27th Annual Meeting

Association for the Advancement of Industrial Crops

October 18-22, 2015

Overton Hotel and Conference Center

Lubbock, Texas, USA

Industrial Crops: Research to Commercial Application

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Medicinal & Nutraceutical Plants	Rodolfo Juliani, Rutgers University, New Brunswick, NJ

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Conference Program

Sunday, October 18

2:00-4:00 PM	Germplasm Committee Meeting	CH Foundation Board Room
4:00-6:00 PM	Registration Desk Open	
5:00-6:00 PM	Poster Set up	Sunset A
4:00-6:00 PM	Welcome reception	Sunset A

Monday, October 19

8:00- 10:00 AM	Registration Desk Open and Poster set up	Sunset A
8:00 AM-10:00 AM	AAIC Board of Directors Meeting	CH Foundation Board Room

Monday, October 19 – Plenary Session

Moderator: Greg Holt
Room: Sunset A

10:00 AM	Keynote speaker Michael Gilbert, Bayer CropScience	Bayer CropScience and the Genetic Modifications for Output Traits
10:40 AM	Break	
10: 50 AM	Keynote speaker Gavin McIntyre, Ecovative Design, LLC	Are Mushrooms the New Plastics? Leveraging Lignocellulosic Feedstocks as a Source for New Materials.
12:00 PM	Lunch at Hotel	
1:30-5:30 PM	Tours (Crops Research – Texas A&M AgriLife Research and Extension Center; Cotton Processing and Byproducts - USDA-ARS Cotton Production and Processing Research Unit; Fiber Processing Equipment Manufacturer)	
6:00 PM	Dinner at American Wind Power Center	

Tuesday, October 20

TECHNICAL SESSIONS

1. Oilseeds
Moderator: Liv Severino, EMBRAPA Algodao, Brazil
Room: Horizon C

8:00 AM	**Division guest speaker** Pranjivan P. Zaveri, Biogene Agritech, Ahmedabad, India	Castor bean (*Ricinus communis* L.) hybrid seed production – experience in India
8:40 AM	Travis W. Witt, D.L. Rowland, T.F. Kilcer, C.L. Trostle, J. Todd, R Grohs, R. Van Acker, B.L. Johnson, Liv Severino, Brian Baldwin, and D.L. Auld	Castor bean (*Ricinus communis* L.) is adapted to commercial production in temperate regions in North America

9:00 AM	Terry A. Isbell, Laura F. Marek, David A. Dierig, and Steve C. Cermak	Development of a non-dormant germplasm from *Thlaspi arvense* L., pennycress)
9:20 AM	Win B. Phippen, J. Sedbrook, and D M. Marks	Advances in field pennycress (*Thlaspi arvense* L.) breeding.
9:40 AM	Russ W. Gesch, F. Forcella, S. Papiernik, C. Eberle, W. Riedell, J. Lundgren, K. Nemec, S. Weyers, J. M-F. Johnson, and M. Thom	Industrial oilseeds bolster "hub" crop yields when used in rotation
10:00 AM	Coffee Break	
10:20 AM	Federica Zanetti, D. Righini, G. Di Girolamo, and A. Monti	The European project 'COSMOS' for the introduction of camelina (*Camelina sativa* L.) and crambe (*Crambe abyssinica* L.) in Europe: early observations from field trials in the Mediterranean basin
10:40 AM	Loren C. Davis, R.K. Imel, B.R. Hendon, D. Mishra, and D.L. Auld	Modification of oil content in cottonseed (*Gossypium hirsutum* L.) using chemical mutagenesis
11:00 AM	Sukhbir Singh, K.J. Boote, S. Angadi, K. Grover, S. Begna, and D. Auld	Adapting the CROPGRO model for an industrial oilseed crop: spring safflower (*Carthamus tinctorius* L.)
11:20AM	Steve Csonka	Sustainable Alternative Jet Fuel Commercialization Efforts: Progress Update
1:30 PM	**Oilseeds Division Meeting**	

Fibers and Cellulosics I
Moderator: Dilpreet Bajwa, North Dakota State University
Room: Horizon B

1:00	Amar Mohanty	Low cost ligno-cellulosic biomass and biofuel co-products for sustainable manufacturing: challenges and opportunities.
1:30 PM	S.G. Bajwa, D.S. Bajwa, and Pankaj Pandey	Development of a biofiber composite building material with DDGS/corn (*Zea mays* L.) fiber
1:50 PM	P.T. Wansapura, and N. Abidi	Preparation and characterization of cellulose-chitin hybrid materials
2:10 PM	Sanjit Acharya, Y. Hu, and N. Abidi	Preparation and characterization of cellulose films in n,n-dimethyl acetamide/lithium chloride (DMAc/LiCl): effect of drying method of cellulose and its concentration
2:30 PM	Yang Hu, and N. Abidi	Acetic acid assisted dissolution of raw cotton (*Gossypium hirsutum* L.) fiber
2:50 PM	Rohan S. Dassanayake, C. Gunathilake, T. Jackson, M. Jaroniec, and N. Abidi	CO_2 capture at ambient temperatures by aerocellulose-derived activated carbon monoliths
3:10 PM	**Coffee break**	
3:30 PM	D.J. Sundquist and Dilpreet S. Bajwa	Dried distillers grains with solubles as a multfunctional filler in low density particleboards
3:50 PM	Andres Tapia-Carrillo, Alex J. Lara, .G. Pelletier, G.A. Holt, J.D. Wanjura, and K.K. Castillo-Villa	Mycelium based acoustic absorbers grown on agricultural by-product substrates
4:10 PM	D.S. Bajwa and Evan D. Sitz	Soybean (*Glycine max* L. Merr.) straw and wheat (*Triticum aestivum* L.) straw blended medium density fiberboard with epoxidized sucrose soyate binder
4:30 PM	Sumedha Liyanage, N. Abidi, and E. Rajakaruna	Cell wall organization and molecular characterization of developing cotton fibers in two cotton (*Gossypium hirsutum* L.) varieties
4:50 PM	**Fiber and Cellulosics Division**	

	meeting	
5:00-6:00	**Poster Session- Room Sunset A**	

Wednesday, October 21

Concurrent Sessions

1. Fibers and Cellulosics II
Moderator: Dilpreet Bajwa, North Dakota State University
Room: Horizon B

8:00 AM	Bralie R. Hendon, E.F. Hequet, D. Mishra, R.K. Imel-Vice, L.C. Davis, and D.L. Auld	Development of divergent HVI fiber quality traits from two chemically mutated populations of upland cotton (*Gossypium hirsutum* L.)
8:20 AM	Burton L. Johnson, B.K. Hanson, A. Hermann, M.T. Berti, and P.J. Petersen	Screening industrial hemp (*Cannabis sativa* L.) varieties for adaptation in North Dakota
8:40 AM	Efi Alexopoulou and X. Heping,	The importance of fiber crops as sustainable source for biobased products and bioenergy in Europe and China
9:00 AM	Ana Luisa Fernando, M.P. Duarte, and E. Alexopoulou	How sustainable are bioproducts from fiber crops?
10:00	**Coffee break**	

2. General Crops Division
Moderator: Efthymia Alexopoulou, CRES, Greece
Room: Horizon B

10:20 AM	Efthymia Alexopoulou, M. Christou, Y Papatheohari, I. Papamicahel, and K. Tsiotas	Switchgrass (*Panicum virgatum* L.), miscanthus (*Miscanthus* x *giganteus*), and giant reed (*Arundo donax* L.): which one fits best in the marginal areas of the Mediterranean basin?
10:50 AM	Valerie H. Teetor, C. Schmalzel, and D. T. Ray	Stalk size of sweet sorghum (*Sorghum bicolor* L.) is affected by planting arrangement

11:10 AM	Steven F. Vaughn, F. D. Dinelli, B. Tisserat, N. Joshee, M.M. Vaughan, and S.C. Peterson.	Addition of biochar to simulated golf greens promotes creeping bentgrass growth
11:30 AM	Robert K. Imel-Vise1, N. Abidi, R.B. Williams; D.L. Auld	Agronomic and economic analysis of guar (*Cyamopsis tetragonoloba* L.) in comparison to drought tolerant crops adapted to the Texas High Plains
11:50 AM	Lopa Pattanaik and S. Naik	Kinetics of natural indigo dye production from *Indigofera tinctoria* plant biomass
12:10 AM	**Lunch**	
1:30 PM	**General Crops and Products Division Meeting. Chair,**	
	Lunch	

3. Medicinal and Nutraceutical Plants
Moderator: Rodolfo Juliani
Room: Horizon C

8:00-8:40 AM	Invited speaker, Brad Morris, M.L. Wang, and B. Tonnis	Trends in underutilized medicinal plants with phyto-pharmaceutical, functional vegetable, and nutraceutical traits
9:00 AM	Diana Jasso de Rodríguez, M.C. Victorino-Jasso, N.A. Rocha-Guzman, M.R. Moreno-Jimenez, R. Rodríguez-García, M.L.V. Díaz-Jimenez, R.F. González-Laredo, J.A. Villarreal-Quintanilla, and F.M. Peña-Ramos	Antibacterial activity in vitro of *Flourensia retinophylla*. Endemic plant from semi-desert of Coahuila, Mexico
9:20 AM	R. Rodríguez García, Diana Jasso de Rodriguez, A.L. Salas Gómez, D. Hernández Castillo, J. A. Villarreal Quintanilla, and F.M. Peña-Ramos	Antifungal effect of *Jatropha dioica*, *Flourensia retinophylla*, and *Flourensia microphylla* on *Fusarium oxysporum* in tomato crop
10:00 AM	**Coffee break**	
10:30 AM	Deepika Mishra and D.L. Auld	Sesame (*Sesamum indicum* L.):

		prescription for the modern health epidemics
11:10 AM	H. Rodolfo Juliani	Diversification in the commercial use of essential oils
11:30 AM	**Medicinal and Nutraceuticals plants Division meeting**	
	Lunch	

5. Natural Rubber and Resins – Moderator: Colleen McMahan Room: Horizon C

1:30 PM	S. Michael Lusher, and D.N. Richardson	Guayule (*Parthenium argentatum* L.) plant extracts as recycling agents in hot mix asphalt with high reclaimed binder content
2:00 PM	Lauren Johnson	Direct seeding guayule(*Parthenium argentatum* L.) : some recent results
2:30 PM	Colleen McMahan, Niu Dong, Chen Dong, Kevin Holtmann, Trinh Huynh, Grisel Ponciano, Maureen Whalen	Fructan reduction by downregulation of 1-SST in guayule (*Parthenium argentatum* L.)
	Von Mark Cruz	
3:00 PM	**Rubber and Resins Division Meeting**	
3:30 PM	**AAIC Board Meeting**	**CH Foundation Board Room**

Awards Banquet

6:30 PM	Welcome drink and AAIC Awards Banquet, Bayer Museum of Agriculture

Posters Presentations

Room: Sunset A

Fiber and Cellulosics

1	Deepika Mishra, E.F. Hequet, and D.L. Auld	Breeding for improved fiber quality using cotton mutants (*Gossypium hirsutum* L.) In a pedigree selection scheme
2	M. Kiprioti, Efi Alexopoulou, and Ch. Yancheva	Irrigation and fertilization effects on growth and yields of kenaf (*Hibiscus cannabinus* L.)variety G4
3	Cassie Marie Welker, V. Mendu, and M. Pang	Functional evolutionary studies of a cotton (*Gossypium hirsutum* L.) fiber initiation transcription factor
4	Travis W. Witt, M. Ulloa, D.L. Auld, R. C. Schwartz, G.L. Ritchie, M.G. Pelletier, and J.J. Burke	Exploring high throughput phenotyping, plant architecture, and plant-boll distribution for improving drought tolerance in cotton (*Gossypium hirsutum* L.)
General Crops		
5	Sudhir Singla, K. Grover, S. Angadi, B. Schutte, D. Vanleeuwen, and D. Auld	Growth and seed yield performance of promising guar (*Cyamopsis tetragonoloba* L.) genotypes under different planting dates in desert Southwest
6	F. Cativa and Ana Luisa Fernando	A preliminary analysis on the potential industrial crops for bioenergy in Angola
Medicinal and Nutraceutical		
7	D. Jasso de Rodríguez, L.C. García Hernández, N. A. Rocha-Guzman, M. R. Moreno-Jimenez, R. Rodríguez-García, M.L.V. Díaz-Jimenez, R.F. González-Laredo, Jose Angel Villarreal-Quintanilla, F.M. Peña-Ramos	Antibacterial activity of *Psacalium paucicapitatum*, plant from Ixtlán de Juarez, Oaxaca, Mexico
8	Diana Jasso de Rodríguez, F.A. Trejo-González, R. Rodríguez-García, M.L.V. Díaz-Jimenez, A. Sáenz-Galindo, F.D. Hernández-Castillo, J.A. Villarreal-Quintanilla, and F.M. Peña-Ramos	Effect of *Rhus muelleri* extract against *Fusarium oxysporum* f. p. *lycoperisici* on tomato plants
9	P.C. Brunetti, M. Ojeda, and H. Rodolfo Juliani	Chemical assessment of wild germplasm of *Lippia integrifolia*: a native aromatic and medicinal plant from Argentina.

Oilseeds		
10	Sung-Up Kim, M. Kim, M.-H. Lee, S.-B. Pae, E.-Y. Oh, K.-W. Oh, C.-S. Jung, and I.-S. Oh	Development of non-shattering sesame (*Sesamum indicum* L.) lines
11	Myungsik Kim, S.-U. Kim, M.-H. Lee, S.-B. Pae, E.-Y. Oh, K.-W. Oh, C.-S. Jung, and I.-S. Oh	Development of black seed coat color pre-breeding line for determinate trait in sesame (*Sesamum indicum* L.)
12	Roque L. Evangelista, M.P. Hojilla-Evangelista, S.C. Cermak, and T.A. Isbell	Processing of coriander (*Coriandrum sativum* L.) fruits for the production of essential oil, triglyceride, and high protein seed meal
13	Efi Alexopoulou, M. Christou, and Y. Papatheohari	Preliminary field trials for cuphea (*Cuphea viscossisima* Jacq. *x lanceolata* W.T. Aiton) in Greece
14	Emily A. Oblath, and T.A. Isbell	Development of a NIRS method to measure quality characteristics in brassica germplasm
15	J. Rudy and Win Phippen	Determination of vernalization requirements of field pennycress (*Thlaspi arvense* L.)
16	T. Carvalho Carli and Win Phippen	Effects of nitrogen on field pennycress (*Thlaspi arvense* L.) seed production
17	T. Lima Marques and Win Phippen	Effects of planting density on field pennycress (*Thlaspi arvense* L.) Seed production
18	Sung-Up Kim, M. Kim, M.-H. Lee, S.-B. Pae, E.-Y. Oh, K.-W. Oh, C.-S. Jung, and I.-S. Oh	Development of non-shattering sesame(*Sesamum indicum* L.) lines
19	Liv S. Severino, R.O. Sá, B.S.S. Mendes, and F.T.A.O. Xavier	Evaluation of a head designed for castor bean (*Ricinus communis* L.) combine harvesting

PROGRAM ABSTRACTS

KEYNOTE SPEAKERS AND PLENARY SESSION

BAYER CROPSCIENCE AND THE GENETIC MODIFICATIONS FOR OUTPUT TRAITS

Mike Gilbert

Bayer CropScience
Vice President and Head of Breeding & Trait Development
Lubbock, Texas

From climate change to pest and weed resistance, growers are facing increasing challenges in their work to provide the world with abundant and affordable food, fuel and fiber. Other unmet needs and opportunities exist beyond the farm gate. Bayer is investing approximately $1 billion per year in crop research and development focused on those challenges and opportunities. Through its Seed & Trait function, Bayer focuses on five key crops: cotton (*Gossypium hirsutum* L.), canola (*Brassica napus* L.), hybrid rice (*Oryza sativa* L.), soybean (*Glycine max* (L.) Merr.), and wheat (*Triticum aestivum* L.). To maximize and focus its investment, the Bayer research team uses a multistage decision tree analysis structure that incorporates grower needs to determine and establish key trait priorities and focus areas. Bayer scientists evaluate different approaches with considerations such as efficacy and economics to determine whether genetic modification or other techniques, including new breeding techniques, will be pursued. The full range of considerations and breeding techniques used to develop traits will be discussed and examples of the current focus areas and trait pipeline will be presented.

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ARE MUSHROOMS THE NEW PLASTICS? LEVERAGING LIGNOCELLULOSIC FEEDSTOCKS AS A SOURCE FOR NEW MATERIALS

Gavin McIntyre

Ecovative Design, LLC Chief Scientist, Cofounder
Green Island, NY

Ecovative is a revolutionary biomaterial company that is challenging the current manufacturing paradigm of synthetic materials. Rather than using high-embodied energy processes and finite recourses to manufacture materials, our company takes advantage of regionally sourced farm waste to grow the next generation of high performance materials and products. Ecovative's current biomaterials are comprised of lignocellulosic agricultural byproducts bound cohesively into designed shapes by filamentous fungal tissue (mycelium), analogous to traditional composite fillers and binders respectively. The resultant biomaterials, known as MycoFoam™, offer renewable, safe alternatives to traditional synthetic materials (resins, plastics, foams), while remaining cost and performance competitive. Ecovative has scaled this technology to address the needs of the protective packaging industry ($2.3B/yr), and licensed this business to the Sealed Air Corporation in 2011. This has allowed the company to expand into new, rapidly growing markets in rigid board insulation ($2B/yr in North America) and furniture components ($2.9B/yr worldwide). In order to accelerate growth and become more economically competitive, Ecovative is actively seeking additional domestic recourses that can serve as material precursors.

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ABSTRACTS

OILSEEDS DIVISION

ORAL PRESENTATIONS

CHAIR

LIV SEVERINO, EMBRAPA ALGODAO, BRAZIL

CASTOR BEAN (*Ricinus communis* L.) HYBRID SEED PRODUCTION – EXPERIENCE IN INDIA

Pranjivan P. Zaveri

Biogene Agritech, Ahmedabad, India

Castor bean (*Ricinus communis* L.) is an important industrial oil crop. India is world leader in area and production. It is typically a monoecious plant with pistillate (female) flowers on the upper portion of the raceme and staminate (male) flowers on the lower part. The variation in basic sex form exists to include pistillate, interspersed, and revertants. The polygenic complex sex expression of castor is highly influenced by environmental conditions. Identification of completely pistillate plants and presence of exploitable levels of heterosis paved the way for hybrid castor development in India. The world first castor hybrid, GCH-3 was release in 1968 in Gujarat, India which was based on TSP 10R female introduced from Texas. After that a series of hybrids using diversified S-type pistillate and male parents were released for cultivation by Public and Private sector research work in India. Gujarat State of India is pioneer in seed technology and production of hybrid castor seed with quantity of almost 5500 to 6000 MT of hybrid seed annually from about 6500 to 7000 acres and supplying to all castor growing areas of India. Hybrid seed production in castor is a vigilant exercise requiring great care in rouging of reverted female plants all through the season of crop. The problems associated with currently used S-type female system in hybrid seed production are discussed in this presentation with suggestion on research to improve seed production technology. The certified hybrid seed production in castor is taken up in 3:1 OR 4:1 ratio of female to male lines under recommended isolation of 300 m from other variety of the crop. The velocity and direction of wind determines extent of out crossing. The sensitivity of pistillate line to environmental factors (temperature, nutrition, water and age of plant) causes reversion of female flowers to male flowers. If timely removal of such reverted female plants is not done, it adversely affect genetic purity of hybrid seed produced and leads to failure of about 40 % of seed lots in genetic purity tests. The seed of female lines produced through modified method of seed production, an improved method over conventionally produce female seed, has helped to reduce rejection of hybrid seed by about 12% in purity testing but still there is a high rejection. This is responsible for reduction in hybrid seed quantity, quality of seed as well as huge financial loss to seed farmers. The seed farmers are well trained and experienced in hybrid castor seed production still the problem of seed rejection is faced which is mainly attributed to the used of environmental sensitive pistillate system. The long term experiences of Gujarat in castor hybrid seed production are presented with a suggested remedy to develop a true breeding Cytoplasmic Genetic Male Sterility system in this crop for improving hybrid seed production. The seed production is an equally important as developing good hybrids. The real benefits of improved genetics can reached to farmers through sound seed production system.

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CASTOR BEAN (*Ricinus communis* L.) IS ADAPTED TO COMMERCIAL PRODUCTION IN TEMPERATE REGIONS IN NORTH AMERICA

Travis W. Witt[1], D.L. Rowland[2], T.F. Kilcer[3], C.L. Trostle[4], J. Todd[5], R Grohs[6], R. Van Acker[6], B.L. Johnson[7], L. Severino[8], B. Baldwin[9], and D.L. Auld[1]

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Castor (*Ricinus communis* L.) is a broadly adapted crop and feral weed found across tropical regions of the world. The objective of our study was to determine if it could be grown from 29^0 to 46^0 N latitude in North America. In 2011, five genotypes of castor were selected based on: 1) the ability to be mechanically harvested; and 2) a wide range of plant architecture, and 3) as released or soon to be released status. The environments were chosen based on the interest in castor of individual participants at an Association for the Advancement of Industrial Crops symposium at Fort Collins, CO in 2010. The five genotypes chosen for this trial: Brigham developed by Texas Tech University for release in 2015; Energia developed by Embrapa in Brazil in 2007; Hale developed by USDA-ARS and Texas Agricultural Experiment Station in 1970; Memphis and Ultra Dwarf developed by Mississippi State University for release in 2015. We found that seed yields of the five genotypes averaged over the 12 environments ranged from 1073 kg ha^{-1} for Brigham to 1291 kg ha^{-1} for Memphis. Average total oil yields of the five genotypes over the 12 environments ranged from 568 kg ha^{-1} for Energia to 480 kg ha^{-1} for Brigham. Harvest index was highest for Ultra Dwarf (22.2 % for seed yield and 13.5 % for oil yield). Analysis of variance and F-tests of genotypes, environments, and the genotype by environment showed that they were highly significant ($p = 0.001$) between all three factors for all indices except for seed yield and oil yield. Most of the genotype by environment interaction seems to be due to the superior performance of castor in the five test environments north of 40° latitude. The southern environments (< 40° N latitude) produced seeds with a higher oil content and had higher harvest indices than the more northern environments. However the northern environments produced almost double the seed yield of the southern environments resulting in more kilograms of oil per hectare. Recent research suggests that castor requires a minimum of $464\text{-}15^0$ C degree days to reach physiological maturity. This could help explain the lower oil content found at the more northern latitudes. The broad adaptation and high yield of castor could make this crop important in the production of biopolymers in North America.

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DEVELOPMENT OF A NON-DORMANT GERMPLASM FROM *Thlaspi arvense* L. (PENNYCRESS)

Terry A. Isbell[1], L.F. Marek[2], D.A. Dierig[3], and S.C. Cermak[1]

[1]Terry A. Isbell, Bio-Oils Research, USDA-ARS-NCAUR 1815 N. University St., Peoria, IL 61604, USA.
[2]L. F. Marek, Agronomy Department, North Central Plant Introduction Station, USDA-ARS and Iowa State University, Ames, IA 50011.
[3]Bridgestone Americas Inc., Guayule Research Farm, 4140 W. Harmon Rd., Eloy, AZ 85131.

Pennycress (*Thlaspi arvense* L.) is being developed as an off-season rotation crop between annual corn (*Zea mays* L.) and soybean (*Glycine max* L. Merr.) production. This rotation scheme may offer distinct advantages to farmers by providing additional farm income from an otherwise fallow season with little impact on the subsequent soybean production. Pennycress seed contains up to 36% oil and the major fatty acid is erucic (36.6%). Most fresh harvested pennycress seed are dormant and post harvest maturation can take up to 15 months before seeds germinate at nearly 90%. In addition, pennycress seed has been shown to remain viable in the soil up to 40 years. Two germplasm lines Katelyn (PI 673443) and Elizabeth (Ames 32908) with improved germination rates were developed from the wild population, Beecher (PI 672505). Katelyn was developed by two generations of mass selection based on the germination response of freshly harvested pennycress seeds. The original seed source Beecher was collected from a winter fallow cornfield 2 miles north of Hanna City, IL. The germination rate of the original parent seed under conditions of 12 h light/dark cycles at 27.5 ^{o}C/11.5 ^{o}C was 0%. Seeds kept in 24h dark under otherwise identical conditions germinated at 7% compared to Katelyn S_2 seeds which had an immediate post harvest germination rate of 91% for seeds kept in 24h dark and 9% under the 12 h light/dark 27.5 ^{o}C /11.5 ^{o}C conditions. Elizabeth was selected from the segregating Katelyn S_1 germplasm as seedlings which germinated under the 12 h light/dark *2*7.5 ^{o}C /11.5 ^{o}C conditions. Two more generations selecting only seedings that germinated in 12 h light/dark treatment yielded the Elizabeth S_3 germplasm with an immediate post harvest germination rate of 94% in the 12h light/dark and 97% in 24h dark germination tests respectively. This non-dormant germplasm will provide growers with seed that can germinate immediately post harvest at high rates and provide better stand establishment in fall planted fields. In addition, any seed that is lost during harvest will germinate immediately and the young plants will die under the developing soybean canopy where pennycress cannot compete. As a result, the soil seed bank of pennycress will be diminished along with one of the weedy characteristics of pennycress.

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ADVANCES IN FIELD PENNYCRESS (*Thlaspi arvense* L.) BREEDING

Win B. Phippen[1], J. Sedbrook[2], and D. M. Marks[3]

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Thlaspi arvense L. (field pennycress) is a winter annual Brassica weed species that has been identified as a potential new source for biodiesel. The unique characteristics of pennycress differentiate it from many other oilseeds. With its short growing season, cover crop attributes, high seed oil productivity, and relatedness to other mustard family members, pennycress is well suited for the new genome based techniques that can usher in an era of rapid crop domestication. The objective of this presentation is to discuss the recent advances in techniques and developments in domesticating pennycress. The current wild pennycress populations have inconsistent germination and stand establishment, un-optimized maturity for a given growth zone, less than optimal oils and meal quality for biofuels and feed production, and harvest loss due to pod shatter. From studying *Arabidopsis thaliana* and other Brassicas, the application of TILLING and DeTILLING techniques can represent robust methods for quickly identifying and mining many different gene mutations of interest. Additionally, the application of genetic modification using targeted genome editing can create mutations in genes not identified using TILLING or DeTILLING. Successfully domesticating pennycress as a new winter annual cover crop into existing rotations can positively impact the profitability of production agriculture, enhance livestock sector returns, decrease soil erosion, improve nutrient utilization, reduce carbon emissions via the use of biofuels, and contribute to the health of rural communities.

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INDUSTRIAL OILSEEDS BOLSTER "HUB" CROP YIELDS WHEN USED IN ROTATION

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Lack of agroecosystem diversity across the U.S. agricultural landscape is linked to several environmental issues associated with air, water, and soil quality and biodiversity. Several new industrial oilseed crops with commercial potential, offer farmers new economic opportunities and a portfolio of crops that could be used to rotate with primary commodity crops (i.e., "hub" crops) to diversify cropping systems while improving environmental and economic sustainability. However, few studies have addressed the effects of rotating new crops with hub crops for a given agricultural region. A field study was conducted from 2013 to 2015 at two sites, Morris, Minnesota and Brookings, South Dakota, in the Northern Corn Belt to address some of the effects of following several new/alternative oilseed crops with the hub crops corn (*Zea mays* L.), soybean (*Glycine max* L. Merr.), and spring wheat (*Triticum aestivum* L.). Oilseeds grown in the study included sunflower (*Helianthus annuus* L.), crambe (*Crambe abyssinica* L.), flax (*Linum usitatisimum* L.), canola (*Brassica napus* L.), calendula (*Calendula officinalis* L.), camelina (*Camelina sativa* L.), echium (*Echium plantagineum*), cuphea ((*Cuphea viscossisima* Jacq. *x lanceolata* W.T. Aiton), and borage (*Borago officinalis* L.). Results including water use, water use efficiency, and crop yields are reported for the first two years of the study. Seed yields of new/alternative oilseed crops across both locations ranged from about 0.3 to 2.5 Mg ha^{-1}. Seasonal water use varied among industrial oilseed crops at each location, but was always lower than that of corn and soybean, except for sunflower at Brookings. However, water use efficiency of seed production tended to be greater in the more genetically refined corn and soybean, indicating an area for improvement of industrial oilseeds. Corn, soybean, and wheat yields were generally greater when following the oilseed crops than when they followed each other or were continuously cropped in rotation. When following industrial oilseeds in rotation, soybean grain yields were as much as 44% greater and corn yields as much as 28% greater than when continuously cropped. Our initial results indicate that corn, soybean, and spring wheat yields benefit when following industrial oilseeds in crop rotation.

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MODIFICATION OF OIL CONTENT IN COTTONSEED (*Gossypium hirsutum* L.) USING CHEMICAL MUTAGENESIS

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One of the ways to enhance the economic competitiveness of Upland cotton (*Gossypium hirsutum* L.) production in the U.S., is to increase the oil content of cottonseed for use in the domestic edible oil market. Since 1899, cottonseed oil has been a major co-product of fiber production in the U.S. In 2013, cottonseed ranked third behind soybean (*Glycine max* L. Merr.) and corn (*Zea mays* L.) oils in U.S. annual edible oilseed production. Since most cottonseed oil and the seed meal is marketed domestically, improving the oil content of cottonseed represents a potential strategy to enhance the gross value of cotton grown in the U.S. The objective of this research was to identify mutant lines with differential oil contents to determine if a correlation existed between seed weight and oil content. Historically oil contents of delinted seeds currently range from 15 to 28% in Upland cotton varieties and higher levels may be developed. In May of 2013, six mutant populations (Acala 1517-99 (M_5), FiberMax 958 (M_5), TAM 94L-25 (M_2), TTU 0882 1-5-2 A (M_4), TTU 0882 1-5-2 B (M_4), and TTU 0774-3-3 (M_3)) were increased at Texas Tech University. At the end of the growing season, a total of 900 individual space plants from the six populations were harvested, delinted and evaluated for oil content. Single plant selections with relatively high oil content were selected and planted at the Texas Tech University Research farm in both 2014 and 2015. In 2013, there was a correlation (r= 0.57***, N=59) between oil content and increased seed weight. In 2014 no correlation was found between oil content and seed weight. Continued research to optimize oil content and to enhance seedling establishment continues at Texas Tech University.

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THE EUROPEAN PROJECT 'COSMOS' FOR THE INTRODUCTION OF CAMELINA (*Camelina sativa* L.) AND CRAMBE (*Crambe abyssinica* L.) IN EUROPE: EARLY OBSERVATIONS FROM FIELD TRIALS IN THE MEDITERRANEAN BASIN

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The European commission funded the project COSMOS (**C**amelina and crambe **O**il crops as **S**ources of **M**edium-chain **O**ils for **S**pecialty oleochemicals) within Horizon 2020 framework program since March 2015 for 54 months. Eighteen partners joined the consortium, and their activities are divided into eight interconnected work packages (WP). The main objectives of COSMOS are to introduce the cultivation of crambe and camelina across Europe in order to get a domestic production of medium chains fatty acids to replace part of the import of palm oil. Furthermore, the full valorization of the whole biomass produced (straws, pods, seed residues after oil extraction) by the two crops is of great importance for the project in order to derive new high value products by mean of advanced chemical and/or biological conversion technologies. From the agronomical point of view, for the first time in Southern Europe, a multi-location screening trial has been set up in order to identify the best genotypes of crambe and camelina. Ten varieties of crambe and eleven of camelina were grown at the experimental farm of the University of Bologna in spring 2015. A low input management has been adopted for both species: conventional soil tillage, low fertilization (<80 kg N ha^{-1}), no herbicides and pesticides. The whole growth cycle of the two crops was monitored to determine the phenological phases and the growth rate. At harvest, seed yield, harvesting index, seed weight were determined. Thereafter, oil content was analyzed. Both species appeared well adapted to Mediterranean environment. Growing cycle lasted less than 100 days with remarkable high seed yields (> 2 Mg ha^{-1} DM). Camelina, in view of its short cycle and chilling tolerance, might represent an interesting opportunity also as winter crop or inter-crop before summer crops such as maize or soybean, thus filling the gap in shortage of alternative winter crops to wheat (*Triticum aestivum* L.) in the Mediterranean basin.

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ADAPTING THE CROPGRO MODEL FOR AN INDUSTRIAL OILSEED CROP: SPRING SAFFLOWER (*Carthamus tinctorius* L.)

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Safflower (*Carthamus tinctorius* L.) is gaining importance as an oilseed crop since the interest of producing biofuels has increased. Due to its ability to tolerate multiple stresses, it can adapt well in the desert environment of the Southern High Plains. Information on safflower adaptability and management in the region is very limited. Using a crop model to assess the feasibility of underutilized safflower can open up a new era of using simulation models on a number of new industrial crops to assess their adaptability under diverse environmental conditions with relatively limited field experimentation. At the same time, testing these crop models in diverse environments improves our understanding of many underutilized alternative crops. The objective of the project was to adapt the DSSAT Cropping System Model (CSM-CROPGRO) to simulate growth and seed yield of spring safflower. The CROPGRO module for soybean (*Glycine max* L.) was used as the initial reference, and parameters in species and cultivar files were replaced based on safflower literature. The entered base temperatures for photosynthetic, vegetative, and reproductive processes of safflower ranged from 0 to 5°C, while corresponding optimum temperatures varied from 19 to 40°C. Simulated results were compared with observed data collected from irrigated and water-limited treatments in field experiments conducted at Clovis, NM, USA, during 2013 and 2014 summers. The model predicted the crop life cycle (anthesis and harvest maturity date) with root mean square error (RMSE) of 5.4 days. Average plant biomass, head mass, head number, and seed number were satisfactorily simulated when compared to observed values. Seed yield averaged over irrigation treatments and years was predicted at 1963 kg ha^{-1} and was very consistent with observed value of 1902 kg ha^{-1} with RMSE of 236 kg ha^{-1}. Reasonable prediction of phenology, growth, and yield by the model adapted for safflower suggested that the CROPGRO-safflower model is promising to simulate safflower production in semi-arid climates. However, further testing of the CROPGRO-safflower model under different environments is needed.

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SUSTAINABLE ALTERNATIVE JET FUEL COMMERCIALIZATION EFFROTS: PROGRESS UPDATE

Steve Csonka

Commercial Aviation Alternative Fuels Initiative (CAAFI)

The jet-powered aviation enterprise continues its efforts to facilitate the near term development and commercialization of sustainable alternative jet fuel (SAJF). It has been proven that such drop-in SAJF blending components can technically be produced from a very broad range of feedstocks (fats, oils, and greases; cellulose; sugars; and various waste or conversion streams containing hydrocarbons) and conversion processes. The challenges being focused on now include achieving appropriate economics and scale, and bridging the gap between technical proof-of-concept and commercialization. Feedstock development and availability is critical to such issues.

The summary will outline that SAJF is key for meeting industry's commitments, and that such commitments are being used as the basis for future regulatory approaches for the industry in discussions at the International Civil Aviation Organization.

This progress update will also provide an overview of the following:

- Industry direction / Policy summary
- ASTM qualification efforts (including in-process and pipeline processes)
- Producer progress
- Public-Private programs
- State Project Initiatives and Farm-to-Fly 2.0

It is important that these aspects are understood by the feedstock development community who might be interested in supplying feedstocks for this ~23 B GPY SAJF opportunity in the US.

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ABSTRACTS

FIBERS AND CELLULOSIC CROPS DIVISION

ORAL PRESENTATIONS

CHAIR

DILPREET BAJWA, NORTH DAKOTA STATE UNIVERSITY

LOW COST LIGNO-CELLULOSIC BIOMASS AND BIOFUEL CO-PRODUCTS FOR SUSTAINABLE MANUFACTURING: CHALLENGES AND OPPORTUNITIES.

Amar Mohanty

Bioproducts Discovery & Development Centre (BDDC), Department of Plant Agriculture & School of Engineering, University of Guelph, Ontario, N1G 2W1 Canada

The new Corporate Average Fuel Economy (CAFE) standards of the USA mandate that all vehicles being made between 2017 and 2025 should provide fleet average fuel economy of 54.5 mpg. Reducing vehicle weight is key to improving fuel economy. A typical automobile today contains parts made from plastics weighing around 400 lb. Talc and glass fibers are usually added to the plastics to provide adequate strength and modulus and other required properties for various auto-part uses. Natural fiber composites, often called biocomposites, attract the attention of auto-makers in replacing certain class of injection moulded glass/talc-filled composites as sustainable alternatives thanks to their comparatively low density (the typical density of natural fibers being 1.3-1.4 g/cm^3 vs. that of glass fiber and talc being 2.5 – 2.7 g/cm^3). Constant supply chain and the low cost of natural fibers are some other key considerations aiding the shift from glass/talc-polymer composites to sustainable biocomposites. Perennial grasses such as switchgrass (*Panicum virgatum* L.) and miscanthus (*Miscanthus* x *giganteus*) are originally intended for energy uses. These types of biomass are inexpensive as compared to traditional natural fibers such as kenaf (*Hibiscus cannabinus* L.), flax (*Linum usitatisimum* L.), and jute and have shown tremendous potential in composite applications. In addition, with the increased production of biofuels such as corn ethanol as well as lignocellulosic ethanol we are accumulating a huge amount of co-products like distillers' dried grains with solubles (DDGS) and lignin. Both these co-products also show strong promise for application in sustainable composite materials. Perennial grasses and biofuel co-products as well as their hybrids, being used as reinforcement in petroleum-based plastics such as polypropylene and polyethylene and/or bioplastics such as polylactide (PLA) and polybutylene succinate (PBS) etc., are being explored for industrial uses from consumer products to auto parts. This presentation will highlight recent developments in using these biocomposites in sustainable manufacturing.

Contact: Amar Mohanty

DEVELOPMENT OF A BIOFIBER COMPOSITE BUILDING MATERIAL WITH DDGS/CORN (*Zea mays* L.) FIBER

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Corn (*Zea mays* L.) based Distiller's Dried Grain with Solubles (DDGS) are the co-product of dry grind ethanol fermentation. In the USA, DDGS is mostly used as a protein source for ruminants. With the increased amount of DDGS, it is imperative to find ways to utilize them for value added products. One of the potential applications is to use its fiber as fillers in natural fiber based thermoplastic composites. The objective of this study was to evaluate the applications of DDGS in bio based high density polyethylene (HDPE) in natural fiber filled thermoplastic composites. The DDGS and corn fibers were first milled through 1mm screen in Wiley mill and subsequently particle sized to 20-30 mesh (0.595 mm-0.841 mm) using rotavapor shaker. Twelve formulations consisting of HDPE (bio-based and petroleum based) three fiber types of DDGS, corn and oak wood fibers, and two fiber loadings of 30% versus 50% by weight (with 4% talc and remaining polymer) was used. The mixture was compounded in an extruder and then injection molded to obtain samples for different tests. Properties like flexural, impact, water absorption, and specific gravity were measured to observe the effects of fibers in polymer composites. The study indicates that both DDGS and corn fibers have great potential to be used as a fiber filler in thermoplastic composites, especially in combination with bio-based plastics. While strength properties were comparable or better, moisture affinity of the DDGS and corn fiber fillers seemed to be the major problem. Issues of moisture affinity may be addressed with the use of coupling agents in future research as coupling agents have reported to reduce moisture absorption by composite materials. DDGS and corn fiber can be used as an economically alternative raw material for manufacturing composite materials to wood fiber based composite materials.

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PREPARATION AND CHARACTERIZATION OF CELLULOSE-CHITIN HYBRID MATERIALS

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Non-biodegradable polymers have become a threat to the environment, causing health problems and exhausting much limited petroleum resource. Therefore, scientists are investigating natural polymer based materials. Hybrid biomaterials have useful applications. Cellulose and chitin are considered the most abundant natural polymers on earth. The insolubility in water and in most organic solvents limits the use of these biopolymers for the preparation of new biomaterials. Currently, scientists are focusing on ionic liquids as solvent for cellulose and chitin dissolution because of their interesting properties compared to other solvents. In this research, we report on the dissolution and regeneration of cellulose and chitin in 1-butyl-3-methylimidazolium chloride (BMimCl). The preparation of "bio-component" regenerated hybrid cellulose-chitin films was investigated. Cellulose from cotton (*Gossypium hirsutum* L.) fibers and chitin from shrimp were dissolved in BMimCl and films were prepared. The regenerated biomaterials were characterized using Scanning electron microscopy, Fourier Transform infrared spectroscopy, wide-angle X-ray diffraction and thermogravimetric analysis. The Crystalline structure of cellulose and chitin changed when the hybrid materials were prepared. The hybrid cellulose-chitin material obtained exhibits amorphous structure and degrades at low temperature compared to pure cellulose and chitin.

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PREPARATION AND CHARACTERIZATION OF CELLULOSE FILMS IN N,N-DIMETHYL ACETAMIDE/LITHIUM CHLORIDE (DMAc/LiCl): EFFECT OF DRYING METHOD OF CELLULOSE AND ITS CONCENTRATION

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The dissolution of the cellulosic macromolecules is the first predominant step to broaden the application of cellulosic materials, the most abundant naturally-derived polymer in the world. Effective dissolution is necessary for efficient processing and preparation of materials with desirable properties. In this study, microcrystalline cellulose (MCC, PH-101) was dissolved using DMAC/LiCl solvent system and regenerated films were prepared. The effects of drying method of the MCC before dissolution and its concentration were investigated. The MCC was either freeze-dried or hot air dried. Films were prepared from 5, 10 and 15% concentration by casting the solution on glass surface and then freeze-drying. The physicochemical properties, namely surface morphology, chemical composition, crystallinity, thermal behavior, and mechanical properties, of regenerated cellulose films were characterized by scanning electron microscopy, Fourier transform infrared spectroscopy, X-ray diffraction, thermogravimetric analysis, and dynamic mechanical analysis respectively. The rheological properties of MCC solution were studied by steady state flow measurements. The results showed that films with good mechanical properties can be prepared up to 15% concentration of MCC. However, the films prepared from 5% MCC solutions were more homogenous. Hydrogen bonding and structure of the cellulose was greatly impacted in the regenerated films of 5% MCC concentration. The crystallinity of the films was decreased and the analysis of variance showed significant effect of the drying method and the concentration of MCC on the crystallinity of the film. The thermal stability of the films was reduced compared to the starting material. The adsorption of water by the films was significantly higher than MCC. In steady state flow measurements, 5% MCC solution exhibited resemblance to Newtonian flow while solutions with higher concentration showed pseudo-plastic behavior.

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ACETIC ACID ASSISTED DISSOLUTION OF RAW COTTON (*Gossypium hirsutum* L.) FIBER

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Cotton (*Gossypium hirsutum* L.) fiber is composed of 95% of cellulose after scouring and bleaching. The dissolution of cellulose represents the first key step for most applications of cellulose and it is highly affected by the degree of polymerization (DP) of cellulose. Due to the high DP (9000-15000), the dissolution of cellulose is difficult to achieve under a relatively mild condition. When using a solvent system consisting of N,N-dimethylacetamide (DMAc) and lithium chloride (LiCl), cellulose often requires a high temperature (150^{o}C) and long period. The swelling of cellulose plays a vital role in its dissolution in DMAc/LiCl system. In this work, raw cotton fiber was scoured, beached, and ground using Wiley mill to pass 20 mesh. Ground fibers were soaked in 1% acetic acid (v:v) and then freeze-dried. The results showed that cellulose pre-treated by either freeze-drying or freeze-drying in the presence of acetic acid exhibited a significant improvement in dissolution as compared to hot-dried cellulose. Below 7% of cellulose, the viscosity of the dissolved cellulose pre-treated by freeze-drying in the presence of acetic acid is significantly higher than those pre-treated only by freeze-drying. The freeze-drying pre-treatment of cellulose in the presence of acetic acid could efficiently improve the dissolution of cellulose, as well as, reduce the processing temperature and period. The maximum percentage of cellulose that could be dissolved in DMAc/LiCl is below 7%.

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CO_2 CAPTURE AT AMBIENT TEMPERATURES BY AEROCELLULOSE-DERIVED ACTIVATED CARBON MONOLITHS

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A continuous increment in the atmospheric carbon dioxide (CO_2) concentration has attracted significant attention globally. Therefore, CO_2 capture and sequestration (CCS) technologies that can be employed to control CO_2 emissions from industrial sources and other natural sources are of significant interest. However, the success of these CCS technologies depends upon the CO_2 sorption efficiency of the sorbents as well as the manufacturing cost. Thus far, conventional sorbents including zeolites and silica gels have not been sufficiently effective for CO_2 capture. As a result, extensive studies are currently underway to produce novel sorbents for CO_2 capture. Among those sorbents, carbonaceous materials such as activated carbons, carbon nanotube-based sorbents, carbon-metal composites and carbon molecular sieves have extensively been studied for CO_2 capture due to their high specific surface area, large pore sizes, and high chemical, mechanical, and thermal stability. The main objective of this work was to investigate the use of activated carbon monoliths prepared from cellulose for CO_2 capture. Importantly, cellulose possesses excellent properties such as biocompatibility, biodegradability, non-toxicity, low cost, renewability, thermal stability and good sorption properties. Cellulose-based materials can be used in diverse fields; for instance, aerocellulose (or cellulose aerogels) are utilized in wide range of applications including bio-medicine, catalysts, fuel cell electrodes, cosmic dust collectors, insulation materials, and energy absorbers. In this study, aerocellulose monoliths were prepared using a well-known sol-gel process. Then these samples were carbonized using a tube furnace under flowing nitrogen. The carbonized cellulose monoliths were further activated by heating under flowing CO_2 to improve the specific surface area. Activated carbon prepared from aerocellulose monoliths showed an enhanced specific surface area of ~ 750 $m^2\ g^{-1}$, total pore volume of 0.43 $cm^3\ g^{-1}$, and volume of micropores (pore widths < 2 nm) of ~ 0.24 $cm^3\ g^{-1}$. Physical activation resulted in about 5-fold increase in the specific surface area and over 24-fold increase in the volume of micropores as compared to the as-synthesized material. The activated carbon showed adsorption properties toward CO_2 reaching 5.8 mmol g^{-1} of CO_2 at 0°C and 1 atm and 3.7 mmol g^{-1} of CO_2 at 25°C and 1.2 atm. The excellent adsorption properties, environmentally friendly synthesis route and cost effectiveness make the activated aerocellulose-derived carbon monoliths attractive sorbents for CO_2 capture.

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DRIED DISTILLERS GRAINS WITH SOLUBLES AS A MULTFUNCTIONAL FILLER IN LOW DENSITY PARTICLEBOARDS

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Dried distillers grains with solubles (DDGS) is a byproduct of corn (*Zea mays* L.) ethanol production. Roughly for every bushel of corn processed, 8.16 kg of DDGS and 11 liters of ethanol are produced. The amount of DDGS produced is steadily increasing since 1990 with 35 million metric tons produced in 2012. Currently, the majority of DDGS is utilized as feed stock. With the increasing production of DDGS, new applications have to be explored. The high protein, fat, and fiber contents in DDGS make this material a suitable animal feed but also a promising material as an alternative cellulosic material for industrial purposes. A study was conducted to understand if the addition of DDGS particles in the wood particleboards will improve the mechanical properties of low-density particleboards when compared to a control board with no DDGS. In order to fully investigate the effects of the DDGS filler, different concentrations – 5, 10, and 15 wt. % and particle sizes 125, 300, and 500 μm were investigated in cellulosic fiber based low density composite boards. A variety of mechanical tests were performed following ASTM D1037 including: flexural, internal bond, screw withdrawal, and water absorption. Chemical analysis, thermogravimetric analysis, and differential scanning calorimetry were used to analyze the DDGS filler. The analysis showed that the chemical composition of DDGS was not altered by micronization. The differential scanning calorimetry work also showed that the DDGS bonded to the melamine urea formaldehyde resin. The results show that at concentrations of 5 wt. % DDGS with particles of 500 μm produced superior properties compared to the control panel for the water absorption, flexural, and internal bond tests. This work demonstrates that DDGS can be used as multifunctional filler in particleboards. Application of DDGS in cellulosic composite will help to eliminate or reduce the use of both resin and petroleum based wax. Further it will add value to DDGS and improve corn-ethanol economics.

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MYCELIUM BASED ACOUSTIC ABSORBERS GROWN ON AGRICULTURAL BY-PRODUCT SUBSTRATES

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With the need for a sustainable future, environmentally safe and sustainable materials for future generations are of great interest. In this research, the material under examination is a new bio-material produced by growing a mycelium binder onto an agricultural by-product that provides the bulk substrate. The mycelium is produced by the growth of the Basidiomycetes fungi on the by-products [corn (*Zea mays* L.) fiber, burr fiber, switchgrass (*Panicum virgatum* L.), cotton (*Gossypium hirsutum* L.) burrs, kenaf (*Hibiscus cannabinus* L.), and sorghum (*Sorghum bicolor* L.), rice-straw). The production of these boards requires no added adjuncts and is very energy efficient, as fungi thrives in a warm environment. The objective of the research reported here is to examine the potential for these boards to perform as acoustic absorbers. The experiments tested the material's acoustic properties utilizing an impedance tube. The materials tested were comprised of two alternative variants; a low density and a highly compressed board. One of the sub-objectives of the study was to examine the acoustic properties in correlation with the substrate constituent mixtures such as, corn fiber, switch grass, cotton-burr, corn fiber, etc. Results of the study indicate the compressed hard-board materials' provide significant through-transmission absorption properties and suggests a promising future if it can be adapted to the other constraints of the acoustical absorber's market.

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SOYBEAN (*Glycine max* (L.) Merr.)STRAW AND WHEAT (*Triticum aestivum* L.) STRAW BLENDED MEDIUM DENSITY FIBERBOARD WITH EPOXIDIZED SUCROSE SOYATE BINDER

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Growing markets in the medium density fiberboard industry motivate research in supplementing wood fiber supply with other lignocellulosic materials, and the recognition of formaldehyde as a carcinogen motivates research and development of alternative resins. Soybean straw [*Glycine max* (L.) Merr.] and wheat straw [*Triticum aestivum L.*] show promise as annually renewable and a lightweight alternative to traditional wood fiber sources. Epoxidized sucrose esters of fatty acids or epoxidized sucrose soyate (when produced from soybean oil) have also shown versatility as a thermosetting resin and could be adapted for use in the fiberboard industry. The objective of this study is to evaluate the physical and mechanical properties of medium density fiberboard using wheat and soy straw while using various binders, including epoxidized sucrose soyate. Additionally, determine if epoxidized sucrose soyate can be used as the sole binder or as a resin extender in fiberboard production. Several resins including methylene diphenyl diisocyanate, phenol formaldehyde, urea formaldehyde, and melamine urea formaldehyde were blended with epoxidized sucrose soyate to determine if it could act as an extender or improve binding with the fibers in fiberboard manufacture. Several tests to evaluate then blending effect were performed including lap shear testing in accordance ASTM D2339, Fourier transform spectroscopy, Thermogravimetric analysis, and differential scanning calorimetry. Soy and wheat straw fibers were provided by the Masonite Corporation and then conditioned until pressing was performed using a Carver lab hot press. Several blends of wheat and soy straw were used to make boards with resin being mixed at a 3 wt% loading with the target density of the boards being 640 kg/m^3. Commercial boards made with wheat straw served as the control. Board properties were tested using the methodology outlined in ASTM D1037 as a guideline. Epoxidized sucrose soyate was successfully blended with methylene diphenyl diisocyanate resin and reduced curing temperature while providing superior binding properties for the fiberboards. Boards made from soy straw and blends of soy and wheat straw showed similar properties to that of the control boards, with the only significant variance being a superior screw withdrawal resistance for the control wheat boards. Medium density fiberboard can be produced from wheat and soy straw for commercial use and can be effectively blended with no apparent loss in properties due to blending. Boards made with and epoxidized sucrose soyate methylene diphenyl diisocyanate blend also exhibited superior properties and could potentially be used commercially if it can be produced and blended economically.

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CELL WALL ORGANIZATION AND MOLECULAR CHARACTERIZATION OF DEVELOPING COTTON FIBERS IN TWO COTTON *(Gossypium hirsutum L.*) VARIETIES

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Cotton *(Gossypium hirsutum L.*) fibers, elongated epidermal cells of a cotton seed with well-developed secondary cell wall, go through five major overlapping development phases from fiber initiation to maturity. There is a continuous change in cell wall composition and organization throughout the development of cotton fibers, leading to cellulose macromolecules formation and deposition. The molecular weight and the molecular weight distribution of cellulose as well as the organization of cellulose chains within the secondary cell wall are linked to fiber strength. Those parameters could vary between cultivars and different stages of fiber development. Mature cotton fibers with more than 80% of crystallinity are difficult to dissolve in most common solvent systems. The main objective of this study was to (1) illustrate the changes in the molecular weight and the molecular weight distribution of cellulose in developing cotton fibers using Gel Permeation Chromatography and (2) to study the organization of cellulose in developing cotton fibers using Fourier Transformed Infrared (FTIR) microspectroscopy imaging. Fibers were harvested from two cotton cultivars of, (Texas Marker-I and TX 55) during different phases of fiber development. The variation in the composition and the cellulose organization within individual cotton fibers were investigated using FTIR imaging technique. Then, cotton fibers were subjected to a pretreatment step using 23% NaOH before dissolution in DMAc/ LiCl solvent system. The dissolved samples were analyzed using Gel Permeation Chromatography to determine the molecular weight and the molecular weight distribution. Moreover, the variations in the fiber morphology as well as the cellulose organization due to the pretreatment were investigated using Scanning electron microscopy, FTIR imaging, and X-Ray diffraction (XRD). Both FTIR and XRD show change in the crystallinity type and the level of crystallinity due to the NaOH pretreatment which may facilitate the dissolution process. Cellulose in immature cotton fibers shows lower molecular weight and broader distribution of molecular weight. However, mature cotton fibers have higher molecular weight and narrower molecular weight distribution. This study demonstrates that cellulose reaches maximum molecular weight and degree of polymerization around 36 days after anthesis, and no significant variations were observed towards fiber maturity. NaOH pretreatment is required for facilitating cellulose dissolution at a lower temperature with minimal effect on the molecular weight.

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DEVELOPMENT OF DIVERGENT HVI FIBER QUALITY TRAITS FROM TWO CHEMICALLY MUTATED POPULATIONS OF UPLAND COTTON (*Gossypium hirsutum* L.)

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Cotton (*Gossypium hirsutum* L.) is the world's most valuable natural fiber crop. The production cotton with very high quality fiber properties has become increasingly important over the last few decades. However, improvement of these fiber traits may be difficult because cotton lacks genetic the diversity typically seen in other crop species. The objective of this research was to develop a series of divergent mutant derived lines with fiber quality traits for cotton breeders to utilize in genetic and phenomic studies. Ethyl Methane Sulfonate (EMS) mutagenesis at a rate of 3.0 v/v percent was used to create mutant populations of two upland cotton (*Gossypium hirsutum* L.) cultivars (TAM 94L-25 and Acala 1517-99). High volume instrument (HVI) fiber testing was used to determine the fiber traits of progeny lines. Selections were made for fiber quality traits that exceeded two standard deviations from the mean and resulted in 3,122 mutant cotton lines. Across most measured traits, the phenotypic values of these mutant lines consistently deviated from the means of the parental cultivars (Acala 1517-99 and Tam 94L-25). Multi-year replicated studies at Lubbock, Texas demonstrated the repeatability of these fiber traits and may suggest the heritability of these divergent phenotypes. For all HVI fiber traits tested, the mutant lines exhibited statistically significant deviations from the parental population. This indicates that fiber traits were genetically enhanced through mutation breeding methods. It could be advantageous for cotton breeders to incorporate some of these traits into their breeding programs and to use these lines to develop molecular markers for fiber quality.

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SCREENING INDUSTRIAL HEMP (*Cannabis sativa* L.) VARIETIES FOR ADAPTATION IN NORTH DAKOTA

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After a 70-plus year absence in production, industrial hemp (*Cannabis sativa* L.) is being grown in university research trials in several states across the U.S. This effort begins the process of screening genotypes for adaptation and defining basic guidelines for production that will aid in crop commercialization. Twelve industrial hemp varieties sourced from Canada, France, and Australia were grown in a RCBD with four replicates at the Langdon Research Extension Center in northeastern North Dakota in 2015. Seeding dates were May 27, June 9, and June 16 for seed from Canada, France, and Australia, respectively. Plots consisted of four rows at a 30.5 cm row spacing and row length of 7.6 meters, with a targeted plant population of 130 plants/meter^2. Traits evaluated are stand establishment, seedling vigor, plant height and lodging, flowering, maturity, seed and biomass yield, seed oil content and composition, cannabinoid type and content, and fiber yield and quality. Pest incidence, plant development and competitiveness, and stand establishment and harvest concerns were noted. Stand establishment differed among varieties and ranged from 23.7 to 66.7 plants/m^2 with seedling vigor from 3.8 to 7.8 on a scale from 0 to 9 (high). Variety plant heights began to differ six weeks post-planting, where heights ranged from 1.4 to 1.6 m. Varietal plant height differences increased each successive week with heights ranging from 1.8 to 2.5 m nine weeks post-planting. Finola was the shortest variety, where as Canda and Alyssa were the tallest. Biomass and seed yield varietal differences are anticipated and important in identifying the more productive varieties for this location under the growing season conditions. Several years of varietal performance at a location are recommended when producers select varieties for planting to assure higher productivity and greater net profits. Including industrial hemp in cropping sequences enhances crop diversification which has many sustainability benefits associated with stewardship, economics, and community.

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THE IMPORTANCE OF FIBER CROPS AS SUSTAINABLE SOURCE FOR BIOBASED PRODUCTS AND BIOENERGY IN EUROPE AND CHINA

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Fiber crops are valuable feedstock for the textile industry, for eco-friendly building materials, particleboards, insulation boards, cosmetics, medicine and source for other bio-polymers, agro and chemicals as well as for supplying cellulose and hemicellulose for second generation biofuels. The fiber crops categorized to the: a) bast fiber, b) grass fiber, c) leaf fibers, d) seed hairs, e) palm fibers and f) wood fibers. In Europe the major fiber crops apart from cotton (*Gossypium hirsutum* L.) are the bast fiber crops hemp (*Cannabis sativa* L.), and flax (*Linum usitatisimum* L.). Along with bast fiber crops, high yielding grass fibre crops like miscanthus (*Miscanthus* x *giganteus*), arundo (*Arundo donax* L.), switchgrass (*Panicum virgatum* L.) are alternative and innovative fiber crops. Whether their fibers quality of the grass fibers is lower than that of bast fibers, the high productivity associated with a low energy requirement, could make them interesting feedstocks for papermaking, bio-building or biopolymers, and bioenergy purposes. In the light of a strong renewed interest in fiber crops and sustainable biobased production chains as well as the relevant research activity on fiber crops carried out from Europe and China a project entitled **FIBRA** (www.fibrafp7.net) was established in 2012. FIBRA project is sound link between EU and China that will lead to a wider stakeholders' participation, while providing a long term vision on future and common research activities between EU and the Republic of China. In FIBRA project emphasis is being given in two categories of fibre crops the bast fiber crops (flax, hemp, kenaf [(*Hibiscus cannabinus* L.), ramie (*Boehmeria nivea* (L.) Gaudich.), nettle (*Urtica* spp.), and jute (*Corchorus capsularis*), and grass fiber crops (giant reed, miscanthus, switchgrass, and bamboo (*Bambusa vulgaris* L.)) due to the common interest in these crops in both Europe and China. The area of the cultivation of *bast fiber crops* at world level (FAO, 2009) is estimated around 1975 Mha (64% jute, 16% flax, 10% ramie, 2 % hemp and 11% the bast fiber crops). The total cultivation area of bast fiber crops in China is 11.51 X 10^3 ha. Over the last 20 years, the total planting area of combined kenaf and other allied bast fiber crops has been declined due strong competition by synthetic materials as well as the increasing labor cost (285,000 tons in 2011 versus 648,000 tons in 1995). In China the highest productivity per ha is being reporting by flax (6.47 t/ha) and the lowest by ramie (1.98 t/ha). Miscanthus is one of the main raw materials used in the Republic of China for paper making, and in several studies undertaking miscanthus for paper pulp production. In Europe miscanthus is being cultivated in a total area of 3000 ha (Germany, Poland, Austria and UK) as raw material for solid biofuels, while it is considered a valuable alternative to wood fiber both for bio-building and paper pulp purposes in Europe as well as for second generation biofuels. The products from the fibers crops categorized to: a) fiber based products (such as paper & pulp, textiles, etc.), b) chemical products (sugar, oil, etc.), c) composite products (particle & fiber products, etc.) and d) energy products (pellets, biogas, etc.). The markets of the fiber crops by descending order in term of price value are textiles, non-woven, wood & timber, pulp & paper, board, cellulose dissolving pulp, cellulosic firms, building materials, cellulosic fiber composites, lignocellulosic biorefinery and green chemicals. In the final version of this article will be presented the: a) cultivation area of fiber crops in EU and China, b) the main findings of fiber crops agronomy and harvesting, c) the products from fiber crops (main, secondary and future products), d) the

markets of fiber crops in both Europe and China and e) the socio-economics and environmental implications.

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HOW SUSTAINABLE ARE BIOPRODUCTS FROM FIBER CROPS?

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Biobased materials are being promoted as promising substitutes to conventional fossil based materials, helping to reduce the dependence on non-renewable resources. Biobased industries benefit from the biocompatibility and biodegradability of biomass, along with their renewable and sustainable character, reducing the environmental impacts associated with the use and disposal of fossil derived materials (e.g. reduction of greenhouse gases emissions or disposal at the end of the technical life). Fiber crops, a major group of plants with economic importance, present diverse uses and industrial applications, such as textiles, papers, mats, hats, ropes and cordage material, as also composite applications for the automotive and construction industries. Yet, the increased demand for natural fibers might put pressure on the natural resources allocated to the cultivation and use of fiber based materials, such as biodiversity, water and soil. Also, the use of agrochemicals and the increased competition for land might contribute negatively to the environmental impact of these biochains. Therefore the aim of this work was to evaluate the environmental aspects of the cultivation and use of some bast fiber crops (kenaf (*Hibiscus cannabinus* L.), hemp and flax) regarding use of resources, emission of gases, effects on the quality of soil and water and biological and landscape diversity. Several biobased chains were considered in the analysis. Results indicate that cultivation and use of fiber crops offer ecological advantages over conventional ones, by contributing to carbon sequestration and energy savings, and to the reduction of greenhouse gases and non-renewable resources. Additionally, fiber crops present low input requirements (fertilizers, pesticides), alleviating the threads associated with the use of mineral resources and the acidification and eutrophication potential. Crop traits influence the biological and landscape diversity and impacts associated with soil quality, erodibility and use of water resources are linked with site conditions intertwined with crop traits. Therefore, the development of these crops in a sustainable agro-industrial framework should be based on proper crop management and processing choices, which significantly affect energy requirements, emissions, nutrient status and use of resources. Balancing the amount of fertilizers applied with the nutrient uptake by the plants is one of the options to improve the sustainability of the systems. Moreover, adequacy between crop and location is also mandatory, such as allocating high water demanding crops (e.g. hemp), to sites with high availability of water.

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ABSTRACTS

GENERAL CROPS DIVISION

ORAL PRESENTATIONS

CHAIR

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SWITCHGRASS (*Panicum virgatum* L.), MISCANTHUS (*Miscanthus* x *giganteus*) AND GIANT REED: WHICH ONE FITS BEST IN THE MARGINAL AREAS OF THE MEDITERRANEAN BASIN?

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Perennial grasses considered as ideal feedstock for both bioenergy and biobased products. The main reasons that make perennial grasses attractive feedstock for biomass production are: their high biomass yields, the high contents of lignin, cellulose and hemicellulose polysaccharides and their positive social and environmental benefits. Perennial grasses are also not seen as competing for agricultural land because they can be grown on marginal or degraded lands where intensive agricultural practices harm the environment and where the economic returns to the farmer's labour and capital are not sustainable. For more than two decades three perennial grasses namely miscanthus (*Miscanthus* x *giganteus*), switchgrass (*Panicum virgatum* L.) and giant reed have been investigated in the Mediterranean region in the framework of a number of research projects. Currently, in the framework of the EU research project OPTIMA (www.optimafp7.eu) these three perennial grasses are being compared (among others) on both agricultural and marginal agricultural lands in several experimental fields in the Mediterranean region. In Greece three new field trials (switchgrass, miscanthus and giant reed) have been established (2012) and their yields compared with old experimental fields (10-15 years old) that had been established in marginal lands in the framework of other research projects. The aim of all these trials is: a) to determine the appropriate management methods of these perennial grasses (varieties, planting densities, establishment methods, irrigation and fertilization rates, etc.) for achieving high biomass yields and b) to determine the effect of the land fertility and age of the plantation on yields. In all trials a number of measurements were carried out (plant density, stem diameter, plant height), while yields estimations were made based on harvests (4 square meters per plot) that carried out each year in January. Samples were taken from the final harvests and apart from measurements of the moisture content a number of laboratory analyses were carried out included proximate and elementary analysis as well as calorific value. It was found that when the three perennial grasses where cultivated in typical agricultural lands the yields were quite higher biomass yields and at the end of the second growing period the yields by descending order were 39.15 t/ha for giant reed, 25.91 t/ha for miscanthus and 24.92 t/ha for switchgrass. The corresponding values for these crops when had been cultivated on marginal lands were in some case 50% lower. In marginal lands the perennial grasses not only gave quite lower yields but also reached the peak yields quite later (in the third and the fourth year). Among the three grasses the effect of water deficit on yields was more profound for miscanthus, followed by giant reed. In the second year the yields for all perennial grasses were increased (two to four times higher compared to the establishment year).

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STALK SIZE OF SWEET SORGHUM (*Sorghum bicolor* L.) IS AFFECTED BY PLANTING ARRANGEMENT

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Current efforts to grow *Sorghum bicolor* (L.) Moench for biofuels in Arizona have focused on maximizing biomass, sugar yields, and harvest windows in order to supply optimum feedstock to processing facilities. Varieties tested have been either bred for the southeastern United States (harvested at 140 to 160 days after planting) or bred in Texas to be harvested sooner, around 110 days after planting. Our previous work has shown that as intra-row plant density decreases, stalk diameter and weight increase. Thicker stalks contain more juice and sugar and are sturdier, but the greater biomass can be a challenge to transport and process. This experiment was designed to further explore the relationship between planting density and stalk diameter. Seeds of eight varieties were sown on June 6, 2014 mechanically ('normal') and manually in 'hills'. Normal rows were planted with a tractor-driven grain drill at 18 seeds m^{-1}. Hills were planted as a cluster of three to five seed every 0.5 m. In this split-plot design, planting arrangement was the main plot and variety the sub-plot, with five replications. Each variety was harvested 30 days after half of the plants were flowering, which ranged from 110 to 169 days after planting. A 3.05m section from each of two harvest rows (4-row plots) was cut manually and field weight was recorded. A subsample of 15 plants was weighed with and without leaves and panicles. Stem diameters were recorded before the stalks were passed through a roller mill and juice collected and weighed. Juice samples were analyzed by HPLC with a differential refractometer. Theoretical yields of biomass, sugar, juice, and ethanol were calculated. For all varieties, stem diameters in the hills were significantly greater than those in the normal rows. Weights of the 15-stalk subsamples and juice were also significantly higher for the hill arrangements. However, results of ANOVA for field weight show no significant difference (p=0.4305) between planting treatments. Plants in normal rows were smaller but there were more of them per area.Leaves and panicles of plants in the hills were also heavier, suggesting greater leaf area and potential seed yield. While not used as human food in Arizona, it is the fifth leading cereal crop for subsistence farmers in arid environments in Asia and Africa. One crop that produces sugar, grain, and biomass would be an economical use of finite resources.

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ADDITION OF BIOCHAR TO SIMULATED GOLF GREENS PROMOTES CREEPING BENTGRASS GROWTH

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Organic amendments such as peat moss and various composts are typically added to sand-based root zones such as golf greens to increase water and nutrient retention. However, these attributes are generally lost as these amendments decompose in a few years. Biochar is a high carbon, extremely porous coproduct from the pyrolysis of biomass. Due of this high porosity, biochar has excellent water and nutrient retention. Additionally, unlike other organic amendments, biochar is extremely resistant to microbial decomposition, allowing it to remain in the root zone for many years. The objective of this research was to determine if incorporating biochar into sand-based root zones increased creeping bentgrass growth. Two biochars were prepared using a top-lit updraft design pyrolytic stove from stems of Princess-tree [PT; *Paulownia tomentosa* (Thund.) Steud.] and Frost grape (FG; *Vitis riparia* L.). A third biochar was purchased from a commercial producer (EG; Evolution Group, Alton, IL, USA). Pure calcareous sand (control) or mixtures of the three biochars and sand at 1, 5 and 10% volume biochar/total volume were prepared. Creeping bentgrass (*Agrostis stolonifera* L. 'Pure Distinction') plant heights, root lengths, and fresh and dry weights were evaluated in mixtures grown hydroponically in polyvinyl chloride tubes (112 mm outside diameter, 99 mm inside diameter) filled 30 cm deep with 1 cm diameter pea gravel, over which 30 cm of either pure sand or sand/biochar mixtures were added to mimic a United States Golf Association root zone. Five weeks after seeding plants grown in 5% FG biochar had significantly greater fresh and dry weights, shoot heights and root lengths than the 100% sand control. Shoot heights were also higher than the control in the 5% EG and 10% PT biochar treatments. In all the biochar treatments except for 1% EG, root lengths were significantly greater, with the roots of the 10% FG treatment approximately three times the length of the control. Based on these results it appears that the addition of certain biochars at 5 and 10% (v/v) rates would increase overall plant growth in sand-based root zones.

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AGRONOMIC AND ECONOMIC ANALYSIS OF GUAR (*Cyamopsis tetragonoloba* L.) IN COMPARISON TO DROUGHT TOLERANT CROPS ADAPTED TO THE TEXAS HIGH PLAINS

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Cotton (*Gossypium hirsutum* L.) has long been the most profitable crop on the Texas High Plains, but with depleting Ogallala Aquifer levels, water-efficient, alternative crops have never had a stronger presence. Proceeding many years of a devastating drought, supplemental irrigation has not been sufficient to make a sustainable cotton crop. Many producers need to see results of profitability before including alternative crops such as guar (*Cyamopsis tetragonoloba* L.), sorghum (*Sorghum bicolor* L.), and sesame (*Sesamum indicum* L.) into their current crop rotations. Guar, sorghum, and sesame are all able to grow with sustainable yields on dryland during average precipitation years, but the Texas High Plains never has a normal year of precipitation. This grand challenge calls for a need to decrease supplemental irrigation on current cotton crops, and drive home the idea of growing water-saving crops for generations to come or what we call sustainability. The objective was to conduct guar agronomic trials in Lubbock, Texas during the 2013 and 2014 growing seasons to determine: 1) cultivars adapted to drip irrigation; 2) guar lines resistant to foliar disease; 3) forage potential of guar; 4) and finally perform an economic analysis to determine sustainability of guar, sorghum, and sesame on the Texas High Plains. Two different, agronomic trials were planted at Lubbock, Texas on subsurface drip irrigation. Seventy-four experimental cultivars with five commercial cultivars were compared under drip irrigation for seed yield, seed size, and foliar disease resistance. While nine advanced cultivars with four commercial cultivars were compared under drip irrigation for seed yield, forage yield and value (2014), seed size, and foliar disease resistance. Forage yields in 2014 exceeded 4 tons per ha with a crude protein content exceeding 19%. Experimental lines showed higher disease resistance and seed yields exceeding older, publically released cultivars. Economic analysis was performed to compare the break-even price of guar, sesame, and sorghum to compete with an average two-bale cotton crop, and also the most profitable, water efficient crop-mix for a circle irrigation pivot.

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KINETICS OF NATURAL INDIGO DYE PRODUCTION FROM *INDIGOFERA TINCTORIA* PLANT BIOMASS

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Indigo, due to the contemporary popularity of denim, remains an important industrial product. Up to 19th century, indigo was extracted from plants. The synthetic indigo, owing to less cost and consistent quality, has replaced natural indigo in the market. However, most of the synthetic indigo were banned due to its toxic and carcinogenic nature. This has evoked much interest in the plant –derived indigo. Among the major crops for indigo production, *Indigofera tinctoria* is distributed majorly in India and few Asian countries. In India, presently indigo dye is produced from *Indigofera tinctoria* through traditional method. However, a detailed scientific understanding of the process is largely missing to be taken up for industrial production. The traditional process consist of fermentation, oxidation, followed by product settling. The first stage is fermentation which comprises of hydrolysis of indoxyl group (present as a precursor in the plants) into indoxyl. The unstable indoxyl then undergoes oxidation to form indigo dye and dye is later settled. Among the three stages, oxidation reaction in the fermented broth is critical, as it regulates the rate of production and purity of the indigo dye. Thus, it is very much essential to understand the kinetics of production to increase the rate of oxidation and maximize the production of indoxyl into indigo dye. The present study emphasize on the kinetics of oxidation of indoxyl to indigo. The experimental trials were carried out at various oxidation time from 5-80 mins. The indigo dye were later recovered, quantified using spectrophotometer and the yields were estimated. The kinetics was estimated based on the batch experiments data obtained at regular intervals of time. Using regression analysis with 1st and 2nd order rate equations, it was observed that indigo dye formation follows 2nd order rate equation (R^2 = 0.9739),with a rate constant 0.026 mmoles^{-1}L^{-1} min^{-1}.In the oxidation reaction, two indoxyl molecules reacts to form one indigo dye molecule. Assuming elementary reaction steps, the above inference of 2nd order is consistent with the theoretical understanding. In addition, it was also inferred that although the overall conversion of indoxyl to indigo is higher (nearly 100%), the yield was lower (less than 40%) at higher space time. This is owing to the cleavage of the bonds of indigo at higher concentration of indigo and oxygen in the solution. The proposed kinetic model in the present study will aid in establishing a base for a viable industrial process.

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ABSTRACTS

MEDICINAL AND NUTRACEUTICAL CROPS DIVISION

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RODOLFO JULIANI

TRENDS IN UNDERUTILIZED MEDICINAL PLANTS WITH PHYTO-PHARMACEUTICAL, FUNCTIONAL VEGETABLE, AND NUTRACEUTICAL TRAITS

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Fourteen underutilized legumes including *Bituminaria bituminosa* (L.) C.H. Stirt., guar (*Cyamopsis tetragonoloba* (L.) Taub., horsegram [*Macrotyloma uniflorum* (Lam.) Verdc.], hyacinth bean [*Lablab purpureus* (L.) Sweet, *Indigofera arrecta* Hochst. Ex A. Rich., *I. suffruticosa* Mill., jicama [*Pachyrhizus erosus* (L.) Urb.], *Leucaena leucocephala* (Lam.) de Wit, *Senna alata* (L.) Roxb., *S. alexandrina* Mill., *Tephrosia vogelii* Hook. f., *Teramnus labialis* (L.f.) Spreng, velvetbean [*Mucuna pruriens* (L.) DC, and *Zornia diphylla* (L.) Pers. are used as medicinal plants and functional vegetables worldwide. Additional non-legume species used or have the potential to be used as nutraceutical, medicinal, or functional vegetables include Chinese water chestnuts [*Eleocharis dulcis* (Burm. F.)] Trin. I, roselle (*Hibiscus sabdariffa* L.), *H. mutabilis* L., Madagascar periwinkle [*Catharanthus roseus* (L.) G. Don] and velvetleaf *Abutilon theophrasti* Medik.). Five additional legume species including *Desmodium discolor* (Aubl.) J.F. Macbr., *D. intortum* (Mill.) Urb., *D. sandwicense* E. Mey, *D. tortuosum* (Sw.) DC., and sericea lespedeza [*Lespedeza cuneata* (Dum. Cours.) G. Don] are used or have the potential to be used as medicinal forages. The objective of this study was to review several plant species in the S9 germplasm collection for current and future trends in medicinal, nutraceutical, and functional vegetable uses for both humans and animals. Several legumes and other species currently and with potential to be used in the medicinal markets will be identified and discussed. Phyto-pharmaceuticals including flavonols from roselle calyces, sennosides from *S. alexandrina*, levo-dopa from velvetbean seeds, vinblastine and vincristine from Madagascar periwinkle leaves, deguelin from *T. vogelii* leaves, inulin from Chinese water chestnut corms, flavonoids from several species, and plant extracts from additional species with uses ranging from anti-cancer, laxative, anti-parkinson's disease, tuberculosis, anti-bacterial diseases, anti-inflammatory, wound healing, treatment for rheumatoid arthritis, anti-gastrointestinal parasite, and prebiotic in humans and animals will be discussed. These species provide the medicinal, nutraceutical, and functional food arenas with valuable health products and can provide other scientist's and breeder's with unique germplasm for the potential development of advanced cultivars with one or more of these attributes. Furthermore, plant species in the S9 collection require evaluations for the identification, quantification, and variability of potentially and very valuable health traits which are currently unknown.

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ANTIBACTERIAL ACTIVITY *IN VITRO* OF *FLOURENSIA RETINOPHYLLA*. ENDEMIC PLANT FROM SEMI-DESERT OF COAHUILA, MEXICO

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Flourensia retinophylla is a branched shrub, 1-2.5 m high, strongly glutinous, aromatic (green apple aroma), which grows on rocky hillsides in semiarid regions of Coahuila in Mexico. Scientific information on the chemical composition and biological applications of the extracts of this shrub is scarce. It has been reported *in vitro* antifungal activity of ethanol extracts of this species against pathogens that attack commercial crops: *Alternaria* sp., *Rizoctonia solani* and *Fusarium oxysporum*. Currently, there are no reports on its antibacterial activity. The objective of this study was to evaluate the *in vitro* antibacterial activity of *F.* retinophylla leaf ethanol extract against six bacteria including *Staphylococcus epidermidis* (Gram-positive), *Enterobacter aerogenes*, *Escherichia coli*, *Proteus hauseri*, *P. miravilis*, *P. vulgaris* (Gram-nevative). *F. retinophylla* was obtained at the Paila Sierra (25◦59 N latitude and 101◦28 W longitude, 1300 m a.s.l), the ethanol extract of the leaves was prepared and antibacterial experiment was carried out and consisted of two tests. In the first, four treatments of *F. retinophylla* concentrations (125, 250, 500, 1000 ppm), a control (without extract) and a solvent control, against six bacteria were evaluated. In the second test, extract concentrations of 50 and 75 ppm against *P. hauseri, P. mirabilis, P. vulgaris* and *S. epidermidis* bacteria, and extract concentrations of 1500 and 2000 ppm against *E. coli* and *P. vulgaris* bacteria, and control treatments were evaluated. Each test was set up with a completely randomized design with three replications. The variables evaluated included colonies forming units per milliliter (CFU / ml) and percent of bacterial growth inhibition. The analysis for these two variables was performed by ANOVA ($p < 0.05$) and mean test (method of Tukey, $p = 0.05$) was using the software "R" V 3.2.0. In the two tests, ANOVA showed significant differences between treatments, mean comparison showed that extracts of *F. retinophylla* cause little growth of bacteria (CFU / ml), or a high percentage of bacterial growth inhibition (83 % to 100%). The ethanol extract of the leaves of *F. retinophylla* showed antibacterial activity against six species of bacteria (Gram-positive and Gram-negative), this extract could be the basis for the development of a natural drug for the control of diseases caused by these bacteria.

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ANTIFUNGAL EFFECT OF *JATROPHA DIOICA, FLOURENSIA RETINOPHYLLA*, AND *FLOURENSIA MICROPHYLLA* ON *FUSARIUM OXYSPORUM* IN TOMATO CROP

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Tomato (*Lycopersicon esculentum* L.) is the world's second most important vegetable in the market. One of the major diseases affecting tomato is produced by *Fusarium oxysporum*. Low-cost alternative for the control of this disease are natural plant extracts, which are considered environmentally friendly and suitable for use in food products. *Jatropha dioica, Flourensia retinophylla and Flourensia microphylla* are plants of semi desert of Coahuila that have shown antifungal effect *in vitro* against *Fusarium osysporum*. The objective of this study was to evaluate the antifungal effect of *J. dioica, F. retinophylla and F. microphylla* extracts on *F. oxysporum* f. sp. *lycopersici* (*FOL*) on tomato plants in greenhouse conditions. The experiment was performed during the summer and spring 2014. Tomato seedlings, type Saladett cv. "Rio Grande" with five weeks old were inoculated with *FOL*. The experiment was a completely randomized design for three extract with ten repetitions, in a the concentrations tested for *J. dioica* were 100, 300, 500, 1000, and 2000 ppm; for *F. retinophylla* were 100, 300, 500, 1000, 1500, and 2000 ppm, for *F. microphylla* were 100, 300, 500 and 1000 ppm, and two controls (absolute and inoculated) for each. The extracts were applied on four different dates. The variables evaluated were incidence and severity of the disease; dry weight of roots; height and diameter of the stem of the plant, and fruit yield. The severity was assessed using the non-parametric Kruskal-Wallis test ($p \leq 0.05$). Data root dry weight, plant height and stem diameter and fruit yield were evaluated by analysis of variance (ANOVA) ($p \leq 0.05$) and mean test by the method of DMS ($p = 0.05$). Total phenols content and antioxidant capacity of the extracts were determined. The ANOVA test showed significant differences between treatments for the variables evaluated in the tree species. The three plant extracts from *J. dioica* at 300 ppm, *F. retinophylla* at 300 and 500 ppm and *F. microphylla* at 1000 ppm showed significant antifungal activities. The extracts of these species from México could be considered good sources of natural compounds with significant antifungal and antioxidant activities. These properties can be attributed to their individual active principles or due to synergistic effects among the different constituents.

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SESAME (*Sesamum indicum* L.): PRESCRIPTION FOR THE MODERN HEALTH EPIDEMICS

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Over the past few decades cardio vascular diseases (CVD) has emerged as the major reason for death worldwide with16 million deaths in 2010. The United States, Center of Disease Control and Prevention (CDC) reports about 1 in every 4 deaths occur due to CVD. In 2010, the U.S spent $18.7 billion on statins that are the most effective drugs on the market today. Statins act by blocking a critical step in the production of low-density lipo proteins (LDL) and help reduce blood pressure. Statins also have several side effects including increase in creatine kinase, memory loss and muscle cramps that cause intolerance to this drug. Studies have also reported that frequent use of certain statins leads to increased risk for the development of type 2 diabetes. In order to simultaneously combat the global epidemics of CVD and type 2 diabetes it is essential to limit the use of statins. One of the substitutes for statins is the phytosterols found in plants which have a chemical structure very similar to cholesterol. The main mechanism by which phytosterols reduce blood cholesterol level is by inhibiting cholesterol absorption in the small intestine. Sesame (*Sesamum indicum* L.) seeds, sunflower seed, pistachio nuts, pumpkin seeds and fenugreek have high phytosterol levels. Studies have shown that high amount of phytosterols are found in sesame seeds (400 mg/100g). Sesame seeds are rich in sesamin, sesamol, episesamin and sesamolin that act as antioxidants, anti-diabetics and anti-hypersensitive agents. Phytosterols alone may not be able to lower the cholesterol to target levels but their use may lower the required doses of statins. In addition to this unique use, our results have shown that sesame is an excellent crop for production in arid regions. In our tests, non-dehiscent cultivars have shown potential yield in excess of 1500 kg/ha with seed oil content up to 50 %. Research on gene analysis, expression patterns and transcriptomic pathways of sesame plants with novel compound, such as phytosterols will allow the rapid development of sesame cultivars designed specifically for medical purposes.

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DIVERSIFICATION IN THE COMMERCIAL USE OF ESSENTIAL OILS

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Essential oils have captivated human interest since the dawn of civilization. Essential oils have been associated with history of humanity, particularly due to the aroma and uses of these unique plant products. The size of the fragrance and flavor industry, where essential oils play and important role, has been estimated at US$24 billion (2011 figures), with an annual growth of up to 10%. The growth of the industry makes essential oils high value niche crops that have provided income generation opportunities to rural communities and entrepreneurs in many parts of the world. In 1948, Ernest Guenther published a comprehensive treaty comprised of six volumes on the chemistry, botany, harvesting, processing and distillation of several commercial and non-commercial essential oils. The purpose of this extensive work was to provide the industry and government with exhaustive information on the production of essential oils. By providing a comprehensive study that is still be used today, Guenther contributed to make New York and New Jersey as one of the epicenters of essential oil use and manufacturing of the world. The objective of this work is to assess the number of essential oils used commercially that were described in the Essential Oils book by Guenther in 1948, and to compare this information with the current commercial use of essential oils, with the idea of identifying new trends in the use of essential oils. The number of single commercial essential oils and their species and families were counted in the book of Guenther and then these numbers were compared with the current number of essential oils at the retail online level. Essential oils offered by nine leading companies were used in this study. Guenther described almost 150 essential oils used commercially at that time. The current number of new essential oils used commercially is now more than a hundred, showing a significant change in the commercial diversification of essential oils. The presentation will provide some insights on opportunities for the development of new essential oils.

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ABSTRACTS

RUBBER AND RESINS DIVISION

ORAL PRESENTATIONS

CHAIR

KATRINA CORNISH

GUAYULE *(Parthenium argentatum* L.) PLANT EXTRACTS AS RECYCLING AGENTS IN HOT MIX ASPHALT WITH HIGH RECLAIMED BINDER CONTENT

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Increased usage of reclaimed asphalt pavement (RAP) and reclaimed asphalt roofing shingles (RAS) in hot mix asphalt (HMA) pavement mixtures has increased the use of recycling agents intended to return the age-hardened RAP/RAS binder (asphalt) to its original state. However, a decreasing (and ultimately depleted) supply of virgin liquid asphalt, and concerns over adverse health effects when using petroleum-based recycling agents have created the opportunity for bio-based solutions to these issues. The guayule plant is a woody perennial shrub that is native to areas of the southwestern U.S. and is a well-documented source of resin and high-quality rubber. The study objective was to determine the viability of using guayule-based materials as recycling agents in HMAs with high contents of RAP and/or RAS. Numerous extraction/recovery procedures were developed and performed using different solvents and guayule feedstocks (ground whole-shrub, pulverized leaves and attached stems, dried latex from a water-based extraction, and bagasse). For each solvent/feedstock combination, the de-solventized product was evaluated through testing. Eventually, two of the eleven guayule-based materials produced became the focus of the work: 1) RR or rubber resin; an acetone-extract from the dried latex, and 2) LF; a hexane-extract from the leaves and attached stems. Comparisons were made of these two guayule-based materials to two petroleum-based materials with similar viscosity-temperature relationships: the RR was compared to a commercially available recycling agent (Cyclogen L®), and the LF (stiffer than the RR) was compared to a soft, standard binder (PG 52-28) often used in HMAs with high contents of RAP/RAS. These comparisons were made through binder-blending mixture experiments using varying proportions of reclaimed RAP and RAS binders, and the appropriate recycling agent (guayule- or petroleum-based). The binder-blending mixture experiments eliminated the LF from further consideration regarding the objective. To further evaluate the RR, several tests were used to compare the performance of a HMA made with the RR with that of an identically produced and proportioned HMA made with the CycL. Of the many guayule-based materials investigated, the RR was shown to be effective in meeting the study objective.In conclusion, the study verified that the guayule plant holds great potential as a renewable, domestic source of flexible pavement mixture (e.g. HMA) binder and/or binder additives such as resins, oils, and polymers.

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DIRECT SEEDING GUAYULE (*Parthenium argentatum* L.): SOME RECENT RESULTS

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Guayule (*Parthenium argentatum* L.) continues to show promise as a potential alternative source of natural rubber. Successful commercialization is rapidly approaching, but current practices for establishing the crop are still not as cost effective and timely as desired. Commercialization will be greatly facilitated by successful, time efficient, low risk methods to direct seed guayule. Using a proprietary PanAridus procedure, we have successfully direct seeded guayule over three years and two locations. Our data suggests that direct seeded guayule produces significantly more biomass and rubber per hectare compared to transplanted guayule of the same age.

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FRUCTAN REDUCTION BY DOWNREGULATION OF *1-SST* IN GUAYULE (*Parthenium argentatum* L.)

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Parthenium argentatum L. (guayule) is a natural rubber (NR, *cis*-1,4,-polyisoprene) producing crop native to the southwestern US and northern Mexico that is under development as a source of rubber, resins, and biomass. Natural rubber derived from the guayule plant can provide a strategic raw material necessary for U.S. industry, defense, and medicine. Genetic improvement of guayule holds significant potential for efficiently increasing the yield of natural rubber. Fructan in the form of levulin and inulin polymers have been identified as major storage carbohydrates in guayule and may compete for available fixed carbon. The objective of our study was to determine if carbon flux could be deviated from carbohydrate production to natural rubber production in guayule through downregulation of the *1-SST* gene (sucrose-1-fructosyltransferase (EC 2.4.1.99)), the first committed step to fructan biosynthesis. Plasmid pND9-1SSTi was constructed by replacing the GUS reporter gene in the empty vector pND9 with an RNAi target, formed by an inverted repeat of a 418 bp DNA fragment from the *1-SST* gene. Eight independent transgenic lines and empty vector controls were obtained via leaf disc *Agrobacterium*-mediated transformation. In the laboratory, both resin and NR content of two-month old *in vitro* plantlets showed an increase over the wild type control in all lines. Fructan production was decreased from 30-80%. Green house evaluations were conducted on 6 month-old plants with 3 replications for each line. Downregulation of the *1-SST* gene was confirmed by RNA gene expression in all cases except one biological replicate. Both rubber and fructan production was significantly diminished in greenhouse plants compared to *in vitro* plantlets, to levels too low to differentiate genotypes. Interestingly, resin production was about the same for plants grown under greenhouse vs. culture conditions. In conclusion, we report genetic modification of guayule to downregulate the sucrose-1-fructosyltransferase gene *1-SST*. Rubber and resin yield was improved for *in vitro* plants while fructan production was lowered, suggesting deviated carbon flux from carbohydrate production to natural rubber production. However, greenhouse plants did not confirm the phenotype in most cases.

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DEVELOPMENT OF SSR AND SNP MOLECULAR MARKERS FOR GUAYULE *Parthenium argentatum* L.) BREEDING

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The interest in guayule (*Parthenium argentatum* L.) has increased significantly in the past decade due to its potential as an alternative commercial source of natural rubber. With the projected increase in global rubber demand for tires and other products, and projected cost increases in *Hevea* natural rubber, Bridgestone is investing significantly in research and development to bring this crop to commercialization. Genetic improvement of guayule is one of Bridgestone's research focus and we are seeking ways to improve the crop for higher yield and other traits that will make it suitable for large scale agriculture.

The objective of this study was to develop microsatellite (SSR) and single nucleotide repeat (SNP) markers that can be used as molecular tools to screen for genetic diversity, perform marker assisted selection, and aid trait introgression for guayule breeding.

Publicly available guayule expressed sequenced tags were used to develop 713 SSR primer pairs and testing was completed on 193 SSRs. A subset of 15 SSRs was used to screen the genetic diversity of USDA guayule collection and Bridgestone's private germplasm allowing us to estimate the genetic variation within accessions and among various guayule genetic groups.

In addition to SSRs, SNP markers were developed for guayule breeding. A total of 1,065 SNPs have been identified from four guayule sequence libraries and the level of polymorphism was studied. The two marker systems provide unique opportunities for routine use in guayule molecular breeding for plant improvement.

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ABSTRACTS

POSTER PRESENTATIONS

FIBER AND CELLULOSICS

BREEDING FOR IMPROVED FIBER QUALITY USING COTTON MUTANTS (*Gossypium hirsutum L.*) IN A PEDIGREE SELECTION SCHEME

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Cotton (*Gossypium hirsutum L.*) is one of the world's most important industrial crop. For the U.S. cotton industry to compete in International Markets, we need to develop cultivars with improved fiber length, strength and maturity. The short growing season of the Lower Great Plains of North America provides a difficult environment for the production of high fiber quality. In addition, the narrow germplasm base of our short season; cotton cultivars is a limitation factor. The Cotton Genetic Program at Texas Tech University, Lubbock, TX has historically concentrated its effort on the development of improved fiber quality using induced mutation. Chemical mutagenesis and subsequent selection have helped develop lines with enhanced fiber quality in genotypes adapted to this region. The main objective of this study was to use mutation to increase genetic variability, utilize divergent selection for identifying plants with high and low fiber quality parameters and use identified cotton fiber lines with divergent phenotype for pedigree breeding. From 2003 to 2013, divergent fiber quality traits in mutant populations of TAM 94 L- 25 and Acala 1517-99 were selected for high and low levels of strength, length and micronaire. In 2014, the resulting lines were crossed with three commercial cultivars to initiate a pedigree selection program for improved yield and fiber quality. Selected mutant lines ranged in fiber length from 25.5 to 34.5 mm fiber; fiber strength from 28.0 to 37.5 g/tex and fiber micronaire value from 3.0 to 5.0. Then, the F_1 plants were grown in a greenhouse to produce F_2 seeds. These seeds were planted at Texas Tech University Research Farm in Lubbock, TX in spring of 2015. The progeny derived from this study will hopefully allow for the development of elite germplasm lines with competitive lint yield and fiber quality. The current study will also contribute to the analysis of the inheritance and expression patterns of the traits responsible for desirable fiber quality parameters. These cotton mutant lines could potentially improve the international competitiveness of U.S grown cotton.

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IRRIGATION AND FERTILIZATION EFFECTS ON GROWTH AND YIELDS OF KENAF (*Hibiscus cannabinus* L.)VARIETY G4

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Kenaf (*Hibiscus cannabinus* L.)is an annual spring crop that can be cultivated in South Europe for both bio-based products and biomass production (biokenaf project, www.cres.gr/biokenaf). The purpose of this research work was to study the effect of irrigation, fertilization, and monoculture on kenaf yields for a period of three subsequent years in northern Greece (Xanthi, Thrace). Three field trials were carried out for three subsequent years (2012-2014) in northern Greece (Xanthi, Greece) and the tested factors were: four irrigation rates (I_0: no irrigation, I_1: 25%, I_2: 50%, and I_3: 100% of PET), three nitrogen fertilization rates (N_0: 0, N_1: 75, and N_2: 150 kg N/ha). It should be pointed out that each year the trial was established on the same place in order to test the effect of monoculture on yields. In all years the variety used was G4 (Guatemala 4); an early-maturing type. The field trials were established each year in the beginning of May (by seeds). Row spacing was 50 cm, while within the rows spacing was 10 cm. The experimental layout was a split-split plot design in three blocks. The size of each experimental plot was 6 m x 7 m (42m^2). In each trial the stem diameter and the plant height was measured regularly. At the same time, eight harvests were carried out in all trials for the estimation of the biomass yield. Samples from leaves and stems (bark and core) were taken for dry matter yields estimations. In all trials (2012-2014) the growth and yields were significantly affected by the irrigation rate. When the irrigation rate was increased (from zero irrigation to 100% of PET) the plants were taller, with larger stem diameter, and higher biomass yield. In the beginning of October 2012, the dry matter yield of kenaf was 7.07 t/ha (no irrigation), 14.51 t/ha (25% PET), 14.95 t/ha (50% PET), and 16.06 t/ha (100% PET). The corresponding values in October 2013 were 7.04, 11.06, 13.14, and 15.69 t/ha, while in October 2014 a significant decline was recorded and the biomass yields for the tested irrigation rates were 5.59, 7.00, 7.17, and 8.18 t/ha. As nitrogen fertilization was increased the biomass yields were also increased but the differences only in few occasions were significant. The yields were significantly affected by the fact that the trial was established on exactly the same place and were gradually declined from the first (2012) to the third trial (2014). The largest decline was recorded for the second to the third year. The mean dry matter yield in October 2012 was 13.31 t/ha, at the end of September 2013 was11.72 t/ha, and in the beginning of October 2014 was 7.07 t/ha. The yield reduction from the first to the third year in terms of dry matter yields was 47% (12% from the first to the second growing period and 40% from the second to the third). The yield reduction from the first to the third growing period is strongly depended on the fact that kenaf was cultivated on exactly the same field and on the fact that from year to year the number of the nematodes in the field was increased and affected biomass yield negatively.

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FUNCTIONAL EVOLUTIONARY STUDIES OF A COTTON (*Gossypium hirsutum* L.) FIBER INITIATION TRANSCRIPTION FACTOR

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The cultivate cotton (*Gossypium hirsutum* L.)(AD) is a major fiber producing crop, accounting for 90-95% of the world's cotton. This allotetraploid species originated from a polyploidy event 1-2 million years ago when the genomes of two diploid species [*G. arboreum* (A_2), and *G. raimondii* (D_5)] merged together. The parental A-genome cotton is spinnable fiber producing, with lower quality and abundance than tetraploid cotton, while D-genome doesn't produce spinnable fiber. It is uncertain, in the evolution of cotton species, when and how this spinnable fiber initiation trait emerged or disappeared. Here, we employed a model plant to study the functional evolution of a basic helix-loop-helix (bHLH) fiber initiation transcription factor (TF). Initially, Arabidopsis mutant plants defective in trichome initiation were transformed independently with constructs containing the bHLH TF from A- and D- diploid genomes, the parental genomes of the tetraploid species. The A-diploid species transgenic plants recovered the trichomes while the D-diploids were not perfectly correlating with the fiber initiation property of A-genomes. Further, the study was extended to understand the functional evolution of the bHLH transcription factor to determine whether the fiber initiation gene was evolved to be functional in A-genomes or lost the function in D-genomes. To achieve this, the bHLH transcription factor was amplified from different species of cotton from different genome groups of the different clades of the evolutionary tree (A, D, F, B, E, C, G, K, and *Gossypoides kirkii*, an out group).These were complemented in the trichome initiation defective mutant. The results from this study will lead to a greater understanding of the gain of function of the bHLH transcription factor during the evolution of the cotton initiation trait of A-diploid genomes.

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EXPLORING HIGH THROUGHPUT PHENOTYPING, PLANT ARCHITECTURE, AND PLANT-BOLL DISTRIBUTION FOR IMPROVING DROUGHT TOLERANCE IN COTTON (*Gossypium hirsutum* L.)

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There is a pressing need to identify and understand the effects of different irrigation regimes on plant-boll distribution, seed cotton yield, and plant architecture for improving yield and fiber quality under stress and/or drought tolerance of cotton ((*Gossypium hirsutum* L.).) cultivars. To identify the impact of different irrigation levels on the Texas High Plains 11 commercial cultivars and 7 breeding lines representing diverse genotypes and phenotypes were subjected to three drip-irrigation water regimes. This study had four replications and four row plots 7.62 m per entry arranged in a RCBD within each regime. Differences in soil water use were found between the different genotypes based on neutron probe data. Differences between genotypes based on total water use and irrigation level were also observed. Analyses of boll distribution revealed that there were significant differences ($P \leq 0.05$) between boll distribution and position of all cultivars across all water levels and cultivars within each water rate. High throughput phenotyping (HTP) also showed differences between cultivars based on leaf area indices (LAI), temperature, and plant heights. This data suggests that certain cultivars will be more beneficial under one irrigation then another. These findings also suggest that certain cultivars may perform well under multiple irrigation levels. We are exploring HTP to estimate the stress levels of diverse genotypes under multiple irrigation regimes and breed for better drought tolerance in the future.

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ABSTRACTS

POSTER PRESENTATIONS

GENERALCROPS

GROWTH AND SEED YIELD PERFORMANCE OF PROMISING GUAR (*CYAMOPSIS TETRAGONOLOBA L.)* GENOTYPES UNDER DIFFERENT PLANTING DATES IN DESERT SOUTHWEST

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Guar or cluster bean (*Cyamopsis tetragonoloba* L.) is alternative pulse crop that has potential to grow under limited water conditions in desert southwest. Guar can tolerate high temperatures and dry conditions prevailing in arid and semi-arid climates such as in New Mexico. Guar has multiple uses. It can be used as protein-rich high quality forage for animals. Fresh pods are used to cook as vegetables, while guar gum, a by-product of seed, is used in food, pharmaceuticals, cosmetic, and oil industries. Use of guar gum by oil industries in hydraulic fracturing has made USA biggest importer and consumer of guar. Study was conducted with objective of testing the yield performance of promising guar genotypes on various planting dates at two locations (Las Cruces and Clovis) in 2014. Apart from that, various growth parameters and days to maturity were also measured. 8 genotypes (NMSU1, NMSU2, NMSU3, NMSU4, NMSU5, NMSU5, NMSU6, NMSU7, and NMSU8) were tested under 4 different planting dates (April 25, May 15, June 16 and July 1) at Las Cruces, while 4 genotypes (NMSU1, NMSU2, NMSU3, and NMSU4) were tested under 3 different planting dates (June 18, July 7, and July 22) at Clovis. June planted guar produced comparatively higher photosynthetic rate, above ground biomass, and seed yield at both locations. NMSU5 and NMSU4 had produced significantly higher seed yield at Las Cruces, but no significant difference was observed between genotypes at Clovis. Planting date and genotypes had a significant interaction for seed yield at Las Cruces. NMSU5 produced maximum seed yield in April and May plantings, while NMSU4 and NMSU3 had highest seed yield in June and July plantings. Delayed planting had a negative effect on guar growth and seed yield due to unfavorable environmental conditions, which produced low plant growth parameters like above ground dry biomass, seed yield characters (number of pods and cluster per plant, 1000 seed weight, Harvest Index) and seed yield of guar. Planting date also affected maturity of guar. Low temperature and high humidity at maturity reduced seed yield and seed quality. High mean air temperature, long photoperiod and dry weather stimulated photosynthetic rate resulting in higher above ground dry biomass and seed yield of guar. In general, combined negative effect of low temperature, high humidity and short photoperiod produced low seed yield for delayed planting, while high temperature and long day length helped early planted guar to grow fast and accumulate more seed yield.

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A PRELIMINARY ANALYSIS ON THE POTENTIAL INDUSTRIAL CROPS FOR BIOENERGY IN ANGOLA

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Biomass is the major energy source in Angola contributing to 65% of the country's primary energy supply and 80% of Angolans rely on biomass for most of their energy needs, especially in rural areas. Nevertheless, in Angola, only 30% of the population has access to electricity, although Angola has extensive hydroelectric power resources that far exceed its present needs and crude oil production in Angola ranks second in sub-Saharan Africa.

In this work, an assessment of biomass resources potential for bioenergy in Angola is given, and more specifically the potential dedicated crops to energy and forest and the agricultural crops residues. Angola's biomass resources are substantial. Natural forest is the most significant biomass resource in the country, comprising an estimated 59 million hectares. Closed canopy forests dominate in the North West and in high altitude areas. Tree species include rosewood (*Dalbergia latifolia*), ebony (*Diospyros crassiflora*), and African sandalwood (*Brachyleana hutchinsi*), as well as mahogany (*Swietenia mahagoni*), tola (*Gossweilrodendron balsamiferum* Harms.), and mulberry (*Morus rubra*). There has not been a forestry inventory, either at the national or regional level, since the 1970s and the amount of residue available from forestry industry operations (e.g., logging, saw mills) is unknown. In the agricultural sector, Angola produced some 300 000 MT of sugarcane (*Saccharum officinale* L.) in 2002, and the potential for combined heat and power generation from sugarcane residue (bagasse) is estimated to be equivalent to between 20 and 31 GWh. Agricultural residues included those generated from sugarcane, maize (*Zea mays* L.), rice (*Oryza sativa* L.), sorghum (*Sorghum bicolor* L.) and pearl millet (*Pennisetum glaucum* L.), and other cereals, roots and tubers [cassava (*Manihot esculent*a Crantz), sweet potato (*Ipomoea batatas* L.)], pulses and oil crops, and fruits processing. Regarding dedicated crops; sugarcane, sorghum, and soybean (*Glycine max* (L.) Merr.) represent the most promising crops for bioenergy in a short term, but other crops have shown potential in this country.

ABSTRACTS

POSTER PRESENTATIONS

MEDICINAL AND NUTRACEUTICAL PLANTS

ANTIBACTERIAL ACTIVITY OF *PSACALIUM PAUCICAPITATUM*. PLANT FROM IXTLÁN DE JUAREZ, OAXACA, MEXICO

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Psacalium paucicapitatum is a plant known in Oaxaca, Mexico as "sweet potato deer", the inhabitants of the municipality of Ixtlan de Juarez in the Sierra Norte, have used this plant corms as traditional medicine, as anti-inflammatory, to relieve diabetes, and to heal wounds. Up to date there are no reports on its antibacterial activity. The objective of this study was to evaluate the *in vitro* antibacterial activity of the corms extract of *P. paucicapitatum* against six bacteria: *Staphylococcus epidermidis* (Gram-positive), *Enterobacter aerogenes, Escherichia coli, Proteus hauseri, Proteus miravilis, Proteus vulgaris* (Gram-negative). *Psacalium pauicicapitatum* corms were collected at the site of Rancho Texas, in the municipality of Ixtlán de Juarez, in the northern sierra of Oaxaca, Mexico. The corms extract was prepared and antibacterial experiment was carried out and consisted in two tests: In the first, four treatments of *P. pauicicapitatum* concentrations (125, 250, 500, 1000 ppm), an absolute control (without extract), and solvent control, against six bacteria, were evaluated. In the second, extract concentrations were increased to 2000, 2500, 3000 and 3500 ppm, and absolute control against the six bacteria were evaluated. Each test was set up with a completely randomized design with three replications. The variables evaluated were: colonies forming units per milliliter (CFU / ml) and percent of bacterial growth inhibition. The analysis for these two variables was performed by ANOVA (p <0.05) and mean test (method of Tukey, p = 0.05) was using the software "R" V 3.2.0. The results showed for the first test that, *P. hauseri* had the highest bacterial growth inhibition (98%) to a concentration of 125 ppm. *S. epidermidis*, *E. coli*, and *P. miravilis* showed lower inhibition percent ranged between 50% and 60%, at concentrations of 125 to 500 ppm. By contrast *E. aerogenes* and *P. vulgaris* showed no inhibition. In test two, increasing concentration of the extract it caused 100% inhibition of bacterial, on *E. aerogenes*, *E. coli*, and *P. vulgaris*. Moreover *P. miravilis* and *P. hauseri* presented bacterial inhibition of 85-90%, the lowest inhibition was presented by *S. epidermis* with 75%. The corms extract of *P. paucicapitatum* showed antibacterial activity against six species of bacteria (Gram-positive and Gram-negative), this extract could be the basis for the development of a natural drug for the control of diseases caused by these bacteria.

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EFFECT OF *Rhus muelleri* EXTRACT AGAINST *Fusarium oxysporum* f. sp. *lycoperisici* ON TOMATO (*Lycopersicum esculentum* L.) PLANTS

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Fusarium oxysporum f. sp. *lycopersici* (FOL) is the pathogen that causes one of the most destructive diseases in tomato plants. The use of plant extracts to control this disease is an alternative to using synthetic fungicides. *Rhus muelleri* Standl et F. A. Barkley is an endemic plant of Mexico, distributed in the Sierra Madre Oriental. Antifungal in vitro study of *R. muelleri* against FOL showed a minimum inhibitory concentration 50% (MIC 50) at 3363 ppm, and MIC 90 at 11793 ppm. Currently, there is no scientific information on control of FOL by *R. muelleri* in tomato plants. The objective of this research was to evaluate the effect of different concentrations of ethanol extract of *R. muelleri* in FOL control in tomato plants. The experiment was performed during the summer and spring (2014). Tomato seedlings, type Saladett cv. "Rio Grande" with five weeks old were inoculated with FOL. The experiment was a completely randomized design with 8 treatments and 8 repetitions, the treatments were 6 concentrations of ethanol extract of *R. muelleri* (100, 300, 500, 1000, 1500 and 2000 ppm) and two controls (absolute and inoculated). The extracts were applied on four different dates. The variables evaluated were incidence and severity of the disease; dry weight of roots; height and diameter of the stem of the plant, and fruit yield. The severity was assessed using the non-parametric Kruskal-Wallis test ($p \leq 0.05$). Data root dry weight, plant height and stem diameter and fruit yield were evaluated by analysis of variance (ANOVA) ($p \leq 0.05$) and mean test by the method of DMS ($p = 0.05$). The chemical composition analysis of the ethanol extract was performed by GC-MS. The ANOVA showed significant differences between treatments for the variables evaluated, treatment of 1000 ppm, was the one who achieved the greatest inhibition of the pathogen, represented this at lower incidence (87.5%) and severity (2.38). Besides plants showed greater height (156.37 cm), stem diameter (9.98 mm) and fruit yield (359.20 g/plant). Eight bioactive compounds were identified in the extract of *R. muelleri*. The *R. muelleri* extract representing an alternative to be used as a botanical fungicide, which substitutes the use of synthetic fungicides.

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CHEMICAL ASSESSMENT OF WILD GERMPLASM *OF LIPPIA INTEGRIFOLIA*: A NATIVE AROMATIC AND MEDICINAL PLANT FROM ARGENTINA.

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Lippia integrifolia (Griseb.) Hieron. (Verbenaceae) is an aromatic woody perennial shrub, popularly known as "incayuyo" that grows in northwest and central Argentina. It is a native species of major economic importance currently under intensive harvesting pressure in the wild, according to the National Institute of Agricultural Technology of Argentina, due to its highly value medicinal uses and aromatic/flavor properties. The decoction of the leaves and flowers are traditionally used against dyspepsia, indigestion and stomachaches, diuretic, emmenagogue, antibiotic for gonorrhea infections, febrifuge, to treat cough, and as a sedative. In Argentina, incayuyo is an ingredient of aperitifs and teas, as is included in the Argentine Food Code. The objective of this study was to assess the chemical diversity of *Lippia integrifolia* essential oils and to evaluate the sensory profiles. The collected material was dried and subjected to steam distillation on a Clevenger equipment modified with an extraction chamber. The composition of essential oils was determined by gas chromatography/mass spectrometry (GC/MS). The oils from some of the wild populations showed bright yellow notes that was related with high levels of an unusual essential component, the sesquiterpene africanene that dominated the profile of the oils (35-40%). While other varieties lacking this component, showed a pale yellow color. The sensory evaluation and chemical assessment of essential oils serve to select lines that are best suited for use in beverages and other products. This study will help to assess quality characters of this essential oil to generate trade standards to increase their interest and contribute to their future commercialization as new products.

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ABSTRACTS

POSTER PRESENTATIONS

OILSEEDS

DEVELOPMENT OF NON-SHATTERING SESAME (*Sesamum indicum* L.) LINE

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Sesame (*Sesamum indicum* L.) is an important oil crop in Korea. But upon maturity, the capsules split open, and the seeds fall out. For that reason, sesame is harvested manually. Mechanization of sesame harvest depends on the development of a non-shattering sesame variety. There are three kind of non-shattering sesame types (seamless, closed, and little-opened). Seamless and closed types are difficult to mechanize the harvest. Nowadays little opened sesame type is cultivated in U.S.A. They are called improved non-dehiscent sesame. The objective of this study was to develop several non-shattering sesame lines. We screened about 1,367 germplasms for non-shattering type and selected several non-shattering germplasms. 1,029 accessions were from the Rural Development Administration (RDA) Genebank, Republic of Korea (http://www.genebank.go.kr) and 358 germplasms were from USDA/ARS (http://www.ars.usda.gov). The selected non-shattering germplasm, we made several populations. And we investigate the segregation ratio of non-shattered capsule plant versus shattered plant. The segregation ratio was 15:1 in the F_2 population (opened capsule type versus closed capsule type). And the segregation ratio was unclear in the F_2 population (opened capsule type versus little opened capsule type). Two recessive genes are related to closed capsule type. More studies are needed to confirm genes related to little opened capsule type.

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DEVELOPMENT OF BLACK SEED COAT COLOR PRE-BREEDING LINE FOR DETERMINATE TRAIT IN SESAME (*Sesamum indicum* L.)

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Sesame (*Sesamum indicum* L.) (chromosome number 2n = 26) is a flowering plant in the genus *Sesamum*. Wild relatives of sesame occur in Africa and India. Sesame seed is one of the oldest oilseed crops known, domesticated well over 3000 years ago. It grows well and produces high yields in both tropical and temperate climates. Consumers like to eat sesame oil because it is rich in oil, protein, and other nutritional components. Sesame plant has some problems, such as susceptibility to diseases and pests during the growing season. The indeterminate habit of sesame genotypes influence the seed maturity in producing high quality sesame seeds. A sesame genetic resource 'dt45' was developed with gamma rays by Ashri in 1998. The black seed coat color sesame is much expensive than white seed coat color sesame on the market in Asia countries. The objective of this study was to develop high yielding black seed coat color pre-breeding lines with determinate trait using a 'dt45' white color sesame genetic resource. A high yielding black sesame cultivar 'Daheuk (indeterminate genotype)', and 'dt45 (determinate genotype)' was obtained from the Rural Development Administration (RDA) Genebank, republic of Korea (http://www.genebank.go.kr) to create a new population. Before crossing work, these two plant materials identified with homozygous genotype, determinate or indeterminate phenotype from two times of regeneration in the greenhouse to prevent out crossing by honey bes (*Apis melifera* L.). A population was derived from a cross Daheuk X dt45 in June 2013, and F_1 plant was grown in the greenhouse to produce F_2 seeds for further studies. A F_2 population was planted into plastic pot in May 2014 in the greenhouse and F_3 population was planted in the greenhouse and field to evaluate agricultural traits. It was evaluated for segregating ratio in determinate phenotype, heritability of plant height, number of capsule, seed coat color, sesame yield and dt-allele effects for the other agricultural traits in present population. We found several high yield lines with black and white seed coat color indeterminate phenotype sesame plants compared with high yield parent 'Daheuk', but no determinate phenotype sesame line found with high yield and black seed coat color sesame in this study. It will be needed to increase the population size and number of crossing combinations to select ideal type pre-breeding lines on the next study.

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PROCESSING OF CORIANDER (*Coriandrum sativum* L.) FRUITS FOR THE PRODUCTION OF ESSENTIAL OIL, TRIGLYCERIDE, AND HIGH PROTEIN SEED MEAL

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Coriander (*Coriandrum sativum* L.) is a summer annual traditionally grown for use as fresh green herb or as spice. The essential oil extracted from coriander fruit is also widely used as flavoring in a variety of food products. The fatty oil (triglyceride) fraction in the seed is rich in petroselenic acid (cis 6-octadecenoic acid), which has the potential to be converted into lauric and adipic acids. Lauric acid is a raw material in the manufacture of emulsifiers, detergents, soaps, and other personal care products. Adipic acid, on the other hand, is used in the production of engineering plastics. Some coriander varieties with short growing seasons (less than 90 days from planting to harvest) may be suitable for a double crop rotation with winter wheat (*Triticum aestivum* L.) grown in Midwestern US. Integrating coriander as a second crop will provide oil for industrial use without displacing a crop for food production. Coriander essential oil, the most valuable product from coriander seeds, is commonly produced by steam distillation. There are a few reports on the extraction of triglyceride and none on the processing of defatted coriander seed meals. This study evaluated the dehulling of the steam-distilled ground coriander fruit before triglyceride extraction. The coriander fruits were split using a roller mill before steam distillation. After drying, the steamed ground fruits were passed through an impact mill and the free hulls were separated by screening and aspirating. The triglyceride was extracted from the dehulled seeds by prepressing followed by hexane extraction. About 93% (6.8 g/kg) of the essential oil was recovered after 1.5 h of steam distillation. The dehulling process removed >86% of the hull. Dehulled seed with purity >95% was attainable. Dehulling the coriander fruit reduced its weight by 50% and doubled the oil content. The dehulled seeds have 70% higher crude protein than the whole fruit. Defatting the meal (0.5% oil content) increased the crude protein content to 35%.

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PRELIMINARY FIELD TRIALS FOR CUPHEA (*Cuphea viscossisima* Jacq. *x lanceolata* W.T. Aiton) IN GREECE

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Cuphea ((*Cuphea viscossisima* Jacq. *x lanceolata* W.T. Aiton)) is a new oilseed crop whose seed provides a rich source of medium-chain triglycerides. Its distribution is limited to Mexico and Central America where it is endemic. There are over 260 species, which adapt to different types of soil (from sandy to clay with a tendency for lightly acid soils) and water availability. Cuphea seed oils have a high content in C10 to C14 fatty acids, right in line with theoretical properties of jet fuel. In the framework of the EU research project entitled EUROBIOREF (www.eurobioref.org) cuphea was cultivated in Greece in comparison with other oil crops (crambe (*Crambe abyssinica* Moench.), lesquerella (*Physaria fendleri* L.), safflower (*Carthamus tinctorius* L.), lunaria (*Lunaria annua* L.) and castor (*Ricinus communis* L.) for a period of three subsequent years (2012-4). In all years the variety was used was 'PSR 23', the only one commercially available. The distances between the rows were 50 cm. The sowing in 2012 was done in the beginning of May, while in the following two years (2013, 2014) was carried out earlier in the second half of April. In the first two years were established only three plots that compared with the above mentioned oil crops, while in the last trial cuphea growth and yields were tested in five nitrogen fertilization rates (0, 20, 40, 60 and 80) in three replications. A drip irrigation system was established to irrigate the plants. Special attention was given to the weed control at the early stages of growth. In all years the harvest was done manually in an area of 10 m^2 per plot and the seeds were separated and both seeds and remaining biomass were weighted. Samples from both fractions were taken for dry matter determinations. In all trials the plants had a satisfactory growth with height that varied from 90 cm (2012, 2014) to 123 cm (2013). It was noticed that the seeds did not had homogenous ripening and in all years seed losses were recorded. The achieved seed yields were quite low in the first trial (124 kg seeds/ha) and were significantly increased in the second trial (365 kg/ha, three times higher) and were further increased in the third (605 kg seeds/ha). It was found (third year) the seed yields were gradually increased (from 572 to 633 kg seeds/ha) when the nitrogen fertilization rates were increased (from 0 to 80 kg N/ha). The yields of the remaining biomass was 0.75 t/ha in 2012, 1.24 t/ha in 2013 and 2.52 t/ha in 2014 (oven-dried, moisture content 10-15%). The oil content in seeds collected from 2013 trial was 19.8%, while in the samples of 2014 was higher and was 21.9%. The gross calorific value of the remaining biomass was 3829 kcal/kg that is quite comparable with other energy crops. It was found that the ash content was quite high and was 10.56%, while the nitrogen content was quite low and was 0.99%. The results that were obtained from these three preliminary field trials were satisfactory but lower and comparable with the international literature. In order to have a clear picture of the crop when grown in the climatic conditions of South Mediterranean is needed in order to determine the appropriate cultivation techniques (row spacing, plant density, sowing time, irrigation and fertilization needs, weed and diseases control) for seeds maximization.

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DEVELOPMENT OF A NIRS METHOD TO MEASURE QUALITY CHARACTERISTICS IN *BRASSICA* GERMPLASM

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Hydrotreated renewable jet (HRJ) fuels from plant oils have been commercially demonstrated as an alternative to petroleum jet fuels, but full-scale production has not occurred because of concerns over cost and competition with food production. Rapeseed (*Brassica napus* L.), along with *Brassica carinata, Brassica juncea, Brassica rapa, Camelina sativa* L., and *Sinapis alba*, are potential feedstock for producing HRJ fuel. One challenge for using these oilseeds is the minor seed components, including glucosinolates and chlorophyll that can cause poor oil quality and increased refining costs. Screening seed samples for quality characteristics can be time consuming, destructive, and expensive. Near-infrared spectroscopy (NIRS) is an alternative screening method that is both fast and non-destructive. A total of 367 seed samples from 18 cultivars grown at seven locations across the United States were scanned with NIRS. NIRS scans required approximately 1 g of whole seed and took less than 2 minutes per sample. The moisture content, total oil content, and fatty acid profile were determined for all of the samples while nitrogen, chlorophyll, and glucosinolate content were determined for a subset of the samples. Destructive methods including GC (fatty acid profile), combustion analysis (nitrogen), UV-Vis (chlorophyll), and HPLC (glucosinolates) were used for many of the analyses. Calibration equations were then developed using WinISI and modified partial least squares (PLS) regression analysis. Global calibrations were developed rather than making separate calibrations for each of the 6 species. Comparing predicted values to the reference data, the calibration equations for moisture (r^2=0.83), total oil (r^2=0.97), nitrogen (r^2=0.98), and glucosinolates (r^2=0.92) showed good performance. The range of values for chlorophyll content was very large, 0-390 mg/kg, so two calibration equations were developed, one for the higher range and one for the lower range. When combined, the calibrations also showed very good performance (r^2=0.99). The performance of the calibrations for the fatty acids was more varied with some performing very well, such as the calibration for $C_{18:3}$ (r^2=0.99), and others very poorly, such as $C_{22:0}$ (r^2=0.28). These NIRS calibrations can be used to screen samples in the future and can be updated with additional reference data to become more robust. The NIRS method is especially useful for situations such as genetic trials where only a few grams of sample are available and destructive analysis for all of the quality characteristics is not possible.

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DETERMINATION OF VERNALIZATION REQUIREMENTS OF FIELD PENNYCRESS (*Thlaspi arvense* L.)

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Field pennycress (*Thlaspi arvense* L.) is a winter annual weed species that is being studied as a cover crop and biodiesel source. A critical step in developing new varieties of pennycress is determining the vernalization and flowering requirements. The objectives of this study were to identify the developmental stage in which seeds are able to sense a cold treatment and the optimum ratio of warm to cold days that are required to break floral dormancy. Twenty-five seeds of the dormant winter pennycress line 'Beecher' were placed in 90 separate sealed Petri dishes with moistened filter paper and placed under warm conditions (21°C). At 1 to 7 days, three replicate petri dishes were transferred to the cold (4°C) conditions for an additional 5, 10, 15, or 20 days. After the cold treatment, petri dishes were returned to warm conditions and twelve individual germinated seeds from each petri dish were transferred to soil and scored for flowering after 40 days. Seeds placed in 20 days cold with no prior warm period had a 20% flowering rate, whereas seeds placed under only a warm period had no flowering. The greatest number of flowering plants was seen with 3 days of warm and 20 days of cold (100% flowering rate). Increased exposure to warm temperatures after 3 days increased the cold period required to break floral dormancy. The results from this experiment will give researchers a better understand of how and when genes are up-regulated to control both seed dormancy and floral initiation. Plant breeders could also use this information to coordinate the flowering time of plants for controlled crosses.

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EFFECTS OF NITROGEN ON FIELD PENNYCRESS (*Thlaspi arvense* L.) SEED PRODUCTION

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Field pennycress (*Thlaspi arvense* L.) is being investigated as a new off-season oilseed crop for the Midwest region. Ecotypes of pennycress have been shown to respond differently to applied nitrogen rates. How pennycress flowering and seed characteristics are affected by nitrogen will help breeders better understand how to select varieties to maximize seed yield. This study was initiated to closely evaluate the effect of nitrogen rates on specific flowering and seed production characteristics that directly relate to seed yield. A growth-chamber experiment was conducted on a non-dormant spring pennycress line 'Spring 32', with six nitrogen rates of 0, 28, 56, 84, 112, and 140 kg N ha^{-1}. of nitrogen per acre. Each experimental pot contained a single plant and was replicated five times. All pots were watered by capillary mat irrigation to minimize fertilizer run-off. Plant height, filled and aborted pod number, pod diameter, number of seeds per pod, floral branching, plant tillering, and seed and biomass yield were all measured for each treatment. The highest rate of 140 kg N ha^{-1} resulted in significant changes in branches, tillers, pods per plant and seeds in comparison with the other treatments. The 140 kg N ha^{-1} rate had an estimated total seed yield of 2090 kg ha^{-1} while 0 kg N ha^{-1} had a total seed yield of 771 kg ha^{-1}. Understanding the ideal nitrogen rates for pennycress to obtain optimal seed yields will further improve a producer's ability to grow this new crop successfully.

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EFFECTS OF PLANTING DENSITY ON FIELD PENNYCRESS (*Thlaspi arvense* L.) SEED PRODUCTION

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Field pennycress (*Thlaspi arvense* L.) is a new oilseed crop, belonging to the Brassicaceae family, and related to canola (*Brassica juncea*) and rapeseed (*B. rapa* and *B. napus*). Unlike canola and rapeseed production, optimal production guidelines for pennycress have yet to be established. Planting density or seed rates can dramatically influence seed production and yield. This study investigated the effect of plant density on specific flowering and seed production characteristics that directly relate to seed yield. A growth chamber experiment was conducted on a non-dormant spring pennycress line, 'Spring 32' at eight different plant densities of 1, 2, 3, 4, 5, 6, 8, and 9 plants per pot. Each pot soil measured 10 cm^2 and was replicated five times at a single fertilizer rate of 56 kg N ha^{-1}. Plant height, filled and aborted pod number, pod diameter, number of seeds per pod, floral branching, plant tillering, and seed and biomass yield were measured for each plant in each treatment. The increase of plant density had a significant influence on all plant measurements except number of aborted fruits. The seed weight decreased significantly as plant numbers increased, from 0.12 g with one plant to 0.09 g with nine plants. The mean weight of the total seed produced per pot increased from 1.3 g to 1.7 g, as density increased. Understanding the ideal planting density for pennycress to obtain optimal seed yields will further improve a producer's ability to successfully grow and introduce this new crop into the Midwest.

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DEVELOPMENT OF NON-SHATTERING SESAME (*Sesamum indicum* L.)LINE

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Sesame (*Sesamum indicum* L.) is an important oilseed crop in Korea. But upon maturity, the capsules split open, and the seeds fall out. Sesame is harvested manually and in order to mechanize the harvest developing a non-shattering sesame variety is needed. There are three kinds of non-shattering sesame types (seamless, closed, and partially opened). Seamless and closed type have difficulties to mechanize the harvest sesame. Nowadays partially opened sesame type is cultivated in the U.S.A. They are called improved non-dehiscent sesame. The objective of this study was to develop several non-shattering sesame lines. Approximately 1,367 germplasm accessions for non-shattering type were evaluated and several non-shattering germplasm were selected. The germplasm accessions were 1,029 from the Rural Development Administration (RDA) Genebank, Republic of Korea (http://www.genebank.go.kr) and 358 from USDA-ARS (http://www.ars.usda.gov). Using selected non-shattering germplasm, several populations were developed and the segregation ratio of non-shattered capsule plant versus shattered plant was studied. The segregation ratio was 15:1 in the F_2 population (opened capsule type versus closed capsule type). The segregation ratio was 15:1 in the F_2 population (opened capsule type versus little opened capsule type). Two recessive genes are related to closed-capsule type. Two recessive genes are related to little opened-capsule type.

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EVALUATION OF A HEAD DESIGNED FOR CASTOR (*Ricinus communis* L.) COMBINE HARVESTING

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The increase in production of castor (*Ricinus communis* L.) in several countries is limited by the technology for mechanical harvest because the costs for hand picking became prohibitive. A head for combine harvest was especially designed for castor by the company Jorge Máquinas Agrícolas (Rondonópolis, Brazil). The prototype was developed in 2013, and the operational head was released for commercial use in 2014. The head works with rotating cylinders with bristles that remove castor fruits without cutting the plant stems. The combine harvester used for corn (*Zea mays* L.) receives some adaptations in internal mechanism in order to increase efficiency for castor processing. This study had the objective of evaluating the performance of the head for castor combine harvest at field conditions. Evaluations were performed for three year in castor fields (≈1,000 ha) cultivated in Primavera do Leste, MT, Brazil. The fields were planted with Kaiima hybrid seeds at 0.9 m row spacing. Castor was planted after soybean (*Glycine max* L. Merr.) crop in February/March and harvested in August/September each year. Standard protocols were followed for fertilization and weed control. Harvest aids were not used because the crop was harvested after a long period of drought and leaves were naturally senesced. Sampling points were randomly selected in the field, and the sample area was delimited. Fruits and seeds were carefully collected in the ground before and after the harvesting operation. Fruits that remained attached to the plant after the harvesting operation were collected as well. Samples of the harvested seed were collected inside the harvester to evaluate the content of unpeeled and broken seeds and contaminants. The samples were taken to laboratory; seeds were extracted from fruits, cleaned, and weighed. The seeds found in the ground before harvest were 44 kg ha^{-1} in 2013, negligible in 2014, and 39 kg ha^{-1} in 2015. The harvesting operation dropped the equivalent to 404, 343, and 247 kg ha^{-1} in 2013, 214, and 2015 respectively. The analysis could not separate between how much castor seed was dropped by the head and how much was expelled after the dehulling process. Fruits left attached to the plant totaled 54, 22, and 12 kg ha^{-1} in this order from 2013 through 2015. The quality of harvested seed was not evaluated in 2013. Unpeeled seeds accounted for 6.3% in 2014 and 3.8% in 2015. Broken seeds were 2.2% of the sample weight in both years. Contaminants like stem, leaves, and hulls weighed 0.1% in 2013 and 0.5% in 2015. The head for combine harvest was efficient for castor. Most of the seed loss occurs during the harvesting process. The seed loss due to shattering and uncollected fruits were not expressive. The head is improving the harvest efficiency every year, with reduced seed loss and less fruits being left attached to the plant. The amount of unpeeled and broken seeds and contaminants are acceptable for the quality standard required by the oil extraction industry.

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