

Journal of

# INDUSTRIAL HEMP™

Volume 9  
Number 1  
2004

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Ten years ago the hemp industry was in decline. Efforts of entrepreneurs and activists have reversed that trend. The modern hemp industry is beginning to see main-

stream uses in a variety of industries including food, body care, clothing, accessories, paper and automotive. The future is bright, but factors that can impede the growth of the industry are discussed.

**KEYWORDS.** Hemp, International Hemp Association, history, future prospects, impediments, investment

## PEER-REVIEWED PAPERS

### Accumulation of Cannabinoids in Glandular Trichomes of *Cannabis* (Cannabaceae)

15

*Paul G. Mahlberg*  
*Eun Soo Kim*

Sessile- and capitate-stalked secretory glands are sites of cannabinoid accumulation in *Cannabis* (Cannabaceae). Analyses show cannabinoids to be abundant in glands isolated from bracts or leaves of pistillate plants. Cannabinoids are concentrated in the secretory cavity formed as an intrawall cavity in the outer wall of the disc cells. Specialized plastids, lipoplasts, in the disc cells synthesize lipophilic substances, such as terpenes, that migrate through the plasma membrane and into the cell wall adjacent to the secretory cavity. These substances enter the cavity as secretory vesicles. An antibody probe for THC shows it to be most abundant along the surface of vesicles, associated with fibrillar material in the cavity, in the cell wall and in the cuticle; little THC was detected in the cytoplasm of disc or other cells. The phenol, phloroglucinol, is abundant in both gland types. A working hypothesis for the site of cannabinoid synthesis is proposed, and must be examined further. Knowledge of the mechanism of cannabinoid synthesis and localization can contribute to efforts to further reduce the THC content in hemp strains for potential agricultural use in the United States and elsewhere.

**KEYWORDS.** *Cannabis*, glands, secretory cavity, cannabinoids, THC, localization

### Comparing Hemp Seed Yields (*Cannabis sativa* L.) of an On-Farm Scientific Field Experiment to an On-Farm Agronomic Evaluation Under Organic Growing Conditions in Lower Austria

37

*Christian R. Vogl*  
*Gunilla Lissek-Wolf*  
*Andreas Surböck*

Hemp seed yields of the variety Fedora-19 in an on-farm scientific field experiment on small plots and in an on-farm evaluation in 11 hemp fields under practical organic growing conditions in Lower Austria were compared to give a realistic view of the variability of yields. Dry matter seed yields from the on-farm field experiment ranged from 127 to 143 g m<sup>-2</sup>. Under practical growing conditions, yields ranged from 34 to 151 g m<sup>-2</sup> in the sample plots. The reported hemp seed yield after combine harvesting, drying, and cleaning was between 324 kg ha<sup>-1</sup> and

717 kg ha<sup>-1</sup>. The results of the experiment show that harvesting by hand considerably influences yields. Yields of the manual harvest in sample plots indicate a high correlation with yields harvested by the combine harvester ( $R^2 = 0.91$ ). The commercial yield is 71% of the yields recorded in sample plots in the fields. Our data questions the transfer of results and conclusions drawn from the data of scientific field experiments that employ manual harvest to that of practical circumstances, and support the notion of on-farm research.

KEYWORDS. On-farm research, methodology, experimental design, edge effect, hemp seed, manual harvest

Hemp (*Cannabis sativa* L.) as a Resource for Green Cosmetics:  
Yield of Seed and Fatty Acid Compositions of 20 Varieties  
Under the Growing Conditions of Organic Farming in Austria      51  
*Christian R. Vogl*  
*Helga Mölleken*  
*Gunilla Lissek-Wolf*  
*Andreas Surböck*  
*Jörg Kobert*

The interest in hemp (non-drug *Cannabis sativa* L.) for skin care and cosmetic use is due to the high content of oil, especially unsaturated fatty acids in seed with technological and therapeutic effects. In a field trial on an organic farm, seed weight and content of fatty acids of 20 hemp varieties were surveyed on three different harvest dates. The dry matter seed yields ranged from 27-149 g m<sup>-2</sup>. The varieties Ferimon-12, Fedora-19, and were Bialobreszie produced high seed yields on all three harvest dates but yields were not significantly different from a large group of other varieties. Contents of palmitic acid range from 3.1 to 4.1%, of stearic acid from 0.1 to 1.9%, of oleic acid from 3.7 to 9.2%, of linoleic acid from 44.8 to 60.2%, of  $\alpha$ -linolenic acid from 18.2 to 27.4%, and of  $\gamma$ -linolenic acid from 1.6 to 4.7%. The genotype has no significant influence on fatty acid content. All 20 varieties tested show high quantities of fatty acid depending on the harvest date, so that no variety can be favored. Results confirm that hemp is a very good source of fatty acids for skin care and cosmetic use.

KEYWORDS. Hemp, seed yield, variety, harvest date, renewable resources, skin care, oil, palmitic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, dermatology, organic farming, cosmetics

Indigenous Uses and Ethnobotany of *Cannabis sativa* L. (Hemp)  
in Uttarakhand (India)      69  
*N. C. Shah*

*Cannabis sativa* L. is one of the oldest food, fibre, medicinal, psychoactive and oil plants known. It has been used by innumerable ethnic societies in Asia. Uttarakhand (India) is an ethnic region where the plant is a part of the local culture. In this paper the indigenous uses and ethnobotany of its seed, seed oil, stems, fibre, leaves, inflorescences and resin along with various recipes of seeds are described. A theory of its introduction to Uttarakhand by ethnic races is also given. It is concluded that

in the light of the present commercial and industrial uses of *Cannabis* its cultivation should be promoted in Uttarakhand and other parts of the Himalayan regions of India, where it grows naturally and is cultivated for folk uses.

KEYWORDS. Bhang, fibre, food, medicine, psychoactive, nutrition, food, oil, origin, recipes, seed, Uttarakhand

## COLLECTIONS CORNER: INDUSTRIAL HEMP COLLECTIBLES FROM INTERNATIONAL COLLECTIONS

### Navajo Hemp Rugs *Don E. Wirtshafter*

79

Navajo weavers have produced at least 15 blankets using Chinese grown, industrial hemp sliver. The history of these pieces and their collector value are discussed. The project almost succeeded in getting an hemp cultivation enabling law passed in Arizona.

KEYWORDS. Navajo, hemp, blanket, rug, wool, collection, weaving, sliver

## THE WIDE WILD WORLD OF HEMP

### Hip Hemp Happenings *John E. Dvorak*

83

Hip Hemp Happenings highlights some of the companies and products that are successfully marketing hemp in creative and innovative ways. Ranging from colorful and practical hemp clothing to nutritious hemp nut based desserts, this article illustrates different approaches to the same problem: how to make hemp hip. It also shows how some companies are using the star power of celebrities and athletes to promote their hemp products.

KEYWORDS. Clothing, paper, twine, nutrition, Minawear, Cool Hemp, Hempola, Living Tree Paper

## CANNABIS CLINIC

### Striatura Ulcerosa *John M. McPartland* *Karl W. Hillig*

89

This is the second in a series of “Cannabis clinic” notes, presenting diseases and pests of hemp, featuring colour illustrations of signs and symptoms. This note concerns Striatura Ulcerosa, the name of a hemp disease caused by the bacterium *Pseudomonas syringae* pv. *mori*. The disease was first described in Italy over 100 years ago, but may have originated in China. Greenhouse studies demonstrated that all cultivars of *Cannabis* are susceptible. Signs and symptoms, life history of the pathogen, and control measures are discussed.

KEYWORDS. Striatura Ulcerosa, *Pseudomonas syringae* pv. *mori*, *Morus* species, biological control, seed treatment, *Cannabis sativa*, *Cannabis indica*

## HEMP PRODUCTION NOTES

Hemp Seed Production in Finland <i>J. C. Callaway</i>	97
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This is the third in a series of "Hemp production notes," which focuses on the unique challenge of growing hemp at high latitudes in the European Community. This paper briefly reviews the historical considerations of hemp in Finland, addresses some of the problems inherent at high latitudes and identifies specific market potentials for the Nordic production of hemp seed as an industrial crop.

KEYWORDS. Finola, hemp seed, human food, animal feed, high latitude, nutrition

Hemp Production in Aotearoa <i>John M. McPartland</i> <i>Steve Cutler</i> <i>Donald J. McIntosh</i>	105
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Hemp is new to Aotearoa, the indigenous name of New Zealand (NZ). The NZ government approved the experimental cultivation of hemp in 2001. Eleven cultivars have been cultivated to date, 'Anka', 'Carmen', 'Fasamo', 'Felina', 'Finola', 'Futura 77', 'Kompolti', 'Uniko B', 'USO 14', 'USO 31', and 'Zola'. Crops have been planted at 19 sites the past two seasons, in a wide range of latitudes, climates and soil types. NZ's fragile soil necessitates careful management of its fertility. Hemp fits into the paradigm of sustainable stewardship, organic soil fertilization, and responsible crop rotation. It can be rotated with existing fodder crops and vegetable crops. Hemp's well-known ability to suppress weeds makes its rotation with pasture an attractive way to clean soil banks of weed seeds. Hemp cultivated for seed produced maximal yields of 2800 kg ha<sup>-1</sup>; and fibre crops yielded stalk biomass (dry matter) as high as 13,900 kg ha<sup>-1</sup>. These yields are consistent with or greater than reports from the European literature. Several pests new to hemp were discovered in NZ, but none required pesticides. Birds caused problems in seed crops, requiring control with repellents and bird netting. Future prospects look promising for this new crop.

KEYWORDS. Hemp, soil management, seed production, organic agriculture, diseases, pests

First International Conference of the European Industrial Hemp Association (EIHA) <i>Michael Karus</i>	117
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On October 23rd and 24th 2003, almost 50 hemp experts from 15 different countries met in Germany. Speakers gave lectures on cultivation, processing, and product lines. Special attention was paid to the German introduction program for renewable insulation resources and to ambitious plans such as the establishment of a new hemp industry in China and of a new European hemp textile line. New technical developments from the field of natural fibres (composites, natural fibre PP mould injection, hemp fibre bio-plastics) were introduced.

KEYWORDS. Cultivation, hemp industry, international conference, markets