

## IHC2018-Symposium 37

### International Symposium on Carob: a Neglected Species with Genetic Resources for Multifunctional Uses

#### ORAL PRESENTATIONS

#### KEYNOTE 1

##### CAROB PLANTING SYSTEMS AND ORCHARD MANAGEMENT

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Diverse carob plantation systems are utilised throughout the Mediterranean basin and other new growing areas worldwide, especially in sloping, mountainous and flat areas. The productivity of the Mediterranean traditional carob orchards (about 50 trees/ha) is relatively low and the harvesting cost is very high. Since the 80s and 90s, a slow increase of the total carob area mainly in some regions of Spain and Portugal countries (Catalonia, Andalusia, Algarve, etc.) has been associated with an intensification of the orchards. Several authors recommend higher densities of about 150-200 trees/ha, better pollinators distribution (male and/or hermaphrodite ecotypes), with drip irrigation and mechanical harvesting for improved yields and economic viability. To improve the efficiency of the crop management and the harvester, vigour must be managed to limit tree size while maintaining high productivity. This review describes the current and future situation of carob orchard designs, cultivars, pollinators distribution, some cultural practices, mechanization and production costs. This comparative study of traditional and modern intensive orchard models growing in several regions of Spain reveals differences between ecological conditions and technologies in the following variables: manpower and investment costs, yield potential, and the cost of cultural and harvesting. This crop has received little attention until now, but currently it is being reemphasized as an alternative in dryland (about 500 mm) or in supplementary drip irrigation areas with a Mediterranean climate for the diversification and the revitalization of coastal agriculture.

Keywords: *Ceratonia siliqua*, planting systems, pruning, cultivars, yields, mechanical harvesting, production cost.

#### KEYNOTE 2

##### CAROB GENETIC RESOURCES AND PROPAGATION

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Carob tree is an important component of the Mediterranean basin. The tree has been grown well even on poor, sandy, calcareous and limestone soil. It is important ecologically and nutritionally high value cash crop and a valuable resource for reforestation to prevent erosion processes in marginal lands. In addition, carob leaves, pods and seeds are used for diverse purposes particularly in food industry and as a source of many products such as gum, sugar, fiber and alcohol. The limited information available on carob germplasm conservation of the valuable multifunctional tree. According to literature, there are few studies on the agronomic features and molecular characterization of carob genotypes. A comprehensive and detailed characterization of existing carob genotypes in the Mediterranean region is still lacking. Therefore, that knowledge about existing genotypes in the Mediterranean region is still very poor. Multidisciplinary research to examine phenotypic, agronomical,



technological, and molecular traits of carob genotypes in the Mediterranean region can be contributed to genetic conservation of carob in the future. Carob may be propagated by generative (seed) and vegetative (budding, veneer grafting etc.). Generative propagated carob seedlings are used as rootstocks for grafting. The seedling rootstocks are budded on one-year seedlings after germination in the nursery or two years after planting in the orchard. Vegetative propagation by cuttings is not yet commercially available. Air layering is recommended only genetically important carob. There are studies on micropropagation techniques only research level. Presently, grafting is very common for vegetative propagation.

Keywords: *Ceratonia siliqua*, genetic conservation, germplasm, diversity, vegetative propagation.

## O1:

### PRELIMINARY ASSESSMENT OF ANCIENT CAROB TREES IN LEBANON

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Carob tree is part of the Lebanese landscape and has been historically associated to the lifestyle of rural communities. Despite its multipurpose usage, carob cultivation in Lebanon has been severely neglected in the last century. However, carob genetic resources were rarely studied and not comprehensively assessed while the old carob trees of the country are threatened by several factors. This study aimed to assess the centennial carob trees growing in Lebanon, with the perspective of evaluation, catalogation and conservation of the ancient germplasm. The survey indicated the existence of numerous centennial carob trees distributed in different agro-climatic areas across the country, from 0 to 800 m a.s.l. Centennial carobs were found in woodlands, road edges, and as scattered trees or in mixture with other crops in orchards and gardens. Yet, no reliable information is available regarding the age of these centennials and none has been considered for conservation action. As to the quantitative traits of these trees, a large variability was recorded for foot, trunk and central cavity sizes. Principal component analysis allowed to differentiate the most outstanding trees that were located in different agroclimatic conditions in the South, the North and Mount Lebanon, with more than 7 m of foot circumference. These centennial carobs of Lebanon should be further characterized for their sex (male, female and hermaphrodite), agronomical traits (morphoanatomy of fruit and seed) and molecular features in order to understand their performance through time and to valorize them in selection programs.

Keywords: *Ceratonia siliqua* L., centennials, Lebanon, distribution, trees characteristics.

## O2:

### DETERMINATION OF THE PLANT AND THE FRUIT QUALITY CHARACTERISTICS OF THE SELECTED CAROB GENOTYPES IN NORTH CYPRUS

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Carob became a very popular fruit in some areas of the world, used as fresh and as an industrial crop. Carob demand is increasing day by day in our country and in the global world. However, there is not a special carob cultivar widely used for production in Turkish Republic of Northern Cyprus (TRNC) the quality characteristics of the fruits are not homogene. The pod production of TRNC in 2016 is about 2271 tons obtained from 290.545



carob trees especially located at Iskele area. TRNC, has a great potential for carob which is drought resistant and does not require very special climatic conditions.

For this aim, a study on carob selection from different areas of the country had been done. In this study, the tree and fruit characteristics of 89 carob genotypes determined in the Carob Selection Project carried out by Çukurova University in Turkey and Institute of Agricultural Research and Ministry of Agriculture and Natural Resources of the TRNC were investigated. Also, the fruit quality components of the promising cultivar candidates were determined.

As a result of this study, the most promising carob cultivar candidates will be applied for registration. A carob orchard with the most hopeful genotypes will be planted in Turkmenkoy Station, TRNC and in Çukurova University (Turkey). Then, registered high quality genotypes will be given to growers in Turkey and in TRNC, which are taught to become very popular in the World.

Keywords: North Cyprus, genetic resources, tree and fruit characteristics, quality performances.

### O3:

#### COMPARISON OF THE AGRONOMIC AND COMMERCIAL CHARACTERISTICS OF TRADITIONAL CAROB CULTIVARS AND SELECTED HIGH KERNEL YIELD CLONES IN SPAIN

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The carob tree (*Ceratonia siliqua*, L) shows interesting commercial potential for some coastal Mediterranean growing areas. Carob bean gum is extracted from the pod seed and is a valuable stabilizer and thickener for the food industry. The identification of carob cultivars that produce high seed yields in northeastern Spain, and similar environments, would be of interest to growers. Since the 90's several carob female and hermaphrodite clones have been introduced in the carob experimental plots in Tarragona province (Catalonia) to improve the pollination and regular yields of the new intensive orchards. Vegetative, fruiting and pod characteristics were field evaluated for three traditional carob cultivars ('Matalafera', 'Rojal' and 'Duraio') and nine accessions for their high kernel yield, six female ('SdC', 'E-3', 'E-4', 'E-18', 'E-19' and 'E-26') and three hermaphrodite ('A-19', 'E-13P' and 'Turis') ecotypes. The observations were carried out in the 3-year period, 2014-2016.

The vegetative development of the hermaphrodite accessions 'E-13P', 'A-19' and 'Turis' were lower than all the female cultivars. Regarding early bearing of cultivars, important differences were found, being those mentioned above the most precocious ecotypes (3th year after budding). So far in relation to productivity during the 12 years after budding, accessions like 'A-19', 'E-13P', 'Turis', 'SdC', 'E-4' and 'Rojal' appeared to be more yielding. Another interesting trait observed was the difference in fruit ripening and natural fruit drop, 'Matalafera' and 'E-4' showed earlier ripening and easy fruit drop. These traits improving the mechanical harvesting efficiency.

Fruit records of samples from young producing trees were taken. Some fruit and kernel characters were determinate: weight (g), length (cm), width (cm), thickness (cm), kernel yield (%) and gum content (%). 'Duraio', 'E-26' and 'E-19' produced the largest pods (over 20 g of fruit weight) and 15 %, 16 % and 20 % kernel content, respectively. However, 'E-18', 'E-4', 'SdC' and 'E-13P' produced the smallest fruits (weighing 14 to 17 g) with also the highest kernel content (17-19 %). Gum content, expressed as a percentage of the dry weight, was higher in 'E-18' (62,7 %) and lowest in 'A-19' (51,8 %). So far the information available shows, regarding kernel and pod production, 'Duraio' cultivar, four accessions ('SdC', 'E-3', 'E-4', 'E-18') and two hermaphrodite pollinators ('Turis' and 'E-13P') seem suitable to be used as new cultivars in modern carob groves.

Keywords: *Ceratonia siliqua*, Spain, cultivars, vigour, juvenility, productivity, harvest facility, fruit and kernel characteristics.



## O4:

### INVESTIGATION ON CAROB (*Ceratonia siliqua* L.) PROPAGATION BY CUTTING

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Grafting is the most common vegetative propagation method applied for carob. Few studies have been reported on carob propagation by cuttings in world as well as in Turkey. However, rooting performances of cutting propagation have been greatly varied among studies. Suggesting more research is needed to be carried on to elucidate this production technique for carob propagation which, constitutes to be the main objective of this study. One year old shoots of 1 cm diameter and 20-25 cm in length belong to 'Kıbrisi' cultivated ecotype in Gazipasa province of Antalya/Turkey was used in this study. Two types of cuttings were taken in different times and treated with different concentrations of auxins. Cuttings with apical bud were taken at the beginning of April and May and treated with 6 different concentrations of auxins. Cuttings without apical buds were taken at the beginning of March, April and May and treated with 10 different treatments including control. Perlite was used as the rooting media and experiments were carried out under unheated glasshouse conditions. Rooting rate, number of primary roots, root length and root diameter were evaluated. Rooting performance was found to be limited: only some of the treatments produced roots with very low quantity. Bearing in mind the scarcity of cutting production from carob trees and the requested labour to process it, the results strongly suggest that carob production via cuttings is not very suitable approach for Carob "Kıbrisi" type under experimented conditions described in this work.

Keywords: Cultivated type, propagation, cutting type, rooting, IBA, NAA.

## O5:

### THE CHARACTERIZATION OF CAROB TREE OF KHÉNIFRA'S PROVINCE

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The carob tree, *Ceratonia siliqua* L., is an agro-sylvo-pastoral tree, but it is widely known as a forest tree, and without having specific varieties in Morocco. Nevertheless, it has begun to be planted in modern farms in the last few years. So, a characterization of the carob content of the seeds is of paramount importance in order to enrich the national and international data bases relating to the carob tree, and also to respond to the farmers and industrial needs for the choice of the grafts.

To reach this goal, we carried a sampling tree of the spontaneous populations (Tafechna and Ait Ishaq) as well as different ones from other areas of Khénifra's province, that the only criterion of choice is absence of alternation. After picking up the fruit of the selected trees, the carob underwent a crushing with the aim of separating the seeds from the pulp.

The results obtained show that the carob tree of Khénifra has more seeds than what is cited in the bibliography (In Morocco), with a percentage between 18% and 38%, which has a great agro-economic importance.

Keywords: Carob tree, Khénifra's province, seed's content.



## POSTER PRESENTATIONS

### P1:

#### SUGAR CONTENT OF SOME CAROB TREES OF TURKISH REPUBLIC OF NORTHERN CYPRUS

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Carob became a popular fruit used for fresh consumption and as an industrial crop. Moreover carob is resistant to drought and does not require very special care. Demand for carob is increasing day by day in Turkish Republic of Northern Cyprus (TRNC) although there is no special cultivar used for carob production in the country. Therefore the fruit quality characteristics are not homogeneous. Recently, surveys have been conducted within the Carob Selection Project (carried out by Cukurova University and Institute of Agricultural Research of TRNC, and the Ministry of Agriculture and Natural Resources) to select carob candidates from different areas of the country. In this study, we assess the sugar content for 93 carob accessions. Mature pods are analysed for glucose, fructose, sucrose, sorbitol and total sugar contents by using High-Performance Liquid Chromatography technique. Results will allow to identify the most promising carob candidates which will be further submitted for registration. A carob orchard with the promising carob candidates will be planted in Turkmenkoy Station in TRNC in order to advise farmers and supply them with the needed propagating material.

Keywords: TRNC, genetic resources, sugar content, HPLC.

### P2:

#### CARBON BALANCE OF CAROB ORCHARDS AT EASTERN SPAIN

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Carob trees are main components of the Mediterranean vegetation and its cultivation in marginal and prevailing calcareous soils of the coastal Eastern Spain. It is important from both agronomical and environmental perspectives. In addition, carob leaves, seeds and pulp fruit are rich in phenols and polyphenols making them a good source of antioxidant. Finally, the fruits are used for wide purposes particularly in food industry and as a source of many products such as gum, sugar, fiber and alcohol. Carob world production is estimated at about 310.000 t/year produced from some 200.000 ha with very variable yields depending on cultivar, region and farming practices. The Mediterranean region is largely the leading carob producer worldwide. Spain produces, on average, 80.000 t/year followed by Italy, Portugal, Morocco, and Greece. In this study we demonstrate that carob trees are very efficient species to sequester carbon dioxide from the atmosphere. The presented results indicate that traditional carob plantations exhibit a positive net carbon balance, close to 5,4 tons C equivalent/ha/year that, extrapolated to the whole crop Spanish surface (about 50.000 ha), would represent a total of 250.000 tons C per year. This carbon assimilation activity is similar, or even higher, to other woody crops and suggest that it can be considerably enhanced through the optimization of the cultural techniques and irrigation regimes.

Keywords: *Ceratonia silica* L., carbon sequestration, climate change mitigation, CO<sub>2</sub> balance, soil respiration.





## P3:

### DETERMINATION OF SEED GERMINATION RATIO DURING DRYING PERIOD IN CAROB

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The objective of this study was to determine the germination behaviour under drying conditions of carob (*Ceratonia siliqua* L.,  $2n=2x=24$ , dioecious, Leguminosae (syn. Fabaceae)) seeds. Fruit were collected from one genotype. Seeds were freshly extracted from siliques on July 30, 2015. The seeds were left on Whatman paper on a laboratory bench for natural drying under ambient temperature. Starting with July 30 2015, seeds were sown in paper tea-cups containing perlite every day. There were three cups for each replicates having 10 seeds in each. The earliest germination day was the third day after seed sowing. The weight of seeds and germination time of the seeds were discussed.

Keywords: *Ceratonia siliqua*, drying period, seed germination.

## P4:

### CURRENT SITUATION OF CAROB IN TURKEY

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Carob is a typical fruit species of Mediterranean climate. It is important environmentally and economically in marginal areas. Trees are well adapted to dry condition and grown in a wide range of soil types and have some outstanding features such as rusticity, drought and fire tolerance. Turkey has a rich natural carob population in the Mediterranean and the Aegean basin. Mersin, Antalya, Adana and Burdur can be shown as the most important carob production cities in the Mediterranean region. On the other hand, carob can be grown only in Muğla province in the Aegean region. It is still considered as a typical forest tree. Therefore, cultivation of carob is still of a minor importance in Turkey. At present, degraded, uncultivated, state and private property lands are subjected to private cultivation studies in accordance with the Ministry of Forestry and Water Affairs project. Therefore, cultivation of carob has gained popularity and new orchards have been established in Mersin, Antalya and Adana. In this study, the latest improvement of carob cultivation in Turkey has been discussed. Carob growing areas in Turkey have continued to increase over the past 10 years. The total carob production areas in 2006 were 328 ha and at present has reached up 569.3 ha. Although the areas have increased, the total production is still 13.405 t. Trees are used as ornamental landscaping, as windbreaks and in afforestation in Turkey. Pods are used as animal feed and human food. Ground powdered pods are used as a flavour for cakes, bread, sweets, ice creams, tea bag and etc. There are also factories for locust bean gum production. The range of products is expected to increase day by day in Turkey.

Keywords: *Ceratonia siliqua*, Mediterranean region, production, pod and seed.

