Hands in Hands, Mutual Benefits

IJS2008

Sponsored by

International Society for Horticultural Science (ISHS)

Hebei Association for Science and Technology (HAST)

Co-sponsored by

Section Pome and Stone Fruits (ISHS)

Section Medicinal and Aromatic Plants (ISHS)

Section Tropical and Subtropical Fruits (ISHS)

Organized by

Agricultural University of Hebei (AUH)

Co-organized by

The People's Government of Cangzhou City, Hebei

Hebei Society for Botany

Section of Dry fruits, Chinese Society for Horticultural Science

Chinese Cooperation Group for Jujube Industry

Jujube Working Group of Chinese Association for Economical Forestry

Section of Jujube, Chinese Association for Fruits Circulation

Co-supported by

National Natural Science Foundation of China

Provincial Natural Science Foundation of Hebei, China

Henan Haoxiangni Jujube Industry Development Co. Ltd., China

Web: www.ziziphus.net/2008

Preface

Dear Colleagues and Friends,

The First International Jujube Symposium (1st IJS) sponsored by International Society for Horticultural Science (ISHS) and Hebei Association for Science and Technology will be held in Baoding, China in September 21～25, 2008. This symposium is to provide an international forum on jujube for exchanging information among researchers and academicians as well as related businessmen and officials.

Jujube (*Ziziphus*) is an outstanding multi-purpose economic plant with great potential in drought and marginal districts. Undoubtedly, it will play an increasingly important role in horticulture. China has at least 14 jujube species, of which Chinese jujube (*Z. jujuba* Mill.) and Indian jujube or ber (*Z. mauritiana* Lam.) were widely cultivated with total growing area of over one million hectares and total production of 2.5 million tons. Approximately 10 million farmers rely on jujube production. However, jujube is still an unknown and underutilized horticultural plant in the world. Let's try together to make a brilliant future to jujube industry.

On behalf of the organizing committee of 1st IJS, may I extend a warm welcome to each of you as you embark on an outstanding week of scientific exchange in jujube. I hope all of us will have more and better cooperation in the future under the theme of this symposium, "Hands in Hands, Mutual Benefits." May you enjoy your stay, and return to see us often.

Prof. & Dr. Mengjun Liu
Convenor and Chairman of the symposium

ABSTRACTS

Contributed Papers

1st International Jujube Symposium

Baoding, China

September 21-25, 2008

The abstracts are listed in order of symposium section number and the first author's name. All abstracts are coded as follows: section number (S01, S02, etc.) plus abstract number (01, 02, etc.) according to the author's name. The author presenting the abstract is indicated by underlined the name.

CONTENTS

Keynote Abstracts

S-01-01
Selected Issues in Modern Cultivation of Fruit Trees Relevant to Jujube

Amos Blumenfeld

"Agrihitech" Bet Elazari, Israel 76803

Jujube is a new industry in Israel where modern agricultural technologies developed for other crops are practiced and will be discussed. Modern agriculture is market oriented where high quality fruit is demanded. Therefore good cultivars, grafted on selected rootstocks are needed. High- density plantings of low trees trained and pruned to maximize illuminated areas are aimed to achieve high yields. Fertirrigation according to plant's need will be presented.

**Corresponding author: Amos Blumenfeld, e-mail: Agrihitech@gmail.com*

S-01-02
Germplasm Resources and Production of Jujube in China

Mengjun Liu, Zhihui Zhao, Li Dai

Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, Hebei, 071001, China

Jujube (*Ziziphus* Mill.), the most important genus of family *Rhamnaceae*, consists of more than 170 species distributed throughout the temperate and tropical regions. It is becoming increasingly popular because of its outstanding advantages including bearing early, being rich in nutrition, multiuse, long flowering season, as well as high tolerance to drought and barren. China is one of the origin and distributive centers of *Ziziphus* and the only country having all the sub-genus taxa of *Ziziphus*. There are at least 14 species of genus *Ziziphus* in China, of which Chinese jujube (*Z. jujuba* Mill.) is the most important one, followed by *Z. mauritiana* Lam.(ber or Indian jujube) and *Z. acidojujuba* C Y Cheng et M J Liu (sour jujube or acid jujube) in terms of resource abundance and economical value. Chinese jujube is derived from sour jujube and distributed mostly in temperate zone with utilization and cultivation history for at least 7700 and 3000 years, respectively. It has been introduced to more than 30 countries and has become commercially cultivated fruit tree in South Korea. In 2006, its total growing area in China was approximately 150 million ha with production of 2.5 million tons on a fresh weight basis, accounting for 99% of it in the world. Chinese jujube has about 750 cultivars, which are commonly grouped into table, dried, candied, multipurpose and ornamental type. The present status of propagation, cultural techniques, storage as well as trade and developing trend were also briefly discribed.

**Corresponding author: Mengjun Liu; Fax: +86-* 0312-*7521456; e-mail: kjliu@hebau.edu.cn*

S-01-03
Genetic Diversity and Status of *Ziziphus* in India

O.P. Awasthi and T.A. More

Central Institute for Arid Horticulture (ICAR), Bikaner-334006, Rajasthan, India

Indian jujube known as ber (*Ziziphus mauritiana* Lam.) is an extremely drought hardy and native fruit of India. It is a dominant component of the natural vegetation in the Indian "Thar desert". It can be successfully cultivated even in the most marginal ecosystem of the tropics and subtropics. There is 90, 000 hectares plantation of improved ber trees. The average productivity is 8.34 tons ha^{-1}. Genetic diversity of *Ziziphus* is high in India and about 20 species are found between 8.5-32.5°N and 69-84°E. Economically important species are *Z. nummularia, Z. oenoplia, Z. rugosa, Z. sativa, Z. vulgaris* and *Z. xylopyrus*. The ability of *Ziziphus* species and different varieties/types within *mauritiana* to cross freely has allowed the build up of rich gene pool which depict heterozygosity in their adaptability to soil and climate; morphological, physiological and phenological traits; chromosome number; tolerance/resistance to biotic and abiotic stresses and genomic DNA. The germplasm holding of ber at Central Institute for Arid horticulture (CIAH), the largest in India, consists of total 333 accessions, comprising cultivars, indigenous and exotic selections and rootstocks. From the diverse germplasm at CIAH and All India Co-ordinating Centres working under the ageis of CIAH, considerable basic information on growth and development, floral biology and cytology of a good number of ber cultivars has been generated. Besides, promising germplasms with distinctive traits such as desired adaptation (Gola, Umran, Thar Bhubhraj, Thar Sevika), diverse quality traits (Banarasi Karaka, Illaichi,), high and stable yield (Seb, Ponda), tolerance to biotic and abiotic stress (Tikadi, Katha, Bawal-Sel-1, Sanaur-2) have been identified which have comparative advantages to improve the productivity of this important arid fruit crop. Genetic diversity (D^2 analysis) and status of *Ziziphus* in India along with future line of work are discussed in this paper.

**Corresponding author: O.P. Awasthi; e-mail: awasthiciah@yahoo.com*

General Information

S-02-01
Issues and Options in the Production and Marketing of Jujube in Pakistan

Ali Muhammad Khushk, and Aslam Memon

Technology Transfer Institute (PARC), Tandojam, Pakistan

This paper is based on primary data collected from jujube (*Ziziphus mauritiana* Lam.) growers and marketing intermediaries from main jujube producing area in Pakistan. There are number of jujube varieties grown in the study area of which white Gola is most popular and harvested earlier than other varieties, results growers receiving good prices. From our investigation, it was found that jujube production process is not mechanized and most of the activities are labor intensive. It was also found that most of the growers are unaware of the timely and adequate use of inputs. The most important inputs i.e. chemical fertilizer and labor appear to be limited by the resources poor farmers. The existing marketing system was performed in traditional ways such as rough handling, rudimentary grading and poor quality packing, which reduces product marketability, leading to lower prices in the market. Mostly growers received price information from commission agents, contractors and neighboring growers. The information received was mostly inaccurate, misleading and delayed among growers. Large number of Jujube buyers and sellers had participated in the marketing process. No strong evidence was found of collusion among market agencies and price at each stage are settled on supply and demand basis. The study concluded that jujube marketing system is not perfectively competitive but it is sufficiently efficient to prevent market traders from reaping excessive margins.

**Corresponding author: Ali Muhammad Khushk; e-mail: ttitjam@yahoo.com*

S-02-02
The Current Development and Promise of Fresh Used Jujube Industry in Southern China

Bixia Xie, Sen Wang, Zhanying Gu

Forestry Resources and Environmental Sciences College, Central South University of Forestry and Technology, Changsha 410004, Hunan, China

This paper summarized the main developments in the breeding of cultivars, the intensive cultivation and storage of the fresh used jujube in southern China. The seed breeding and bud mutation were in the part of the breeding of cultivars. The part of the intensive cultivation focused on pollination, fertilization and ecological cultivation. The application of antistaling agent and the measures of fresh keeping were included in the part of storage. The key issue in the development of the fresh used jujube industry and its expectation was put forward.

**Corresponding author:* Bixia Xie*; Fax: +86- 0731-5623456; e-mail: bixiax@163.com*

S-02-03
Introduction, Evaluation and Propagation of *Zizyphus* in Kuwait.

C. Sudhersan and J. H. Ashkanani

Biotechnology Department, Food Resources and Marine Sciences Division, Kuwait Institute for Scientific Research, P.O. Box 24885, Safat 13109, Kuwait.

Zizyphus, locally known as sider or ber is a multipurpose tree species used for food, fodder, medicine and desertification control in arid lands. It is one of the world's most nutritious plants rich in vitamins, minerals and amino acids. It is well known for its multipurpose attributes, wide adaptability towards the arid environment and ease of establishment. It tolerates a wide range of environmental conditions and needs less water for its growth and establishment. As one of the true native species of Arabia, *Zizyphus spina-christi* and *Z. numularia* are growing in Kuwait as native plants along with the exotic plants. Next to the date palm, it is an important fruit crop that is highly adapted to the environmental conditions of Kuwait and being cultivated mainly for fruit production and landscaping. However, being an old native desert crop of Arabian countries, this plant species has not received much attention among the researchers. Recently, an introduction trial on improved cultivars of *Z. mauritiana* for fruit production and *Z. xylopyrus* for desertification control, selection of superior genotypes among the local *Z. spina-christi*, and research on the development of clonal propagation technology via plant cell tissue and organ culture have been carried out at the Kuwait Institute for Scientific Research (KISR). The field performance of both the introduced species of *Zizyphus* in Kuwait proved it to be a drought tolerant multipurpose plant species that can be grown in Kuwait for fruit production, desertification control and other environmental protection programs to enhance the biodiversity in addition to its food, fodder and medicinal values.

**Corresponding author: C. Sudhersan; e-mail: schellan@safat.isr.edu.kw*

S-02-04
Forest Plantation of *Ziziphus spina-christi* in Iran

Hossein. Sardabi, Mohammad Hassan Assareh

Research Institute of Forests and Rangelands, P. O. Box 13185-116, Tehran, I. R. Iran

Several trials have been conducted at different sites of the southern subtropical zone of Iran from 1994 to 2003 in order to identify the best planting method of Christ thorn (*Ziziphus spina-christi* (L.) Desf.). The effects of different treatments, including transplanting and direct seeding, irrigation intervals (control, 15, 30 and 45 days), irrigation years (1, 2, 3, 4 and 5 years), water catchment systems (earth barrier and turkinest) and planting space (6 and 10 m.) on different species performance, including survival, height and crown diameter were investigated under special statistical design. The results showed that the 30-45 day irrigation interval, at least for one year and 30 liter at each time, particularly after transplanting was essential for satisfied establishment. The best plant stock for guaranteed establishment was six month seedlings, of which the seeds were pretreated before sowing by soaking in water for four days. High survival and growth require at least two year irrigation at 15 day interval. There was not significant difference between the water catchment systems and planting space in terms of survival and other species performance.

**Corresponding author: Hossein Sardabi; Fax: +98 2144196575; e-mail: sardabi@rifr-ac.ir or sardabi@yahoo.com*

S-02-05
Research on Cultivation of *Ziziphus Jujuba* Mill. cv. Lizao in Italy

Jianbao Tian[1], M. Pastore[2], Xi. Wang[1], F. Gervasi [2], M. Del Vaglio [2], M. Petriccione [2], and Feng Han[1]

[1]*Pomology Institute, Shanxi Academy of Agricultural Science, 030815 Taigu. Shanxi, China*
[2]*Unità di Ricerca per la Frutticoltura di Caserta. Council for Research in Agriculture, Via Torrino, 3, 81100 Caserta, Italy.*

Through a bilateral co-operation project, Lizao jujube is introduced into Italy from China, and grafted on local jujubes through cleft-grafting and cultivated in green house. Growth characters of this variety under Italian environment are shown in this report. The jujube fruits of a seven-year-old tree are 2.3 cm in lateral diameter and 3.3 cm in vertical diameter. The tree can be more than three meters high, and the leaves are large and splendid green. However in China, the cultivation performance is different. The tree is dwarfing and has some characters such as early blooming-and-fruiting, high yield in an early stage, large fruit size and fine quality. The height of a mature tree is about 2.5~3.0 m. It can bear fruits in the same year it is planted, and the yield can reach 30 000~37 500 kg per hectare in its full-bearing period. The fruit of this cultivar is obovate, with purplish-red and thin skin and an average weight of 31.6 g and the maximum 100 g. The rate of the edible part for fresh jujube is 96.8 %, and the content of soluble solids is 31.6 %, both of which give it a crisp flesh quality and better taste, and make it suitable for fresh-eating. The soils of both Italy and China are analyzed in order to determine whether the concentration of nutrients in the soil have a decisive effect on the final cultivation of this variety. Yet clearly Lizao jujube is not adapted to the Italian environment. These data can help those Italian breeders who would like to get fruit as big as apple and at the same time with the flavor and taste of Chinese jujube. The authors suggest they should change their breeding methods, so as to give the Italian people the possibility of appreciating the taste of original jujube.

**Corresponding author: Jianbao Tian; Fax: +86-354-6215001; e-mail: tianjb-001@163.com*

S-02-06
Socio-religious, Ethnomedical and Economic Uses of Ber in Indian Arid Zone

Khursheed Ahmed[1], Neelam Poonar[2], Hukam Singh Gehlot[2], Tej N. Nag[3] and Narendra Sankhla[4]

[1]*Botany Department, Govt. College, Ajmer*
[2]*J. N. Vyas University, Jodhpur 342001*
[3]*M..L. Institute of Applied Sciences, Bikaner, India*
[4]*Texas AgriLife Research, Texas A & M System, Dallas, TX, 75252, USA*

The antiquity and a wide array of usage of Ber (*Ziziphus spp*.) finds ample reference in Indian scriptures dating back to as early as 1000 BC or even earlier. In the hostile environment and fragile ecosystem as existing in Indian desert Ber (*Z. nummularia, Z. rotundifolia, Z.mauritiana*) ranks as a valuable multipurpose plant. In addition to providing nutritious fruits, fodder and fuel, these species stand apart in their prominent role in traditional socio-economic and cultural web of rural population. This report seeks to knit together and present a coherent account of the historical, socio-religious, ethnomedicinal and other specific and exclusive economic uses of Ber in the Indian arid region. Fruits and other plant parts of Ber form an integral component of rituals, rites, ceremonies and customs

among different ethnic groups in rural areas. It is evident that *Ziziphus spp*. represents an extremely important plant bio-resource in Indian desert. Therefore, in the context of bio-resource conservation and utilization, for achieving a sustained balance between environmental and socio-economic needs, scientific production and management efforts need to be intensified for this underutilized plant bio-resource.

**Corresponding author: Narendra Sankhla; Fax: +972 952 9216; e-mail: n-sankhla@tamu.edu*

S-02-07
Advances in Breeding and Selection of *Ziziphus jujuba* Mill.

Li Li[1], Peng Jianying[1], Huang Ruihong[1], Zheng Baoqiang[2], Lan Haibo[1]

[1] *College of Horticulture, Agriculture University of Hebei, Baoding, China;*
[2] *Key Laboratory of Tree Breeding and Cultivation, Research Institute of Forestry, Beijing, China*

Ziziphus jujuba Mill. is an unique fruit tree originated from China, with long history and rich germplasm resources. The researches of investigation, reorganization, preservation and use had been studied from 1950's initial period until now, and have made important progress in recent years. The progress promoted genetics and breeding researches in-depth. In this study, we introduce the selective breeding history of *Z. jujuba* Mill., and expatiate the selective breeding from the aspects of introduction, chance seeding selection, bud sport selection and germplasm innovation using the bio-engineering methods including *in vitro* culture technology, molecule marker technique and gene transformation. Also, the research directions of germplasm resources and breeding work in future were proposed.

**Corresponding author: Peng Jianying; e-mail: pjy@hebau.edu.cn*

S-02-08
Taxonomy of *Ziziphus* Genus in Iran

Mehri Dinarvand

Research Center of Agriculture and Natural Resources of Khuzistan, Ahwaz, Iran

Present research work is a part of a national project ongoing in Iran. Taxonomy and diversity of *Ziziphus* species was carried out and made a contribution to the Flora of Iran based on field observation and study of all sheets of original herbarium in Iran. *Ziziphus* is a genus of Rhamnaceae family, a family of 58 genera and nearly 900 species. It represented in Iran by three species, two varieties and one hybrid including *Z. spina-christi*, *Z. nummularia*, *Z. jujuba*, and *Z. spina_christi* x *Z. nummularia*. *Z. spina-christi* and *Z. nummularia* are native to tropical region of Iran from 'Illam'province in West to Sistan_Balochestan in East (the Saharo_Sindian area), whereas, *Z. jujuba* is native to Golestan province, Northern area of Iran (Hyrcanian region). These species are commonly used by the people, for industrial purpose, food, fodder, ornamental and medicinal purposes. In Iran, *Ziziphus* tree is considered as a sacred plant and most of the people try to protect it in their holy places, graveyards and even in their houses. At some places some very old plants are found with good growth and huge canopy but in agricultural fields this tree species is being extensively cut by the farmers for their domestic uses, resultantly these species are being rare day by day. Although a good diversity of this plant was seen in Bushkan (Bushehr province), along with the road from Dehloran to Shush (Khuzistan Province) and Kalaleh (Golestan Province) but a lot of efforts are needed for the conservation of this multipurpose plant species, especially *Z. jujuba*, which is the rare plant in Iran as

in most of its habitats it has been completely demolished. In this paper foliar anatomy, identification key and chromosome number of species were discussed.

*Corresponding author:Mehri Dinarvand; e-mail:mdinarvand2003@yahoo.com

S-02-09
A Survey and Textual Research on the Names of Genus Jujube and Its Main Species

Mengjun Liu[1], Yefeng Qi[2] , Zhihui Zhao[1]

[1]*Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, Hebei, 071001, China；*
[2] *Library，Agricultural University of Hebei, Baoding, Hebei, 071001, China*

The existence of a lot of synonym and homonym, caused by divarication in classification and lack of communication, has long been hindering the academic exchange in jujube. An extensive survey and textual research on the English and scientific names of the genus and its main species were carried out. The survey on the name used frequency during 1990-2007 indicated that of the seven scientific names given to jujube, i.e., *Ziziphus, Zizyphus, Jujuba, Sarcomphalus, Mansana, Decorimaand and Ziziphon,* only the first two are still commonly used (making up 72.81% and 27.07%, respectively); Sixteen scientific names have been used for Chinese jujube, of which only five are still alive, and the total (live) scientific names for Indian jujube and small fruit jujube are at least 9 (4) and 10 (2), respectively; The most predominant scientific name for the above mentioned three species, *Z. jujuba* Mill., *Z. mauritiana* Lam. and *Z. oenoplia* Mill., accounting for 76.35%, 91.94%, and 93.33%, respectively, and all of them are the correct ones fortunately. The results of textual research showed that the correct scientific name for jujube is *Ziziphus* Mill. instead of *Zizyphus* Mill, and the proper English name for *Z. jujuba* Mill. should be Chinese jujube rather than Chinese date; *Z. jujuba* Lam. is a synonym of *Z. mauritiana* Lam. (ber or Indian jujube) and a homonym *Z. jujuba* Mill.. The names of the genus jujube and its main species in different languages and countries were also introduced. It is strongly suggested to confirm the unique English and scientific name for genus jujube and each of its species in order to benefit related information exchange and literature searches.

*Corresponding author: Mengjun Liu; e-mail: kjliu@hebau.edu.cn

S-02-10
Constraints in Adoption Ber (Jujube) Production Technology in Sindh Province Pakistan

M.Ismail Kumbhar, M.U. Mallah, Dr. Saghir Ahmed Sheikh

Sindh Agriculture Univeristy Tandojam, Pakistan .

The purpose of this paper is to examine the constraints in the adoption of improved jujube technology and obtained suggestion of farmers to overcome these constraints. This research was kind of descriptive survey. The population of this study includes 190 Ber (Jujube) farmers. The research tool was questionnaire. The data of research are analyzed by SPSS/13 software into two descriptive and analysis section. In order to validity of research instrument, designed questionnaire was given to some of scholars of Sindh Agriculture University, Tandojam and some of the Agriculture Extension and Technology transfer specialists, that after necessary correction and changing some questions, questionnaire validity is approved, for testing research reliability. The results revealed that the major

constraints in adoption of recommended technologies of jujube cultivation were: Lack of Knowledge about various recommended cultivation practices; non-availability of inputs in time and at reasonable prices; non-availability of improved implements; inadequacy of labors; high rates of wages; inadequate market facilities; poor storage; and other post harvest facilities, insufficient capital; high labor costs and increased cost of plant protection; chemicals. Suggestions of farmers to overcome these constraints were also presented. The study showed that the jujube technology has a great potential to the farming community in Sindh province and has enormous provision for extended local market. However, the constraints identified by the stakeholders need to be addressed adequately before the potential is realized.

**Corresponding author: M.Ismail Kumbhar; e-mail: mikumbhar@yahoo.com*

S-02-11
Ber (*Ziziphus spp.*) in Indian Thar Desert: Eco-physiology, Biotechnology, Horticulture and Socio-Economic Impact

Narendra Sankhla[1], Hukam Singh Gehlot[2], Neelam Poonar[2], Narpat Singh Shekhawat[2] and Timothy D. Davis[1]

[1]Texas AgriLife Research, Texas A & M System, Dallas, TX, 75252, USA
[2]Botany Department, J. N. Vyas University, Jodhpur 342001, India

In Indian Thar Desert, with its unique environmental constraints, *Ziziphus* species (e.g., *Z. nummularia, Z. rotundifolia, Z. mauritiana*), rank as important multipurpose life support plants, and play a vital role in the overall socio-economic web of rural population. As for Chinese jujube, the antiquity and wide usage of Ber have also been reflected in several Indian scriptures. Besides their multipurpose uses, the wild species of Ber constitute the only source of low cost nutritious fruits in hot, arid and saline tracts of Indian desert. With the availability of improved cultivars, obtained by budding *Z. mauritiana* scions on drought hardy root-stocks of native *Ziziphus* species, Ber cultivation has become highly popular and visible as an integral component of silvi-pastoral and agri-horticulture system in this region, although the development of an appropriate postharvest and processing technology and organization of efficient supply chains is still in infancy. Current efforts of regional research organizations in improvement and up scaling ber production in arid regions point out that for a sustained environmental and socio-economic impact scientific production and management of Ber in Indian desert derives a top priority. In this outreach presentation, while reviewing available information on Ber, we aim to provide an overview of our results on eco-physiology, antioxidant defense systems, biotechnology and arid horticulture in the context of bio-resource utilization and conservation coupled to its socio-economic impact in this highly fragile ecosystem**.**

**Corresponding author: Narendra Sankhla; Fax: +972 952 9216; e-mail: n-sankhla@tamu.edu*

S-02-12
Total Phenol Content and Antioxidant Potential of Dry Fruits of Some *Ziziphus* Species and Cultivars of Indian Arid Region

Neelam Poonar, Hukam Singh Gehlot, Rashmita Parihar, Printal Kachwaha, Khursheed Ahmed[1], and Narendra Sankhla[2]

J. N. Vyas University, Jodhpur 342001
[1]Botany Department, Govt. College, Ajmer
[2]Texas AgriLife Research, Texas A & M System, Dallas, TX, 75252, USA

Traditionally, three species of Ber (*Z. nummularia, Z. rotundifolia, Z.mauritiana*) are used for commercial low cost fruit production in hot and arid Indian desert region. Fruits of the newly introduced improved cultivars of *Z. mauritiana* bear high quality big nutritious fruits which are generally eaten fresh, but can also be dried and stored for future use. This study was undertaken to evaluate and compare the total phenol content, reducing power and free radical scavenging capacity of antioxidants using 2,2-diphenyl-1-pycril-hydrazyl (DPPH) method in dry stored fruits of *Z. nummularia* and *Z. rotundifolia*, and four cultivars (Chuara, Gola, Illaichi and Tikadi) of *Z. mauritiana*. The highest amount of total phenols was recorded in fruits of cv. Illaichi, while the fruits of *Z. nummularia* indicated the lowest level of total phenols. In contrast, the fruits of cv. Chuara exhibited the highest reducing power which was followed by fruits of *Z.nummularia*, cv. Illaichi and *Z. rotundifolia*. Fruits of cv. Chuara also had the highest free radical scavenging capacity which was followed by fruits of cultivars Illaichi, Gola and Tikadi. The fruits of *Z. nummularia* and *Z. rotundifolia* showed relatively very low free radical scavenging capacity. These results indicate that the antioxidant potential of fruits differed in various species and cultivars of Ber, and unlike some other fruits, no correlation was found between total phenol content and antioxidant potential in fruits of these species and cultivars of Ber.

**Corresponding author: Narendra Sankhla; Fax: +972 952 9216; e-mail: n-sankhla@tamu.edu*

S-02-13
Status of Indian Jujube (*Ziziphus mauritiana* Lamk) in Irrigated Sub-humid and Arid Irrigated Eco-system of Punjab

Rajbir Singh Boora and J. S. Bal

Punjab Agricultural University, Regional Fruit Research Station, Bahadurgarh Patiala (Pb) India

Indian Jujube (*Ziziphus mauritiana* Lamk) is an important commercial fruit crop of Punjab. It ranked fourth in area and fifth in production and is grown on an area of 2.87 thousand ha. with a production of 43095 tones. The productivity of ber in Punjab is 15 tones per ha. The major growing areas are Sangrur, Patiala, Mansa, Bathinda, and Ferozepur. It is a rich source of Vitamin C (120 mg/100g pulp), Protein (1%), Phosphorus (0.03%), and Iron (1%). The most popular commercial cultivars of ber in Punjab are Umran and Sanaur-2. Umran is a heavy bearer late season variety, having very good self-life but it is susceptible to powdery mildew. The average fruit yield of this variety is 140-205 kg per plant. The TSS of this variety ranged from 17.4 to 19.2 per cent. Sanaur-2 is a mid season variety and very good bearer. The fruit have special characteristics of having TSS and Acid blend. The TSS is ranged from 17 to 19 per cent. This is a juicy variety. The average fruit yields potential of this variety is 150 kg. per plant. The canopy of this variety is dropping in nature that facilitate in harvesting and intercultural operations. In addition to these two cultivars, other commercial varieties are ZG-2,

Wallaiti, and Kaithali. In 1981, the total area under Ber production in Punjab was 698 hectares but after 2 decade the area increased to 2873 hectares with the production of 43095 tones.

*Corresponding author: Rajbir Singh Boora; e-mail: rsboorapau@yahoo.co.in

S-02-14
Present Status and Development Strategy of *Zizyphus jujuba* Mill. cv. Dongzao in Zhanhua

Xiaojun Li[1] , CHT Su[2] , QZH Yin[1] , LZH Bai[3] , Y Zhang[1]

[1] *Shandong Institute of Pomology,Taian Shandong*
[2] *Zhanhua Institute of winter jujubehanhua Shandong*
[3] *Zhan Agriculture Bureau,Zhanhua Shandong*

Zhanhua county is the main habitat of late-maturing fresh 'Zhanhua Dongzao' in northern Shandong province. The areas has amounted to 33,000 hectares since 1984 till now, and it approximately occupied 25% Dongzao cultivation area in China. However, because of small-scale dispersion, poor management and laggard production practices, the quality of jujube has declined, and the fame of 'Zhanhua Dongzao' has also descended. That even caused the appearance of sluggish market, low price, and no profit to jujube merchant. Government should be stand to market, and exert every professional associations'effect, shift its work to focus on optimized variety and structure, improve the capacity of precision machining, promote the optimization of practical integration of new techniques. It would spread gradually to Zhanhua Dongzao cultivation and management standardization, model diversification, variety choiceness, balanced fertilizing, spraying pollution-free, post-processing upgrading, green products, so as to make Zhanhua Dongzao industry to be the development of international trade target.

**Corresponding author: Xiaojun Li; Fax: +86- 13705388161; e-mail: zbs@sdip.cn*

S-02-15
Statistics and Analyses of Science Research Literature in Genus *Ziziphus*

Yefeng Qi, Li Dai, Mengjun Liu

Agricultural University of Hebei, Baoding, Hebei 071001

Statistical research on the literature of the genus *Ziziphus* was carried out basing on Agris, Agricola and CABI tabloid database in 1990-2007 AC. The results showed that China, India and Korea Pep. were the three leading countries in the research on the genus *Ziziphus*，the paper numbers of 3 nations was 44.9%、28.6 and 6.5% separately. The most common English name for the genus *Ziziphus* was jujube and scientific name was *Ziziphus* or *Zizyphus*. The main research institutions on the genus *Ziziphus* in each nation included Agricultural University of Hebei, Shanxi Agricultural University etc.(China), CCS Haryana Agricultural University, Rajasthan Agriculture University etc.(India), Chongbuk National University, Yeungnam University etc.(Korea Rep). The main international sci-tch journals compartmentalized according to numbers of donation country for publishing papers on the genus *Ziziphus* included Phytochemistry（8 nations）, Acta Horticulturae（5 nations） and Journal of Horticultural Science（4 nations）. The paper quantity on the genus *Ziziphus* in all the relative journal was also statisticed, The main journals for the genus *Ziziphus* included china fruit(China), Acta Horticulturae Sinica(China), J.of Fruit Science(China) and Haryana J.of Horti. Science(India) etc..

**Corresponding author: Mengjun Liu; Fax: +86-* 03127521456; *e-mail: kjliu@hebau.edu.cn*

Germplasm and Breeding

S-03-01
Studies on Seed Germination of Tunisian Jujubes

A. Laamouri[1], Y. Ammari[1], A. Albouchi[1], A. Dachraoui[2] and M. Tej Yakoubi[2]

*[1]. National Institute for research in Rural Engineering, Water and Forests, B.P.*10*, Ariana 2080, Tunisia.*
[2]. Dept. Of Biology, Sciences Faculty, University of Tunis El Manar II, Tunisia.

In Tunisia, *Ziziphus* genus is represented by one native species: *Z. lotus* and two others, acclimated: *Z. zizyphus* (ex. *Z. vulgaris*) and *Z. spina-christi.* Works on the propagation or the seed germination of these jujubes in our country are scanty. The first trials started with Laamouri (1996, 1999, 2000, 2005, 2006). This article is a contribution to improve the celerity and the seed germination rates using some new treatments.
The seeds of the three jujube species mentioned above were submitted to two tests: Test of viability using tetrazolium staining and a raising test. Germination has been worked out under two factors: Germination tests at three temperatures (20°C, 30°C, 40°C) and four treatments,Ta= dipping into gibberellic acid (GA_3), Tb= GA_3 + $Ca(NO_3)_2$, Tc = GA_3 +$Ca(NO_3)_2$, Td= GA_3 + KNO_3, at a concentration of 100 ppm for one hour.
The jujube seeds exhibited high rates of viability: 96% for *Z.* lotus, Z. *spina-christi* and 82% for *Z. zizyphus.*
At 30°C, *Z. lotus, Z. zizyphus and Z. spina-christi* showed a germination capacity of 77%, 37% and 67%, respectively, but only 19%, 5% and 37% at the room temperature (20°C). The requirement in high temperature seems to be closely related to the geographical origins of these species. The treatment with GA_3 as well as the interaction with $Ca(NO_3)_2$ has increased the germination percentage of *Z. lotus and Z. spina-christi* (>60%). This hormone seems to remove the embryonic seed dormancy. $Ca(NO_3)_2$ gave satisfactory results especially for *Z. zizyphus* in which the germination capacity has increased from 5% to 56% in the presence of KNO_3 (Td). Concerning the raising of the seedlings, a notable improvement was recorded for the three species with all treatments, especially in presence of GA_3 witch is known for its role in speeding the emergence of hypocotyles. The recorded observations on Tunisian jujubes' seed germination may contribute to a better understanding of such plants, facilitate their propagation and improve their economical and ecological standards. In combination with the results obtained before, the new information will be of a great usefulness to achieve a practical guide to seed propagation of multi-purpose trees or shrubs like the jujube species in Tunisia. However, more studies should be carried on the different jujube ecotypes or provenances of the country.

**Corresponding author: M.T Yakoubi, e-mail: g.yakoubi@voila.fr*

S-03-02
Improved ber (*Ziziphus mauritiana*) Germplasm for the Sahelian Smallholder Farmer

Antoine Kalinganire, John Weber, Harold Roy-Macauley and Salimata Coulibaly

The World Agroforestry Centre (ICRAF-WCA), BP 320 Bamako

The west African Sahel, a semi-arid landscape stretching from Niger and Senegal (West Africa), is characterised by high temperatures throughout the year, with a low and highly unpredictable rainfall

pattern (400-1000 mm/year), occurring during a 3-month period, and a 9-month dry season. Trees and shrubs, mostly indigenous tree species, provide many functions for the rural poor farmers. Smallholder farmers cultivate such species, including ber *Ziziphus mauritiana,* together with staple food crops such as millet and sorghum for specific functions enhancing their livelihoods. Ber is a moderate sized fruit tree, highly preferred by smallholder farmers in the Sahel. The performance of introduced germplasm from Indian and Thai accessions is poor in terms of adaptability and production. Fruit borers, fruit flies and leaf and fruit eaters have been reported as a major limiting factor to the cultivation of most improved varieties of ber. Improving performance of ber in the Sahel necessitates the introduction of a wider range of planting material, including the more productive individuals from local accessions, and the creation of more tolerant varieties to drought, insect attack and diseases, with longer fruit shelf life. The Sahel counts more than 50 accessions, including those selected participatory with farmers and partners. Fruit production varied between accessions. Although introduced cultivars are 6 fold more productive and fruits are 140 times bigger than local accessions introduced cultivars are not easily shelf conserved and are less tolerant to pests. Local accessions are being conserved *ex-situ* on-farms for future breeding and improvements. On-farm conservation, selection from the existing gene pool and creating new accessions will continue targeting the identification of highly productive genotypes under the Sahelian conditions.

**E-mail: a.kalinganire@cgiar.org Fax: +223-222 8683*

S-03-03
A New Table Jujube Cultivar Miguanxin No.1

Chang-zhu Wang, Wen-hai Gao, and Xin-gang Li

Northwest science and technology university of agriculture and forestry, Yangling, Shaanxi 712100, China

Miguanxin No.1 is a new early table cultivar of jujube selected from Fengmiguan, a local variety of Shaanxi province. The fruit is oblong and uniform but larger than Fengmiguan's. The average fruit weight is 8.4g, and maximum is 25g, containing a soluble solid content of 26%~32%, edible rate of 96.5%. The fruit flesh is crisp and juicy with excellent quality. Early bearing, easy to be grown, early ripening (ripe in middle August) and certain resistance to fruit cracking are its main characters. It is suitable for high density planting in field and for growing in green house.

**Corresponding author: Wang changzhu; e-mail:wangchangzhu55@126.com*

S-03-04
Yanliangcuizao, a New middle-early Maturating and Fresh Cultivar of Jujube

Chang-zhu Wang [1], Wei Meng [2] Xin-gang Li [1]

[1] Northwest Science and Technology University of Agriculture and Forestry, Yangling,, Shaanxi, 712100, China;
[2]Fruit and forestry station of Yanliang zone, Yanliang, Xian, 710089, China

"Yanliangcuizao", a new fresh cultivar of Chinese jujube, was selected from the local germplasm in Yanliang zone, Xian city. It ripens in early September in Yanliang zone, and has super quality for fresh-consuming, high yield and resistance to shrinking. The fruit is cylinder in shape and uniform. The average fruit weight is 21g, and maximum is 34g, containing a soluble solids content of 28.5%,

edible rate of 95.5%. The fruit flesh is crisp and juicy. The flavor is sweet sour. It is suitable to be cultivated in high density.

*Corresponding author: Wang changzhu; e-mail:wangchangzhu55@126.com

S-03-05
Processing and Value Addition to Indian Jujube (*Ziziphus mauritiana*)

Dheeraj Singh, Lobsang Wangchu [1] and V.C.Prahalad[2]

College of Horticulture and Forestry, Jhalawar, Maharana Pratap University of Agriculture and Technology
[1]College of Horticulture and Forestry, Pasighat, Central Agricultural University, Imphal.
[2]College of Horticulture and Forestry, Jhalawar, Maharana Pratap University of Agriculture and Technology.Udaipur (Raj).
Department of Post Harvest Technology, College of Horticulture and Forestry, Krishi Vighyan Kendra, Jhalawar -326001,Rajasthan, India

Ber (*Ziziphus mauritiana*) is one of the important fruit crop indigenous to India and the country occupies prime position in its production. To prevent the seasonal glut of fruit in the market processing industry plays a very important role. *Ber* fruit are processed into several products, such as jam, jelly, pulp, juice, powder, dried *ber,* candy, slices, *tutti-frutti* and wine. The by-products of the processing industries are utilized for the extraction of pectin. Juicy varieties of the *ber* are better suited for preparing the juice. A process for the extraction of juice from the *ber* fruits has been standardized in which extracted juice is allowed to stand at 4°C and passed through four layers of the muslin cloth. The recovery of juice is about 40% of the fresh weight. Ber juice (10%) can also be used for preparation of ready to serve beverage and carbonated beverage. Dehydrated *ber* is prepared by giving a treatment of the sulphur dioxide at 3.5 to 10 g/kg of the fruits for two hours followed by drying in sun or in a cabinet drier at 60°C until the moisture content of the product is reduced to 15%. Dry powder has successfully been prepared from the *ber* fruits. Candy may also be prepared from the dried *ber* by soaking them in syrup for 24 hours and cooking for 10 minutes. A soft and delicious product having appearance like dried fig may be prepared from the *ber* fruits. The yield of the final product is about 40 per cent. The product looks like dried fig and exhibits an attractive golden yellow colour and appealing taste. Good quality wine is also prepared from ber juice. Excellent jelly and jam can be prepared from fruits by adding a proper amount of pectin and acid to thus fruit or by mixing it with other fruits.

*E-Mail: dheerajthakurala@yahoo.com Fax: +91 7432232103

S-03-06
Two New Wild Jujube Cultivars – Dasuanzao and Cuisuanzao

Dongzhi Liu [1], Chuntong Wang [2], Tingjuan Yu [2], Chuanwen Li [2], Dengchao Zhao [3], Liqun Hou [3]

[1]Shandong Normal University, College of Life Science, Jinan, Shandong, 250014 China
[2]Jinan Forestry Administration, Jinan, Shandong, 250002 China
[3]Shandong Academy of Forestry Sciences, Jinan, Shandong, 250014 China

Wild jujube (Z. *acidojujua* C.Y.Cheng et M. J. Liu), a wild fruit species, was of high economic value and of great importance in preventing soil erosion and greening environment. This species was widely distributed across China, especially in provinces along mid-reaches and lower-reaches of Yellow

River，such as Shandong, Hebei, Henan, and Shanxi. In this paper, the main characteristics of Dasuanzao and Cuisuanzao, two new cultivars were studied in morphology, growth, development, economic value, phenological phase and stress resistance. The results showed that although the fruits of the two cultivars were different in shape, size, color, the average weight（5.03g for Dasuanzao and 6.07g for Cuisuanzao）, sugar content, and vitamin C content (445mg/100g for Dasuanzao and 468mg/100g for Cuisuanzao), they shared several key characteristics. For example, both of them possessed excellent integrated economic charac- teristics such as thin epicarp, crisp sarcocarp, abundant juice and particular flavor. Moreover, they were both good in drought resistance, leanness tolerance and adaptability. Therefore, they were potential cash crops if extensively planted. Particular flavor and abundant nutritive value turned wild jujube into a popular fruit. Now the demands of the market have been rising at home and abroad. It would be a profitable investment to rationally develop and utilize the resource of wild jujube. It can help develop mountain district economy, enrich people's lives, and improve environment.

*Corresponding author: Liqun Hou; e-mail:lqhou@163.com

S-03-07
Investigation of Genetic Variation and Cluster Analysis Different Jujube(*Ziziphus jujuba* Mill.) Ecotypes in Iran

Hossein Tavakoli Neko and Abbas Pourmeidani

Qom Agricultural and Natural Resouces Research Center , Iran

By this paper genetic potential and variation of Jujube (*Zizyphus jujuba* Mill.) ecotypes were investigation. The plants were collected from 15 provinces zone of Iran with different ecological and geographical conditions and have been evaluated during 1999-2002. Experiments were done with 29 ecotypes in Badiei station in western part of Qom and characters of growth and birth orderly was recorded. Randomized complete blocks design with three replications was done. Traits of each ecotype in three years were measurement as following characters: Angle of branch with stem, number of thorn in stem, length of longest thorn, length of annual branches, length of annual thorn, border and shape of leaf, length of petiole, length and width of leaf, length and width of new leaf, and color leaf. Analysis Variance and Factor analysis were done. Analysis of variance indicated that length and width leaf in every repeat had significant differences, Correlation coefficient indicated that ″Angle branches″, ″Number of thorn″ and ″leaf length″ together and with other characters had significant correlation, so this can be used in separating ecotypes. Factor analysis determined four Factors that describe 64% of variance. Factor analysis with Varimax method, determined three factors included ″leaf shape″, ″new leaf″ and ″Angle of branch with stem″ and ″Number of thorn in annual branches″. Cluster analysis separated, collected ecotypes in three groups to Esfahan, Mazandaran and Khorasan basis. Fars ecotype is originated from Esfahan and Qom ecotype is originated from Esfahan and Mazandaran basis.

*Corresponding author:Hossein Tavakoli Neko;Fax:+98 251 2907574;
e-mail:TavakoliNeko@yahoo.com

S-03-08
Discovery of a Stable Male-sterile Germplasm of Chinese Jujube (*Ziziphus jujuba* Mill.) and Its Potential Use in Cross Breeding

J R Wang[1], M J Liu[2], P Liu[2], M Zhang[1] and J L Guo[1]

[1] *College of Forestry, Agricultural University of Hebei,Baoding 071001 China；*
[2] *Research Center of Chinese Jujube, Agricultural University of Hebei,Baoding 071001 China*

A male sterile germplasm of Chinese jujube（*Ziziphus jujuba* Mill.）, named 'male sterile No.3'（JMS3）, was found from natural population by testing the pollen number and observing the anther morphology and anatomical features. Anthers of JMS3 at the unopened flower buds were small, shrunken and dingy yellow, and became brown after anthesis. No survival pollens were observed in the yellow bud of JMS3 and the male sterile trait kept stable during flowering season in different years. Although embryo abortion of JMS3 occurred at early development stage to some extent, the seed rate was higher than 80% in the fruits at late development stage. A total of 175 fruits were obtained from three cross combinations, *i.e.*, JMS3 × 'Jinmangguo', JMS3 × 'Laishuilingzao' and JMS3 × 'Wuhexiaozao' *via* controlled hybridization from 2006 to 2007. The seed rate of fruit from the three crosses ranged from 80% to 100% and 159 seeds were obtained. Twenty four immature embryos germinated directly and plantlets were regenerated about 40 days after inoculation in the medium MS + sugar 30g/L + agar 3.3g/L. Furthermore, callus formed from most of the immature embryos and more plants could be possibly regenerated by means of adventitious bud inducement in the future. In view of its stable male-sterile, high embryo fertility, excellent table quality as well as late ripening, 'JMS3' could be employed as a well suited female parent to overcome the two main obstacles in Chinese jujube cross breeding, *i.e.,* severe emasculation damage and heavy embryo abortion.

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@mail.hebau.edu.cn*

S-03-09
The Spatial Distribution Pattern of Over-winter Eggs, the First Generation of Nymphs and Ecological Control of *Lygus lucortum* Meyer Dur in Jujube Orchard

Liu Chunqin[1], Wang Qinglei[1], Feng xiaojie[1], Xi guocheng[1], and Zhen Wenchao[2, 3]

[1.] *Cangzhou academy of agricultural and forestry sciences, Cangzhou 061001, China*
[2.] *College of Plant Protection, Agricultural University of Hebei, Baoding 071001, China*
[3.] *Research Center for Biocontrol Techniques against Pests on Crops of Hebei Province, Baoding 071001, China*

From 2005 to 2007, the number and spatial distribution pattern of over-winter eggs of *Lygus lucortum* Meyer Dur were investigated in jujube orchards under different management level. Results showed that the amount of over-winter eggs of *L. lucortum* Meyer Dur was large, and the eggs were laid in the residual piles, the top of mother spurs of jujube, and the dead mother spurs in the jujube orchard under careless management. On the contrary, the amount of over-winter eggs in the fine management orchard was much smaller, and the eggs were laid on the residual piles or the dead mother spurs on the top of secondary branches. In mid May, ecological environment directly affected the spatial distribution of the first generation of nymphs. If there were more weeds such as amaranthus color Chenopodium album and hedgerow under the trees, then more eggs were laid on weeds, and only a small amount of eggs were laid on the trees. On the contrary, if there were few weeds under the trees,

the eggs amount of *L. lucortum* Meyer Dur on the trees would be larger. The reasonable retaining of the ground surface covered, planting cover crops, or increasing weed amount can reduce the number of the first generation of nymphs and reduce the hazard rate accordingly.

**Corresponding author: Zhen Wenchao E-mail: wenchao@hebau.edu.cn*

S-03-10
Genetic Diversity of Sour Jujube (*Ziziphus acidojujuba* C. Y. Cheng et M. J. Liu) in China

Ping Liu, Mengjun Liu, Yuanlin Wu and Lei Yang

Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, Hebei, 071001 China

Sour jujube, *Z. acidojujuba* C. Y. Cheng et M. J. Liu（*Z. spinosa* Hu.) is originated from China and widely distributed in most northern provinces. It is the direct ancestor and main rootstock of Chinese jujube (*Ziziphus jujuba* Mill.). Because of its wide adaptation, important medicinal value, great potential in production of fruits containing high vitamin C and for juice making, sour jujube is being more and more utilized, and cultivated. Sour jujube has a very high genetic diversity. Its fruit weight ranges from 0.14g to 6.33g; fruit color from orange, red to dark red; fruit shape from oblate, globose, oblong globose, to ovoid. The variation coefficient differs with characters. According to the investigation and statistics of 211 kinds of germplasms sampled from main sour jujube production area including Hebei, Shanxi and Shannxi province, the ratio of fruits with two kernels has the biggest variation coefficient (0.59), followed by fruit weight(0.56), straight thorn length(0.33), stone weight (0.32), fruit No. per bearing shoot (0.30), secondary branch No. per extension shoot (0.28), one–thousand-kernel weight (0.26), short thorn length(0.26), extension shoot length(0.26), secondary branch length(0.26), cross diameter of extension shoot (0.22), thickness of kernel(0.20), fruit cross diameter(0.19), fruit longitudinal length (0.19), internodes No. of secondary branch(0.19), stone longitudinal length (0.15), ratio of kernel(0.14), stone shape index (0.14), kernel longitudinal length(0.13), stone cross diameter(0.12), fruit shape index(0.12), kernel cross length (0.11) and ratio of edibility(0.10). Among the quantitive characters studied, 8 characters are not conformed of normal distribution at α =0.01 level while 3 characters at α = 0.05 level. The other 12 characters were of normal distribution. In case of the contents of nutritional compounds, sugar acid ratio showed greatest difference among germplasms with variation coefficient of 1.00, followed by water soluble polysaccharide (0.74), titratable acids (0.59), flavonoids (0.44), jujubosides (0.41), Vitamin C (0.40) and total soluble sugar (0.27). Of the above 7 characters, only the last five are of normal distribution.

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@mail.hebau.edu.cn*

S-03-11
Breeding of a New Fresh Used Jujube Cultivar 'Zhongqiusucui' for Southern China

Sen Wang [1], Bixia Xie [1], Qiuping Zhong [1], Zhanying Gu [1], Jiangqiao Zeng [2,] Jianxin Zeng [2]， Hongyan Du [3]

[1] College of Resources and Environment, Central South University of Forestry and Technology, Changsha 410004, Hunan;
[2] Xinfeng fruit industry Limited company, Qidong 414400, Hunan； Non-timber Forestry Research and Development Center, Chinese Academy of Forestry, Zhengzhou 450003, China

Zhongqiusucui jujube is a bud mutation from Sugar jujube. The fruit of Zhongqiusucui jujube is medium size and cylindrical form with thin pericarp, thick pulp, and small core. The weight of a fruit is 13.8 g, and the edible percentage is up to 97.1%. The pulp is white, smooth, crispy, and juicy with 31.76% soluble solids and 29.41% total sugar. The favor is strong sweet and slight fragrant. It matures about 8d later than Sugar jujube. Its fruit weight is 2.2 times as that of Sugar jujube and the total sugar content is 4.44%, which is higher than that of the latter. It has a nice favor, excellent quality, and good appearance. Quality comparison experiments and local trials proved that it is adaptable to the local growing conditions having high and stable production, which should be extended in the southern China.

**Corresponding author: Sen Wang; Fax: +86 731 5623456; e-mail: csuftwangsen@163.com*

S-03-12
Morphological Characterization of Variability in Ber (*Ziziphus mauritiana* Lamk.) Germplasm

S.K.Sehrawat, P.L.Saran, V.P.Ahlawat, D.S.Dahiya and S.S.Sindhu

Department of Horticulture,CCS Haryana Agricultural University, Hisar, India

The ber (*Ziziphus mauritiana* Lamk.), a member of Rhamnaceae family, is an ancient and hardy fruit indigenous to India. It grows throughout the tropical, subtropical and arid regions of the world as it has wide adaptability. Nutritionally the ripe fruit is richer than apple in protein, phosphorus, calcium, carotene and vitamin C. The ber tree is also important for integration into desert ecosystem for economic sustenance and insurance against ecological degradation. A large number of ber cultivars are grown for commercial purpose in India and these seedlings originated as chance variants which are being maintained vegetatively in the areas of cultivation. Yet no serious attempt has been made for nomenclature, characterization and classification of these genotypes on the basis of vegetative as well as flower and fruit characters. It is hoped that the description of these characters will help the research workers, horticulturist and nurserymen alike in distinguishing the ber genotypes. Thus, the present study was made to characterize and classify twenty four genotypes based on vegetative and reproductive attributes. Lots of variation for vegetative and floral character of ber genotypes was observed. The highest foliage density was observed in *Ziziphus numularia* (18.60) while it was lowest in Umran (6.50). The maximum petiole length was recorded in Type 1/12 genotypes while minimum was noticed in Type 15/16 (0042 cm). The mean longest leaf was recorded maximum in Mudia Murhara (9.66 cm) while mean leaf width was maximum in Gurgaon Gola (5.62 cm). The lowest mean value was observed in Type 15/16 (2.67 cm) for leaf length and in case of leaf width in Type 15/12 (1.43 cm) germplasm. Illaichi had maximum leaf area (26.29 cm^2) while minimum was noticed in Type 15/12 (1.40 cm^2). The period of bloom was maximum in Illaichi (64.00 days) while lowest mean value was observed in Type 1/2 (38.00 days). Peak blooming period lasted longer in Type 3/12 genotype (30.00 days). The minimum peak blooming period was observed in Kakrola Gola (11.00 days). The maximum number of flowers/cyme was observed in Kala Gola (30.60) while minimum in case of *Z. numularia* (8.00). The longest pedicel length was observed in Illaichi (0.86 cm) while shortest in case of Type 6/8 (0.32). Maximum total soluble solids were recorded in Gola genotype (21.00) while it was minimum in Type 2/7 (10.00). The highest per cent acidity was observed in *Z.numularia* (1.20) while minimum in Type 15/12 and Type 15/14 (0.30). The highest ascorbic acid was recorded in Mudia Murhara (170.00 mg/100gm) while minimum in case of Rashmi (87.00 mg/100 gm).

**Corresponding author: S.K.Sehrawat; e-mail: sehrawatsk@hau.ernet.in*

S-03-13
Performance of Ber Cultivars Raised Through Top-working in Close Spacing

S. N. Ghosh[1], R. K. Tarai[2], B. Bera[3] and A. Kundu[3]

[1]Department of Fruits and Orchard Management, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, Nadia, West Bengal, India
[2]Krishi Vigyan Kendra (Gajapati), Orissa University of Agriculture and Technology, R. Udyagiri, Orissa, India
[3]MPS Farm, Jhargram – 721504, Paschim Midnapore, West Bengal, India

Ber (*Zizyphus mauritiana* Lamk.) is an ideal fruit tree for arid and semi-arid regions due to its wide adaptability and xerophytes in nature. The choice of suitable cultivar/s, for a set of agro-climatic condition, is of paramount importance for its commercial profitability. A number of varieties have been recommended for ber cultivation in different parts of India. No such recommendation is available for West Bengal, an eastern state of the country. The red laterite zone of West Bengal, where the soil is acidic in nature, low in organic matter and nutrients and rainfall is lower than other parts of the state, is found to be suitable for growing ber. To find out suitable varieties for commercial cultivation for the red laterite zone of West Bengal, a long-term investigation was undertaken in a private orchard where the soil was red and laterite. Eleven varieties of ber *viz.,* Banarasi Karka, Chhuhara, Dandan, Gola, Ilachi, Jogia, Kaithali, Mundia, Umran, Sanaur-2 and Seb were raised through top-working on 5 years old trees of local ber plants (*Zizyphus rotundifolia*), planted in a close spacing of 5 m - 4.5 m. Results from 5 years of investigation after top-working, indicated that the cultivar 'Jogia' gave highest fruit yield of 72 kg/plant followed by 'Gola' (54 kg/plant), Banarasi Karka and Seb (51 kg/plant). Fruit weight was highest in Jogia (30 g) and lowest in Ilachi (08 g). Natural fruit drop was highest in Kaithali (90%) and lowest in Gola (66%). The fruits of Ilachi having highest pulp content with maximum in T.S.S. (21.1^0B), sugar/acid ratio (54.2) and vitamin C (180 mg/100 g pulp). Fruits of Sanaur-2 and Kaithali had maximum storage life (18 days) while Seb had the minimum under normal room temperature. A good number of cultivars showed resistance against powdery mildew under field condition.

**Corresponding author: S.N.Ghosh; Fax:+ 91-03473-222659; e-mail: profsnghosh@yahoo.co.in*

S-03-14
Evaluation and Characterization of Ber (*Ziziphus mauritiana* Lamk.) Germplasm Under Semi-Arid Rain Fed Conditions

S. S. Hiwale, T. A. More and B. G. Bagle

Central Horticultural Experiment Station, Vejalpur, Panchmahals, Gujarat-389340, India

Ber or Indian jujube belongs to the genus *Ziziphus a*nd family Rhamnaceae having more than 600 species. DeCandole (1886) stated that the original home of ber is Myanmar and India. There are about 200 varieties of ber in cultivation in India. The existence of the enormous diversity seems to be because of the role of prevalent heterozygosity, hybridity and polyploidy in the evolution of varieties. Efforts were made to collect the variability, evaluate and catalogue under rain fed semi-arid climatic conditions of Gujarat. Presently 50 germplasm of ber are maintained at CHES, Vejalpur. Studies on germplasm evaluation revealed that 23 out of 50 cultivars were found to be erect and 27 were spreading type. Plant height ranged from 2.20 to 4.66 m. Tree spread ranged was from 3.40 to 5.40 m (North-South) and 3.56 to 5.00 m (East-West). Stock girth varied from 10.00 to 25.83 cm and scion

girth from 10.00 to 21.33. Shoot length and shoot diameter were observed to be 2.11 to 4.05 m and 19.03 to 35 mm respectively. Number of secondary branches per shoot varied from 14.00 to 28.33. Leaf characteristics also showed vide variation i.e. petiole length- 6.90 to 22.3 cm, leaf length- 6.73 to 12.12 cm, leaf breadth-3.16 to 6.60 cm and leaf area-18.69 to 46.54 cm².Flowering and fruiting characteristics were also varied considerably. Number of flowers per cluster ranged from 14.42 to 35.30. Fruit set per cluster and per shoot varied from 1.01 to 6.40 and 72 to 1633 respectively. Number of fruits retained per shoot from 20.00 to 1004.66. Per cent fruit set and retention was in the range of 0.13 to 16.0 and 7.41 to 13.67 respectively. Time of peak of flowering was recorded from 1st week August to 2nd week of September in all the germplasm under Gujarat conditions. Considerable variation was observed for fruit characters in different cultivars. A wide variation was noted for fruit length (14.80 to 48.29), fruit width (14.18 to 48.29 mm) and fruit weight (3.40 to 21.30 g), stone length (1.01 to 3.18 cm), stone breadth (0.58 to 1.14 cm), stone weight (0.39 to 1.96 g) and pulp: stone ratio (4.30 to 25.25). Physico-chemical characters of fruit also showed great variation. For example, total soluble solid content (12.9 to 26.09%), acidity (0.21 to 0.73%), reducing sugar (1.97 5.14%), total sugar (6.80 to 12.50%), ascorbic acid content (67.81 to 135.40 mg/100g) and yield (1.50 to 27.50 kg/plant. Incidence of powdery mildew also varied in all the cultivars (0.52 to 93.82%).

**Corresponding author: S. S. Hiwale ; Fax: (02676) 234657*

S-03-15
Characterization of Two Romanian Local Biotypes of *Ziziphus jujuba*

Stănică F.

Faculty of Horticulture, University of Agronomic Sciences and Veterinary Medicine, Bucureşti, Romania

In Romania, the only region where the Chinese jujube exists in semi spontaneous status is Dobrogea area, located between the Danube River and the Black Sea. It is important to mention that the Chinese jujube populations founded in Romania are located in the neighborhood of antique sites with Greek, Roman and Byzantine ruins. Probably those old civilizations had an important role in the introduction of the Chinese date in the area from the Mediterranean basin. Until now we identified only two Romanian local populations of Chinese jujube: 'Ostrov' and 'Jurilovca'. The paper presents a complete description of the two genotypes. 'Ostrov' called also Dobrogea olive, has a tree habitus, produces a high number of small fruits, some of them being parthenocarpic. It is locally propagated by root suckers and cultivated in small private gardens. Instead, 'Jurilovca' growths spontaneously on the border of the Razelm Lake as a small bush being considered a weed and for that cut and burned by the local shepards. The plant has smaller leaves and fruits than 'Ostrov' genotype but a good production of seed with high germination. The Romanian genotypes of Chinese jujube produce small fruits but they adapted during centuries at the local climate and soil conditions. Their presence in Dobrogea region shows how far the Chinese jujube specie migrated from the origin area. In the same time they are extremely important for the ecosystem biodiversity. 'Jurilovca' genotype could be interesting for a future use as rootstock. Our first experimental results showed that in the southern part of Romania there exist appropriate natural conditions for Chinese jujube cultivation. The trees are extremely drought resistant, until now, they seem to have no natural enemies and the cultivation is not complicated. We underline that, Chinese date is promising new fruit specie in Romania. Its cultivation must be extended in integrated and organic farms, but also in small private gardens.

**Corresponding author: Stănică F. ; e-mail :flstanica@yahoo.co.uk*

S-03-16
Improvement of *Z. mauritiana* Lam. In India through Breeding

T.A. More and O.P. Awasthi

Central Institute for Arid Horticulture (ICAR), Bikaner-334 006 Rajasthan, India

Ber (*Ziziphus mauritiana* Lam.) is known in India for the last 4000 years and is one of the important fruits cultivated in arid and semi-arid regions of Indian sub-continent including the tropical and sub-tropical regions of the world between 34° S and 51° N latitude. In India, jujube tree has great commercial importance owing to the usefulness of almost all its parts. Its fruits have higher protein, mineral and vitamins A and C content than apple or citrus. The total area under ber in India is 90,000 hectares with an annual production of 750,000 ton fruits. The existence of polyploidy and entomophily in *Ziziphus* species has resulted in wide hybridization and hence acceptable eco-specific genotypes having characteristic quality attributes and productivity potential have been developed. However, improvement work is realized when commercial cultivation of a particular crop is to be done in agro-ecologically different environments. To promote *Ziziphus* as an important crop of 21st century, breeding programmes in India were initiated during the early 80's considering the problems hindering successful cultivation of this crop. The main objective of breeding in ber were to develop types resistant to diseases particularly powdery mildew (*Oidium erysiphoides*), pests like fruit fly (*Carpomyia vesuviana*), tolerance to low temperature injury, types giving good fruit set under high temperature condition and staggered harvesting which could benefit the *Ziziphus* growers. As concentrated efforts of CIAH and All India Co-ordinated Research Project on Arid Zone Fruits, several hybrids and selections have been developed. Promising hybrids are "Thar Sevika" (early maturing, frost tolerant, resistance to powdery mildew and tolerant to fruit fly), “Bawal Selection-1” (resistant to powdery mildew) and variety "Thar Bhubhraj" (early maturing, tolerant to low temperature (-1°C). In addition to these some of them are in the advance stage of their release. Breeding strategies and future line of work has been suggested for this important crop.

**Corresponding author: T. A. More; e-mail: tamore@indiatimes.com*

S-03-17
Chinese Dates Genofund(*Ziziphus jujuba* Mill.) and the Ways of Its Using in Nikitsky Botanical Gardens

Tetiana Lytvynova

Nikitsky Botanical Gardens – National Scientific Center, 98648, Yalta, Crimea, Ukraine

Zizyphus jujuba Mill. was brought in the Nikitsky Botanical Gardens – National Scientific Center for the first time in 1953. Those days 7 cultivars and 42 forms from China were planted on experimental garden-plots. As a result of introduction and breeding the collection of zizyphus in the Nikitsky Botanical Gardens has been increased in number and now consists of about 140 cultivars. There are cultivars with different ripening periods, sizes of fruits (from 3 g up to 50 g), taste, harvesting, fruit’s technological qualities, and content of biologically active substances in this collection. Due to different breeding methods we have obtained new selection material (more than 1500 forms). Using the screening method of selection, new cultivars were chosen. All of them have early period of ripening (second half of September). They are quite productive (120-150 centners from hectare) and its fruit mass varies from 12 g to 50 g. The basic breeding methods that were used in work with zizyphus are experimental mutagenesis, cultivars crossings, sowing of seeds from free pollination and then new forms’ selection. The main demerit of fresh Zizyphus fruits is short period of storage.

There are different ways of Zizyphus fruits' preservation: stewed fruits, pickled fruits, candied fruit, paste, dried fruits. It is especially important, that during thermal processing while obtaining tinned products the content of vitamin C in Zizyphus fruits is reduced not so intensively, as in canned food of other fruits, and makes more than 50% from initial quantity. Therefore it is expedient to use fresh Zizyphus fruits for preparation of treating and prophylactic products.

E-mail: in_vitro@ukr.net, Fax: +38 0654 336550

S-03-18
Antioxidant Capacity and Phenolic Content of Selected Jujube (*Ziziphus jujuba* Mill) Genotypes

Wang Qinglei[1], Liu Chunqin[1], Feng xiaojie[1], Xi guocheng[1], Zhen Wenchao[2, 3]

[1] *Cangzhou academy of agricultural and forestry sciences, Cangzhou 061001, China.*
[2] *College of Plant Protection, Agricultural University of Hebei, Baoding 071001, China;*
[3] *Research Center for Biocontrol Techniques against Pests on Crops of Hebei Province, Baoding 071001, China;*

Antioxidant capacity and phenolic content are important indicators to evaluate the quality of fruits. In this paper seven fresh use Jujube cultivars were evaluated on their antioxidant capacity and phenolic content by the way of ABTS free-radical-scavenging and the Folin-Ciocalteu (FC) method respectively. Meanwhile the effect of different storage time on the antioxidant capacity and phenolic content of *Ziziphus jujuba* Mill. cv. dongzao was evaluated. The antioxidant capacity and phenolic content of different cultivars were significant different. According to antioxidant capacity and phenolic content, *Z. jujuba* cv. dongzao showed to be the highest quality, while *Z. jujuba* cv. jinsixiaozao was found poor quality both on antioxidant capacity and phenolic content. *Z. jujuba* cv. wuhexiaozao had higher antioxidant capacity while lower phenolic content; on the contrary, *Z. jujuba* cv. Zanhuangdazao had lower antioxidant capacity while higher phenolic content. Antioxidant capacity and phenolic content of *Z. jujuba* cv. dongzao decreased after a period of storage. The antioxidant capacity of fresh *Z. jujuba* cv. dongzao was two times higher than that after three months storage.

Corresponding author: Zhen Wenchao; e-mail: wenchao@hebau.edu.cn

S-03-19
Variation in Morphological Characteristics of Muzao (*Ziziphus Jujuba* Mill.) in Loess Plateau of China

Wenhai Gao[1], Xingang Li[1], and Changzhu Wang[2]

[1]*College of Forestry, Northwest A & F University, Yangling, Shaanxi 712100, China*
[2]*College of Horticulture, Northwest A & F University, Yangling, Shaanxi 712100, China*

Muzao, a group of varieties of *Ziziphus jujuba* Mill., is widely distributed and cultivated in the Canyon of the Yellow River between Shanxi and Shaanxi Provinces, with 65% of 300,000 ha growing area in the region. Due to diversity and complexity of the site types, Muzao shows the great variation in morphological traits. However, the studies on the variations are not well-known. In order to understand the variation of Muzao and the effect of the variation on cultivar selection, we study Muzao's main characteristic variation in shoots, leaves, fruits and stones. In the Jujube Cultivated Region of the Yellow River's Reaches between Shanxi and Shaanxi Provinces, 29 clones of Muzao were collected and grafted with 5 duplications per clone in the spring of 2000 and 2001 in Xiejiagou,

Qingjian County, Shaanxi Province. Main characteristic variations of clones within Muzao were studied by comparing of main morphological traits. The results showed that there were significantly different among variations of morphological characteristics of the shoots, leaves, fruits and stones, and the shoots showed largest variation, followed by leaves, fruits and stones. And in the shoots, variation of primary extension shoot was the biggest, next was secondary shoot, variation of bearing shoot was the least except mother-bearing shoot. In the leaf traits, leaf index showed least variation. But in the fruit traits, variation of fruit mass was the largest while that of edible rate was the least. And there were great variations in dried rate, total sugar and soluble acid content among fruits of different clones, with variation coefficient of 17.52%, 15.59% and 22.58%, respectively. In the traits of fruit-stones, variation of stone mass was the largest, with variation coefficient of 26.54% while variation of stone index was the least, with variation coefficient of 7.65%. Meanwhile, 12 traits were used for clustering analysis, and the clustering result showed that 29 clones were divided into four kinds based on genetic distance of 8.5. These results could play important roles in selection of high quality Muzao clones.

**Corresponding author: Xingang Li; Fax: +86-29-87082256; e-mail: xingangle@nwusaf.edu.cn*

S-03-20
Blossom Characteristics of *Zizyphus jujuba* Mill. cv Dongzao ×Linyilizao Segregations

Yanhui LI, Lianying Shen, Yongmin Mao, Liang Chen

Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, Hebei 071001, China

The blossom characters of 136 six-year-old Dongzao×Linyilizao segregations were studied in this paper. The results showed that flowering time, flower number per tree, flower size and pollen viability in the segregations presented a different extent of segregation. There are 60% plants that had flowers in 136 segregations. The highest amount of flowers per tree was 7650. There were 24 plants that had flowers over 1000. The flowering time presented obvious difference between segregations. Of 62 out of 80 flowering segregations belongs to night-flowering type, accounting for 78 percent. The variation coefficient of tree height was the largest, next came east-west branch spread and trunk girth, and north-south branch spread was smallest (0.204). Most flowering related traits such as the number of bearing shoot per tree, number of flowering-bearing shoot per tree and flower number per bearing shoot presented obvious segregation in the segregations, and the variation coefficient were between 0.5-0.8. There was a certain variation in flower size. The extreme difference of flower diameter was 0.34cm, and that of length of stamen was 0.08cm. The mean value of pollen fertility of segregations was 1.3%, and the lowest was only 0.3%. The distributed parameters of Kurtosis and Skewness of the blossom traits in seeding population were less than 2, and it can be identified from the secondary distribution map that distribution types of several traits such as tree height ,trunk girth, number of Bearing base branch per tree, number of bearing shoot per tree, flower number per tree, honey disk diameter, flower diameter and pollen fertility. All were single-peak distribution, which were typical of quantitative inheritance at the assumption of the equivalent multiple gene. The frequency distribution should to be standard normal distribution. The results of Correlation coefficient among 12 traits showed that the tree height and number of bearing shoot per tree, number of bearing shoot per bearing base branch had a significant positive correlation with the trunk girth. The tree height, number of bearing shoot per tree, number of flowering-bearing shoot per tree, and flower numbers per tree exited a significant positive correlation with the flower diameter. The number of flowering-bearing shoot per tree and the number of per bearing shoot had a significant positive correlation with the number of flower per tree. A strikingly positive correlation exited between the honey disk diameter and the length of stamen.

**Corresponding author: Yongmin Mao; Fax: 0312-7528300; e-mail: ymmao@hebau.edu.cn*

S-03-21
Conservation and Utilization of Chinese Jujube Germplasm Resources

Yongkang Wang, Dengke Li, Chuanling Sui, Ailing Zhao, and Xuemei Du

Pomology Institute, Shanxi Academy of Agricultural Sciences,Taigu,Shanxi,030815,China

Over the last 50 years, jujube germplasm collection, conservation, identification and utilization have made tremendous achievements. Through analysis on the status and problems, the future research directions were proposed. Jujube has been introduced directly or indirectly to more than 30 countries and regions. In china, National Jujube Germplasm Repository has been established, and there are two species and three varieties including 530 varieties and types in it. A number of specific or fine germplasm resources have been selected by characterization of morphological and biological traits, especially the main agronomic traits of over 400 accessions. In addition, molecular marker technology such as RAPD and AFLP has been applied to jujube identification, classification and studies on the origin and evolution. The formulation and improvement of descriptors and data standards for jujube, the establishment of a database system and the realization network information sharing have been achieved. New breeding techniques such as embryo culture have been explored. Up to now, over 20 new cultivars have been registered or recognized through strain selection systematically.Collection and conservation of rare and endangered germplasm and identification and evaluation of resistance and nutrient characters should be strengthened and emphasized. Physiology, biochemistry, heredity and breeding techniques should be studied thoroughly. The germplasm management system, the network information platform construction and the germplasm utilization system will be perfected, so as to improve the efficiency of utilization.

**Corresponding author: Dengke Li; Fax: +86 354 6215025; e-mail: ldkzao@yahoo.com.cn*

S-03-22
Core Collection Construction Based on Agronomic Characters in Chinese Jujube

Yuhui Dong[1,2], Mengjun Liu[1], Jianying Peng[1], Ping Liu[1], Dengke Li[3], Yibo Zhao[3]

[1] Research Center of Chinese Jujube, College of Horticulture, Agricultural University of Hebei, Baoding, 071001, China;
[2] Science and Technology Department of Hebei Province, Shijiazhuang, 050021, China;
[3] Pomology Institute of Shanxi Academy of Agricultural Science, Taigu, 030800, China

The concept of core collection was initiated by Frankel in 1984, defined as a representative sample of the whole collection with minimum repetitiveness of the genetic diversity of a crop species and its relatives. Establishing a core collection is an effective way for crop germplasm conservation, evaluation and utilization. As a native plant and the leading dry fruit, Chinese jujube (*Ziziphus jujuba* Mill.) had a large quantity of germplasm, but no study on core collection has been conducted yet. It is necessary to establish the core collection of Chinese jujube in order to facilitate their further development and utilization. The data on the agronomic characters of 170 representative cultivars collected from all over China and conserved in National Repository of Chinese Jujube, Pomology Institute of Shanxi Academy of Agricultural Science were systematically analyzed in this study. Based on 15 quantitative and 11 qualitative characters, the 170 cultivars were clustered by using Ward's method and Flexible UPGMA method. Eight primary core collections were established with

sampled ratio of 10%, 20%, 30%, and 40% using sampling method of combination of grouping and preference of particularity. Conformities of means, standard deviations, ranges of quantitative characters and the ratios of reserving phenotypes of qualitative characters between core collections and original germplasm were studied. The results showed that the core collection established combining clustering method of Ward's and sampled ratio of 20%, preserved 90.8% genetic background and 91.7% phenotype of qualitative characters. Other 6 special cultivars (not being included in the 170 evaluated cultivars) such as the unique triploid 'Zanhuangdazao', 'Chahuzao' with teapot-shape fruits were added into the primary core collection. Finally, a core collection including 39 cultivars was established, which preserved 100% phenotype of qualitative characters.

*Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@mail.hebau.edu.cn;
Jianying Peng; Fax: +86 312 7521456; e-mail: pjy@hebau.edu.cn

S-03-23
The Distribution and Grading of Quantitative Characters in *Ziziphus jujuba* Mill.

Yuhui Dong[1,2], Ping Liu[1], Mengjun Liu[1], Jianying Peng[1]

[1]*Research Center of Chinese Jujube, College of Horticulture, Agricultural University of Hebei, Baoding, 071001, China;*
[2] *Science and Technology Department of Hebei Province, Shijiazhuang, 050021, China*

China has the most germplasm resources of *Ziziphus jujube* Mill. all over the world. Evaluation on genetic diversity of jujube germplasm may facilitate their further development and utilization. For morphology evaluation, it is very important to get a description with rations and grading method of quantitative characters. In recent years, a probability grading system of quantitative characters of jujube germplasm was tried to be established, while the grading result provided a better reference than using traditional arithmetical progression grading method. In this study, 248 cultivars from all over China conserved in National Repository of Chinese Jujube, Pomology Institute of Shanxi Academy of Agricultural Science were sampled to study the variations, distribution and grading of 23 quantitative characters. It was found that short thorn length, fruits per bearing branch, and ratio of kernel had the highest variation coefficient (1.42, 1.00, 0.92), while ratio of edibility, growing days, and flower diameter had the lowest. Most quantitative characters (accounting for 78%), except short thorn length, fruits per bearing branch, ratio of kernel, years before fruiting and fruit weight, accord with normal distribution. The characters according with normal distribution (18 characters) and $\chi 2$ distribution (fruit weight) were graded using probability grading method, and others were using traditional arithmetical progression grading method. The reference cultivars of each grade of all characters were suggested.

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@mail.hebau.edu.cn*

S-03-24
Comparison between Jujube "Zhongqiusucui" and Other Six Jujube Cultivars

Zhanying Gu, Bixia Xie, Sen Wang

Forestry Resources and Environmental Sciences College, Central South University of Forestry and Technology, Changsha 410004, Hunan, China

The experiment of cultivar comparison was carried out by using Zhongqiusucui jujube, Jidan jujube, Chaling winter jujube, Mu jujube, Zhanhua winter jujube, Sugar jujube and Niunaizao jujube as

materials with completely random block experimental design in Qidong, Hunan. The height, stem diameter, canopy size, quantity of fruiting branch, quantity of 1st year fruiting branch, percentage of fruiting branch, fruit weight and yield of each plant were measured in local nursery for continuous 4 years, and the averaged numbers were used as characteristics value. The results showed that the comprehensive characters of jujube "Zhongqiusucui" is better than other 6 cultivars in Qidong, Hunan, and it can be extended in the southern China as an early fruiting, high yield and excellent quality cultivar.

**Corresponding author: Zhanying Gu; Fax: +86 7315623456;e-mail:guzhanying@yahoo.com.cn*

Molecular Biology and Biotechnology

S-04-01
Somatic Embryogenesis and Plant Regeneration from Cotyledons of Immature Embryo of Chinese Jujube

Guoping Wang, Xiaomei Li and Qiufang Chen

Pomology Institute, Shanxi Academy of Agricultural Science, Taigu, 030815, China

Somatic embryogenesis and plant regeneration from immature cotyledons were achieved with Chinese jujube (*Zizyphus jujuba* Mill.). Open-pollinated fruits were collected from orchard-grown trees 40-70 days after full bloom. The cotyledons were transversely excised in the middle and the proximal half placed abaxial side down on the medium. The embryoid inducing experiment was demonstrated by complete experimental method of L_{16} (4^5). The effects of different concentrations of thidiazuron (TDZ), indole-3-acetic acid (IAA), sucrose, MS (Murashige and Skoog, 1962) medium and the presence or absence of light during the cultivation were determined. The optimal somatic embryogenesis rate was obtained on ½ MS medium, containing 0.4 mg l^{-1} TDZ, 0.2 mg l^{-1} IAA and 20 g l^{-1} sucrose, followed by maintaining in darkness for the first 30 days. Somatic embryos were then transferred onto the MS medium, containing different concentrations of different kinds of auxin and 62.41% germination rate was obtained with 0.001 mg l^{-1} 2,4-D, and 31.25% complete plantlets were achieved on the same medium.

**Corresponding author: Guoping Wang; Fax: +86-354-6215036; e-mail: gsswgp@163.com*

S-04-02
High Efficiency Shoot Regeneration from Leaf Explants of Taishan Sour Jujube(*Zizyphus spinosus* Hu.)

H. Sun, Q. Sun, G. Zhou, Q. Liu

Shandong Institute of Pomology, Taian, Shandong 271000, China

With high resistant to cold and drought, excellent tolerance to barren and saline-alkali soils, more developed root systems, sour jujube is a good rootstock of cultivated jujube. Taishan sour jujube is deciduous shrub, grown on mountain Taishan. A highly efficient protocol was developed for shoot regeneration in Taishan sour jujube (*Zizyphus spinosus* Hu.) from leaf explants. By this protocol, thidiazuron (TDZ) and indole-3- acetic acid (IAA) were used for callus induction from leaf explants in dark culture, and IAA and gibberellic acid (GA_3) were used for shoot buds regeneration and elongation. The optimal media for shoot buds formation and elongation were the medium WPM, containing 0.5-1 mg l^{-1} TDZ and 0.1 or 0.5 mg l^{-1} IAA in combination with the medium WPM, containing 0.1 mg l^{-1} IAA and 0.5 mg l^{-1} GA_3 , the highest frequency of shoot regeneration was 100%. The induction of shoot buds from leaf explants cultured in light directly was also examined, the bud formaton was observed, but in this case, the buds were smaller and directly formed from leaf explants. These buds did not develop, elongate or form shoots. The dark culture of leaf explants with inducing callus step later promoted normal development and elongation of shoot buds. This regeneration protocol may be applicable to the improvement of this crop by genetic engineering in the future.

**Corresponding author:Qingrong Sun; e-mail:qingrongsun@hotmail.com, sunqr@sdip.cn*

S-04-03
A Sustainable Preservation and Multiplication System for Jujube Witches' Broom Phytoplasma via Tissue Culture in Chinese Jujube

Jin Zhao[1], Mengjun Liu[2]

[1] *College of Life Science, Agricultural University of Hebei, Baoding, Hebei, 071000, China*
[2] *Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, Hebei, 071001, China*

Jujube witches' broom disease (JWB) caused by phytoplasma (MLO) is a destructive disease of Chinese jujube (*Ziziphus jujuba* Mill.), an important multi-purpose fruit tree both in China and South Korea. Stem tips, stem segments and buds were collected as explants from the Chinese jujube with JWB. After being washed in running water for 30 min., followed by immersion in 0.12% $HgCl_2$ for 6-8 min., and subsequently rinsed four to five times with sterile deionized water, the explants were cultured on MS medium without hormones. Thirth to fourty days later, the explants showed typical symptoms of JWB. The plantlets with symptoms showed strong specific fluorescence of phytoplasma in sieve tubes under fluorescence microscope after dyed with DAPI. The optimum media for initiating, proliferating, and rooting culture of diseased plantlets were established, i.e., MS (no hormones), MS + 6-BA0.5-1.0mg/L + IBA1.0-2.0 mg/L + NAA0.1-0.3 mg/L or MS without hormones, and MS + IBA0.5 mg/L or MS+ NAA0.1-0.3 mg/L, respectively. JWB phytoplasma has been keeping higher level in the diseased plantlet for more than seven years. This study show that tissue culture of diseased host plants is not only an excellent solution for the sustainable preservation and multiplication of JWB phytoplasma but also an new indoor research platform for a series of basic and applied research on phytoplasma such as screening germplasm with high resistance, selecting of curing medicines, *etc*..

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@hebau.edu.cn*

S-04-04
Analysis of QTLs for 4 Agronomic Characteristics in Chinese Jujube

Jing Qi[1], Lianying Shen, Yongmin Mao[1], Zhen Dong [2], Liang Chen[1],Xiaoling Wang[1]

[1]*Research Center of Chinese Jujube, Agricultural University of Hebei,Baoding,Hebei 071001,China*
[2]*Hebei Women's Vocational College, Shijiazhuang 050091, China*

The F_1 segregation population derived from a cross between Dongzao (*Zizyphus jujuba* Mill. cv. Dongzao) and Linyilizao (*Zizyphus jujuba* Mill. cv. Linyilizao) was used to analysis the QTLs for trunk diameter (TD), branch angle (BA), branch crankle angle (BCA) and branch bent angle (BBA). By using interval mapping method, a total of 34 QTLs were detected, including 6 for TD, 14 for BA, 7 for BCA and 7 for BBA, and phenotypic variation explained by each QTL ranged from 8.6% to 54.2%. These QTLs controlling the related agronomic traits were often mapped on the same or adjacent intervals, forming several clusters in the linkage groups, and this will provide useful genetic information, which could be used as molecular marker-aided selection in breeding program of Chinese jujube.

**Corresponding author: Yongmin Mao; Fax: +86-0312-7528300; e-mail: ymmao@hebau.edu.cn*

S-04-05
Plant Regeneration from Immature Embryo in Chinese Jujube （*Ziziphus jujuba* Mill.）

Junrui Wang[1], Man Zhang[2] and Mengjun Liu[2]

[1] *College of Forestry, Agricultural University of Hebei, Baoding 071001,China*
[2] *Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding 71001, China*

In order to overcome embryo abortion and efficiently use male sterile germplasm as female parent in cross breeding of Chinese jujube, embryo rescue system was explored and established using germplasm 'male sterile No.1 (JMS1)', 'male sterile No.3 (JMS3)' and 'Daxuezao'. The results showed that plant regeneration from immature embryo was obviously influenced by genotype, embryo age and hormones. Among them, embryo age was the key factor. Plants were directly regenerated from embryos at late cotyledonal stage. In contrast, plants regenerated from invisible or barely visible young embryos in colloidal inclusion of young ovule through two steps, i.e., cotyledonal embryo formation and plant regeneration. A successful rescue for a very young embryo took about 60 days. Firstly, the colloidal inclusion of ovule was cultured on medium MS+ IAA 0 ~ 2.0 mg/L + BA 0 ~ 0.5 mg/L + sugar 50 g/L+ agar 3.3 g/L +LH 800 mg/L+ activated carbon 1g/L until the invisible or barely visible embryo developed into cotyledonal stage about 30 days later. Secondly, the cotyledonal embryos were transferred into medium MS + sugar 50 g/L + agar 3.3g/L + LH 500 mg/L + IBA 0.1mg/L + BA 0.5 mg/L+ NAA 0.1 mg/L and regenerated plants were obtained about 30 days thereafter. The rate of cotyledonal embryo formation in JMS3 and 'Daxuezao' reached as high as 61.0% and 75.6%. Plant regeneration rate of JMS3 was 6.4%. In addition, cotyledonal embryo formation in JMS3 and 'Daxuezao' was not significantly accelerated by 10 days dark treatment.

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@.hebau.edu.cn*

S-04-06
Tissue Culture of Chinese Jujube Using Different Explants

Li Dai[1], Jin Zhao[2], Mengjun Liu[1]

[1] *Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, Hebei, 071001, China*
[2] *College of Life Science, Agricultural University of Hebei, Baoding, Hebei, 071000, China*

The tissue culture of Chinese jujube (*Ziziphus jujuba* Mill.) was studied with different explants including stem tips, stem segments, leaves, anthers and embryos. The results showed that: (1) The MS medium could be used as basal medium for all above-mentioned explants in Chinese jujube. (2) The optimum kinds and concentrations of growth regulators in medium were quite different among explants. Higher concentrations of 6-BA (about 0.5-3.0 mg/L) plus lower concentrations of IBA (about 0.1-0.5 mg/L) were suitable for initiating and proliferating culture of stem tips and stem segments. TDZ of 1.0 mg/L was best in case of shoot regeneration from leaves and callus induction from anthers. Zero or low concentration of growth regulator (0.1 mg/L 6-BA+0.5 mg/L IBA + 0.1 mg/L NAA) was suitable for 20-70 days old embryo culture. (3) 6-BA at lower concentration (0-0.1 mg/L) and IBA at higher concentration (about 0.5-1.5 mg/L) or IAA of 1.0 mg/L were suitable for rooting culture of plantlet originated from different kinds of explants. These tissue culture systems could be used as both excellent solutions for micropropagation but also in vitro research platforms for a series of basic and applied research in Chinese jujube.

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@hebau.edu.cn*

S-04-07
Genetic Analysis of *Ziziphus Jujuba* 'Huizao' Using ISSR Markers

Li Jidong，Bi Huitao， Li HaiTao， Li Zhenshan， Feng Jiancan*

Forestry and Horticulture College,Henan Agricultural University,Zhengzhou,China，450002

To evaluate the genetic structure of *Ziziphus Jujuba* 'Huizao', which is one of the most popular cultivated jujube cultivar in Henan province, the author collected 117 sample trees from the distributing area of *Ziziphus Jujuba* 'Huizao'. DNA was extracted from the mature leaves and a most efficient ISSR-PCR reaction system was established. Ten most efficient primers were selected from 70 ISSR primers. 96 patterns were amplified and 76 of them (79.17%) were polymorphic patterns. Gel analysis by POPGEN 1.32 software showed that the mean standard genetic distance was 0.3951，the observed number of alleles (Na) was 1.7917，effective number of alleles （Ne） was 1.2941，Shannon's information index (I) was 0.2903, and the Nei's genetic diversity (He) is 0.1834. The result showed a high genetic diversity level among the population, and thus great breeding potential existed in the *Ziziphus Jujuba* 'Huizao'. Cluster and principle coordinate analysis showed that the population cannot be separated significantly. There is no co-relationship between geographic and genetic distance. The author suggests collecting some sample trees by the phenotypic variation for germplasm conversation and new cultivar selection.

**Corresponding author. Feng Jiancan; e-mail: jcfeng@henau.edu.cn*

S-04-08
The Orthogonal Optimization of SRAP Amplification System in Chinese Date

Li Li[1], Peng Jian-ying[1], Huang Rui-hong[1], Zheng Bao-qiang[2], Bai Rui-xia[1]

[1] College of Horticulture, Agriculture University of Hebei, Baoding, China
[2] *Key Laboratory of Tree Breeding and Cultivation, Research Institute of Forestry, Beijing, China*

Sequence-related amplified polymorphism (SRAP) is a new marker technique with the characteristics of simplicity, reliability, moderate throughput ratio and facile sequencing of selected bands. The orthogonal design was used to optimize SRAP-PCR amplification system on Chinese date in three levels of four factors (dNTP, primer, Mg^{2+}, Taq DNA polymerase, and DNA template) respectively. The results showed that the orthogonal experiment design was a practicable method and in a total volume of 20 μL SRAP-PCR system, it contained 1×buffer, 200 μmol/L dNTP, 30 ng primer, 2.5 mmol/L $MgCl_2$, 1.0 μ Taq DNA polymerase and 20 ng template DNA. The suitable PCR procedure was as follows: initially denaturing at 94°C for 5 min; then at 94°C for 1 min., at 33°C for l min., and at 72°C for 1 min. for the first five cycles; then the annealing temperature was raised to 53°C for another 30 cycles; and at 72°C for 5 min. as the final extension. The newly established SRAP-PCR amplification system and procedure for Chinese date were fully reproducible with good stability, and also satisfied with genome amplification requests of *Ziziphus*. SRAP-PCR system can be applied in genetic relationships between various groups in *Ziziphus*.

**Corresponding author:Jianying Peng; e-mail: pjy@hebau.edu.cn*

S-04-09
Studies on the Phylogenetic Relationships of Chinese *Ziziphus* by RAPD Technique

Li Li[1], Peng Jian-ying[1], Huang Rui-hong[1], Zheng Bao-qiang[2], Bai Rui-xia[1]

[1] *College of Horticulture, Agriculture University of Hebei, Baoding, China;*
[2] *Key Laboratory of Tree Breeding and Cultivation, Research Institute of Forestry, Beijing, China*

The genomic DNA variations of fourteen species of Chinese *Ziziphus*, eleven varieties of *Z. jujuba* Mill.and one outgroup were analyzed by using random amplified polymorphic DNA (RAPD). 919 bands (99.78%) behaved polymorphy in 921 RAPD bands amplified by 31 random primers. The size of the amplified fragments ranged from 300bp to 4 000 bp. The number of amplified bands varied from 19 to 45 with an average of 30 bands. The data of 921 RAPD bands were used to generate Dice's similarity coefficients and to construct a dendrogram by means of UPGMA in the NTSYS-pc program. It is concluded as follows: all types were classified into six clusters at genetic similarity 0.26. The first cluster included *Z. pubinervis* Rehd.; The second cluster included *Z. oenoplia* (L.) Mill. and *Z. laui* Merr.; The third cluster included *Z. incurva* Roxb.; The fourth cluster included *Z mairei* Dode, *Z. xiangchengensis* Y. L.Chen et P. K.Chou , *Z. montana* W.W.Smith, *Z. jujuba* Mill., eleven varieties of *Z. jujuba* Mill. and one outgroup *P. spina-christi* Mill.; The fifth cluster included *mauritiana* Lam., *Z. fungii* Merr., *Z. rugosa* Lam.; The sixth cluster included *Z. attopensis* Pierre. and *Z. apetala* Hook. f.. The results can't support the classification of *Ziziphus* that was based on single characteristic. *Z.jujuba* Mill. and *Z.acidojujuba* C.Y.Cheng et M.J.Liu. should be treated as one species. *Z. xiangchengensis* Y. L.Chen et P. K.Chou and *Z.montana* W.W.Smith should be treated as one species. Infraspecific classification of *Z. jujuba* Mill.should be classified into two subspecies, and given new Latin names. It is agreed that the varieties of *Z.jujuba* should be merged into *Z.jujuba*.

**Corresponding author:Jianying Peng; e-mail: pjy@hebau.edu.cn*

S-04-10
Direct Shoot Regeneration from Leaf Explants of Sour Jujube

Na Wang[1], Mengjun Liu[1], Zhihui Zhao[1], Ziyu Qin[2]

[1] *Research Center of Chinese Jujube, Agricultural University of Hebei, 071001, Baoding, Hebei, P. R.China*
[2] *Department of life Science, Hebei Normal University of Science & Technology, 066004 Changli, Hebei, P. R. China*

The direct shoot regeneration from leaf explants obtained from adult plantlets of sour jujube is reported. Young leaves excised from plantlets of sour jujube were cultured on different media compositions based on half of Murahige and Skoog (1962) salts. The highest frequency of shoot regeneration (88.1%) occurred on shoot inducing medium supplemented with benzylaminopurine (BA) (44.4μm) and silver nitrate ($AgNO_3$) (58.9μm) after 3-week incubation in the dark. Medium free of silver nitrate and supplemented with only benzylaminopurine did not induce shoot regeneration. The regenerated shoots were transferred to medium supplemented with 44.4μm BA and 24.6μm indole-3-butyric acid (IBA) for growth. When the shoots were about 2 cm in height they were transferred to rooting medium. Subsequently abundant rooting of shoots was observed. A good frequency of rooting shoot and root quality (96.6%, 4.8 roots $shoot^{-1}$) were achieved on half of MS medium supplemented with IBA 49.2μm. Complete plantlets were recovered within 7 weeks. The plantlets were hardened and transferred into soil. This direct plant regeneration method can be used for rapid mass cloning, genetic transformation and polyploidization of sour jujube.

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@ hebau.edu.cn*

S-04-11
Virus-free and Rapid Propagation of Chinese Jujube Jinchang No.1

Qin Cao and Junjie Du

Shanxi Agricultural University, Taigu, Shanxi, China 030801

Chinese jujube, Jinchang No.1 is a new bud-mutation variety found in Taigu, Shanxi province in 1999. It has high yield and an early maturing trait, which is suitable for table and dehydration. The average fruit weight varies between 30 and 48 g. In this paper the process is reported of virus-free tissue culture, technique of rapid propagation and manifestation of cultivation in the field for the variety.

The study was carried out in 2003-2007. Shoot tips 2-3cm in length were taken during the month of May and soaked in 75% alcohol for 15-20 seconds and washed 3-5 times with sterile water. Then they were soaked in 0.1% mercuric chloride for about 8 min. and washed 3-5 times with sterile water. Finally these shoot tips were striped to 0.1-0.5 mm under dissecting microscope. The micro-stem tips were inoculated in induction medium (MS+6-BA3.0 mg/L) and cultured for 15 days. They were then placed into illumination box and cultured for 60 days below 38°C.

These shoots cultured were found free of jujube witches' broom by PCR detecting. The virus-free shoot tips were then inoculated in proliferated medium (MS + 6-BA 2.0 mg/L + IBA0.5mg/L) and proliferated 3.5 times. The condition of culture was providing light for 14-16 h, and maintaining light period temperature at 30°C and dark period temperature at 18°C. The 95.19% shoots rooted on the rooting medium (1/2 MS + IAA 2.4mg/L). The survival rate of rooted virus-free plantlets transplanted into the greenhouse was more than 85% between June and August. The medium of transplantation comprised of soil, peat, sand and perlite powder. The plantlet transplanted was covered with small plastic tent and shaded from 12:00 to14:00. The plantlets were transplanted into nutritive pots when they attained 10 cm in height. After 30 days they were planted in the field. The growth of virus-free plantlet was strong, and it grew up to 30 cm in current year, followed by 1.1m in the second year. The tree could grow 3-4 vegetative shoots, started fruiting in the third year, and bore 2.1 kg in the fourth year. The virus-free plants also had disadvantages, such as shoot with thorn and bearing later.

**Corresponding author: Junjie Du; e-mail:djj738@163.com*

S-04-12
Construction and Analysis of a cDNA Library of Deciduous Fruit-bearing Shoots in Their Early Growing Season in Chinese Jujube

Qiu-fen Cao, Yu-ping Meng, Hai-feng Sun, Chun-fen Zhang

Agricultural Biotechnology Research center of Shanxi province, Taiyuan, 030031, China

By using directional cloning, a cDNA library in the fruit-bearing shoot of *Ziziphus jujuba* Mill. during the period of flower bud differentiation was constructed. We collected 1388 white clones, and there were 557 cDNA inserts. 469 cDNA inserts larger than 500bp were sequenced, and there were 238 useful inserts. Among which there were 229 EST having high similarity with the known genes of NCBI, and 9 EST were unknown genes. Among these known sequences, the number of genes involved in protein's synthesis and transfer were 46 which accounted for 19% of the total genes, and the numbers of genes involved in basic metabolism were 26 which accounted for 11% of the total genes. The numbers of genes involved in cell growth were 25 which accounted for 10% of the total

genes and the numbers of genes related to resistance were 23 which accounted for 10% of the total genes and the numbers of genes involved in metal transfer were 2 only accounted for 1% of the total genes. Moreover, there were 45 genes (19% of the total) which are not be classified. Among them, the genes related to stress protein and metallothionein may be associated with the property of jujube trees' high resistance (for example, freezing and drought resistance and tolerance to heavy metals)to the adverse environments. It is worthy of being researched.

Corresponding author: Qiu-fen Cao; Fax: +86 0351-7123546

S-04-13
Effect of Auxins on in Vitro propagation of Jujube Infected by Witches'-broom Phytoplasma

Q. Sun[1], G.Zhou[1], H. Sun[1], G. Jiang[2]

[1]Shandong Institute of Pomology, Taian, Shandong, 27100, China;
[2]Science and Technology Bureau of Taierzhuang, Zaozhuang, Shandong, 277400

The effects of different auxins at varying levels on *in-vitro* culture of withches' broom phytoplasma infected jujube shoots were studied. Number of shoots increased when indole-3-acetic acid (IAA) concentrations rose from 0.5 to 3 mg l^{-1}. The maximum number of infected shoots proliferation reached 16.8 when cultured on medium containing 3 mg l^{-1} IAA, and healthy shoots had maximum propagation number 4.6 on medium containing 2 mg l^{-1} BA and 0.4 mg l^{-1} IBA. And 6-benzylaminopurine (6-BA), β-indole-3-butyric acid (IBA) and α-naphthaleneacetic (NAA) at different concentrations from 0.5 to 4 mg l^{-1} have not effected on proliferaton of phytoplams infected jujube shoots, strongly indicating that witches's-broom phytoplasma caused changes in endogenous cytokinin and auxin levels, and may cause cytokinin increase, because the better propagation of *in vitro* shoots required the proper ratio of cytokin and auxin. Supplement of exogenous IAA promoted *in vitro* shoot proliferation of phytoplasma infected jujube, which supported the previous report that the increase of zeatin concentration of diseased jujube resulted in jujube withches'-broom symptom.

Corresponding author:Qingrong Sun; e-mail:qingrongsun@hotmail.com, sunqr@sdip.cn

S-04-14
Establishment of AFLP Analysis System and Relationship among Several Cultivars in Chinese Jujube

Ruixia Bai, Jianying Peng, Bin Han, Li Li, Lisha Zhang

College of Horticulture, Agricultural University of Hebei, Baoding, Hebei, 071001, China

An efficient and stable AFLP analysis system for Chinese jujube was established, and successfully used for the studies on the relationship among several cultivars. Several main factors influencing AFLP analysis were studied including the preparation and purification of genomic DNA, restriction and ligation of genomic DNA, the pre-amplification reaction, selective amplification reaction, electrophoresis on denaturing polyacrylamide gels, and sliver-staining. The results indicated that the genomic DNA extracted by modified CTAB method was pure, complete and suitable for AFLP analysis. Restriction digestion of genomic DNA was performed by using two restriction enzymes, around 400ng DNA digested with 3 units of *Eco*R I and *Mse*I enzymes respectively, and incubated at 37°C for 5h. The digested DNA fragment was diluted to 5 times with TE buffer and used as templates for pre-amplification. The pre-amplification products were diluted to 10 times with TE buffer and

used as templates for selective amplification. The selective amplification fragments were subjected to PAGE electrophoresis and silver-staining. The relationship between Hetaowen and Laopozao was much closer. AFLP analysis failed to distinguish between Suyuanling and Yuanling, which may be caused by synonyms.

*Corresponding author: Jianying Peng; e-mail: pjy@hebau.edu.cn

S-04-15
The Problem of Infraspecific Classification of *Ziziphus jujuba* Mill. Using AFLP Marker Technique

Ruixia Bai, Jianying Peng, Li Li

College of Horticulture, Agricultural University of Hebei, Baoding, Hebei, 071001, China

Chinese jujube (*Ziziphus jujuba* Mill.) is a native fruit tree of China and has been grown for more than 3000 years. It is becoming increasingly popular for its wide adaptation, easy management, early bearing, rich nutrition, and multiple usage. The genetic relationships of 22 accessions that represented 6 varieties and a wild related species (*Z. acidojujuba* C.Y.Cheng et M.J.Liu.) of Chinese jujube were analyzed using AFLP (amplified fragment length polymorphism) technique. In total, 502 marker loci were assessed from 17 selective primer combinations, of which 255 were polymorphic (50.80%). Based on the AFLP data, Dice similarity coefficients among the samples were calculated and a dendrogram was constructed by using UPGMA' s method. The results showed that the similarity coefficient within varieties were smaller than those among varieties, suggesting that the genetic differences among those accessions of Chinese jujube could not be precisely reflected by the current taxonomic system. We consider therefore that the classification of varieties was artificial, and those varieties should be reduced. According to the genetic relationships among varieties, a new infraspecific classification of Chinese jujube should be made.

*Corresponding author: Jianying Peng; e-mail: pjy@hebau.edu.cn

S-04-16
DNA Finger Printing of Ber Germplasm Using RAPD Markers

S. Raja, S.K.Sehrawat, K.S.Boora, V.P.Ahlawat and D.S.Dahiya

Department of Horticulture,CCS Haryana Agricultural University,Hisar, India

Ber or Indian jujube (*Ziziphus mauritiana* Lamk) is an ideal fruit tree for arid and semi-arid regions. Ber is cultivated all over the drier parts of the Indian subcontinent for its fresh fruits. Ber can be successfully cultivated even in the most marginal ecosystems of the subtropics and tropics, since its cultivation requires little care. This ideal fruit tree is suitable to rehabilitate extensive resource poor areas. It's cultivation has received a great impetus in recent years in the northern parts of India. The ber belongs to family Rhamnaceae that has about 50 genera and 600 species. Genus *Ziziphus* has 40 species that are scattered in the tropical and subtropical regions. There are more than 125 cultivars grown in India. These cultivars have been developed by selection in different regions. Lot of confusion exists in naming of these cultivars and several species. So far poor systematic efforts have been done to characterize the variability existing in ber. Proper characterization with respect to morphological characters and at molecular level has been proposed by various investigators. The descriptors currently available are restricted to few morphological characters. Morphological characters are liable to be influenced by a complex genotype x environmental interaction. It is desirable to develop alternative methods, which are rapid, reliable and more or less not influenced by environment. Analysis of polymorphism at molecular level can differentiate the genotypes that are

non-distinguishable by other tests. Random Amplified Polymorphic DNA (RAPD) markers have been extensively used in DNA finger printing. These markers are mostly dominant and can be used to detect variation in both coding and non-coding region of genome. RAPD analysis is technically simple and provides an approach to characterizing different genotypes, thus to estimate genetic diversity which will further be useful in improvement of breeders.

Young leaf samples of twelve unknown ber genotypes were collected from the experimental orchard of Department of Horticulture, CCS Haryana Agricultural University, Hisar, Haryana, India. Genomic DNA was isolated from 1 to 2 weeks old young, not fully expanded leaves ber genotypes following CTAB extraction method

A total of 20 unique 10-base random oligonucleotide primers were used to find out polymorphism among the twelve genotypes of ber. Amplified DNA fragments were resolved by submerged horizontal electrophoresis in 1.0 per cent agarose gel and visualized by staining with ethidium bromide.

Molecular weight of different fragments was determined by using EcoRI-Hind III double digest of λ DNA as a standard marker. The gel was photographed using VDS Image Master of Pharmacia Biotech.

Of the twenty random decamer primers tested, 17 generated polymorphic bands, while rest of the primers showed monomorphic bands. The primers that amplified all the 12 genotypes were OPD-1, OPD-3 and OPD-4. Two unique bands were found in genotype G-12 amplified by the primer OPD-19. Three unique bands were found in genotype G-9 amplified by the primer OPD-20, while the same band was amplified in only two cultivars by 7 primers. The size of amplified DNA fragments varied from 0.56-4.26 Kilobase pair (OPD-3).

In total, 109 bands were obtained, of which 85 bands were polymorphic, while 24 bands were monomorphic. For the cultivars tested between 2-9 bands were obtained for each primer with an average of 5.45 bands per primer. The highest number of bands (9) was generated by OPA-4 and OPD-3, followed by OPD-1, OPD-17 and OPD-20 that gave 7 bands. The lowest numbers of bands were obtained from OPC-15, OPD-14 and OPD-15 that gave 2 bands. No single primer was able to distinguish all the cultivars, however, all the cultivars were distinguishable with the combinations of polymorphic bands generated by various primers. The ability to differentiate all the tested cultivars by RAPD bands suggests that this technique may be practically applied for ber cultivar identification. With unweighted group method using arithmetic mean (UPGMA) cluster analysis, the twelve ber genotypes fell into four major clusters. First cluster comprised of genotypes G-1, G-5, G-7, G-9, G-10 and G-11, second cluster comprised of genotypes G-2, G-3 and G-12, third cluster comprised of only one genotype G-4 and fourth cluster includes genotypes G-6 and G-8. The pair wise dissimilarities of ber genotypes showed that genotypes G-9 and G-8 were close to each other. Maximum dissimilarity was observed between the genotypes G-8 and G-12.

**Corresponding author: S.K.Sehrawat; e-mail:sehrawatsk@hau.ernet.in*

S-04-17
Secondary Metabolites from Tissue Cultures and Plant Parts of *Ziziphus mauritiana* Cultivars

T.N.Nag and Neelam Chouhan

Plant Tissue Culture & Biotech. Laboratory, M. N. Institute of Applied Sciences, Bikaner, India

Plants growing in the xeric and harsh environment of desert produce various types of secondary metabolites which not only play a part in plant defense against drought, salinity and pathogens but may also serve as an excellent source of bioactive metabolties such as flavonoids, alkaloids, steroids etc. Therefore, a screening of plants of arid areas both *in vivo* and *in vitro* for useful metabolites have been conducted in our laboratory. Of the twenty one plants investigated *Ziziphus mauritiana* (Ber) *cultivars GOLA and SEB* gave excellent results. Tissue cultures of both the cultivars were raised from

leaves excised from mature plants and established for eighteen months by frequent sub-culturing on Murashige and Skoogs (1962) medium supplemented with cytokinins. The presence of quercetin, kaempferol, sitosterol, stigmasterol, lanosterol and diosgenin in tissue cultures of both the cultivars were confirmed using TLC, MP, MMP and IR spectral analysis. Experiments were also designed to increase the production of secondary metabolites by supplementing the media with various precursors and nutrients. Studies relating to enhancing the amount of secondary metabolites using hairy root cultures, immobilization and elicitation has been attempted earlier also by various workers. In the present report we plan to present and discuss our results in the light of contemporary knowledge.

**Corresponding author: T.N.Nag; e-mail: tejnnag@yahoo.co.in*

S-04-18
Tissue Culture and Rapid Propagation of Jinzao (*Zizyphus jujuba*) and the Study on Stability of Chromosome

Xiangying Qi[1] Ning Li[1.2] Xiangqian Zhang[1] Zongli Chen[2]

[1] Shaanixe Engineering and Technological Research Center for Conservation and Utilization of Regional Biological Resourcus; College of life sciencesl of Yan'an University shannxi Yan'an China 716000
[2] Gansu Agricultural University Lanzhou, Gansu

To study tissue culture technology and search the difference in chromosome number by Jinzao.
The "84 solution" and $HgCl_2$ were used as antiseptics, the MS as minimal medium and the 6-BA and IBA as ecto-hormone.
Explants showed a great difference at different concentrations of the exogenous hormones in the medium.
The suitable subculture is MS + 1.0mg l^{-1}6-BA + 0.2 mg l^{-1}IBA + 0.01 mg l^{-1}TDZ + 3%suger + 0.5%agar. After 30d the average height of plantlets is 3.7 cm. The suitable rooting subculture is MS + 1.0 mg l^{-1}IBA + 0.2 mg l^{-1}NAA + 2%sugar + 0.5%ager. Chromosome number did not change.

S-04-19
Cloning and Analyzing of Jujube Witches's Broom Phytoplasmas Gene from *Ziziphus jujuba*

X.P. Fan[1], J.B. Tian[1] and A. Bertaccini[2]

[1]Pomology Institute, Shanxi Academy of Agricultural Science, Taigu, Shanxi, P.R. of China
[2]DiSTA, Patologia Vegetale, Alma Mater Studiorum, University of Bologna, Bologna, Italy

Jujube witches' broom phytoplasma is the most dangerous jujube disease in China. Nucleic acid extracted from midribs of samples collected from three jujube varieties ("Suan-zao", "La-jiao-zao", and "Lang-zao") from symptomatic and asymptomatic shoots were tested by random amplified polymorphic DNA analyses. Using 13 different 10 and 11-bp random primers the amplification of jujube DNA was achieved from all the samples; AM14 primer provided amplification of specific DNA fragments of about 400 bp, only from samples collected from symptomatic plants. No genetic variations in these varieties were identified using the other 11 arbitrary primers; only with primer AL07 it was possible to differentiate "Lang-zao" from the other two varieties tested. All the experiments were repeated twice and the results were consistent. Compared with PCR analyses with

phytoplasma-specific primers, RAPD techniques resulted in an alternative rapid and sensitive method for detecting jujube phytoplasmas presence among different jujube varieties.

S-04-20
AFLP Analysis of Genetic Relationship and Discrimination on Jujube Germplasm Resources

Yafeng Wen[1], Gang He[2] , Sen Wang[1]

[1].College of Resources and Environment, Central South University of Forestry and Technology, Changsha,410004, China
[2].College of Life Science and Technology, Central South University of Forestry and Technology, Changsha,410004,China

Jujube (*Ziziphus jujuba* Mill.) is a popular fruit tree originated in China. Many cultivars have been developed during its long history of cultivation. Unfortunately, the nomenclature and seedling trade are confusing due to their extreme similarity in morphology. In this report, 58 jujube cultivars and 2 wild species, sour jujube (*Ziziphus jujuba* Mill. var. *spinosa* (Bunge) Hu), were analyzed using fluorescent-labeled AFLP markers to determine their relationship. Of 40 AFLP primer combinations screened, 9 were selected for the analysis based on number and quality of polymorphic fragments. A total of 1118 AFLP markers between 100 and 450 base pairs (bps) were generated, of which 1066 (95.35 %) were polymorphic. The number of amplified bands was different among each cultivar with an average of 490. The analysis showed that abundant genetic diversity exists among jujube cultivars. The genetic similarity coefficients (Nei and Li's) ranged from 0.4712 to 0.8670. Using UPGMA clustering method, 60 germplasms were placed into four different clusters. The 2 sour Jujube types were distinctly different from all other Jujube cultivars and grouped in Cluster Ⅰ, which indicate that sour jujube had farther genetic distance with jujube cultivars and should be classified as two species. 57 jujube cultivars grouped into two major clusters in 0.7025 similarity coefficients and showed close genetic relationship each other. Fresh, dry and ornamental cultivars showed insignificant difference in molecular level. Sucuizao and Kongfusucuizao were very close genetically. Jidanzao coming from Henan and Hunan had farther genetic distance and they were different cultivars. Shiyuehong was separated from other cultivars firstly in clustering. PCOA (Principal Coordinates Analysis) also supported the UPGMA cluster-grouping. The study could be useful in jujube germplasm discrimination, conservation and new cultivar breeding.

**Corresponding author: Yafeng Wen; Fax: 086-0731-5623153; e-mail: wenyafeng7107@163.com*

S-04-21
Development of Somatic Embryo and Adventitious Buds from the Differentiating Cultured Calli of Chinese Jujube Mu-Zao

Zongli Chen[1,2]*, Xiaojian Wang[1,2], Shipeng Liu[1,2], Wei Cao[1,2], Xiaojuan Ning[1,2], Xiangying Qi[1,2], Xiangqian Zhang[1,2]

[1] Shaanxi Engineering & Technological Research Center for Conservation & Utilization of Regional Biological Resource，Yanan 716000, China
[2] Collage of Life Sciences，Yanan University, Yanan 716000, China

The tissue culture technique has been demonstrated to be available for creating new Zizyphus jujuba with virus-free and somatic mutations. To date, there have been few data about the callus development of Chinese date Mu-Zao in Northern Shaanxi province. Thus, the development of

somatic embryo and adventitions buds from differentiating cultured calli of Mu-Zao was pursued in the present study by using the selective tissue culture and microscopic observations.

The young tender leaves from Chinese date in Northern Shaanxi province were taken as explants for tissue culture.

The calli were induced from leaves by inoculating on MS or 3/4 MS medium with the affixture 6-BA 1.0 mg.L-1, IBA 0.2 mg.L-1, TDZ 0.015 mg.L-1, agar 0.55% and sugar 3%. Then, the induced calli were transferred into CY Ⅰ basic medium with the affixture 6-BA 1.0 mg.L-1, IBA 0.2 mg.L-1, TDZ 0.015 mg.L-1, agar 0.55% and sugar 3% for the differentiating culture. After being cultured continuously for 40 d, the somatic embryos developed. The histological observations showed that leaf somatic embryoids could be derived from a single somatic embryonic cell, the embryo sac mother cell or a cluster of embryonic cells. Moreover, the development of leaf somatic embryoids underwent different stages including a single embryonic cell, and then became two-cell embryo, quadrant embryo, many-cell embryo, globular-shaped, heart-shaped, torpedo-shaped, mature embryo and bud stages. During the developmental process, the conducting tissue could be observed evidently in the area concentrating with embryonic cells, and new-formed meristem in calli was also observed. The active regions of occurrence of somatic embryogenesis and meristem were at surface layer of calli.

When cultured with the selective medium, the calli and meristems could be induced from the tender leaves of Chinese date in Northern Shaanxi province. The development process of the cultured somatic embryo was similar to that of zygotic embryo of discotyledonary plants. These results may be helpful for us to modify and creat date plants from Northern Shaanxi province, China.

**Corresponding author: Zongli Chen, Fax: +86-0911-2331915,e-mail:zongli_chen@yahoo.com.cn*

Biology and Physiology

S-05-01
Influence of Uniconazole on Photosynthetic Pigments and Photosynthetic Parameters in *Ziziphus mauritians* cv. Gola under NaCl Stress

B.R. Gadi*[1], R.N. Godara[1], R.K. Gahlot[1] and S.P. Bohra[2]

[1]*Research Laboratory, Department of Botany, Dungar College, Bikaner-334003, Rajasthan, India*
[2]*Stress Physiology Laboratory, Department of Botany, J.N. Vyas Univeristy, jodhapur-342005, Rajasthan, India*

Ziziphus mauritiana is an extremely drought-hardy species and is a dominant component of the natural vegetation of the Indian desert. In this region, plants often face an acute shortage of water, extreme of temperature, high thermal and irradiation load and at specific sites supra-optimal levels of salt in the soil. Uniconazole belongs to a group of triazole which, in addition to their fungitoxic and plant growth regulating (PGR) properties, protects plants from various stresses. Hence, an attempt was made to study the effect of uniconazole on photosynthetic pigments and photosynthetic parameters under NaCl stress on one year old plants of *Ziziphus mauritiana* cv. Gola. NaCl (75 and 150 mM) salinity decreased photosynthetic pigments contents, photosynthetic rate (Pn), transpiration rate (Tr), stomatal conductace (Gs) an internal CO_2 concentration (Ci), whereas, uniconazole (5 mg/l) increased the photosynthetic pigments, Pn and Ci in the plants. Plants treated with uniconazole showed lower transpiration rate and stomatal conductance as compared to control and NaCl stressed plants. Uniconazole with combination of low (75 mM) and higher (150 mM) concentration of NaCl increased the photosynthetic pigments, Pn and Ci but it decreased in the Tr and Gs in the plants. From these observations it can be concluded that uniconazole mitigate the adverse effect of salinity in plants.

**Corresponding author: B.R. Gadi; e-mail: brgadi@rediffmail.com*

S-05-02
Salt-tolerance Ability of Different Jujube Cultivars

Chengqing Shen[1,2], Shangyin Cao[2], Ling Zhang[3], Shenxi Xie[1], Junying Guo[2], Yuling Chen[2], Huabai Xue[2], Peng Si[1]

[1] *Hunan Agricultural University, Changsha, Hunan, 410128, China*
[2] *Zhengzhou Fruit Institute, Chinese Academy of Agricultural Science, Zhengzhou, Henan, 450009, China*
[3] *Linwu Agricultural Bureau, Linwu, Chenzhou, Hunan, 424300, China*

The salt-tolerance ability of different varieties of Chinese jujube (*Ziziphus jujuba* Mill.) were studied with the fresh cutting of 'Zhanhuadongzao', 'No.1 Shankang', 'Bianhesuan', and 'Qiyuexian'. The treatments included 0%, 0.3%, 0.45%, and 0.60% NaCl with 3 replicates. For each time, 10 pots, in which one tree was planted, were used. The indicators of leaves' salt injury, MDA content, electrolyte leakage, soluble protein content, and proline content were measured 10 days later. The results showed that after treated with NaCl, the injury of leaves became serious, relative permeability of membrance and MDA content increased with the rising of NaCl content, the injury symptom of 'Qiyuexian' was the least, implying that it had the highest salt-tolerance ability; Soluble protein content of each jujube leaf increased with the rising of salt contents under the salt stress. When NaCl content reached 0.6%, 'Qiyuexian' protein content was the highest, weighing 16.5mg/gFW, which suggested this cultivar had the highest salt-tolerance ability. The change of

proline content was not significant. When NaCl content reached 0.6%, the highest proline content was found in 'Zhanhuadongzao', weighing 55.48ug/g, next was 'Bianhesuan' and 'No.1 Shankang', and the lowest was in 'Qiyuexian', weighing 44.5ug/g.

Corresponding author: Shangyin Cao; Fax: +86 371 65330963; e-mail: s.y.cao@163.com

S-05-03
The Determination of Chilling Requirement and Changes of Carbohydrate during Dormant Period for Chinese Jujube

Junjie Du

Shanxi Agricultural University , Taigu ,Shanxi, China 030801

Chinese jujube has been cultured in greenhouses, but there is little knowledge about the chilling requirement of different varieties, which is an important factor affecting culture successfully in greenhouses. In this paper, the chilling requirements of 30 varieties of Chinese jujube were determined with three methods including ≦7.2℃, 0-7.2℃ and Utah mode. The results indicated that the chilling requirements were 775h-1737h based on ≦7.2℃, 395-567h on 0-7.2℃ and 399-580 C.U on Utah model. Thirty varieties could be divided into 4 types according to the data. The changes of starch and soluble sugar content were different during dormant period. The starch content decreased before the end of dormancy and increased after it. The contents of starch and soluble sugar remained nearly the same as that at the end of dormancy. Therefore, the chilling requirement and/or the content of carbohydrate could be used to determine dormant release date for Chinese jujube.

Corresponding author: Junjie Du; e-mai:ldjj738@163.com

S-05-04
Molecular Mechanism on Salt Tolerance of Wild Jujube with Mycorrhizal Fungi

Liang Chen，Lianying Shen, and Yongmin Mao

Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, Hebei 071001, China

Wild jujube (*Zizyphus spinosus* Hu), one kind of old fruit trees belong to the *Rhamnaceae* family and the *Zizyphus* Mill. genus, originated from China, is the initial species of Chinese jujube. Arbuscular mycorrhiza is a product of the adaptive coevolution with arbuscular mycorrhizal fungi in the long-term life process, and is a kind of beneficial symbiont of plants. It can promote the resistance ability of plants to poor surroundings, and accelerate plant growth. The seedlings of wild jujube were used as materials in this research. Total RNA was extracted from wild jujube seedlings that inoculated with AMF and/or treated by NaCl stress, and then the purity of RNA was tested. After getting cDNA by reverse transcription, some researches were carried out on salt-resistance related gene expression by cDNA-AFLP technique. The following results were obtained: The 96 pairs of primers which were combined by 9 *Mse I* and 12 *EcoR I* random primers were screened. The results showed that 23 pairs of primers with the excellent expansion effect were found, and 6 cDNA-AFLP display types were observed. No.1 difference band (E41/LM1) in the first cDNA-AFLP display type was recycled and re-amplified, and its sequence was tested and analyzed. Finally a 437bp's expression sequence was obtained, and was analyzed on NCBI with BALASTN comparatively analysis. The result shows that, the 437bp's expression sequence, being no homology with other plants' salt-resistance related gene sequences and all plant gene sequences already existed, is merely homologous to CX943087.1

sequence, an expression sequence in algae, with which the homologous rate is 96%. It may be from a new special gene which is correlated with salt-resistance ability of wild jujube with mycorrhizal fungi.

*Corresponding author: Yongmin Mao; Fax: +86-0312-7528300; e-mail: ymmao@hebau.edu.cn

S-05-05
Comparative Studies on Cold-Hardiness of *Zizyphus jujuba* Mill. cv. Dongzao from Different Origins

LiXin Yao，JiuRu Xu，Jin Xue，QingHua Ma

The Key Laboratory for Genetics and Breeding in Forest Tree and Ornamental Plants of Ministry of Education，Beijing Forestry University, Beijing, 100083, China

Zizyphus jujube Mill. cv. Dongzao is a native fruit tree species vastly planted in Northern China which plays an important role in the production of economic forest products and the improvement of ecological environment. The distribution of Dongzao is greatly influenced by temperatures. Comparative studies on cold-hardiness of Dongzao have important reference value for its extension and application. The samples used for conductivity test were one-year-old grafted seedlings of Dongzao in dormancy, which were from 5 different origins, Zhanhua, Haunghua, Qingyun, Leling, and Cang County. During the winters of 2006 and 2007, the variation of cell membrane's permeability (electrolyte leakage) in different months and different low temperatures was studied by means of conductometry. Meanwhile, the germination rates of the seedlings at different low temperatures were also investigated synchronously. Relative electrolytic conductivity of Dongzao increased gradually with the decrease of external temperature, and attained the maximum value in January during the dormant period. Then with the increasing of the temperature, the relative electrolytic conductivity decreased again, and the species from Zhanhua decreased most rapidly. As a whole, the relative electrolytic conductivity of Dongzao from Cang County and Leling was significantly lower than that from other origins. The germination rate of Dongzao from 5 origins tended to decrease with the dropping of the temperatures. In early spring, the germination rates of Dongzao in Cang County and Leling were the highest, being 47% and 46%, respectively. When treated with decreasing temperatures, the relative electrolytic conductivity of Dongzao from 5 origins all increased, but with different degrees. When the temperature decreased to -20℃, the relative electrolytic conductivities of Dongzao in Zhanhua and Cang County were over 50%.. When the temperature decreased to -40℃, the relative electrolytic conductivities from all origins reached 90%. The cold-hardiness of Dongzao from different origins was compared by the values of ｜b｜of the regression coefficients. The results showed that the ｜b｜of Huanghua, Cang County, and Leling was relatively smaller, while that of Zhanhua and Qingyun was relatively larger.

*Corresponding author: JiuRu Xu; e-mail: xjru@sohu.com

S-05-06
Floral Biology of *Ziziphus* lotus L.

M. Ben Nasri-Ayachi & M.A. Nabli

Dept. Of Biology, Sciences Faculty of Tunis, University of Tunis El Manar II, Tunisia

Ziziphus lotus L. is a very common species in Tunisia. It is found mainly in the mediterranean bioclimatic semi-arid and arid zones according to Emberger classification. In the Central and the South of Tunisia, it contributes to the landscape formation. It is usually bushy because of the sandy winds often occurring in these regions and the cattle grazing (goats, sheep and Arabian camels). It

grows on deep clayey soils which are good for shrubbing. It is considered as an ancient weed because people could not uproot it formerly with their usual means. Its vegetative and reproductive apparatus were studied by using light microscopy, Scanning Electron Microscopy, and Transmission Electron Microscopy. *Ziziphus* is generally bushy but, the state tree can be seen (rarely). Foliage is deciduous and appears by the end of spring and during summer. The leaves are glabrous with a thin cuticle but the whole plant (leaves, flowers, stems…) is filled with mucilage. **F**lowers are usually pentamerous but sometimes 4, 6 and 7-merous ones were observed. In anther development, there is an asynchronism in the meiosis development and in the release of microspores from anther loculi. The tapetum is of the secretory type. Its cell walls persist and form a bag surrounding the pollen grains before their dispersal. Mature pollen grains are bicellular, tetraedric in shape, breviaxes, tricolporate, angulo-aperturate and oblate. Exine is striato-rugulate. Ectexine is columellar in the beginning and seems to become granular later because of the thickening of the tectum and the nexine. The aperture is entirely built up during the tetrad stage. Apertural intine thickens and forms a zwischenkörper rich with trabecula. It pushes out the discontinuous and weak exine. Ovary is inferior and the ovule has two integuments. It is usually bicarpellate (rarely tricarpellate) and bilocular. It contains frequently, only a single anatropous ovule in each loculus. Fruit is drupaceous. It usually contains two seeds. In conclusion, according to some available descriptions of the Rhamnaceae, *Ziziphus lotus* shares some morphological and anatomical characters with the other members such as 4 or 5-merous flowers, secretory tapetum, pollen 2-celled, 3-colporate and triangular, anatropous ovule and drupaceous fruit and some ultrastructural features adapted to drought. Besides the abundant mucilage, other features shall be analysed for the understanding of the leaf ultrastructure, with a thin cuticle and numerous naked stomata.

**Corresponding author: M. Ben Nasri-Ayachi; Fax: 00216 710885408; e-mail: samir.bennasri@gmail.com*

S-05-07
Investigation on the Characteristics of Fruiting and Seed Development in Chinese jujube (*Ziziphus jujuba* Mill.)

Ping Liu[1], Mengj Liu[1], Jiurui Wang[2], and C Yan[1]

[1] *Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, 071001 China;*
[2] *College of Forestry, Agricultural University of Hebei, Baoding，071001 China*

Fruiting habit and seed development are closely related to high-yield. Chinese jujube (*Ziziphus jujuba* Mill.) is a kind of fruit tree with long flowering season (more than one month), abundant flowers and very low fruit set. Investigation of 180 cultivars showed that 87.9%～99.9% flowers and 68.5%～100% young fruits dropped off during development and the final fruit set was only 1.1% on the basis of flower amount. The fruit number per 100 bearing branches varied with cultivars from 4.26 to 175. Only 8.5% of the cultivars could set more than one fruit per bearing branch. It seemed that fruit number was negatively correlated to fruit size among cultivars. Of 87.8% Chinese jujube cultivars could set fruits under self-pollination. However, natural pollination could increase fruiting rate by 3.5%~600%, or even more. Significant difference in fruit set was found among strains of cultivar 'Jinsixiaozao'. The male-sterile germplasm 'JMS1' could set fruit without pollination, which indicated that parthenogenesis probably existed in Chinese jujube. The seed percentages were less than 10% for 68.8% cultivars, and only 5.9% cultivars had seed percentage over 50%. The seed rate in cultivar JMS1 increased dramatically from 10.3% to 29.5% during June 25 to July 5 because of the dropping of seedless young fruits, while the seed rate of cultivar 'Linyilizao' kept almost zero throughout the whole developing period. Pollination was helpful to seed development. Only 1% cultivars had seed rate over 10% under self-pollination, while 30.8% cultivars had seed rate more than 10 % under natural-pollination.

**Corresponding author: Mengjun Liu; e-mail: kjliu@hebau.edu.cn*

S-05-08
Aquifer a Coordinate Effort in line with Regeneration of the Konar stands (*Ziziphus spina-christi*) in Southern Iran

Seyed Mousa Sadeghi, and Ali jafary

Agricultural and Natural Resources Research Center of Bushehr Province ,Iran

Floodwater caused by the rainfall in auriferous basins of the slopes of Zagross mountains in Boushehr province inflicts great losses and damages upon the residents of the region due to lack of poor plant cover in these lands in some years. Therefore we need to introduce resistant and compatible species in order to restore and perform forestation activities in these regions. On the other hand planting and extension of native species especially Somr or *Prosopis Juliflora* in southern Iran and the threat for other native species, reveals, much more than before, the necessity to extend the vegetation of native plant in dry lands and semi-dry lands, especially by application of methods of saving the precipitation. Geological investigations, soil science (pedology), climatology and vegetation have been done through using scientific references, field visits and surveys and gathering the samples from plants. After field visits and surveys for study of Konar regeneration, natural regeneration of Konar in the regions was classified according to existence or non existence and approximately 150 Konar seedlings were counted per hectare. The results indicated that saving rainfall has effect on regeneration. Therefore, the extension of aquifer started in the damaged Konar stands located on the alluviums of the 4th geological alluviums(quaternary era) around the city of Ahram located 60 kilometers from Bushehr. After execution of the first stage of aquifer in 1995 the floods occurred in the region and the seeds near the water were distributed in the region and a very satisfactory regeneration was observed in the regions where the flood waters had been distributed. A satisfactory regeneration also occurred in the succeeding years. Now an amazing cover of Konar has been established in the region and the field observations and surveys show that we can create lush forests of Konar by help of aquifer.

Corresponding author:seyed Mousa Sadeghi;Fax:+98 771 2526813;e-mail:smbooraki@yahoo.com

S-05-09
Ecological Investigation on Christ-thorn (*Ziziphus spina- Christi*) in Bushehr Province

Seyed Mousa Sadeghi[1], Karim Javanshir[2], Manochehr Namiranian[2], Hasan lotfian[3]

[1] *Agricultural And Natural Resources Research Center of Bushehr Provience,Iran*
[2]*Natural Resources Faculty,University of Tehran,Iran*
[3]*Research Institute of Forest and Rangelands,Iran*

In order to conduct an ecological investigation on *Ziziphus spina – Christi* stands, the authors paid field visits and surveyed information in Bushehr Province. Then on topographic maps (E: 1.50000) Konar(Christ-thorn) sites were determined and specified and then they were investigated geologically, soil, climatically, and in terms of flora and Fauna, pests and diseases, the factors and parameters being effective in destruction of natural Christ-thorn stands, also in terms of the quantitative conditions of stands, and their natural regeneration. Natural stands of Christ-thorn exist on two forms (rare trees, scattered trees) in this province and two regions Rahdar and Chanir Plain in Bushghan were selected as the representation of scattered stands. Then ecological investigations were carried out on them. The most important stands of Christ-thorn *(Ziziphus spina-christ)* are spread on alluvial fans with small stones, fine texture lands and sand dunes under which fine textured alluvial are placed. Their soils have loamy, sandy – loamy, silty – loamy and clay- silty texture. Their salinity is about 0.18 – 3.9 mil

m/c. Their pH is about 7- 8.20 and their saturate percent is about 23-60. Christ-thorn doesn't grow on low lands with high salinity and high level of subsurface water and Hormoz Geological formation. According to Umbrgee method, natural sites of Christ-thorn exist in low hot desert climate, high hot desert climate, mid hot desert climate, semi arid moderate climate, and arid moderate climate. Annual rainfall of these sites is between 150 mm in Taherei port to 383. 6 mm in Bushgan. Christ-thorn sites have very rich flora and can play a very important role in the improvement and revival of these stands. Average number per hectare in Rahdar sites is 17.5- 23 and average crown canopy is 2.13-2.28%.

**Corresponding author: Seyed Mousa Sadeghi; Fax: 0098 771 2526813; e-mail: smbooraki@yahoo.com*

S-05-10
Biochemical and Physiological Studies on Moisture Stress in *Ziziphus Spp.*

Shashi kala, Godara. A.

Department of Horticulture, College of Agricuture, CCS Haryana Agricultural University, Hisar, Haryana, India-125004

Ber *(Ziziphus spp.)* is drought tolerant and survives under extended moisture stress even when the surface soil completely dries out. In the present investigation moisture stress was created by withholding of irrigation up to 28th days in pots planted with *Ziziphus nummularia* and *Z .rotundifolia*. The control was taken at field capacity and different observations were recorded after 7, 14, 21, and 28 days of field capacity. During the stress period, soil moisture content, leaf water potential, leaf osmotic potential and relative water content of leaves were found to be decreased in both the *Ziziphus* species. The decline in leaf water potential and leaf osmotic potential were found at higher rate in *Z. nummularia* than *Z. rotundifolia.* In *Z. rotundifolia*, the decline in leaf relative water content was found at faster rate than *Z. nummularia.* Biochemical parameters like sugars (Total, reducing and non reducing), free amino acids, proline and electrolyte leakage (relative stress injury) were increased, however starch, total proteins and chlorophyll content (total, chlorophyll a, chlorophyll b) decreased in the leaves during moisture stress in both the *Ziziphus spp.* . In *Z. nummularia*, accumulation of proline, sugars and free amino acids were at higher rate than *Z rotundifolia*. Relative stress injury (electrolyte leakage) and chlorophyll content were found to be decreased at lower rate in *Z. nummularia*. The decline in total proteins and starch content were at faster rate in *Z. nummularia*. *Z. nummularia* was found more drought tolerant than *Z. rotundifolia*.

**Corresponding author: Shashi kala; e-mail: shshi_ hort@yahoo.com*

S-05-11
Protoplast Isolation of leaves of *Ziziphus jujuba* Mill.cv. dongzao

Xiaoguang Liu[1], Qiang Ning[2], Yanfang Peng[1], Mengjun Liu [1,*]

[1] Research Center of Chinese Jujube, Agricultural University of Hebei, 071001, Baoding, Hebei, P. R.China
[2] Vocation College of Political Science and Law of Hebei,Shijiazhuang 050061,China

Plantlets leaves of dongzao were used as materials for isolation and researched the factors influencing the process of protoplasts preparation, the result indicated it was easy to isolate protoplast from leaves of dongzao. The result showed that the best Cellulase concentration was 5g/L, and the optimal Macerozyme concentration was 5g/L, the best Mannitol concentration was 0.7mol/L. The digestion time was 16 ~20 h.

**Corresponding author: Mengjun Liu; Fax: 0312-7521251; e-mail:kjliu@hebau.edu.cn*

S-05-12
Relationship of Fruit Composition and Fruit Cracking Rate in Chinese Jujube (*Zizyphus jujuba* Mill.)

Yongmin Mao, Lianying Shen, Yanhui Li，Liang Chen

Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, Hebei, 071001 China

Cracking rates of Chinese jujube fruits were observed after completely immersing fruits in water at different time, and the relationship of cracking rate and the contents of sugar, acid, hormone and vitamin C in the fruit were studied. The results showed that fruit cracking rate varied largely with the varieties. High cracking-resistant varieties were 'Changhongzao', 'Liulinmuzao' and 'Dalilongzao'; and cracking-susceptive varieties were 'Jinsixiaozao', 'Hupingzao' and 'Linyilizao'. Sugar concentration of fruit was positively correlated with cracking rate within same variety (r=0.717-0.996), but no any correlation among different varieties(r=-0.167). The content of Vc in the fruits was negatively correlated with the fruit cracking rate. The content of acid in the fruit was no correlation with cracking rate. The fruit endogenous GA_3 contents for different varieties were negatively correlated with the cracking rates, but it was just opposite for ABA. The correlation coefficient of GA_3/ABA and cracking rate was -0.74 ($p<0.01$). The greater the ratio of GA_3/ABA in the fruits was, the less the cracking rate was. Both of the content of IAA and Zr had no significant correlation with the cracking rate.

**Corresponding author: Yongmin Mao; Fax: +86-0312-7528300; e-mail: ymmao@hebau.edu.cn*

S-05-13
Effect of Plant Growth Regulating Substance on Tissue Culture in Chinese Jujube

Zhou Ruijin[1] , Liu Mengjun[2]

[1] College of Landscape Architecture, Henan Institute of Science and Technology Xinxiang, Henan, China, 450003;
[2] College of Horticulture, Hebei Agricultural University, Baoding, Hebei, China, 071001

Plant growth regulating substance was an indispensable meteral in culture medium, and it was important to the plant tissue induction, organ differentiation and growth. Therefore, the effects of seven plant growth regulating substances such as BA, TDZ, KT, NAA, IBA, IAA and GA3 with different concentrations on the leaf regeneration, subculture of shoots and rooting of Chinese jujube were studied. The results indicated that the efficiency of TDZ was significantly higher than BA in the induction of adventitious bud from leaf. Leaves should be first induced on MS medium supplemented with TDZ (1.0mg•L-1) and IBA (0.1mg•L-1) for 28 days, and than transferred to medium MS+IBA 0.1mg•L-1+GA3 0.05mg•L-1. In this way, the regeneration rate reached 92.45%. MS+BA 1.0mg•L-1+KT 0.5mg•L-1+IBA 0.1mg•L-1 was suitable for subculture of shoots, with the multiplication coefficient of 3.64. Supplements of GA_3 at 0.5 mg•L-1 attached to the medium could significantly increase the elongation of shoots. The efficiency of IAA was best in IAA, IBA and NAA in the induction of rooting. The regenerated plantlets rooted well in 1/2MS medium plus IAA (1.5 mg•L-1), with rooting percentage of 95.3%.

**Corresponding author: Mengjun Liu; Fax: +86-0312-7521251; e-mail:kjliu@hebau.edu.cn*

Propagation and Rootstocks

S-06-01
Studies on Post Rejuvenation Performance of India Jujube Varieties

J.S.Bal

Department of Horticulture，Punjab Agricultural University，Ludhiana-141 004 (India)

The ber or Indian Jujube is the important fruit crop of India and cultivated practically all over the country. The trees start giving poor yield and small fruits after bearing normal crops for about three decades. The old wood goes on a accumulating every year, the trees become unproductive and may get easily infested with insect-pests and diseases. The fruit size is reduced, and the fruits become disfigured and drop heavily. The old orchards can be successfully revived through rejuvenation.
The investigations were conducted on thirty years old trees of promising Indian jujube varieties. The trees were headed back during the second fortnight of May, 1999 with retention of 30 cm length of main limbs. The average height of main limbs in different ber varieties was about one metre from ground level and each tree has 4 or 5 main limbs. During the rainy season, a great number of shoots were emerged from the stub. The first thinning of shoots was done during fourth week of August by retaining 12-18 shoots depending upon the vigour of the plant. The second thinning of shoots was carried out during second fortnight of September (before flowering) and on an average 8-12 shoots were retained on each tree on the basis of bearing behaviour of individual variety. The post rejuvenation performance of promising jujube varieties was studied and observations on fruit size, yield and quality of fruits of sixth fruiting season are presented.
The fruit size in terms of length and breadth was recorded maximum in Sanauur-2 and Sanaur-5 varieties. The average fruit weight varied from 10.0 g in Chhuhara to 26.3 g in Sanaur-2. Heavier fruits were recorded in Sanaur-2, Sanaur-5 and Kaithli varieties. The fruit yield per tree varied greatly among the varieties after rejuvenation. The fruit yield was considerably improved in sixth fruiting season and recorded maximum (174 kg/tree) in Sanaur-5. Heavy bearing to the tune of 162 kg per tree was recorded in Sanaur-2. The total soluble solids of different varieties varied between 13.8 percent in Kaithli and 18.0 percent in Sanaur-5. The acidity was estimated slightly high in Sanaur-2 (0.42%) and Sanaur-5 (0.36%). The vitamin C content in fruits was recorded highest in Sanaur-2 (128 mg/100 g pulp) and lowest in Wallaiti (104 mg/100 g pulp).
It is concluded that jujube trees need to be rejuvenated after the age of thirty years. The trees start giving commercial crop with higher yield of excellent fruit quality after three years.

S-06-02
Rootstock Evaluation in India Jujube

J.S.Bal

Department of Horticulture, Punjab Agricultural University, Ludhiana-141 004 (India)

Indian jujube is an ideal fruit for growing in the arid and semi-arid zones of India. It is generally propagated vegetatively and seeds of *Zizyphus mauritiana* Lamk. are commonly used for raising rootstocks. Choice of high yielding and compatible rootstocks for jujube is very important for profitable cultivation. Similarly, development of dwarf rootstocks for jujube is a pressing problem, which can prove a boon to commercialize jujube cultivation, thus reducing the operational cost. A rootstock trial was conducted to find out commercially suitable and compatible rootstocks for Indian

jujube. Twelve rootstocks were included in this trial viz. *Zizyphus mauritiana* (Punjab), *Zizyphus mauritiana* (Globular Dehradun), *Zizyphus mauritiana* (Elongatd Dehradun), *Zizyphus mauritiana* (Calcutta), *Zizyphus mauritiana* (Coimbatore), *Zizyphus jujuba* (SAIO TSAO), *Zizyphus zoaziroo*, *Zizyphus xylopyrus*, *Zizyphus numularia* (Punjab), *Zizyphus numularia* (Rajasthan), *Zizyphus numularia*. (Haldwani) and *Zizyphus numularia* (Dehradun). The commercial cultivar Umran was budded on these rootstocks. The plants budded on *Zizyphus mauritiana* rootstocks gave higher yield. The highest yield was recorded on *Zizyphus mauritiana* (Elongated Dehradun) closely followed by *Zizyphus mauritiana* from Punjab. The fruit yield from the trees on different *Zizyphus numularia* strains was much less than on *Zizyphus mauritiana* strains. The poor fruit yield was recorded from the plants budded on *Z.zoaziroo*, *Z. jujuba* (SIAO TSAO) and *Z. xylopyrus*. The plants on *Z. mauritiana* (Coimbatore) were having lower height, spread and volume than the other mauritiana strains, thus exhibited dwarfing affect. The plants raised on *Z. mauritiana* (Coimbatore) can profitably be planted at a closer spacing of 6 × 6 m instead of 7.5 × 7.5 m on vigorous rootstocks like *Z. mauritiana* (Elongated Dehradun and Punjab). Thus, fifty percent more plants can be accommodated per unit area. More rootstock research trials in different jujube growing regions of the world need to be conducted. Different *Zizyphus* species like *Z. mauritiana*, *Z. jujuba, Z. numularia, Z. xylopyrus, Z. mistol, Z. oenoplia, Z. spina-christi, Z. rugosa, Z .xylocarpa and Z. vulgaris* should be tested for stock-scion compatibility, growth, yield and fruit quality for important varieties.

**Corresponding author: J.S.Bal, Fax 91-161-2401421, e-mail: jsbal2002@yahoo.co.in*

S-06-03
Macro and Micro Propagation of Crist Thorn (*Ziziphus spina-christi* (L.) Desf.) in Iran

Mohammad Hassan Assareh, Hossein Sardabi

Research Institute of Forests and Rangelands, P. O. Box 13185-116, Tehran, I. R. Iran

The seeds of Crist thorn germinate easily after soaked in water for four days, but since it is a cross-pollinated plant and wide range of genetic variability exists in nature, the investigation was carried out to determine the best method for mass and clonal propagation. Four vegetative methods were examined, including cutting, layering, budding and tissue culture. Shoots with 22-25 cm in length were treated by two culture media, three stem diameters, two seasons, three humidity conditions, two cutting sources, two stem forms and two growth regulators for cutting trial. The layering treatments consisted of three growth regulators, two layering methods (trench and air layering) and two stock sources. Nine operation dates of budding was applied. Scions and rootstocks were provided from the seedless variety and the native trees of Christ's thorn species (seedling), respectively. Tissue culture nodal segments bearing axillary buds were removed from shoots of mature trees in different seasons. Several experiments were carried out to determine the best disinfectant chemical, appropriate conditions and materials to prevent phenolic compound exudation explant characteristics, media type and cytokinin-auxin ratios. Rooting was successful only on the sandy beds and cuttings with more than 8.0 mm in diameter in spring season and under the controlled humidity condition. For the trench layering method, only one specimen in one replicate rooted a very small root. For the airlayering method, only the seedlings under growth regulator treatments rooted successfully. The best date for T-budding was 7-21 October. The best season for explant harvesting was mid-summer. Among the disinfecting treatments, $Ca(OCl)_2$ at the concentration of 0.5 g kg^{-1} for 20 minutes was the best. Average amount of rooting on media containing IBA and activated charcoal was the greatest. Average amount of rooting on media containing IBA and activated charcoal was the greatest.

**Corresponding author: Hossein Sardabi; Fax: +98 2144196575; e-mail: sardabi@rifr-ac.ir or sardabi@yahoo.com*

S-06-04
Survey of Sexual and Non- sexual Propagation Methods of *Ziziphus jujuba*

Mohammad Reza Naeini, and Hossein Tavakoli

Qom natural resources and agriculture research center, near to engelab bridge, iranmerinoos square, Qom, Iran.

This study was conducted during 1995-1996 to survey sexsual and non-sexual propagating methods of Jujube(*zizyphus jujuba* Mill.)trees. Experimental materials including seeds, hardwood and softwood cuttings were collected from old trees in Hamvar-e-Lakha forestry park and Hossein Abad-e-Mishmast sand establishment station. In this experiment, because of hardness and stony endocarp, jujube seeds were scarified for six minutes in concentrated sulfuric acid and cultured after washing with distillated water. The seeds had no kernel could not germinate after planting. In propagation by softwood and hardwood cuttings, softwood cuttings from current season's growth branches were treated with IBA in concentrations of 2000, 3000 and 4000 mg/L and then cultured in sand medium, the cuttings treated with IBA in concentration of 4000 mg/L produced the highest rate of callus but could not root, and the hardwood cuttings could not produce any callus or root. In micropropagation (tissue culture), single-node explants were cultured on Moorashig and Skoog culture medium. The explants grew on this medium and proliferated new shoots. Then subcultures that were cutted from new shoots grew on M.S medium and then transplanted to new medium for rooting, but did not generate any root. There were too many off-roots around the Jujube trees that could generate new plants. The off-roots in early spring were originate from main root and could be planted in a new location. The off-roots were established very well and grew in main locations. This is the best non-sexual method of Jujube propagation.

**Corresponding author: mohammad reza naeini; Fax: +982512907574; e-mail:naeini2000@yahoo.com*

S-06-05
Propagation Studies in Ber for Commercial Multiplication

S. N. Ghosh

Department of Fruits and Orchard Management, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, Nadia, West Bengal, India

In ber (*Zizyphus mauritiana* Lamk.), budding has been found to be the best method for commercial multiplication. However, its degree of success depends on various factors like time of budding, condition of budding, varietal compatibility, *etc*. For commercial multiplication of ber in an area, such factors to be standardized for getting maximum success. On view of the above-mentioned objectives, complete investigation was made on various aspects of propagation in ber during the period of 2004 and 2005. The study was made at the Regional Research Station, Jhargram, West Bengal of Bidhan Chandra Krishi Viswavidyalaya where the climate is dry sub-tropical in nature. To understand the varietal compatibility with the local rootstock (*Zizyphus rotundifolia*), ten cultivars *viz.,* Banarasi Karka, Chhuhara, Dandan, Elachi, Gola, Jogia, Kaithali, Mundia, Seb and Umran were patch budded on 25th June in 2004 and 2005. The cultivars 'Elachi' and 'Gola' showed the best compatibility with the local rootstock as it resulted in 100 percent success with maximum in buddling growth while Banarasi Karka gave the lowest of 70 percent success. As Banarasi Karka is one of the good varieties, an attempt was made to improve the budding success by using 50 and 75 percent shed-net. The study

indicated that the budded scion of Banarasi Karka performed best in open condition then under shed-net. To know the best time for budding under nursery (seedlings grown in polybags) and field conditions, budding operation was carried out in 12 months of 2004 and 2005. Results indicated that the months of May, June and September were the best for *in-situ* budding as it showed higher percent success with maximum plant growth while for polybag grown seedlings in the nursery, the months of May and June were only the good time with 75 to 85 percent success. The rate of plant growth after budding was more in open field (*in-situ* budding) as compared to nursery condition.

∗*Corresponding author: S.N.Ghosh ; Fax :+ 91-03473-222659; e-mail: profsnghosh@yahoo.co.in*

Orchard Management and Harvest

S-07-01
Effect of Nutrients and Growth Regulators on Physico-chemical Characteristics of Indian Jujube (*Zizyphus mauritiana* Lamk.)

Chaturjeet Singh and J S Bal

Department of Horticulture, Punjab Agricultural University, Ludhiana-141 004 (India)

Indian jujube is one of the ancient fruit crops, which is popular due to its wider adaptability under adverse soil and climatic conditions. It is the major fruit crop of arid and semi-arid regions of tropical and subtropical areas. 'Umran' is the leading cultivar of Indian jujube and commercially cultivated in Punjab. However, about 50 % fruits of 'Umran' cultivar remain very small, which adversely affects the yield, quality and profit to the growers. Also, bulk of immature fruits dropped during initial stages of fruit growth and development due to various factors like hormonal imbalance, abortion of embryo and inclement weather. Thus, the fruit retention and other physico-chemical characters can be improved with the use of nutrients, growth regulators and other chemicals. The investigations were undertaken on nineteen years old trees of Indian jujube cv. Umran. Different chemicals *viz*., potassium sulphate (0.5, 1.0 and 1.5%), potassium nitrate (0.5, 1.0 and 1.5%), paclobutrazol (100, 200, 300 ppm) and naphthalene acetic acid (20, 40 and 60 ppm) along with control were sprayed at active growth phase of the fruit *i.e.* 29th January, 2005. The highest fruit retention (26.01%) was recorded with 0.5 percent potassium sulphate followed by 1.0 percent potassium sulphate sprays. The highest fruit weight (26.50 g) and maximum fruit yield (81.30 kg/tree) were recorded with 60 ppm NAA spray. The palatability rating (7.76) was noted higher with 100 ppm paclobutrazol and the fruits obtained with this treatment were rated as 'Very much desirable'. The highest total soluble solids content (10.83%) and total sugars content (8.20%) were recorded with100 ppm paclobutrazol treatment. Vitamin C (98.77 mg / 100 g pulp) was recorded maximum with 200 ppm paclobutrazol which was found at par with 100 ppm paclobutrazol (91.91 mg/100g pulp). It was concluded that fruit retention was increased with the foliar application of 0.5 percent potassium sulphate. The highest fruit weight and yield were obtained with spray of 60 ppm NAA. Fruit size, palatability rating, TSS, vitamin C and total sugars were recorded higher with 100-200 ppm paclobutrazol.

**Corresponding author: Chaturjeet Singh; Fax: +91 161 2401421; e-mail: csrattan@yahoo.com*

S-07-02
Effect of Pruning Severity and Time on Vergetative, Yield and Quality Attributes of India Jujube (*Zizyphus mauritiana*. LAMK.) CV. Umran

K.S. GILL AND J.S. BAL

Punjab Agricultural University Regional Station, Gurdaspur,
Dept of Horticulture, P.A.U., Ludhiana

The ber (jujube) tree owing to its particular growth habit has a strong tendency to trail sideways and downwards. The annual growth in ber is very high and it occupies a large area within a few years of planting. Ber tree bears on the current season's growth and requires regular annual pruning to replace the old unproductive wood by the new one. In unpruned trees, old wood goes on accumulating every year and consequently leads to barren centre, reduced productivity and

poor quality fruits due to shading and susceptibility to diseases and pest problems. Moreover, the tree will attain bushy appearance and owing to multiple buds, more than one shoot emerge from the base forming a large number of weak crotches and straggly branches that easily split and break under heavy fruit load and pressure of wind action. Work on the standardization of pruning has been done, but the findings differ considerably with regard to time and severity of pruning. So, the present investigation was carried out in Umran (commercial cv. of Punjab) to standardize the pruning time and severity.

Investigations on effect of pruning severity and time in Indian jujube cv. 'Umran' were carried out on eighteen-year-old trees at Punjab Agricultural University, Ludhiana during the year 2003-2004. The trees were pruned at fortnightly intervals *i.e.* on 25th April, 9th May, 23rd May and 6th June with seven pruning levels *i.e.* retention of 2,4,6,8,10,12 buds and no pruning. Several vegetative, quality and yield parameters were noted at regular intervals during the course of study and data thus obtained were analyzed statistically according to Randomised block design with factorial arrangements.

Maximum shoot length and diameter were recorded in trees pruned on 23rd May by retaining 6 buds and 2 buds, respectively. Early leaf bud emergence was noted in early (25th April) 2 and 4 buds pruning. Earliest flower initiation on 2nd Sept. was recorded in unpruned trees and late flowering on 15th Sept in severely (2 buds) pruned trees. Significantly higher number of flowers per node was recorded in trees pruned on 6th June. The percent of fruit set and retention increased with the decrease in the pruning severity and recorded significantly higher in the unpruned trees and lower in trees pruned by retaining 2 buds. Both fruit set and retention increased with the delay in pruning upto 9th May and 23rd May, respectively. Maximum fruit size and weight were recorded in trees pruned between 9th and 23rd May by retaining 6 buds. Fruit yield increased significantly with the decrease in pruning severity and obtained maximum from unpruned trees. Palatability rating of fruits was observed maximum in fruits obtained from trees pruned on 23rd May by retaining 6 buds. The fruit quality in terms of TSS and acidity was significantly better in trees pruned on 9th May by retaining 2 buds. Vitamin C content was estimated higher in fruits harvested from the trees pruned on 23rd May by retaining 8 buds.

It was concluded that 'Umran' ber trees pruned on 9th May by retaining 6 buds yielded fruits of superior quality.

**Corresponding author: K.S.Gill, email:karanbirgill@rediffmail.com*

S-07-03
Studies on Fruit Drop, Size and Quality of Indian Jujube under Submontane Zone of Punjab

Parmpal Singh Gill and Jagtar Singh Bal

Department of Horticulture, Punjab Agricultural University, Ludhiana -141004, Punjab, India

Indian jujube is a hardy fruit tree that can be successfully grown in arid and semi-arid zones of Indian states particularly Haryana, Rajasthan and Gujarat, where most of other fruit crops fail to grow due to lack of irrigation facilities. In Punjab, Sanaur 2 cultivar of Indian jujube is recommended for sub montane region due to its higher tolerance to powdery mildew as compared to more popular variety 'Umran'. Heavy pre-harvest fruit drop in ber poses an obstacle in flourishing ber industry in sub-montane tract. An experiment was conducted to study the efficacy of foliar sprays of NAA (20, 30 and 40 ppm), KNO_3 (0.5, 1.0 and 1.5 %) and $ZnSO_4$ (0.3, 0.4 and 0.5 %) on fruit drop, retention and quality of Indian jujube. These sprays were made in last week of October and again superimposed in last week of November. Minimum fruit drop and maximum fruit retention was recorded in plants sprayed with NAA 30 ppm. The plants sprayed with KNO_3 (1.5 %) resulted in maximum fruit weight and fruit size. However these parameters were recorded minimum in untreated trees. Total soluble solids were not affected significantly with different treatments. The palatability rating of fruits was recorded maximum with KNO_3 1.5 %, which also produced attractive colored fruit and rated

'Excellent' in taste. Maximum vitamin C content was observed in NAA 30 ppm treatment followed by KNO_3 1.5 % treatment. It can be concluded that NAA 30 ppm spray resulted in minimum fruit drop. The fruit quality in terms of size, colour and palatability rating was better in KNO_3 1.5%.

*Corresponding author: Parmpal Singh Gill; Fax: +91 016 -2400945; e-mail timgill740@rediffmail.com

S-07-04
Nutrient Indexing Survey of Indian Jujube (*Ziziphus maurtiana* L.) Orchards in Punjab, North -west India

Rajbir Singh Boora, Kuldip Singh*, Dhanwinder Singh* and H.S. Hundal*

Punjab Agricultural University
Regional Fruit Research Station, Bahadurgarh, Patiala (Pb) India
**Department of Soils Sciences, PAU, Ludhiana*

In Punjab Ber *(Ziziphus maurtiana* L.*)* is cultivated in 2.87 thousand hectares area with a production of 43,095 tons. The Ber fruit is a good source of Vitamin C and minerals like P, Ca and Fe. To monitor the nutrient status of ber fruit plant, recently fully matured leaf samples were collected at inflorescence stage during the month of September 2007, from 40 different orchards of Punjab, North-West, India. The leaf samples were washed with the deionized water, oven dried at 50^0C, and then ground and stored. The dried leaf tissues were digested in HNO_3-$HClO_4$ acid mixture and elemental compositions were determined on ICAP model Thermo Electron corporation IAP 6000 series. The concentrations of P, Ca, Mg and S varied from 0.105-0.408, 0.172-2.263, 0.104-2.319, 0.029-0.528 and 0.014-0.240 percent with their mean values being 0.252, 1.446, 1.399, 0.313 and 0.164 percent, respectively. The concentrations of Zn, Cu, Mn and B ranged from 11-57, 0.5-18.0, 7-152 and 13-120 ppm with their mean values being 28,9,56 and 49 ppm, respectively. In macronutrients, on the basis of sufficiency limits, 12, 20, 11, 85 and 68 percent of total samples were found deficient in P, K, Ca, Mg and S respectively. In micronutrients, 4, 1, 1 and 3 percent of the total samples were found to be deficient in Zn, Cu, Mn and B, respectively.

**Corresponding author: Rajbir Singh Boora; e-mail: rsboorapau@yahoo.co.in*

S-07-05
Study on Fruit Quality of Jujube Varieties during Maturity

R P He, J Li, F Zhao, W N Kong, R S Niu

Plant Protection Institute, Academy of Shanxi Agricultural Science, Taiyuan, China

It is important to determine harvesting period of jujube fruit.
Some indexes in relation to jujube quality were determined by plant physiological methods at different stages in 2007.
From 29 August to 24 September, the total Vc contents of Jinchangyihao and Junzao decreased and Hupingzao and Lizao increased. The contents of soluble sugar, reducing sugar, raw fiber, acid, water and ratio of sugar to acid increased during experimental period.
The quality of jujube fruit was gradually improved during maturity. For sake of nutritive values, Jinchangyihao, Junzao and Hupingzao should be picked between 29 August and 24 September and Lizao should be picked after 24 September in Taiyuan, Shanxi.

**Corresponding author:J. Li, email:lijie_durham@hotmail.com*

S-07-06
Technology Interventions for Successful Ber Cultivations under Arid Climate of Rajasthan, India

R.S.Rathore, A.Chandra1, Krishi Vigyan Kendra, Bhilwara,

Maharana Pratap University of Agriculture & Technology,Udaipur, Rajasthan, India.
[1]Department of Horticulture, College of Agriculture, Rajasthan Agricultural University, Bikaner, Rajasthan, India.

Ber/jujube (*Zizyphus mauritiana* Lamk.) is ideal fruit crop for the arid and semi arid region of India where most of other fruit crops cannot be grown either due to lack of irrigation facilities or adverse climatic and soil conditions. Its cultivation is particularly significant due to recurrent drought conditions and failure of field crops in most of the years because of low and erratic rainfall. In arid region, most of the farmers are illiterate. Therefore, they have not properly adopted new technologies for cultivation of Ber. There are many technological interventions for successful Ber cultivation; mainly selection of planting materials, pit filling & planting, water management, nutrient management, training and pruning, suitable intercropping, and timely pest and disease management. Availability of improved cultivars is scare in rural areas. Farmers are not digging pits of proper size and not filling these with recommended doses of manures, fertilizers and insecticides. There is much scare of water in dry areas. Drip irrigation is not popular because of its high initial expenditure and clogging of system in salty water. Farmers are not applying recommended doses of manures and fertilizers. Knowledge of time and methods of pruning and training is scare in arid areas. Farmers are not taking suitable intercrops in orchards. They prefer traditional crops like maize (*Zea mays* L.), pearl-millet (*Pennisetum typhoides*), barley (*Hordium vulgare* L.), sorghum (*Sorghum vulgare* Pers.), *etc*., which compete with Ber plants for nutrition, sunlight *etc.*, and thus, growth of fruit plants, is adversely affected. Timely management of pests and diseases is not followed. Farmers are applying pesticides when pests and diseases are in advance stage rendering these measures ineffective. These are the main interventions for successful cultivation of Ber under arid climate of Rajasthan, India.

**Corresponding author: R.S.Rathore;Fax: 91-1482-239063; e-mail: rsrathorekvk@yahoo.co.in*

S-07-07
Evaluation of Varieties and Standardization of Production Technologies in Ber (*Zizyphus mauritiana*) under Rainfed Vertisols

S. Anbu, S. Balasubramanyan, K. Venkatesan，M. Selvarajan

[1]Horticultural College and Research Institute,Periyakulam East – 625 604. Tamil Nadu， India
[2]Regional Research Station, Aruppukottai – 626 107. Tamil Nadu, India

Ber is considered as the King of arid zone fruits, because of its adaptations to tolerate the biotic and abiotic stress prevailing under rain fed conditions. It is cultivated in arid areas (in states like Rajasthan and Gujarat) and semiarid areas(in states like Anthra Pradesh, Maharastra Tamil Nadu, etc.,). Crop diversification through arid fruits like ber ensured some production during the drought year when traditional crops fail. Ber as a multipurpose fruit crop acts as wind break, checks soil erosion and shifting sands and serves as a source for food, fodder timber and fuel. Among commercial varieties (Umran, Banarsi, Kaithali, Gola) evaluated Kaithali provided consistently significant higher yields compared to other varieties. Pruning ber in the month of February recorded higher yield when pruning was affected between January and June. As regards the *in-situ* water

harvesting, increasing the catchments area 2.5 times of normal area with 5 percent slope exhibited higher yield compared to 1.5, 2.0 times of normal area, and normal area with and without slope. The yield contributing factors were also positively improved. Dense planting of ber with a spacing of 8×3m recorded higher yield per unit area than other spacing affected (8×4, 8x6 and 8×8 m). In the trail on weed management with cover crops, mulching, herbicides, use of herbicides diuron and glyphosate effectively controlled the weeds and increased the fruit yield also.

Corresponding author: S. Anbu; Fax: +91 4546 231726; e-mail: sanbuhort@yahoo.co.in

S-07-08
Selection of Fresh Jujube Cultivars in Purple Shale Areas in South of China

Sen Wang [1], Bixia Xie [1], Qiuping Zhong [1], Zhanying Gu[1], Jiangqiao Zeng [2], Jianxin Zeng [2]

[1] College of Resources and Environment, Central South University of Forestry and Technology, Changsha 410004, Hunan, China
[2] Xinfeng fruit industry Limited company, Qidong 414400, Hunan, China)

More than 10 jujube cultivars, Zhongqiusucui jujube, Winter jujube, Jidan jujube, Pear jujube, etc. were selected and cultivated in the purple shale areas in South of China. The cultivars were compared with multiple dimension method. Therefore, Winter jujube, Zhongqiusucui jujube and Daxue jujube were selected as the desired cultivars.

**Corresponding author: SenWang; e-mail: csuftwangsen@163.com*

S-07-09
Effect of Different Treatments on Fruit setting in *Ziziphus Jujuba* Mill.

S. Mishra, B. Krška

Department of Pomology, Faculty of Horticulture in Lednice
Mendel University of Agriculture and Forestry in Brno
Czech Republic

Chinese date, popularly known as jujube (*Ziziphus jujuba* Mill.), is a native of China and belongs to the buckhorn family (Rhamnaceae). It is a tree growing at a moderate climate, from 5 to 7 m in height. It is a genus of about 100 species of deciduous or evergreen trees and shrubs distributed in the tropical and subtropical regions (Singh et al. 1972). The flowers are small, fragrant, yellow or white in color. The fruits are 2.5 cm long, dark red and brown in color. Today it is also grown in Russia, northern Africa, southwestern Europe, the Middle East and the south western United States. Generally fruit set of Ziziphus jujuba Mill. is achieved by pollination, chemical spray and girdling (Yun et al. 1995). Pollination is used mainly for breeding purposes. It is very difficult to collect pollens from the jujube flower in order to increase fruit set. *Ziziphus jujuba* Mill. has five pieces of stamen. It is difficult to carry out hybridization programmes because many obstacles are encountered in artificial hybridization, such as small flowers, seedless, and so on.
Fruit-set was improved using the following methods:
1.Spraying during full blooming season (25% - 50% flowers are open).

2.During blooming season (approximately 30% flowers are opening), main stem ring-girdling was made (removing the bark of 3-5 mm wide strip of bark, depending on the diameter of the tree) just like in apple tree. Pollination was assisted by insect movement, e g. honeybees flying.
10 trees of the cultivar `Lang` were used for the trial of different treatments for pollination. 2 plants were used for each treatment. 6 different treatments were used to improve pollination: Borax: 0.3%, Urea: 0.5%, KH_2PO_4: 0.4%, GA_3: 5-10 ppm (or mg/L), Girdling, Control. Treatments were sprayed on jujube twice. First, when 25% flowers were open and again when 50% flowers were open. A pomological description based on shape, color, weight, thickness, height and width was made for each different treatment, 20 fruits were evaluated for each treatment.
On the basis of first year's result, these treatments don't affect fruit shape and color. Treatments affect weight, thickness, width and height of fruit, and there were statistically highly significant differences between Urea and other treatments.
A one-year evaluation of different treatments for improving fruit set has given good results. Borax is the best treatment for both fruit set and pomological characteristics as well. Urea gave poor results. The results in second year also seem to be the same.

**Corresponding author: Saket Mishra; Fax: +420519367222; e-mail: mishrasaket1@rediffmail.com*

S-07-10
Effect of Plant Growth Regulators on Fruit Retention, Yield and Physico-Chemical Characteristics of Fruits in Ber cv. Banarasi Karka Grown in Close Spacing

S. N. Ghosh[1], B. Bera[2], A. Kundu[2] and S. Roy[2]

[1]Department of Fruits and Orchard Management, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, Nadia, West Bengal, India
[2]MPS Farm, Jhargram – 721504, Paschim Midnapore, West Bengal.

Banarasi Karka cultivar of ber locally called 'Narkeli' is most choice variety in West Bengal. The cultivar produces good crop and quality fruits during January-February. One of the main constraints in fruit production with this cultivar is the occurrence of high natural fruit drop (about 70%). It is established that plant growth regulators can significantly change the hormonal status of the plant resulting in good fruit retention and thereby improving the fruit yield and quality. A study was taken up on 6 years old Banarasi Karka cultivar of ber raised through *in-situ* budding on 2 years old rootstocks with the spacing of 3.5 m (row to row) and 4.5 m (plant to plant). There were seven treatments with two growth regulators *viz.,* NAA at 25, 50 and 100 ppm; GA at 10, 20 and 40 ppm and control (water spray). These chemicals were thoroughly sprayed three times just after fruit set at 21 days interval. Results of two years of investigation revealed that application of NAA at 25 ppm gave significantly highest fruit retention (75%), which resulted in highest fruit yield of 120.5 quintals as against 64.7 quintals per hectare in control. No beneficial effect of GA on fruit retention or improving fruit yield was observed. But, fruit quality was significantly improved.

**Corresponding author: S.N.Ghosh ; Fax:+ 91-3473-222659; e-mail : profsnghosh@yahoo.co.in*

S-07-11
Fruit Production and Quality Improvement in Banarasi Karka Cultivar of Ber Through Canopy Management

S. N. Ghosh

Department of Fruits and Orchard Management, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, Nadia, West Bengal, India

Just because the ber fruit is borne in axil of young growing shoots of the current year, regular annual pruning is an utmost cultural practice for sustainable production of quality fruits in ber. The extent to which ber trees to be pruned depends mainly on genotype and agro-climatic conditions where the crop is being grown. In red and laterite zone of West Bengal and its adjoining states, where the agro-climatic feature is completely different from other parts of the country, ber is being grown successfully and profitably. As no scientific investigation on pruning standardization of ber has so far been done in West Bengal, an investigation was therefore, made to standardize the best pruning technique for Banarasi Karka cultivar of ber grown in close spacing (3.5 - 4.5 m) under irrigated condition. To find out the best pruning method, seven levels of pruning were performed, *i.e.*, - i) removal of primary branches leaving 30 cm, 60 cm and 90 cm from the base of the trunk; removal of 25%, 50% and 100% of primary shoots from the tip and unpruned (control). Results of two consecutive years of investigation reveal that 25% pruning of primary branches resulted in the highest fruit yield of 197.2 quintal as against 104.0 quintal per hectare for control, which resulted in an additional income of Rs.1.08 lakh per hectare at the plant age of 8 years. Fruit quality in respect of T.S.S., total sugar and vitamin C was better in all the pruned plants as compared to control.

**Corresponding author:S.N.Ghosh ;Fax :+ 91-03473-222659; e-mail: profsnghosh@yahoo.co.in*

S-07-12
Effect of Molybdenum Foliar Sprays on Fruiting, Yield and Fruit Quality of Jujube

Wangbin[1] , Wang yu-kui[2], Zhang Yue-hua[3] , Liu jia-fen[1] ,Xulin[1]

[1]*Shandong Institute of Pomology, Tai'an,Shandong 271000, China；*

[2] *Xinhu Township of Hekou District,Dongying,shandong 257236,China；*

[3] *Subdistrict Office of Hekou, Dongying，shandong 257200 ,China.*

Field experiments with jujube "Dongzao" (*Z. jujuba* Mill.) were carried out in Dongying and Taian in China for 3 years (2005, 2006 and 2007) to examine the effects of molybdenum (Mo) foliar sprays on fruiting, yield and fruit quality. "Dongzao" was planted in 2001 or 2002. Fourteen treatments and 1 control were designed, with a single tree serving as a plot and 3 replications, and sprays were applied during flowering period. Two treatments (Mo 50 $mg \cdot kg^{-1}$ + girdling + $GA_3$15 $mg \cdot kg^{-1}$ and Mo 100 $mg \cdot kg^{-1}$ + girdling + $GA_3$15 $mg \cdot kg^{-1}$) applied during flowering period increased fruit/shoot ratio by 1.48% and 19%, yield per tree by 7.11kg and 5.95kg, and both treatments reached significant level ($P < 0.01$ or $P < 0.05$= as cpmpared to other treatments. The results showed that Molybdenum deficiency could be a major factor affacting the occurrence of fruit disorders, such as poor fruit set and yield in "Dongzao". The application of Mo100mg/kg + $GA_3$15mg/kg during flowering period increased the fruit average weight by 17.76g and fruits treated with Mo100mg/kg+$GA_3$15mg/kg were significantly greater than those by other treatments. The soluble solid and total sugar contents in Mo 20 $mg \cdot kg^{-1}$, 50 $mg \cdot kg^{-1}$,100 $mg \cdot kg^{-1}$ were raised by 23.15%, 23.46%, 22.95% and 24.15%, 24.58%

and 23.79%, respectively, compared with other treatments. Mo Foliar Sprays can affect fruiting, yield and fruit quality of jujube.

*Corresponding author: BinWang; Fax: +86 538-8260715; e-mail: wangbina-0002@163.com

S-07-13
Effect of Arbuscular Mycorrhizae on the Growth and Absorption of Phosphorus and Zinc from the Soil by Wild Jujube (*Zizyphus spinosus* Hu) Seedlings

Yongmin Mao[1], Lianying Shen[1], Jinying Lu[2]

[1] *Research Center of Chinese Jujube, Hebei Agricultural University, Boding, Hebei 071001 China;*
[2] *Institute of Genetics and Developmental Biology, CAS, Beijing 100101, China*

Mycorrhizae are mutualistic associations between plant roots and fungi. This beneficial symbiosis is ubiquitous in nature and almost all plant species have some form of mycorrhizal association with fungi. Arbuscular mycorrhizae, or AM (formerly known as vesicular-arbuscular mycorrhizae, or VAM), are mycorrhizae whose hyphae enter into the plant cells, producing structures that are either balloon-like (vesicles) or dichotomously-branching invaginations (arbuscules). The current study examined the effects of arbuscular mycorrhizae inoculation on the growth and P and Zn absorption from the soil by wild jujube (*Zizyphus spinosus* Hu) seedlings grown in synthetic glass boxes. The box had three compartments, a central compartment for root growth separated by 30μm nylon mesh and two outer compartments for mycorrhizal hyphae growth. For the control the meshes were 0.45μm to prohibit the fungi of the inner compartment into the outer. The results showed that no colonization occurred in non-mycorrhizal wild jujube seedlings. In the AM-inoculated plants, 82.5%-87% of roots were colonized. AM inoculation was able to significantly increase the growth of fruit bearing shoots and improve P and Zn amount of plant. With the increasing of soil P concentrations in the outer compartments, hyphal uptake of P increased. The percents of P absorption by the fungi were between 17.4% and 28.1% and those of Zn were between 13.1% and 33.1%.

*Corresponding author: Yongmin Mao; Fax: +86 312-7528300; e-mail: ymmao@hebau.edu.cn

Plant Protection

S-08-01
Histopathology of Jujube (*Zizyphus mauritiana* Lam.) Roots Naturally Infected with Root-knot Nematode Meloidogyne Incognita (Kofoid and White 1919) Chitwood, 1949.

Aly Khan[1], F.M. Bilqees[2] and N. Khatoon[3]

[1]*Crop Diseases Research Institute, PARC, University of Karachi, Karachi-75270*
[2]*Dept. of Zoology, Jinnah University for Women, Nazimabad, Karachi-74600*
[3]*Dept. of Zoology, University of Karachi, Karachi-75270, Pakistan*

Histopathological studies revealed that Meloidogyne incognita larvae penetrated roots by a puncturing action of the stylet and intercellular penetration reached to the steller region where giant cells were produced. The changes brought by M. incognita infection included formation of several empty giant cells, abnormal xylem, hyperplasia of outer layer and hypertrophy. The trees heavily infected with root-knot nematodes had stunted growth and yellowing of leaves was a common symptom.

**Corresponding author: Aly Khan; e-mail:dralykhan@hotmail.com*

S-08-02
Population Dyamics and Management of Ber Butterfly,Tarucus Theophrastus(Fabricius) on *Ziziphus Spp*. in Punjab

D. R. SHARMA AND J.S. BAL

Department of Horticulture, Punjab Agricultural University, Ludhiana -141004 India

The ber trees are always severely pruned during May-June and the newly sprouting tender shoots and leaves are attacked by ber butterfly, Tarucus theophrastus (Fabricius). Due to its attack, the leaves dried up and tender shoots do not grow properly. The chemical control at this stage is very useful to protect the fresh and tender shoots for better growth, vigor of the trees as well as the fruit set. The observations were recorded daily from first week of June onwards i.e. soon after the pruning of ber trees. The larval population as well as the leaves infested was recorded from 100 leaves taken from four branches per tree. Endosulfan (0.0525 and 0.07%), quinalphos (0.05 and 0.0625%), triazophos (0.08 and 0.1%) and lindane (0.04 and 0.05%) were evaluated for the control of T. theophrastus. Each concentration was sprayed with foot pump at the maximum pest population i.e. second fortnight of June to first fortnight of July. There were two treatments (T1 and T2) i.e. in T1 two applications were made at the appearance of fresh leaves followed by second spray 15 days after first spray and in T2 single application was made. There were 3 replications each having 2 trees. The population counts were made at 0-and 10-days after 2nd spray. The larval population and infested leaves were counted from 50 leaves of fresh growth from the four sides of each tree. The reaction of 27 genotypes was also recorded by counting number of damaged leaves and larvae/100 leaves. T. theophrastus attacked the young leaves soon after the pruning or on the appearance of leaves on the unpruned trees. The larvae are yellowish green, hairy and sessile which feed both on the upper and lower side of the leaves. The larvae often caused upto 10 feeding streaks on a single leaf. It started appearing on leaves in the end of June and reached at its maximum in the first week of July. Endosulfan (0.07%), quinalphos (0.05%), triazophos (0.1%) and lindane (0.05%) were significantly effective in decreasing the butterfly damage in terms of larval population and infested leaves. The reaction of 27 genotypes/cultivars of ber on the basis of leaf infestation and larval population revealed that none of the genotypes was free from the

attack of ber butterfly. Ttheophrastus attacked the young leaves soon after the pruning i.e. from the end of June to first week of July. None of the genotypes was free from the attack of ber butterfly Endosulfan (0.07%), quinalphos (0.05%), and triazophos (0.1%) were effective.

*Corresponding author:D.R.SHARMA; e-mail:drajsharma@redffmail.com; Fax: +091--161-2400945

S-08-03
Diversity and Geographical Distribution of Phytoplasmas Infecting Chinese Jujube in North of China

Haixu Yang[1], Jin Zhao[1], Xiaobo Wu[1] and Mengjun Liu[2]

[1] *College of Life Science, Agricultural University of Hebei, Baoding 071000,China*
[2] *Research Center of Chinese jujube, Agricultural University of Hebei, Baoding 071001,China*

Jujube witches'broom (JWB), a destructive disease caused by phytoplasma, happened in Chinese Jujube. Phytoplasma is a prokaryote has no cytoderm, and it is impossibility in isotation and culture. Homology analysis for sequences of gene 16SrDNA used to identify and classify phytoplasmas internationally. PCR primer from this particular sequences is use to phytoplasmas detection and indentification. This paper used the method of CTAB to extract genomic DNA from samples of 9 sensitive cultivars to JWB.The 16SrDNA were cloned by polymerase chain reasction (PCR) from those cultivars infecting by phytoplasma. The homology analysis for sequences of 16SrDNA shows that homology rate of nucleotide sequences was above 98% among different cultivars. Phytoplasmas belonging to 16SrⅤgroup. There are several different nucleotides in 16SrDNA between *Ziziphus jujuba* Mill. cv. Zanhangdazao and others. At the same time, the study to analyze *Ziziphus jujuba* Mill. cv. Dongzao particular nucleotide sequences from different geographical distribution, it is found that pathogens from Beijing, Hebei, Shandong, Henna are the same, and the homology rate of nucleotide sequences above 98.5%. There has been no previous report to determine their diversity and geographical distribution in China. It provided genetic basis for research of prevention and cure Jujube witches'broom in different areas and cultivars.

**Corresponding author: Mengjun Liu, Fax:+86-312-7521456, email: kjliu@hebau.edu.cn*

S-08-04
Identification of Pathogen of Postharvest Diseases in *Ziziphus Jujuba* cv. Dongzao

Haoyuan Sun[1], Yuzhu Wang[1], Li Yang[1], and Shouyong Li[2]

[1]*Institute of Forestry and Pomology, Beijing Academy of Agriculture and Forestry Sciences, Beijing, 100093, China*
[2]*Rural Development Center of Beijing Science and Technology Committee, Beijing, 100101, China*

Ziziphus jujuba cv. Dongzao is among the most famous and widely-planted jujube cultivars used for fresh marketing in China for its delicious taste and high quality. Postharvest diseases are the main problem during its storage. The pathogens of the postharvest diseases of its fresh fruits were identified in this study. According to morphological comparison, three fungal pathogens (i.e. *Alternaria sp*., *Aspergillus sp*., and *Trichothecium sp*.) and three bacterial pathogens (i.e. *Xanthomonas sp*., *Pseudomonas sp*., and *Erwinia sp*.) were isolated. In order to select effective reagents to eliminate the fungal infection during the period of fruit storage, the effect of plant extract with different concentrations from 100 $mg \cdot L^{-1}$ to 600 $mg \cdot L^{-1}$ against fungal pathogens was tested by filter paper

method. The result showed that the effect of plant extract with the concentration of 200~400 mg·L^{-1} on fungal pathogens was best in compared with other concentrations.

*Corresponding author: Haoyuan Sun; Fax: +86 1062598744; e-mail: sunhy.fruit@yahoo.com.cn

S-08-05
The Content Variation of Mineral Element in Chinese Jujube with Witches' Broom Disease

Jin Zhao[1], Zhihui Zhao[2], Mengjun Liu[2]

[1]*College of Life Science, Agricultural University of Hebei, Baoding, Hebei, 071000, China*
[2]*Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, Hebei, 071001, China*

Chinese jujube (Ziziphus jujuba Mill.), an increasing popular fruit species, is being endangered with the destructive disease named jujube witches' broom disease (JWB) caused by phytoplasma. In order to reveal the physiological influences of phytoplasma in Chinese jujube, the content variations of 7 kinds of mineral elements during growing season in healthy trees, diseased trees, and the diseased trees cured with oxytetracycline were determined with atomic absorption spectrophotometer. The results showed that the content of mineral elements were greatly different between the healthy trees and the diseased ones. The content of K in diseased leaves was significantly higher than in leaves of healthy trees. The content of Ca, Mg, and Mn in diseased leaves was significantly lower than that in healthy leaves, and the content of Fe in diseased leaves was lower in the late growing season. There was no significant difference between the healthy and diseased leaves in the content of Cu and Zn. In addition, the content and variation trend of above-mentioned mineral elements were similar between healthy trees and the diseased trees cured with oxytetracycline.

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@hebau.edu.cn*

S-08-06
The Strategy and Techniques for Controlling Jujube Witches' Broom Disease

Jin Zhao[1]，Mengjun Liu[2]

[1] *College of Life Science, Agricultural University of Hebei, Baoding, Hebei, 071000 China*
[2] *Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, Hebei, 071001 China*

Chinese jujube (*Ziziphus jujuba* Mill.) is an important multi-purpose fruit tree in China with annual production of over 250 million tons and growing area of around 150 million ha. Jujube Witches' broom disease (JWB), a destructive disease caused by phytoplasma (MLO), kills 3-5% or even more jujube trees every year in many orchards because of no proper cure remedy. To cure phytoplasma diseases is a historical and worldwide difficult problem. Through 10 years' study, an excellent new cultivar with very high resistance to JWB, named 'Xingguang', was bred up and released in 2005. It could be used not only to establish new orchards free from JWB, but also to re-construct the crown of diseased tree for recovering normal growing and fruiting. At the same time, an excellent drug combination named 'Qufeng No.1' was screened out through lab and field experiment. According to the results of a large scale field application, the cure rate and effective rate of once trunk injection of the drug combination before blooming were 85% and 100%, respectively. The cure effects of one injection may last for 2-3 years and even more. In addition, an integrated strategy was put forward contraposing orchards and trees with different levels of JWB.

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@hebau.edu.cn*

S-08-07
The Viability of Jujube Witches' Broom (JWB) Phytoplasma in Branches during Winter and the Necessity of Roots in Developing JWB Symptom in Chinese Jujube

Jin Zhao[1] , Li Dai[2], and Mengjun Liu[2]

1 College of Life Science, Agricultural University of Hebei, Baoding, Hebei, 071000, China
2 Research Center of Chinese Jujube, Agricultural University of Hebei, Baoding, Hebei, 071001, China

Jujube witches' broom disease (JWB) is a destructive disease in Chinese jujube caused by phytoplasma. It has long been debated that whether JWB phytoplasma can survive in branches during winter and whether it is necessary for JWB phytoplasma to be transported to and propagated in roots before causing symptoms. Two new methods, water culture and tissue culture of diseased branches/shoots, were firstly employed to clarify the above-mentioned important questions. A great amount of phytoplasma fluorescent spots were found in the new shoots from water-cultured diseased branches during winter (December, January, and February). Moreover, explants from these new shoots, which were cultured in MS medium without hormone and produced plantlets, showed typical JWB symptoms.These results sufficiently proved that JWB phytoplasma could well survive in branches throughout the winter. Tissue culture also showed that rootless plantlets might contain large amount of phytoplasma and show typical symptom of JWB. With multiplication of the rootless plantlets, their symptom continuously developed. In addition, obvious grads of JWB phytoplasma concentration were found in the branches just showing symptoms, and usually no phytoplasma could be detected in the root of the trees with only one or very few newly diseased branches. These results confirmed that roots were not necessary for the multiplication of phytoplasma and development of the symptom.

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@hebau.edu.cn*

S-08-08
The Spatial Distribution Pattern of Over-winter Eggs, the First Generation of Nymphs and Ecological Control of Lygus lucortum Meyer Dur in Jujube Orchard

Liu Chunqin[1], Wang Qinglei[1], Feng xiaojie[1], Xi guocheng[1], and Zhen Wenchao[2, 3]

[1] Cangzhou academy of agricultural and foresty sciences, Cangzhou 061001, China
[2] College of Plant Protection, Agricultural University of Hebei, Baoding 071001, China
[3] Research Center for Biocontrol Techniques against Pests on Crops of Hebei Province, Baoding 071001, China

From 2005 to 2007, the number and spatial distribution pattern of over-winter eggs of *Lygus lucortum* Meyer Dur were investigated in jujube orchards under different management level. Results showed that the amount of over-winter eggs of *L. lucortum* Meyer Dur was large, and the eggs were laid in the residual piles, the top of mother spurs of jujube, and the dead mother spurs in the jujube orchard under careless management. On the contrary, the amount of over-winter eggs in the fine management orchard was much smaller, and the eggs were laid on the residual piles or the dead mother spurs on the top of secondary branches. In mid May, ecological environment directly affected the spatial distribution of the first generation of nymphs. If there were more weeds such as amaranthus color Chenopodium album and hedgerow under the trees, then more eggs were laid on weeds, and only a

small amount of eggs were laid on the trees. On the contrary, if there were few weeds under the trees, the eggs amount of *L. lucortum* Meyer Dur on the trees would be larger. The reasonable retaining of the ground surface covered, planting cover crops, or increasing weed amount can reduce the number of the first generation of nymphs and reduce the hazard rate accordingly.

**Corresponding author：Zhen Wenchao; Phone: +86-312-7528158; E-mail:wenchao@hebau.edu.cn*

S-08-09
Status of Diseases on Ber (*Ziziphus mauritiana* Lamarck) in India and Their Management Options

M. M. Jamadar and R.A. Balikai

University of Agricultural Sciences, Dharwad, College of Agriculture & Regional Agricultural Research Station, Bijapur – 586 101, Karnataka, India

Ber is a drought tolerant, poor mans' fruit crop known for its nutritive value and low price. However, it is affected by many serious diseases like powdery mildew, sooty mold, leaf spots (*Alternaria*, *Cercospora*, *Septoria*, *Cladosporium*, *Pestalotiopsis* etc.,) and rust among fungal infections and witches' broom by phytoplasma.

Powdery mildew (*Oidium erysiphoides* var *zizyphi* Yen & Wang) is economically important disease, which results in 50-60 per cent loss in fruit yield and reduces market value of the produce. The disease is known to be severe in early pruned crop (April first fortnight) and generally favoured by rainfall, warm humid conditions preceding to its appearance on fruits during September to December. The disease can be effectively managed by alternate sprays of triadimefon @ 0.1% followed by wettable sulphur @ 0.3% at an interval of 12-15 days. Among many genotypes, Jogia and Mundia were found resistant while, popular cultivar Umran was highly susceptible and another cultivar Kadaka was moderately resistant to powdery mildew.

Among the other diseases, sooty mould caused by *Isariopsis indica* var. *zizyphi* (Gupta & Madaan) that causes sooty/ black spots on leaf surface covering large area of leaves, often resulting in defoliation and reduced yields. The leaf spots caused by *Cercospora zizyphi* Petch. and *C. jujube* (Chowdhury) cause circular oval spots on the leaves whereas *Alternaria chartarum* Preuss forms small irregular brown spots resulting in defoliation. These diseases can be managed by carbendazin @ 0.2% spray. The rust (*Phakopsora zizyphi-vulgaris* Diet.) causes small irregular reddish brown pustules covering entire leaves resulting in drying and defoliation. The disease can be managed by spraying mancozeb @ 0.2% or zineb @ 0.2% or wettable sulphur @ 0.3%. Witches' broom, a phytoplasma disease causes phyllody of plants producing auxiliary bud proliferation giving bushy appearance and transmitted through grafting.

**Corresponding author: M.M. Jamadar; Fax: +918352267194; email: mm_jamadar@rediffmail.com*

S-08-10
Forecasting of Powdery Mildew Disease Incidence on Ber(*Ziziphus mauriana* Lam.) Based on Weather

M. M. Jamadar, H. Venkatesh, D.R. Patil and R.A. Balikai

University of Agricultural Sciences, Dharwad, College of Agriculture & Regional Agricultural Research Station, Bijapur – 586 101, Karnataka, India

Ber, a drought tolerant hardy arid fruit crop cultivated in the northern dry zone of Karnataka, India suffers severe yield losses due to infection by powdery mildew disease. Field experiments were carried out during 1997-2002 on two ber cultivars, namely, Umran and Kadaka, to understand the role

of weather on the incidence of the disease. Different growing environments were provided by pruning the trees on different dates between mid April and mid May. The results indicated that, cv. Umran was more susceptible than cv. Kadaka to the disease. The disease incidence was significantly high on the early pruned (Middle of April) ber trees compared to the later pruned ones. The forecastability of the disease was evaluated by using the meteorological data of the antecedent lead times of one to four weeks. For disease incidence in September, November and December months, the role of maximum temperature and afternoon relative humidity was important, whereas rainfall showed dominating influence for forecast of the disease. Further, the analysis revealed that, the lead time for forecast of disease in September was three to four weeks, whereas it was three weeks in October, one week in November and three weeks in December. Again, the dependent meteorological variables were afternoon relative humidity, rainfall, maximum temperature and afternoon relative humidity respectively for the four months. Importance of the rainfall march during the canopy as well as disease growth is ascribed as the main reason for importance of different sensitive variables in different months. Graphical presentations are made to indicate the limits of maximum temperature and afternoon relative humidity to detect the sensitive limits of the two parameters for high incidence (>60%) of powdery mildew disease on ber during the four months. Appropriate regression models were developed to forecast disease incidence in different months.

**Corresponding author: M.M. Jamadar, Fax: +918352267194;e-mail: mm_jamadar@rediffmail.com*

S-08-11
Studies on Parasitism of Fopius Carpomyie (Silvestri) (Hymenoptera: Braconidae) an Egg-pupal Parasitoid of Ber Fruit Fly, *Carpomyia vesuviana* Costa (Diptera: Tephritidae) in Bushehr – Iran

Nasser Farrar[1], Mohammad Hasan Assareh[2], Hasan Askari[2] and Reza Golestane[2]

[1] *Agricultural and Natural Resources Research Center, Bushehr- Iran*
[2] *Research Institute of Forests and Rangelands*

Fopius carpomyie (Silvestri) belonging to family Braconidae and subfamily Opiinae is an egg-pupal parasitoid of ber fruit fly, *Carpomyia vesuviana* Costa which is a key pest of several species of genera "*Ziziphus*" in the south Iran. In accordance with special status of the natural disperse of jungles and agronomic–horticultural development of *Ziziphus* spp. in southern province, use of chemical control against this pest is not applicable. In this investigation, eggs, different larval stages and pupae of ber fruit fly were collected from natural areas for evaluation of parasitism potential of this parasitoid. Each of the stages was counted and allowed to grow separately into the Petri dishes that contained soft soil with enough aeration. The parasitism percentage was evaluated monthly. Some parasitic behaviors were studied by direct observation on establishing wasps on the non infested and infested ber fruits in experimental tubes. Also, the search and finding behavior of the wasps were conducted in a complete randomized design with five replications, with four treatments (1. Wasp sitting on non-infested fruit, 2. Just wasp going towards non-infested fruit, 3. Wasp sitting and searching on infested fruit, and 4. Just wasp going towards infested fruit) and carried out for three years by using an alfactometer system. The observations and statistical experiments showed that, at first female wasps attracted towards fruits infested with eggs or larvae of fruit fly, by using some chemicals, which were probably released on ber fruits at the time of oviposition by fly. The female wasp started to move for searching, found larvae and eggs on the fruits by using probable chemical materials (odor) and antennal searching, then released and established only one egg into the host body after digging a hole under fruit skin. The parasitoid emerged from puparium of host fly after its complete development by killing the host. The statistical data showed differences in parasitism potential of this wasp during different

months of the year. The mean percentage of parasitization in the Samal zone and Tangestan area of Bushehr province was estimated to be 24% over three years' period.

*Corresponding author: Nasser Farrar; Fax: +98 771 2526813; e-mail: farrar29@yahoo.com

S-08-12
Status of Arthropod Pests on *Ziziphus spp*. in South Iran

Nasser Farrar[1], Mohammad Hasan Assareh[2], Ebrahim Sadeghi[2] and Sayed Mosa Sadeghi[1]

[1] *Agricultural and Natural Resources Research Center, Bushehr- Iran*
[2] *Research Institute of Forests and Rangelands,Iran*

Ziziphus spp. is the important plant species in South Iran. The Arthropod fauna of *Ziziphus* spp. (*Ziziphus spina-christi* (L.), *Z. nummularia* (Burm.f.) Wight & Arn., *Z. mauritiana* Lam. and *Z. lotus* (L.) Lam.) were studied during 2001-2007 at different areas in south Iran. The insects were collected with net traps, optic traps, aspirator and direct method, and the parasitoids were also collected from its hosts by rearing in the laboratory. The results showed that, there were 28 insects and 3 mites that damaged different parts of the trees. Among them the ber fruit fly, *Carpomya vesuviana* Costa was the most destructive pest on *Ziziphus* spp. in Iran. *Thiacidas postica* Walker, *Alicidodes* sp. and *Larvacarus transitans* (Ewing) were important pests, while *Tarucus rosaceus* (Austaut), *Streblote (Taragama) siva* Lef., *Plodia interpunctella* (Hubner), *Bactrocera zanatus* (Saunders), *Eriophes cernus* Nal, *Eutetranychus orientalis* (Klein) and *Aleurotrachelus alhagi* Priesner & Hosny were the occasional pests. *Alidodes* sp., as pest of seed and thrips, *Dolicholepta micrura* (Bagnall) were reported for the first time from Iran. Two natural enemies *viz.*, *Pales murina* Mes. (Tachinidae: Diptera), a larval parasitoid on *T. postica* and *Fopius carpomyie* (Silvestri) (Braconidae: Hymenoptera), an egg-pupal parasitoid of ber fruit fly, *C. vesuviana* were also recorded.

*Corresponding author: Nasser Farrar; Fax: +98 771 2526813; e-mail: farrar29@yahoo.com

S-08-13
Insect Pest Status of Ber (*Ziziphus mauritiana* Lamarck) in India and Their Management Strategies

R.A. Balikai

University of Agricultural Sciences, Dharwad, Regional Agricultural Research Station, Bijapur-586 101, Karnataka, India

Though as many as 130 species of insect pests have been recorded in India, only few species have attained the pest status and cause substantial economic damage to ber. However, a total of 22 insect and non-insect pests feeding on ber were recoded from the extensive ber growing districts of Karnataka state. Out of these, thee insects *viz*., Ber fruit borer, *Meridarchis scyrodes* Meyrick and two species of Ber fruit flies, *Carpomyia vesuviana* Costa and *Dacus correctus* (Bezzi) were recorded as major pests on this crop with infestation varying from high to very high degree, whereas five insects (Grape mealy bug, *Maconellicoccus hirsutus* (Green); Ber mealy bug, *Perissopneumon tamarindus* (Green); Ber fruit weevil, *Aubeus himalayanus* Voss; Castor semilooper, *Achaea janata* Linn. and Snail, *Cryptozona semirugata* (Beck)) were recorded as moderate pests. As many as nine insect pests *viz*., Cow bug, *Tricentrus bicolor*; Thrips, *Scirtothrips dorsalis* (Hood); Longicorn beetle, *Celeosterna scabrator* Fabricius; Gray weevil, *Myllocerus discolor* (Boheman); Spiny beetle, *Platypriya andrewesi* Weise; Hairy caterpillar, *Thiacidas postica* Walker; Tassar silk moth, *Anthearea paphia* Linnaeus; Tobacco caterpillar, *Spodoptera litura* (Fabricius) and Eriophyid mite, *Eriophyes*

cernus Massee were recorded as minor pests on this crop. Five insect pests including Green striped leaf hopper, *Eurybrachys tomentesa* Fab.; Jassid, *Amrasca biguttula biguttula* (Ishida); Spittle bug, *Machaerota planitiae* Distant; Lac insect, *Laccifer lacca* Kerr. and Ber butterfly, *Tarucus theophrastus* (Fabricius) were recorded as negligible pests. Various management practices for these pests are discussed in this paper.

**Corresponding author: R.A. Balikai; Fax: +918352267194; email: rabalikai@gmail.com*

S-08-14
Seasonal Occurrence of Ber Fruit Weevil, Aubeus Himalayanus Voss in India

R.A. Balikai

University of Agricultural Sciences, Dharwad, Regional Agricultural Research Station, Bijapur-586 101, Karnataka, India

Ber (*Ziziphus mauritiana* Lamarck) is one of the fruit crops in India. Ber fruit weevil, *Aubeus himalayanus* Voss (Curculionidae: Coleoptera) was recorded as a new pest of ber for the first time from Karnataka state of India in 1993. During July-August of 1993 and 1994, some abnormal fruits (5-10%) were noticed in the ber orchards with cultivar Umran. When such fruits were cut open, the developing seed was completely eaten away by the pest. In the hollowed area, each of these fruits had a grub, a pupa or an adult which was identified as ber seed weevil. The infested fruits were round in shape and varied in size ranging from pea to pebble. They had abnormally enlarged calyx and adhered to the fruit in such a way that nearly half portion of the fruit towards petiole turned to reddish brown with rough surface and the remaining half portion towards navel region with greenish color. The fruits did not attain maturity and never increased in size more than pebble. This is because of the fact that the pest fed only on the seed portion of developing fruit and arrested further development of attacked fruit. Since it was a new pest, its seasonal incidence was not known. Seasonal occurrence of the pest studied over two seasons indicated that only one peak was observed during July-August months.

**Corresponding author: R.A. Balikai; Fax: +918352267194; email: rabalikai@gmail.com*

S-08-15
Epidemiological Studies on Powdery Mildew of Ber

Ram Gopal Jat and Shashi Kant Goyal

Dept. of Horticulture, Rajasthan Agricultural University, S. K. N. College of Agriculture, Jobner 303 329, Rajasthan, India

Ber (*Ziziphus mauritiana* Lamk.) is an ancient and poor man fruit crop grown in semi arid and arid regions of India and other few countries. The powdery mildew of ber incited by *Oidium erysiphoidae* f. sp ziziphi (*Microsphaera alphitoides* f.sp. *ziziphi*) is a major disease in ber growing areas in India, causing great loss in productivity and quality of fruits. To know the effect of different abiotic factors on the development of the disease, a field experiment was conducted during 1993 to 2000 on susceptible ber cultivars 'Jogia' at Horticulture farm of the SKN college of Agriculture, Jobner. On the basis of seven years data on epidemiology of ber powdery mildew, it was observed that the disease initiation took place at 39-46 meteorological weeks. At this period the average maximum and minimum temperature 32 ^{0}C and 13.8 ^{0}C, average morning and evening relative humidity 75.8 % and 41.42 % and average rainfall 4.04 mm, respectively was noted. The peak percent disease index (PDI) was recorded in December. At this period the average maximum and minimum temperature 24.68 ^{0}C and 4.85 ^{0}C, average morning and evening relative humidity 82.75 % and 35.71 %, respectively was

observed. Temperature had significant and humidity had non- significant correlation with PDI. Matrix studies indicated that there was a significant relation between PDI and temperature. It was also found that the correlation coefficient of determination (R^2) = 0.1269 for abiotic factors taken was able to explain the variation in the ber powdery mildew PDI to the extent of 12.29 percent.

Corresponding author: Ram Gopal Jat: Fax +911425 254022, e-mail: rgj.53@gmail.com

S-08-16
Control Effect and Application Technology of Different Kinds of Insecticides to Lygus lucorum Meyer-Dür

XJ Li, K Fan, Y Zhang, T Wang, and B Qi

Shandong Institute of Pomology, Taian Shandong

Lygus lucorum Meyer-Dür is one of the major pests in Chinese jujube. A field experiment was conducted on control Lygus lucorum Meyer-Dür with 18 insecticides. The results showed that cypermethrin, beta cyfluthrin, fipronil, naled, chlorpyrifos,methidathion, triazophos, methomyl, and carbosulfan had preferable effect sprayed once 5 days between bud breaking and bloomimg stage. Cypermethrin, beta cyfluthrin, and fipronil were safer than other insecticides and had no influence on fruit-set if sprayed at bloomimg and fruitlet stage. Other insecticides were not suitable sprayed at blooming, fruitlet, and late growth stage.

Corresponding author: XJ Li; Fax: +86-538-8266651; e-mail: zbs@sdip.cn

S-08-17
Genetic Diversity Analysis of 23 Strains of *Ziziphus jujuba* Mill. cv Junzao with Different Resistance to Jujube Witches' Broom Disease

Yong Qiao[1], Jin Zhao[1], Yanrong Yang[2] and Mengjun Liu[2]

[1] *College of Life Science, Agricultural University of Hebei, Baoding 071000,China；*

[2] *Research Center of Chinese jujube, Agricultural University of Hebei, Baoding 071001,China*

Jujube witches' broom disease (JWB), a destructive disease in production, is almost spread all the cultivated area of jujube. Most cultivars of Chinese jujube are sensitive to JWB. In the former study, we had found that the different strains of same cultivar had different resistance to JWB. During 2006-2007, 23 strains of Junzao were grafting on the diseased jujube trees, according to investigating in field there were 6 strains with high-resistance to JWB, 12 strains with middle-resistance to JWB and 5 strains with no-resistance to JWB. At the same time, the 23 strains had been employed to study by AFLP in this paper. 104 polymorphic bands were screened out by using 47 pair primers. Among them, 3 bands were related to the resistance of JWB, 2 bands were related to the sensitive of JWB. The result showed that there are difference on morphologic and genome among the different strains of same cultivar. Those result could provided academic evidence to further breeding.

Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@hebau.edu.cn

S-08-18
Study on the Symptom, Harm, and the Key Factor for Epidemic of Black-spot Disease in *Ziziphus jujuba* Mill. cv. Dongzao

Zhen Wenchao [1,2], Liu Chunqin [3], and Wang Shutong [1,2]

[1] *College of Plant Protection, Agricultural University of Hebei, Baoding 071001, China;*
[2] *Research Center for Biocontrol Techniques against Pests on Crops of Hebei Province, Baoding 071001, China;*
[3] *Cangzhou academy of agricultural and forestry sciences, Cangzhou 061001, China.*

Black-spot disease was reported recently occurring in *Ziziphus jujuba* Mill. cv. Dongzao at Hebei and Shandong province in China. Serious yield loss caused by black-spot disease was reported. From 2004 to 2007, the symptom, harm, and the key factor for the epidemic were surveyed in 10 counties or cities of Hebei and Shandong province. The result showed that black-spot disease mainly occurred on fruits of *Ziziphus jujuba* Mill. cv. Dongzao, and the symptom appeared from the last ten day of June to the first ten day of July. Beige irregular spots first appeared on the surface of the fruits, and then developed to dark round or elliptical lesion with clear or unclear border. The lesions limited at the surface of the fruits while not going into the sarcocarp, and the lesion could be cupped or flat. Some small black spots (pycnidium) appeared above or under the surface of some lesions. Black-spot disease developed to the top during the last ten-day of July or the first ten-day of August, and developed into decline phase in the first ten-day of September. Black-spot disease occurred widely at the 10 counties investigated during 2004 to 2007. The most serious diseased orchards were found at Cangxian county in 2006 and at Botou city in 2007. The disease ratio and disease index in Cangxian (2006) were 45.8% and 51.2, while the disease ratio and disease index in Botou (2007) were 48.1% and 54.9, respectively. Incubation period of black spot disease was investigated during 2004 and 2007 at Hejian and Botou city, Hebei province. Combining with the weather condition of the same period as the disease occurred, disease temporal dynamic of epidemic was analyzed. Rainfall and the period of relative humid above 90% were reasonably the key factor of the epidemic of black-spot disease of *Ziziphus jujuba* Mill. cv. Dongzao.

**Corresponding author：Zhen Wenchao; e-mail: wenchao@hebau.edu.cn*

S-08-19
Resistant Abilities to Thick Rotten Disease in Two Genotypes of *Ziziphus jujuba* Mill. cv. Jinsixiaozao

Zhen Wenchao[1, 2], Liu Chunqin[3], Wang Qinglei[3], Feng Xiaojie[3], and Xi Guocheng[3]

[1.] *College of Plant Protection, Agricultural University of Hebei, Baoding 071001, China;*
[2.] *Research Center for Biocontrol Techniques against Pests on Crops of Hebei Province, Baoding 071001, China;*
[3.] *Cangzhou academy of agricultural and foresty sciences, Cangzhou 061001, China.*

Thick rotten disease is one of the most serious diseases in *Ziziphus jujuba* Mill. cv. jinsixiaozao in Northern China. Yield loss caused by the disease became more and more serious in recent years. According to our investigation from 1998 to 2005, different genotypes of *Z. jujuba* Mill. cv. jinsixiaozao showed significant difference in resistance to thick rotten disease. The average disease ratio of susceptible genotypes was 38.2%, and the average disease index was 20.7. While the average disease ratio and the average disease index of resistant genotypes were 4.4% and 1.4, respectively. By injury inoculation and non-injury inoculation, the average disease ratio and the average disease index of resistant genotypes were lower than that of the susceptible genotypes both in field and laboratory

condition. The average disease ratio and the average disease index of resistant and susceptible genotypes of injury inoculation in laboratory were 90%, 76.8 and 100%, 100, while that of non-injury inoculation were 55%, 20.2 and 100%, 92.7, respectively. In the field trial, the average disease ratio and the average disease index of resistant and susceptible genotypes by injury inoculation and non-injury inoculation were 60%, 32.7; 100%, 98.6; 5%, 2, and 95%, 87.2, respectively. The resistant genotypes had thicker fruit peel, fewer lenticels of unit area, and less percentage of big lenticels than that of the susceptible genotypes.

**Corresponding author：Zhen Wenchao; e-mail: wenchao@hebau.edu.cn*

Nutrition and Utilization

S-09-01
Study on the Contents of Triterpenic Acid and Flavonoids in Jujubes of Different Cultivars in Different Growing Periods at Different Positions

AL Zhao , DK Li ,YK Wang, , CL Sui, , XM Du

Pomology Institute, Shanxi Academy of Agricultural Sciences, Taigu 030815, Shanxi, China

Jujube is an important tree species originated from China. Its fruit is rich in nutrition and has various types of bio-active substances, such as triterpenic acid and flavonoids that have a wide pharmacological effect on humans.
In this research, 24 quality jujube cultivars are studied, and samples of fruit skin, flesh, leaves and stems of these jujubes at white-maturing, crisp-maturing and complete-maturing stages were collected. The contents of triterpenic acid and flavonoids in the samples was tested and analyzed by the method of colorimetry.
The result showed (1) there's an extremely distinct difference in the content of triterpenic acid and flavones among different cultivars. For example, the content of triterpenic acid in Yunchengxiangzao jujubes can reach 10.85mg/g, but it's only 2.63 mg/g in Puyanghetaowen jujubes; Taigushenglizao jujubes have a highest content of flavones (24.38 mg/g), while it is only 7.53 mg/g in Jiaochengjunzao jujubes; (2) there was an very significant or significant difference In the contents of triterpenic acid and flavonoids among cultivars at different growing stages. The highest content of triterpenic acid in jujubes was at complete-maturing stage, while the lowest was at white-maturing stage. The change in the contents of flavones was reversed; (3) there was an very significant difference in the contents of triterpenic acid and flavones in different positions. The highest content of triterpenic acid was in the flesh, which could be 8.31mg/g, followed by skin and leaves with the lowest content in stems, which is only 1.13 mg/g. The highest content of flavones was in the skin (23.49 mg/g), followed by leaves and stems, with the lowest content in flesh(2.04 mg/g).
After two years research, quality cultivars with higher contents of triterpenic acid and flavonoids were selected. The highest content of triterpenic acid was in the flesh of complete-maturing jujubes, while the highest content of flavones was in the skin of white-maturing jujubes. Therefore, the developing and utilizing bio-active substances in jujubes are feasible.

**Corresponding author:Dengke Li; e-mail: ldkzao@yahoo.com.cn*

S-09-02
Ziziphus a Naturally Endowed Plant as a Feed for Small Ruminants in Semi-arid Regions

Bandla Srinivas[1] and Ravindra Kumar[2]

[1]Central Sheep and Wool Research Institute, Avikanagar 304501, India
[2] 325--Krishi Anusandhan Bhavan-I, Indian Council of Agricultural Research, New Delhi 110012, India

Zizyphus is a drought resistant and dependable source of feed for livestock, particularly for small ruminants in semiarid regions. It is rich in soluble carbohydrates, proteins and minerals. It is indeed a treasury of secondary plant metabolites that may induce positive impact on the health but, condensed

tannins present in it may adversely affect protein utilization to certain extent. It contained 13, 17 and 70 % of essential, semi-essential and non-essential amino acids, respectively. Thus, making it a good source of digestible CP (5%), total digestible nutrients (62%) with a very optimum nutritive value of 7. Condensed tannins present in *Zizyphus* may to certain extent hamper protein utilization but tannin binding proteins present in the saliva of small ruminants may work as defensive mechanism. A variety of saponins have been identified in the *Zizyphus* however, these reported to have beneficial effect on the health management. Exceptional to little incriminating affect of secondary plant metabolites present in Zizypus, the nutritive value index of 68% indicate that it is a good potential to use as feed supplement for small ruminants with a good comparison to cultivated fodders.

**Corresponding author: Ravindra Kumar*

S-09-03
Sensory Evaluation of Different Product of *Ziziphus Jujuba* Mill.

B. Krška, S. Mishra

Department of Pomology, Faculty of Horticulture in Lednice
Mendel University of Agriculture and Forestry in Brno
Czech Republic

The Chinese jujube (*Ziziphus jujuba* Mill.) is a drupe, varying from round to elongate and from cherry-size to plum size depending on cultivars. Chinese jujube fruits contain 20–28% sugars, 0.3–2.5% acids, 2.9% protein, 500–600 mg/100 g vitamin C and minerals such as Fe, P, Ca, etc. Chinese jujube fruits are eaten fresh, dried or processed, as "Chinese dates" which have been included in confectionery recipes such as Graham bread, cake, candy, compote, seraph etc. As with fresh horticultural commodities, it is important to establish quality standards and to ensure their fulfillment through the use of a quality assurance program at the processing facility. Therefore, this investigation was carried out to evaluate different product of *Ziziphus jujuba* Mill. on the basis of sensory evaluation.

The present investigation on sensory evaluation of different products of *Ziziphus jujuba Mill*. was carried out at postharvest technology laboratory of the Department of Pomology in Lednice, Mendel University of Agriculture and Forestry in Brno, during 2007 – 2008. Seven different products of jujube were used for evaluation. Processed fruits and different ways of processing like cloying of jujube fruits with honey (½ green - ½ brown and full brown), preservation in jujube fruits in sweet sour infusion vinegar (½ green - ½ brown and full brown), conservation of jujube fruit in sweet infusion like Compot (cultivars and seedlings) and dry jujube fruits. These processed products evaluated on the basis of appearance, aroma, consistency, taste and overall acceptability by a panel of 11 judges by Hedonic Rating Test (0 - 10 scale and averaged)

The Compot (cultivar) scored highest value (204) on the basis of hedonic scale (1-5) in 2007 followed by cloying with Honey (½ green and ½ brown) having the score value of 195.The least score (153) was with sweet sour infusion vinegar **(**½ green and ½ brown). In 2008 the experiment was repeated; in which maximum hedonic score (367.5) on 1-10 scale was found to be associated with cloying with Honey (full brown) followed by both Compot (cultivar) and compot (seedling). The minimum score (285) was found with sweet sour infusion vinegar **(**½ green and ½ brown).

On the basis of average hedonic score value, the maximum score (279.5) was with Compot (**cultivar**) followed by cloying with Honey (full brown) where as least score was again with sweet sour infusion vinegar (½ green and ½ brown). Therefore it was concluded from the investigation that the jujube product Compot (cultivar) is the best.

Two years evaluation on different products of jujube for improving quality standard and evaluating processed products of jujube has given good result. Compot (cultivar) is the best product of jujube. Jujube with vinegar (½ green - ½ brown) gave poor results.

******Corresponding author: Boris Krska; Fax: +420519367222; e-mail: krska@zf.mendelu.cz*

S-09-04
Effect of Ultra High Pressure on Polyphenoloxidase of Jujube Fruit

Guangyuan. Zhao*, Qingping Xu

School of Food and Biological Engineering, Zhengzhou University of Light Industry, Zhengzhou , 450002, China

Jujube juice was a kind of natural fruit drinking beverage with rich nutrition. But polyphenoloxidase (PPO) could cause the browning of juice during the processing and storage. Ultra-high Pressure (UHP) was an alternative potential nonthermal preservation method for pasteurization of food products. So, in this paper the effects of ultra high pressure (UHP) treatment on the activity of polyphenoloxidase under different conditions were studied. Polyphenoloxidase was extracted from jujube fruit. The ectracted polyphenoloxidase was ultra-high pressured alone or combined with heating, and then the activity of polyphenoloxidase was assayed. As the pressure used increased, the activity of PPO reduced slowly during the pressure scope from 200MPa to 500MPa and the effect of pressure on activity was insignificant when the pressure reached 300 MPa. Effect of pressure on inactivation of PPO became remarkable when pressure rose above 600 MPa. PPO added vitamin C was activated when pressure got below 500 MPa and was inactivated when pressure reached above 600 MPa or combined with heating. The activity of PPO decreased step by step with the increasing of heating temperature and pressure holding time. The treatment of 400MPa above 50℃ could inactivate PPO by 63% activity and for 750 MPa above 50℃ by more than 92% activity. UHP above 600 Mpa or combined with 50℃ could inactivate PPO in jujube fruit and could be potential for pasteurization of jujube juice or jujube fruit.

**Corresponding author:Guangyuan Zhao; Fax: +86 371 63556627; e-mail: guangyuan-zhao@163.com*

S-09-05
Study on the Synthesis of Jujube Polysaccharide-Fe(III) Complex(JPC)

Hua Wang , Chunni Tang , Jun Fan

Department of chemical engineering Northwest University, Xi'an , 710069, China

The aim of this work was to synthesize Jujube Polysaccharide–Fe(Ⅲ) Complex, which was useful in the treatment of iron deficiency anaemia.

Jujube Polysaccharide–Fe(Ⅲ) Complex(JPC) was obtained by the reaction of Jujube polysaccharide with ferric chloride under the alkaline condition. And the saturated sodium carbonate solution was used as buffer solution in the reaction. The polysaccharide was extracted from Chinese Jujube with hot water. The content of Fe(Ⅲ) was characterized by UV with the color reagent of o–phenanthroline and atomic absorption spectrophotometry. And the general chemical property was also studied.

JPC, a kind of water-soluble polysaccharide iron complex, showed an excellent stability at the pH values from 3 to 12. Jujube Polysaccharide was able to combine with complex Fe (Ⅲ). And the study proved that Fe(Ⅲ) can be deoxidized to Fe(Ⅱ) in the presence of ascorbic acid. The content of Fe(Ⅲ) in JPC is 20.34％ by the method of UV and 20.26％ by the method of atomic absorption spectrophotometry. The complex characterized of FT-IR has been found to have the structure of β–FeOOH.

These results suggest the potential employment of the complex in the oral treatment of iron deficiency anaemia or as supplement of iron in foods.

**Corresponding author:Jun Fan; e-mail: fanjun@nwu.edu.cn*

S-09-06
Extraction and Separation of Oligosaccharides from *Ziziphus Jujuba* Fruits

Meifeng Jiang, Qinbao Lin *

The Institute of Applied Chemistry, Shanxi University, Taiyuan, 030006, China

Ziziphus jujuba as a native plant of China belongs to the genus *Ziziphus* (Rhamnaceae) and is widely distributed in China. China shared over 90% of Chinese jujube production and its production has increased in the last ten years due to demand in the food and pharmaceutical industries. Recently, oligosaccharides extracted from plants have drawn the attention of researchers. However, few researches have been carried out extraction and separation of oligosaccharides from Chinese jujube fruits.

In this study, response surface methodology (RSM) was employed to optimize the extraction conditions. Ultrafiltration was used to purify oligosaccharides. Ultrafiltration of the solution was studied with commercial membranes of molecular weight cut-off (MWCO) of 50 kDa and 800Da, which removed the large molecular (polysaccharides and protein) and the small molecular (monosaccharide) respectively in order to obtain the crude oligosaccharides. Through classifying the crude oligosaccharides by sephadex-G15, component Ⅰand Ⅱ were obtained. Component Ⅰwas oligosaccharide and component Ⅱ was monosaccharide. Molecular weight of oligosaccharides was assayed by HPLC.

The results of RSM indicated optimum extraction conditions. The result of ultrafiltration showed that crude polysaccharides(MW＞50kDa) block rate was 2.77%, crude oligosaccharides(800Da＜MW＜50kDa＝ block rate was 0.63%, and the monosaccharide(MW＜800Da＝ permeation rate was 79.03%. The crude oligosaccharides were further purified by sephadex-G15 and assayed by HPLC, and the molecular weight of oligosaccharides was 3951.

**Corresponding author.:Qinbao Lin,e-mail Address: qblin@sxu.edu.cn*

S-09-07
Study on Technology of Extraction and Isolation Total Triterpene Acids from the Jujube

Pu Guo[1], Jun Fan[1], Xuchun Gao[2]

[1] Department of chemical engineering Northwest University, Xi'an , 710069, China
[2] Department of Chemistry Yulin college , Yulin, 719000, China

Study extraction method of total triterpene acid from the jujube.

The process of extraction and isolation was primarily studied. Ethanol was used to extract total triterpene acid, and then ethanol elution was treated with acid and alkaline orderly. Absorption spectrophotometry was used to determine the content of total triterpene acid in the product, which used ursolic acid as comparison substances, and used Vanillin, ice acetic acid and perchloric acid to show color. By making the yield ratio and the content of total triterpene acid from the jujube as index, the influencing factors for extraction of total triterpene acid from the jujube was studied, such as the concentrations of extractive solvent and the dosage of acid.

According to the conditions, the yield ratio of total triterpene acids from the jujube is up to 0.508%，and the content is 55.41%.

The process is simple and feasible; Absorption spectrophotometry method is proved to be a simple and reliable method.

**Corresponding author:Jun Fan; e-mail: fanjun@nwu.edu.cn*

S-09-08
The Nutrition and Physico-chemical Properties of Ripe(*Ziziphus Jujuba*) Fruits Grown in Istria

R. Vidrih[1], N. Poklar Ulrih[1], Ž. Prgomet[2], E. Zlatić[1], J.Hribar[1]

[1] *Biotechnical faculty, Dep. of Food Science and Technology, Jamnikarjeva 101, 1000 Ljubljana, Slovenia*
[2] *Polytechnic of Rijeka, Department of Agriculture, Trpimirova 2/5, Croatia*

Ziziphus jujuba is a plant growing wildly in Istria (Slovenia, Croatia). It is mostly known as an ornamental plant. Fruits are used for nutritional purposes, mostly in their fresh form or dried like dates. In our study the nutritional and physico-chemical properties of ripe *Ziziphus jujube* fruits from Istria were determined including water content, fibres, proteins, sugars, total fat, soluble solids, vitamin C, organic acids, total phenols, ash, minerals and fatty acids in seeds. Ripe *Ziziphus jujuba* fruits contain 42.25 % water and 44.0 % soluble solids. Mesocarp contains, on dry matter basis, 36.5.0 % glucose, 33.4 % fructose, 0.22 % sucrose, 83.8 mg/100 g ascorbic acid and 39.4 mg/100 g dehydroascorbic acid. We have also found that mesocarp contains 1.1 % proteins, .0.73 % total phenols, 1.7 % of ash, 12.4 % of insoluble and 6.7 % of soluble fibres. *Jujube* seeds contain 2.5 % of total fat.

**Corresponding author: R. Vidrih; Fax: +386 1 2566296; e-mail: rajko.vidrih@bf.uni-lj.si*

S-09-09
The Chemical Constituents of *Zizyphus jujuba*

SHAIKH SIRAJUDDIN NIZAMI & SUMAYYA SAIED

Department of Chemistry, University of Karachi-75270-Pakistan

Zizyphus jujuba, Lamack, belonging to family Rahmnaceae and commonly known as 'Unab' is a cultivated deciduous tree growing upto 12 m in height. Different parts of this plant have been used in indigenous system of medicine. Earlier we had reported amino acids and sugars from the aqueous extract of the fruits of *Zizyphus jujuba*.
The present paper describes the physical characteristics of the oil and quantitative analysis of the fatty of the oil obtained from the fruit of this plant. In addition to this a new saponin is also isolated from the fruit of this plant. The structure of the isolated compound is confirmed on the basis of chemical and its spectroscopic data together with the comparison of the published data.

**Corresponding author: SHAIKH SIRAJUDDIN NIZAMI , email:sh_nizami@yahoo.com*

S-09-10
Phytochemical and Anti- Dandruff Studies on *Zizyphus vulgaris* Roots

S.H. Ansari*, Sarfaraz Ahmad, Deepika Bhatt and M.U. Khan

Herbal Cosmetics and Immunomodulator Laboratory
Department of Pharmacognosy & Phytochemistry
Faculty of Pharmacy, Jamia Hamdard (Hamdard University)New Delhi- 110062 (INDIA)

Zizyphus vulgaris Mill (roots), commonly known as Jujube, (Family Rhamnaceae), are mainly cultivated in China and in Himalayan range upto 6500 ft. It is small deciduous tree upto 12 m in height

and contains protein, fat, fibre, reducing sugars, citric acid, pectin and high amounts of carotene. Medicinally, it is used as anti-diabetic, demulcent, expectorant, in constipation and in fever etc. The roots of *Zizyphus* have been investigated phytochemically and antidandruff activities have been reported in the present studies. The drug was extracted with chloroform and subjected to phytochemical screening showing prescence of alkaloids, carbohydrates, phenolic compounds, proteins and amino acids, saponins, sterols etc. Four compounds namely, β-sitosterol, Zizypuluphenone, Zizypursanoic acid and Zizyphulupenoic acid, were isolated using column chromatography. The alcoholic extract of drug was further subjected to antifungal activity on two strains viz, *Candida albicans* and *Candida tropicallis*, common dandruff causing fungi, taking Nystatin as standard. The significant antifungal activity was reported. Thus, the roots of *Zizyphus* can be used as one of the constituent of antidandruff herbal shampoos.

**Corresponding Author:S.H. Ansari ;Fax. : 00-91-11-26059663, e-mail: shansari189@rediffmail.com*

S-09-11
Antioxidant Capacity and Phenolic Content of Selected Jujube (*Ziziphus jujuba* Mill.) Genotypes

Wang Qinglei[1], Liu Chunqin[1], Feng xiaojie[1], Xi guocheng[1], Zhen Wenchao[2, 3]

[1.] Cangzhou academy of agricultural and foresty sciences, Cangzhou 061001, China.
[2.] College of Plant Protection, Agricultural University of Hebei, Baoding 071001, China;
[3.] Research Center for Biocontrol Techniques against Pests on Crops of Hebei Province, Baoding 071001, China;

Antioxidant capacity and phenolic content are important indicators to evaluate the quality of fruits. In this paper seven Jujube cultivars for fresh use are evaluated on their antioxidant capacity and phenolic content by the way of ABTS free-radical-scavenging and the Folin-Ciocalteu (FC) method, respectively. Meanwhile, the effect of different storage time on the antioxidant capacity and phenolic content of *Ziziphus jujuba* Mill. cv. dongzao was evaluated. The antioxidant capacity and phenolic content of different cultivars were significantly different. According to antioxidant capacity and phenolic content, *Z. jujuba* cv. dongzao showed the highest quality, while *Z. jujuba* cv. jinsixiaozao was found with poor quality on both antioxidant capacity and phenolic content. *Z. jujuba* cv. Wuhexiaozao had higher antioxidant capacity but lower phenolic content; on the contrary, *Z. jujuba* cv. Zanhuangdazao had lower antioxidant capacity but higher phenolic content. Antioxidant capacity and phenolic content of *Z. jujuba* cv. dongzao decreased after a period of storage. The antioxidant capacity of fresh *Z. jujuba* cv. dongzao was twice as much as that after 3-month storage.

******Corresponding author：Zhen Wenchao, e-mail: wenchao@hebau.edu.cn*

S-09-12
Separation and Determination of Sweetness Inhibitors from *Ziziphus Jujuba* Leaves

Yuanyuan Xue，Qinbao Lin *

Institute of Applied Chemistry, Shanxi University, Taiyuan 030006, China

China is rich in resuorces of jujube (*Ziziphus jujuba* Mill.) leaves. The research and use of jujube leaves are less reported on domestic and international literature. Separation, determination and analysis of sweetness inhibitors from the jujube leaves were studied in this paper.

The sweetness inhibitors were extracted by water extraction. Extraction temperature, the ratio of jujube leaves mass to adding water as well as extraction time were the major factors affecting extraction yield. Three factors and three-level orthogonal experiments were designed to optimize the extraction conditions. The extracts were separated by different macroporous resins, and the most effective macroporous resin was chosen. UV spectrophotometry was used to determine the contents of sweetness inhibitors at 258 nm. The determination of sweetness inhibitor compositions was completed by HPLC-UV and HPLC-MS.
The optimal extraction process was as follows: 24 times of water was added and extraction process was done at a temperature of 78 ℃ for 12 hours. Results demonstrated that the two methods of HPLC-UV and HPLC-MS were of high sensitivity, good repeatability and could be used in the rapid determination of the sweetness inhibitors in the jujube leaves.

**Corresponding author: Qinbao Lin; Fax: +86 351 7011743; e-mail:qblin@sxu.edu.cn*

S-09-13
Study on Extraction and Separation of cAMP from *Ziziphus Jujuba* Fruit

Yuemei Chang[1], Junjie Du[2]

[1] *Shanxi Forestry Academy of Sciences, Taiyuan, Shanxi, 030012, China*
[2] *Shanxi Agriculture University, Taigu, Shanxi, 030801, China*

A novel extractive method of the natural cyclic adenosine -3',5'-monophosphate (cAMP) from jujube was built up in the paper. The ultrasonic wave was used to assist in extraction of cAMP .The appropriate conditions of ultrasonic extraction were as follows: the treatment time was 30min at 60℃, the extracting power was 400w; the ultrasonic-assisted method shortened the extracting time from 6 h to 30 min compared with water soaking. The results showed that the extractive rate and efficiency of ultrasonic wave were more than those of traditional method (water soaking extraction). During the separation by ion exchange method, the time course of diluted liquid was also investigated. The volume of eluate reduced with the increase of the concentration of formic acid in water. The best concentration of formic acid was 5%. The extract of natural cAMP with high purity (no less than 98.0%) was obtained after further purifications. Retention time of HPLC and Infra-red spectrum (IR) of this extract were indistinguishable from those of the standard cAMP; and constitute of element analysis was also the same as the standard cAMP; its compositions was listed below: carbon (34.2%), hydrogen (3.9%), nitrogen (20.1%) and phosphor (9.4%).

**Corresponding author:Junjie Du Fax: +86 354 6252138; e-mail:djj738@163.com*

S-09-14
Screening of Cultivars and Organs with High Nutritional Values in Chinese Jujube

Zhihui Zhao[1], Mengjun Liu[1], Li Dai[1], Xianghong Wang[2], Yanfang Peng[1], Lei Yang[3], Shoule Tian[4], Lijun Miao[5], Xinyun Liu[1]

[1] Research Center of Chinese Jujube, Agricultural University of Hebei, 071001, Baoding, Hebei, China
[2] Food Science Department, Agricultural University of Hebei, 071001, Baoding, Hebei, China
[3] Pomology Institute of Shijiazhuang , Shijiazhuang 050061 , China
[4] Pomology Institute of Shandong; Taian 271000; China
[5]China Environmental Management Cadre College; Qinhuangdao; Hebei 075000; China

Chinese jujube (*Ziziphus jujuba* Mill.) is famous for its high nutrition value and has long been used as a kind of troditional Chinese medicine. Six kinds of the main nutritional and functional components of Chinese jujube fruit were selected to evaluate cultivars and organs in terms of nutritional values. The contents of soluble sugar, titratable acid, vitamin C, water-soluble polysaccharides, cAMP and triterpene acid varied with cultivars, being 53.3～70.4g/100g. dw, 1.15～2.03 g/100g. dw , 203.13~372.19 mg/100g fw, 2.84~7.29%. dw, 54.41~305.84μg/g. dw, and 58.89~728.9μg/g. dw, respectively. The highest levels of soluble sugar, cAMP, polysaccharides and triterpene were at mature stage, and for vitamin C and titratable acid, they were at earlier stage of fruit development. Young fruit had more vitamin C content than ripe fruit, and flowers contained more titratble acid than fruits. The leading cultivars in terms of nutrition content were listed and the utilizing potentials of different organs of Chinese jujube were discussed.

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@mail.hebau.edu.cn*

S-09-15
Study on the Changes of Water-soluble Polysaccharides during Development of Chinese Jujube Fruit

Zhihui Zhao[1], Mengjun Liu[1], Pengfei Tu[2], Li Dai[1], Xinyun Liu[1], Xiaoling Wang

[1] Research Center of Chinese Jujube, College of Horticulture , Agricultural University of Hebei, Baoding 071001 China
[2] Modern Research Center for Traditional Chinese Medicine, Peking University Health Science Center, Beijing 100083 China

The variations in the contents and components of water-soluble polysaccharides during fruit development of 'Jinsixiaozao' were investigated. The results showed that the water-soluble polysaccharides changed greatly with respect to its total content and their ratio to monosaccharides. The total polysaccharides and acid polysaccharides were at a lower content in the earlier stage, but got the highest degree when fruits approached the ripe stage. The analysis of polysaccharides' composition showed that mannose of monosaccharide was detected only in the early stage. Arabinose and galactose were dominant in all stages. Xyloses and glucoses kept in lower proportions.

**Corresponding author: Mengjun Liu; Fax: +86 312 7521456; e-mail: kjliu@mail.hebau.edu.cn*

Postharvest Treatment and Processing

S-10-01
Effect of 1-MCP on Texture Properties of Fresh Fruit in Storage Shelf Period of *Zizyphus jujuba* cv. 'Zhongqiusucui'

Bixia Xie[1], Sen Wang[1], Zhanying Gu[1], Jianxin Zeng[2], Jiangqiao Zeng[2], Hongwei Zhuang[1]

[1] *College of Resources and Environment, Central South University of Forestry and Technology, Changsha 410004, Hunan*

[2] *Xinfeng Fruit Industry Limited company, Qidong 414400, Hunan*

The effect of 1-Methylcyclopropene on texture properties of fresh fruit in storage shelf period was investigated using *Zizyphus jujuba* cv. 'Zhongqiusucui' as materials by TA-XT2i. Results showed that the effects of 1-MCP of 0.4μL/ L on the texture properties of fresh fruit reached a very significant level, and it affected the hardness, frangibility, resilience and adhesiveness at a very significant level.

**Corresponding author: Bixia Xie; Fax: +86 731 5623456; e-mail: bixiax@163.com*

S-10-02
Storage of 'Umran' Ber-Temperature Optimization and Quality Assessment

B.V.C. Mahajan and A.S. Dhatt

Punjab Horticultural Postharvest Technology Centre，Punjab Agricultural University,

Ludhiana - 141 004

The Ber (*Zyziphus mauritiana* Lamk.) is an important fruit of India, liked by both producers as well as consumers due to its high productivity, better fruit size and pleasant flavour. In Punjab, the fruit ripening in 'Umran' cultivars occurs during March – April. The hot and dry climatic conditions, during harvesting periods, interfere with postharvest quality and results in poor marketing life. In order to expand the availability period of quality fruit the postharvest handling and storage can play an important role. The ber has 2-4 days life under ambient conditions. Several workers in India have examined, the effect of low temperature (0-3^{O}C) on the storage behaviour of ber fruits and reported storage life of 3-4 weeks. Perhaps prior to the conduct of these studies optimum storage temperatures were not worked out. Therefore, it is essential to workout optimum storage temperature for predominant ber cultivar Umran. The ber fruits of cv. Umran, of uniform size and free from blemishes and injuries were harvested at colour break stage. The fruits were surface sanitized with water containing 100 ppm Chlorine, air dried, packed in corrugated fibre board cartons and stored at different temperature regimes viz. 0^{O}C, 2.5^{O}C, 5^{O}C, 7.5^{O}C, 10^{O}C and 90-95% RH. The observations on the development of chilling injuries and changes in physico chemical constituents were recorded at 5 days intervals. It was noticed that fruits stored at 5°C or below, developed chilling injury symptoms, surface pitting and brown streaks, bland taste on 5th day of storage. Such low temperature storage may cause fruit disorders as to lose consumer appeal and economic value. On the other hand the fruits at 10^{O}C developed softening and browning at neck, which progressed towards the distal end on further storage. The best temperature for storage of ber fruits was thus found to be 7.5±1^{O}C and 90-95% RH, for maintaining highly acceptable organoleptic quality. At this temperature, the fruits developed attractive colour and acceptable quality and could be stored upto 2 weeks.

S-10-03
Investigation on Harvesting Time, Drying Methods and Packaging in Jujube in Iran

Elham azarpajooh, Ali mokhtarian

Scintific member of Khorasan agriculture research center. Mashad,-Iran

In order to determine the best harvesting time, drying, packaging and preservation of jujube fruit, the experiment was done in city of Birgand for 3 years. The experimental design was based on two factors in form of completely randomized design with 3 replicates. Factor A was harvesting time (100 days after full bloom and120 days after full bloom), and factor B was drying methods (drying on tree, drying among the ash and industrial drying). Quality parameters including moisture percent, ash, contamination and panel tests were done on samples.
The results of first phase showed that the best harvesting time was 120 days after full bloom, when fruits had more weight, width, length, TSS and TA. The best drying methods were drying in ash in that the fruits had better texture color, taste and overall acceptance. In the second phase the selected fruits of the first phase (harvested 120 days after full bloom dried in ash) were packaged with 3 methods (Cartoon, low density polyethylene and celophon), and preserved in 25, 10 or 4 degrces centigrade for 1 year.
The factors including weight changes, contamination to insicts, moisture, test panels (texture, color, taste and overall acceptance) were tested every 6 months. The results showed that low dnsity polyethylen was the best packaging material and the samples preserved under this condition had the best quality after 1 year.

**Corresponding author: ali mokhtarian; e-mail:mokhtarian105@yahoo.com*

S-10-04
Primary Study on Respiratory type of Lingwu Changzao(*Ziziphus. jujuba* Mill)

Guangdi Zhang[1], Xiaoyan Yu[2], Mei Feng [1] ,Wenping Xu[3] ,Dong Yang [1] ,Guohua Liu [1]

[1] *Agricultural School , Ningxia University, Yinchuan 750021,China.*
[2] *Bureau of Garden and forestry， Yinchuan city,yinchuan 750001,China*
[3] *Agricultural and Biology School, Shanghai JiaoTong University, Shanghai 200240, China.*

Lingwu Changzao (*Ziziphus. jujuba* Mill) is a local variety of Ningxia, and has a good table quality despite its short postharvest life. The respiration rate, the weight change of single fruit during growth development and the water loss of postharvest fruit were studied by the methods of quiescence- placeding and weighing. The results showed that the curve of fruit growth development was a double sigmoid type. At the end of first rapid growing phase, the weight of single fruit was 9.5 g, and the stage was very important to determine yield of fruit tree. When the red colour of fruit surface changed from 1/3 to 2/3， the weight of single fruit was 11.4 g. The second slowed-growth period lasted ten days, and the red colour of fruit surface changed from 2/3 to overall red color. When the red colour of fruit surface changed from a crimson status to alizarin crimson, the fruit weight was 12 g, it was a key complementarity stage for yield and good quality of fruit. When the surface colour of fruit changed form jade-green to alizarin crimson, the respiration rate tended to fall during an entire growth development of fruit, which showed a fluctuation phenomenon. The respiration rate descended when the surface color changed from coloring to baby red, but after a crimson stage the respiration rate recurred to its original downtrend. With increasing of single fruit weight, phenomenon of respiration climacteric did not happen and the respiration rate curve showed a concavity characteristic at some stages. The respiration rate descended slowly from 12.87mgCO_2/kg.h to 11.78 mgCO_2/kg.h during first rapid growth of fruit. At first slowed-growth period of fruit, the respiration rate descended slowly to 11.57mgCO_2/kg.h. Althought the weight

of single fruit increased significantly, the respiration rate dropped sharply during rapid growth of fruit at the coloring stage of surface area of 2/3. During second slowed-growth of fruit, the respiration rate curve ascended to a peak step by step, which attended by a crimson surface color, and the respiration rate was 12.48 mg CO_2/kg.h. When the surface colour of fruit changed from crimson to alizarin crimson in six days, the respiration rate value descended to 10.85 mgCO_2/kg.h. In addition, the water loss of postharvest fruit ascended to 5.7% in third day, and the respiration rate descended continuously to 9.96 mgCO_2/kg.h. As a result, there was not a phenomenon of respiration climacteric with a double sigmoid growth development curve characteristic of fruit.

**Corresponding author: Guangdi Zhang;e-mail:zhangguangdi333909@sina.com*

S-10-05
Suitable Temperature and O_2/CO_2 Ratio for Fresh Fruit Storage of *Ziziphus Jujuba* cv. Dongzao

Haoyuan Sun[1], Yuzhu Wang[1], Li Yang[1], Shouyong Li[2]

[1]*Institute of Forestry and Pomology, Beijing Academy of Agriculture and Forestry Sciences, Beijing, 100093, China*
[2]*Rural Development Center of Beijing Science and Technology Committee, Beijing, 100101, China*

To prolong the duration of fresh fruit storage of *Ziziphus jujuba* cv. Dongzao, the respiration of fruit should be controlled to the lowest level. The effective way is to lower the storage temperature while considering chilling-injury on the fruits. In the present paper, the freezing points of fresh fruits with different maturity degrees were studied using a modified method of thermoelectric couple. This will be useful for determining the storage temperature of different maturity degrees. Atmosphere in the storage package also plays a very important role in extending the duration of fresh fruit storage. In this study we found that high concentration of CO_2 and low concentration of O_2 lead to fresh fruit injury of *Ziziphus jujuba* cv. Dongzao. O_2/CO_2 ratio should be maintained at a certain level (approximately 19: 0.2) for long-term storage, and it is recommended that the fresh fruit may be stored in polyethylene bag with holes for air exchange and CO_2 absorbent in the bag in order to keep a balance of O_2 and CO_2.

**Corresponding author: Haoyuan Sun; Fax: +86 1062598744; e-mail: sunhy.fruit@yahoo.com.cn*

S-10-06
Postharvest Disease of Lingwu Long Jujube Fruit and the Effect of Natamycin on Fruit Decay

Honglian Guo, Xihong Li, Yunfeng Hu , Li Li

College of food engineering and biotechnology, Tianjin University of Science &Technology, Tianjin, 300457, China

Lingwu long jujube (*Ziziphus jujuba* Mill.) is considered as a favoured and profitable Chinese jujube, which is admired for its high nutritional value and pleasent taste. Most of the Lingwu long jujube production has been consumed in fresh forms. Moreover, the jujube fruits are easily infected by fungi and the postharvest disease incidence is up to 35% and the decay of postharvest during storage is the main problems that result in decline of its market value, just as the losses of other fresh fruits and vegetables. Therefore，the alternative technologies to reduce postharvest decay of Lingwu long jujube fruit play an essential role in reducing the losses.

The objectives of this study were to investigate the main infected fungi in postharvest fruits and evaluate the effects of the antifungal drugs natamycins on the control of the disease in vivo at room temperature.
Pathogens were isolated from Lingwu long jujube fruit on PDA(potato degluse agar) medium to find out the main pathogen according to the methods of Fang. The jujube fruits without physical injuries or infections were harvested at about 80%-maturing stage and selected for uniform size and colour, the fruits were soaked in the 2% Natamycin solution for 3 minutes, air dried, packed into a plastic punnet and wrapped with a 0.2 mm polyethylene bag, then stored in a room at 25 ±1 ℃ with 80–90% relative humidity (RH), and decay incidence was determined 4 days after treatments.
Five strains of dominant pathogens（*Penicillium, Rhizopus, Alternaria alternate, Botrytis cinerea, Fusarium*）and one type of yeast were isolated from Lingwu Long Jujube fruits, five fungi could cause decay after back inoculation, the higher efficacy was achieved when treated with Natamycin solution after 4 days *in vivo*, and only 20% of the fruits were decayed while the control decay incidence was 60%.
There were five fungi causing postharvest decay of Lingwu long jujube fruits and the function of yeast was not determined. 2% Natamycins could reduce the decay incidence to some extent at room temperature.
Efficacy of oligochitosan in combination with Natamycin could control decay of naturally infected jujube fruit kept at 0℃for 30 days and 25℃ for 5 days.

**Corresponding author: Honglian Guo; email: honglianguo@yahoo.com.cn*

S-10-07
Effect of Gases Packaging on 'Alcohol Softening' and Its Relative Physiological Changes in Stored Dongzao Jujube

HW LI[1], H. Tao[1], LP LI [2]**

[1]*Dept of Food Science, Beijing University of Agriculture, Beijing，China*
[2]*Dept of Food Science, Technology & Business University, Beijing, China*

The effects of O_2, CO_2 or partial vacuum packaging on the 'alcohol softening' in primary mature fruits of Dongzao jujube (1/3 red area on the fruit surface) were studied. The correlations between softening and ethanol accumulation were also explored. Dongzao jujube was treated with O_2 , CO_2 or partial vacuum packaging, and stored at 0±1℃. Initial air packaging was as control. Fruit firmness, ethanol and acetone acid contents or activities of softening related enzymes were measured for investigating the relations among them. The firmnesses and starch contents of Dongzao jujube decreased and pectin methylesterase activities increased during storage. The activities of polygalacturonase or starch splitting enzyme, and acetone acid contents increased at early stage of storage, and then decreased at later stage. A negative correlation between ethanol content and firmnesses of the fruits or a positive corrrelation between PG activity and ethanol content were observed. The physiological metabolism in the fruits was severely distributed by carbon dioxide packaging and CO_2 injuryed was resulted in. The treatments of O_2 or partial vacuum packaging promoted "alcohol softening" of the fruits at various degrees.

**Corresponding author: HW LI; Fax: +86-10-81724236; email: yinpenxijiao@126.com*

S-10-08
Standardization of Procedures for Ber Processed Products

S. Anbu, V. Vani and S. Balasubramanyan

Horticultural College and Research Institute, Periyakulam East – 625 604.Tamil Nadu，India.

Ber fruits can be processed into different products such as juice, candy and wine. Juicy varieties are better suitable for extraction of ber juice. The juice can be used for preparation of ready to serve (RTS) beverage

using 10% Juice. Ber juice can also be used for preparation of wine. Dehydration of ber can be done by treating fruits with sulphur dioxide at 3.5 – 10g / kg for 3 hours followed by drying in the sun for 7-10 days or in a cabinet drier at 60^0C for 20 to 35 hours until the moisture content of the product is reduced to 15%. Ber fruits can be utilized for preparation of candy by sugar syruping process. Ber candy was prepared by pricking the whole fruit and pretreated with 2% salt and 2% KMS for a week and washed thoroughly. Then the pretreated ber fruits were blanched until soft. The ber fruits were impregnated with sugar syrup of 40% TSS for a day and the next day the fruits were drained out and increased the consistency of syrup to 60% TSS by boiling and steeping the fruits for a day. This process was repeated until the syrup strength was raised to 70% TSS by adding sugar on alternate days. The fruits were drained and shade dried for 4 days and packed in 400 G polyethene bags. The prepared ber candy was found highly acceptable for taste, colour, flavour and texture. The ber candy can be stored up to 3 months under ambient storage. Same procedure could be adopted for cut fruit candies also. The whole ber fruits are cut into lengthy pieces by sharp knives, and the cut pieces could be used for making candies.

**Corresponding author: HW LI; Fax: +86-10-81724236; email: yinpenxijiao@126.com*

S-10-09
Effect of Dofferent Post-harvest Treatments on Colour Changes of Ber Furit during Cold Storage

Sukhjit Kaur Jawandha and J.S.Randhawa

Department of Horticulture
Punjab Agricultural University ,Ludhiana —141 004

Ber (*Zizyphus mauritiana* Lamk) is a hardy and nutritious fruit. But, due to its perishable nature it cannot be stored for long period under ambient conditions. Fruit colour is the major factor, which affects the consumers' acceptability. Browning of ber fruits few days after harvest leads to the deterioration of fruit quality. Study was conducted on the colour changes of 'Umran' ber fruit during cold storage. Ber fruits were dipped for 5 minutes in $CaCl_2$ (0.5%,1.0% and 2.0%) ,$Ca(NO_3)_2$ (0.5%,1.0% and 2.0%) and GA_3(20, 40 and 60ppm) after harvesting at golden yellow colour stage. Results showed that fruit retained the original colour upto 10 days of storage in all the treatments except control. But, after 20 days of storage deep golden yellow colour of fruit was noted in all the treatments. At the end of storage (after 30 days) browning was also observed in all the treatments, but in GA_3 (40ppm or 60ppm) and $CaCl_2$ (2.0%) treated fruit only 5% browning was observed. Total carotenoids content was also recorded at each storage interval. In all the treatments carotenoid contents decreased with the advancement of storage period. At the end of storage maximum carotenoid contents (45.38 and 46.20µg/ 100g fruit pulp) was recorded in GA_3 (60ppm) treated fruit and it was followed by $CaCl_2$ (2.0%) treatment. It was concluded that high carotenoid contents and better colour of ber fruit can be retained by GA_3 (60ppm) and $CaCl_2$ (2.0%) treatments.

**Corresponding author: S. Anbu; Fax: +91 4546 231726; e-mail: sanbuhort@yahoo.co.in*

S-10-10
Effect of Ultra High Pressure on Softening of Fresh-cut jujube Fruit during Storage

Wei Zong, Guangjie An

School of Food and Biological Engineering, Zhengzhou University of Light Industry, Zhengzhou , 450002, China

Jujube was a kind of fruit, which has a distinctive flavour and rich nutrition. But after harvest, jujube often

quickly loses its hardness and nutritive value in storage. Fresh cut jujube was a new product for maintaining the quality of jujube. So in this paper, the effect of ultra high pressure (UHP) treatment was studied on softening of fresh-cut jujube during storage. Pieces of fresh-cut jujube was treated with 600MPa for 10min and then stored at 4℃ for 9 days. The effects of ultra high pressure (UHP) on the change of polygalacturonase (PG) activity, firmness of pieces, contents of non-water soluble pectin, and ascorbic acid in fresh-cut jujube were evaluated. After stored at 4℃ for 9 days, the relative PG activity of UHP treated jujube pieces was 4.6%, the content of non-water soluble pectin, hardness and ascorbic acid of UHP treated fresh-cut jujube were 0.081% , 11.6kg/cm^2 and 3256mg/kg , respectively. The results indicated that UHP could inhabit the PG activity and decrease the hydrolyzation of non-water soluble pectin. The firmness and ascorbic acid of UHP treated fresh-cut jujube fruit have no significant change ($P>0.05$) compare with untreated jujube pieces. UHP treated at 600 MPa for 10min could effectively prevent fruits from losing firmness of jujube pieces associate with decreasing the hydrolyzation of non-water soluble pectin.

**Corresponding author: Wei Zong; Fax: +86 371 63556627; e-mail: zongwei1965@126.com*

S-10-11
Effects of Citric Acid Treatments on Fruit Quality Retention of *Ziziphus jujuba* Mill. cv. Linyilizao During Storage

Zhihui Zhao[1], Mengjun Liu[1], Lei Yang[2], Li Dai[1]

[1] *Research Center of Chinese Jujube, Agricultural University of Hebei, 071001, Baoding, Hebei, China*
[2] *Pomology Institute of Shijiazhuang , Shijiazhuang 050061 , China*

The fresh fruits of Linyilizao (*Ziziphus jujuba* Mill.) were soaked in different concentrations of citric acid solution (0.5%, 1% and1.5%) for 3 hours after harvest, and then stored in refrigerator at 4℃. The soluble sugar, titratable acidity and vitamin C contents were determined every 5 days. The results showed that both the contents of soluble sugar and titratable acidity tended to decline. Treatment with 0.5% citric acid could slow down the declines of soluble sugar and titratable acidity contents. The content of vitamin C increased at the initial storage stage and then decreased during fruit storage. All the citric acid treatments kept the Vitamin C at a higher level than the contrast. The treatment with 1.5% citric acid presented a better result in keeping the content of vitamin C. In conclusion, treatment with citric acid (0.5～1.5%) is helpful for keeping fruit quality of Chinese jujube during storage.

**Corresponding author: Mengjun Liu, Fax:+86-312-7521456, email: kjliu@hebau.edu.cn*

S-10-12
Recent Studies on Postharvest Physiology and Storageof Winter jujube (*Ziziphus jujuba* Mill) Fruits

Zhu Xiangqiu , Yuan Junwei , Wei Jianmei , Liu Changjiang

Chang li Institute of Pomology He bei Academy of Agricultural and Forestry sciences , 066600 , China

This paper reviews the recent studies on storage of winter jujube fruits. The advance in the research on postharvest winter jujubes fruits includes the following fields: The respiratory style; The relationship between Vc content and respiration rate; The changes of physiology (PPO, POD, ethanol accumulation) during storage; The key issues during storing process including harvesting, grading, pretreating and storing technology.

**Corresponding author: Zhu Xiangqiu, email: xqz0203@163.com*

S-10-13
Effects of Freezing Methods and Storage Temperatures on the Firmness of Jujube Fruits

Zihua Wang, Jia Xie, Liping Liu, Ximin Deng

Department of Fruit Sciences, China Agricultural University, Beijing 100193, China

Jujube (*Ziziphus jujuba* Mill.) is a fruit rich in ascorbic acid. However, due to its perishable nature, it cannot be stored for long period under ambient conditions. Freezing the fresh jujube fruit is one way to solve the problem, but change in flesh firmness of the frozen fruit after being thawed is the major factor, which affects the consumers' acceptability of the frozen fruits. A preliminary study was conducted to determine the effects of freezing methods and storage temperatures on the fruit firmness. Fresh jujube fruits (Dongzao) were frozen in cold air chamber and in low-temperature liquid media, respectively. The frozen fruits were stored at -32℃ and -22℃. Results showed that, liquid frozen fruits, after being thawed, retained 88% of the fresh fruit firmness, while those frozen in cold air chamber had only 43% of fruit firmness. The firmness of the frozen jujube fruits did not further decrease after 12 months' storage either at -32℃ or -22℃, as long as they were rapidly and deeply frozen in the low-temperature liquid media. It was concluded that long-term storage of jujube fruits can be realized by properly freezing the nutrition-rich fruits in low-temperature liquid media and keeping the frozen fruit temperature below -22℃.

**Corresponding author: Ximin Deng; Fax: +86 10 62733404; e-mail: dengxm@cau.edu.cn*