

**PHENOLOGY OF FLOWERING OF THE EVERGREEN ORIENTAL PLANES
(*PLATANUS ORIENTALIS* VAR. *CRETICA*) ENDEMIC IN THE ISLAND OF CRETE**

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Received December 8, 1999; accepted July 20, 2001

ABSTRACT

Preliminary studies on flowering of the evergreen *Platanus orientalis*, were based on observations on some of the naturally growing evergreen planes in the island of Crete, on seedlings originated from artificial selfing of evergreen, as well as, on ramets produced from naturally growing evergreen trees.

Flowering of the evergreen planes has special morphological and seasonal characteristics: Most of the evergreens flower continually during autumn and winter with a pause of flower production in late June–July; few evergreen planes were found to deviate from this flowering pattern, some producing very few flowers in winter and others being sterile. Partial overlap of evergreen and deciduous flowering takes place in spring.

The population of the evergreen planes in Crete, though of limited size since antiquity, continuous to exist and naturally growing evergreen young seedlings, have been discovered. Although there are indications that ecological and seasonal factors, as well as, internal physiological ones, operate as obstacles for the natural reproduction of evergreen planes, it is assumed that, natural hybridization among evergreens in winter, as well as, natural hybridization among evergreens and deciduous, takes place to the certain extent.

Keywords: *Platanus orientalis* var. *cretica*, evergreen, deciduous, flowering

INTRODUCTION

Evergreen variety of *Platanus orientalis*

Platanus orientalis grows naturally in the Balkan peninsula up to the 42nd parallel. Eastward, it grows naturally in Turkey, Cyprus, in the countries of Western Asia as far as the western Himalayas (PANETSOS 1984). *Platanus orientalis* is a deciduous species in all the area of its natural distribution, exhibiting the seasonal alteration of growth and dormancy, which is a characteristic of the trees of the Temperate zone.

In Crete, though, some individuals, which are evergreen and continue to grow throughout autumn and winter, grow naturally and they have been characterized as a variety of the species (*Platanus orientalis* var. *cretica* Dode).

Pertaining the population size, PLATAKIS (1966) reports of 29 evergreen trees scattered in different locations of the island. NIKOLAKAKI (1993, 1997) reporting her foundations, mentions of 27 more evergreens. One of the evergreen planes grows at the archeological place of Gortyna, at the same place which

has been mentioned by Theophrastos (PLATAKIS 1966)

The following experiments were conducted by Panetsos, at the Experimental Station of the Laboratory of Forest Genetics and Breeding of the Aristotelian University of Thessaloniki: seeds from open pollinated evergreen planes of Crete, were sown and produced evergreen and deciduous plants whereas layering of cuttings collected from evergreen donor planes, produced evergreen plants. Limiting factor in the expression of the evergreen habit, appeared to be the temperature as, in winter, the growing tops were destroyed by frost.

These experiments, as well as the finding of an evergreen graft on a deciduous stock, which was performed about 80 years ago (personal communication of professor Panetsos with Isihakias at Chania) gave evidence that the evergreen character is genetically controlled.

The retaining of the evergreen habit of donor trees, by the way of layering of cuttings, was reaffirmed by NIKOLAKAKI (1997). Artificial pollinations between evergreen and deciduous oriental planes in Crete were performed and thus, the genetic basis of the evergreen

¹ The paper is based in parts on a Doctoral dissertation defended by the senior author in the Department of Forestry, University of Thessaloniki, Greece.

² This paper is dedicated to the memory of Hassan Hajaje, who past away unexpectedly before the completion of this work.

habit was established (NIKOLAKAKI 1997).

In the framework of the genus *Platanus* Improvement Program (PANETSOS 1991), a special subprogram was initiated for the evergreen oriental planes of Crete. The main goals of the investigation program, were: (a) to investigate the mode of inheritance of the evergreen habit, (b) to develop methods of mass production of the evergreens, and (c) to protect the evergreen variety which is unique in the European flora.

Below the leaves and flowers production is shown within the period of one year for the evergreen and deciduous *Platanus* of Crete, as it was presented by NIKOLAKAKI et al. (1993) (Table. 1).

The flowering studies

Phenological studies on the evergreen oriental planes flowering, aimed to investigate the main characteristics of the flowering of the evergreen *Platanus orientalis*, as compared to the typical deciduous species, such as morphological characteristics of flowers and seasonality of flower production.

The flowering studies also aimed to produce the first important elements, upon which, further studies can be based on, pertaining the natural reproduction of the evergreen oriental planes and also to study the mode of inheritance of the evergreen character.

Platanus orientalis is a monoecious tree species. Flowers aggregate in clusters (heads). Each inflorescence of the oriental planes consists of pendulous strings of 2–7 dense, globose heads of flowers; the heads of one inflorescence are exclusively either male

or female. The ball-shaped see clusters often persists after leaf fall, until late winter.

MATERIAL AND METHOD

Three naturally growing evergreen planes at “Gortyna”, an archeological site, and two at the village Vori, which were found to flower continually during autumn and winter, were used for the phenological observations on flowering.

At the same time, measurements were taken in an evergreen seedling which was produced from artificial self-pollination of evergreen, concerning time of flower production, development, final size of flowers in maturity.

Ramets derived by layering of cuttings taken from one evergreen plane at Gortyna also served for phenological observations as they produced flowers soon after the new shoots and leaves emerged from the soil.

After continuous observations in deciduous oriental planes, during successive years, we concluded that the changes in colour of the inflorescence can be used as an indication for the flowering phase (immature, receptive, seed development) (NIKOLAKAKI 1997); In the deciduous planes, after the flowering bud burst (head diameter size of 0.5–0.7 cm), females are distinguished from males visibly, male are green-brown and females are green-red, having distinguishable pistils. As the bud bursts, the heads appear and then the peduncle is unfolded. Female heads turn red, while males turn white-yellow as they mature. Immature seedballs are greenish, until seed maturation with the globose heads

Table 1. Appearance of phenological characters during the period of one year for the evergreen and the deciduous *Platanus orientalis* (NIKOLAKAKI, PANETSOS & LYRINTZIS 1993).

EVERGREEN *PLATANUS ORIENTALIS*

Phenological observations	Monthly duration of the phenomenon within the period of one year											
	J	F	M	A	M	J	J	A	S	O	N	D
New leaves production	Intense	Intense	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Flowering	Intense	Intense	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

DECIDUOUS *PLATANUS ORIENTALIS*

Phenological observations	Monthly duration of the phenomenon within the period of one year											
	J	F	M	A	M	J	J	A	S	O	N	D
New leaves production	Minimum	Minimum	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
Flowering	Minimum	Minimum	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

Note:



Intense appearance of the character
 Normal appearance of the character
 Minimum appearance of the character

Table 2. Flowering of evergreen versus deciduous *Platanus orientalis*.

	J	F	M	A	M	J	J	A	S	O	N	D
Winter eve flowering	█	█							█	█	█	█
Spring eve flowering			█	█	█	█		█				
Summer eve flowering						█		█				
Deciduous flowering			█	█	█							
Overlap			█	█	█							

being brown (NIKOLAKAKI 1997).

The changes in colour of the flower heads, together with the maximum diameter attained before seed development starts, were taken into account in order to describe the duration of the flowering phases of the evergreens.

The phenological observations on flowering were conducted during four successive years (1989–1993).

RESULTS

Morphological features of evergreen oriental planes flowering, compared with the common deciduous – flowering phases

In the evergreen planes, during the first stages of flower development (inflorescence diameter size of 0.1–0.5 cm), males are not always visibly distinguished from females, as they are both small and reddish and the surface of the inflorescence looks smooth without distinguishable pistils or anthers. This may cause problems during artificial pollination procedure.

In winter, flower heads of the evergreen generally attain smaller diameters. The development of winter flowers is slower (usually 30–40 days from appearance until maturation) and, as they do not get easily pollinated due to the unfavorable environmental conditions, observations tend to support that the receptivity period of the females is prolonged. Nevertheless, it is a common phenomenon in winter, for the inflorescence not to develop perfectly, or even to get destroyed due to the environmental conditions. Spring flowers of the evergreens mature within 15–18 days as the deciduous (NIKOLAKAKI 1997).

Seasonality of the evergreen oriental planes flowering

After a pause of flowering in the middle of the summer, flowers are produced again at the end of August and flowering continues throughout autumn and winter.

In late February, the evergreens begin to produce flowers morphologically different from those of winter, as the mature inflorescence is larger, having a deep red color, distinguishable pistils and anthers and, they also

develop in shorter period. The inflorescence developed during this period, is usually comprised from more than three heads. This period, which lasts until May/June, will be referred as "the spring flowering for the evergreens" (therefore the beginning and ending of spring flowering of evergreen and deciduous does not coincide).

By the time that flower production of deciduous begins, which is about 20 days later than the beginning of the spring flowering of the evergreens, the evergreen planes bear already many mature female inflorescences. Therefore, by the time that the "deciduous" pollen is dispersed, many females of evergreen, have already been pollinated by its pollen. For the evergreen individuals at "Vori" and "Gortyna", it was extremely difficult, to find immature female flowers by the time the pollen of the deciduous was dispersed. This was found to be repeated for the four successive years (NIKOLAKAKI 1997) and therefore in this case, it is fair to assume a partial seasonal incompatibility between evergreen and deciduous *Platanus orientalis*. At the beginning of May, all pollen of the deciduous *P. orientalis* has been dispersed, females are pollinated and seed development starts. Most of the evergreen planes stop producing flowers at the end of June. Then, upon the autumn's arrival, by the time deciduous are shedding their leaves, evergreens start again to produce flowers, along with the continuous leaf production.

Other observations

During some periods in the winter, an unexpected asymmetry was found in the number of male and female flowers for the evergreens at Gortyna. One evergreen plane tree at the village named Azogyres, was found to bear only male flowers during two of our visits, in January and February of the same year 1992; this extreme finding remains to be reaffirmed.

During 1993 and 1994, six hermaphrodite inflorescence in evergreen and deciduous *Platanus orientalis* trees were recorded. The same peduncle bore both male and female "heads".

Evergreen seedlings planted at a spacing of 1.2 × 1.2 m, entered the reproduction phase when they were three years old.

DISCUSSION

The morphology and development of the flowers of *Platanus orientalis* var. *cretica*, were found to be different in different seasons.

The systematic observations on flowering of the evergreen variety of *Platanus orientalis*, over successive years, supported the conclusion that a number of factors operate as obstacles for the natural reproduction among evergreen planes as well as the gene flow between the evergreen and deciduous oriental planes.

1. External factors: (a) ecological factors: low temperatures hinder normal development of male and female flowers, humidity hinders pollen dispersal. The ecological factors, hinder natural hybridization of evergreens during winter; (b) seasonal factors: the beginning and ending of spring flowering of evergreen and deciduous does not coincide, resulting in reducing the chances for hybridization of the evergreen variety with the common deciduous species. Nevertheless, it is assumed that during the overlap flowering period of evergreen and deciduous planes of Crete, in the locations where evergreen and deciduous co-exist, natural hybridization takes place in some extent.

2. Internal physiological factors: Separation of male and female flower production of the evergreens in time (although it is not the rule) in winter, which results in pollen dispersal before the females maturation or, on the contrary, by the time that stigmata are receptive, pollen has not matured yet. Also, in some evergreens, it was observed an asymmetry in the numbers of male and female flowers.

Seeds developed from winter flowers of the two evergreen planes at Vori, did not germinate. Artificial self-pollination of evergreen plane at Gortyna in winter, produced few evergreen seedlings. Nevertheless, artificial pollination between evergreens in winter, which will include the collection and storage of pollen and subsequent protection of the pollinated flowers in pollination bags, can have positive results.

Natural pollination between evergreens, theoretically can also happen, in winter. The natural reproduction of evergreen trees during winter, should depend on the close existence of at least two fertile evergreen individuals, the favorable climatic conditions for the development of male and female flowers and pollen dispersal and the absence, or, minimum appearance of the above mentioned internal physiological factors operating as obstacles for the hybridization.

We conclude, that flowering studies, despite the very few existing material, (small number of recognized evergreen oriental planes in accessible locations) contributed to the determination of the evergreen variety, as well as, to the recognition of the variability

among the evergreen individuals. In this way we established a base for further research, in order to study the mode of inheritance of the evergreen character and to broaden the genetic base of the population of the evergreen oriental planes of Crete.

ACKNOWLEDGMENTS

Special thanks are extended to Prof. K. P. Panetsos for helpful discussions and advise throughout the research work. Dr. A. Papageorgiou is gratefully acknowledged for valuable discussions who played important role to the presentation of this research work. The research was funded by the Mediterranean Agronomic Institute of Chania. Special acknowledgments to the Director of the MAICH, A. Nikolaidis, for supporting the research on the evergreen planes. Last, but not least, I would like to express my gratitude to Professor L. Paule, Editor-in-Chief of the Forest Genetics, for the advise and the opportunity to publish this manuscript.

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