POSTERS: INDUSTRIAL CROPS

I-1
KENAF PRODUCTION: STRENGTH IN DIVERSITY

H.L. Bhardwaj[1] and C.L. Webber III[2]

[1]Virginia State University, Petersburg, VA 23806, USA; [2]South Central Agricultural Research Laboratory, USDA-ARS, Lane, OK 74555, USA

Intensive production research on kenaf, especially in the last decade, has created a strong and diverse storehouse of knowledge, understanding, and experience in kenaf production which serves as a vast reservoir for critical, timely information for producers, processors, and consumers. A crop that sixty years ago was only entertained as a cordage crop, and then more recently as only a pulp crop, now has many diverse commercial applications for development.

The purpose of this project was to review and summarize the diverse production research recently conducted to provide a unified location for accessing the information and references. Recent kenaf production research has crossed the entire spectrum from genetic and seed development to harvest aids and wind erosion prevention of an established crop. Cultural practices evaluated have included such items as cultivars, seed treatments, herbicides, row spacings, plant populations, irrigation, fertility, rotations, ratooning, and harvest dates.

The diversity of production research provides ample opportunity to apply specific production practices not only to differing geographically areas, but also in adapting production practices to equipment availability, to existing cropping systems, and to unique market applications. Commercial interest in kenaf continues to grow, as does the need to provide current information on the useful application of recent kenaf production research.

Contact: C.L. Webber III, South Central Agricultural Research Laboratory, USDA-ARS, P.O. Box 159, Lane, OK 74555, USA, Tel. 580-889-7395. E-mail: cwebber-usda@lane-ag.org

I-2
KENAF HARVESTING AND PROCESSING

R.E. Bledsoe[1], V. K. Bledsoe[1], and C.L. Webber III[2]

[1]Ladonia Market Center, Ladonia, TX 75449; [2]South Central Agricultural Research Laboratory, USDA-ARS, Lane, OK 74555

The increased diversity of harvesting and processing methods have strengthened the potential avenues for commercial development of kenaf. Researchers, producers, and businesses have developed and adapted harvesting and processing systems that use either locally available equipment, increase harvesting and transportation efficiency, or uniquely prepare kenaf fibers for a specific market.

The purpose of this report is to review and summarize these diverse harvesting and processing systems. Research and development has moved from the simple hand harvesting and retting of kenaf bast fibers to harvesting equipment specifically designed for kenaf and new high tech uses of the fibers. The natural low density of kenaf stalks produced numerous equipment adaptations and unique approaches to increase the density to optimize the handling, storage, and transportation efficiency of the material. As the kenaf density increased, so did the commercial applications for the kenaf fibers. The diverse harvesting and processing possibilities need to be correctly understood in order to select the optimum harvesting and processing system best adapted to the commercial uses in the United States and around the world.

Contact: C.L. Webber III, South Central Agricultural Research Laboratory, USDA-ARS, P.O. Box 159, Lane, OK 74555, USA, Tel: 580-889-7395. E-mail: cwebber-usda@lane-ag.org

I-3
CROP MATURITY AND YIELD COMPONENTS

V.K. Bledsoe[1] and C.L. Webber III[2]

[1]Texas A&M, Commerce, Texas 75428, USA; [2]USDA, ARS, SCARL, P.O. Box 159, Lane, Oklahoma 74555, USA

Kenaf (*Hibiscus cannabinus* L.) plant maturity at harvest not only influences the total biomass harvested, but also the composition and quality of the yield components. Additional information is needed to determine the ideal harvest age to maximize the various kenaf yield components for different product applications.

The objective of this research was to determine the effects of kenaf plant age on kenaf yield components. A field study was repeated over a three-year period with kenaf variety 'Everglades 41' at Lane, Oklahoma, USA on a Bernow fine sandy loam, 0 - 3% slope, (fine-loamy, siliceous, thermic Glossic Paleudalf). The kenaf plots were harvested at either 60 days after planting (DAP), 90 DAP, 120 DAP, or 150 DAP. At each harvest date, a 3-m long plant row was cut at ground level and used to determine plant population, stalk height, percentage stalk by weight, percentage leaves by weight, stalk yield, leaf yield, total biomass, crude protein, and digestible protein. The experiment was a randomized complete block design with five replications.

Harvest age (60, 90, 120, and 150 DAP) did not significantly affect plant populations, but did have a significant effect on all other yield parameters.The total biomass yields, averaged across years, increased from 60 DAP (5,705 kg/ha) to 150 DAP (21,005 kg/ha). Although the growth rates did level off or even decrease after 120 DAP, the significant increase in stalk yields after 120 DAP justify the additional 30 days of growth for stalk production. Stalk yields ranged from 3.8 Mt/ha for 60 DAP to 19.3 Mt/ha for 150 DAP. The percentage of leaf biomass (32%, 60 DAP to 12%, 150 DAP), and leaf digestible protein (18.3%, 60 DAP to 15.5%, 150 DAP) decreased with each harvest date. Leaf yields increased from 2.4 Mt/ha (60 DAP) and 4.0 Mt/ha (90 DAP) to 4.4 Mt/ha at 120 DAP and then decreased to 3.9 Mt/ha for the 150 DAP harvest.

This research provides valuable information to assist in the management of kenaf to maximize specific yield components for different uses, including stalk production for fiber and plant material for livestock.

Contact: V.K. Bledsoe, 101 Depot, Ladonia, TX 75449, USA. Tel: 903-367-7216. E-mail: bledsoe@koyote.com

I-4

FLAX FIBER: POTENTIAL FOR A NEW CROP IN THE SOUTHEAST

Danny E. Akin[1], Roy B. Dodd[2], Jonn A. Foulk[3], and David D. McAlister III[3]

[1]Russell Research Center, USDA-ARS, Athens, GA 30605, USA; [2]Dept. Agricultural and Biological Engineering, Clemson University, Clemson, SC 29634, USA; [3]Cotton Quality Research Station, USDA-ARS, Clemson, SC 29633, USA

Flax (*Linum usitatissimum* L.) is the source of fiber for textiles, i.e., linen, and linseed oil. Globally, the U.S. is the largest per capita consumer of flax fiber, but no flax is produced for fiber and as a result all textile and composite grade fiber is imported. Development of a flax/linen industry in North America is needed to supply a domestic source of clean, consistent quality fiber for blending with cotton in textiles and to supply the emerging composite industry. The commercial method for obtaining flax fiber uses expensive, specially designed equipment for pulling and turning stems for dew-retting and often produces fiber of low and inconsistent quality. More economical means are required to produce flax fibers and an improved method for separating fiber from the flax stem is required to establish a flax/linen industry.

The objective of this work was to evaluate traditional farm equipment for flax production and to develop and test an enzyme-retting method to replace dew-retting. Fibers retted by various formulations were tested for yield and for properties required in the textile and composites area.

Flax was grown as a winter crop in the southern U.S. and harvested with traditional mowing and baling equipment. A retting formulation based on commercial, pectinase-rich enzyme mixtures plus chelator was used to ret flax, including both varieties grown for fiber and for seed, using a recently developed spray-enzyme-retting method. Flax stems were crimped to disrupt the stem integrity and sprayed with an enzyme formulation, in water adjusted to pH 5.0, to soaking or soaked for 2 min in formulation. Soaked flax stems were incubated at 40^0 C for up to 24 h, after which retted stems were washed in water and air dried. Retted stems were cleaned by a variety of means, including the commercial Unified Line and cottonizing system at Ceskomoravsky len, Czech Republic. Methods to improve the efficiency of the retting formulations were evaluated, including pre-soaking, vacuum/pressure to increase penetration, and various ratios of enzyme/chelators. Yield and fiber properties were determined for strength and fineness using modified cotton methods.

New methods of harvesting flax, using traditional agricultural equipment to mow, bale and store flax produced fibers adequate for new retting methods. Fiber with suitable properties of strength and fineness were produced by enzyme-retting, with commercial pectinase-rich enzymes and chelators, and commercial cleaning equipment. Flax fiber yield and properties can be varied with different levels of chelator or enzyme, respectively.

Flax fiber can be produced in the southern U.S. with traditional farming equipment. Fibers of suitable properties can be adequately produced using a newly developed enzyme-retting method. Large scale production of fiber by this method should focus on improving retting efficiency, based on

cost and fiber quality, and should be integrated with commercial cleaning systems. Toward this goal, a pilot plant for flax research is being established at Clemson, USDA-ARS.

Contact: D. E. Akin, Russell Research Center, USDA-ARS, PO Box 5677, Athens, GA 30604, USA. Tel: 706-546-3482. E-mail: deakin@qaru.ars.usda.gov

I-5

EUROPEAN AND NORTH AMERICAN PERSPECTIVE: THE DEVELOPMENT OF MARKETS FOR AGRI-FIBERS INCLUDING NEW CROPS AND RESIDUAL FIBERS

Peter A. Nelson

AgroTech Communications, Inc., Memphis, TN 38120, USA

AgFiber Technology News, an internet newsletter, has developed a worldwide network of entrepreneurs, processors, researchers and users of agri-fibers. This network has brought some clarity to the agri-fiber industry, while allowing companies to develop a greater comfort level in developing agri-fiber products. The purpose of this paper is to present an update on new developments with agri-fiber in both Europe and North America and includes:

- Business news
- Market activities and pricing
- Patent updates and research horizons
- Acreage and processing reports
- Legislative and policy information

This paper covers new crops such as kenaf and flax, grasses such as esparto and switchgrass, and exotic fibers such as sisal and coir. The paper also includes information on harvesting and utilization of crop residues including wheat straw, rice straw, cotton gin byproducts, and corn stover. Data will be presented on the utilization of these fibers in biobased products including absorbency products, chemicals, composites, fuels, nonwoven plastics, pulp, textiles, and other high-tech products.

Contact: Peter A. Nelson, AgroTech Communications, Inc., 7777 Walnut Grove Rd., Suite LLB4, Box 50, Memphis, Tennessee 38120, USA. Tel: 901-309-1668. Fax: 901-309-3823, Email: pnelson@agrotechfiber.com. Web: http://www.AgFiberTechnology.com

I-6

ACCESSING THE INTERSPECIFIC GENETIC DIVERSITY OF MEADOWFOAM: REPRODUCTIVE BARRIERS AND HYBRID FERTILITY OF INTRA AND INTERSECTIONAL HYBRIDS

S.D. Gandhi, J.M. Crane, O. Riera-Lizarazu, V.K. Kishore, and S.J. Knapp

Department of Crop and Soil Science, Oregon State University, Corvallis, Oregon, 97331-3002, USA

Cultivated meadowfoam (*Limnanthes alba* Benth.) is one of eight species of *Limnanthes* assigned to two taxonomic sections: Inflexae (*L. alba*, *L. gracilis*, *L. floccosa*, and *L. montana*) and Reflexae (*L. douglasii*, *L. bakeri*, *L. striata*, and *L. macounii*). Various subspecies of *L. alba*, *L. gracilis*, *L. floccosa*, and *L. douglasii* have been described. Several fertile intrasectional hybrids have been reported, whereas no fertile intersectional hybrids have been reported.

The specific aim of this research was to assess the feasibility of producing sexual hybrids between cultivated meadowfoam (*L. alba*) and *L. floccosa* ssp. *pumila*, *L. douglasii* ssp. *douglasii*, *L. douglasii* ssp. *nivea*, and *L. douglasii* ssp. *rosea*. This research was undertaken to access untapped interspecific genetic diversity in meadowfoam and search for cytoplasmic male-sterile lines by substituting the nuclear genome of *L. alba* into alien cytoplasms.

Cytological analyses of pollinated pistils and ovaries showed that pollen tube growth was inhibited in the stigma or style of *L. alba* x *L. douglasii* and *L. douglasii* x *L. alba* crosses. Callose deposits on the stigmatic surface blocked pollen tube penetration in some crosses, whereas the growth of pollen tubes in the upper three-fourths of the stylar transmitting tissue was arrested in others. The hybrids between *L. floccosa* ssp. *pumila* and *L. alba* were fertile. These were backcrossed and selfed. The genetic diversity of the section Reflexae gene pool apparently cannot be accessed through sexual crosses with cultivated meadowfoam. Conversely, the genetic diversity of the section Inflexae gene pool, based on the new hybrids

and several previously reported hybrids, can be accessed through sexual crosses.

Contact: S.J. Knapp, Department of Crop and Soil Science, Oregon State University, Corvallis, Oregon, 97331-3002, USA. Tel: 541-737-5842, E-mail: steven.j.knapp@orst.edu

I-7

MEADOWFOAM INDUSTRY DEVELOPMENT: AN UPDATE

Gary D. Jolliff

Oregon State University, Corvallis, OR 97331-3002, USA

Meadowfoam (*Limnanthes* spp.) is a winter-spring annual forb native only to certain ecozones in the Mediterranean climates of Pacific coast regions of North America. It was domesticated and commercialized in Oregon. The first cultivar was plant-variety-protected, and licensed by Oregon State University exclusively to an open-enrollment association of Oregon farmers in 1984 before the first known sale of seed oil product in commerce. This approach to commercialization was chosen because of the long history of difficulties in dealing with new-crop development ventures, which usually are: 1) high risk, 2) long-term, and 3) difficult for farmers to gain and retain a fair share in the crop value chain.

Economic theory predicts under-investment in agricultural research because it is too easy for "free-riders" to benefit from investments while the investors may not realize acceptable rates of return. This can be especially problematic with new crops, and more particularly when farmers add risk to their existing high-risk enterprise. Therefore, the meadowfoam grower organization has been developing multi-faceted positions to shield the member-growers' high risk capital exposure involved in nurturing this new industry. This presentation focuses on activities dating since our 1988 review paper of the chronological history of meadowfoam domestication in Oregon.

Central to the current health and stability of the meadowfoam grower industry is the reorganization that was planned and implemented during the approximate 3-year period of 1996 through 1998. The Oregon Meadowfoam Growers Association, with activities focused in Oregon, was transformed into OMG, the Meadowfoam Oil Seed Grower Cooperative Corporation, with national and international activities, associations, and collaboration – including the worldwide wholesale marketing of meadowfoam oil by its wholly owned subsidiary NPP (Natural Plant Products, LLC) with a Website "www.meadowfoam.com." A full-time Executive Director who reports to a Board of elected grower-members manages both OMG and NPP.

More than 100 farmers have been OMG members, contract growers, or collaborators in this new industry. Nearly all of the 80+ current OMG members in Oregon are or have been involved in some aspect of grass seed production. Oil sales increased more than 30 % in 2000 over 1999. The oil is found in more than 600 products worldwide. The vertical integration structure allows OMG acreage management to assure oil buyers of a dependable supply, and to sustain acceptable profit margins for OMG grower-members.

Contact: G. Jolliff, Crop Science Bldg., Oregon State University, Corvallis, OR 97331-3002, USA. Tel: 541-737-5849. E-mail: Gary.D.Jolliff@orst.edu

I-8

GROWERS AS SCIENTISTS: PERSPECTIVES FROM A FARMER – UNIVERSITY COLLABORATION.

George D. Hoffman[1], Doug Duerst[2], and Gary D. Jolliff[1]

[1]Oregon State University, Corvallis, OR 97331-3002, USA; [2]IOKA Farms, Silverton, OR 97381, USA

Globalization of agriculture is rapidly changing the set of skills necessary for family farms to be successful. New and expanding survivor skills and mindsets are needed, particularly to enhance leadership capabilities within the farm community. The oil seed crop meadowfoam is grown under contract by OMG, the open-enrollment Meadowfoam Oil Seed Growers Cooperative. A subsidiary of the grower cooperative buys the seed and extracts, refines, and markets the oil worldwide. While working with this grower-led cooperative we realized that trying to enhance the grower skill set is a valuable contribution to the industry. The Fund for Rural America grant that supports this research has as an objective the development of farmer skills to enhance leadership.

The objective of the collaborations reported here was to facilitate farmer-directed and executed farm-scale field trials. We hope that the skills the grower gains through this collaboration will enable them to engage in their own scientifically valid field research, rather than waiting for someone from the university to solve their agronomic difficulties. We also hope that the self-leadership skills the growers develop during the course of these

collaborations will translate into improved grower leadership within the OMG organization and the larger agricultural community.

In the 1999-2000 growing season, our collaborator wished to examine the benefits of direct cutting and combining of the crop rather than the traditional swathing and combining. The grower designed the experimental layout based upon the size of his equipment and other logistical factors, while our primary task was to insure the statistical integrity of the design. Most of the experiment was carried out in our absence, with communication taking place via personal visits, telephone, and e-mail.

During the 2000-1 growing season the grower executed a planting date study. The design and implementation were largely the responsibility of the grower. We ensured the statistical integrity of the design and did the data analysis. We developed better ways of ensuring the data were collected and communicated accurately based on our experiences from the previous year. The grower developed more efficient ways of incorporating the dictates of the scientific protocol into the logistics of their farming operation. Independent of any input from us, the grower repeated the direct-cut versus swath harvesting comparison study from the year before. We showed the grower how to use the statistical capabilities of MS-Excel spreadsheet to analyze this data. Next year we are expanding our collaborations to include more growers.

The lessons that we have learned from the collaboration, and the questions that arose from it will be discussed.

Contact: G. Hoffman, Crop Science Bldg., Oregon State University, Corvallis, OR 97331-3002 USA. Tel. 541-740-6812 / 737-5851. E-mail: George.Hoffman@orst.edu

I-9

MAPPING QUANTITATIVE TRAIT LOCI UNDERLYING SHIFTS IN THE MATING SYSTEM OF MEADOWFOAM FROM ALLOGAMY TO AUTOGAMY

V.K. Kishore, S.D. Gandhi, J.M. Crane, and S.J. Knapp

Department of Crop and Soil Science, Oregon State University, Corvallis, Oregon, 97331-3002, USA

Cultivated meadowfoam (Limnanthes alba Benth.), a novel very long-chain oilseed crop, is a predominantly allogamous, insect-pollinated species; however, partially autogamous variants have been discovered in wild populations and strongly autogamous variants have been developed by artificially selecting for increased autogamy in wild populations and crosses between autogamous and allogamous genotypes. The development of self-pollinated (autogamous) meadowfoam cultivars could reduce production costs by eliminating pollinator rental fees and might curb seed yield losses attributed to incomplete honeybee pollination.

The aim of this research was to elucidate the anatomical, developmental, and genetical mechanisms underlying the shift from allogamy to autogamy in a meadowfoam population segregating for selfing rate and floral morphology. We produced 160 BC1S1 lines from a cross between OMF64 (a partially autogamous inbred line) and OMF40-11 (an allogamous inbred line); the hybrid was backcrossed to OMF64. Selfing rates (seed per flower) and flower petal dimensions were measured on ten BC1S1 individuals per line (1,600 individuals total). Quantitative trait loci (QTL) underlying selfing rate and flower petal dimension differences were mapped using a genetic map comprised of 90 simple sequence repeat markers spanning the genome.

The analysis uncovered QTL affecting selfing rate and flower petal dimension. Cytological analyses of pollen mother cells at diakinesis showed that recombination rates were high in meadowfoam (1.7 chiasmata per bivalent) compared to most plant species and that the mean number of chiasmata was significantly greater in OMF64 (9.3 chiasmata per cell) than OMF40-11 (7.4 chiasmata per cell) ($p < 0.0001$). The latter suggests that the chromosomes of the autogamous line (OMF64) undergo greater recombination than the chromosomes of the allogamous line (OMF40-11).

We speculate that increased autogamy and recombination have co-evolved in meadowfoam. The map locations of the QTL can be used to develop QTL-NILs and facilitate the development of autogamous lines in new crosses by marker-assisted selection.

Contact: S.J. Knapp, Department of Crop and Soil Science, Oregon State University, Corvallis, Oregon, 97331-3002, USA. Tel: 541737-5842. E-mail: steven.j.knapp@orst.edu

I-10

LARGE SCALE DEVELOPMENT OF SIMPLE SEQUENCE REPEAT MARKERS FOR HIGH-THROUGHPUT GENOTYPING IN MEADOWFOAM

V.K.Kishore, P. Velasco, M.B. Slabaugh, and S.J. Knapp

Department of Crop and Soil Science, Oregon State University, Corvallis, Oregon, 97331-3002, USA

DNA markers, especially high-throughput sequence-based DNA markers, are powerful tools for intellectual property protection, genetic diversity analysis, genetic resource conservation management, cultivar identification, and molecular breeding in crop plants.

One of the goals of our laboratory has been to develop robust, high-throughput, sequence-specific DNA markers for such purposes in the novel oilseed crop meadowfoam (*Limnanthes alba* Benth.). None have been developed or described thus far for meadowfoam. The specific aim of this research was to develop and screen a large collection of simple sequence repeat (SSR) markers for functionality, utility, and polymorphisms in meadowfoam.

Fourteen germplasm accessions from nine taxa were screened (*L. alba* ssp. *alba*, *L. alba* ssp. *versicolor*, *L. floccosa* ssp. *floccosa*, *L. floccosa* ssp. *grandiflora*, *L. gracilis* ssp. *gracilis*, *L. gracilis* spp. *parishii*, *L. montana*, *L. douglasii* ssp. *douglasii*, *L. douglasii* ssp. *nivea*, and *L. douglasii* ssp. *rosea*). We isolated and sequenced 1,596 clones from genomic DNA libraries enriched for GA_n or CA_n. Six hundred and ninety-six clones harbored unique SSRs ranging in length from 6 to 148 bp; primers were designed and tested for 624 unique SSRs.

Three hundred and eighty-nine primer pairs (62.3%) produced clean amplicons and yielded functional SSR markers. Ninety-six percent of the SSR markers (373 out of 389) were polymorphic among the 14 germplasm accessions and the polymorphic information content (PIC) scores ranged from 0.0 to 0.93 with a mean of 0.64. Genetic distances ranged from 0.35 to 0.69 with a mean of 0.57. Cluster and principal component analyses of the genetic distance matrix uncovered patterns of diversity concordant with species, subspecies, and breeding origin.

The SSR markers described herein are powerful tools for efficiently and accurately discriminating between genotypes. This can be accomplished in most cases by carefully selecting fewer than 20 highly polymorphic SSR markers from the complete set. We designed the SSR markers to facilitate multiplexing by uniformly sorting target amplicons into 100 bp length bins in the ~100 to ~500 bp window. When coupled with the use of multiple fluorophores, 8 to 12 SSR markers can be routinely multiplexed, thereby facilitating very high-throughput genotyping.

Contact: S.J. Knapp, Department of Crop and Soil Science, Oregon State University, Corvallis, Oregon, 97331-3002, USA. Tel: (541) 737-5842. E-mail: steven.j.knapp@orst.edu

I-11

MAPPING GENETIC FACTORS UNDERLYING GLUCOSINOLATE CONCENTRATION DIFFERENCES IN MEADOWFOAM

P. Velasco, V.K. Kishore, J.M.Crane, and S.J. Knapp

Department of Crop and Soil Science, Oregon State University, Corvallis, Oregon, 97331-3002, USA

Glucosinolates are an important class of bioactive secondary compounds found in the Limnanthaceae, Brassicaceae, and several other plant families. The breakdown products of glucosinolates, e.g., isothiocynates, thiocynates, nitriles, and epithionitriles, have been shown to adversely affect human health, suppress the growth of nematodes, fungi, and other microorganisms, allelopathically affect plant growth, reduce or stimulate insect herbivory, and suppress the growth of human tumors.

This study is one component of a breeding program geared towards developing cultivars with increased seed glucolimnanthin concentrations. Because glucosinolates are produced by cultivated meadowfoam (*Limnanthes alba* Benth.) and other members of the family and could positively or negatively affect the meadowfoam industry, we have been surveying and cataloging the glucosinolate diversity of *Limnanthes* and mapping genetic factors underlying quantitative and qualitative differences in glucosinolates in cultivated meadowfoam.

Quantitative trait loci (QTL) underlying glucolimnanthin differences in the seeds and buds of OMF40-11 and OMF64 were mapped using a genetic map constructed from 160 OMF64 x [OMF40-11 x OMF64] BC_1S_1 lines. Glucolimnanthin concentrations were measured by HPLC on two replicate bulk samples of 10 BC_1S_1 seeds per line and buds harvested from two replicates of 10 BC_1 S_1 individuals per line. *L. alba* produces glucolimnanthin. Glucolimnanthin concentrations in OMF40-11, an *L. alba* ssp. *alba* inbred line, were significantly less than in OMF64, an *L. alba* ssp. *versicolor* inbred line. OMF40-11 leaves, flower buds, and seeds accumulated 31, 81, and 98 _moles/g glucolimnanthin, respectively, whereas MF64 leaves, flower buds, and seeds accumulated 54, 126, and 138 _moles/g glucolimnanthin, respectively.

If glucosinolates play a significant role in the bioactivity of meadowfoam seed meal, as has been postulated, then an increase in glucosinolate concentration should increase the potency of the seed meal as a soil amendment for the horticultural industry.

Contact: S.J. Knapp, Department of Crop and Soil Science, Oregon State University, Corvallis, Oregon, 97331-3002, USA. Tel: 541-737-5842, E-mail: steven.j.knapp@orst.edu

I-12

PRODUCTION AND USES OF JOJOBA OIL IN THE WEST BANK – PALESTINE: A MODEL FOR THE SEMIARID ARAB REGION

Said A. Assaf

Arab Scientific Institute for Research and Transfer of Technology (ASIR), El-Bireh/Ramallah, Palestine

Author not available for presentation

I-13

SURVEY OF PESTS OF *VERNONIA GALAMENSIS* IN ETHIOPIA

Tesfaye Baye [1, 2] and Sileshi Gudeta[1]

[1]Alemaya University of Agriculture, P.O.BOX 138, Dire Dawa, Ethiopia; [2] Institute of Agronomy and Plant Breeding, University of Goettingen, Von-Siebold Str. 8, D- 37075 Goettingen, Germany

Vernonia galamensis is a new industrial oilseed crop that originated in Ethiopia. Its unique properties make it economically and environmentally interesting. Very little and/or no effort has been made so far in Ethiopia to improve this crop.

This survey was made to investigate the pathogens and insect pests associated with *Vernonia galamensis* in the 1994/95 cropping season on experimental fields at Alemaya, Harar and Babile This was conducted during the germplasm collection expedition mission from November-December, 1998 and November-December, 2000 to different parts of Ethiopia including: Hararghe, Arsi, Bale, Sidamo, Borena (Yabello), Gamo Gofa, Shewa, Wollo, and Tigray.

Preliminary identification of *Vernonia* diseases revealed the presence of six different fungal pathogens and one bacterial pathogen. Infestation by damping off during the seedling stage across the experimental plots was serious. Over 10% of the seedling was lost at this stage to this disease. Late in the growing season severe infestation was caused by powdery mildews. Similar problems were observed for the naturally growing *Vernonia*. Thirteen insect species belonging to seven families and six orders were also identified. Infestation and damage by *Vernonia* worm at the early stage and helmet bug (*Captosoma* spp.) at the late stage were very high. Helmet bug alone caused over 80% damage in Yabello areas on a wild, naturally growing *Vernonia* of southern Ethiopia.

Future research should try to address the damage and loss assessment due to the major pests noted and design appropriate management controls together with commercialization efforts.

Contact: Tesfaye Baye, Department of Plant Sciences, Alemaya University of Agriculture, P.O.Box 138, Dire Dawa, Ethiopia. Tel.: 251 5 11 13 99. E-mail: btesfaye@yahoo.com

I-14

NEW INDUSTRIAL OILSEED CROP COLLECTING EXPEDITION IN ETHIOPIA

Tesfaye Baye

Department of Plant Sciences, Alemaya University of Agriculture, P.O.BOX 138, Dire Dawa, Ethiopia

Vernonia galamensis is a new potential industrial oilseed crop with a very high content of vernolic acid in the seed oil. Ethiopia is the center of origin and diversity. Very little and/or no effort has been made so far in Ethiopia to study the naturally existing variability and to improve this crop.

In order to collect, conserve, and study the existing variability in the country, a germplasm collecting expedition was carried out between 10 October and 20 December 2000. *Vernonia* grows in wild forms in various ecosystems. Ten regions were explored from the North, South, East, Southeast, Southwest, and Central Ethiopia. A diverse range of habitats, covering an area of about 9,000 km^2, and having different altitudes,

ecological conditions, in which the plant usually grows, were explored. Detailed site, ecological, and population information were recorded at every site.

Approximately 480 accessions were collected from 80 sites. Mature pods were collected whenever possible. Passport data collected at each site showed that the altitude of collecting sites varied between 1,250 and 2,050 m, and soil pH from 5.06 to 8.47. The most common soil type was sandy loam, and organic matter content ranged from 0.22 to 12.93%. A wide diversity of *Vernonia* was collected with various agromorphological attributes including different stages of maturity, plant type, flower color, and branching patterns as well as fatty acid compositions. The mean of vernolic acid of the accessions was 74.31% and ranged from 34 to 87% with 65 % of the accessions having vernolic acid content above the mean. A wide variability for other fatty acid compositions was also observed. All of this information will be useful in *Vernonia* improvement programs.

It was not possible to find samples in all locations visited that have been identified by herbarium specimens since 1840. This could be an indication of a change in land use system and environmental degradation causing a loss of genetic resources of the unique *Vernonia* populations found in Ethiopia. Conservation, research, and development strategies including current status will be discussed.

Contact: Tesfaye Baye, Department of Plant Sciences, Alemaya University of Agriculture, P.O.Box 138, Dire Dawa, Ethiopia. Tel: 251 5 11 13 99. E-mail: btesfaye@yahoo.com

I-15

HIGH-PRESSURE EXTRACTION OF NATIVE HIBISCUS OILSEEDS

R. A. Holser[1] and G. Bost[2]

[1]USDA-ARS-NCAUR, Peoria, IL 61604, USA; [2]Village Botanica, Inc., Houston, TX 77055-5025, USA

The seeds of native Hibiscus species contain a variety of phytochemicals with potential applications in functional foods, natural, and specialty products. Triglycerides, phospholipids, and sterols, for example, are conventionally extracted from oilseeds by organic solvents and subsequently recovered during a multi-step refining process. The rapid and efficient recovery of such compounds without organic solvents would improve the marketability of these compounds and promote the development of native Hibiscus as an alternative crop.

Pressurized extraction techniques using water or carbon dioxide in place of organic solvents have demonstrated promise for the separation of hydrophilic and lipophilic compounds from oilseeds. The density and dielectric of the solvent show significant dependence on pressure near the critical point and may be controlled to obtain greater selectivity in extractions.

Hibiscus seed samples were reduced to 0.1-mm diameter particle size and subjected to a series of extractions performed with sub-critical carbon dioxide, super-critical carbon dioxide, super-critical water, and sub-critical water. Extracts were collected and characterized by standard analytical methods (GC-FID, GC-MS, HPLC) for the identification of major extractable components.

The analytical results indicated that manipulation of both temperature and pressure could extend the solvating power of both solvent systems to achieve recoveries of predominately nonpolar components, e. g., triglycerides, moderately polar, and polar components.

Pressurized extraction techniques provide a rapid method to separate a range of both polar and nonpolar natural products from Hibiscus seeds with environmentally benign solvents.

Contact: R. A. Holser, USDA-ARS-NCAUR, 1815 North University Street, Peoria, IL 61604, USA. Tel: 309-681-6458. E-mail: holserra@ncaur.usda.gov

I-16

CANOLA-BASED MOTOR OILS

Duane Johnson[1], Blaine Rhodes[2], and Rob Allen[3]

[1]Northwest Ag Research Center, Montana State University, Kalispell, MT 59901, USA; [2]Rhodes Consulting, Seattle, WA 98124, USA; [3]Agro Management Group, Inc, Colorado Springs, CO 80904, USA

The shortages of the past year in the supply of petroleum- and other non-renewable energy sources have reinforced the need for research and

development of biobased fuels and lubricants. Such fuels and lubricants must be renewable, functional, environmentally nonhazardous and cost-effective. It would also be desirable for these sources to be recyclable. Prior research has shown these oils to be renewable, nonhazardous and cost-effective.

The objective of the current study was to evaluate canola-based motor oils using standardized ASTM protocols to meet industry standards for targeted consumers and original equipment manufacturers.

Using Michigan-grown high-oleic canola as a base, the seed was processed by Michigan farmer-members of the Great Lakes Oil, LLC. The base oils were then blended by Agro Management Group, Inc. to produce a "standardized" motor oil. This oil was distributed to Colorado, Montana, and the Michigan U.S. Postal fleet for final evaluation prior to commercialization.

In Montana, field-trial data has been collected from a 6 hp, one cylinder Kohler engine mounted on an AT and from the first author's private vehicle (300 hp, 10 cylinder Chrysler engine). In Colorado, field trials were conducted using a 140 hp, 4 cylinder Volkswagen Turbo-Diesel. In Michigan, the USPS has concluded their field trials successfully and have initiated dynamometer and EPA evaluations using their mandated EA85 delivery vehicles.

Canola-based motor oils were fully functional under a broad spectrum of field applications. Results generally showed an increased base horsepower rating (4 hp), increased fuel economy (4-6%), and decreased exhaust emissions. Similar results were shown using bench dynamometer evaluations.

The use of common sources of high oleic vegetable oils reduces costs of vegetable-based motor oils. Modifying these oils by blending can easily be accomplished in rural communities, adding value to farm production. In addition, niche oils from specialty crops are required to maintain a fully functional oil. This creates a new market for both existing and new vegetable oils.

Contact: Duane Johnson, NWARC, 4570 MT 35, Kalispell, MT 59901, USA. Tel: 406-755-4303. E-mail: duanej@montana.edu

I-17
GERMPLASM ENHANCEMENT, CULTIVAR DEVELOPMENT, AND MOLECULAR BREEDING ADVANCES IN THE NEW INDUSTRIAL OILSEED CROP *CUPHEA*

S.J. Knapp, J.M. Crane, and M.B. Slabaugh

Department of Crop and Soil Science, Oregon State University, Corvallis, Oregon, 97331-3002, USA

Cuphea viscosissima Jacq. (Lythraceae) seed oil is a rich source of saturated medium-chain fatty acids (MCFAs). The commercial sources of MCFAs are imported tropical oils, petrochemicals, and genetically modified organism (GMO) high lauric rapeseed (*Brassica napus* L.) oil.

The long-term goals of our research are to introduce *Cuphea* as a domestically produced substitute for imported and non-renewable MCFA sources and as a new crop for corn (*Zea mays* L.), soybean (*Glycine max* L.), and tobacco (*Nicotiana tabacum* L.) rotations in the U.S. We recently completed the development of self-pollinated, partially non-shattering cultivars. Field tests of the new cultivars are underway in Oregon, Illinois, and Minnesota in collaboration with the USDA (Peoria, IL and Morris, MN) and WIU (Macomb, IL). The characteristics and performance of the new cultivars will be described. Additionally, we will review our ongoing breeding work, the development, characteristics, and performance of non-sticky germplasm and cultivars, and progress towards the development of a genome map comprised of sequence-based DNA markers and the cloning and analysis of genes underlying seed shattering in *Cuphea*. We are presently concentrating on the development of fully non-shattering cultivars using GMO and non-GMO strategies.

The development of such cultivars would open the way to the widespread cultivation of *Cuphea* and create a new source of medium-chain oils for the soap and detergent industry.

Contact: S.J. Knapp, Department of Crop and Soil Science, Oregon State University, Corvallis, Oregon, 97331-3002, USA. Tel: 541-737-5842. E-mail: steven.j.knapp@orst.edu

I-18
NURSERY PRODUCTION OF TEA OIL CAMELLIA UNDER DIFFERENT LIGHT LEVELS

John M. Ruter

University of Georgia, Department of Horticulture, Tifton, GA 31793-0748, USA

The tea oil camellia, *Camellia oleifera* Abel., is used extensively in the Orient for cooking oil, inks, lubricants, and cosmetics. After the oil has been extracted from the seed, the remaining seed cake can be used for animal feed, fertilizer, and development of natural pesticides. Commercial production in China has decreased dramatically in the last ten years while demand has increased. Although tea oil has been produced in China since 1949, no production is known to have occurred in the United States. With the loss of traditional agricultural commodities and low prices, growers are looking for alternative crops. I have initiated a research program to develop *Camellia oleifera* as a commercial oilseed crop in the southeastern United States.

The objective of this study was to determine 1) the levels of light exclusion that were best suited for the production of container-grown *Camellia oleifera*, and 2) whether photoinhibition had an influence on the photosynthetic processes under different conditions.

Seeds of *Camellia oleifera* PI 162475 were obtained from the U.S. National Arboretum in Washington D.C. in the fall of 1999 and germinated. Treatments in this study consisted of 1) full sun, 2) 30% light exclusion under woven shade cloth, and 3) 55% light exclusion under woven shade cloth. Plants were grown in #1 (3.8 liter) containers with a pine bark:sand (8:1 v/v) substrate amended with 1.2 kg m^{-3} dolomitic limestone and 0.9 kg m^{-3} Micromax micronutrients (The Scotts Company, Marysville, OH). Plants were fertilized with 30 g of Osmocote Plus 15.0-4.0-9.9, 8-9 month Southern formula (The Scotts Company) at the initiation of the study in April 2000. Dark-acclimated chlorophyll fluorescence measurements were made in July using an OS-500 modulated fluorometer (Opti-Sciences, Tyngsboro, MA). At the termination of the study in November 2000, the final plant height, leaf area, leaf dry mass, stem dry mass, specific leaf area, root dry mass, and total biomass were determined.

Final plant height, leaf area, leaf dry mass, stem dry mass, specific leaf area, root dry mass and total biomass were greater for plants grown under 30% light exclusion compared to plants produced in full sun. Plant growth at 55% light exclusion was generally intermediate between plants grown in full sun and 30% light exclusion. Dark-acclimated chlorophyll fluorescence measurements (F_v/F_m) made in July indicated that photoinhibition was not a problem for plants produced in full sun.

Container-grown plants of *Camellia oleifera* can be produced without shading in south Georgia. We still need to determine whether plants produced under 30% light exclusion would perform better once transplanted into a field production setting or whether photoinhibition during the winter would be a problem for plants grown under light exclusion when placed in full sun conditions. Work is ongoing in an attempt to refine container production standards for this new crop.

Contact: John M. Ruter, University of Georgia, Department of Horticulture, Coastal Plain Station, Tifton, GA 31793-0748, USA. Tel: 229-386-3907. E-mail: ruter@tifton.cpes.peachnet.edu

I-19

PROSPECTS OF CANOLA AS AN ALTERNATIVE WINTER CROP IN VIRGINIA

David E. Starner[1], Anwar A. Hamama[2], and Harbans L. Bhardwaj[2]

[1]Northern Piedmont Agricultural Research and Extension Center, Virginia Tech, Orange, VA 22960, USA; [2]Agricultural Research Station, Virginia State University, Petersburg, VA 23806, USA

The U.S. demand for canola oil is increasing at a tremendous rate. Even though canola production in the United States tripled by 1998 and reached 1.13 million acres, consumption still outpaces production at the rate of nearly 3 to 1. During 1998, the United States imported approximately 419,000 tons of canola oil from Canada with approximately 355,000 tons per year average for 1992-1998. Recent research has demonstrated that canola is a potential winter crop in Virginia, however, this research has also indicated the need for cultivars with greater winter-hardiness. Virginia is unique given that environmental conditions preclude use of cultivars developed for production in Georgia and other southeastern states where winter-hardiness is not a requirement.

We have been conducting research to develop/identify winter-hardy, high yielding cultivars and to develop a production system. Our participation in the National Winter Canola Variety Trial has identified several cultivars/lines suitable for production in Virginia. We have developed a new canola cultivar (VSX-1) which is currently being evaluated at approximately 30 U.S. locations. The production research has determined that ideal canola planting time is different for the three locations: northern Piedmont (middle of September to early October), southern Piedmont (during October), and coastal plain (mid October to early November). This research has also indicated that approximately 5 pounds of seed/acre and use of approximately 100 pounds/acre each of nitrogen, phosphorous, and potassium resulted in optimal seed yields at the three university locations.

We are currently conducting experiments to identify the best row spacing and response to additions of sulfur and boron. The canola seed yields in Virginia have averaged in excess of one ton/acre with approximately 35 percent oil content. The canola crop in Virginia is relatively free of insect-pests and diseases if adequate crop rotations are practiced. We did not plant canola in the same field within three years. Detailed results from our studies, results of which may be applicable to not only Virginia but also to other states in the mid-Atlantic region, will be presented to indicate that prospects of canola, as a new winter crop in this region, are excellent.

Contact: D.E. Starner, Northern Piedmont Agricultural Research and Extension Center, Virginia Tech, Orange, VA 22960, USA. Tel: 540-672-2600. E-mail: nparec@vt.edu

I-20

AN OVULE CULTURE TECHNIQUE FOR PRODUCING INTERSPECIFIC *LESQUERELLA* HYBRIDS

Pernell Tomasi, David Dierig, and Gail Dahlquist

USDA, ARS, U. S. Water Conservation Laboratory, Phoenix, AZ 85040, USA

The cultivated species of *Lesquerella* [*Lesquerella fendleri* (Gray) Wats.] has a narrow range of genetic variation determining hydroxy fatty acid seed oil content. Germplasm evaluations at the U. S. Water Conservation Laboratory have revealed significant fatty acid profile variation in other *Lesquerella* species. These species may be suitable donors for possible novel gene introgression by interspecific hybridization. Hybrids resulting from interspecific crosses are male-sterile and mature seed rarely develops within siliques. Utilization of ovule culture can overcome this problem.

The objective of this study was to develop an ovule culture protocol for production of interspecific hybrids between *L. fendleri* (*2n* = 12) and four other *Lesquerella* species: *L. auriculata* (*2n* = 16), *L. lindheimeri* (*2n* = 12), *L. lyrata* (*2n* = 16) and *L. pallida* (*2n* = 12).

Swollen siliques were excised 7 to 13 days after pollination (DAP) and aseptically dissected. Developing ovules were placed into 60 x 15 mm plates containing 5 mL of Murashige and Skoog (MS) media supplemented with 0.5 gL^{-1} Casein Hydrolysate and 1.0 mgL^{-1} Gibberellic acid, at 25°C under continuous illumination. Germinated ovules were transferred to MS media supplemented with 1.0 mgL^{-1} Kinetin and 4.25 mgL^{-1} Silver Nitrate ($AgNO_3$) for shoot initiation. Recently initiated shoot explants were then placed in a MS shoot media containing 0.1% Colchicine for 48 h to overcome male sterility by inducing amphidiploidy. Surviving explants were rooted in MS media supplemented with 0.1 mgL^{-1} Auxin (NAA) and transferred to Jiffy peat pellets in the greenhouse.

Ovule culture greatly improved embryo germination and seedling establishment. Hybrids were produced between *L. fendleri* and the four other species. Some sterile F_1 hybrids were restored to fertility by the *in vitro* colchicine treatments. First and Second backcross generations, with *L. fendleri* as the donor parent, were also successfully produced from ovule culture. Germination rates ranged from 8 to 19 %, depending on species involved and generational stage. Ovule abortion may be due to a lack of genetic homology and a high rate of post zygotic, late-acting self-incompatibility.

A successful ovule culture protocol will allow breeders to introgress traits, such as increased variation of fatty acid profile into *L. fendleri* from related wild species through backcrossing. This technique has the potential to greatly improve the commercialization of this new crop.

Contact: P. Tomasi, U. S. Water Conservation Laboratory, 4331 East Broadway Road,Phoenix, AZ 85040-8832, USA. Tel: 602-437-1702, x274 Email: ptomasi@uswcl.ars.ag.gov

I-21

DETERMINATION OF BASE AND OPTIMUM TEMPERATURES FOR *LESQUERELLA* SPECIES

L. Windauer and D.A. Ravetta

Cultivos Industriales, Facultad de Agronomía, Universidad de Buenos Aires, Av. San Martin 4453 (1417), Argentina

Author not available for presentation

I-22

PERFORMANCE OF CANADIAN AND AUSTRALIAN CANOLA VARIETIES IN SOUTHERN SONORA, MÉXICO

Sergio Muñoz-Valenzuela[1], Greg Buzza[2], and Roberto Avalos-Pérez[1]

[1]Instituto Tecnológico Agropecuario No.21, Ciudad Obregón, Sonora, México; [2]Advanta Canada, Inc., Winnipeg, MB, Canada

Author not available for presentation

I-23

METHODS OPTIMIZATION FOR MEDIUM-SCALE GUAYULE LATEX PURIFICATION AND QUALITY TESTING OF LATEX FROM BIMONTHLY SHRUB HARVESTS

K. Cornish[1], J.L. Brichta[1], F.S. Nakayama[2], T.A. Coffelt[2], and S.H.Vinyard[2]

[1]USDA-ARS, Western Regional Research Center, Albany, CA 94710, USA; [2]U.S. Water Conservation Laboratory, USDA-ARS, Phoenix, AZ 855040, USA

Guayule is under development as a new, industrial crop because (1) the rubber it produces in vivo is primarily long chain rubber (M_r ^{3}10^6 Da) comparable in quality to that obtained from Hevea brasiliensis, which is currently the sole commercial source, and (2) guayule latex (Yulex^{TM}) has a considerable advantage over existing materials because it does not cause allergic reactions in patients suffering from Type I latex allergy, which is caused by proteins in products made with H. brasiliensis latex.

Little is known about the effect of post-harvest processing conditions on latex quality. Although, large-scale purification methods are established, the investigation of post-harvest conditions on latex quality required the development of methods suitable for the purification of latex from harvested plant materials.

The objectives of this study were to develop and optimize latex purification methods and to determine the quality of the latex of plants harvested at different times of the year.

Latex in whole plants (1.6 to 30 kg) was extracted with a water-based solution consisting of 0.1% sodium sulfite as an antioxidant adjusted to pH of 11. The plant was ground in a hammer mill-type chipper. For the initial grinding, the chipped whole plant was directed into the extract solution. This plant-solution mixture was pressed to remove the homogenate containing the latex. Two additional chippings were made, and for these two grindings, the plant material was saturated with the extracting solution during the chipping process. After the third grinding, the homogenates from the separate grindings were combined and passed through a clarifier. The clarified liquid was put into a cream separator to concentrate the latex. This latex was further purified with a creaming process using 0.05% (w/w) ammonium alginate.

Creaming produced latex concentration greater than 40%. Preliminary results show that season had no effect on the rubber particle size or latex protein content, suggesting that guayule could be harvested throughout the year for latex production.

Contact: Dr. K. Cornish, USDA-ARS Western Regional Research Center, 800 Buchanan Street, Albany, CA 94710, USA. Tel: 510-559-5950. E-mail: kcornish@pw.usda.gov

I-24

RAPID, RUBBER TRANSFERASE MICRO-ASSAYS USING A MULTI-WELL FILTRATION SYSTEM

C.J.D. Mau, D.J. Scott, and K. Cornish

USDA-ARS, Western Regional Research Center, Albany, CA 94710, USA

In spite of the importance of this agricultural product derived currently from a tropical tree, *Hevea brasiliensis* Muell. Arg, little is known about the regulation of rubber biosynthesis. Characterization of the rubber transferase (EC 2.5.1.20) that catalyzes the *cis*-elongation of polyisoprene has been largely limited to a few kinetic studies of three species, *H. brasiliensis*, *Parthenium argentatum* Gray, and *Ficus elastica* Roxb. In all species investigated, biosynthesis is catalyzed by the rubber particle-bound enzyme "rubber transferase." Rubber biosynthesis requires two isoprenoid substrates, an allylic pyrophosphate and isopentenyl pyrophosphate (IPP), which participate in the initiating and polymerization steps, respectively,

and a divalent metal cofactor, such as Mg^{2+}. The role of any inhibitory or stimulatory interactions among the isoprenoid substrates and metal ion in regulating yield, and the polymer molecular weight (a determinant of rubber quality) has not been extensively investigated. The slow pace of progress in this area has been largely caused by the lengthy processing of the rubber transferase assay.

We present a rubber transferase microassay that allows for rapid processing (96 samples in less than 30 min) after the enzymatic reactions are halted. The amount of rubber synthesized by washed rubber particles (WRP) is measured by the incorporation of radiolabelled isopentenyl pyrophosphate in enzymatic reactions assembled in a 96-well plate with wells sealed underneath with a membrane which prevents leakage but allows rapid harvesting. After stopping the reactions, the plate is placed on a vacuum manifold. After dilution with water, WRP are trapped on the underlying membrane by applying vacuum. The filters are rinsed with water, treated with acid, and thoroughly rinsed with ethanol. The radioactive rubber on the filters, which are removed from the plate, is counted by liquid scintillation spectroscopy.

The processing time for 96 samples takes less than 30 min. The MultiScreen® Assay can accurately measure the activity present in 0.07 mg of WRP and can be performed in a volume of 5 µL, which is smaller than any other assay reported. This assay can be used to measure rubber transferase activity in divergent species, such as *H. brasiliensis, P. argentatum,* and *F. elastica*.

Contact: Dr. K. Cornish, USDA-ARS Western Regional Research Center, 800 Buchanan Street, Albany, CA 94710, USA. Tel: 510-559-5950. E-mail: kcornish@pw.usda.gov

I-25

MODELING THE RUBBER TRANSFERASE ACTIVE SITE USING ENZYME KINETICS

K.Cornish, D.J. Scott, M.H. Chapman, D.J. Siler, and J.J. Windle

USDA-ARS, Western Regional Research Center, Albany, CA 94710, USA

Based on our studies of the kinetics and substrate requirements of rubber biosynthesis in purified enzymatically-active rubber particles, we have proposed a model of the rubber transferase active site in which, in addition to separate isopentenyl pyrophosphate and allylic pyrophosphate binding sites, there exists a hydrophobic region that interacts with the hydrocarbon tail of the allylic pyrophosphate. Substrate affinity increases until the active site is traversed and the rubber interior of the rubber particle is reached. The linear portion of allylic pyrophosphate proximal to the pyrophosphate interacts with the hydrophobic region of the enzyme. However, the conformational change caused by a *cis*-*trans*-linkage in the molecule places the *trans* tail of the allylic pyrophosphate in a non-interactive position.

We describe aspects of the biochemical regulation of rubber biosynthetic rate (a prime determinant of rubber and latex yield) in three contrasting rubber-producing species, *Hevea brasiliensis*, *Parthenium argentatum,* and *Ficus elastica*. Although many similarities are revealed, considerable differences also exist in enzymatic mechanisms regulating biosynthetic rate. In all three species, rubber molecule initiation and biosynthetic rate *in vitro*, are dependent upon substrate concentration and the ratio of isopentenyl pyrophosphate (IPP, the elongation substrate, or monomer) and allylic pyrophosphate (initiators), but these parameters are affected by intrinsic properties of the rubber transferases as well.

The kinetic data suggest that the hydrophobic region in *H. brasiliensis* and *F. elastica* is about 1.8 nm long, but only 1.3 nm in *P. argentatum*. The estimates are supported by measurements of the *P. argentatum* rubber particle monolayer membrane using electron paramagnetic resonance spectroscopy.

Contact: Dr. K. Cornish, USDA-ARS Western Regional Research Center, 800 Buchanan Street, Albany, CA 94710, USA. Tel: 510-559-5950, E-mail: kcornish@pw.usda.gov

I-26

A PRELIMINARY POST-HARVEST CROP MODEL FOR MAXIMIZING LATEX YIELD FROM GUAYULE (*PARTHENIUM ARGENTATUM* GRAY)

K. Cornish[1], J.L. Brichta[1] 1, M.H. Chapman[1], D.J. Scott[1], D.K. Stumpf[2], and D.T. Ray[2]

[1]USDA-ARS, Western Regional Research Center, Albany, CA 94710, USA; [2]Department of Plant Sciences, University of Arizona, Tucson, AZ 95721, USA

Parthenium argentatum (Gray), commonly known as guayule, is a perennial, woody shrub native to the Chihuahuan desert of the United States and

Mexico currently under development as a source of high quality, low protein, hypoallergenic latex. This latex provides a safe alternative source of natural rubber latex for patients suffering from life-threatening Type I latex allergy. Factors affecting the extractability and stability of latex rubber in harvested guayule shrub are under investigation in order to maximize latex yields, and optimize post-harvest practices.

We investigated the effects of dehydration and temperature, and their interaction, on the yield of latex and rubber in harvested guayule branches of different size, and the implications of these treatments on the latex extraction process itself. Also, we determined the quality of the latex remaining after the different treatments.

When fully hydrated, we found that harvested guayule branches can be stored at 4°C for at least two weeks without compromising latex yield, provided that dehydration does not occur. However, latex levels declined quickly at warmer temperatures. When subjected to drying, rates of dehydration varied considerably depending upon the temperature and branch diameter. Dehydration rates were faster the warmer the temperature. Also, as expected, the smallest diameter branches dried out the fastest at all temperatures used, although this effect was most marked at the warmest temperature of 40°C. In general, the largest diameter branches dried slowest at both 26 and 40°C, but surprisingly, the medium branches dried the slowest at 4°C. Total rubber content did not appear to be greatly affected by temperature or dehydration. However, latex levels were more adversely affected at the higher storage temperature, and the greater the degree of dehydration. In addition, high temperatures caused a decline in latex content in branches stored wet.

We extrapolated our results to a whole plant model based on the relative proportion of the different branch sizes on a whole shrub. This allowed us to develop a preliminary post-harvest crop model, which could guide post-harvest procedures throughout the year.

Contact: Dr. K. Cornish, USDA-ARS Western Regional Research Center, 800 Buchanan Street, Albany, CA 94710, USA. Tel: 510-559-5950. E-mail: kcornish@pw.usda.gov

I-27

COMMERCIALIZATION OF SOUTH AFRICAN INDIGENOUS CROPS – ASPECTS OF RESEARCH & CULTIVATION OF PRODUCTS

Cobus Coetzee and Emmy Reinten

ARC-Vegetable & Ornamental Plant Institute (Elsenburg), Elsenburg, South Africa

Commercial agriculture in South Africa has in the past mostly focused on existing traditional crops for their land use activities. The new generation rural farmers can't commercially compete with traditional agriculture and have to investigate new and alternative crops to become competitive.

The large and rich biodiversity of the indigenous plants of South Africa offers a valuable source for investigation into new crops. Research funding for indigenous crops is a limiting factor in scientific evaluations and trials to commercialize new crops, but worthwhile results have been achieved by academic institutions with regard to basic taxonomic documentation and general botany.

Research by the Agricultural Research Council in South Africa focusing on the commercialization of indigenous plant material has contributed to the establishment of alternative and new crops. Research has been conducted in the field of floriculture using fynbos (*Protea*, *Leucadendron*, *Leucospermum*) and bulbous plants (*Ornithogalum*, *Lachenalia*, *Gladiolus*, *Crinum*). Indigenous crops for tea purposes include rooibos (*Aspalathus*) and honeybush (*Cyclopia*). Medicinal plants include buchu (*Agathosma*), aloes (*Aloe*), and *Hypoxis*. Indigenous vegetables derived from *Amaranthus* spp, *Cleome*, *Dovyalis*, *Plectranthus*, and *Vigna* have also been extensively researched for commercialization purposes.

Although some of these plants are only useful to fill small niche markets, others have the potential to become new products for consumers, while others such as the rooibos and honeybush tea industries are expanding with a world market. Proteaceae flowers are already a definite component of the international flower trade.

Implementation of the research results in rural farming operations has proved to be difficult. In many cases, these farmers are the legal owners of the original genetic material and must participate in benefit sharing. They have been using these products or derived-from products for centuries and should benefit in the transition from wild harvested plants into commercial crops.

By making technology available to rural farmers and communities is however only one part of the process of commercialization. Other aspects that are required include market information, entrepreneurial and business skills training, social awareness, environmental awareness, and access to finance. Together with cultivation technology these factors must be addressed to assist rural farmers in South Africa to enter the mainstream economy.

Contact: Cobus Coetzee, ARC-Vegetable & Ornamental Plant Institute (Elsenburg), P/Bag X1, Elsenburg, 7607, South Africa. Tel: +27 21 808 5434. E-mail: cobus@igs5.agric.za

I-28

INVESTIGATION OF SEED TREATMENT SOLUTIONS ON GUAYULE GERMINATION

C.R. Bekaardt[1], J.H. Coetzee[1] , P.J. Pieterse[2], and A. Agenbag[2]

[1]ARC-Elsenburg, P/Bag X1, Elsenburg, 7607, South Africa; [2]University of Stellenbosch, Department Agronomy and Pastures P/Bag X1; Matieland; 7602, South Africa

Author not available for presentation

I-29

SURFACTANT TREATMENT REDUCES BOTH THE ALLERGEN CONTENT AND THE CURE EFFICIENCY OF NR LATEX

W. W. Schloman, Jr.

Department of Chemistry, The University of Akron, Akron, OH 44325-3601, USA

Multistage washing of natural rubber (NR) latex substantially reduces the level of extractable protein in a dipped film product. However, the proteins that remain include some of those implicated in Type I allergic response. These particular allergens are not washed away because they are bound to the rubber particle surface.

We report here the treatment of commercial NR latex with surfactants as a means of solubilizing particle-bound protein allergens. We report further the impact of low protein levels on dipped film formation.

A 4-stage washing sequence (dilution-centrifugation-redilution) reduced the level of protein (mg/g NR) in commercial NR latex serum by 69%. By comparison, treatment with Triton X-100 followed by a 4-stage washing sequence (alginate creaming-phase separation-redilution) reduced the total protein by 92%. Reductions in allergen were similar: 53% with washing, 93% with surfactant treatment followed by washing.

A dipped film prepared from surfactant-treated latex gave high recoveries of both total proteins and allergens, 15 times the quantities extracted from a control film prepared from unwashed NR latex. The films from both unwashed and washed NR latices yielded equivalent levels of extractable allergens. The film formation process itself apparently renders any remaining allergens susceptible to extraction from the film surface.

One possible explanation for the high level of extractable film proteins relates to the quality of the dipped film. In comparison to the commercial NR and washed NR latices, surfactant-treated latex required extended prevulcanization at 65°C to give a stable film. Even so, the highest state of cure, as measured by crosslink density, was obtained with unwashed NR latex. A significantly lower state of cure (61% of the control's level) was obtained with washed latex. Surfactant-treated latex gave the least effective cure of all (42%). Crosslink development in the washed latex film was complete after dipping and drying; heat aging did not increase crosslink density. The efficiency of vulcanization correlates well with both total latex serum proteins and latex serum allergens. The more protein in a latex, the better it cured.

Surfactant treatment is an effective means of reducing allergen levels in NR latex, but at the cost of reduced vulcanization efficiency. The use of more aggressive cure systems such as those applied to guayule (GR) and synthetic polyisoprene (IR) latices may be necessary.

Contact: W. W. Schloman, Jr., Department of Chemistry, The University of Akron, Akron, OH 44325-3601, USA. Tel: 330-972-7359. E-mail: wwschlo@uakron.edu

I-30

NON-TRADITIONAL CROP PRODUCTION IN DEVELOPING COUNTRIES FOR EXPORT

Bharat P. Singh

Fort Valley State University, Agricultural Research Station, Fort Valley, GA 31030-4313, USA

Crops can be grown year-round in the developing tropical countries. It may be possible to grow cool season crops at the high altitudes also. Recent increase in consumer demand in developed countries for out-of-season fresh fruits and vegetables has opened a niche for tropical countries to produce these crops for export at attractive prices. Rising costs of heating greenhouses and labor, and pricing pressure in increasingly global economy have made tropical countries a favored alternative for producing greenhouse crops. Some tropical minor crops show promise for large-scale production as a result of increased demand due to consumer awareness of their health benefits.

A number of developing countries in recent years have considered diversifying their agricultural and foreign exchange earnings in the production of non-traditional crops. The competition among the countries has become increasingly fierce. Thus, it is paramount for a new entrant to systematically analyze its competitive advantages and disadvantages compared with other countries producing the same crop. A developing country desiring to enter the non-traditional crop export market can utilize the following model while making the final decision and developing the requisite enterprise. The components of the model are as follows:

1) Make an appraisal of the existing infrastructure of the country to determine if it can support a high value export crop industry comprising mainly of fresh produce. The infrastructures analyzed should include input-suppliers, producers, produce transport and postharvest handling facilities, buyers and consolidators, and exporters.

2) Develop a plan to correct infrastructure weaknesses.

3) Identify non-traditional crops that are likely to succeed within a reasonable time period.

4) Estimate the production potentials of the short-listed crops in relation to the soil and climatic conditions of the country by conducting appropriate field research. Project the total production, volume available for export, potential for internal consumption of the commodity, and the estimate of potential production for domestic consumption.

5) Conduct market analysis to ascertain the profitability of the enterprise.

6) Provide baseline data to prospective growers to enable them in deciding whether to engage in producing the new crop.

7) Identify promising export markets by compiling preliminary country profiles, product market matching, and on site visits.

8) Estimate potential revenue from exporting the commodities produced. Make prediction under various policy scenarios over next one, two, five and ten years.

7) Develop promotional strategy for the target market. Participate in the trade shows, develop product brochures and catalogs, outfit and update country missions abroad with literature and upcoming promotional events, and promote the quality of the produce on the worldwide web.

8) Develop a monitoring mechanism against future constraints at the governmental, private sector, and farm level to the non-traditional crop enterprise.

Contact: Bharat P. Singh, Fort Valley State University, Agricultural Research Station, Fort Valley, GA 31030-4313, USA. Tel: 478-825-6829. E-mail: singhb@mail.fvsu.edu

I-31

A FRAMEWORK FOR THE DEVELOPMENT OF NEW-CROPS INDUSTRIES IN SOUTH AFRICA

J.G. Theron and B.F.A. Visser

Chief Directorate: Agriculture, Western Cape, Oudtshoorn, South Africa

Established and traditional agricultural industries in South Africa are under increased pressure in terms of viability. Historical and political factors are the main reasons for this situation. Diversification or substitution by new crops provides opportunities to improve the viability of the agricultural sector and also to stimulate rural development. However, the development of most new industries is usually complicated with high risks involved. It is therefore imperative to develop guidelines, frameworks and processes to assist in the establishment of sustainable new agricultural industries.

Studies on past and present situations in South Africa, as well as world trends in agriculture, have been performed. Information on new agricultural

industries has been used to create a framework that could improve the success rate of new crop development. The objective of this presentation is to provide a framework for the development of new-crops industries in South Africa.

Opportunities in the present agricultural situation are identified technically, economically and socially. This process provides a calculated estimate of viability. A development plan, with the role players identified, is compiled for the proposed industry, with detailed planning applied for every element involved. Elements in this development plan include people, product, technology, infrastructure and market.

The development plan specifically provides the option to identify partners needed. Each situation would determine, where necessary and to what extent strategic alliances are formed with external partners, as well as the proportion of value-adding locally.

National resources should be coordinated to apply the local intellectual capital in the most efficient way. This would enhance ventures with international role players through better communication, e.g., by means of linked information systems.

The framework could be used as a dynamic tool to improve the planning, implementation and sustainability of new crops industries. The framework can also be used to identify and improve weak spots in new crops industries already established.

Contact: J.G. Theron, Chief Directorate: Agriculture, Western Cape, P.O. Box 351, Oudtshoorn, South Africa. Tel: +27 442726077. E-mail: jant@wcape.agric.za

I-33

ANTIINSECT ACTIVITY OF BUFADIENOLIDES FROM *URGINEA MARITIMA* (L.) BAKER (LILIACEAE)

M.J. Pascual-Villalobos

Consejería de Agricultura, Agua y Medio Ambiente, Centro de Investigación y Desarrollo Agroalimentario, Estación Sericícola, Murcia, Spain

Squill (*Urginea maritima*) is a native Liliaceae from the Mediterranean Area. The bulb is a source of rodenticide products where scilliroside is the main active ingredient. Attempts were made in the fifties to introduce this new crop for arid lands in the United States.

In our research to screen botanicals for insecticidal activity, we tested this plant and obtained that ethanolic extracts of the bulbs were active against *Tribolium castaneum* (Coleoptera:Tenebrionidae), the insect that damages stored products. The objective of this study was to test pure bufadienolides (proscillaridin A, scillaren A, scillirosid, gammabufotalin, and scillirosidin) isolated from *U. maritima* against *T. castaneum*.

Antiinsect activity was assayed by: 1) topical application bioassays, in which the contact toxicity was observed after product application at rates of 10, 20, 30 and 40 µg/larvae and 2) insect growth inhibition and fertility bioassay, in which such effects were measured after incorporation of the squill products at 2% in the insect diet.

In this paper we report for the first time that *U. maritima* bufadienolides show antiinsect effects on *T. castaneum*. Proscillaridin A, scilliroside, and scillirosidin were active by topical application. The aglycone, scillirosidin was more active, causing over 50% mortality in *Tribolium* larvae at 10 µg/insect, than its glycoside scilliroside. Scillaren A and gammabufotalin were less toxic on insects and a response to increasing doses was not obtained. Only data from scilliroside applications fitted to the probit model being LD_{50} of 25.5 and 17.1 µg/insect for mortality after one and seven days, respectively.

Intake of bufadienolides at 2% in the diet caused an statistically significant larvae growth inhibition and adult fertility reduction. Ingestion of scillirosidin or proscillaridin A was most deleterious (larvae of 4.36 mm and 4.73 mm, respectively in comparison with 6.9 mm of control). With these treatments, the pupal stage was delayed from 21 to 29.2 days. The number of eggs laid per female was clearly reduced when the compounds were added to the diet. Again, scillirosidin and proscillaridin A were more active by completely inhibiting the fertility. Also, the aglycone scillirosidin appears to be more active than the glycoside (scilliroside).

Contact: María Jesús Pascual Villalobos, CIDA Estación Sericícola, 30150 La Alberca, Murcia, Spain. Tel: +34-968-366768, Fax: +34-968-366792, E-mail: MJesus.Pascual@carm.es

I-34

TAXOL AND 10-DEACETYLBACCATINE III CONTENTS IN THE NEPALESE *TAXUS BACCATA* LEAVES

Dharmatma Lal Srivastava[1], S.K.Dhungel[2], Hom Lal Sharma[1]

[1]Department of Plant Resources, Thapathali, Kathmandu, Nepal; [2]Ward 32, Maitidevi, Kathmandu, Nepal

Author not available for presentation

Top of Page

Return