disease are observed. Plants in the 7- to 8-leaf stage were inoculated by spreading *R. solani*-infected barley grains (16 g) along the length of a 9-m row and lightly racking soil over the inoculum. Azoxystrobin was applied the same day in an 18-cm band at 0.014 g a.i./m; one to two additional applications of product were made at 2-week intervals. At canopy closure, another set of beet plots were inoculated (as previously described) and immediately followed with a broadcast application of azoxystrobin at 168 g a.i./ha, with a second application 2 weeks later. A third set of beet plots were inoculated at canopy closure and the first application of azoxystrobin (168 g a.i./ha) was made when limited dark discoloration of petioles was observed at the crown, followed by a second application 2 weeks later. Controls included untreated beets and those inoculated with *R. solani* but not treated with azoxystrobin. Band applications of azoxystrobin did not provide adequate full-season control of disease on beets inoculated at the 7- to 8- leaf stage. Broadcast applications of azoxystrobin most effectively protected beets from *R. solani* when applied at row closure but were ineffective in stopping development of disease when applied on plants with early symptoms. In conclusion, application of azoxystrobin at time of canopy closure is effective in controlling Rhizoctonia root and crown rot in the Red River Valley.

BUTTNER, G. **Rhizoctonia root rot in Europe – incidence, economic importance and concept for integrated control.**

The soil-borne fungus Rhizoctonia solani (Kühn) is the causal agent of numerous diseases in agricultural and horticultural crops world-wide. In sugar beet the pathogen causes root and crown rot, which has become increasingly more important over the past years in Europe. An excess of 5 to 10 % of the total European sugar beet acreage are affected or threatened by the disease. Rhizoctonia root rot results in substantial losses for farmers and the sugar industry. Diseased plants yield less and the sugar content of the beet crop is reduced; the capability for storage and the processing quality of the beets are negatively affected resulting in difficulties during beet processing in the sugar factory.

Phytopathologists from public and private research institutes, the sugar beet breeding companies and the agro-chemical industry are cooperating with the sugar industry and the sugar beet producers to investigate the etiology, pathophysiology and epidemiology of the disease and to develop control strategies. An integrated approach combines the cultivation of Rhizoctonia resistant sugar beet varieties and seed treatment with Rhizoctonia specific fungicides with an improved crop rotation and other agronomic practices to reduce the infection pressure in the field. First available results to control Rhizoctonia root rot with such an integrated concept have been promising.

The poster presents data on the incidence of the disease in Europe, shows disease symptoms and estimates the influence on sugar beet yield and processing quality. Research

strategies, current research projects and cooperating institutions are being discussed.

Campagna, G., Massimo Zavanella, Servizio agronomico CO.PRO.B. - Via Mora, 56 - Minerbio 40061 Italy **CONTROL OF CLEONUS (*Temnorhinus mendicus*) WITH SOIL INSECTICIDES IN LOCALISATION DURING SOWING AND SEED DRESSING IN SUGAR BEET - SECOND CONTRIBUTE**

An investigation is reported regarding some environmental controlled tests and on field trials with soil insecticides used in localisation during sowing and/or as seed dressing. The trials aimed to evaluate the degree of control of cleonus after the very interesting results obtained in a previous contribute. The heavy losses caused to beet crops from the gradual coming out of the weevil during spring, can be avoided with soil insecticides. In-checking the degree of the control of sugar beet weevil by usage of traditional and new soil insecticides, we noted that fipronyl had the best results. Fipronyl used both as seed dressing and in localised application during sowing, allowed a high control of this harmful insect.

The use of tiametoxam on seed determined inappetence, but with this soil insecticide is possible to obtain good efficacy too. The use of soil insecticides made unnecessary the utilization of other insect-killers, thus reducing the environmental impact and the waste of money, and improve the managing of the crop.

CAPRIOTTI, G. **Fitosit: A tool for pest and disease control.**

The GIS is a tool, used in several fields, that can be also employed in beet growing to examine and control the pests and diseases which hit the beet like the heterodera schachtii, the BNYVV, etc. It is possible to create maps for pathogens presence and to inquire into the correlations between their biological cycles and the pedoclimatic and geographic characteristics of the epidemiological zone.

CIONI F. **The use of the additives in weed and disease control in sugar beet.**

Results of the last five years field trials with amino acids, peptides, surfactants and pH stabilizers of the chemical solution employed in weed, Cercospora leaf spot and Oidium control are reported.

The aim was to improve the efficacy, the selectivity, the persistence and reduce environmental impact of the mixture employed in stress condition of the crop too.

Field trials have shown the possibilty to replace the higher toxic products and increase the biological activity of some mixtures employed.

DESPREZ, B. **Violet Root Rot – French situation and research development.**

Among the different soil-borne diseases of sugarbeet, violet root rot (rhizoctonia violaceae) is nearly the only one which is not or not even on the way to be controlled. This disease is rather important in some areas in France, and could be an essential limiting factor for quality and quantity of sugarbeet crops. After a brief presentation of the epidemic cycle of violet root rot, breeding methods using artificial infection are presented. Different sugar and fodder beet lines have been tested using a unique collection of 30 different strains of fungi. After in vitro culture during 7 days at 20°C on a malt-agar-agar medium, the different culture samples are directly used for barley seed inoculation or stored in liquid nitrogen. Barley seed inoculum is laid at the bottom of plant pots or 10 cm below the expected seed planting depth, or located directly in touch with the bottom of developed root rots. The results are scored on a range from 0 to 6 (0 = healthy root, 6 = destroyed or dead). The use of in vitro culture medium "pills" of rhizoctonia in direct contact with developing roots is also studied. Differences in phenotypes are also noticed for

different susceptibility stages (always at a stage over 8 leaf stage) among the different tested genotypes. The bottom part of the roots is always the one which is the most infected. Most of the different genotypes are susceptible to very susceptible. Sowing date, seed treatment, fungus strains as well as soil types have been evaluated. Only one fungus strain was demonstrated as non-aggressive and only one of the tested soils was found to enhance the aggressiveness of the fungi. Genetic solution is anyway on the agenda even if this solution would probably be complex, combining later susceptibility stage with lower speed of infection.

DEWAR, A. M., HAYLOCK, L. A., BAKER, P., GARNER, B. H., and SANDS, R. J. N.
**Neonicotinoid seed treatments to control aphids and virus yellows in sugar beet.**

Imidacloprid (Gaucho, Bayer) applied as a seed treatment to pelleted sugar beet seed was used on 73% of crops in the UK in 2002 to control soil and foliar pests of sugar beet, of which the aphid vectors of virus yellows were the most important target. Two new neonicotinoid insecticides, thiamethoxam (Cruiser, Syngenta) and clothianidin (Ti435, Bayer) have been developed as alternatives, and were compared with imidacloprid in 5 field trials conducted over five years. Trials were inoculated with virus-infective aphids, which were placed on six plants per plot in mid-June. This represented approximately 2% primary infection - similar to that which would occur naturally in a moderate-high virus year. Both thiamethoxam and clothianidin, applied at 60 g a.i./unit, a 33% lower rate than imidacloprid, gave excellent control of the green aphids Myzus persicae and Macrosiphum euphorbiae, resulting in significant reductions in virus yellows incidence (range 29% to 78 %), and sometimes in significant increases (range 9 % to 57 %) in sugar yield compared to untreated plots. In addition, all three neonicotinoid insecticides controlled clones of M. persicae that contain one or more of the three known resistance mechanisms (elevated carboxylesterases (R1-R3), modified acetylcholinesterase (MACE) and knockdown resistance (kdr)), which confer resistance to other types of insecticides, including organophosphates, carbamates and pyrethroids, which have different modes of action.

GALLIAN[1], J. J., NEUFELD[2], J. D., and REDDY[3], S. J., University of Idaho, [1]P.O. Box 1827, Twin Falls, ID 83303-1827, [2]P.O. Box 1058, Caldwell, ID 83606, and [3]485 East 3rd St., Weiser, ID 83672. **Integrated management of rhizomania in Idaho and eastern Oregon.**

Approximately 89,000 ha of sugar beets are grown annually in Idaho and eastern Oregon, with a majority of the area in Idaho. Average yield for the area is about 60 tons/ha. Since rhizomania was first detected in Idaho, the infested area has increased from 271 ha in 1992 to more than 30,700 ha in 2002. Although planting resistant varieties is the most important practice for rhizomania control, significant yield loss can result without proper management. An increasing number of growers are successfully achieving maximum production with an integrated approach using a) resistant varieties, b) a minimum four-year rotation, c) irrigation monitoring, and d) green manure crops. Rotations shorter than four years usually result in a yield decrease. All sugar beets in this area of the country are irrigated. Monitoring soil moisture and scheduling irrigation using soil moisture probes and data loggers allow growers to avoid excessive irrigation. Growers experience a sugar beet yield improvement incorporating green manure crops of *Rhaphanus sativus* in rhizomania infested fields.

GODFREY[1], L. D., HAVILAND[2], D., and GOODWIN[3], B., [1] Dept. of Entomology, One Shields Ave., Univ. of California, Davis, CA. [2] University of California Cooperative Extension - Kern Co., 1031 S. Mt. Vernon Ave., Bakersfield, CA 93307, and [3] California Beet Growers Association, Two West Swain Road, Stockton, CA 95207. **Progress Towards Implementing Reduced Risk Management of Beet Armyworm (*Spodoptera exigua*) in California Sugarbeets.**

Beet armyworm (*Spodoptera exigua*) larvae are significant pests of sugarbeets in the Central Valley of California. Larvae skeletonize the plant leaves which can cause significant yield losses. In addition, in recent years the larvae often feed on the beet roots near or slightly below the soil surface which provides entry ports for root rotting organisms into the beet roots. Control of beet armyworm infestations during the growing season has been largely accomplished with applications of organophosphate and carbamate insecticides (primarily Lorsban® and Lannate®). In recent years in the Central Valley, repeat applications of insecticides are often needed for acceptable beet armyworm management and control has still been inadequate. These applications have eroded the profitability of sugarbeets and the lack of control has reduced sucrose yields; the multiple applications have flared populations of secondary pests such as spider mites, leafhoppers, etc. The efficacy of the organophosphate insecticides appears to be waning probably because of the development of resistance. In addition, regulatory actions, such as the Food Quality Protection Act, water quality concerns, and others complicating factors, may also limit the use of these products in the future. Biorational compounds, such as *Bacillus thuringiensis* and spinosad, may offer improved management opportunities for lepidopterous larval pests of sugarbeets. These materials, especially Bt products, may require additional field monitoring to optimize the efficacy. For instance, information on timing of beet armyworm flights may be helpful to time applications. A three-year research and demonstration project was conducted to investigate the feasibility of refining management of key sugarbeet arthropod pests.

HANSON*, L. E., USDA-ARS, NPA, Fort Collins, CO 80526. **Biological control of damping-off in sugar beet seedlings with *Trichoderma* species.**

Isolates of *Trichoderma virens* and other *Trichoderma* species are effective biocontrol agents for diseases of several crops. Control of damping-off caused by *Rhizoctonia solani* has been observed in a number of crop species. To test for biocontrol activity on sugar beet, *Trichoderma* strains were grown in 5% ground wheat bran and 1% ground peat moss. The preparation was air dried and applied to seed with latex sticker. Seeds were planted in greenhouse potting mix with either sterile vermiculite or *R. solani* grown on sterile barley and mixed with vermiculite. The survival of sugar beet (PC403) seedlings under severe *Rhizoctonia* pressure was compared for different *Trichoderma* isolates in the greenhouse at 7, 14, and 21 days. Seedling roots were collected, washed and plated to determine fungal colonization. All of the *Trichoderma* isolates colonized sugar beet radicles and young roots well. Some fungal isolates significantly improved seedling emergence and survival in greenhouse tests. There was no significant correlation between *in vitro* antibiosis against *R. solani* and biological control activity. However, biocontrol-effective strains induce a higher level of peroxidase activity in seedling roots grown in sterile glass dishes than do biocontrol-ineffective strains.

HANSON, L. E., HILL, A. L., and PANELLA, L., USDA-ARS, NPA, SBRU Fort Collins, CO 80526. **Variable virulence and genetic diversity in *Fusarium oxysporum* from sugar beet.**

Fusarium yellows of sugar beet can cause reductions in root yield in addition to reducing sucrose percentage and purity in the root. The primary causal agent is *Fusarium*

*oxysporum* f. sp. **Betae** (FOB). Some strains of FOB also infect spinach and some weed species, so FOB may have a less restricted host range than is usually reported for *forma specialis*. We investigated the variability in strains of *F. oxysporum* isolated from sugar beets from seven states in terms of their pathogenicity and virulence on sugar beet in greenhouse tests and their variability in RAPD banding patterns. Four-week-old beet plants (*Fusarium*-susceptible line FC716) were inoculated by dipping clipped roots in spore suspensions of the different isolates. From a total of 98 isolates, 26 were pathogenic on sugar beets and 24 were identified as FOB. These pathogenic isolates were from three states, CO, MT and OR. One isolate each of *F. solani* and *F. accuminatum* also were pathogenic in our greenhouse assay. Twelve isolates of FOB were analyzed by RAPD analysis using nine primers. Based on RAPD patterns, the eight isolates of FOB from Colorado clustered together, but some non-pathogenic isolates clustered with the FOB strains. FOB strains from Montana and Oregon showed divergent patterns and also clustered with no-pathogenic isolates. Thus FOB appears to be a diverse group within *F. oxysporum*. When a subset of isolates were tested on a set of sugar beet varieties with reported resistance to Fusarium yellows, some isolates gave different reactions with the varieties. This may indicate the existence of races within FOB.

HARVESON*, R. M. and CARLSON, C. C., University of Nebraska, Panhandle Research and Extension Center, Scottsbluff, NE 69361. **Response of sugar beet cultivars to Aphanomyces and Rhizoctonia root rots under optimum conditions in the greenhouse.**

Rhizoctonia root and crown rot has been present in western Nebraska for many years, and is considered the most widespread and consistently damaging disease of sugar beets in the state. Aphanomyces root rot has been more recently reported in Nebraska, but its known incidence and distribution has rapidly expanded. It is also becoming more common to find both diseases occurring simultaneously in fields. Resistant cultivars are available for both diseases, but no one cultivar with resistance to both has been developed for use in the Central High Plains. Therefore a greenhouse study was begun to investigate the response of a *Rhizoctonia*-resistant (Betaseed 4546) and an *Aphanomyces*-resistant (Crystal 205) cultivar, each planted into soils infested with *A. cochlioides*, *R. solani*, and both pathogens combined. The experiment was conducted in controlled temperature boxes at a constant rhizosphere temperature of 27 C for 3 months. Data collected prior to harvest included seedling mortality and stand establishment, and leaf area and dry weights at 10 leaf stage. At harvest, taproots were rated for disease severity on a scale of 0-4, and dry weights were obtained from foliage and roots. Seedlings from treatments including *Rhizoctonia* alone and combined with *Aphanomyces* began dying within a week of emergence, whereas disease due to *A. cochlioides* was not apparent until 2-3 weeks after emergence. *Rhizoctonia solani* also caused more severe damage to plants, as measured by disease ratings and dry plant weights. In general, Betaseed 4546 responded better to both diseases than did Crystal 205. Because *R. solani* appears to be more aggressive and causes more extensive damage to plants than *A. cochlioides*, it may be more important for growers to place an emphasis on managing Rhizoctonia root rot in situations where both pathogens are present simultaneously.

HARVESON*, R. M. and BLEHM, E. S., University of Nebraska, Panhandle Research and Extension Center, Scottsbluff, NE 69361. **Comparing protectant and systemic fungicides using different application timings for management of Cercospora leaf spot in the Nebraska Panhandle.**

Cercospora leaf spot is the most important and destructive foliar disease of sugar beets in western Nebraska. There is a wide range of fungicides available for grow-

ers, but there have been questions regarding identifying the spray program that most effectively controls the disease, while also managing fungicide resistance in the pathogen. Thus, a study was conducted during 2000 and 2001 with the objective of comparing a systemic fungicide (Benlate/Topsin) with a protectant (Super Tin) applied at different times during the season. Two other newer fungicides (Headline and Eminent) were additionally evaluated in 2001 based on a previously developed forecasting system. The 2000 study used furrow irrigation while the 2001 study employed sprinkler irrigation. Both studies relied upon natural infection, and disease severity was measured by a leaf rating using a non-linear scale of 0-9. Additional data collected included root and sucrose yields, and sucrose percentages. Compared to controls, significant differences were observed from disease severity ratings in all fungicide treatments during both years, however yield differences were seen only in 2001. Early fungicide treatments in 2001 resulted in significant increases for both root and sucrose yields, but not sucrose percentage. Results from both years suggest that the timing of the fungicide application is more important for reducing disease effects than the type of fungicide employed. The results also show that during years when conditions are favorable for Cercospora leaf spot to occur, early applications can significantly imporve sugar beet yields and profitability.

HAVILAND[1], D. R., GODFREY[2], L. D., and KEILLOR[3], K., [1]University of California Cooperative Extension, 1031 S. Mt. Vernon Ave., Bakersfield, CA 93307, [2]Entomology Department, University of California Davis, One Shields Avenue, Davis CA 95616 and [3]Department of Entomology, University of California Shafter Research and Extension Center, 17053 North Shafter Ave., Shafter, CA 93263. **The development of IPM for beet armyworm, *Spodoptera exigua*, in California sugarbeet.**

Management of beet armyworm, *Spodoptera exigua*, has been a topic of concern for growers and pest control advisors of California sugarbeet. Beet armyworm defoliate sugarbeet, as well as feed on the exposed portion of the taproot. This latter damage makes the taproot more susceptible to root rot pathogens. Management of beet armyworm is accomplished, primarily, through applications of chlorpyrifos and methomyl. Growers suggest that these insecticides result in outbreaks of both primary and secondary pests. This research was conducted to determine the factors influencing pest outbreaks and late-season defoliation, and to develop a management strategy for summer beet armyworm populations.

Field experiments were established at the West Side Research and Extension Center near Five Points, CA during 2001 and 2002. The first experiment was designed to evaluate conventional and reduced-risk insecticides for their effects on arthropod populations and sugarbeet productivity. In the second experiment, data were collected to study the interactive effects of beet armyworm-induced defoliation and spider mite damage. The goal was to determine if beet armyworm damage makes sugarbeet more susceptible to injury by twospotted spider mite. In the third experiment, three sugarbeet varieties were tested for their ability to compensate for defoliation without a loss in sugarbeet productivity. Varietal preference by beet armyworm was also evaluated. The fourth experiment evaluated the effects of single and repeated, complete defoliation events on sugarbeet productivity. The last experiment was used to determine the optimal application timing of Success as a possible replacement for repeated applications of organophosphate and carbamate insecticides.

HERMANN, O. and CORNELIS, P. **Quantification of *Hererodera schachtii* in soil using different molecular techniques and serological tests.**

*Heterodera schachtii* is a cyst-forming nematode that can cause severe damage in sugar beet crop. The morphological identification and quantification of this para-

site is a difficult and labour-intensive procedure.
For this reason a molecular test using primers specific for *H. schachtii* was developed by the Department of Crop Protection of the Centre for Agricultural Research in Ghent (Belgium) and in collaboration with the IRBAB. This test offers a quick and reliable qualitative method for detection and identification of the species *H. schachtii*.
In this paper we describe a method of quantification *H. schachtii*, by performing a PCR using these primers followed by an immuno-assay (ELISA). PCR-products obtained by 2 specific primers carrying at their 5'-ends either biotin or fluoresceïn can by quantitatively analysed by this serological test. The biotin labelled primer allows the PCR-product to bind to a microtitre plate coated with strepavidin or avidin. After washing and removing primer residues, anti-fluorescein antibodies linked to horse-radish-peroxidase can bind to the PCR-products. Unbound antibodies are removed by washing.
Identification and quantification can then be realised by adding a substrate that colours in the presence of the peroxidase. The optical density, measured by a photo-spectrometer and compared to the optical density of a standard sample that has a known amount of eggs and juveniles of *H. schachtii*, represents the quantity of this parasite in a given sample.
The PCR/ELISA procedure is a fast and sensitive method, which allows automation.

Furthermore this method is relatively cheap in comparison with quantitative PCR.

HEIN[1*], G. L., BLODGETT[2], S., and YONTS[1], C. D., [1]University of Nebraska, Panhandle Research and Extension Center, 4502 Ave. I, Scottsbluff, NE 69361, [2]Department of Entomology, Montana State University, Bozeman, MT 59717. **Field dynamics of sugar beet root aphid populations and factors influencing populations.**

The sugar beet root aphid is commonly seen throughout all of the sugar beet growing areas of the Rocky Mountain region. Even though sugar beet root aphid populations in individual fields are sporadic, losses from this insect are significant. A better understanding of the population dynamics of the aphid and the factors that affect it are needed to better manage this serious insect pest. The objectives of this study were to establish the seasonal population buildup of root aphids in sugar beet fields in the region and identify major factors that may influence root aphid survival.
Root aphid populations were monitored in sugar beet fields planted to a root aphid susceptible variety in Nebraska and Montana in 2000 and 2001. Beginning in late July, samples were taken in these fields and monitored approximately weekly for root aphids to determine the aphid infestation levels and aphid population densities in these fields. Results indicate root aphids populations increase slowly through July and early August with much more rapid increase in late August, peaking in early to mid-September. These data indicate that September irrigation/rainfall may be an important factor influencing aphid impact.
The influence of irrigation on aphid populations and aphid impact on yield were done with replicated studies looking at the effects of various levels of irrigation and irrigation timing. The data indicate that even under well irrigated conditions the aphid can have a significant impact and that irrigation timing may influence that overall impact. Increasing irrigation does reduce aphid populations, but does not eliminate them under the conditions tested.

KUYKENDALL[*], L. D. and STOCKETT, T. M., USDA, Agricultural Research Service, BARC, PSI, Molecular Plant Pathology Lab, Beltsville, MD 20705 USA.
**Improving *Cercospora beticola* leafspot disease resistance.**

Transgenic sugar beets carrying genes designed to improve *Cercospora* leafspot resistance are being developed. *Cercospora* leafspot disease-resistant sugar beet germplasm

could produce an overall 30% increase in crop profitability. In order to control crop losses due to this foliar disease, the *cfp* gene from *Cercospora*, which specifies an export pump for cercosporin toxin, is being used to make transgenic plants. The *cfp* gene was obtained from ARS scientist Dr. R.G. Upchurch at North Carolina State University, where, in tobacco, it has shown some preliminary promise in producing increased resistance to *Cercospora*. In order to experimentally transform sugar beets with the *cfp* gene, hundreds of cotyledons were treated with bacteria engineered for gene transfer into plants. About ≤1% regeneration was obtained, several distinct *cfp*-carrying transgenics were selected and examined by PCR analyses. Transgenic clones are now being propogated to obtain material for gene expression analysis and for evaluation of leafspot disease susceptibility. Resistant germplasm, once identified, would be released for use in commercial breeding programs.

LARSON[1], B. J., ANSLEY[1], J. C., ZIDAK[1], N. K., ECKHOFF[2] , J. L. A., and JACOBSEN [1], B. J., [1]Department of Plant Sciences and Plant Pathology, Montana State University, P.O. Box 3150, Bozeman, MT 59717-3150.[2] Eastern Agricultural Research Center, 1500 Central Ave., Sidney, MT 59270. **Integrating fungicides, resistant varieties and biological controls to manage Cercospora leaf spot.**

Cercospora leaf spot is a difficult disease to manage economically because of fungicide resistance in the pathogen, cost of fungicide spray programs and lack of high levels of resistance in commercial cultivars. In four years of field research at Sidney, MT we have demonstrated that varieties with intermediate levels of resistance (e.g. KWS scores <5.3) will have the same yield and area under the disease progress curve with 1-2 fewer fungicide applications per year as varieties with KWS scores>6.0 with 4 fungicide applications. All varieties required fungicide application at disease onset to achieve maximum returns. Four applications of the biological control Bacillus isolate Bac J applied alone starting 1 week before disease onset or at disease onset with tetraconazole (Eminent) followed by Bac J alone provided yield and disease control equal to the susceptible variety with four fungicide treatments on varieties with KWS scores<5.3. On these moderately resistant varieties, Bac J alone provided yield comparable to the standard fungicide program and nearly equal disease control. The standard fungicide program was tetraconazole at disease onset followed 14 days later with benomyl, followed 14 and 28 days later with Super Tin. Isolates resistant to the benzimidazole fungicides and tolerant to 1 ppm tetraconazole and azoxystrobin have been identified in these plots since 1998. The use of fungicide rotations, combinations with Bac J or alternations with Bac J have proven effective in reducing the incidence of fungicide resistance or tolerance. Bac J has been proven to activate induced systemic resistance (ISR) in the sugarbeet plant.

LEMAIRE, O., BEUVE, M., STEVENS, M., LIU, H. Y., WINTERMANTEL, W. M., and HERRBACH, E. **Phylogeny of sugar beet poleroviruses: applications in molecular epidemiology and vector specificity studies.**

Three distinct plant virus species belonging to the *Polerovirus* genus in the family *Luteoviridae*, persistently transmitted by aphids, have been described as being able to induce mild yellowing disease on sugar beet : *Beet mild yellowing virus* (BMYV), *Beet chlorosis virus* (BChV) and *Beet western yellows virus* (BWYV-USA). The rape and lettuce isolates of Turnip yellows virus (TuYV) are known as a cluster of BWYV isolates that infect transiently sugar beet. We analyzed the biological and serological properties of these viruses as well as their molecular organization. Full-length genomic sequences for all of these species were obtained and we performed intra- and inter-specific alignments between all the putative viral proteins. Phylogenetic studies suggested that BWYV-USA originated from recombination events between a *Cucurbit aphid-borne yellows virus* (CABYV)-like common ancestor of CABYV and BMYV,

donating P0, P1 and P2 and a beet polerovirus progenitor providing the 3' open reading frames (3, 4 and 5). Analysis of the viral genomes enabled the development of species-specific diagnostic tools for the study of molecular epidemiology of the virus yellows disease complex. To date, our epidemiological data showed that BMYV and BChV are present in Europe, whereas BWYV-USA and BChV occur in USA on yellowing sugar beet. Moreover, these molecular epidemiology studies have revealed that mixed infections do occur in the field, enabling potential recombination events. All these biological and molecular features make the vector specificity studies of the beet poleroviruses a promising model, for which the first results will be presented.

LIU*, H-Y., SEARS, J. L., and LEWELLEN, R. T., USDA-ARS, 1636 East Alisal Street, Salinas, California 93905. **A new beny-like sugarbeet virus emerging in the United States.**

A virus with rigid rod-shaped particles was isolated in addition to *Beet necrotic yellow vein virus* (BNYVV) from rhizomania infested fields in California. The infected sugarbeet leaves showed oak-leaf pattern symptoms different from rhizomania. For purposes of discussion this unnamed virus will be tentatively called Beet oat-leaf virus (BOLV). BOLV is serologically distinct from BNYVV, *Beet soil-borne mosaic virus* (BSBMV), and *Beet soil-borne virus* (BSBV)/*Beet virus Q* (BVQ). The host range of BOLV is similar to BNYVV and BSBMV mostly infecting *Chenopodiaceae* plants. BOLV produces chlorotic local lesions with a necrotic ring after mechanical inoculations. Particles were 18 to 20 nm wide and ranged from 80 to 640 nm long with three modal lengths: 180-200 nm, 260-280 nm, and 300-320 nm. *Polymyxa betae* transmission of BOLV was demonstrated through a bioassay by using BOLV-infected cystosori and sugarbeet as bait. BOLV has been purified from *Chenopodium quinoa*. The molecular mass of the capsid protein was estimated to be 43.0 kDa. A polyclonal antibody from rabbits has been produced and can be used in ELISA and immunogold labeling tests. BOLV appears to be wide spread in U.S. It has been found also in Colorado, Michigan, Minnesota, Nebraska, and Wyoming. BOLV was found in sugarbeet alone or co-infected with BNYVV and/or BSBMV. The economic significance of BOLV and its interaction with other benyviruses are not known.

MARTIN DOMINGUEZ, R., RUIZ-HOLST, M., and GUZMAN SANCHEZ, J. **The beet lepra (*Physoderma leproides*) : a technological industrial case study about this southern spanish autumn sown beet disease.**

ABSTRACT NOT RECEIVED

METZGER[1], M. S. and WEILAND[1,2], J. J., [1]Department of Plant Pathology, North Dakota State University, Fargo, N.D. 58105 and [2]USDA-Agricultural Research Service, Red River Valley Agricultural Research Center, Fargo, N.D. 58105. **Field biocontrol of *Aphanomyces cochlioides*.**

Seedling damping off and chronic root rot of sugarbeet caused by *Aphanomyces cochlioides* has caused increasing losses to U.S. producers. Lack of effective control measures for Aphanomyces root rot prompted the initiation of a program aimed at the discovery of new, safe components for disease control. A biological control bacterium and a known inducer of systemic resistance were tested for their ability to control Aphanomyces root rot at two locations in the Red River Valley of the north central U.S. during the 2001 growing season. At both field locations, sugarbeet yield was increased where seed was treated with the bacterium *Burkholderia cepacia* AMMDR1. At one location, treatment with formulated harpin protein (Messenger™) also resulted in increased sugarbeet yield.

Tests in 2002 included an additional *Pseudomonas* biocontrol bacterium and treatments involving harpin in combination with standard fungicides for seedling disease control. Future studies will aid in determining new approaches to be implemented alone or in conjunction with current disease control measures to reduce losses caused by this serious pathogen of sugarbeet.

PETERSEN*, B., BLOOMBERG, J. R., and WOLLAM, J. D., Bayer CropScience, Kansas City, MO 64120. **Gem: a new fungicide for disease control in sugar beets.**

Cercopsora leaf spot and powdery mildew are important widespread and destructive diseases in sugar beets in the United States that can cause severe yield losses if not controlled. Gem, a new strobilurin fungicide from Bayer CropSciences, offers excellent "locked in" foliar control of both diseases. These "locked in" properties include: high affinity for the plant surface, penetration into the plant tissues, translaminar activity, redistribution by superficial vapor movement and redeposition onto plant surfaces that together result in excellent rainfastness and improved plant protection. Gem has a very favorable profile regarding human safety and safety to the environment, and has been classified as "reduced rick" chemistry by EPA. Multistate evaluations over several years have show that Gem applied at 6 to 7 oz. product/acre in a 10 to 14-day preventative spray program provided excellent control of both diseases and improved yields. Gem will be recommended for use in alternating spray programs with other effective mode of action fungicides to ensure sound resistance management.

POTYONDI, L. **Present situation of Hungarian Sugar Beet production.**

Presently in Hungary sugar beet is produced on 55-60 thousand hectares of 6 sugar factories owned by three sugar companies. After the expected EU accession in 2004 we will be allowed to produce our sugar quota of approximately 400.000 t on an area of similar magnitude. It is guaranteed by the right to deliver 2.5 million t sugar beet in total that was granted to producers in 2002.

We are going to describe the current level of sugar beet production by providing an overview of the major technological elements, with special emphasis on the Hungarian ecological conditions as well as pathogens and pests.

In Hungary the most important decisive factor of sugar beet production is the amount and distribution of rainfall. More than half of the last 10 years was droughty, however we have only been able to irrigate maximum 20% of the crop.

The most important pests are weevils (Curculionidae), beet flea (Chaetochnema tibialis Marsh), aphids (Aphis fabae Scopoli), a beet moth (Scrobipalpa ocellatella Boyd), the cutworms of moths (Noctuidae) and of rodents vole (Microtus arvalis levis) and hamster (Cricetus cricetus L.).The most important diseases are rhizomania (BNYVV), a cercospora leaf spot (Cercospora beticola Sacc.) and Powdery mildew (Erysiphe betae (Vahna) Weltzein). We have efficient protection methods against most of the pests and diseases.

ROEHL*, S. R., BREDEHOEF, M. W., and WIDNER, J., Southern Minnesota Beet Sugar Cooperative, P.O. Box 500, Renville, MN 56284. **Variety approval and screening at Southern Minnesota Beet Sugar Cooperative in the presence and absence of beneviruses.**

Beet Necrotic Yellow Vein Virus (rhizomania) and Beet Soil-Borne Mosaic Virus were positively identified at Southern Minnesota Beet Sugar Cooperative (SMBSC) in 1996. Efforts to contain and exclude viral diseases were immediately initiated. However, experiences from other infected areas of the world indicated that tolerant varieties held the

greatest promise to maintain economically feasible sugar beet production. Beet seed companies quickly began developing tolerant varieties suitable for the southern Minnesota growing area. By 1998, these varieties were tested in strip trials and small-scale variety screens to evaluate varietal performance in the presence of rhizomania. In 1999, rhizomania tolerant varieties made up 4% of planted acres at SMBSC. By 2000, availability and usage of rhizomania tolerant varieties had increased to 20%. In that same year, SMBSC began full-scale official variety trial screenings on both known viral infected fields and fields tested to be apparently free of virus infestations. In 2001, over 40% of sugar beet acres were planted to rhizomania tolerant varieties while variety screening continued in the presence and absence of the disease. This past year, SMBSC planted over 67% of total acres to rhizomania tolerant varieties. It is likely that eventually all varieties approved at SMBSC will have some level of rhizomania tolerance. The 2002 SMBSC official variety trials marked the third year of testing on infected as well as non-infected fields. This has enabled SMBSC to compare three-year variety performance in the presence of viral diseases to three-year variety performance in the absence of viral diseases and also to investigate a modified variety approval system based upon these comparisons. The approval process recognizes the importance of correct placement of available tolerant varieties to fields based upon verification of disease presence and an estimate of disease severity.

RUIZ-HOLST, M., MARTIN DOMINGUEZ, E., BURBA, M., DOMINGUEZ Y ELIAS, P., and DIENER, G. **The technological industrial value of sugar beets: the new VTIR formula for industrial economical prediction of spring and autumn sown beets.**
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STEVENS, M. AND HALLSWORTH, P. B. **The effect of beet chlorosis virus (BChV) on the yield of sugar beet.**

Virus yellows remains an important disease of the UK sugar beet crop because the maritime climate favours the survival of the aphid species that transmit the viruses to the crop. Several different viruses are involved in the disease complex including the poleroviruses Beet mild yellowing virus (BMYV) and the recently identified Beet chlorosis virus (BChV). Studies have shown that the biological and molecular properties of BChV differ significantly from BMYV; the effects of BChV on the yield of UK sugar beet are unknown. Therefore, in studies at IACR-Broom's Barn, the separate effects of BMYV and BChV, on the yield of field-grown sugar beet were studied following sequential inoculations from May to July in 1997, 1999 and 2000. Each sugar beet plant within the appropriate plots was infected with virus using at least 10 wingless viruliferous Myzus persicae per plant. In all three years, yield losses were negatively correlated with time of infection with early season (May) inoculations causing 18-27% losses in sugar yield but late season losses only 4-15%. BChV decreased the yield and sugar content of beet following early season inoculations, although the effects on yield were more variable (range 8-24%) and less pathogenic than those caused by BMYV. However, inoculations with BChV in July of each year caused greater root and sugar losses than inoculations with BMYV at that time. Both poleroviruses increased the sodium content of the roots early in the season, although neither virus had an effect on potassium levels at any stage.

VEREIJSSEN **Potential primary site of infection of *Cercospora beticola* in sugar beet.**

Repeated observations of isolated, growth reduced sugar beet plants with Cercospora leaf spot symptoms as early as late June, early July made us question the

primary infection site of this pathogen. In this study we showed that it is possible to obtain leaf spot symptoms in the greenhouse as soon as two weeks after immersion of sugar beet seedling roots in conidial suspensions of Cercospora beticola. Not all infected seedlings showed leaf spot symptoms. In future research the use of molecular techniques will help to detect C. beticola in sugar beet plants without symptoms.

VILLANUEVA, E., WORKNEH, F., and RUSH, C. M., Department of Plant Pathology, Texas Agricultural Experiment Station, Bushland, TX 97012. **Effect of Temperature on Infection of *Chenopodium quinoa* by Beet Soilborne Mosaic Virus and Beet Necrotic Yellow Vein Virus and Subsequent Disease Development.**

Beet soilborne mosaic virus (BSBMV) is closely related to beet necrotic yellow vein virus (BNYVV), the causal agent of rhizomania. Both viruses are widespread in sugar beet (*Beta vulgaris)* growing regions of the United States. They are vectored by *Polymyxa betae* (Keskin), a soilborne fungus, and are similar serologically and biologically. *Chenopodium quinoa* is a local lesion host for both viruses. Temperature requirements for BNYVV infection have been described previously, but the effect of temperature on infection by BSBMV, potential interactions in mixed infections with BNYVV, and subsequent disease development are not known. Leaves of *C. quinoa* were mechanically inoculated with BSBMV and BNYVV alone or in combination. The plants were incubated in growth chambers at 10°C, 15°C, 20°C, 25°C and 30°C for 18 days. Leaves were harvested and rated for disease severity. Lesions were tested by ELISA for the presence of each virus. Results indicated that BSBMV symptoms, either alone or in combination with BNYVV, developed faster than those caused by BNYVV at all temperatures. The optimum temperature for BSBMV infection was between 20°C and 25°C. Plants inoculated with BSBMV and BNYVV in combination exhibited more severe BSBMV symptoms at all temperatures. Plants inoculated with BNYVV displayed symptoms at all temperatures except 10°C, in contrast to plants inoculated with BSBMV, which developed symptoms at all temperatures tested. These results suggest that BSBMV can infect at cooler temperatures than BNYVV and, that in plants infected simultaneously with BNYVV and BSBMV, BSBMV symptoms will predominate.

WEILAND*, J. J. and FRIESEN, T. L., USDA-ARS, Red River Valley Agricultural Research Center, Fargo, N.D. 58105. **Functional genomics of *Cercospora beticola*.**

Cercospora leaf spot continues to be a damaging and costly disease to sugarbeet production, yet our understanding of *Cercospora* genetics and biology remains incomplete. Studies were carried out to better characterize the genome of *C. beticola* and to provide methods for genome manipulation. An electrophoretic karyotype of *C. beticola* isolate 98-23 revealed the presence of 7-8 chromosomes ranging from ~0.5 megabases to ~5.5 megabases in size, comparable to the size range for the related soybean pathogen, *C. kikuchii*. Southern blot analysis of total *C. beticola* genomic DNA with fungal telomere probes supported the chromosome number estimate. The genome size of *C. beticola* estimated from the study is ~26-28 Mb. A gene transfer technology useful for gene ablation in this haploid fungus, as well as for gene introduction and analysis, was developed using *Agrobacterium tumefacies* strain EHA105. To date, a library consisting of 57 independent *C. beticola* transformants have been generated using the technique. Mutants of *C. beticola* produced in this manner that are compromised for the ability to infect sugarbeet will be detected using leaf disc inoculation. Analysis of genes disrupted by the transforming DNA will lead to new information regarding the basis for the infection of sugarbeet by this pathogen.

WHITBEY, R. M. and FRANC*, G. D., University of Wyoming, Department of Plant Sciences, Laramie, WY 82071. **Relative fitness of benzimidazole sensitive and resistant *Cercospora beticola* isolates recovered from diseased sugar beet in the High Plains.**

The relative fitness of benzimidazole resistant and sensitive *Cercospora beticola* isolates was compared. *In vitro* experiments revealed that the sensitive phenotype had a significantly greater growth rate on potato-dextrose agar, and that the resistant phenotype had significantly greater growth rates on water agar (WA) and sugar beet leaf extract agar (SBLEA: *P*?0.05). The sensitive phenotype produced more spores on SBLEA on day 5 while the resistant phenotype had significantly greater spore production by day 15 (*P*?0.05). No significant difference was detected between phenotypes for 24-hr spore germination rates on WA (*P*>0.05), although 3% more spores germinated for the resistant phenotype. Two *in vivo* tests of sugar beet plants inoculated under greenhouse conditions were performed. For test #1 and test #2, the sensitive phenotype had significantly greater lesion sizes over time (*P*?0.05), and for test #2 more lesions also resulted (*P*?0.05). For both tests, no significant differences were detected between phenotypes for foliar disease severity, the presence of stromata in lesions, or for the number of spores produced per lesion (P>0.05). An overwintering soil-burial study revealed no significant differences in lesion viability between phenotypes (*P*<0.05). For all studies reported above, we detected no obvious fitness-cost, or enhancement, that was associated with the benzimidazole resistant *C. beticola* phenotype.

WINDELS[1*], C. E., BRANTNER[1], J. R., and DYER[2], A. T., University of Minnesota, [1]Northwest Research and Outreach Center, Crookston, 56716 and [2]Department of Plant Pathology, St. Paul, 55108. **Survival of *Aphanomyces cochlioides* in soil amended with green manure crops and solarization.**

Oospores of *A. cochlioides* survive in soil for years in the absence of a sugar beet crop, so options are being investigated to reduce inoculum densities of this economic pathogen in producers' fields. Plots were established in an Aphanomyces nursery with a soil index value of 97 (0-100 scale) to determine the effect of buckwheat, oilseed radish, sorghum sudan grass and a fallow control (each with and without solarization) on root rot of sugar beet and survival of *A. cochlioides* oospores in soil. After 8 weeks, crop biomass was incorporated into soil and soil samples were collected to later determine soil index values. Sugar beet hypocotyls containing oospores of *A. cochlioides* were placed in nylon mesh bags and buried at 8, 15, 23 cm depths. Then, half of each plot was covered with a clear polypropylene tarp for 9 wk. Green manure crops of buckwheat, oilseed radish and sorghum sudan grass resulted in significantly lower soil index values (63, 75, 78, respectively) than the fallow control (97). After burial in soil for 9 weeks, numbers of oospores recovered were directly related to amounts of sugar beet hypocotyls tissues remaining in nylon bags. Viable, dead, and decomposing oospores were observed in the cortex, but not the vascular system of buried sugar beet hypocotyls. Recovery of viable oospores was not affected by green manure crop or solarization and averaged 38, 34, 52% at the 8, 15, and 23 cm depths, respectively. Thus, green manure crops may suppress Aphanomyces root rot of sugar beet through mechanisms not directly related to a reduction in oopsore inoculum.

WISLER[1], G. C., LEWELLEN[2], R. T., SEARS[2], J. L., WASSON[2], J., LIU[2], H-Y, and WINTERMANTEL[2*], W. M., (1) Department of Plant Pathology, University of Florida, Gainesville, FL 32611; (2) USDA-ARS, Salinas, CA 93905. **Effects of two soil-borne viruses of sugarbeet and their fungal vector, *Polymyxa betae*, on virus accumulation and plant growth in sugarbeet.**

Soils naturally infested with cultures of aviruliferous *Polymyxa betae* and viruliferous *P. betae* carrying the two sugar beet benyviruses *Beet necrotic yellow vein virus* (BNYVV) and *Beet soil-borne mosaic virus* (BSBMV), alone and in combination, were compared to non-infested soil with regard to their effects on virus content, fresh plant weight, and seedling emergence. Two sugar beet varieties were used: a diploid (*Rzrz*) that carries resistance to rhizomania caused by BNYVV, and a triploid rhizomania-susceptible variety (*rzrzrz*). These studies clearly demonstrated that the Rz resistance gene does not confer resistance to BSBMV. Additionally, *P. betae* alone had a significant negative effect on growth of sugarbeet, and soils infested with *P. betae* containing one or both viruses, tended to have reduced seedling emergence and reduced fresh weight, even when protective fungicides were used. BSBMV titers were significantly higher in single infections than in mixed infections with BNYVV in both rhizomania resistant and susceptible varieties. In contrast, BNYVV titers were very high in single and in mixed infections in the Rhizomania-susceptible variety, but low in the resistant variety. Therefore, in the absence of BNYVV, BSBMV concentrations are high in infected roots, regardless of the resistance genotype. In the presence of BNYVV, however, BSBMV concentrations are low in both resistant and susceptible varieties, with absorbance readings similar to those of plants grown in non-infested soils. It appears that even at low levels, BNYVV either out competes or suppresses BSBMV, and suggests that both viruses target similar cellular processes in the sugarbeet plant.

WORKNEH, F., VILLANUEVA, E., PICCINNI, G., and RUSH, C. M., **Investigation of Association between of beet necrotic yellow vein virus and beet soil borne mosaic virus in sugar beet fields**.

Beet necrotic yellow vein virus (BNYVV) and beet soilborne mosaic virus (BSBMV) are widely distributed in sugar beet growing regions of the United States. Both viruses are vectored by the soilborne Plasmodiophoromycete *Polymyxa betae* Keskin. They are also closely related in many other biological characteristics. In some instances, both can be detected in the same sugar beet plants. However, the extent of their association in sugar beet fields is not known. To determine the degree of their association, gird soil samples were collected from sugar beet fields in Colorado, Minnesota, North Dakota, and Texas in 1999 and 2000. The viruses were baited by planting sugar beets in the soil samples in the green house and then their incidences was were determined using ELISA. The incidence of their association in samples from various fields ranged between 1 and 42%. Overall, both viruses showed more or less similar spatial patterns. Hence, in spatially structured distribution patterns, there is a possibility that the frequency and distribution pattern of one virus may be estimated from that of the other.

# Section E, Physiology and Biotechnology
## Oral Presentations

CAMPBELL*, L. G. and KLOTZ, K. L., USDA-ARS, Northern Crop Science Laboratory, Fargo, ND 58105-5677. **Impact of root diseases on sugarbeet postharvest storage.**

In recent years, the sugarbeet (*Beta vulgaris L.*) root diseases, Aphanomyces and rhizomania (causal agents *Aphanomyces cochlioides* Drechal. and Beet Necrotic Yellow Vein Virus, respectively), have become more prevalent throughout Minnesota and eastern North Dakota. Accompanying any increase in root disease in the field will be an increase in the proportion of diseased roots placed in storage piles. Information on the effects of root disease on initial quality and storability would, therefore, assist growers and agriculturalist when determining the disease severity that would justify not harvesting a field or if roots from diseased fields should be segregated and processed first. Respiration rate, extractable sucrose per ton, and the formation of carbohydrate impurities were determined in roots exhibiting varying degrees of Aphanomyces or rhizomania symptoms. Respiration rates of roots with moderate or severe Aphanomyces were substantially higher than respiration rates of healthy roots. The concentrations of the invert sugars, glucose and fructose, were also elevated in severely rotted roots, although trisaccharide impurity concentrations were reduced. The higher respiration rates of Aphanomyces infected roots are not only indicative of higher sugar loss but would also increase storage pile temperatures and increase sugar loss in adjacent healthy roots. Further sucrose loss would occur during the processing of rotted roots due to their increased concentrations of invert sugars. Initial observations of the effects of rhizomania on sugarbeet root storage properties suggest that rhizomania is not nearly as detrimental to root storability as Aphanomyces, however, this indication is based on a single year's data. The impact of genetic resistance on storage properties appeared to be negligible as neither rhizomania nor Aphanomyces resistance was associated with higher respiration rates in the absence of disease.

DE LOS REYES, BENILDO G.[1], and MCGRATH*, J. M., USDA-ARS, 494 PSSB, Michigan State University, East Lansing, MI 48824-1325, [1]current address: Department of Crop, Soil and Environmental Sciences, 115 Plant Science Building, University of Arkansas, Fayetteville AR 72701. **Differential expression of glyoxylate cycle enzymes in sugar beet related to seedling vigor.**

One component of seedling vigor is the efficient utilization of the seed storage reserves to provide energy necessary for growth. This study examined the relationship between the genes of energy metabolism and differences in seedling vigor of sugar beet hybrids under different stress germination regimes. Analyses of 1,718 5' Expressed Sequence Tags (ESTs) from subtracted cDNA libraries, combined with gene expression profiling by northern blots and enzyme activity assays indicated that stress drastically reduces the expression of α-amylase in a poor-emerging sugarbeet cultivar. In contrast, a good-emerging variety exhibited only a moderate reduction in α-amylase gene expression. This pattern of gene expression indicates that mobilization of energy from stored carbohydrates can be limited to various extents by abiotic stresses. As a supplement to reduced carbohydrate catabolism, the good-emerging, but not the poor-emerging, variety appeared to catabolize lipids for use in respiration and biosynthetic processes. Induction of glyoxylate cycle activity, whose pathway bridges lipid and carbohydrate metabolism in germinating seeds, was indicated by high transcript levels and increased enzyme activity for the key glyoxylate cycle enzymes, isocitrate lyase and malate synthase. The differential activity of the glyoxylate cycle is another potential physiological marker to differen-

tiate between high- and low-vigor sugarbeet cultivars.

HELLGREN, O. **Sugar beet – pH and other environmental factors for nutrient uptake for a maximum growth rate.**

Growth rate, defined as biomass increase rate, was studied on sugar beet plants, in an aeroponics system, in order to establish non-limiting proportions of nutrient elements. In our experiments we used methods with continuous control of nutrient supply and uptake rates under controlled environmental conditions. The nutrients were supplied at constant relative addition rate and the plants were maintained under steady-state conditions, i.e. the plants were acclimatized. Through systematic elimination of different limitations we succeeded to obtain a maximum stable growth rate of 0.50 (+/-0.04) g biomass per g biomass and day. This means a capacity to double the biomass in one day and 9 hours. The type of limitation that we found was the first that had to be minimized was low and unstable pH in the rhizosphere. The low and unstable pH was observed to be caused by the plants. Sugar beet was found to strongly acidify the rhizosphere in both ammonium and nitrate based nutrient solutions. To maintain stable and non-limiting pH conditions the nutrient solution had to be continuously titrated with sodium hydroxide. An optimum pH range of 5.2 to 6.2 was established. Under stable pH conditions (approx. +/- 0.1 pH unit) non-limiting proportions of nutrient elements could be established (N:100%, K:145%, P:21%, S:9%, Mg:23%, Ca:24%, Fe:0.7%, Mn:0.4%, Zn:0.09%, B:0.065%, Cu:0.03%). Other environmental factors that we optimized in our experiments were concentration of nutrient solution, pH range, nitrogen source, daylength, light intensity, constant and shifted temperature. In experiments with constant temperature pH activity was parallell with growth (the highest growth rate was established at 24°C). When temperatures was shifted from periods of low temperature to 18°C, growth was acclimatized within a few hours to 18°C, while the pH activity of the plants took longer to parallell growth.

HOFFMANN, C. and MÄRLÄNDER, B. **Components of harmful nitrogen in sugar beet – Influence of variety and environment.**

The total soluble nitrogen in sugar beet impairs sugar recovery during processing and is therefore called harmful nitrogen. It consists of amino N, betaine, nitrate and the non-identified residual N. For quality assessment in Germany, only amino N is determined as a representative of all soluble nitrogen compounds. The aim of the project was to study the effect of variety and environment on the components of harmful nitrogen and the relationship to each other. For the study beet brei samples from variety trials with 52 varieties at 22 sites in 2000 and 2001 were analysed.

For total soluble N, amino N and betaine the effect of environment was higher than the effect of variety. Furthermore, interactions between environment and variety became evident. The data show a close correlation between the concentration of total soluble N and amino N, although the slope was not identical for all varieties. The proportion of amino N on total soluble N increased with increasing amino N concentration, irrespective of whether the amino N concentration was increased due to the influence of variety or environment. The proportion of betaine decreased with increasing proportion of amino N, since betaine showed not as much response to environmental factors as amino N. This clearly demonstrated that the proportion of these fractions on total soluble N varied and thus it cannot be judged as constant, neither among different varieties nor for one variety in different environments.

HUIJBREGTS, A. W. M. **Technical quality assessment of sugar beet in Europe.**

Sugar content is the most important parameter in the assessment of the techni-

cal quality of sugar beet. However, the percentage of sugar that can be gained as granulated sugar during processing is influenced by several compounds in the beet. These compounds are characterised by melassigenic properties and/or influence the alkalinity of the extracted juice.
The most important melassigenic compounds are: amino nitrogen compounds, pyroglutamate, betaine, lactate (from reducing sugars), chloride, nitrate and sulphate. The accompanying kations mainly are potassium and sodium.
The alkalinity is negatively affected by amino nitrogen compounds (by splitting of ammonia), reducing sugars (by conversion to acids) and magnesium and calcium (by precipitation).
Phosphate, oxalate, citrate, sulphate and malate have a positive effect on the alkalinity by precipitating with calcium ions.
To estimate the amount of non-extractable sugar, several formulas have been developed in Europe. To allow the assessment of the internal quality on a large scale at reasonable analytical costs, these formulas contain only a few parameters. Most formulas are based on the quantity of potassium, sodium and α-amino nitrogen. Some also take into account the amount of reducing sugars in the beet.
Examples are given of formulas used in Europe and of the effects of these formulas on the losses calculated.

KLOTZ*, K. L. and CAMPBELL, L. G., USDA-ARS, Northern Crop Science Laboratory, Fargo, ND 58105-5677. **Comparison of sucrose catabolism in roots of three *Beta vulgaris* L. genotypes with different yield and sucrose accumulating capacities.**

Sucrose catabolism is a major determinant of sink strength in nearly all plants and affects sucrose partitioning to growing sinks as well as sink size and carbohydrate content. Three major enzyme families are responsible for sucrose catabolism in sugarbeet roots: acid invertase, alkaline invertase and sucrose synthase. Previous work suggested that sucrose synthase may have a role in sink strength and root size in sugarbeet. To examine this observation more thoroughly, sucrose catabolism was compared in three *Beta vulgaris* genotypes with varying capacities for root yield and sucrose accumulation. Soluble acid invertase, cell wall acid invertase, alkaline invertase and sucrose synthase activities were compared at five stages of root development in a fodder beet hybrid (high yield, low sucrose content), a commercial sugarbeet hybrid (typical yield and sucrose content) and the sugarbeet breeding line, L19 (low yield, high sucrose content). Sucrose, glucose and fructose concentrations and mass accumulation were also determined. Generally, sucrolytic activity was greatest in the high yielding fodder beet and lowest in the low yielding L19 breeding line at any stage of development. Nearly all sucrolytic activity for all genotypes was due to sucrose synthase activity. Sucrose synthase activity was the predominant sucrolytic activity at all the stages of development examined, and accounted for 90% or more of the total sucrolytic activity in fodder beet and sugarbeet roots by six weeks after planting and in L19 eight weeks after planting. Differences in sucrose concentration between genotypes were observed and these were inversely correlated with soluble acid invertase activity. The differences in sucrose concentration, however, were largely differences in water content. Only L19 exhibited a significant increase in sucrose concentration when differences in water content were taken into account.

MORILLO-VELARDE, R., JAVIER CEJUDO, F., GONZALEZ, MC., and GORDO, L. F. **Bolting control in sugar beet with gibberellins synthesis inhibitors.**

Bolting is a serious problem in Autumn sown sugar beet in countries bordering the Mediterranean. There are references to percentages of over 75%. The known means of control are delay in sowing or the use of varieties which are tolerant to bolt-

ing. Both these means affect production and quality. It is known that bolting is connected to the presence of gibberellins.
In preliminary experiments (2000) carried out in a cultivation chamber it was shown that PCB, a gibberellin synthesis inhibitor, was effective when applied to beet plants, causing an inhibition of growth and a characteristic aspect in the plants treated. A test was carried out by applying PCB in April, which caused a significant reduction in bolting.
In 2001 a field test was carried out in which PCB was applied at different times (January, March and May) at a dosage of 0.5 ml/L and the treatment repeated after two weeks on a very sensitive variety (Oryx). The March treatment produced bolting of 15.5% over the control group of 26.1%. Other treatments had greater bolting. The treatment had a positive effect on the richness and improved the quality (less Na and fewer reducing sugars). In order to gain a better understanding of this effect a study was carried out on how PCB affects the expression of the genes associated with the metabolism of the sucrose, which control the distribution of sucrose in the plant, the sucrose synthase (SS) and the invertases (I). Treatment with PCB modifies the pattern of expression of the SS and the vacuolar acid I. This can explain the lower quantities of reducing sugars.
In 2002 the optimising of the treatment has been studied. Three agriculturally employed inhibitors have been tested (Daminozide, PCB and Mepiquat Cl), at different dosages (logarithmic applications) and at different times. The three locations have had bolting percentages of from 0 to 27%. The results confirm a significant effect on bolting of the product (PCB best) of the month (April best) and the dosage (when the percentage of bolting is highest, the highest dosage is best). The production and quality results under the different conditions are shown. Residual effects of the 2001 PCB on subsequent crops have not been detected.

OBER, E. S., CLARK, C. J. A., and JAGGARDS, K. W. **Factors contributing to improved efficiency of the sugar beet crop during the autumn in the UK.**

Random samples from c. 500 fields in the UK have shown that in recent years the growth of the sugar beet crop through the autumn months has been 15% higher than previously. Typically, a healthy, unstressed crop converts intercepted radiation to stored sugar at the rate of 1g/MJ. In September and October the conversion rate has increased to 1.15 g sugar/MJ, which translates to a 5% increase in yield. We have begun investigating factors that may contribute to this faster autumn growth. One hypothesis is that increased use of second and third generation strobilurin fungicides have produced a 'staygreen' effect similar to that observed in cereals. Field experiments tested the effect of triazole- (flusilazole) and strobilurin-type (trifloxystrobin) fungicides on yield and canopy physiology. Application of fungicides during the 2001 field season had a significant effect on disease control and hence on final root and sugar yield. During the autumn the senescence of the canopy was delayed by fungicide treatments, and the effect of the strobilurin helped maintain a greater percentage crop cover and top yield compared with other control measures. The 'stay-green' effect of the strobilurin was confirmed by measurements of chlorophyll content in September and October. Interestingly, however, there was only a small difference in net photosynthetic rate between untreated and triazole-treated leaves, presumably because the efficiency of the remaining canopy in untreated plots was not affected as much as the total leaf area. Preliminary results from pot experiments conducted in the glasshouse show that in the absence of disease the strobilurin and triazole fungicides had no effect on leaf expansion, net photosynthetic rate or leaf chlorophyll content within 40 d of treatment. The beneficial effects are most likely seen as the crop begins to age.

PIDGEON, J. D., WERKER, A. R., JAGGARD, K. W., RICHTER, G. M., LISTER, D. H., and JONES, P. D. **Climatic impact on the productivity of sugar beet in Europe.**

Recent study showed that drought stress was the major factor causing yield loss of the sugar beet crop in the UK. That study has been extended here by modelling potential and rain-fed yields (1961 – 1995) for European areas where irrigation of sugar beet is uncommon. Potential yields increased from north to south and from west to east due to increased radiation receipts. Drought losses were greatest in east Ukraine and southern Russia, at over 40% of potential yield (5 tha-1). Losses were intermediate (15-30% or about 2 tha-1) in central Ukraine, west Poland, east Germany and England (sandy soils) and lowest in NW Europe and west Ukraine. Model output was also used to examine the efficiency of sugar beet production across Europe. The impact of future climate change on sugar beet yields is assessed over western Europe using future (2021-50) climate scenario data from a General Circulation Model (GCM) and the Broom's Barn simulation model of rain-fed crop growth and yield. Yield increases due to future climate change are expected in northern Europe of around 1 t/ha of sugar for 2021-50 but decreases of similar magnitude in northern France, Belgium and west/central Poland, despite accelerated growth in warmer springs. Drought losses are expected to approximately double in areas with an existing problem and to become a serious new problem in NE France and Belgium. The annual variability of yield will also increase by half. These changes are independent of the 10% yield increase expected as a direct effect of the increase in atmospheric CO2 concentration.

POINDEXTER, S. S., Michigan State University Extension Sugar Beet Advancement, One Tuscola Street, Saginaw, MI 48607. **Effects of Priming Advance Treatment on Seed Germination and Yield of Sugar Beets.**

Rapid germination and even emergence of seedlings are desirable traits when establishing optimum plant populations. The objective of this study was to determine how the Priming Advanced Treatment (PAT) utilized by Seed Systems, Inc. would affect speed of seed germination, stand establishment and yield of sugar beets under field conditions. Varieties used in the studies compared PAT to standard seed treatments from the same seed lots. Over four years, different environmental conditions were encountered including warm, cool, wet and dry soil conditions. PAT treatments generally emerged and established faster under most conditions. Largest differences in emergence occurred in cool soil, improving speed of emergence up to seven days. Largest yield enhancement occurred for PAT treatments under cool emerging conditions and ranged from 0-3 tons under all conditions.

SMIGOCKI[1*], A., IVIC-HAYMES[1], S. D., WILSON[1], D., CAMPBELL[2], L., DREGSETH[3], R., and BOETEL[3], M., [1]USDA, ARS, Molecular Plant Pathology Laboratory, Beltsville MD 20705, [2]USDA, ARS, Northern Crop Science Laboratory, Fargo, ND 58105, [3]North Dakota State University, Department of Entomology, Fargo, ND 58105. **Molecular approaches for control of the sugar beet root maggot.**

The sugar beet root maggot (*Tetanops myopaeformis* Roder) is a major insect pest of sugar beet in the United States and Canada accounting for yield losses in the range of 10 to 100%. Currently no biological control measures exist and crop rotation has been ineffective due to the mobility of the adult flies and existence of several weed species as substitute hosts. A few insecticides are available but provide inconsistent results. In the last few years, we have developed a method for direct gene transfer to sugar beet leaves that uses greenhouse grown plants and generates transgenic plants within three months. We have identified and engineered a number of beneficial genes for specific expression in sugar beet leaves and taproots. One class of genes targets the digestive system of the maggot thus starving the insect. We identified two major classes of digestive enzymes in midguts excised from feeding maggots and demonstrated their inhibition by specific pro-

teinase inhibitors. Genes encoding these proteinase inhibitors will be introduced into sugar beet to evaluate their effect *in planta*. We have also initiated studies to profile the defense response genes in maggot resistant sugar beet lines. As a first step, we developed an *in vitro* root maggot bioassay using resistant (F1016) and susceptible parental (F1010) lines to generate infested tissues as source of mRNA for preparation of differential cDNA libraries enriched for resistance genes. Clones with potential roles in root maggot (and disease) resistance will be characterized, reconstructed for plant expression and their role in resistance evaluated in transgenic plants.

TREBBI[1], D. and McGRATH[2*], J. M., [1]Dept of Crop and Soil Sciences, Michigan State University, and [2]USDA-ARS, 494 PSSB, Michigan State University, East Lansing, MI 48824-1325. **Sucrose accumulation during early sugar beet development.**

This study examined sucrose accumulation in different breeding lines during the first weeks after emergence in order to identify early morphological and physiological differences correlated with final root sucrose content. Six germplasm lines (US H20, SR87, SR95, SR96, SR97, and Syngenta-Hilleshög E17, ranging in harvested sucrose contents from 15 to 18%) were planted with three replications. Plants were grown in the greenhouse under controlled temperature (15 to 22 C) and photoperiod (16 hours of light per day). Samples were harvested weekly from the third to the tenth week post-emergence. At each harvest, roots, leaves and hypocotyls were weighted and freeze-dried, and hypocotyl diameters were measured. From freeze-dried roots, sucrose was extracted with 80% ethanol and then analyzed with liquid chromatography (HPLC). Transverse sections of roots were also analyzed with the light microscope to detect anatomical differences between lines and during development. Sucrose concentration expressed as fresh weight increased from ca. 0.5% at the third week (all germplasm) to 10.7% in US H20 through 13.3% with E17 by the tenth week, with measured sucrose levels proportional to those from field-harvested beets over the entire eight-week experiment. Incremental changes in sucrose levels were not constant during this period, but followed a weekly step-wise trend alternating between higher then lower sucrose accumulation. Sucrose concentrations as dry weight were over 55% at the tenth week for all lines, and ranged between 3.5% to 8% at week 3. Differential gene expression analysis combined with examination of anatomical differences of root tissues during these alternate developmental stages may provide additional insight on the molecular mechanisms of sucrose accumulation in sugar beet.

VAN SWAAIJ, A. C. P. M., VAN DER LINDEN, J. P., and VANDERGETEN, J.-P.
**Effect of growth conditions and variety on damage susceptibility of sugar beet.**

Damage to sugar beet causes sugar losses either by loss of beet tissue during harvest, by increased respiration of sugar due to wound healing during storage or by leaching to the wash water during processing. One way to reduce damage is the careful handling of beets at harvest and transport, however, efforts to reduce soil tare often have the opposite effect.

An other possible strategy to reduce beet damage is to grow less susceptible beet. This may be achieved by choosing the right variety or growth conditions. Therefore, we want to know more about the effect of these factors on damage susceptibility.

During a three year collaborative study this has been investigated in a number of field trials in The Netherlands and Belgium. Manually harvested beet samples were treated on a turbine in order to inflict damage in a standardized way and were then visually examined for root tip breakage and superficial damage. In other beet samples from the same plots the internal quality and the elasticity were assessed.

Significant effects of beet weight, variety, N-fertilization, year and harvest period on damage susceptibility were found. Multiple regression showed that a considerable part

of the root damage could be attributed to beet weight, elasticity and composition. However, the predictive value of individual parameters was only poor.
From the results it can be concluded that variety and growing conditions affect damage susceptibility of sugar beet. Further research will have to focus on simple and reliable methods for assessing this property.

WEILAND, J. J., USDA-ARS, Red River Valley Agricultural Research Center, Fargo, N.D. 58105. **Protease secretion in *Aphanomyces cochlioides*.**

Protease activities have been implicated in the infection of fish and crayfish by *Aphanomyces astaci*, a pathogen of these host organisms. In an effort to characterize protease activities produced by the sugarbeet pathogen *A. cochlioides*, culture supernatants of this oomycete were tested for bulk enzyme activity and examined for protease isozyme complement. Bulk protease activity was readily detected using azocoll as a colorimetric substrate. At least 8 distinct isoforms of protease secreted by *A. cochlioides* were detected after electrophoretic fractionation in native polyacrylamide gels containing co-polymerized gelatin. A subset of the protease activities was sensitive to inhibitors of trypsin, including the proteinacious trypsin inhibitors from lima bean. Co-culture of sugarbeet seedlings in the presence of *A. cochlioides* and lima bean trypsin inhibitor resulted in increased seedling survival relative to control inoculations. The data suggest that protease activities secreted by *A. cochlioides* may be virulence determinants in the infection of sugarbeet by this pathogen.

## Section E, Physiology and Biotechnology
## Poster Presentations

IVIC-HAYMES, S. D. and SMIGOCKI, A. C., USDA, ARS, Molecular Plant Pathology Laboratory, Beltsville MD 20705. **Direct gene transfer to sugar beet leaves.**

Sugar beet transformation methods in the public domain are not readily reproducible and yield low transformation frequencies. These methods utilize sugar beet cotyledons, shoot basal tissues, and hypocotyl callus generated in tissue culture for gene transfer experiments. We developed a particle bombardment transformation method that uses leaves from greenhouse grown plants. Leaf discs or squares were excised from surface sterilized FC607 leaves and placed on B1 medium (Doley and Saunders, 1989, Plant Cell Rep 8: 222-25) with added mannitol and sorbitol. Leaf tissues were bombarded with the *uidA* (GUS) gene under control of the osmotin (OSM) gene promoter or with the enhanced green fluorescent protein (EGFP) gene fused to the double 35S CaMV promoter. After 2 days, leaf fragments were transferred to B1 medium (2 fragments per petri plate) and cultured at 31°C in the dark. Two days after bombardment, 1 to 30 GUS(+) units per leaf fragment were observed. With the EGFP gene, 20 to 150 fluorescent cells per leaf fragment were visualized with an epifluorescence microscope. Both GUS and EGFP expression decreased significantly during the first 2 weeks of culture. After 6 to 8 weeks, embryogenic callus was removed from the bombarded leaf discs and analyzed for GUS expression. Presence of the GUS and the selectable marker (NPTII) gene was confirmed by PCR analysis. GUS(+) shoots regenerated from several GUS(+) calli. The advantages over previously published transformation methods include an abundant source of leaf material from greenhouse grown plants, the ease of handling leaf material in tissue culture, and the overall rapid regeneration of transgenic shoots within three months.

KLOTZ[1*], K. L. and ANDERSON[2], M. D., [1]USDA-ARS, Northern Crop Science Laboratory, Fargo, ND 58105-5677, and [2]Department of Biological Sciences, North Dakota State University, Fargo, ND 58105. **Contribution of cytochrome *c* and alternative oxidase pathways to respiratory sucrose loss in postharvest sugarbeet (*Beta vulgaris* L.) roots.**

It is estimated that cellular respiration is responsible for 50 to 70% of the sucrose loss that occurs during postharvest storage of sugarbeet roots. Respiration occurs to provide the metabolic energy and carbon substrates needed to maintain healthy tissue during storage, heal wounds acquired during harvest and defend against pathogens. Two respiratory pathways, the cytochrome *c* oxidase pathway and the alternative oxidase pathway, contribute to total respiration. In sugarbeet, little information is available on the role of these two pathways in sucrose utilization and postharvest sucrose loss. This information, however, may prove useful to not only improve our understanding of this physiological process but may potentially provide insight into methods to reduce postharvest respiratory sucrose loss. Analyses of the changes in total respiration and the contribution of the two pathways in sugarbeet roots subjected to different storage conditions and durations, and in response to typical harvest stresses are in progress. Initial results indicate that the cytochrome *c* respiratory pathway predominates in healthy, nonstressed sugarbeet roots, as has been observed in most other plant species. Respiration is also greatest at the root surface. Oxygen utilization by epidermal tissue was approximately 3- to 4-fold higher than by internal cortical tissue, consistent with the idea that a higher level of energy is needed at the surface of the sugarbeet root for repair of mechanical damage and defense against pathogen attack.

MACK, G. **Glutamine in sugar beet : where is it synthesized?**

Glutamine is the predominant amide in the beet. It is assumed that it is produced in the leaves and translocated to the beet (Burba et al., 1984). The aim of the present study was to evaluate the contribution of the different plant organs in synthesis and accumulation of glutamine when either nitrate (NO3-, 5 mM) or ammonium (NH4+, 5 mM) is supplied as N source. The plants were grown hydroponically under controlled conditions for 40 days.

The results indicate that glutamine in the beet is imported via xylem and phloem from various organs, not only from leaf blades. Furthermore, it is snythesized in the beet (crown and root) itself. The contribution in glutamine synthesis of the different organs changes with the N source of the plant. Synthesis of glutamine accumulating in the beet is catalyzed by both the chloroplastic and cytosolic isoenzymes of glutamine synthetase.

MACK, G. **Effect of N source on accumulation of amino acids in sugar beet.**

N is taken up by the plant from the soil as nitrate (NO3-) and ammonium (NH4+) and reduced inside the plant to yield amino-N. Accumulation of amino-N in the beet is undesirable because it lowers the technical quality during the process of sugar crystallisation. The aim of the present study was to evaluate the effect of the plant's N source on content and pattern of amino acids in the beet. The investigations were done on two genotypes which, in prior field trials, showed a different amino-N content of the beet (low- and high-N line). Seeds of these plants were germinated and the plants were grown hydroponically with either 5 mM NO3- or NH4+ as N source in the growth chamber for 40 days.

The results show that content and pattern of amino acids of the beet depend strongly on the plant's N source. Genotypic differences between the two breeding lines are considerably reduced when NH4+ is supplied instead of NO3-. NH4+ as N source lowers the technical quality of the beet.

MAIDL, F. X. **Estimating Nitrogen status of sugar beets with spectrometer measurement.**

ABSTRACT NOT RECEIVED

SACCOMANI, M., STEVANATO, P., CAGNIN, M., and BIANCARDI, E. **Morpho-physiological mechanisms of adapting to water-nutritional stress in sugar beet.**

The identification of adaptive characters involved in the response to water-nutritional stress is necessary for maintaining crop productivity at sustainable levels. The objective of the present work was to determine: (1) the extent of genetic variation of the morpho-physiological traits "root length" and "sulfate uptake rate" involved in nutrient acquisition; (2) their relations with productivity. These traits were measured after water-nutritional stress in six sugar beet varieties characterized by different sugar production ability. A significant correlation between root length and sulfate uptake rate was evidenced. The varieties characterized by higher root length and sulfate influx to the root after water-nutritional stress were those that have shown the highest sugar yield. These traits are to be considered morpho-physiological markers of productivity.

SAVARY*, B. J., NUNEZ, A., LIU, L., and YOO, S-H., Eastern Regional Research Center, USDA-ARS, 600 East Mermaid Lane, Wyndmoor, PA 19038. **Pectin Acetylesterase – Function and Application for Sugar Beet Pectin Utilization.**

Sustainable technologies are being sought to provide new and higher-value coproducts from sugar beet pulp. Pectin is a complex plant cell wall polysaccharide that

represents a major fraction of sugar beet pulp. One distinguishing feature of sugar beet pectin is a high content of C2 and C3 acetyl esters. Such esters impart unique physical, chemical, and functional properties. Acetyl esters probably function biologically to restrict pectin depolymerizing enzyme activities. The enzyme pectin actylesterase (EC 3.1.1.6) can specifically hydolyze such acetyl esters in homogalacturonan regions of pectin, thus it may play a critical role in cell wall modification during root development and during pest/pathogen interactions. Pectin acetylesterase may be used technically in an efficient, environmentally-friendly bioprocess for modifying sugar beet pectin structure to improve performance and increase functionality. Such pectins can be used to fabricate new biobased materials for application in drug delivery systems. This presentation will summarize our recent developments in four areas supporting enzymatic modification of sugar beet pectin: 1) A new GC-MS method, with headspace solid-phase microextraction, for efficient determination of ester content in pectin and of esterase enzyme activity. 2) A specific polyacrylamide gel electrophoresis method to distinguish pectin esterase types. 3) The purification and biochemical characterization of pectin acetylesterase. 4) The preparation of porous "microsponge" matrices using enzyme-modified sugar beet pectins.

# Section D, Chemistry and Instrumentation
## Oral Presentations

AUGUSTINE, G. and KAWLEWSKI, R., Southern Minnesota Beet Sugar Cooperative, P.O. Box 500, Renville, MN 56284. **The results of using an on-line color analyzer directly after the white centriguals.**

Color is an important parameter in the supply of sugar. In the past no rapid method or application existed to directly obtain the color of granular sugar as it is produced. The past methods used indirect measurement references or grab samples of the sugar just produced to confirm compliance to internal and external specifications. This often resulted in too large of time lags to avoid off specifications sugar from reaching the storage bins. The use of the Neltec color monitor directly after the white centrifugal station has prevented this problem as well as allowing an optimization of the overall station and individual batch machines. The relationship of the mixer level, start and end of individual strikes of sugar can be monitored and evaluated. Process changes are able to be monitored immediately for benefits. Results of varying process parameters and being able to monitor the results over extended periods of time have confirmed or altered relationships allowing a better understanding of the white sugar side of the process.

JACOBSON*, B., JARSKI, H., and McGILLIVRAY, T., American Crystal Sugar Co., 1700 N. 11St, Moorhead, MN 56560. **Use of NIR for determination of cossette purity and cossette sugar.**

Paper cancelled

FOWERS*, M. J., The Amalgamated Sugar Company, LLC., 2320 Orchard Drive East, Twin Falls, ID 83301. **Microbial risk assessment: pathogen challenge evaluations of granulated and liquid sugar.**

Since the terrorist attack in September 2001, increased emphasis has been given to the safety of the nation's food supply. The risk potential due to the intentional contamination of sugar by pathogenic microorganisms is best described through direct pathogen challenge evaluations. Several such studies have been done within the industry recently. Three such evaluations have been completed at The Amalgamated Sugar Company. Two of the evaluations were done by applying pathogenic cultures to granulated sugar while liquid sugar wss used as the test substrate in the third evaluation. Pure cultures of *E. coli, Staphylococcus aureus, Salmanella, Listeria monocytogenes,* and *Bacillus cereus* were applied in know concentrations to both granulated and liquid sugar. The aliquots were evaluated for survival rates of each organism at various concentrations utilizing AOAC- FDA/BAM enrichment methods. Infective dose curves were also generated for each organism and concentration utilizing enumeration methodology. There is a direct relationship of the initial inoculum concentration to the infective dose curves over time; i.e. the higher the initial concentration the longer the survivability of the organism. Each pathogen has a different survival rate based on the ability to function at lowered water activity ($a_w$) levels. These data indicate that there is a low risk to human health as a result of intentional or incidental contamination by currently recognized pathogens.

GARCIA DE QUEVEDO, M. and RUIZ-HOLST, M. **Trubidity: a new approach of the sugar properties.**

**Abstract not submitted**

GODSHALL[1]*, M. A., GRIMM [2], C., MOORE [1], S., and BATISTA [2], R., [1] Sugar Processing Research Institute, Inc., 1100 Robert E. Lee Blvd., New Orleans, LA 70124, and [2] Southern Regional Research Center, ARS, USDA, 1100 Robert E. Lee Blvd., New Orleans, LA 70124. **Comparison of two methods of volatile analysis for determining the causes of off-odors in white beet sugars — SPME and headspace.**

White beet sugars periodically exhibit off-odors, which cause them to be rejected by many customers. An understanding of the nature and source of the compounds responsible will help in eventually eradicating the problems that cause them. Determining volatile substances in white sugar is challenging because the amounts present are very small, often in the sub-parts-per-million range. In this study, two methods for determining the volatiles in white beet sugar were compared. Solid Phase Micro Extraction (SPME) is a recent technique that utilizes a fine fiber coated with adsorbent material that is placed in the headspace of a sample of sugar; the fiber is subsequently desorbed into a gas chromatograph-mass spectrometer (GC/MS) for identification. Headspace analysis consists of removing a measured volume of the headspace from a sample of sugar and introducing it directly into the GC/MS. Both methods are simple, inexpensive, rapid, and do not use solvent extraction. Only a small amount of sugar is needed for the analysis. Results indicate that headspace may obtain more of the higher molecular weight volatiles and SPME the lower molecular weight volatiles.

GODSHALL, M. A. and SPRI GROUP. Sugar Processing Research Institute, Inc., 1100 Robert E. Lee Blvd., New Orleans, LA 70124. **Qualitative and quantitative differences between beet and cane sugar colorants.**

Sugar Processing Research Institute (SPRI) has studied the nature of beet and cane colorants for many years. High molecular weight compounds, which include colorant and polysaccharides, are among the more important constituents contributing to color differences between beet and cane, and in the transfer of color from syrup to crystal. The high molecular weight components are also the most difficult to remove during refining. The transfer of color (from syrup to crystal) is much higher in cane sugar processing than in beet sugar processing. White beet sugar, with color of 20-30 IC, can be boiled from 2000-3000 IC color syrup, but only from about 200 IC cane syrup. In chromatographically separated beet molasses extract, the color of the syrup can be as high as 5000-7000 IC and still produce a 30-45 IC sugar. What is the reason for this? We present recent studies that compare beet sugar and cane sugar colorant and polysaccharide. The results indicate that beet and cane colorant are fundamentally different. Beet colorant tends to be produced during processing, mainly from alkaline degradation of invert and melanoidin formation. There is a tendency for this type of colorant to increase during processing. Cane colorant enters the process in the cane juice as plant pigments associated with polysaccharide, and changes little in process, due to the milder conditions associated with cane processing. Cane colorant has a strong affinity for the sugar crystal, whereas beet colorant has less affinity, is of a lower molecular weight than cane colorant, and has much less associated polysaccharide.

GROOM, D. R., McGILLIVRAY, T. D., HEGGENESS, J. H., and SAMARAWEERA, I., American Crystal Sugar, Technical Services Center, 1700 North 11th Street, Moorhead, MN 56560. **Chemistry of storage and processing problems encountered with molasses desugarization extract.**

Storage issues were encountered in Hillsboro ND extract plant during the 2000 campaign. Multiple issues were encountered in processing the extract in the sugar end. Traditional markers used to monitor extract quality in storage were inadequate. Several experimental trials were conducted to investigate the cause(s) of poor processing extract.

Variables tested were pH, invert concentration, treatment temperature, purity, and water activity among others. Experiments were design to investigate the interactions between various factors. A comparison study was done using coupled loop extract from Hillsboro and SMB extract from our East Grand Forks facility. Samples were incubated at 50 deg Celsius to speed up reaction rates. Hillsboro extract was observed to degrade, lose purity, increase color with little change in microbial counts, lactic acid and pH change. Invert sugar was found to be an effective predictor of juice degradation. Invertase activity was found in the pH range of 8 to 10.5, but negligible at pH 11. High pH and pasteurization were found to mitigate degradation. The problem with Hillsboro extract was found to be primarily two fold. Enzymatic activity lowered purity levels and increased invert levels. Increased invert levels created high color issues in sugar end processing. Root cause investigation lead to discovery of microbial infection in extract evaporator loop.

McGILLIVRAY, TERRY, D., HEGGENESS, J. H., and GROOM, D., American Crystal Sugar, Technical Services Center, 1700 North 11th Street, Moorhead, MN 56560. **The effects of molasses desugarization extract on sucrose solubility coefficients.**

Sucrose solubility coefficients (SSC) were determined on a monthly basis during the 2001-2002 campaign. Composite samples representing one month of molasses production were taken from each of the five beet sugar factories of American Crystal Sugar Company. Three of these factories intermittently introduced molasses desugarization extract into their process streams during beet campaign. One factory introduced extract (co-processed) throughout most of the campaign. The remaining factory did not process any extract. Analysis consisted of determining SSC trends throughout the campaign. The effects of co-processing extract on both SSC and sugar recovery was investigated. A comparison was made with regard to sugar recovery and standard liquor sugar recovery.

SAMARAWEERA*, I. S., GROOM, D. R., RHEAULT, D. L., and BUSCHETTE, L., American Crystal Sugar Company, Technical Services Center, PO Box 1227, Moorhead, MN 56561-1227. **Microbiological problems associated with long-term storage of extract from molasses desugarization facilities.**

American Crystal Sugar Company began extract storage from its first molasses desugarization (MDS) facility at East Grand Forks during the fall of 1993. This was followed by a second MDS facility being constructed at Hillsboro with extract storage in February of 2000. Hence as we developed our expertise with storage at the East Grand Forks facility we found that microbial issues were manageable at this facility with the limits set. Therefore, the same microbial limits and standards set up for East Grand Forks were used at the Hillsboro MDS facility as well. However, since the start of the Hillsboro facility, though microbial counts were minimal or comparable to those at East Grand Forks, the processing of extract from long-term storage was a problem. Therefore this paper will deal with some of the microbial issues associated with the differences at the two facilities and the problems we had to work through as a result.

SCHULZE[1*], B.-C. and SUHR[2], M., [1]Advanced Services & Engineering, Schlossstrasse 48a, D – 12165 Berlin / Germany and [2] MS Processes Intl LLC, **Real-time process control - management-systems for the sugar industry.**

Nowadays, sugar factories possess computerised information systems like process control systems, laboratory data systems and higher management and information systems. The wise combination of these different information and process data still establishes the experience of the factory engineers and the operating personnel. It is desirable

to have an online tool, which combines the given information, monitors the technological process and calculates the consequences of the current process operation. This would allow to inform the operating personnel at any time about problems that already occurred or soon will have an influence on the factory performance. During the last three years, an online management system was developed that combines the available data and conducts an online factory balance. The factory performance data range between an upper and a lower limit value, which are defined in the developed management-system. If the process data leave the given range, the system releases a chain of calculations to locate the spot in the factory that causes the deviation. These can be process data like i.e. temperatures and pressures or technological parameters like i.e. brix, purities or colour. A warning occurs to inform the operating personnel about the arising problem and the reason for it. With this flexible online-tool, the factory process is permanently monitored by an early warning system. Any occurring bottleneck within the process that already has an influence on the factory performance or soon will generate such an error, is located and can be removed by the operators. The experiences with the first delivered systems proved the necessity of the development of real time control at sugar factories. Real-time information like overall heat transfer coefficients of heat exchangers and evaporators help to adjust the cleaning cycles and decreasing factory performance can be optimised at any time.

THEISEN, K-H., DIRINGER, T., and SENKOWSKI, K., pro/M/tec Theisen GmbH, Pforzheimer Str. 162, D-76275 Ettlingen, Germany. **The development of the microwave concentration measurement for the sugar industry from 1996 to 2003.**

Microwave technology is one of the most modern technologies used in the industry for process control. In its early years this technology has been used for level indication inside vessels and for moisture measurement in bulk materials.
Since 1996 the microwave technology is also used for the concentration measurement of dry substance content of syrups and massecuites in the sugar industry.
The vest first installations in 1996 have been done in batch pans only. Due to various improvements during the last 7 years this technology today is also used in continuous and in pipelines of various diameters. Moreover the installation set up and calibration of the instrument has become much easier compared to the instruments of the first generation.
The following paper gives a review of the first installation in batch pans and describes the different improvement steps, which have lead, the microwave technology to the most accepted concentration measurement in the sugar industry.

THOMPSON, P., Sugar Knowledge International Ltd, 3 Mill Road, Yarwell, Peteborough, England, United Kingdom. **Significance of the ratio color/non-sugars in sugar end operations.**

When a high color or low purity thick juice or MDS extract is processed in a conventional 3 boiling scheme the molasses purity can be very high and control of sugar color very difficult. This paper explores the use of the ratio color/non-sugars to predict sugar end performance and to determine the optimum boiling scheme for a range of "non standard" feed materials. Mass and color balances are shown, along with a comparison of predicted performance using this approach with actual operating conditions in a factory processing MDS extract.

## Section D, Chemistry and Instrumentation
## Poster Presentations

BEDDIE[1], D., WIRTH[1], T., PAINTER[1], S., POLLACH[2], G., and HEIN[2], W., [1]BetaTec Hop Products GmbH, Freiligrathstrasse 7/9, 90482 Nurenberg, Germany, and [2]Zuckerforschung Tulln GmbH, Reitherstrasse 21-23, A3430 Tulln, Austria. **Rosin acids and Beta acids - Natural biocides to control micro-organisms throughout sugar factories.**

There is a great need for safe and environmentally friendly biocides to control micro-organisms, which cause losses and impurities during the sugar process. In 1994 the first natural biocide was developed based on hops and sold as BetaStab®10 A. This biocide has been shown not only to control bacteria during extraction but also later on in the process such as preliming, heat exchangers, ion exchangers and thick juice storage. Additionally reduced antifoam consumption has been observed at some factories. Recently a new natural anti-bacterial agent has been discovered from the pine tree. Laboratory experiments have shown that less than 10ppm of the active ingredients, the rosin acids, are needed to control sugar bacteria such as *Bacillus* and *Leuconostoc*. Full-scale factory trials over the past three campaigns have confirmed the potential of rosin acids as an excellent anti-bacterial agent. The results have shown that they can be used on their own or in conjunction with other biocides such as BetaStab®10 A. As well as being safe to handle for factory workers, this new natural product is stable under factory conditions and has the potential to be more cost effective than hops.

## Section F, Factory Operations
## Oral Presentations

HELMUT [1], B. and JOACHIM[2*], P. H., [1]Keller & Bohacek GmbH & Co. KG, Liliencronstr. 64, D-40472 Düsseldorf and [2]Praus, Hans Joachim, Dr.-Kottmann-Str. 15, 41516 Grevenbroich. **Scales in Evaporators.**

A scale thickness of only 0.2 mm reduces the coefficient of heat transmission to almost the half and in case of high silicate contents even to a third in the first body of an evaporation station. In beet sugar factories the main components of evaporator scales are calcium oxalate and silicate. Referring to 1 liter thin juice the average CaO-contents in Europe are as follows in the individual countries (table). The silicate contents in the juice depend on the following factors: pH-value at the 1st carbonatation (table), further post-defecation at the 2nd carbonatation (table), entering of clay minerals by dirty beet, $SiO_2$ content of the limestone. Cleaning of evaporators in beet sugar factories: alkaline cleaning with sodium carbonate / caustic soda solution by adding of the dispersant KEBOSOL PM und the surfactant KEBOSOL VD. This procedure, particularly combined with the previous application of scale inhibitor KEBO DS, mainly succeeds in clean evaporator tubes in one step only. Acidification with hydrochloric acid and inhibitor LITHSOLVENT 620 or if necessary with formic or sulfamic acid and inhibitor LITHSOLVENT CS. Never recommend hydrochloric acid in case of stainless steel to be treated. After the acidification it is absolutely necessary to carry out an alkaline aftertreatment with a caustic soda solution by adding of KEBOSOL VD. Scales consisting of highly degraded organic substances can be formed in heat exchangers of the raw juice area, at the steam or juice side of evaporators and vacuum pans. KEBOPLEX SC is used as additive for the removal of these scales. In 1975 KEBO developed a scale inhibitor for the duration of the beet processing to succeed in possibly little scale in the evaporators at the end of the campaign. In the following years our scale inhibitor KEBO-DS has been continuously improved so that today it is possible to reduce the formation of scales in evaporation stations by 80 to 90 % and more. KEBO DS is the only antiscalent worldwide which has successfully passed a 90 days toxicological examination. The Suisse Institute RESEARCH AND CONSULTING COMPANY (RCC).

BARTELS*, B., CASPERS, G., and HAFEMANN, H., Braunschweigische Maschinenbauanstalt AG, AM Alten Bahnhof 5, D-38122 Braunschweig, Germany. **Latest experiences with newly developed sugar drying and cooling systems.**

First industrial-scale applications of newly developed sugar drying and cooling systems are currently realized. At a German sugar factory, two parallel lines of existing rotary drying/coolers are retrofitted with downstream fluidized-bed coolers with integrated banks of cooling tubes. In a facility in Morocco, a complete new unit will be installed in 2002. It consists of a rotary drying operating in counter-current flow and a downstream fluidized-bed cooler also equipped with integrated banks of cooling tubes. Most conventional sugar drying and cooling technologies are based on the rotary principle. An essential advantage of these machines is their simple and sturdy design, and they are regarded as relatively unsusceptible to sudden changes of the sugar inlet conditions. In the 1990s, systems practicing the alternative fluidized-bed technology became more and more successful. Especially the stationary (non-vibrating) units convinced by their light-weight design, their extremely reduced maintenance requirements and their excellent cooling efficiency. The combination of a rotary dryer and a fluidized-bed cooler unites the advantages of the two processes and reduces and/or eliminates their respective disadvantages. Simultaneous convective and contact cooling as practiced by the use of integrated cool-

ing elements in the fluidized-bed unit allows a considerable reduction of the air quantity as compared with conventional fluidized-bed units. This leads to a drastic reduction in the consumption of electric energy in such plants, along with a reduction of the screen bottom surface of the fluidized-bed unit. This in turn has a positive effect on the space required. Moreover, ancillary equipment such as fans, filters, etc., can partially be dispensed with, or at least reduced in capacity. Heating steam can be saved by complete reutilization of the heated cooling air as part of the drying air.

DELOREY*, D. C., The Amalgamated Sugar Company LLC, P.O. Box 8787, Nampa, ID 83653-8787. **Community air quality improvement plan: Effects on a sugar beet processing facility.**

The Amalgamated Sugar Company LLC facility located in Nampa, Idaho has participated in the development of an air quality improvement plan for a neighboring county. This improvement plan was required by the Idaho Department of Environmental Quality to ensure particulate matter (PM-10) concentrations were in compliance with federal health standards. The highest measured PM-10 concentrations occur during wintertime inversions. A detailed analysis of all emission sources in the area was conducted. Predominant sources impacting air quality are associated with motor vehicles and wood stoves. On a regional basis, industrial sources have only a very small impacts. However, predictive models indicate higher local impacts from industry including Amalgamated. As a result, Amalgamated has proposed a series of improvements including the replacement of two direct-fired pulp dryers with a steam dryer and increasing the height of a boiler stack.

EHRENREICH[1], S. and TOEBE[2*], P., Balcke-Duerr Service GmbH, Hans-Joachim-Balcke-Str., 46049 Oberhausen, Germany. **Advanced condenser designs for the beet sugar industry.**

In beet sugar factories condenser units are located at the end of each evaporation line and lined up with each vacuum pan. The most popular design of the these condensers are the well known barometric condensers, where the generation of vacuum and the condensation of vapours is done by circulation of tremendous amounts of water, thus requiring large quantities of electrical power for the water pumps. A new generation of direct contact condensers, equipped with an effective curtain nozzle design is working with much lower pressure losses (approx. 10 to15 mbar), small approach temperatures and high condensing efficiencies. Due to their large free cross-sections this nozzle design is insensitive to fouling and impurities in the cooling water. In combination with water ring pumps these units are working as a central condenser unit for the complete evaporation and vacuum pan station. The new curtain nozzles design can be applied for the retrofit expansion of existing condensers. The total power demand of this arrangement is remarkably lower compared to the common layout.

EKERN*, E. P., Monitor Sugar Company, 2600 S. Euclid Ave., Bay City, MI 48706. **Molasses filtration using a Putsch filter press.**

Filtration of molasses is essential for reliable operation of a molasses desugarization plant. Use of conventional pressure leaf filters results in sugar losses in the filter sluice and adds organic load to the waste water system that the sluice is discharged to. Both of these issues could be addressed by using a filter press to recover the residual molasses and produce a dry cake for disposal. During the 2001-2002 campaign, a Putsch filter press was tested in three applications in support from the molasses pressure leaf filters. Then it was used to directly filter the molasses instead of using the pressure leaf fil-

ters. For the third test, it was used to direct filter molasses from a chemical softening process. In all three modes, the Putsch filter was able to produce a clean filtrate and discharge a solid cake, demonstrating the ability to reduce both sugar losses and wastewater loading. As a further benefit, throughput when filtering molasses was equal to two similarly sized pressure leaf filters. These improvements were translated into gains of more than 1% in overall sugar recovery from the desugarization plant.

FRY[1], P. and APPEL[2], M., [1]Sugar Knowledge International, Ltd., Riverside Business Center, River Lawn Road, Tonbridge TN9 1EP, England, [2]Johnson Screens, 1950 Old Highway 8 NW, New Brighton, MN 55112. **Wedge wire screen basket for continuous centrifugals**

Conventional screens for continuous centrifugals use a thin working screen supported by a backing screen. The slots in the working screen are etched electro-chemically or burned by laser. This paper describes a new alternative one piece screen constructed from stainless steel wedge wire, replacing both the backing and the working screen. The wedge wire screen is more robust with an expected life of more than one campaign and there is more flexibility in the design to offer different apertures and larger open areas. Experiences with operating screens are reported, highlighting potential improvements in molasses purity as well as extended screen life.

FUENTES[1], O., SESTAK[1], J., HATCH[1], R. O., and SCHAEFER[2], J., [1]LUBRIZOL FOAM CONTROL ADDITIVES, 311 Cleveland Place, Cheyenne, WY 82007 and [2]WESTERN SUGAR COMPANY, 18317 Highway 144, Fort Morgan, CO 80701. **Industrial evaluation of surfactant effects on vacuum pans and its correlation with crystal formation and purity.**

Boiling time and massecuite fluidity are two factors in the formation of crystals during sugar boiling. In theory, by reducing the surface tension the overall heat transfer coefficient increases thus improving pan operation. This study evaluates how variables like surface tension and viscosity are modify by adding a surfactant or wetting agent and how pan operation is modified. The pan purity, RDS, MACV (crystal size) were monitored at each pan step with and without surfactant addition in order to detect and compare any changes or improvements in the process.

HELGE, JOHN M*, SCOTT A. NISWANDER, and TOM D. CHARBONEAU, Ondeo Nalco Company, One Nalco Way, Naperville ILL, 60563. **Bioengineering methods for improving pond performance**

Organic loading to factory ponds and flume systems may be causing some concerns with EPA and NPDES legislation requirements. With increased NPDES demands, and more stringent requirements coming for many States, it is becoming more important to find ways to meet the standards in an economical and efficient manner. We will show how a bioengineering approach to biomass management in the wastewater treatment ponds has helped reduce BOD, TSS, and ammonia nitrogen in the effluent as well as reduced the incidents of H2S odor complaints from the pond systems. By Quoting specific references from existing biomanagement programs we will show how these results can be accomplished.

JENSEN, A. S., EnerDry Aps, Moelleassparken 50, Dk 2800 Lyngby, Denmark. **Steamdrying of Beet Pulp. Development by rebuilding of old dryers.**

Over the latest 5 years EnerDry has worked on rebuilding 5 of the 8 plants for

steamdrying, that exist in Europe. The 5 had a need for increased capacity, and up to 25% was achieved. The latest rebuilding took place in Holland and made it possible to dry 70 metric t/h pulp from 70% moisture to 10% moisture in one dryer.

KEARNEY, M. and REARICK, D. E., Amalgamated Research Inc., 2531 Orchard Dr. East, Twin Falls, ID 83301. **Weak cation exchange softening: long-term experience and recent developments.**

Weak cation softening systems operate in several factories in the U.S. beet sugar industry. Due to the weak acid functionality of the resin, the softener can be operated in the very efficient hydrogen form with no significant inversion of sucrose. This is in opposition to acid form strong cation resins wherein sucrose is inverted. A first favorable result is that compact softener cells are used since the capacity of weak cation resins is more than double that of strong cation resins. Additionally, the fast kinetics of weak cation resin allow operation at about 50 bed volumes/hour compared to the typical 10 bed volumes/hour for the strong cation. This provides a further reduction of softener size.

The weak acid characteristics also allow for extremely efficient regeneration. Regenerant use is typically 105% to 110% on operating capacity.

The weak cation softener is also unique in that the used regenerant is not a waste, but rather, is used as a pulp pressing aid. In this sense the regenerant is cost free – or from a different point of view, the pulp pressing aid can be considered cost free.

The recent introduction of fractal softener configurations has further reduced cell size and resin requirements. These systems operate at 500 bed volumes/ hour. As a result, the fractal weak cation softener uses only about 2% of the resin used for strong cation juice softening and is operated using correspondingly small cells. Although operating at very high specific flowrate, the fractal configuration exhibits negligible pressure drop typically 1 psi or less. The extremely high flowrates also allow rapid turn-around of the softener. A complete cycle of sweet-off, regeneration, regeneration rinse and backwash is completed in 25 minutes.

KOCHERGIN*, V., PRYOR, T., and JACOB, W., Amalgamated Research Inc., 2531 Orchard Dr. East, Twin Falls, ID 83301. **Pilot-scale thick juice decolorization using fractal equipment.**

Fractal distributors have been proven to improve fluid distribution in chromatographic applications. Recent reports also demonstrate that fractal distribution principles are applicable to softener applications – significantly reducing resin requirements and allowing thin juice exhaustion flowrates as high as 500 BV/hr. An effort has now been made to expand fractal distribution principles to thick juice decolorization with the goal of reducing resin inventories and improving operational characteristics. The results of a pilot study are presented where highly colored thick juice was decolorized with strong base resin. Color removal is compared for conventional and shallow resin bed height. Potential utilization of softening equipment during the off-campaign period for decolorization of thick juice streams is discussed.

KRELL, L. and HEMPELMANN, R., Braunschweigische Maschinenbauanstalt AG, Am Alten Bahnhof 5, D-38122 Braunschweig, Germany. **Low-energy pulp drying in a high-capacity fluidized-bed steam dryer.**

The more stringent regulations the authorities in several countries have recently issued for the reduction of air pollution by industrial plants also concern pulp drying which in a large number of the world's sugar factories is conventionally practiced in directly fired drum dryers. The higher demands on environmental protection and the necessity to save energy have resulted, some years ago, in the development and employ-

ment of an alternative progressive drying technology: Drying with superheated steam. After twelve units of this type, know as the Niro steam dryer and designed for maximum water evaporation rates of 44 sht/h; have been employed worldwide, BMA will now install an FSD of type 12 designed for 55 sht/h water evaporation at the Uelzen sugar factory in Germany for the 2002 beet campaign. At average pulp pressing conditions, this corresponds to a beet slice rate of approx. 11,000 sht/d. Technological and design modifications made in the scale-up to the new size to ensure an optimum availability of the dryer will be presented, and an assessment of first results and experiences will be discussed.

MERGNER[1], D. and HERRMANN[2*], M., [1]H. Putsch & Company, P.O. Box 5128, Asheville, NC 28804 and [2]H. Putsch GmbH & Comp..Postfach 4221, 58042 Hagen, Germany. **Effective beet cleaning with newly designed rock catcher.**

Efficient beet slicing due to the newly designed "closed version" rock catcher. Good high quality cossettes and lower usage of Koenigsfelder knives improve efficiency in every beet sugar factory. Because the old type "open" rock catchers were not that effective, we designed the new "closed version" rock catcher. This "closed version" rock catcher improved production in several European and American beet sugar factories. Factories, which use this new rock catcher, saw a tremendous reduction in knives usage, due to cleaner beets, less sand and the elimination of 99% small and large rocks. Very low maintenance on the rock catcher itself as well as lower maintenance on the Putsch or any other slicer and almost no discharge of sugar beets from the rock catcher, reduces the loss of sugar in this very important early step of sugar production.

MILNER, T. and HOUSTON, D., T. D. M. Design, 9170 Stuart Street, Westminster, CO 880031. **Reaching Uniformity in Vacuum Pan Seed Stock**

This research study is dedicated to establishing specific "methods" of grinding seed-stock sugar to reach uniformity of grind, resulting in better vacuum pan yield. The results of testing various grinding methods have established a process to reach uniform grind of particle size, the use of surfactants, and the ability to produce batch sizes of stock to feed several traditional vacuum pans as well as continuous units. This study will continue through the actual results of yield etc. in the coming months.

MUEHLBERG*, B. A., HAUGEN, J. R., SAMARAWEERA, U., and CARLSON, J. L., Minn-Dak Farmers Cooperative, 7525 Red River Road, Wahpeton, ND 58075-9698. **First Year Experiences in Operating a Sulfur Furnace at Minn-Dak Farmers Cooperative.**

During the 2001 intercampaign Minn-Dak Farmers Cooperative installed two sulfur furnaces and two absorbing towers, one each for diffusion fresh water and thin juice. The system was designed so one or both of the furnaces could be used to supply the factory with SO2. The decision to switch from purchasing liquid sulfur dioxide to generating it on site was driven by environmental, safety and economic factors. A number of minor problems were encountered during the first year's operations. Plugging was experienced in the aftercoolers due to iron sulfate and in the firebox due to ash. Excess juice flow reduced SO2 flow through the absorbers. Control problems included surging of gas flow when using a single furnace, too low of a furnace temperature to operate them on an automatic mode, difficulty in tuning the control scheme and the sulfur inlet gate sticking. Overall the installation was successful with the system consistently delivering SO2 to the factory safely and effectively.

REGITNIG*, P J., NITSCHELM, J. J., LLEWELYN-JONES, A., Rogers Sugar Ltd., 5405 – 64th Street, Taber, Alberta, T1G 2C4. **Shoulder coverings for sugar beet storage piles in Alberta.**

Sugar beets on the surface of pile shoulders, and to some extent within the shoulders, are exposed to widely fluctuating environmental conditions over the storage season in Alberta. Straw has been applied on the shoulders of piles to reduce the effects of environment on these beets; however, observations on the benefits of straw coverings have been largely visual with few quantitative measurements. This two-year study investigated the effect of straw and wet lime coverings on pile shoulder temperature fluctuations and sugar beet quality. Results suggested that straw coverings were effective in moderating surface temperature fluctuations. Surface temperature peaks were moderated slightly by lime application, particularly early in the storage season. Straw shoulder coverings appeared to have more effect on moderating shoulder temperatures and on improving the visual appearance of sugar beets than lime shoulder coverings. Straw coverings may also delay thawing of frozen sugar beets during warm periods. In the absence of a pile covering, surface temperature fluctuations were lower on the north pile shoulder than on the south pile shoulder. North shoulder fluctuations were comparable to fluctuations for the straw treatment on the south shoulder. Results from two years of sugar beet quality monitoring with different pile coverings were inconclusive. Unrealistic values in year two implied that accurate determination of sucrose in highly deteriorated and dehydrated sugar beets was not achieved in this study.

RUIZ-HOLST, M., MARTIN DOMINQUEZ, F., and BURBA, M. **An industrial colour study and balance linked to the agronomy and beet varieties.**
**Abstract no submitted**

SAMARAWEERA*, I. S., NOBLE, D., BUSCHETTE, L., and RHEAULT, D. L., American Crystal Sugar Company, Technical Services Center, PO Box 1227, Moorhead, MN 56561-1227. **Bench studies and factory trials with the use of beta hop acids.**

Beta hop acids have been used as a biocide in the sugar industry in Europe for several years. However, its usage in the United States is relatively new. These hop acids are natural products derived from a plant source and therefore user friendly and have less safety concerns than other biocides in usage. Therefore, several bench studies and factory trials were carried out at American Crystal Sugar Company's Technical Services Center and factories with the prospect of its use as an alternative to sulfur dioxide in a cost effective manner. The results of these studies and factory trials will be discussed in this paper.

SANDERS, D. O., 1105 Westshore Place, Loveland, CO 80538. **Increase available lime without increasing kiln capacity.**

A process system that uses a reduced amount of lime to clarify or purify juice obtained from sugar beet. Specifically, apparatus and methods to reduce volatile materials in juice providing a product juice stream that has an increased pH requiring the use of less lime or other base to achieve the desired results for clarification or purification.

SANDERS[1], R. and PELLETAN[2], C., [1]Fletcher Smith, Norman house, Friar gate, Derby DE1 1NU, England, and [2]Fives Cail, 22 rue du Carrousel, 59666 Villeneuve d'Ascq, France. **How to improve low raw massecuite curing by the appropriate use of massecuite conditioning?**

The curing of low raw massecuite is one of the most critical steps in the process

of sugar production. Indeed, many factors affect the performances of the continuous centrifugals. Amongst them the physical characteristics of the product to be treated are of the foremost importance; factors such as non sugar content, temperature, viscosity, crystal content, size of the sugar crystals, etc. On the other hand, the permanent challenge for the sugar industry is to find ways to reach higher throughput, lower losses, and reduction of the production costs. To answer both of these general requirements, a new range of equipment has appeared on the market with the aim of conditioning the low raw massecuite before curing. A review and a comparison of those products based on two commonly used processes, namely the dilution and the reheating of the massecuite, is undertaken from a theoretical and practical point of view.

SCHWARTZ, E., Filtomate Self-Cleaning Filters-Israel, 5 Attatzoran Street, P.O. Box 8242, New Industrial Zone, South Netanya, Israel 42506. **Filtomate successful application in thick juice in European sugar factories.**

Since the first introduction of Filtomate filters in thick juice / standard liquor took place in Holland in 1986. The filters were successfully applied in more than 60% of all sugar factories in Europe. The filter eliminates pipe scale, rust particles, burned sugar and other non-sugar particles down to a level of 25 micron, with a self-cleaning screen of 50 micron. Measured values vary from 1400 mg/l insoluble at the inlet of the filter to 11, 2 mg/l at the outlet. The filter only flushes between 1 and 4 hours depending dirt load. The drained 250l/per $m^2$ filter area is sending back to the pre-limning stage and is not lost.

1. A fully automatic filter system, no handling.
2. High quality juice result with very low ash content.
3. Filter result was acceptable for the company standard *Coca Cola* and *Unilever*.
4. Lifetime expectance of the filters is more than 15 years.
5. Maintenance costs are very low.

Conclusion is that these filters are worth the investment. World sugar groups as Sud Zucker did choose these filters in order to improve their sugar quality.

SUHR[1], M. and AUGUSTINE[2], G., [1]MS PROCESSES INTL. LLC, 410 Campbell Ln., Hutchinson, MN 55350 USA [2]Southern Minnesota Beet Sugar Cooperative, P.O. Box 500, Renville, MN 56284. **Cleaning regimes used in falling film plate type evaporators**

The development and use of more efficient equipment is part of business. The falling film plate type evaporator is a development that allows the sugar industry to use a compact design with higher heat transfer rates and lower wetting rates to achieve reductions in color development, sucrose losses and utilization of lower vapor pressures. The principles of the design have allowed it to achieve very favorable results. However, precipitation of organic and inorganic substances as well as potentially oxidizing sucrose breakdown products adhering to the heat transfer surfaces will occur and cleaning regimes are discussed relevant to this design. The design of the juice entering and leaving complicates successful cleaning. The complications of wetting the heat transfer surfaces with cleaning chemicals and the choices of cleaning chemicals are discussed in as it relates to cost effectiveness and successfulness. Results of removing layers of different plated out materials is also covered.

SUHR[1], M. and THOMPSON[2], P., [1]MS PROCESSING INTL. LLC, 410 Campbell Ln., Hutchinson, MN 55350, USA [2]Sugar Knowledge International Ltd, 3 Mill Road, Yarwell, Peteborough, England, United Kingdom. **Applications of decanter centrifu-**

**gals in the beet sugar process**

In the processing of sugar beets into granular sugar many liquid – solid Separations are encountered. In selecting the right equipment for the separating step, the underlying principles of the equipment and the process application must be understood. The general operating principles of the decanting centrifuge is highlighted and the proper applications points in our industry is discussed, including material selection, dealing with foaming liquids and varying particles sizes for solids. Results from actual applications are included. Capital and operating costs are compared to other separation techniques for evaluation along with other potential benefits that can result with equipment.

THOMPSON[1], P. and SUHR[2], M., [1]Sugar Knowledge International Ltd, 3 Mill Road, Yarwell, Peteborough, England, United Kingdom, [2]MS PROCESSING INTL, LLC, 410 Campbell Ln., Hutchinson, MN 55350, USA. **Thick juice storage and reprocessing – a viable strategy**

The rationales used for thick juice storage over the history of processing sugar beets is marketing flexibility, lower capital investments, processing flexibility, utilization of assets, lower maximum steam demand, cogeneration, manpower, and processing the sugar beets during its optimum time period for extraction. Each rationale is examined and quantified. Implication to the operation is highlighted. Strategy of which stream of sugar solution, raw juice, thick juice, standard liquor, or an even lower grade of syrup should be stored is discussed. A matrix with potential cost and/or savings associated with these different strategies is presented.

WALLEVAND*, J. H., GROOM, D. R., HEINBAUGH, T. A., and CARLSON, L. T., American Crystal Sugar Co., PO Box 1227, 1700 North 11th St., Moorhead, MN 56561-1227. **An on-line autotitrator for measuring juice hardness.**

The requirement to provide soft molasses to chromatographic separators has placed additional demands upon operational control and has heightened the analytical load on the factory lab. During periods when degraded beets are being processed and lime usage is increased, rapid swings in juice hardness necessitate tight management of the process in order to minimize chemical use (NaOH, HCl, and $Na_2CO_3$) and to achieve optimum softener performance. Hence, frequent sampling of juice before and after softening is needed to capture changes in hardness levels. At the Moorhead (MN) factory, hardness samples are taken only twice during an 8-hour shift leaving long periods of operation without timely information. Typical hardness titrations (involving difficult to detect color changes) tend to be operator dependent. To provide more timely feedback to the beet end process operators, we installed an Iotronic Aquacon SH-20 on-line hardness autotitrator. Cost of the instrument (1999) was $3000 (US). Originally designed for the water treatment industry, the manufacturer modified this instrument for use on filtered second carbonation juice. In use throughout three campaigns, it gives near real-time data using photometric determination of titration end points on hardness levels of 60PPM to 400PPM CaO at a sampling rate of four times an hour. With this information, operators can control soda ash addition during periods of degraded beet processing to within 1/8 pound per ton of beet compared to 1 pound per ton of beet previously. Additionally, with the prediction of softener regeneration cycles tightened up, instances of column overloading and under-regeneration have been reduced, promoting increased resin life, diminished chemical use, and insuring soft molasses production.

WILLEMS, M. L., Tiense Suikerraffinaderij n.v., Aandorestraat 1, B-3300-Tienen. **Meet at the interface 'beet quality' and 'sugar processing'!**

The author illustrates how important the interface between 'beet quality' and 'sugar processing' is for factory operations. Examples, drawn on studies and experiences with deteriorated beets, beet bruises, the ionic balance of beets, the difference between polarization and sucrose content show risks in terms of processing costs, quality of sugar and by-products. The examples call beet researchers and processing sugar processing technologists up to a more interactive approach of this interface.

## Section F, Factory Operations
## Poster Presentations

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**Effect of mean particle size of fractionation resin on chromatographic separation of molasses desugarization**

Chromatographic separation of saccarose from molasses is an essential part of modern industrial sugar post-treatment process. It is impossible to separate saccarose from molasses with standard separation methods like distillation, precipitation or crystallization. The very efficient and novel technology is to separate chromatographically sucrose from the molasses. With the help of chromatographic resins molasses is divided into two main streams: non-conductive sucrose fraction and non-sucrose salt fraction.

The efficiency of chromatographic separation is related strongly to the mean bead size of the stationary phase. Typical mean particle size of fractionation resin in large scale chromatographic applications is 300 to 400 um. This is a compromise between kinetic performance and pressure drop over column. The trend to smaller particle sizes is becoming more and more important.

The effect of mean particle size for molasses desugarization was carried out with 6 % croslinked SAC resins ( Finex Ltd, Finland) in monovalent form ( Na+).

Particle size ranged from 100 um to 500 um, all the resin samples were of monobead type, ie. having narrow particle size distribution. Pulse test technique with water as an eluant was applied for single components and molasses- saccarose mixtures to evaluate chromatographic separation.

The chromatographic performance was characterized by using the method of moments for calculation of performance parameters like bed porosity, adsorption, equilibrium co-efficient, separation factor, HETP and resolution.

We show the importance of customizing the mean particle size. If process equipment and other parameters allow, the reduction of particle size even by a relatively small degree is emphasized as an effective tool for improving cost effectiveness of the process.

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2. Golding R. W. 1976 J. Chromat. 103 :232
3. Ruthven D.M. 1984 Principles of Adsorption and Adsorption processes Wiley New York

ROUSSET, F., THEOLEYRE[1], M-A., and SASKA[2], M., [1]Applexion Inc., 606 Potter Rd, Des Plaines, IL 60016 and [2]Audubon Sugar Institute, LSU, South Stadium Drive, Baton Rouge, LA 70803. **Raffinate regeneration of ion-exchange softeners in Beet Sugar Industry.**

During the last decade or so, a signification part of the US Beet Sugar Industry has introduced thin juice softening by ion-exchange in their operations. In addition to the many benefits associated with ion-exchange softening (true removal of Ca from juice and molasses, less evaporators scaling/cleaning, increased heat transfer coefficients, reduced sugar turbidity), thin juice softeners allow for the production of soft molasses for chromatographic separation. One-third of the US beet sugar factories include an Ion-Exclusion Process in their operations for the recovery of sugar, and sometimes betaine, from molasses. About half of the US beet sugar factories already soften their thin juice by ion-exchange: 25% use a weak cation resin and regeneration with dilute sulfuric acid; 25% use a strong cation resin and NRS regeneration with soft think juice and caustic soda. Eighty percent of the US factories working on beet molasses separation also use ion-

exchange softening of thin juice. For those factories, Applexion/ASI have developed an efficient and cheap regeneration process, using raffinate. Raffinate is the by-product from molasses chromatographic separation ; it contains 90% of the non-sugars and 10% of the sugar from the molasses. Its concentration in monovalent cations (K, Na) has been enriched during the multiple-stage crystallization, and during the chromatographic separation. One liter of raffinate 25 Brix has the same regeneration power as one liter of 6% NaCl solution. Unlike other regenerants, it is available for free from the molasses separation plant. This new softening process is available for the Cane and the Beet Sugar Industries. When used in the Beet Sugar Industry, one must take great care to avoid back-mixing of sugar and colorants between thin juice and raffinate. Therefore, counter-current regeneration and small intermediate water flush have been introduced in the process available to the Beet Sugar Industry for the production of white sugar. Raffinate regeneration of thin juice softeners can be done very efficiently, using a cheap strong cation resin, for only a fraction of the operating cost of the existing weak cation and NRS juice softeners.