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# 2007-2010

# AROMATIC PLANT

## CROP HUSBANDRY (1 JDL)

Saudan Singh, Man Singh, Anil Kumar Singh, Alok Kalra, Anju Yadav, D.D. Patra, Enhancing productivity of Indian basil (Ocimum basilicum L.) through harvest management under rainfed conditions of subtropical north Indian plains,
***Industrial Crops and Products,*** Volume 32, Issue 3, November 2010, Pages 601-606, ISSN 0926-6690, DOI: 10.1016/j.indcrop.2010.07.007.
(http://www.sciencedirect.com/science/article/B6T77-50V4VMH-1/2/fcafb1d307818f75d7a12e4218861745)

**Abstract:**

A field experiment was conducted during 2004 and 2005 at the research farm of Central Institute of Medicinal And Aromatic Plants, Lucknow located at 26.5[degree sign] N 80.5[degree sign] E and 120 m above the mean sea level to study the effect of harvesting stage and cutting height on growth, yield and quality of Indian basil. The objective of this study was to increase the essential oil yield of Indian basil without adverse effect on quality by taking two harvests through manipulating harvesting stage and cutting height and to increase the land and rain water utilization efficiency under rain fed condition. The treatments consisted of four stages of first harvest (40, 60, 80 and 100 days after transplanting (DAT)) and three cutting height (0, 7.5 and 15.0 cm above ground level). The Indian basil (Ocimum basilicum L.) crop harvested at 40 and 60 days after transplanting maintaining 7.5 and 15 cm height from ground level could produce second (ratoon) crop. The crop harvested at 40 DAT at a 15 cm height produced 20% higher essential oil (162.5 kg ha-1) compared to 132.0 kg ha-1 oil obtained from traditional practice of harvesting at 80 days after transplanting from ground level, without any adverse effect on the quality of essential oil. For maximizing oil production first harvest of Indian basil at 40 DAT from 7.5 or 15 cm above the ground level and ratoon crop at 50 days after first harvest is suggested.

**Keywords: Cutting height; Essential oil yield; Harvesting stage; Indian basil; Ocimum basilicum; Oil quality**

**PLANT PROPOGATION (1 JDL)**

G. Farias, O. Brutti, R. Grau, P. Di Leo Lira, D. Retta, C. van Baren, S. Vento, A.L. Bandoni, Morphological, yielding and quality descriptors of four clones of Origanum spp. (Lamiaceae) from the Argentine Littoral region Germplasm bank,
***Industrial Crops and Products***, Volume 32, Issue 3, November 2010, Pages 472-480, ISSN 0926-6690, DOI: 10.1016/j.indcrop.2010.06.019.
(http://www.sciencedirect.com/science/article/B6T77-50KMVPC-2/2/a19b042b96644435f2804dcf4328f697)

**Abstract:**

In order to preserve, characterize and improve the quality of some accessions in Entre Rios province, Argentina, a germplasm bank of aromatic and medicinal plants has been set up, including among other species, the oregano (Origanum spp.). To simplify the identification and characterization of the accession entries belonging to this genus, a chart containing 41 descriptors has been elaborated to allow the easy and quick individualization of any material being added to the collection. The first four accessions added to the collection were characterized using this chart and studied taking into account their biomass and essential oil yields and the quality of their volatile fraction. The materials analyzed are locally known as '27-09', 'Peruvian' and 'native' clones and are taxonomically identified as hybrids of Origanum x majoricum Cambess; and a fourth material, known as 'green Spanish' clone belonging to the species Origanum vulgare L. ssp. viridulum (Martrin-Donos) Nyman. The essential oil yield was similar for all the materials (1.7% (v/w) on dried basis). The estimated aired biomass yield was superior for the Origanum x majoricum hybrid clones (ranging from 4700 to 11,900 kg ha-1), whereas the 'green Spanish' clone only reached a biomass of 2450 kg ha-1. Meanwhile, based on the quality of the essential oils, O. vulgare ssp. viridulum was more promissory, since it corresponded to a carvacrol type oregano. Finally, it will be necessary to assess the role of the agronomical and ecological variables on the latter clone, in order to increase the content of carvacrol in the essential oil and, at the same time, to improve its biomass yield.

**Keywords: Origanum; Morphological descriptors; Yield; Essential oil; Carvacrol; Germplasm bank**

**CROPPING PATTERN AND SYSTEMS ( 3 JDL)**

S. Sujatha, Ravi Bhat, C. Kannan, D. Balasimha, Impact of intercropping of medicinal and aromatic plants with organic farming approach on resource use efficiency in arecanut (Areca catechu L.) plantation in India,
***Industrial Crops and Products*****,** Volume 33, Issue 1, January 2011, Pages 78-83, ISSN 0926-6690, DOI: 10.1016/j.indcrop.2010.09.001.
(http://www.sciencedirect.com/science/article/B6T77-51509CW-1/2/905338cbcc28738ce3e46fc554f11299)

**Abstract:**

The present investigation was conducted at Vittal, Karnataka, India during 2004-2007 to study the feasibility of intercropping of medicinal and aromatic plants (MAPs) in arecanut plantation. The results revealed that MAPs can be successfully grown as intercrops in arecanut plantation with increased productivity and net income per unit area. Kernel equivalent yield of MAPs varied between 272 kg ha-1 in case of Piper longum to 1218 kg ha-1 in Cymbopogon flexuosus. Pooled data indicated that Asparagus racemosus produced fresh root yield of 10,666 kg ha-1 of arecanut plantation and contributed to maximum kernel equivalent yield of 1524 kg ha-1 among all medicinal and aromatic plants. Intercropping of MAPs in arecanut was found economical. The net return per rupee investment was highest in C. flexuosus (4.25) followed by Bacopa monnieri (3.64), Ocimum basilicum (3.46) and Artemisia pallens (3.12). The total system productivity of arecanut + MAPs intercropping system varied from 2990 to 4144 kg ha-1. Arecanut + O. basilicum intercropping system registered significantly higher production efficiency 8.2 kg ha-1 day-1 than other systems. Intercropping of MAPs had more positive effect on soil pH in arecanut based cropping system. The soil pH was 5.6 in 2004 and it was 0.3-0.9 units higher in 2007. Soil organic carbon (SOC) content varied significantly due to intercropping of MAPs at the end of experiment. The SOC content increased in Aloe vera, A. pallens, P. longum and B. monnieri, while it depleted in grasses and rhizomatic MAPs. Based on demand and marketing opportunities for MAPs, farmers are advised to grow aromatic plants in large areas on a community basis to meet huge industrial demand and variety of medicinal crops in small areas to meet the requirement of traditional systems of medicine.

**Keywords: Asparagus racemosus; Bacopa monnieri; Vetiveria zizanoides; Piper longum; Cymbopogon flexuous; Ocimum basilicum; MAPs; Intercropping; Arecanut**

S. Sujatha, Ravi Bhat, C. Kannan, D. Balasimha, Impact of intercropping of medicinal and aromatic plants with organic farming approach on resource use efficiency in arecanut (Areca catechu L.) plantation in India,

***Industrial Crops and Products,*** Volume 33, Issue 1, January 2011, Pages 78-83, ISSN 0926-6690, DOI: 10.1016/j.indcrop.2010.09.001.

(http://www.sciencedirect.com/science/article/B6T77-51509CW-1/2/905338cbcc28738ce3e46fc554f11299)

**Abstract:**

The present investigation was conducted at Vittal, Karnataka, India during 2004-2007 to study the feasibility of intercropping of medicinal and aromatic plants (MAPs) in arecanut plantation. The results revealed that MAPs can be successfully grown as intercrops in arecanut plantation with increased productivity and net income per unit area. Kernel equivalent yield of MAPs varied between 272 kg ha-1 in case of Piper longum to 1218 kg ha-1 in Cymbopogon flexuosus. Pooled data indicated that Asparagus racemosus produced fresh root yield of 10,666 kg ha-1 of arecanut plantation and contributed to maximum kernel equivalent yield of 1524 kg ha-1 among all medicinal and aromatic plants. Intercropping of MAPs in arecanut was found economical. The net return per rupee investment was highest in C. flexuosus (4.25)

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**Keywords: Asparagus racemosus; Bacopa monnieri; Vetiveria zizanoides; Piper longum; Cymbopogon flexuous; Ocimum basilicum; MAPs; Intercropping; Arecanut**

Man Singh, A. Singh, S. Singh, R.S. Tripathi, A.K. Singh, D.D. Patra, Cowpea (Vigna unguiculata L. Walp.) as a green manure to improve the productivity of a menthol mint (Mentha arvensis L.) intercropping system,

***Industrial Crops and Products,*** Volume 31, Issue 2, March 2010, Pages 289-293, ISSN 0926-6690, DOI: 10.1016/j.indcrop.2009.11.004.
(http://www.sciencedirect.com/science/article/B6T77-4XW04RR-1/2/e023e20528eb719e22e403e2bfd2d241)

**Abstract:**

A field experiment was conducted at Central Institute of Medicinal and aromatic Plants (CIMAP), Lucknow, India in a sandy loam soil (entisol) during 2004 and 2005. Cowpea (Vigna unguiculata L. Walp.) was intercropped with transplanted menthol mint (Mentha arvensis L.) for green manuring (GM) and for fodder plus green manuring (F + GM) with four levels of urea N (0, 30, 60, 90 kg N ha-1). In GM, cowpea was incorporated in the soil 30 days after sowing (DAS), while in F + GM 50% (alternate) cow pea plants were used for fodder at 30 DAS and 50% were incorporated in soil at 35 DAS. No significant differences were found between GM and F + GM with respect to herb and oil yield of menthol mint and succeeding palmarosa crop and nitrogen economy. Fresh biomass yield of menthol mint increased by 23.4% and essential oil yield by 25.2% by cowpea green manure (mean of GM and F + GM) as compared to without GM across all N levels. The contribution of green manure, as a nitrogen source, was equivalent to 30 kg N ha-1 when no fertilizer nitrogen was applied in menthol mint. The residual effect of cowpea GM was studied in a succeeding crop of fast growing essential oil yielding palmarosa (Cymbopopogon martinii (Roxb.)Wats. var motia Burk.) over two harvests (July and December). Averaged across N levels green manure resulted in an increase of 18.5% in the fresh biomass and 17.7% in essential oil yield of palmarosa over no green manuring.

**Keywords: Mentha arvensis; Vigna unguiculata; Intercropping; Green manure; Cymbopopogon martinii; Essential oil yield**

**PLANT GENETIC AND BREEDING (3 JDL)**

S. Bruna, E. Portis, C. Cervelli, L. De Benedetti, T. Schiva, A. Mercuri, AFLP-based genetic relationships in the Mediterranean myrtle (Myrtus communis L.),
***Scientia Horticulturae*,** Volume 113, Issue 4, 14 August 2007, Pages 370-375, ISSN 0304-4238, DOI: 10.1016/j.scienta.2007.04.007.
(http://www.sciencedirect.com/science/article/B6TC3-4NVCG5G-2/2/594d1be3fbca46cd9897c7da5045bd11)

**Abstract:**

Myrtle is an important plant species of the Mediterranean maquis, and is widely exploited for its aromatic properties. It is used in Italy for the production of a typical liqueur, for cut foliage and as an ornamental pot plant. We report the use of amplified fragment length polymorphism (AFLP) profiling to estimate genetic similarities within myrtle germplasm collected from six Italian regions, and from the Botanical Gardens of six other Mediterranean countries (including the outgroup Myrtus communis subsp. tarentina). Five AFLP primer combinations identified 122 polymorphic fragments analysing 92 individual samples, most of them (56%) were informative in discriminating among the populations. The AFLP patterns indicated that the majority of the variation occurs among rather than within populations (GST = 0.61). A neighbour-joining (NJ) tree separated the populations into two main branches: the first one grouped some of the Italian populations with those from Spain and Portugal; the second one included a Southern Italian subcluster together with samples from Greece, Israel, France and Croatia. A principal coordinate analysis supported the two major branches identified in the NJ analysis and showed the separation of Western and Eastern Mediterranean populations along the first axis. The Italian populations did not cluster in a single clade, but rather form distinct regional groups. The present analysis suggests that Italy represents a botanical transition zone between the Western and Eastern Mediterranean region in Myrtus communis.

**Keywords: Myrtle; Molecular markers; Genetic similarity; Mediterranean maqui**

Sarah S. Conte, Alan M. Lloyd, Exploring multiple drug and herbicide resistance in plants--Spotlight on transporter proteins,
***Plant Science***, Volume 180, Issue 2, February 2011, Pages 196-203, ISSN 0168-9452, DOI: 10.1016/j.plantsci.2010.10.015.
(http://www.sciencedirect.com/science/article/B6TBH-51F7PHW-1/2/4b762a607afb2ed14f74f743518c8caf)

**Abstract:**

Multiple drug resistance (MDR) has been extensively studied in bacteria, yeast, and mammalian cells due to the great clinical significance of this problem. MDR is not well studied in plant systems, although plant genomes contain large numbers of genes encoding putative MDR transporters (MDRTs). Biochemical pathways in the chloroplast are the targets of many herbicides and antibiotics, yet very little data is available regarding mechanisms of drug transport across the chloroplast membrane. MDRTs typically have broad substrate specificities, and may transport essential compounds and

metabolites in addition to toxins. Indeed, plant transporters belonging to MDR families have also been implicated in the transport of a wide variety of compounds including auxins, flavonoids, glutathione conjugates, metal chelators, herbicides and antibiotics, although definitive evidence that a single transporter is capable of moving both toxins and metabolites has not yet been provided. Current understanding of plant MDR can be expanded via the characterization of candidate genes, especially MDRTs predicted to localize to the chloroplast, and also via traditional forward genetic approaches. Novel plant MDRTs have the potential to become endogenous selectable markers, aid in phytoremediation strategies, and help us to understand how plants have evolved to cope with toxins in their environment.

**Keywords: Multiple drug resistance (MDR); Herbicide resistance; Antibiotic resistance; Transport; Chloroplast**

Dorcas Osei-Safo, Ivan Addae-Mensah, Francois-Xavier Garneau, Honore Kossi Koumaglo, A comparative study of the antimicrobial activity of the leaf essential oils of chemo-varieties of Clausena anisata (Willd.) Hook. f. ex Benth,
***Industrial Crops and Products,*** Volume 32, Issue 3, November 2010, Pages 634-638, ISSN 0926-6690, DOI: 10.1016/j.indcrop.2010.07.016.
(http://www.sciencedirect.com/science/article/B6T77-50TJNWS-2/2/118fddb12c5df143179e2ccc134f8ffb)

**Abstract:**

The emergence of multiple drug resistance to human pathogenic organisms has necessitated a search for new antimicrobial substances from various sources including plants. The present study was carried out as part of this search using the essential oils of the leaves of three chemo-varieties of Clausena anisata (Willd.) Hook. f. ex Benth. namely, estragole, trans-anethole and feniculin-containing chemo-varieties. The oils were screened against six bacteria (Escherichia coli, Staphylococcus aureus, Salmonella typhi, Shigella sp., Proteus sp. and Pseudomonas aeruginosa) and three fungi (Candida albicans, Aspergillus niger and Aspergillus parasiticus) isolated from clinical specimen using the disc sensitivity test. Microbes which showed significant sensitivity were further assayed with various concentrations of the active extracts in a dilution sensitivity test. The microorganisms were also assayed against seven broad spectrum antibiotics: penicillin G, amoxycillin, ampicillin, tetracycline, ceftizoxime, fosfomycin and urotractin. Results from the disc sensitivity test showed that the estragole-rich oil exhibited significant antimicrobial activity against E. coli (16.3  0.3 mm) and Shigella sp. (17.2  0.4 mm). The trans-anethole-rich oil exhibited less significant activity (11.4  0.7 mm and 12.1  0.3 mm respectively) whereas the feniculin-rich oil, acting alone and in combination with the trans-anethole-rich oil did not show any significant activity against the all microbes tested. Only the neat oils and their 1:2 dilutions showed visible inhibition of microbial growth in the dilution sensitivity test. The estragole-rich oil gave minimum inhibitory concentrations of 3.7, 6.7 and 13.2 mg/ml against C. albicans, S. aureus and E. coli respectively with corresponding ED50 values of 1.3, 2.1 and 1.2 mg/ml. The trans-anethole-rich oil gave a minimum inhibitory concentration of 1.8 mg/ml against C. albicans with an ED50 of 0.2 mg/ml. The findings

suggest a significant antimicrobial activity of these plant essential oils though of lower efficacy compared to ampicillin. The results further suggest that such plant essential oils could potentially be exploited in the development of novel antibiotics.

**Keywords: Clausena anisata; Chemo-varieties; Estragole; trans-Anethole; Feniculin; Antimicrobial**

## PLANT PHYSIOLOGY AND BICHEMISTRY (1 JDL)

Anita M. Brinker, Jun Ma, Peter E. Lipsky, Ilya Raskin, Medicinal chemistry and pharmacology of genus Tripterygium (Celastraceae),

***Phytochemistry***, Volume 68, Issue 6, March 2007, Pages 732-766, ISSN 0031-9422, DOI: 10.1016/j.phytochem.2006.11.029.
(http://www.sciencedirect.com/science/article/B6TH7-4MWGYPF-1/2/9a24d96e662d91356532cf2b60eda311)

**Abstract:**

Plants in the genus Tripterygium, such as Tripterygium wilfordii Hook.f., have a long history of use in traditional Chinese medicine. In recent years there has been considerable interest in the use of Tripterygium extracts and of the main bioactive constituent, the diterpene triepoxide triptolide (1), to treat a variety of autoimmune and inflammation-related conditions. The main mode of action of the Tripterygium extracts and triptolide (1) is the inhibition of expression of proinflammatory genes such as those for interleukin-2 (IL-2), inducible nitric oxide synthase (iNOS), tumor necrosis factor-[alpha] (TNF-[alpha]), cyclooxygenase-2 (COX-2) and interferon-gamma (IFN-[gamma]). The efficacy and safety of certain types of Tripterygium extracts were confirmed in human clinical trials in the US and abroad. Over 300 compounds have been identified in the genus Tripterygium, and many of these have been evaluated for biological activity. The overall activity of the extract is based on the interaction between its components. Therefore, the safety and efficacy of the extract cannot be fully mimicked by any individual constituent. This review discusses the biochemical composition and biological and pharmacological activities of Tripterygium extracts, and their main bioactive components.

**Keywords: Tripterygium; Celastraceae; Thunder god vine; Terpenoids; Triptolide; Inflammation; Antiinflammatory drugs; Immunosuppression**

## PLANT PHYSIOLOGY-GROWTH AND DEVELOPMENT (1 JDL)

David G. Robinson, Markus Langhans, Claude Saint-Jore-Dupas, Chris Hawes, BFA effects are tissue and not just plant specific,

***Trends in Plant Science***, Volume 13, Issue 8, August 2008, Pages 405-408, ISSN 1360-1385, DOI: 10.1016/j.tplants.2008.05.010.
(http://www.sciencedirect.com/science/article/B6TD1-4T118NN-1/2/4ba3c05bcf10c0f888056f267f2448c4)

**Abstract:**

Brefeldin A (BFA) is one of the most popular drugs used by researchers for studies on secretion and endocytosis because it interferes with specific vesicle coat proteins via action on a guanine nucleotide exchange factor. Due to its range of morphological effects on the Golgi apparatus in a variety of plant tissues, we believe that there is more to the BFA response than the primary molecular targets so far identified.

Justin Thomas Fischedick, Arno Hazekamp, Tjalling Erkelens, Young Hae Choi, Rob Verpoorte, Metabolic fingerprinting of Cannabis sativa L., cannabinoids and terpenoids for chemotaxonomic and drug standardization purposes,

***Phytochemistry***, Volume 71, Issues 17-18, December 2010, Pages 2058-2073, ISSN 0031-9422, DOI: 10.1016/j.phytochem.2010.10.001.

(http://www.sciencedirect.com/science/article/B6TH7-51C2Y6G-1/2/05ac9586e962d2a67fba83626a538590)

**Abstract**:

Cannabis sativa L. is an important medicinal plant. In order to develop cannabis plant material as a medicinal product quality control and clear chemotaxonomic discrimination between varieties is a necessity. Therefore in this study 11 cannabis varieties were grown under the same environmental conditions. Chemical analysis of cannabis plant material used a gas chromatography flame ionization detection method that was validated for quantitative analysis of cannabis monoterpenoids, sesquiterpenoids, and cannabinoids. Quantitative data was analyzed using principal component analysis to determine which compounds are most important in discriminating cannabis varieties. In total 36 compounds were identified and quantified in the 11 varieties. Using principal component analysis each cannabis variety could be chemically discriminated. This methodology is useful for both chemotaxonomic discrimination of cannabis varieties and quality control of plant material.

**Keywords: Cannabis sativa; Cannabis; Cannabinoids; Terpenoids; Metabolic fingerprinting; Chemotaxonomy; Gas chromatography**

**PROTECTION OF PLANTS (1 JDL)**

Maria Isabel Gomez Jimenez, Katja Poveda, Synergistic effects of repellents and attractants in potato tuber moth control,

***Basic and Applied Ecology***, Volume 10, Issue 8, December 2009, Pages 763-769, ISSN 1439-1791, DOI: 10.1016/j.baae.2009.06.009.

(http://www.sciencedirect.com/science/article/B7GVS-4XM6NK0-5/2/1eeacf8ab7835c5df4b295d6f546fce9)

**Abstract:**

Pest management strategies aimed at reducing pesticide input often rely on behaviour-modifying stimuli to manipulate the distribution and abundance of pests and/or beneficial insects. However, the combined effect of more than one stimulus has rarely been tested. Here we show that the combination of two stimuli has a synergistic effect that controls herbivore damage and increases potato yield, despite the fact that

each stimulus alone has no effect. A main potato pest in Colombia is the Guatemalan potato moth (Tecia solanivora) whose larvae specialize on potato tubers. To control this pest we tested the oviposition interference (repellence) of eight aromatic plants and the oviposition stimuli (attractiveness) of eight potato varieties. In the field we tested the effectiveness of the single and combined use of repellent and attractive stimuli on herbivore damage and tuber production of potato plants and compared the efficacy of these treatments to conventional management systems that employed insecticides. Although there was no effect of the attractive and repellent stimuli in the field when used alone, the combined use reduced the number of damaged tubers and increased the weight of undamaged tubers relative to the untreated plots, thus demonstrating a synergistic effect. Productivity in the conventionally treated plots was similar to plots treated with the combined stimuli. We demonstrate that the simultaneous use of garlic-pepper extracts and intercropping with S. tuberosum cv Roja Narino are an effective strategy for the management of T. solanivora. This strategy maintains the productivity attained with conventional management practices, but without the health, environmental and ecological costs associated with the use of insecticides.

**Keywords: Garlic-pepper extract; Gelechiidae; Habitat management; Lepidoptera; Potato; Repellent plants; Solanum tuberosum; Tecia solanivora; Trap crop**

**PLANT DISEASES ( 1 JDL)**

T.S. Suryanarayanan, N. Thirunavukkarasu, M.B. Govindarajulu, F. Sasse, R. Jansen, T.S. Murali, Fungal endophytes and bioprospecting,

***Fungal Biology Reviews***, Volume 23, Issues 1-2, February-May 2009, Pages 9-19, ISSN 1749-4613, DOI: 10.1016/j.fbr.2009.07.001.
(http://www.sciencedirect.com/science/article/B8G3K-4X2BVCW-1/2/7e9d8c3e63e14220010f89ae63fab118)

**Abstract:**

Horizontally transmitted fungal endophytes are an ecological group of fungi, mostly belonging to the Ascomycota, that reside in the aerial tissues and roots of plants without inducing any visual symptoms of their presence. These fungi appear to have a capacity to produce an array of secondary metabolites exhibiting a variety of biological activity. Although the ability of fungi to produce unique bioactive metabolites is well known, endophytes have not been exploited, perhaps because we are only beginning to understand their distribution and biology. This review emphasizes the need to routinely include endophytic fungi in the screening of organisms for bioactive metabolites and novel drugs; it also underscores the need to use information obtained concerning fungal secondary metabolite production from other groups of fungi for a targeted screening approach.

**Keywords: Bioprospecting; Drug discovery; Endophytes; Fungal metabolites; Mycotechnology**

**SOIL BIOLOGY ( 1 JDL)**

Valtcho D. Zheljazkov, Charles L. Cantrell, Tess Astatkie, Variation in podophyllotoxin concentration in leaves and rhizomes of American mayapple (Podophyllum peltatum L.), ***Industrial Crops and Products***, In Press, Corrected Proof, Available online 15 January 2011, ISSN 0926-6690, DOI: 10.1016/j.indcrop.2010.12.025.
(http://www.sciencedirect.com/science/article/B6T77-51YGH4P-2/2/82fb7927050bcd653f12e4722f932f51)

**Abstract:**

Podophyllotoxin is a precursor for compounds used in the synthesis of commercially available anticancer drugs and their precursors etoposide, teniposide, and etopophos. Podophyllotoxin is currently obtained from the underground plant parts (roots and rhizomes) of Himalayan mayapple (Podophyllum emodii Wall.) but is also found in several other species, including American mayapple. There is no information in the literature on podophyllotoxin concentration in the roots or rhizomes of the American mayapple, and it was not clear if podophyllotoxin concentration in underground plant parts is correlated with the concentration in aboveground plant parts. The objective of this study was to estimate podophyllotoxin concentration in the leaves and rhizomes of 28 accessions of American mayapple under natural conditions (wild) and compare this to podophyllotoxin concentrations of the same accessions in the leaves when cultivated. Podophyllotoxin concentration in the rhizomes was positively correlated to soil organic matter content and to the concentrations of soil-available P and Na. Podophyllotoxin in the leaves was negatively correlated to soil-available Mg concentrations. The concentration of podophyllotoxin in the leaves varied from undetectable amounts to 2.52%, whereas podophyllotoxin in rhizomes varied from 0.14% to 0.42%. Most of the accessions had greater than 0.45% podophyllotoxin concentration in the leaves under both wild and cultivated conditions. There was no significant correlation between the podophyllotoxin concentrations in rhizomes and leaves; nine accessions had the highest podophyllotoxin concentration in leaves under natural environment. Another nine accessions had the highest podophyllotoxin in the leaves under cultivated conditions, and an additional eight accessions had greater podophyllotoxin concentrations in roots than in leaves irrespective of the environment. The results from this study may contribute toward developing American mayapple into a new cash crop for U.S. farmers.

**Keywords: Mayapple; Podophyllum; Podophyllotoxin; Leaves; Roots**

**SOIL FERTILITY (1 JDL)**

Emmanuel Ibukunoluwa Moyin-Jesu, Use of plant residues for improving soil fertility, pod nutrients, root growth and pod weight of okra (Abelmoschus esculentum L),
***Bioresource Technology***, Volume 98, Issue 11, August 2007, Pages 2057-2064, ISSN 0960-8524, DOI: 10.1016/j.biortech.2006.03.007.
(http://www.sciencedirect.com/science/article/B6V24-4N5CSJF-1/2/bd0af90de03d87dc61452107499a2d68)

**Abstract:**

The effect of wood ash, sawdust, ground cocoa husk, spent grain and rice bran upon root development, ash content, pod yield and nutrient status and soil fertility for okra (Abelmoschus esculentum L NHAe 47 variety) was studied. The five organic fertilizer treatments were compared to chemical fertilizer (400 kg/ha/crop NPK 15-15-15) and unfertilized controls in four field experiments replicated four times in a randomized complete block design. The results showed that the application of 6 t ha-1 of plant residues increased ($P < 0.05$) the soil N, P, K, Ca, Mg, pH, and SOM; pod N, P, K, Ca, Mg and ash; root length; and pod yield of okra in all four experiments relative to the control treatment. For instance, spent grain treatment increased the okra pod yield by 99%, 33%, 50%, 49%, 65% and 67% compared to control, NPK, wood ash, cocoa husk, rice bran and sawdust treatments respectively. In the stepwise regression, out of the total R2 value of 0.83 for the soil nutrients to the pod yield of okra; soil N accounted for 50% of the soil fertility improvement and yield of okra. Spent grain, wood ash and cocoa husk were the most effective in improving okra pod weight, pod nutrients, ash content, root length and soil fertility whereas the rice bran and sawdust were the least effective. This was because the spent grain, wood ash and cocoa husk had lower C/N ratio and higher nutrient composition than rice bran and sawdust, thus, the former enhanced an increase in pod nutrients, composition for better human dietary intake, increased the root length, pod weight of okra and improved soil fertility and plant nutrition crop. The significance of the increases in okra mineral nutrition concentration by plant residues is that consumers will consume more of these minerals in their meals and monetarily spend less for purchasing vitamins and mineral supplement drugs to meet health requirements. In addition, the increase in plant nutrition and soil fertility would help to reduce the high cost of buying synthetic inorganic fertilizers and maintain the long term productivity of soils for sustainable cultivation of okra.

**Keywords: Plant residues; Soil fertility; Pod nutrients; Pod weight; Okra**

**RENEWABLE ENERGY RESOURCES (2 JDL)**

Miroslaw Mleczek, Pawel Rutkowski, Iwona Rissmann, Zygmunt Kaczmarek, Piotr Golinski, Kinga Szentner, Katarzyna Strazynska, Agnieszka Stachowiak, Biomass productivity and phytoremediation potential of Salix alba and Salix viminalis,
***Biomass and Bioenergy,*** Volume 34, Issue 9, September 2010, Pages 1410-1418, ISSN 0961-9534, DOI: 10.1016/j.biombioe.2010.04.012.
(http://www.sciencedirect.com/science/article/B6V22-5027DV1-3/2/00a738bc51cee9124507ed3145ec7653)

**Abstract:**

The aim of this work was to determine selected Salix clones' capacities for biomass production and accumulation of heavy metal ions. Determination of the relationship between sorption of metals and biomass productivity was a further purpose of this study. Eight Salix viminalis cultivars and one Salix alba cultivar were analyzed. The taxa characterized by greatest biomass production were S. alba var. Chermesina and S. viminalis `1056' (respectively 6.8 and 4.3 kg of fresh mass per shrub per

year).The results have revealed significant differences among clones. The clones most effective in accumulating all five metals were S. viminalis `1154' and `1054'. The studied Salix population was significantly diverse as regards accumulation efficiency. The differences between the highest and lowest heavy metal content in extreme clones were for: Cd 84%, Cu 90%, Hg 167%, Pb 190% and Zn 36%. At the same time, significant differences were observed in Salix structure. The greatest cellulose content was observed in S. viminalis `Sprint' (49.69%) and the lowest in S. viminalis `1059' (42.09%).

**Keywords: Accumulation; Biomass; Heavy metals; Salix clone; Soil**

Adriana E. Downie, Lukas Van Zwieten, Ronald J. Smernik, Stephen Morris, Paul R. Munroe, Terra Preta Australis: Reassessing the carbon storage capacity of temperate soils,

***Agriculture, Ecosystems & Environment***, Volume 140, Issues 1-2, 30 January 2011, Pages 137-147, ISSN 0167-8809, DOI: 10.1016/j.agee.2010.11.020.
(http://www.sciencedirect.com/science/article/B6T3Y-51SMS5G-2/2/b959e76b0750079d400e60c41113e9ae)

**Abstract:**

Soils developed on the sites of Australian Aboriginal oven mounds along the Murray River in SE Australia, classified as Cumulic Anthroposols under the Australian Soil Classification, are shown to have traits similar to the Terra Preta de Indio of the Amazon basin. Seven such sites were characterised and compared with adjacent soils. The Cumulic Anthroposols contained significantly ($p < 0.05$) more soil carbon (C), compared to adjacent non-Anthroposols. Solid-state 13C NMR spectroscopy showed that the C in the Cumulic Anthroposols was predominantly aromatic, especially at depth, confirming the presence of charcoal. Radiocarbon analysis carried out on charcoal collected from two of these sites showed that it was deposited 650 +/- 30 years BP at one site and 1609 +/- 34 years BP at the other site, demonstrating its recalcitrance in soil. The charcoal originated from plant material, as shown by SEM, and had high levels of Ca agglomeration on its surfaces. The Cumulic Anthroposols were shown to have altered nutrient status, with total N, P, K and Ca being significantly greater than in the adjacent soils throughout the profile. This was also reflected in the higher mean CEC of 31.2 cmol (+) kg-1 and higher pH by 1.3 units, compared to the adjacent soils. Based on the similarity of these Cumulic Anthroposols with the Terra Preta de Indio of the Amazon, we suggest that these Cumulic Anthroposols can be classified as Terra Preta Australis. The existence of these soils demonstrates that Australian soils, in temperate climates, are capable of storing C in much higher quantities than has been previously recognised, and that this capability is founded on the unique stability and properties of charred organic matter. Furthermore, the addition of charcoal appears to have improved the physical and chemical properties of these soils. Together, this provides important support for the concept of soil amendment with 'biochar', the charred residue produced by pyrolysis of biomass, as a means for sequestering C and enhancing agricultural productivity.

**Keywords: Australian aboriginal oven mounds; Biochar; Carbon sequestration; Soil carbon; Terra preta**

## FOOD COMPOSITION (1 JDL)

Rafaela Guimaraes, Maria Joao Sousa, Isabel C.F.R. Ferreira, Contribution of essential oils and phenolics to the antioxidant properties of aromatic plants,
***Industrial Crops and Products***, Volume 32, Issue 2, September 2010, Pages 152-156, ISSN 0926-6690, DOI: 10.1016/j.indcrop.2010.04.011.
(http://www.sciencedirect.com/science/article/B6T77-50237D6-1/2/615ce7965a323922779da695374c61d3)

**Abstract:**

Different in vitro assays characterise most of the essential oils and phenolic compounds as antioxidants. These molecules can be found in a variety of aromatic plants and have been related to their bioactive properties. For the first time, a comparative study between the antioxidant properties of essential oils and phenolic extracts from Cistus ladanifer leaves, Citrus latifolia fruit peels, Cupressus lusitanica foliage and Eucalyptus gunnii leaves was performed. Overall, the antioxidant properties of phenolic extracts (unless scavenging activity of C. latifolia) were excellent and better than those obtained from the essential oils extracts, and even for the standards BHA (2-tert-butyl-4-methoxyphenol) and [alpha]-tocopherol. The better EC50 values for all the assays (scavenging activity, reducing power and lipid peroxidation inhibition) were obtained in the E. gunnii phenolic extract (less than 0.1 mg mL-1). Among the essential oils extracts, the best contribution was given by C. ladanifer.

**Keywords: Aromatic plants; Essential oils; Phenolics; Antioxidant activity**

## FOOD CONTAMINATION AND TOXICOLOGY (1 JDL)

F. Bakkali, S. Averbeck, D. Averbeck, M. Idaomar, Biological effects of essential oils - A review,
***Food and Chemical Toxicology***, Volume 46, Issue 2, February 2008, Pages 446-475, ISSN 0278-6915, DOI: 10.1016/j.fct.2007.09.106.
(http://www.sciencedirect.com/science/article/B6T6P-4PSK90K-3/2/62dcd64718e83e54364ee2ef5311ebbc)

**Abstract:**

Since the middle ages, essential oils have been widely used for bactericidal, virucidal, fungicidal, antiparasitical, insecticidal, medicinal and cosmetic applications, especially nowadays in pharmaceutical, sanitary, cosmetic, agricultural and food industries. Because of the mode of extraction, mostly by distillation from aromatic plants, they contain a variety of volatile molecules such as terpenes and terpenoids, phenol-derived aromatic components and aliphatic components. In vitro physicochemical assays characterise most of them as antioxidants. However, recent work shows that in eukaryotic cells, essential oils can act as prooxidants affecting inner cell membranes and organelles such as mitochondria. Depending on type and concentration, they exhibit cytotoxic effects on living cells but are usually non-genotoxic. In some cases, changes in intracellular redox potential and mitochondrial dysfunction induced by essential oils can be associated with their capacity to exert antigenotoxic

effects. These findings suggest that, at least in part, the encountered beneficial effects of essential oils are due to prooxidant effects on the cellular level.

**Keywords: Essential oil; Cytotoxicity; Genotoxicity; Antigenotoxicity; Prooxidant activity**

## FEED CONTAMINATION AND TOXICOLOGY (1 JDL)

Laura M. Appenzeller, Susan M. Munley, Denise Hoban, Greg P. Sykes, Linda A. Malley, Bryan Delaney, Subchronic feeding study of herbicide-tolerant soybean DP-356O43-5 in Sprague-Dawley rats,

***Food and Chemical Toxicology***, Volume 46, Issue 6, June 2008, Pages 2201-2213, ISSN 0278-6915, DOI: 10.1016/j.fct.2008.02.017.
(http://www.sciencedirect.com/science/article/B6T6P-4RY6WWR-1/2/5fa9ecb290703fec05d157fe3db782d9)

**Abstract:**

Optimum(TM)GAT(TM) 1 soybean is a genetically modified (GM) soybean containing event DP-356O43-5 (356043) that was produced by integration of the coding sequences of the GAT4601 and GM-HRA proteins. In planta expression of these proteins confers tolerance to glyphosate and sulfonylurea/imidazolinone herbicides, respectively. This paper reports the results from a subchronic rat feeding study conducted with 356043 soybeans. Dehulled/defatted toasted meal and toasted ground hulls were prepared from soybeans from untreated plants (356043), herbicide-treated plants (356043 Gly/SU), non-transgenic isoline control (091), and three commercial non-transgenic reference varieties (93B86, 93B15, and 93M40). Individual diets conforming to standard certified rodent chow formulation (Purina Rodent LabDiet(R) 5002) were prepared with 20% meal (w/w) and 1.5% hulls (w/w). Diets were fed to young adult Sprague-Dawley rats (12/sex/group) for at least 93 days. Compared with rats fed the isoline control or conventional reference diets, no biologically-relevant, adverse effects were observed in rats fed diets containing 356043 or 356043 Gly/SU soybean with respect to body weight/gain, food consumption/efficiency, clinical signs, mortality, ophthalmology, neurobehavioral assessments (sensory response, grip strength, motor activity), clinical pathology (hematology, coagulation, serum chemistry, urinalysis), organ weights, and gross and microscopic pathology. The results from this study indicate that 356043 soybeans are as safe and nutritious as conventional non-GM soybeans.

**Keywords: Biotechnology; Genetically modified; Glyphosate acetyltransferase; Rat; Soybean; Subchronic**