KENAF & FIBER

LOW-THC HEMP (*Cannabis sativa*) RESEARCH IN THE BLACK AND DARK BROWN SOIL ZONES OF ALBERTA, CANADA

Stanford F. Blade

New Crop Development Unit, Alberta Agriculture, Food and Rural Development, R.R. # 6, Edmonton, Alberta, Canada T5B 4K3

blade@agric.gov.ab.ca

Many Alberta farmers are interested in low-THC (D^9-tetrahydrocannabinol) hemp due to the crop's potential to diversify agricultural production. Hemp (*Cannabis sativa*) was tested under Alberta field conditions to evaluate its potential for seed and fiber production. Only cultivars with THC levels below 0.3% (deemed to have no psychoactive effects by Health Canada) were used in the research project.

Soil fertility response (N, P and K) and herbicide tolerance will be reported. Ten cultivars from European breeding programs were evaluated in the black and dark brown soil zones. Plant heights were 2.1-3.4 m (black) and 1.2-2.3 m (dark brown). Total biomass was 14.1-17.3 t ha^{-1} (black) and 1.7-2.7 t ha^{-1} (dark brown). Seed production in the black soil zone was 700-1,350 kg ha^{-1}. Seed oil analysis of fatty acid composition and tocopherol content showed a valuable nutritional profile.

EVALUATING THE FEASIBILITY OF ADOPTING KENAF ON THE EASTERN SHORE OF VIRGINIA: IMPLICATIONS FOR TWO DISTINCT CROPPING SYSTEMS

Altin Kalo, Susan B. Sterrett, Paul H. Hoepner, and Daniel B. Taylor

Eastern Shore Agricultural Research and Extension Center, 33446 Research Drive, Painter VA 23420 USA

vators@vt.edu

The introduction of new crops is often suggested in response to various economic and/or environmental challenges. Producers are advised to adopt new crops to achieve better crop diversification, higher economic returns, and improve environmental impacts.

This research focuses on the economic and environmental feasibility of producing kenaf on Virginia's Eastern Shore. A mathematical programming model was developed to determine the optimal farming operations for two representative cropping systems in the region. The first system consists solely of wheat and soybean production. The second alternative evaluates a cropping system that produces vegetables in addition to wheat and soybeans. The economic and environmental feasibility of producing kenaf under both systems was evaluated.

A direct comparison of the relative profitability of kenaf and other crops showed that kenaf was not a feasible crop alternative for the region. Equally important, its least potential to reduce environmental impacts did not make kenaf a viable candidate from either an economic or an environmental prospective. Several conditions need to be met before kenaf can successfully compete with other production alternatives on the Eastern Shore. In the wheat and soybean cropping system, kenaf would be feasible if one of the following conditions prevailed: a) its price increased to $120 per ton (our assumption $75); b) its yield increased to 8 tons per acre (our assumption 5 tons), or; c) a processing plant located less than 50 miles away (our assumption 150 mile distance). For a mixed wheat/soybean and vegetable system, kenaf would be feasible if its price were $100 per ton, or its yield was 7 tons per acre, or the raw product could be delivered to a processing plant less than 50 miles away.

Barring other institutional constraints, including the absence of well-developed, competitive markets, the best alternative for adopting this crop on the Eastern Shore is the establishment of a processing plant in the region.

Caution is warranted, however, because this suggestion does not address questions of whether there is a large enough volume to justify a processing plant, or adequate water and infrastructure to support that facility, or the environmental impact of processing the raw product.

A NEW CROP FOR PENNSYLVANIA: *GOSSYPIUM HIRSUTUM* RESEARCH FOR IMPROVED FIBER STRENGTH, SHORTENED GROWING SEASON, AND INCREASED WAX CONTENT

Polly S. Leonhard and Patricia H. Wee

Ephrata Senior High School, 803 Oak Boulevard, Ephrata, PA 17522-1221 USA

leonhard@redrose.net

Can a variety of cotton be developed that would thrive in Pennsylvania? This research project explores that question. Several types of cotton were grown in Pennsylvania fields for two years. Data collected included morphological development, agronomic, and physiological characteristics. Desirable traits were identified within a number of genotypes during year one and hybridizations among those genotypes were attempted during year two.

Most evaluations were conducted using the various cotton fiber types. These cotton types included regular white cotton grown in Arkansas, naturally colored cotton grown in Arizona and Texas, and both naturally colored and regular white cotton grown in Pennsylvania that descended from the plants grown in the other states mentioned. The assorted tests were as follows: seed index, wax extraction, carding and drawing sticky test, staple length comparison, fiber strength, and micronaire (fineness and maturity). All these tests are standard requirements of cotton industry for registration of cultivars and valuable in ensuring that specific cotton cultivars meet the strict standards for spinning, and provide useful information for crop improvement.

Analysis of fiber characteristics (Pearson's correlation) suggests that wax content and micronaire index have a negative correlation ($r = -0.52$), wax content and fiber strength have a negative correlation ($r = -0.64$), and fiber strength and fiber length have a positive correlation ($r = 0.72$).

HIGH QUALITY, NATURALLY PIGMENTED, ARID-ADAPTED COTTONS

Robert G. McDaniel

Department of Plant Sciences, University of Arizona, Tucson, AZ 85721-0036 USA

rgm@u.arizona.edu

Three cotton strains that produce naturally pigmented (colored) fibers have been selected from segregating progeny of interspecific Acala *(Gossypium hirsutum* L.) by Pima (*Gossypium barbadense* L.) hybrids. Pigmented fiber variants appear to have arisen spontaneously in the advanced generation progeny, as did many other mutant vegetative and floral characteristics. The distinguishing characteristics of these naturally pigmented cottons are excellent heat tolerance and agronomic plant type. These are evidenced by production data and boll size and numbers as well as high quality fiber characteristics, and consistent fiber colors relatively stable over several successive generations.

All colors have been advanced for at least three generations from pigmented fiber parents that exhibited fiber length of at least 25 mm and fiber strength of at least 25 g per tex. Mean fiber length averaged about 29 mm and mean fiber strength averaged about 29 g per tex across all parents. Micronaire varied widely across breeding lines, locations, and years of production with a normal range between 3.0 and 5.5. The green fibers usually had the finest (lowest micronaire). Three distinct germplasms are presented and discussed: one with cinnamon colored fiber; one with champagne colored fiber; and one with emerald green colored fiber. Results and examples of extensive fiber analyses, spinning tests, and thread and cloth samples are shown.

CULTIVATING KENAF FOR FIBER IN TENNESSEE

Peter A. Nelson and Anne L. Cook

Galloway Fields Company, Inc., 7344 Raleigh Lagrange Road, Cordova, TN 38018 USA

fiber@netten.net

The purpose of this project is to determine the highest fiber yielding variety of kenaf (*Hibiscus cannabinus* L. Malvaceae) for cultivation in Tennessee. Interest in the production of kenaf in Tennessee has risen recently because of several influential factors. These consist of interests in the South as a production area by foreign investors, concerns over decreasing pulp supplies, as well as government and consumer demand on the tobacco industry. Because of this and several prominent paper companies expressing interest in purchasing kenaf fiber from Tennessee farmers, Galloway Fields Company, Inc. planted four kenaf varieties on May 15, 1997.

Kenaf, a relative of cotton and okra, is a warm season annual that grows from 8 to 20 feet in three months with one central stalk. The composition of the stalk is made up of bast and hurd, similar to that of industrial hemp. Kenaf is best grown in well-drained soil with high temperatures. Kenaf is highly susceptible to root-knot nematodes and other nematode species. Four kenaf varieties were grown in 1997 to compare yield and nematode resistance. These varieties included Everglades 41 (E41), Everglades 71 (E71), Tainung 2 (T2), and SF459. The first two varieties, E41 and E71, were released by the USDA in 1963. Tainung 2 is from Taiwan and was released in 1962, and SF459 of the USDA and Rio Farms Inc. released in 1994.

Each of the three plots planted contained all four varieties and was approximately 20 feet by 75 feet. Every plot contained four rows of each variety with every row being 30 inches wide and every variety spaced ten feet apart. Within the middle rows, a small section was harvested to get a representative sample and avoid border effect. No chemicals were used on the crop and an attempt was made to analyze its weed suppression abilities. Also, the bulk of the first crop was donated for testing for manufacturing several industrial products.

Although this is an ongoing project, the yield data collected during the summer of 1997 is already going to be put into practice for the 1998 season. From the preliminary data collected, the Tainung 2 variety seemed to outperform the other varieties in three specific areas. The T2 variety achieved quick germination with a consistently high germination rate. The Everglades 41 strain had germination approximately 2 days earlier than the Tainung 2, but the seedlings were few and sporadic. The consistently early germination of the T2 variety led to better weed suppression, as well as more uniform stalk diameter. The T2 variety also achieved larger yield and size. Its average height of approximately 13’ 5" towered 8-11 inches over the other varieties. It also excelled over the other varieties in crude yield. Finally, the T2 variety had the best total plant health and durability. This was observed in color, bushiness of the plant, and the ability to store and utilize moisture and nutrients.

This yield information will be applied in selecting varieties for several projects in west Tennessee and southeast Missouri in the 1998 season. These projects include extensive agronomic research with accredited institutions and production research with agricultural producers.

MID-SOUTH FIBER NETWORK JOURNAL OF SUSTAINABLE FIBER PRODUCTION AND PROCESSING

Peter A. Nelson and Anne L. Cook

Agro-Tech Communications, 7344 Raleigh Lagrange Rd., Cordova, TN 38018 USA

fiber@netten.net

The Mid-South Fiber Network is a national magazine that features original articles, contact information, university reports, and other information designed to enhance the marketing opportunities for producers of agricultural fibers by presenting new value-added enterprises. The journal also serves as a unique distribution vehicle for agricultural fiber papers and a testing ground for new papers and inks derived from agricultural materials. The fibers currently used in these papers include: kenaf, cotton, flax, and agricultural crop residuals. The Mid-South Fiber Network is supported by a wide range of services designed to bring agri-business,

researchers, producers, and industry together.

Agricultural fiber paper is derived from any fiber source, but the most likely candidates include: kenaf, cotton, flax, and agricultural crop residuals. Kenaf (*Hibiscus cannabinus* L. Malvaceae) is a warm season annual that is related to cotton and okra. It may grow from 8 to 20 feet in three months with one central stalk. Kenaf is best grown in well-drained soil with high temperatures. Flax (*Linum usitatissimum*) is another plant that can be made into paper. Currently, it is being pulped into fine grades of cigarette and stationery papers. The crop can be grown throughout the North. Flax is grown for seed oil and the fiber makes suitable pulp. Cotton from the genus Gosypium is originally from the tropics, but is grown throughout the South. The crop is the most produced agricultural fiber and is typically used in textiles. Agricultural crop residuals are the scraps of stem left in the field after a grain crop is harvested. Agricultural crops being used for paper include corn and wheat straws.

The Mid-South Fiber Network enhances the work of countless university, private sector, and government research and development programs. The magazine shows new options for consumers that are environmentally safe and of high quality. The magazine also reinforces government policy concerning diversified agricultural opportunities. The industries of the United States are introduced to new materials and marketing concepts that can increase jobs, job safety, compliance regulations, and spur added productivity.

The publication of the Mid-South Fiber Network is an applied study of the viability of agriculturally derived publishing materials in common business settings. The success of this project creates a model magazine for the entire publishing industry.

REQUIREMENTS FOR PHENOLOGICAL DEVELOPMENT OF *CROTALARIA JUNCEA* (VEGETATIVE STAGE) AND PHENOMETRIC OBSERVATIONS IN DIFFERENT SOWING DATES

Daniel Sorlino[1], *Roberto Villalobos Flores*[2], *Nora Gomez*[1], *and Charles Cook*[3]

[1]Buenos Aires University, Buenos Aires, Argentina; [2]National Meterological Institut of San Jose de Costa Rica, San Jose, Costa Rica; [3]USDA-ARS, Weslaco, TX, USA

dsorlino@charao.agro.uba.ar

Crotalaria juncea is an annual crop that provides textile fiber similar to Corchorus sp. Variations in stem length (from 2 m to 4 m) and flowering dates have been observed at different sowing dates and latitudes for the same variety. A photoperiod influence in these observations was clear.

To begin the species characterization using a Hawaiian variety, three sowing dates were made at Buenos Aires (BS AS) (34° 35' S, 58° 29' W, and 25 m o.s.l.) the first year and another three sowing dates in the second year. Emergence dates were: a) First year: 10/14/96, 11/24/96, and 1/1/97; b) Second year: 11/01/97, 12/10/97, and 06/02/98. One sowing (2/2/97) was made in Costa Rica (10° 02' N, 84° 10' W, and 1,060 m o.s.l.) in 1997. The experimental design was similar in both countries. Supplemental irrigations were made in BS AS and Costa Rica. BS AS soil was fertilized with N even though the nodulation was good. Phenological and phenometric observations were made in the two countries, and phenometric observations also made in the second year.

Plants showed a quantitative short day response because flowering dates for the first and second sowing dates in BS AS were 3/10/97, and 3/20/97 for the third date (the first year), the second year: 3/6/98 and 4/19/98. Photoperiod was always short in Costa Rica so that the plants were soon induced to flowering (4/4/97) and achieved a mean height of 94 cm. At BS AS, stem lengths were 100-270 cm. In the first year, some of those plants had a little flower on 12/2/96, but after they aborted, the plants blossomed in March. The second-year first and second sowing dates had some plants with flowers at 1/4/98 and after this date new individual plants appeared with flowers in January and February. In March, all the plants had flowers.

EFFECT OF KENAF AND SOYBEAN ROTATIONS ON YIELD COMPONENTS

Charles L. Webber III

USDA, ARS, SCARL, P.O. Box 159, Lane, OK 74555 USA

cwebber@ag.gov

As kenaf (*Hibiscus cannabinus* L.) production in the United States continues to increase, it is essential to integrate this alternative fiber crop into existing cropping systems. Soybean (*Glycine max* (L.) Merr.) is now grown widely in the same production areas where kenaf can be successfully produced. A kenaf-soybean rotational system could have long-term economic and pest control advantages, if there are no adverse effects of rotating these two crops.

A three-year field study was conducted at Haskell, OK to determine the effect of six kenaf-soybean rotations on kenaf and soybean yield components. The kenaf cultivar 'Everglades 41' and soybean cultivar 'Forrest' were planted on a Taloka silt loam soil in mid-May and harvested each October. The crops received no irrigation; rainfall was the only source of moisture. The individual kenaf/soybean rotations did not adversely affect the kenaf stalk yields or soybean seed yields. Kenaf stalk yields across all rotational combinations and years averaged 7.9 Mt/ha, whereas soybean seed yields averaged 866 kg/ha. Seasonal rainfall affected soybean growth and yielded more than any effects due to the cropping sequence. A continuous kenaf rotation produced the greatest kenaf yields (9.4 Mt/ha) in the final year. It was determined that either a three-year continuous or rotational cropping system can be used for kenaf and soybean production without reducing crop yields.

SOIL MOISTURE, FERTILITY, AND CULTIVAR INTERACTIONS FOR KENAF YIELD COMPONENTS

Charles L. Webber III[1], *Stephen E. Hawkins*[2], *and Gary Strickland*[3]

[1]USDA, ARS, SCARL, Lane, OK 74555 USA; [2]Purdue University, West Lafayette, IN 47907 USA; [3]Formally Oklahoma State University, Stillwater, OK 74078 USA

cwebber@ag.gov; stephen.e.hawkins.1@purdue.edu

Research information is limited concerning the effect of soil moisture, fertility, and cultivar interactions on kenaf (*Hibiscus cannabinus* L.) yield components.

The objective of this two-year research study in Oklahoma was to investigate the interaction of these factors on kenaf development and yields. The factorial design involved two levels of irrigation (irrigated and non-irrigated), five levels of nitrogen fertilization (0, 57, 114, 171, and 228 kg/ha), and two cultivars (Tainung #2 and Everglades 41). Drip irrigation was used for the irrigated treatments. Fertilizer was manually spread before planting.

Plant populations were unaffected by the irrigation treatments, although additional water did increase plant height, development, stalk percentage, and stalk yields across all other factors. Tainung #2, a deeply divided leaf cultivar, had greater yield components than Everglades 41, entire leaf cultivar. The yield components for both cultivars were adversely affected by nitrogen applications greater than 114 kg/ha.

Top of Page

Return

MEADOWFOAM

ESTABLISHMENT OF MEADOWFOAM AS A NEW CROP IN VIRGINIA

Harbans L. Bhardwaj, *Muddappa Rangappa, and Anwar A. Hamama*

Agricultural Research Station, Box 9061, Virginia State University, Petersburg, VA 23806 USA

hbhardwj@vsu.edu

Production of meadowfoam (*Limnanthes alba* Bentham, Family Limnanthaceae), traditionally grown in the Willamette Valley of Oregon, is currently being attempted in Virginia. Interest in meadowfoam is based on the high proportion of long-chain fatty acids (20- and 22-carbons) in its oil. Meadowfoam oil is characterized by very high levels of mono-unsaturation and very low levels of poly-unsaturation. These characteristics make meadowfoam oil very stable, even when heated or exposed to air. The uses of meadowfoam oil include personal care products such as cosmetics and toiletries as well as industrial applications including lubricants and inks. Meadowfoam oil can also be a replacement for sperm whale oil.

Observation plots of meadowfoam were established during 1992-93 and 1993-94 at Petersburg, Virginia under the New Crops Program of Virginia State University. The meadowfoam planted in this location produced seeds indicating that it may have potential in Virginia. During the 1994-95 season, replicated experiments were conducted with the "Mermaid" to determine yields and to study the effects of nitrogen fertilization on seed yield and oil characteristics. The average seed yield was approximately 495 kg/ha with the highest yield of 634 kg/ha. Oil content ranged from 21-25%. The oil contained an average of 93% long-chain fatty acids (20 and 22 carbons).

These observation studies were followed with commercial meadowfoam production on approximately 4 ha during 1996-97. The average seed yield from this production effort was approximately 457 kg/ha, the oil yield was approximately 26%, and the long-chain fatty acid content of the oil was 97%. The crop was direct-combined and resulted in shattering seed loss of approximately 38%. Additional research showed that row spacing of approximately 15 cm and a nitrogen fertilizer rate of up to 100 kg/ha may be desirable for meadowfoam production in Virginia. During the 1997-98 crop cycle, meadowfoam was planted on approximately 50 ha in cooperation with Oregon Meadowfoam Growers. A tentative meadowfoam production system for Virginia include planting during late November to early December, seeding rate of approximately 28 kg/ha, row spacing of approximately 15 cm, swathing at approximately 42% seed moisture, and combining with a belt-pick up. The results of this production investigation will become available in late June 1998.

Currently, the existing meadowfoam cultivars need pollination by honey bees. The honey produced from the 1996-97 crop was determined to be of high quality by the local bee keepers. Efforts are underway to develop high yielding meadowfoam genotypes that combine the desirable oil characteristics with adaptation to Virginia's agro-climatic conditions. Additionally, research is also being conducted to develop self-fertile meadowfoam genotypes to eliminate the need for honey bees. The efforts to establish meadowfoam in Virginia are supported by a multi-disciplinary team. Details of these production and research efforts will be presented.

MEADOWFOAM (*Limnanthes*) GENETICS: SOME CRITICAL ISSUES FOR DOMESTICATION PROGRESS

Subodh Jain

Department of Agronomy, University of California, Davis, CA 95616 USA

Meadowfoam oil, as a unique source of long-chain, unsaturated fatty acid, has received considerable attention among the new crop scientists. Besides several notable strides in our knowledge of systematics and ecology, the genus *Limnanthes* has provided wonderful opportunities for genetic research. Germplasm accessions show heritable variation in phenology, breeding system, plant architecture, and oil composition.

Our findings on the genetics of nonshattering, gene-cytoplasmic male sterility, nutlet polymorphisms, oil content, and higher selfing ability are of considerable interest in breeding work. Research at Davis, CA and Corvallis, OR will be reviewed to summarize our current genetic database in relation to the goals of developing higher yielding, inbred or hybrid cultivars with improved plant architecture, nonshattering, and various adaptive features. Both Mendelian and quantitative genetic findings will be presented and new genetic objectives will be discussed. Limnanthes domestication has progressed well given rather small inputs and its story could serve as a good model for many similar projects.

A GENOME MAP FOR GENETIC ANALYSIS AND MOLECULAR BREEDING IN MEADOWFOAM: QUANTITATIVE TRAIT LOCI AFFECTING SELF-POLLINATION, SEED YIELD, AND OTHER ECONOMICALLY IMPORTANT TRAITS

Sureeporn Katengam, Jimmie M. Crane, and Steven J. Knapp

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

steven.j.knapp@orst.edu

The demand for meadowfoam (*Limnanthes alba* Benth.) oil is increasing along with the demand for new cultivars to boost seed yields and profits. One of our aims is to increase the supply of meadowfoam oil by increasing seed yield and oil content, decreasing lodging, and developing self-pollinated cultivars. We are using molecular breeding tools to facilitate this process.

A genetic map was produced using inter-subspecific (*L. alba* ssp. *alba* x *L. alba* ssp. *versicolor*) backcross progeny, inbred parent lines (Mermaid S_5 and OMF-64 S_5), and amplified fragment length polymorphisms (AFLPs). The map is presently comprised of 110 AFLP markers spanning five linkage groups (x = 5). Mermaid S_5 is a cross-pollinated *L. alba* ssp. *alba* line. OMF-64 S_5 is a self-pollinated *L. alba* ssp. *versicolor* line. The two parents were highly polymorphic. This greatly facilitated the development of the map and should greatly facilitate marker-assisted selection in inter-subspecific crosses.

BC_1S_1 progenies were produced and field tested in 1997-98 at Corvallis, Oregon and segregated for self-pollination, seed yield, oil content, biomass, flower, stem, and leaf morphologies, plant height and diameter, and maturity. The progenies were planted in the open and under insect-proof field cages. The latter were used to phenotype the progeny for self-pollination. Genes affecting self-pollination, seed yield, oil content, and other traits were mapped in this study.

We will report the quantitative trait loci (QTL) mapping results and describe how this knowledge is being used for molecular breeding in meadowfoam. The findings reported in this study should give us tools to accelerate cultivar development more precisely and rapidly shuffle genes between the two subspecies, and find favorable alleles in exotic germplasm.

MAPPING GENES AFFECTING FATTY ACID COMPOSITION IN MEADOWFOAM

Sureeporn Katengam, Jimmie M. Crane, and Steven J. Knapp

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

jimmie.m.crane@orst.edu

Meadowfoam (*Limnanthes alba* Benth.) produces a seed oil with novel chemical and physical properties. *L. alba* subspecies have different wild-type fatty acid profiles. *L. alba* ssp. *versicolor* produces significantly more erucic acid (22:1) and significantly less dienoic acid (22:2) than *L. alba* ssp. *alba*. This difference has ramifications for marketing and cultivar development. Cultivars presently must have the *L. alba* ssp. *alba* fatty acid profile to meet market requirements. Whether the marketplace can tolerate oils with the *L. alba* ssp. *versicolor* fatty acid profile is not known. The 22:1 and 22:2 content differences between the subspecies are caused by a dominant gene (*E*). Genes with quantitative effects could be segregating in intra- and inter-subspecific populations.

We used the genetic map of meadowfoam to map the *E* locus and search for the quantitative trait loci (QTL) affecting 22:1 and 22:2 content. The genetic map was built using backcross progeny from a cross between *L. alba* ssp. *alba* and *L. alba* ssp. *versicolor* inbred lines (Mermaid S_5 and OMF-64 S_5, respectively). OMF-64 S_5 was used as the recurrent parent.

The *L. alba* ssp. *alba* parent produced 8% 22:1 and 30% 22:2, whereas the *L. alba* ssp. *versicolor* parent produced 24% 22:1 and 9% 22:2. The phenotypic distribution for 22:1 and 22:2 content was 90:90; thus, the *E* locus segregated 1:1 (p = 1.0) in this sample. Erucic and dienoic acid content varied among dominant (*E_*) and

recessive (*ee*) class progeny. The differences may have been caused by QTL or non-genetic factors or both.

We will report the findings of a QTL analysis to address this question. Regardless, cultivars with the prerequisite fatty acid profile can be developed by selecting for and fixing the *E* allele. The *E* locus could be linked to genes affecting other economically important traits. This will be assessed in a companion gene mapping study.

SINGLE-SEED SELECTION TOOL FOR OIL CONTENT IN MEADOWFOAM

Brett Patrick and Gary D. Jolliff

Oregon State University, Corvallis, OR 97331-3002 USA

Gary.D.Jolliff@orst.edu

Profit incentives for producers, buyers, brokers, processors, manufacturers, and retailers can be critical in driving Research & Development for a new crop and products it produces. Costs of production may strongly impact the profit margins for producers, and thus can strongly influence the economic competitive position of a new crop with respect to other crops available to farmers to grow.

Oil is the prime economic product sought from the seed of the new crop meadowfoam. Thus, oil yield per acre is the prime measure of crop economic output. Many factors may significantly impact meadowfoam oil yield per acre. Example factors may include the cultivar used; seeding dates; seeding rates; row widths; nitrogen fertility management; weeds; insects; diseases; pesticide toxicity; extreme temperatures; insect pollination; water deficit stress; harvest timing; and harvest losses from swathing, swath pickup, and combining. Several of these variables may interact, but their interrelationships to oil yield per acre may not yet be known or well understood. The components of oil yield are seed yield and oil content of the seed. Therefore, increased oil content of new cultivars may increase oil yield per acre even if optimum production practices have not yet been established.

The presentation will include: 1) photos of near-infrared transmittance spectroscopy (NITS) equipment used for the nondestructive single-seed analysis of oil content in meadowfoam, 2) data from single-seed measurements that illustrate the kind of selection options made possible with this technology, and 3) literature citations to the detailed description of the development of this tool.

Top of Page

Return

MEDICINAL

NITROGEN FERTILIZATION OF ST. JOHN'S WORT

Marisol Berti, Felicitas Hevia, Jean Paul Joublan, Rosemarie Wilckens, Humberto Serri, and Susana Fischer

Facultad de Agronomía, Universidad de Concepción, Casilla 537, Chillán, Chile

mberti@buho.dpi.udec.cl

St. John's wort (*Hypericum perforatum)* is a successful antidepressant drug with high demands worldwide. Chile exported 4,000 tons of this herb in 1997, which were all collected from the wild. Cultivation is just starting in Chile, but more information on crop management is needed.

A trial was conducted at Chillán, Chile (36° 26' S, 72° 06' W) to evaluate the effect of nitrogen fertilization on St. John's wort. The crop was sown on August 5, 1997 and first harvested in January 1998. The crop was irrigated and chemical and hand weeded. Nitrogen treatments were 0, 37.5, 50, 75, 100, and 150 kg ha^{-1}. Each

amount was applied as sodium nitrate immediately before seeding. Nitrogen application was repeated in October because excessive rainfall occurring immediately after seeding leached the nitrogen. The experimental design was a randomized complete block with four replications.

Evaluations conducted were: Top 25 cm biomass yields; flower, leaf and stem composition; hypericin content of flower, leaf, and stem; threshed yield (based on dried flowers and leaves from the 25-cm biomass harvest).

Nitrogen increased the biomass yield up to 100 kg ha^{-1} without decreasing the hypericin content. A biomass yield of the top 25 cm reached approximately 4,000 kg ha^{-1}. This yield is considered good for the first harvest because the plants were only five months old. Highest hypericin content was found in the flowers followed by leaves and stems. The stems have small amounts of hypericin. Therefore, threshing out the stems and keeping the leaves and flowers to increase quality is important. Threshing yields decreased as nitrogen rates increased mainly because plants with higher nitrogen rates had the higher moisture content.

CULTIVATION OF *LIPPIA ALBA*, AN IMPORTANT MEDICINAL PLANT IN BRAZIL

Dulce Marcia de Castro and Lin Chau Ming

Department of Horticulture - Agronomical Sciences College, São Paulo Statal University, Botucatu, São Paolo, Brazil CEP 18.603/970

dulcem@mailcity.com.br; linming@fca.unesp.br

Lippia alba, family Verbenaceae, popularly called "cidreira"or "melissa" in Brazil, is one of most important medicinal plants used by the Brazilian population. Its therapeutic actions include somatic, sedative, antidepressant, and analgesic activities.

This species occurs in South America, mainly Brazil and northern Argentina, in sandy soils along margins of rivers, and in tropical and subtropical areas. In Brazil, it grows all over the country and is cultivated in some regions to provide raw material for medicinal products. Different natural varieties are found in several areas in northwest Brazil. In Brazilian Amazonia, local people know two ethnovarieties using both for different diseases. One of these varieties is called "cidreira" and is used as an analgesic and sedative. Another variety, "carmelitana," is used for stomach aches and digestive problems.

It is a shrub with a quadrangular branch reaching 1.7 m tall. The leaves are membranaceous, petiolate, pubescent with a strong flavor. Its limbs have variable forms with pointed apex, cuneiform or decumbent base, and serrated or crenated border.

Its secondary metabolites are flavonoids, alkaloids, and mainly essential oils produced by glandular hairs in the epidermis and the cells of the mesophyll. In recent researches, the main compounds of essential oils observed in leaves of the species are terpinene, p-cymene, caryophylene, myrcene, geraniol, and neral.

Agricultural researches conducted in the Parana and São Paulo states showed important characteristics to its cultivation and development. Plant propagation is vegetative, using stem cutting about 20-25 cm long and 0.5 cm diameter. The planting in certain areas has to done about 40 days after the preparation of the stem cuttings. Plant spacing depends on the variety used. The recommended fertilization is 4 kg/ha of organic manure. The foliar biomass yields are about 5 ton/ha in four harvests during an year. The yield of essential oil is about 0.3 - 0.4 %.

Studies on harvesting seasons showed that, in the summer, the leaves at the base section of the stems produced more essential oil than leaves from the apical section. The first harvest can be done four months after planting.

PRODUCTION OF ANTHOCYANINS AND EXTRACELLULAR POLYSACCHARIDESBY CELL CULTURES OF *PERGULARIA TOMENTOSA*

Hamid Elhag, Mahmoud M. El-Olemy, and Mansour S. Al-Said

Dept. of Pharmacognosy, College of Pharmacy, K.S.U., P.O. Box 2457, Riyadh 11451, Saudi Arabia

Fferaly@ksu.edu.sa

Pergularia tomentosa (Asclepiadaceae) is an endangered medicinal plant indigenous to Saudi Arabia. The plant was shown to produce cardenolides in the roots.

Vigorously growing cell cultures were established from parts of axenic seedlings. Newly established callus cultures from roots produced anthocyanin pigments on MSB5 medium containing NAA in the light, and differentiated into roots on a similar medium in the dark. Hormonal autotrophic suspension cultures were developed that produced a viscous extracellular polysaccharide (ECP) on MSB5 liquid medium. Transformation with *Agrobacterium rhizogenes* resulted in fast growing hairy roots that spontaneously proliferated transgenic callus. Such callus produced intense anthocyanin pigments on NAA containing medium compared with normal callus. The nature of the ECP and the individual anthocyanin components will be presented.

ANTIMICROBIAL AND CYTOTOXIC ACTIVITY OF THE EXTRACTS OF KHAT CALLUS CULTURES

Hamid Elhag, Jaber S. Mossa, and Mahmoud M. El-Olemy

Dept. of Pharmacognosy, College of Pharmacy, K.S.U., Box 2457, Riyadh 11451, Saudi Arabia

Fferaly@ksu.edu.sa

Khat, *Catha edulis* Forssk (Celasteraceae), is an evergreen tree indigenous to East Africa and Yemen. The young leaves are habitually chewed to alleviate hunger and fatigue, and for its central nervous system stimulant effect.

Callus cultures were induced from young leaves on MSB5 basal medium (Murashige and Skoog inorganic salts with Gamborg-B5 vitamins) supplemented with 3.0 mg/l of either IBA or NAA. The callus produced dark pigments on both treatments. Callus tissues collected from several subcultures on IBA or NAA containing media were used for extraction and analysis of pigments.

Two orange-colored compounds, tingenone and 2,2-b-hydroxytingenone, were isolated and identified by spectral analysis and by comparison with reported data. The compounds exhibited strong antimicrobial activity against several strains of infectious bacteria (0.3 - 0.6 µg/ml, MIC values). 2,2-b-hydroxytingenone also exhibited significant cytotoxic activity against leukemia (ED_{50} 0.54 µg/ml) and prostate cancer (ED_{50} 0.85 µg/ml). The isolated compounds could not be detected in the mother plant grown in the greenhouse.

EFFECTS OF WATER STRESS ON PHYTOCHEMICAL CONCENTRATIONS IN PURPLE CONEFLOWER (*Echinacea purpurea* L.) AND ST. JOHNS WORT (*Hypericum perforatum* L.)

Dean Gray, H. E. 'Gene' Garrett, Steven Pallardy, and Thomas Mawhinney

University of Missouri, Columbia, MO 65211 USA

c648324@showme.missouri.edu

Based on the economic and medicinal value of their biologically active compounds, *E. purpurea* and *H. perforatum* were chosen to test the effects of moderate to severe water stress imposed during different times of the growing season on the concentrations of the medicinally valuable cichoric acid (the predominant root phenolic in *E. purpurea*) and hypericin (the pigment in the leaves and flowers of *H. perforatum*).

This study will attempt to quantify aspects of the relationship between water stress and the cellular responses that result in the production of secondary compounds. On a practical level, the investigated species are complementary to current agroforestry management practices such as alley cropping. One objective of this study is to provide

useful management techniques to the landowner to grow more economically and medicinally valuable plants with greater concentrations of the desired compounds.

All plants were grown in three-gallon pots and watered with individual drip irrigation during the spring through early summer of the 1997 growing season. The three dry down treatments plus a control that received water were tested from August to October. During this period, water was withheld from selected plants to induce a slow dry down. The selected plants were closely monitored by taking predawn water potential (y_{pd}) and midday stomatal conductance measurements (gs) to determine the severity and duration of moisture stress. At the end of the season, all monitored plants were harvested, fresh and dry root weights measured, and samples prepared and stored for chemical analyses.

Chemical analyses will consist of standard procedures to determine concentrations of cichoric acid and hypericin. Chemical testing will be conducted after the first season of dry downs and will continue for two additional seasons to quantify the cumulative differences in chemical concentrations that accrue after two and three seasons of water stress treatments. Preliminary data concerning the relationship between level and timing of water stress and the effects on chemical concentration will be presented.

HARVEST DATES ON CHILEAN ST. JOHN´S WORT (*Hypericum perforatum*) HYPERICIN CONTENT

Felicitas Hevia, Marisol Berti, Jean Paul Joublan, Inés Figueroa, Mercedes Tello, Rosemarie Wilckens, and Humberto Serri

Facultad de Agronomía, Universidad de Concepción, Casilla 537, Chillán, Chile

mberti@buho.dpi.udec.cl

An experiment was conducted to determine the effect of harvest dates on the yield and hypericin content of flowers, leaves, and stems of St. John´s wort grown in Chillán, Chile.

Treatments were seven harvest dates starting before anthesis and until the beginning of fruit formation. The experimental design was a randomized complete block with three replications. To determine hypericin content, chlorophyl was first extracted with sequential extractions with ether, followed by hypericin extraction with ethanol. Hypericin quantification was done with molecular absorption spectrometry at 589 nm. Data collected were subjected to ANOVA analysis and differences among treatments were detected with Tukey´s test.

Threshing yields (dried flowers and leaves from total fresh biomass harvested) increased as harvest dates were delayed reaching its maximum at the beginning of fruit formation. However, biomass yield was at its maximum when the flower petals fell. The highest hypericin content in flowers, leaves, and stems was observed at the beginning of anthesis. Hypericin yield per kg of fresh herb collected was highest at flower petal fall, whereas the maximum hypericin yield per ha was obtained at the beginning of flowering. Results suggested that St. John´s wort harvest must be done at the beginning of flowering when most flowers are in the bud stage and only a few flowers have opened.

STUDIES OF GEL COMPOSITION AND YIELD IN *ALOE VERA* GROWN IN MEXICO

Diana Jasso de Rodriguez[1], *J. L. Angulo-Sánchez*[2], *and R. Rodriguez-García*[1]

[1]Universidad Autónoma Agraria Antonio Narro (UAAAN), [2]Centro de Investigación en Química Aplicada (CIQA), Saltillo, Coahuila, México

Aloe vera is an industrial crop that possesses a gel that affects several biological and physiological activities, such as burn skin healing, prophylactic effect against radiation leucopenia, inhibitory action against some bacteria and fungi, and anti-ulcer activity. The gel is also used for manufacturing cosmetics. The objective of the present study objective is to evaluate the composition and yield of *Aloe vera*.

Wild plants were collected from the Palma Gorda area, a region close to Saltillo, México. Their compositions were compared with those of garden cultivated plants and fresh, commercial gel products. Plant collections were made during March. They were transported to the laboratory and stored at 4-6°C until analysis. The plants were then washed and weighed. The number of leaves and leaf thickness at three points were measured. For gel extraction, the leaves were cut longitudinally and the gel separated by hand with a knife, weighed, and stored at -20°C. The gel was later freeze-dried and the yield of gel was calculated. Nitrogen and protein contents of the dry gels were determined by the Kjeldahl method. Manganese, iron, sodium, magnesium, and calcium were determined by atomic absorption. Leaf protein content was measured by the modified Bio-Rad method, molecular weight determined by electrophoresis in SDS gel, and Aloin and Aloe-emodin by chromatography.

The results show that the plant weight was between 850-2,500 g. Fresh gel content was 42-55% of the fresh leaf weight. The dry gel weight was 2.2-4.2% of the fresh gel weight. Nitrogen content ranged from 0.28-0.81%, dry gel basis, and the protein ranged from 1.8-5.3%. Elemental analysis values of sodium and manganese were equal to those reported by others. However, the calcium, iron, magnesium, and phosphorus contents were different. Aloin and Aloe-emodin contents will be presented in the full paper.

GERMPLASM FOR PLANT BREEDING OF SEA BUCKTHORN IN SWEDEN

Niklas Jeppsson

SLU-Balsgård, Fjälkestadsvägen 123-1, 291 94 Kristianstad,Sweden

niklas.jeppsson@hvf.slu.se

Sea buckthorn is native to northern and central Europe, and throughout central Asia. Its domestication process started in Russia in the 1930's. In 1986, a project started at Balsgård with the aim to introduce sea buckthorn as a new commercial berry crop in Sweden. Since then, different plant materials have been used in the breeding program.

Out of three different species of the genus Hippophae tested at Balsgård, only the most widespread species *Hippophae rhamnoides* have survived. Out of six subspecies of *H. rhamnoides*, only the two with the most northern most native distribution have performed well in Sweden. The two subspecies *H. rhamnoides* ssp. *rhamnoides* and *H. rhamnoides* ssp. *mongolica* now serve as the base for the breeding program.

SEA BUCKTHORN

Thomas S. C. Li and Doug Wardle

Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada, Summerland, British Columbia V0H 1Z0 Canada

lit@em.agr.ca

Sea buckthorn (*Hippophae rhamnoides* L.) is a winter-hardy, deciduous shrub with yellow or orange berries. It develops extensive root system rapidly and is, therefore, an ideal plant for soil erosion prevention and land reclamation. The shrub can withstand low temperatures from -43 to 40°C. It is considered to be drought resistant; however, irrigation is needed in regions receiving <400 mm of rainfall per year for better growth.

Sea buckthorn is a dioecious shrub, usually spinescent and 2 to 4 m tall. It has brown or black rough bark and a thick grayish-green crown. Leaves are alternate, narrow, and lanceolate with a silver-grey color on the upper side. Flower buds are formed mostly on the three-year-old wood, differentiated during the previous growing season.

Sea buckthorn can be used for many purposes and has major economic potential. It has been used for centuries in its native Europe and Asia. Recently, it has attracted considerable attention from researchers around the world, including North America, mainly for its nutritional and medicinal value.

Sea buckthorn fruits are rich in carbohydrates, proteins, organic acids, amino acids, and vitamins. The concentration of vitamin C in sea buckthorn fruit, ranging from 100-300 mg/100 g fruit, is higher than strawberry, kiwi, orange, tomato, carrot, and hawthorn. Sea buckthorn is also high in protein, especially globulins and albumins, and fatty acids such as linoleic and linolenic acids. Vitamin E content in sea buckthorn (202.9 mg/100 g fruit) is also higher than wheat embryo, safflower, maize, and soybean.

Medicinal uses of sea buckthorn are well documented in Asia and Europe. Clinical tests on its medicinal uses were first initiated in Russia during 1950's and later in China. Sea buckthorn oil was formally listed in the Pharmacopoeia in 1977. The important pharmacological functions attributed to sea buckthorn oil are: anti-inflammatory, antimicrobial relieving of pain, and promoting regeneration of tissues. Sea buckthorn oil is also touted as a treatment for oral mucositis, rectum mucositis, vaginal mucositis, cervical erosion, radiation damage, burns, scalds, duodenal and gastric ulcers, chilblains, skin ulcers caused by malnutrition, and other skin damages.

More than ten different drugs have been developed from sea buckthorn in Asia and Europe and are available in different forms such as liquids, powders, plasters, films, pastes, pills, liniments, suppositories, and aerosols. Sea buckthorn oil extracted from seeds is popular in cosmetic preparations such as facial cream. In Europe and Asia, many products are made from sea buckthorn, such as tea from leaves, beverages and jam from fruits, fermented products from pulp, and animal feed from leaves, pulp, and seed residues.

STEROIDAL SAPOGENIN PRODUCTION FROM PLANTATION-GROWN ARIZONA AGAVES

Robert G. McDaniel

Department of Plant Sciences, University of Arizona, Tucson, AZ 85721-0036 USA

rgm@u.arizona.edu

A mutant agave clone (*Agave vilmoriniana*, Berger) has been identified, which is capable of synthesizing commercial levels of steroidal sapogenins. Such steroidal compounds are useful in the production of odor-control formulations, beverage foaming agents, food grade additives, and as resource materials in the manufacture of pharmaceutical drugs.

Agronomic trials of this variant clone have been underway at three Arizona locations for several years. This clone does not produce offshoots, but has been vegetatively propagated by rooting aerial "bulbils" produced on the flower stalks.

Efforts to mechanize nearly all aspects of agave cultivation and harvest have been successful. Growth rate data for this clone as well as appropriate agronomic practices are presented. The thick cuticle of this agave mutant allows the use of RoundupTM herbicide, which, along with cultivation, controls competitive weeds. The ability of this clone to initiate CAM metabolism under stress also makes it quite competitive in the desert high temperature environment. The superior growth rate of this clone has resulted in plants with harvest weights in excess of 136 kg in less than four years following transplanting. Establishment of cultivated agave plantations appears to be economically feasible for the southwestern desert agricultural areas, based upon projections of the input costs and value of the harvested product.

FIELD SURVEY AND GERMPLASM COLLECTION OF THE NORTH AMERICAN GENUS *ECHINACEA* (ASTERACEAE)

Kathleen A. McKeown

Department of Plant and Soil Sciences, University of Massachusetts, Amherst, MA 01003 USA

kmckeown@pssci.umass.edu

Echinacea is a North American genus with pharmaceutical, insecticidal, and ornamental potential. Its root is commonly harvested from the wild as a commodity for the international medicinal plant trade. The historical and

continued harvesting of wild roots and a new development, the harvesting of wild seeds, are having an as yet unmeasured impact on the viability of native populations of the genus.

A comprehensive field survey of the center of diversity of *Echinacea*, which lies within the continental United States, was conducted in 1997. The purpose was to identify and put into *ex situ* conservation a representative genetic sample of the 11 recognized taxa of *Echinacea*, two of which are federally listed as endangered. A total of 88 new accessions have been deposited with the USDA/ARS National Plant Germplasm System with 15 or more projected for 1998.

The full agricultural and economic potentials of the genus *Echinacea* are far from fully investigated. Its closely related species exhibit high phenotypic diversity and are easily misidentified from each other. Although only three of the species have been demonstrated to have medicinal value, other species within the genus, endemics, and hybrid swarms are being wild- harvested. An overview of the accessions will be presented with emphasis on their agronomic characters and taxonomic variations. The report represents the first scientific survey of this genus in 30 years.

AGERATUM CONYZOIDES L. - A NEW SOURCE FOR MEDICAL AND AGRICULTURAL PRODUCTS IN TROPICAL COUNTRIES

Lin Chau Ming

Department of Horticulture, Agronomical Sciences College, São Paulo Statal University, Botucatu, São Paulo, Brazil

linming@fca.unesp.br

The species *Ageratum conyzoides* L., Asteraceaes family, is a medicinal plant used for a long time in traditional medicine in several tropical countries of the world. It originated in America and Caribe and also occurs in other tropical countries. It is a herbaceous, perennial species with glandular hairs and secretory channel that produce essential oils. The small and light fruit associated with its aristed papus permits its easy and long range dispersion. In Brazil, it occurs over most of the country and in some area is considered a weed in the cropped lands. However, it is used as medicine in almost all regions of the country.

The aqueous extract of leaves and other parts of the plant is used for the treatment of stomach aches, burns, pneumonia, and arthritis, and as a bactericide and antispasmodic. Recent clinical research in Brazil confirmed positive results for patients with arthritis without any side effects. The aqueous extract was 66% efficient in analgesic relief, 24% in articular mobility with a decrease or disappearance of inflammation.

The plant is also important in agriculture. The extract of the whole plant or leaves is used to modify insect metamorphosis, mainly in Diptera and Hemiptera. Cromens (precocens I and II) present in the essential oil has the ability to produce incomplete juvenile forms or sterile or deformed adults. The extract also has insecticidal properties. *A. conyzoides* as vegetative cover in citrus orchards increases the presence of predator spiders of leprosis virus vectors. The extract decreases the emergence of *Meloidogyne incognita* larvae.

Results from agricultural studies in Botucatu, São Paulo, Brazil showed the best method for seed sowing and procedures to follow in the nursery. The seeds are positively photoblastic so that they must be placed on the surface of the substrate. The seedling must be transplanted 30 - 35 days after sowing. Research also showed that higher biomass yield could be obtained when organic manure instead of mineral fertilizer was used.

Leaf yield ranged from 600 to 3,000 kg/ha depending on the growth stage of the plant. The best growth stage to produce leaves and/or flowering stems is pre-flowering. Essential oil yield from the leaves ranged from 0.01 to 0.04 %, and in the flowers from 0.02 to 0.07 %. The cromens content was 85.4% in the leaves and 81.5 % in the flowers. The compound dimetoxiageratocromeno represented 72.0 and 52.0 % of the total cromens in the essential oil of the leaves and flowers, respectively. Ageratocromeno content was 13.4 and 29.5 % of the cromens in the essential oil of the leaves and flowers, respectively.

SPECIAL-PURPOSE LEGUME GENETIC RESOURCES CONSERVED FOR INDUSTRIAL AND PHARMACEUTICAL USE

J. Bradley Morris

USDA, ARS, PGRCU, University of Georgia, 1109 Experiment St., Griffin, GA 30223-1797 USA

bmorris@gaes.griffin.peachnet.edu

Consumer preferences and scientific developments are changing and these are leading to a significant adjustment for U.S. agriculture. During the last century, most agricultural research and production were to increase yields of food and fiber. Within the last decade, more attention is being focused on the production of new and alternative crops and their by-products for agricultural, industrial, and pharmaceutical uses.

Many legumes produce economically important organic compounds such as gums, dyes, pharmaceuticals, pesticides, phytochemicals, and many specialty products. However, most legumes have never been or have just begun to be studied for their phytochemical or biologically active components. New reservoirs of commercially valuable materials remain to be discovered.

THE DEVELOPMENT AND USE OF ENDEMIC AROMATIC AND MEDICINAL PLANTS IN POST-APARTHEID SOUTH AFRICA: IMPLICATIONS FOR BIODIVERSITY, AGRICULTURAL SUSTANABILITY AND RURAL ECONOMIC EMPOWERMENT

Maxwell A.T. Poswal[1]*, Puffy Soundy*[1]*, Gray DeVilliers*[1]*, Marco Brutsch*[1]*, and James E. Simon*[2]

[1]Department of Agronomy, Fort Hare University, P. Bag X1314, Alice 5700, South Africa; [2]Center for New Crops and Plant Products, Purdue University, West Lafayette, IN 47907-1165 USA

simon@hort.purdue.edu

South Africa is blessed with a vast array of native aromatic and medicinal plant species of economic value. For many years, attempts have been made to exploit the indigenous aromatic plants for use in the pharmaceutical, cosmetics and toiletries, foods and flavor, perfumery, and aromatherapy industries, as well as serving as a vehicle for economic empowerment of the disadvantaged communities.

The paper will highlight the progress regarding the development of new crops from *Artemisia afra*, *Tagetes minuta*, *Eriocephalus punctulatus*, *Pteronia incana*, *Salvia stenophylla*, *Agathosma* spp., *Lippia javanica*, and other aromatic plant species. Implications for biodiversity within populations in nature and sustainability of agricultural productivity in rural communities will be discussed. The role of various stakeholders in biodiversity conservation will be presented. Examples will be drawn from the Eastern and Western Cape Provinces of South Africa.

PIPER HISPIDINERVUM (C. DC.) - A SUSTAINABLE SOURCE OF SAFROLE

Sérgio F.R. Rocha and Lin Chau Ming

Departments of Horticulture - Agronomical Sciences College, São Paulo Statal University, Botucatu , São Paulo, ECP 18603-970, Brazil

linming@botunet.com.br

Piper hispidinervum is one of most promising Brazilian crops for possible substitution of sassafras oil from the endangered *Ocotea pretiosa* Ness (Mez.), *Cynamomum petrophilum*, *C. mollissimum*, and *Sassafras albidum* Nutt.

Until the 1960's, Brazil was the major exporter of sassafrás oil in the world. Production has declined since then

with the depletion of the natural resource from which it was obtained, wild *O. pretiosa* in the Mata Atlântica areas of southern Brazil. Governmental restrictions in the late 1980's have resulted in a further decline in its production and export.

P. hipidinervum, called "Pimenta Longa", is distributed throughout South America, especially in the Acre state of Brazil. It is believed to extend into the Amazona state as well as Peru and Bolivia. The plant is frequently found in open fields, colonizing such areas like a "weed." Our recent laboratory studies showed that this plant is positively photoblastic.

The leaves contain high levels, 83-93%, of safrole that is an important raw material for the chemical industry. Two derivatives, heliotropin, which is widely used as a fragrance and flavoring agent, and piperonal butoxide (PBO), a vital ingredient of pyrethroid insecticides, can be obtained. Commercially, it is present in many household fragrances and applications such as floor waxes, polishes, soaps, detergents, and cleaning agents.

Ethnobotanical studies had been showed that it is used by Brazilian rubber-tappers in restorative baths. The safrole is a phenolic ether; allylcatechol methylene ether; allyldioxybenzene methylene ether, which has been used as a topical antiseptic. The sassafras oil price is about US$4 to $6/kg.

The growing techniques and propagation methods developed for its production have possibilities for adoption in the local communities. Mixed planting of *P. hispidinervum* with other cash crop is a practical possibility and would be economically attractive to growers. Harvesting of this crop before the harvest of the primary crops could provide early cash return. Sustained management is another production alternative in open areas bordering the primary rainforest.

An integrated project among research institutes, universities, governmental and non- governmental establishments on this species could produce a sustainable alternative with environmental and social benefits for the local populations in the forested areas of Acre.

ALOE VERA RESPONSE TO LOW-TEMPERATURE CONDITIONS

Raúl Rodríguez García[1], *Diana Jasso de Rodríguez*[1], *and José Luis Angulo Sánchez*[2]

[1]Universidad Autónoma Agraria Antonio Narro (UAAAN); [2]Centro de Investigación en Química Aplicada (CIQA), Saltillo, Coahuila, México

One possible limit to establishing *Aloe vera* culture in the southern regions of the Mexican state of Coahuila is the low winter temperatures. These may cause the freezing of the lower part (leaves) or even of the whole plant depending on intensity and duration of the low temperatures. Temperatures of -3 to -4°C are common during the night and they frequently continue for several days. The objective of this study is to determine the response of *Aloe vera* to low-temperature conditions. This information will allow adequate planning in establishing the crop.

Forty *Aloe vera* plants from the southern region of the Mexican state of Tamaulipas were used. The plants were tagged and transplanted into 10-liter pots containing a mixture of soil, peat moss, and perlite in the same proportional volume. They were then placed in a greenhouse at the University. After six months, groups of four plants were selected to undergo different treatments of -1, -2, -3, and -4°C exposed for 12 h until the temperature causing damage to the plants was detected. After the treatments, the following measurements were taken: leaf damage, gel production loss, leaf thickness, pH of the extracted gel, and tissue damage. The results will be presented in detail in the full paper.

GERMINATION STUDIES ON *ECHINACEA ANGUSTIFOLIA*

Ali O. Sari, Mario R. Morales, and James E. Simon

Center for New Crops and Plant Products Laboratory, Purdue University, West Lafayette, IN 47907-1165 USA

alio@omni.cc.purdue.edu; mmorales@omni.cc.purdue.edu; simon@hort.purdue.edu

Echinacea (*E. purpurea* and *E. angustifolia*) is among the most popular medicinal herbs grown and wildcrafted in the United States. The increased market demand for the whole plant (roots, leaves, and flowers) has prompted concern for the loss of native populations and potential loss in genetic diversity. Cultivation of echinacea can reduce or replace the need for a wildcrafted product, but field sowing is hindered by both low and uneven seed germination.

To solve this problem, dormancy breaking studies were conducted on freshly harvested seeds of *Echinacea angustifolia*. Seed lots were treated with tap water, 1 mmol ethephon (2-chloroethylphosphoric acid), 2,500 and 3,500 mg/l gibberellic acid, and combinations of these treatments, before transferring them to germination or stratification incubators. Seeds were stratified under light at 0°C and 10°C for 4, 8, and 12 weeks. An untreated seed lot was used as a control. Seed lots were placed under light at a constant temperature of 25°C and at alternate temperatures of 25/15°C for 14/10 h, respectively.

Germination was more rapid and uniform, and percent germination was higher at 25 °C than at 25/15 °C. Untreated seeds (control) at 25°C and 25/15°C resulted in 65 and 14% germination, respectively. Pre-soaking under tap water did not increase seed germination. Seed treatments by ethephon and GA resulted in ca. 90% germination with no stratification. There were minimal seed germination differences between 0 and 10 °C stratification. Germination percentage increased at both stratification and germination temperatures for seeds subjected to the prechill with water and soaking treatments as stratification duration increased from 4 to 12 weeks. Soaking+ethephon resulted in > 90% germination after 4 weeks of stratification, whereas the same germination rate was only achieved by soaking + GA after 8 weeks of stratification.

CONSERVATION OF MEDICINAL AND AROMATIC PLANTS IN BRAZIL

Roberto F. Vieira

Centro Nacional de Pesquisas em Recursos Geneticos e Biotecnologia

EMBRAPA / CENARGEN, SAIN Parque Rural, caixa postal 02372, 70849 - Brasilia, DF, Brazil

rfvieira@cenargen.embrapa.br

Approximately two-thirds of the biological diversity of the world is estimated to be in tropical zones, mainly in developing countries. Brazil contains around 60,000 species of flowering plants, distributed in five large locations: Amazon (30,000); Cerrados (10,000); Caatinga (4,000); Atlantic rainforest (15,000); and the subtropical forest (3,000). Optimistic estimations indicate that less than 5% of the Brazilian flora has been chemically or pharmacologically studied.

In the last years, serious efforts to collect and preserve the genetic variability of medicinal plants have been initiated. The National Center for Genetic Resources and Biotechnology - Cenargen, in collaboration with other centers of EMBRAPA (Brazilian Agricultural Research Corporation), has a program to establish genetic reserves and germplasm banks for medicinal and aromatic species. There are three basic research areas in this program including ethnobotanical studies, germplasm collection and characterization, and *in situ* conservation.

The most important species collected will be presented with supportive data including their description, medicinal uses, chemical constituents, and pharmacological activity. A current status of conservation for each species, germplasm availability, collecting and *in situ* conservation areas will be highlighted.

Some of these species include*: Cephaelis ipecacuanha* (ipecac), a source of the alkaloids emetine and cephaline*; Pilocarpus microphyllus* (jaborandi), the unique source of pilocarpine used in glaucoma treatment; *Solanum mauritianum* (cuvitinga), a potential source of solasodine, a raw material to the semi-synthesis of steroidal hormones; *Dimorphandra mollis* (faveiro), source of rutine*; Maytenus ilicifolia* (espinheira santa), anti-ulceric; *and Phyllanthus niruri* (quebra-pedra) used in hepatitis B treatment.

MODELING PHOTOPERIOD EFFECTS ON DEVELOPMENT OF *BORAGO OFFICINALIS*

Liliana Windauer, Daniel Sorlino, and Nora Gómez

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

dsorlino@charao.agro.uba.ar

Borago officinalis is the major source of gamma-linolenic acid used in several medicinal applications. These include lowering blood pressure and cholesterol levels, and for various hormone-related conditions such as atopic eczema and premenstrual syndrome.

The objective of this study was to describe the flowering response by a model of environmental influence on the emergence-flowering stage with a Spanish white flower variety.

The model used only photoperiod effects without vernalization effects.

Eight sowing dates were used: 03/09/96, 08/10/96, 15/11/96, 27/12/96, 27/02/97, 17/04/97, 10/05/97, and 26/08/97 at Buenos Aires (34° 35' S, 58° 29' W).

Phenological observations at emergence and first flowering were made in a Randomized Complete Block design with three replications. The model used was:

$$TT = a + b\,P + c/P$$

where TT is thermal time in °C day, P photoperiod mean, and a, b, and c are the genotype-specific constants.

In previous experiments, we assumed that vernalization effects are null (Sorlino et al, AAIC Conference, 1997), but now we have included more sowing dates. The good fit of this model did not include the 15/12, 27/12, and 27/02 sowing dates (summer dates). On these dates, the vernalization effects were important and the model fall off. Nevertheless, it was a good tool for production sowing dates at the field.

A COMPARATIVE BIOCHEMICAL AND ECO-PHYSIOLOGICAL STUDY ON *HYPERICUM SPP.*

T. B. Kireeva[1], V.L. Sharanov[1], and W. Letchamo[2]

[1]Department of Botany and Plant Ecology, Faculty of Biology and Chemistry, Udmurtian State University, Russia; [2]Trout Lake Farm Co., P.O.Box 241, Trout Lake, WA 98650 USA

Among four different Hypericum spp (*Hypericum perforatum*, *H. maculatum*, *H. pulchrum* and *H. hirsutum*) known to grow wild in Udmurtia, Russia, only *Hypericum perforatum* is officially registered in the Russian State pharmacopoeia for internal and external medicinal treatments. *H. perforatum* and *H. maculatum* are found frequently to grow side by side. Therefore, traditionally both species are collected for industrial processing. The objective of this study was to determine the variations or differences in the content of hypericin, tannins, and total extractive matter between *H. perforatum* and *H. maculatum* under various growing conditions and developmental stages of the plants.

In *H. perforatum*, the highest tannin content was measured during intensive vegetative growth just before the beginning of flower buds. However, the tannin content was significantly lower during the early (seedling stage) and late (after the onset of fruit capsules) developmental stages. The highest hypericin content was measured during massive bud formation and the onset of flowering (5-10 % flowering), whereas this level drastically decreased after full blooming of the plants. There was a significant correlation between tannin formation and the accumulation of hypericin. The total extractive matter was at the highest peak just before the bud formation and during intensive flowering periods. In *H. maculatum*, the total extractive matter was significantly higher than *H.*

perforatum in all developmental stages. In contrast to *H. perforatum*, the highest tannin concentration in *H. maculatum* was measured during full blooming, whereas the highest hypericin content was measured during intensive vegetative growth (just before bud formation). This finding is the first in its character and represents an important economic and therapeutic application. In line with *H. perforatum*, we suggest including *H. maculatum* as an official herb for pharmaceutical and cosmetic processing.

CICHORIC ACID AND ISOBUTYLAMIDE CONTENTS IN *ECHINACEA PURPUREA* TOPS AS INFLUENCED BY THE DEVELOPMENTAL STAGES OF THE PLANT

W. Letchamo[1] *and V.S. Krutilina*[2]

[1]Trout Lake Farm Co. 149 Little Mountain Road, Trout Lake, WA 98650 USA; [2]Moscow Timiriazev Agric. Academy, Dept. of Soil Sciences, Moscow, Russia

Echinacea purpurea is among the most important and best selling native American medicinal plants that is used as a good source for animal and human immunostimulation. In recent years, there has been a growing interest from various countries in organically cultivated Echinacea for the preparation of various herbal medicines and food supplements. The aerial parts of *E. purpurea* containing flower heads are used in the form of expressed juice, hydroaclcoholic extract, alcoholic tincture, encapsulated powders or tea preparations. However, there is no published information on how growing conditions, plant and flower developmental stages would affect some of the biologically active components of *E. purpurea* flower heads.

The objective of this study was, therefore, to investigate the variations in the content of hydrophilic (coffeic acid derivatives, such as cichoric acid, chlorogenic acid, echinacoside), and lipophilic (alkamides and polyacetylenes) components of Echinacea flowers. The aerial parts of the plants were harvested and the flowers separated at four developmental stages (1st stage, 2nd stage, 3rd stage, and 4th stage). HPLC was used to determine the components. The highest content of cichoric acid was measured during the 1st flower development stage, whereas the highest concentration of isobutylamides was found at the 3rd stage with further development of the flowers. As the seeds attained their maturity to dryness, however, isobutylamide levels started to significantly decline.

THE EFFECT OF NATURAL PLANT CONDITIONER RIBAV ON SEED GERMINATION AND PHOTOCHEMICAL ACTIVITY OF MEDICINAL AND AROMATIC PLANTS

V.S. Krutilina[1] *, S.M. Polyanskaya*[1]*, E. Bloshenko*[2] *, and W. Letchamo*[3]

[1]Moscow Agricultural Academy, Dept. of Soil Sciences, Moscow, Russia; [2]Moscow Agricultural Academy, Dept. of Medicinal Plants, Moscow, Russia; [3]Trout Lake Farm Co., 149 Little Mountain Road, Trout Lake, WA 98650 USA

Unlike traditionally cultivated food or forage crops, the knowledge of the cultural practices for many medicinal and aromatic plants is limited to a handful of institutions or none existent. Many medicinal plants are still collected from the wild. Low level of seed germination is among the most limiting factors that affect successful cultivation and processing. As part of our long-term biotechnological research program for many cultivated crops at the Soil Science Department of Moscow Agricultural Academy, we developed a natural plant conditioner, RIBAV, by directly isolating it from the plants.

The objective of this study was to determine the effects of natural plant conditioner RIBAV on seed germination and photochemical activity of medicinal and aromatic plants and the establishment of the seedlings under greenhouse and field conditions. RIBAV is a none-chemical (none-synthetic) natural product obtained through proprietary biotechnological method. Dried seeds of *Chamomilla recutita, Echinacea angustifolia*, *E. purpurea*, *Baptisia tinctoria, Hypericum perforatum, Salvia triloba*, *Lomatium dissectum*, and *Rummex acetosella* were pretreated for 1 min, 1 h, and 24 h with RIBAV at the concentration of 1%, 10%, and 20%. The application of RIBAV significantly affected the rate of germination. The highest germination rate for chamomile, echinacea and sheep sorrel was obtained at a concentration of 1% dipped in the liquid for a duration of 1 min. The highest

germination rate for baptisia, lomatium, St. John's wort, and sage was obtained at a 10% concentration for 1 min. The photochemical activity of chamomile and echinacea showed significant difference compared to the control variants.

Top of Page

Return

OILSEEDS

GLYPHOSATE-TREATED CANOLA MULCH INHIBITS WEEDS DURING STRAWBERRY ESTABLISHMENT

Frank Forcella[1] *and Steven R. Poppe*[2]

[1]USDA-ARS, North Central Soil Conservation Research Laboratory, [2]West Central Experiment Station, University of Minnesota, Morris, MN 56267, USA

fforcella@mail.mrsars.usda.gov

Canola (*Brassica napus*) is known to produce high levels of glucosinolates. As canola tissues die, these compounds are converted to isothiocyanates, which are toxic to many crop pests. We tested the ability of 'Jupiter' canola, purposefully killed by simulated mowing or glyphosate application, to inhibit green foxtail (*Setaria viridis*) and redroot pigweed (*Amaranthus retroflexus*) seed germination and seedling growth during establishment of 'Glooscap' strawberry (*Fragaria americana*) in two identical experiments.

Although mown canola had enough shoot material to cover the soil surface completely, it had little effect on weed growth compared with untreated weedy checks. In contrast, canola treated with glyphosate eliminated nearly all weeds from strawberries. In this treatment, glyphosate was applied before strawberry transplantation and weed seed germination. Thus, glyphosate had no direct effect on weed control. This same treatment also stunted strawberry plants somewhat, but the crop eventually overcame this initial suppression.

In conclusion, a glyphosate-treated canola mulch may be a new use for canola by providing a possible short-term replacement for soil fumigants, such as methyl bromide, during strawberry establishment.

SALINITY EFFECTS ON GROWTH, SHOOT-ION RELATIONS AND SEED PRODUCTION OF *LESQUERELLA FENDLERI* (GRAY) S. WATS

Catherine M. Grieve[1], *Michael C. Shannon*[1], *and David A. Dierig*[2]

[1]U. S. Salinity Laboratory, 450 West Big Springs Road, Riverside, CA 92507-4617 USA; [2]U.S. Water Conservation Laboratory, 4331 East Broadway Road, Phoenix, AZ 85040 USA; cgrieve@ussl.ars.usda.gov; mshannoon@ussl.ars.ag.gov; ddierig@uswcl.ars.ag.gov

Little information is available on the response of lesquerella grown under saline conditions. This study was conducted at the U. S. Salinity Laboratory, Riverside, CA to determine the response of the crop to sodium sulfate-dominated saline irrigation waters commonly encountered in drainage water reuse systems in the San Joaquin Valley of California.

Two-month-old seedlings were transplanted into 24 outdoor sand tanks with 72 plants per tank and irrigated with a complete nutrient solution. Eight salinity treatments were imposed two weeks after transplanting. Salts were added over a two-week period to avoid osmotic shock to the seedlings. Electrical conductivities of the irrigation

waters (EC_{iw}) were 3, 6, 9, 12, 15, 18, 21, and 24 dS m . Vegetative growth was monitored at three monthly intervals commencing 15 February 1998 by selecting two representative plants per tank to determine fresh and dry weight, height of the main axis, number of primary lateral branches, and leaf area.

Fitted salinity tolerance curves indicated increased tolerance with plant age. For six- month-old plants, the threshold soil water was 7.6 dS m^{-1} with a 9% decrease in the vegetative yield per unit increase in salinity above the threshold. The salinity level that resulted in a 50% reduction in biomass production (C_{50}) was 12.8 dS m^{-1}. This is less tolerant than was previously reported for seed yields in field studies. Leaf area, number of branches, and axis height were all reduced by salinity. Ion concentrations in leaf and stem tissue were determined. Seed yield, seed oil content, and fatty acid profiles were measured. Growth was significantly reduced at EC_{iw} in excess of 6 dS m^{-1} and the highest salinity level (24 dS m^{-1}) was lethal to most plants. The few survivors in the highest salinity treatment were rescued and grown in crossing blocks under nonsaline conditions.

A preliminary trial was conducted in greenhouse sand cultures to compare the response of lesquerella with isosmotic solutions of chloride- and sulfate-dominated salinities. The experimental design was two salinity types (chloride, sulfate), two salt levels (osmotic potential = -0.16 MPa; EC_{iw} @ 4.4 dS m^{-1} and osmotic potential = -0.52 MPa; EC_{iw} @ 15.2 dS m^{-1}), and three replications. Seeds were planted in six rows per tank; seedlings were thinned to 25 per row. Plants were irrigated three times daily with low salinity water that contains all essential nutrient ions. High salinity stress was applied three weeks after seedling emergence. Growth parameters as well as shoot ion uptake and distribution were measured.

BIOMASS, GRAIN, AND OIL YIELD FOR FOUR SUNFLOWER VARIETIES IN NORTHERN MÉXICO

Diana Jasso de Rodrigueza[1], *J. L. Angulo-Sánchez*[2], *and R. Rodriguez-García*[1]

[1]Universidad Autónoma Agraria Antonio Narro (UAAAN), [2]Centro de Investigación en Química Aplicada (CIQA), Saltillo, Coahuila, México

Sunflower is a crop that may be adapted to soil and environmental conditions that do not allow the cultivation of other plants. The sunflower oil has high concentration of polyunsaturated fatty acids and may be used as a fuel; in addition, the protein has a high biological (nutritive) value. México imports 90% of oil seeds from different countries. Better knowledge about the physiology of the plant will allow us to increase the yield and to help adapt it for different environments. This may improve sunflower production in México and reduce imports.

This work was undertaken to study the biomass production and grain and oil yields of four sunflower genotypes in northern México. The varieties studied were: SAN-3C developed at the UAAAN; Victoria, developed at Institute National de Investigations Forestales, Agricales y Peccaries (INIFAP); Cernianka and Iregi, two Russian varieties. The four genotypes were seeded in June at the experimental field at the University in six rows plots, 700 m long and 0.8m between rows, and plant spacing of 0.25 m. A randomized block design with four treatments and three repetitions was used. Three irrigations were applied at different times after seeding: 8 days (emerging stage), 12 days (vegetative stage), and 56 days (blooming start). The variables evaluated were: leaf area, plant height, dry weight, stem diameter, grain yield, oil and protein content, and yield. The results were analyzed by ANOVA.

Results show that the variety SAN-3C is the higher biomass producer (7.17 t/ha) followed by Victoria (4.9 t/ha), Iregi and Cernianka (4.6 t/ha each). For grain yield, SAN-3C produced 2.25 t/ha, Victoria 1.69 t/ha, Cernianka 1.61 t/ha, and Iregi 1.57 t/ha. The oil yields were SAN-3C, 697 kg/ha, Victoria, 661 kg/ha, Cernianka, 632 kg/ha, and Iregi, 550 kg/ha.

The variety developed at UAAAN is the highest producer under limited, semiarid water supply.

LESQUERELLA FENDLERI A NEW CROP FOR NORTHWEST MEXICO

Ignacio Moreno-Murrieta[1], *Sergio Muñoz-Valenzuela*[1], *and David Dierig*[2]

[1]Yaqui Valley Field Station, CIRNO-INIFAP, P.O. Box 515 Cd., Obregón, Sonora, México; [2]U.S. Water Conservation Laboratory, Phoenix, Arizona 85040 USA

morenoi@cirno.inifap.conacyt.mx

In northwest Mexico, wheat has been the main winter crop for several decades. However, identifying new species to improve the cropping practices is important, especially when other potential markets are available. *Lesquerella fendleri* has been introduced to this area as a viable choice because the crop can be established during October and November. Research conducted recently indicates that *Lesquerella* can yield from 800 to 1,800 kg/ha. A market exists for lesquerella in food coating, plastic fabrication, and several other commercial uses. With the cooperation of the U.S. Water Conservation Laboratory, *Lesquerella* was established at the Yaqui Valley Experiment Field Station to determine its adaptation and response to nitrogen fertilization.

Treatments evaluated were: nitrogen fertilization (urea, 46% N) at 0, 100, and 200 kg/ ha using 1,000 m^2 plots. Planting date was 5 November 1997. Seeding was done with an experimental grass seeder equipment. For weed control, a mixture of Stinger plus Goal 2EC at a rate of 250 and 480 ml/ha for each product was applied in January. A second application was made in February using the mixture of Stinger plus Fusilade at a rate of 300 ml and 2 l/ha, respectively. The experimental design was randomized block. Seed yield was calculated from eight samples of 4 m^2 each per treatment. Harvest was made by hand and initiated on 28 May 1998. Variables recorded were: length of five secondary branches; plant and stem diameters, and number of pods. Oil content and fatty acid composition were determined at the U.S. Water Conservation Laboratory.

Germination and stand establishment of *L. fendleri* were very good. Rapid vegetative development was observed during December. Flowering occurred from February through April. Seed maturity began around 15 May. Significant statistical differences were recorded for plant characteristics in the different nitrogen fertilization treatments. Several correlations on such differences were conducted. Seed yield and fatty acid content due to fertilization treatment will be discussed.

ADAPTATION OF CHIA *(Salvia hispanica* L.) TO NORTHWEST MEXICO

Ignacio Moreno-Murrieta[1], *Sergio Muñoz-Valenzuela*[1], *and Hugo Zagal-Maldonado*[2]

[1]Yaqui Valley Field Station, CIRNO-INIFAP, P.O. Box 515, Cd.Obregón, Sonora, México; [2]Centro de Investigaciones Biológicas, Universidad Autónoma de Morelos, Cuernavaca, Morelos, México

morenoi@cirno.inifap.conacyt.mx

Salvia hispanica L. is commonly known as chia or black chia. This plant is originally from the central part of Mexico and is currently found in Central America, West Indies, U.S., and Argentina. It has cholesterol and triglyceride reducing properties and appreciated in the foreign market. This plant can be established between November and December and has a 130- to180-day growing season. Seed yield ranges from 800 to 1,500 kg/ha. At present, agriculture in northwest México is developing, but few choices of crops are available. Therefore, the purpose of this research was to evaluate chia cultivation for the environment conditions specific for this region.

This trial was conducted in collaboration with the Morelos Autonomus University Research Center. Plants were established on the Yaqui Valley Field Station. The three planting dates evaluated were: 27 November, 4 and 11 December 1997. The experimental plot consisted of six furrows, 8 m long, and spaced 0.75 m apart. Planting was done by hand with two plants every 0.40 m. The plot was fertilized with 120 kg/ha nitrogen and 80 kg/ha phosphorous. The experimental design was a randomized block with 10 replications. Harvest began on 1 June 1998. Variables recorded were: number of days to flowering and maturity; plant height; number of heads per plant; head length; and grain yield. Oil content and fatty acid composition were analyzed by the Morelos Autonomus University.

Results obtained indicate that chia has good adaptation for the three planting dates evaluated. The plant has a fast

initial growth. Flowering started on 24 February 1998. Crop maturity began in late and early June. All branches kept an upright position during the entire cycle, which favors mechanical harvesting. The plants were similar in height and number of branches. The number and length of heads per plant were variable. Some heads were 0.52 m long. No seeds were lost due to dehiscence, and the seeds combined easily. Yield levels and other characteristics such as oil quality will be discussed. Overall results indicate that *S. hispanica* can be grown successfully in this part of México.

CANOLA AS AN ALTERNATE CROP FOR SOUTHERN SONORA, MEXICO

Sergio Muñoz-Valenzuela and *Ignacio Moreno-Murrieta*

CIANO-INIFAP. A.P. 515, Ciudad Obregon, Sonora, México

muñozs@cirno.inifap.conacyt.mx

At the Yaqui Valley, Sonora, México, farmers have a limited crop choice for the winter season. Wheat, maize, safflower, and vegetables are some of the winter crops, and maize and sorghum are the most common summer crops. Soybean and sesame are strongly affected by white fly and consequently are not grown. From the economic and ecological point of view, it is important to increase the number of crop choices for this region. The purpose of this trial is to introduce canola as a winter crop for southern Sonora.

The plot was established with a cooperative farmer at the Yaqui Valley. One-half ha was planted with each of the following canola varieties: Hyola 308, Hyola 330, and Hyola 401. The seeds were obtained from the University of Georgia. Planting date was 29 December 1997. Seeding rate was 3 kg/ha. A "Gandy" planter was used to plant in rows 80 cm apart. Nitrogen was applied at a rate of 138 kg/ha. Yield, crop development and composition (flowering, physiological maturity, plant height, lodging, fatty acid balance, protein content), and other components will be reported.

GROWTH ANALYSIS OF LESQUERELLA IN RESPONSE TO MOISTURE STRESS

Naveen Puppala and James L. Fowler

Department of Agronomy and Horticulture, MSC 3Q, PO Box 30003, Las Cruces, New Mexico 88003-0003 USA

npuppala@nmsu.edu

In 1995 and 1996, two field experiments were conducted in southwestern USA. The objective of this study was to determine the effects of moisture stress at different phenological stages on photosynthetic rate, leaf water potential, and growth. The species used was *Lesquerella fendleri*. Water use efficiency and photosynthetic rate of the upper expanded leaves of lesquerella were measured prior to the release of stress. Leaf and xylem water potentials were measured using the pressure chamber and osmometer.

The experimental design was a randomized complete block with six replications. Treatments consisted of (a) continuous favorable soil moisture [irrigated at 50% available water content (AWC)], (b) moisture stress (irrigated at 25% AWC) from establishment to final harvest, (c) moisture stress (irrigated at 25% AWC) from establishment to flowering with no stress afterwards (50% AWC), and (d) no stress imposed from establishment to flowering (50% AWC) followed by stress (25% AWC).

The consumptive use of water (CUW) for the 50% AWC treatment was 660 mm. Seed yields were 850 to 1,000 kg ha^{-1}. The water use efficiency (WUE) was 1.13. The photosynthetic rate (P_S) ranged between 27 to 47 mmol m^{-2} s^{-1}. Irrigating the crop at 25% AWC resulted in lower CUW of 330 mm, low yields 450 to 600 kg ha^{-1}, and low WUE of 1.0. Low yields were mainly due to lower P_S of 3 to 6 mmol m^{-2} s^{-1}, fewer number of flowers, and lower dry matter production. Stress prior to flowering (25:50% AWC) did not reduce the yield (800 to 850 kg ha^{-1}) drastically compared with the control, but resulted in 588 mm of CUW, higher WUE of 1.17 and lower P_S of

25 to 35 mmol m^{-2} s^{-1} than the control (50% AWC). Stress after flowering resulted in lower CUW (519 mm), seed yield (700 to 750 kg ha^{-1}), WUE (1.09), and P_S (13 to 22 mmol m^{-2} s^{-1}). The poster will also discuss the effects of moisture stress on growth analysis such as crop growth rate, relative growth rate, and net assimilation rates.

EVALUATION OF SALINITY TOLERANCE OF CANOLA—A LOW ERUCIC ACID OIL SEED CROP

Naveen Puppala[1], *James .L. Fowler*[1], *Linnette Poindexter*[1], *and Harbans. L. Bhardwaj*[2]

[1]Department of Agronomy and Horticulture, MSC 3Q; PO Box 30003, Las Cruces, New Mexico 88003-0003 USA; [2]Virginia State University, Petersburg, VA 23806 USA

npuppala@nmsu.edu

Canola varieties belong to either the *Brassica napus* or *Brassica rapa* species. Canola is a genetically altered form of rapeseed. Both the species belong to the Cruciferae (mustard) family. Both species differ in agronomic characteristics and yield. Canola oil is increasing in the USA because of its low saturated fatty acids among major oilseeds.

Many soils contain soluble salts sufficient to be harmful to plants during germination. Little information is available concerning the response of canola seed germination under saline conditions.

A laboratory study was conducted to determine the salinity tolerance of canola during germination, salinity x temperature, and salinity x variety interactions that may influence germination and stand establishment. Treatment solutions were prepared using NaCl and $CaCl_2$ in a 2:1 molar ratio. Electrical conductivities of the six salinity treatments were 0.03, 5.43, 10.13, 16.23, 21.60, and 26.35 dS m^{-1}; seven temperatures (5, 10, 15, 20, 25, 30, and 35°C) using five varieties (Falcon, Jetton, HNO31-91, ST9194, and W4689E) obtained from the Agricultural Research Station, Virginia State University, Petersburg, Virginia. Fifty seeds were placed in 90 x 15 mm plastic petri dishes containing one blotter paper to which 5 ml of distilled water or various solutions of NaCl and $CaCl_2$(2:1 molar ratio) were added. The covered petri dishes were arranged in an incubator in a randomized complete block experimental design with one block per shelf over four shelves. Germination responses to salinity at seven temperatures were evaluated by replicating the temperatures twice in the two incubators. Counts were made at three-day intervals over 12 days.

Analysis of the combined two runs data showed that canola seed germination declined with an increase in salinity above a threshold of 21.60 dS m^{-1}. Based on these results, canola can be classified as a salt tolerant crop. Salinity x temperature interactions and salinity x variety interactions were highly significant. Among the five varieties tested, HNO31-91, ST9194, and W4689E performed better even at higher salinity levels. Treatment effects on the Mean Rate of Germination (MRG) and Germination Performance Index (GPI) will be discussed.

EFFECTS OF PRODUCTION PRACTICES ON CANOLA OIL YIELD AND QUALITY

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

[1]Virginia Polytechnic Institute & State University, Northern Piedmont Agricultural Research and Extension Center, Orange, VA 22960-0263 USA; [2]Virginia State University, Agricultural Research Station, Petersburg, VA 23806 USA

nparec@vt.edu

Canola (*Brassica* spp.) oil is considered healthy for human nutrition due to its very low saturated fatty acids

content and moderate amounts of polyunsaturated fatty acids. The annual demand for canola oil by U.S. consumers has increased from about 45 million kg to over 635 million kg, whereas U.S. production of canola has increased from virtually zero in 1986 to more than 150,000 ha in 1996. At this level, U.S. production meets less than 10 percent of the domestic demand. To remedy this situation, need for agricultural diversification, and to develop an alternative to low-profit winter wheat, the two Land Grant Universities in Virginia have been attempting to develop canola as an alternate cash crop. Research conducted from 1993-1995 in Virginia has indicated that, depending upon genotype and location, canola can yield approximately 2,000 kg/ha, which compares well with yields from other U.S. and foreign locations. However, information about canola oil content and quality produced in Virginia was not available.

This presentation will include results from various experiments to characterize effects of planting times, seeding rates, and nitrogen fertilizer rates on oil content, oil yield, and fatty acid contents. The oil yield during 1994-95 season was 543, 799, and 922 kg/ha when canola was planted on October 7, September 28, and September 13, respectively. Delayed planting reduced both seed yield and oil content. The planting date did not affect the 14:0, 16:0, 18:0, 20:0, 18:1, 18:2, 18:3, 20:1, and 22:1 fatty acid contents. However, delay in planting from either September 13 or 28 to October 7, increased the content of 22:0 by almost three and seven times, respectively. The highest content of 16:1 fatty acid (1.05%) was observed following planting on September 28, which was significantly higher than in canola planted on September 13 (0.77%) and October 7 (0.71%). Planting dates did not affect the saturated or unsaturated fatty acid contents in canola oil. Seeding rates significantly affected the oil yield. The oil yield was 1,098, 1,246, and 1,402 kg/ha when seeding rates were approximately 4.5, 9.0, and 13.5 kg/ha, respectively. In general, seeding rates did not affect the fatty acid profile of canola. In other experiments, we had previously observed that canola produced in Orange had significantly higher contents of 14:0, 18:0, 20:0, 20:1, 22:1, and total saturated fatty acids compared to those produced at the Petersburg location. The seed produced at Petersburg had significantly higher contents of 16:1, 18:3, and unsaturated fatty acids as compared with those produced at the Orange location. Details of various experiments and results will be presented.

NOVEL WOOD ADHESIVE FROM RENEWABLE RESOURCES

Shelby F. Thames and Richard C. Cook

The University of Southern Mississippi, Box 10037, Hattiesburg, MS 39406-0037 USA

Shelby.F.Thames@usm.edu

With continual population increase in the United States, the need for suitable building materials has continued to grow at a phenomenal rate. Increased demands on wood materials during World War II and the introduction of petrochemicals led to the development of new water-resistant wood adhesives with rapid curing profiles. Urea-formaldehyde (UF) and phenol-formaldehyde were two adhesives introduced to help compensate for dwindling supplies of whole lumber. Consequently, UF has become the primary adhesive used to produce indoor wood composites such as particle board. Although UF produces composites with good physical strengths, it is a source of formaldehyde emissions. Formaldehyde is classified as a hazardous air pollutant, and dependence on petrochemicals for formaldehyde production has raised concern about its use, particularly over the last two decades. Stricter air pollution regulations and foreseeable increases in petroleum costs have refocused attention to renewable resources as sources of raw materials for wood adhesives.

Prior to World War II, Henry Ford pioneered the use of agrochemicals as raw materials for automobile parts. He utilized soybeans in plastic production for items such as gear shift knobs and entire car body. The soybean plastics possessed good physical properties, but absorbed high amounts of water and were prone to cracking over time. In addition to Ford's pursuit of soybean products, soybeans have also been used in plywood adhesives as an extender. Soybean protein has also been mixed with animal blood to produce more water resistant glue, but the need for strong alkaline dispersions of the protein and inherent water sensitivity have greatly contributed to its lack of use as a primary component of wood glues.

Research at the University of Southern Mississippi is focused to reinvestigate soybean protein as a wood adhesive to replace current UF adhesives. Specifically, our efforts are to improve soybean protein's water-resistant characteristics. Soybean protein can be blended with various liquid plasticizers and wood chips to produce composites with good physical properties. Although the strength is comparable to commercial wood composites, water absorption of the soybean-based composites requires improvement. For example, composites produced from

only the soybean protein and plasticizer disintegrate in water in less than 2 h, whereas commercial boards submerged for up to 24 h with no ill effects.

Through the introduction of agrochemicals, such as epoxidized soybean oil and the naturally epoxidized vernonia oil, novel wood composites have been prepared, which can remain submerged in water for up to 24 h with little change in dimensions. The agrochemicals were chosen in an effort to exploit their multifunctionality, thereby providing dimensional stability via crosslinking. The materials plasticize the protein during processing while also introducing the needed water resistance. A key issue for soybean protein adhesives is the large amounts of protein required. The percentage by weight of protein used ranges from 60 to 80%, with modified oils and other agrochemicals combining to form the remaining percentage. The final results of this work are soy-based adhesives, which are ~100% agro-based with the potential to replace current UF particle board adhesives.

CYTOLOGY AND ANDROGENIC RESPONSE OF *LESQUERELLA FENDLERI* MICROSPORES

Pernell Tomasi[1] *and Ralph A. Backhaus*[2]

[1]U. S. Water Conservation Laboratory, Phoenix, AZ 85040 USA; [2]Department of Plant Biology, Arizona State University, Tempe, AZ, 85287-1601 USA

ptomasi@uswcl.ars.ag.gov

Obtaining homozygous lines from highly out-crossing, self-incompatible species requires multiple generations of time-consuming and frequently failed self crosses. The use of microspore embryogenesis can generate purely homozygous lines rapidly and efficiently, thus allowing for mutational breeding and selection of beneficial crop traits. The present study was initiated to establish an effective androgenic culture protocol for the potentially promising, new oilseed crop *Lesquerella fendleri* (Gray) Wats., Brassicaceae.

Anthers and isolated microspores of lesquerella were cultured *in vitro* by utilizing various modifications of existing *Brassica* species androgenic culture protocols. These modifications included: sampled floral bud sizes ranging from 1.77 to 5.59 mm; liquid ½-NLN and Gamborg B5 media; sucrose concentrations of 3, 6, 9, 10, 12, 13 or 14%; colchicine concentrations of 0, 10, 25, 31, 50, or 63 mmol; 6-benzyladenine (BA) concentrations of 0.2, 1.1, 1.3, 2.2, 4.4, or 5.6 µmol; 1-naphthaleneacetic acid (NAA) concentrations of 0.5, 1.1, 1.6, 2.1, or 2.7 µmol; and plate incubation temperature regimes of 28, 30, 32 or 35°C.

A comparative staging system that reliably predicts microspore developmental stage based on floral bud morphometrics, specifically floral bud and mean petal length was developed. Unfortunately, existing anther culture protocols and attempted variations of them proved ineffective at producing efficient numbers of haploid embryos. Similarly, cultures of isolated microspores from 12 greenhouse-grown lesquerella lines in 1996 and 1997 yielded undesirable diploid calli and no microspore-derived embryos. These results show that the application of microspore culture techniques for lesquerella breeding requires further refinement before androgenic progenies can be obtained and used.

THE EFFECT OF VERNALIZATION ON *LESQUERELLA FENDLERI* AND *LESQUERELLA MENDOCINA* DEVELOPMENT

Liliana Windauer, D. Ravetta, and E. Ploschuk

Cátedra de Cultivos Industriales. Dpto. de Producción Vegetal e IFEVA, Facultad de Agronomía, Universidad de Buenos Aires, Av. San Martin 4453 (1417), Buenos Aires, Argentina

ravetta@ifeva.edu.ar

Lesquerella fendleri, a non-native to Argentina with annual growth habit, and *Lesquerella mendocina*, a native and perennial, are among the species of interest as potential new crops for arid lands in Argentina. Both of the species accumulate lesquerolic acid in similar amounts in their seeds. One of the first steps in a wild species

introduction into cultivation is the understanding of the environmental influence on growth and development. The objective of this work was to compare the effects of vernalization and temperature on the development rate during emergence-flowering stages, and on the number of leaves produced by *L. fendleri* and *L. mendocina.*

A set of experiments were carried out under controlled conditions (18 h of light, 700 µmol $m^{-2}s^{-1}$ and 20ºC) with plants growing in 1-liter pots containing a mixture of peat-moss and vermiculite. Treatments included vernalized (4°C in darkness, for 14 days) and non-vernalized seed with 12 replicates each. Plants were watered and fertilized with Hoagland's solution as needed. The leaf appearance rate and thermal time (TT) to flowering were calculated.

TT was significantly lower for vernalized and non-vernalized *L. fendleri* plants ($P < 0.001$) than for *L. mendocina*, whereas there was significantly higher biomass accumulation in *L. mendocina* plants than for *L. fendleri.*

The number of leaves was significantly higher for vernalized *L. fendleri* ($P < 0.001$), although no significant differences were found for vernalized and non-vernalized *L. mendocina*. TT was significantly lower for vernalized plants ($P < 0.001$) in both species. These results confirm a faster development in *L. fendleri*, higher biomass accumulation in *L. mendocina*, and the need for vernalization in both species. It is necessary to determine the influence of duration and intensity of vernalization to achieve full vernalization.

Top of Page

Return

ORNAMENTALS

EVALUATION OF *CARTHAMUS TINCTORIUS* GERMPLASM FOR ORNAMENTAL USE

Vicki L. Bradley, Robert L. Guenthner,

Richard C. Johnson, and Richard M. Hannan

USDA-ARS, Western Regional Plant Introduction Station, P.O. Box 646402, Washington State University, Pullman, WA 99164-6402 USA

w6vb@ars-grin.gov

Safflower, *Carthamus tinctorius*, is normally grown as an oil crop, but a potential market for both fresh and dried flowers also exists. These can be used in decorative arrangements or for herbaceous ornamentals to attract wildlife.

Germplasm Resources Information Network (GRIN) narrative data describing safflower accessions were studied and 80 accessions were selected for evaluation of their ornamental potential. The accessions were planted in 3-m rows at the Central Ferry, Washington Research Farm in the spring of 1998. Data were collected on plant height, spines, and flower size and color. Plant samples were cut and dried for evaluation for use in wreaths and arrangements.

DICHROMANTHUS CINNABARINUS - A TERRESTRIAL ORCHID OF ORNAMENTAL POTENTIAL

Helena Leszczyñska-Borys, Michal W. Borys, and J.L. Galván S.

Universidad Popular Autónoma del Estado de Puebla, Agronomía - Recursos Naturales, 21 Sur 1103, Col. Santiago, 72160 Puebla, Pue., Mexico

hborys@sun1.pue.upaep.mx

The terrestrial orchids are very numerous, but are rarely cultivated, and even less used as a cut flower, pot or garden plant. This is surprising because the species *Dichoromanthus cinnabarinus*, the objective of the present report, resists xerophytic conditions of the brushland. The orange color of its inflorescence contrasts with the green or gray background and attracts the attention of the observer. Its adaptation to the extended dry season suggests excellent use in urban areas, which usually have water deficiency (parks, street dividers), and sites affected by industrial activities.

The evaluation of its ornamental values was done by sampling plants growing in their natural habitat in 1995, 1996, and 1997. In 1996, measurements and observations were made on plants included in the Germplasm Bank. The attributes registered were: height of the scape, length of the inflorescence (1996). The dimensions of the scape ranged from 61.5 cm (open-air) to 80.6 cm (half-shade) and the inflorescence from 10.3 cm (open-air) to 10.7 cm (half-shade).

NORTH AMERICAN SPECIES OF MARIGOLDS (*TAGETES*) AS NOVEL NEW HORTICULTURAL PLANTS

Jacqueline A. Soule

Tierra del Sol Enterprises, P. O. Box 5687 Tucson, AZ 85703 USA

Marigolds (*Tagetes*) are well known, popular, bedding plants. The horticultural trade currently features four annual species of *Tagetes* (*T. erecta*, *T. patula*, *T. lunulata*, and *T. tenuifolia*), neglecting the other 52 species in the genus, which includes 29 perennial species and 5 species with white florets. A native habitat was visited and plants and seed were collected. Plants and seedlings were established in both greenhouse and common garden conditions. Plants were evaluated for their potential use as a new crop for the nursery trade. Evaluation included color, size, number of flowering heads, duration of flowering, cold hardiness, heat tolerance, adaptability to cultivation, and general acceptability as an ornamental plant.

Four species of native and naturalized Tagetes were selected (*T. filifolia*, *T. micrantha*, *T. lemmonii*, and *T. palmerii*). Evaluation results, as well as features of the habit, habitat, phenology, soil type, temperature requirements, endemism, and potential drawbacks of each of these species will be presented.

Top of Page

Return

RESINS

PRELIMINARY RESULTS ON PRE-EMERGENT HERBICIDES FOR *GRINDELIA CHILOENSIS* (ASTERACEAE)

Ramón Cinco Castro[1], *Damián A. Ravetta*[2], *and Alejandra Vilela*[2]

[1]University of Arizona, Dept. of Plant Sciences, Tucson, AZ 85721 USA; [2]Universidad de Buenos Aires, Av. San Martin 4453, (1417) Buenos Aires, Argentina

rcinco@ag.arizona.edu; ravetta@ifeva.edu.ar; vilela@biolo.bg.fcen.uba.ar

Diterpene resin acids produced by *Grindelia chiloensis* and other related species could potentially be used in various applications in the naval stores industry. The value of the goods produced by the naval stores industry in Argentina is around 31 million $US. *G. chiloensis* could complement this industry allowing for new, modified

products. It is being studied as a crop for Patagonia, Argentina. Stand establishment can be achieved by transplanting seedlings (and more recently rooted-cuttings) or by direct seeding. The preferred method depends on agronomic and economic considerations as well as on the possibility of obtaining selected lines that compare favorably with available clones. Direct seeding of *G. chiloensis* in Patagonia is limited by weed competition (mostly dicots) until the plants accumulate enough biomass to overcome weed competition.

This study is part of a scheme to develop a weed control strategy for *G. chiloensis*. Six pre-emergent herbicides were tested: Zorial 80 DF (norflurazon, 0.5, 1.0, and 2.0 lb ai/a); Dual 8E (metholachlor, 1.5, 3.0, and 4.5 lb ai/a); Karmex 80 DF (diuron, 1.0, 2.0, and 4.0 lb ai/a); Caparol 4L (prometryn, 1.0, 2.0, and 3.0 lb ai/a); Treflan 5EC (trifluralin 0.5, 1.0, and 1.5 lb ai/a), and Astrex (atrazin, 1.0, 2.0, and 3.0 lb ai/a). Herbicides were dissolved in 45 ml of water and mixed with the soil at the time of seeding. Three seeds were planted in each of eight 4-inch pot/treatment. Seedling survival and plant dry biomass were evaluated 30 days after seed germination.

Dual 8E in applications up to 4.5 lb ai/a, Karmex 80DF and Aatrex up to 2.0 lb ai/a, and Caparol 4L at 1.0 lb ai/a did not reduce seed germination, seedling survival or dry biomass compared with the control. Zorial, Karmex and Caparol at the highest doses applied resulted in total mortality of the seedlings. Pre-emergent as well as post-emergent herbicides should allow for direct seeding of *G. chiloensis*, reducing production costs once the selected lines are obtained.

VEGETATIVE PROPAGATION OF *GRINDELIA CHILOENSIS* (ASTERACEAE)

Diego Wassner, Diego Kalman, and Damián Ravetta

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

ravetta@ifeva.edu.ar

The use of vegetative propagation to multiply selected genotypes has produced breakthroughs in the cultivation of new crops such as jojoba. *Grindelia chiloensis* is a shrub native from Patagonia, Argentina in the process of domestication as a source of resin to complement rosin production by pines. The only available way to propagate *Grindelia* has been the transplant of seedlings or direct seeding; both alternatives need to rely on selected varieties, a process which would take several years in an open-pollinated, self-incompatible species like *G. chiloensis*.

The objective of this study was to generate a protocol for vegetative propagation of *G. chiloensis*. Two factorial experiments were carried out to evaluate the effect of cutting position in the stem (apical or basal) and concentration of plant regulator on rooting success and root formation. Fifteen-cm-long stems were cut from several mother plants growing in the field and stored in plastic containers with ice for about 4 h. Two types of cuttings were prepared from each stem: apical (upper 6-8 nodes) and basal (lower 6-8 nodes). A commercially available IBA source (Hormex, rooting powder, Brooker Chemical Co., Hollywood CA) was used in six concentrations: 0.1, 0.3, 0.8, 1.6, 3.0, and 4.5%. Cuttings were dipped into water and into the plant regulator and placed in speedlings filled with peat moss, vermiculite and sand (1:1:1). Seedlings were placed under a mist system set at 9 min intervals for 3 s in a greenhouse at 25°C. Rooting success and root weight were evaluated 30 days after the experiments were started.

Cutting position was the most important variable influencing rooting success. None of the basal cuttings rooted. For apical cuttings, IBA concentrations between 0.8 and 3.0% resulted in 100% rooting and the largest root bulbs ($P < 0.01$). The control cuttings (0% IBA) did not produce adventitious roots.

Vegetative propagation will allow the multiplication of *Grindelia* clones selected for their productive superiority. Traits such as resin content and composition, and regrowth after harvest are some of the most important characters for selection. Currently, enough information is available from field tests in Patagonia, with individual records of several dozen plants from seven accessions that will be used to produce selected clones to be tested in the field for their performance.

THE EFFECT OF SHADING ON BIOMASS AND RESIN PRODUCTION IN *GRINDELIA*

Jorge Zavala and Damián Ravetta.

Cátedra de Cultivos Industriales e IFEVA, Facultad de Agronomía, Universidad de Buenos Aires, Avda San Martin 4453, Buenos Aires, Argentina

Grindelia chiloensis (Asteraceae) native of Patagonia, Argentina produces terpenoid resin that could potentially be used in various applications in the naval stores industry as a complement for pine rosin. It is recognized that the production of nonnitrogenous secondary metabolites, such as terpenoids, is positively correlated with light availability. In this context, the objective of this study was to assess the effect of light availability on biomass and crude resin (CR) production in *Grindelia chiloensis.*

The underlying hypothesis is that low levels of radiation will reduce resin production, thus, restricting *Grindelia* cultivation to high radiation environments. Two-month-old seedlings were transplanted in October 1996 in a completely randomized design with four replications consisting of six plant rows. The experiment was established in Trelew, Patagonia, Argentina (43? 16´ S, 65? 21´ W). Three radiation treatments (25, 50, and 100% of full sunlight), which were adjusted with shade cloth, were established. Plots were furrow-irrigated and 20 plants per treatment were harvested by hand on 8 January and 15 May 1997.

CO_2 uptake was significantly reduced in the treatments with 25 and 50% of full sunlight for both harvests ($P<0.01$). Biomass production and CR content were highest for 100% of full sunlight treatment (30.47 g, 16.26%, and 155.64 g, 16.3% for the first and second harvests, respectively; $P<0.01$) and lowest for 25% of full sunlight treatment (11.34 g, 12.64%, and 84.48 g, 7.32%, for first and second harvests, respectively; $P<0.01$).

These results show, that because of reductions in biomass production and resin content, the cultivation of *Grindelia chiloensis* would be restricted to environments with high radiation availability (i.e. arid lands with low cloudiness).

Top of Page

Return