olive4 climate

CLIMATE CHANGE MITIGATION THROUGH A SUSTAINABLE SUPPLY CHAIN FOR THE OLIVE OIL SECTOR

ACTION D2

LIST OF CULTIVARS, WILD OR CULTIVATED ROOTSTOCKS, WEED SPECIES AND COVER CROPS SHOWING THE BEST PERFORMANCE UNDER DROUGHT OR HEAT STRESS CONDITIONS

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Introduction

Thousands of olive varieties are cultivated in the Mediterranean area and in various other areas of the world.

Their geo-climatic distribution is linked to gene pools that distinguish all varieties into different populations.

Some aspects related to the plant and olive-grove response to the climate pressure may be considered.

The role of the olive growing in a context of climate change include:

- protection from desertification;
- hydrogeological protection;
- tolerance to environmental stresses (drought, high temperatures, salinity, cold)

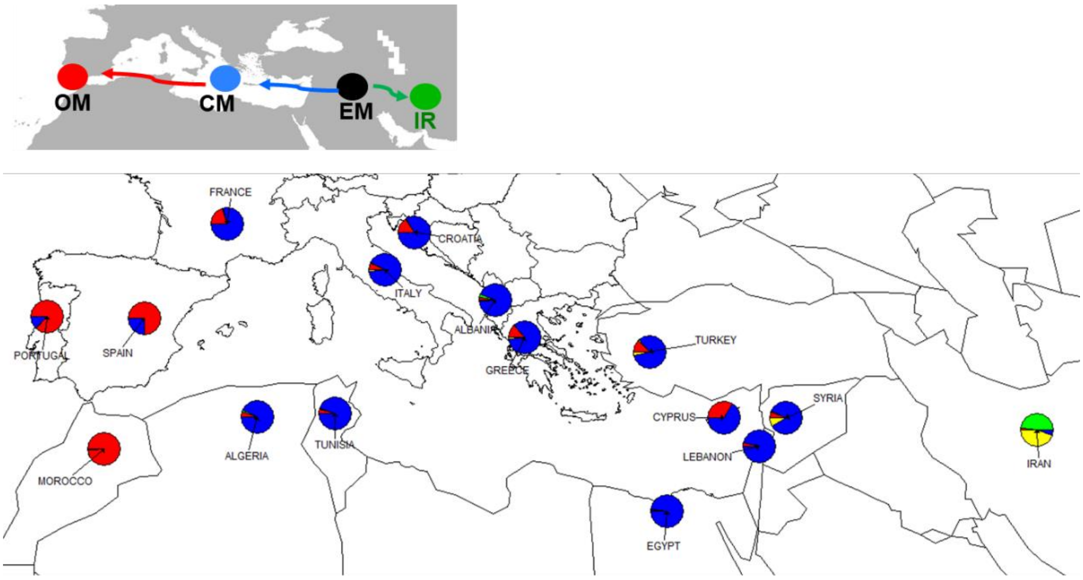
On the other side, the effects of climate change on the olive trees include:

- Flower differentiation;
- Fertilization and fruit production;
- Phytosanitary emergencies.

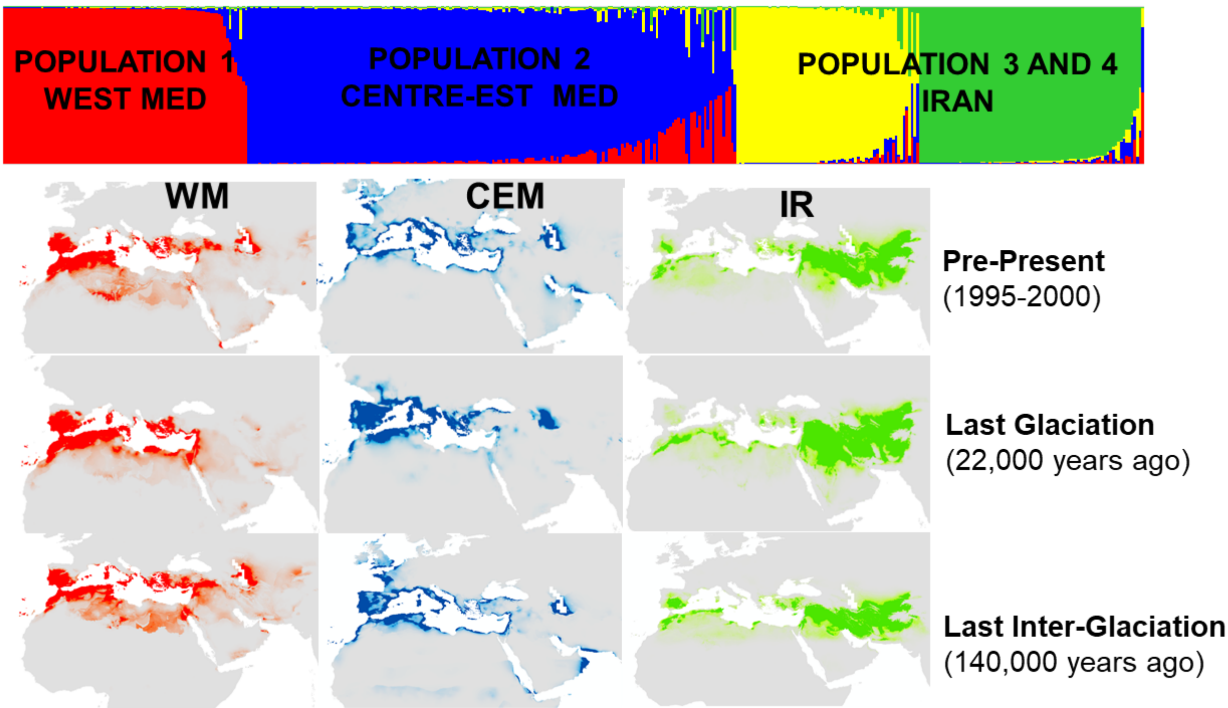
Some of these aspects have been considered within the OLIVE4CLIMATE project.

Relationships between olive gene pools and climate

In order to verify which olive cultivars may show a better agronomical performance in terms of sustainable production under different climatic scenarios, numerous activities have been performed.



Populations of olive cultivars genetically different

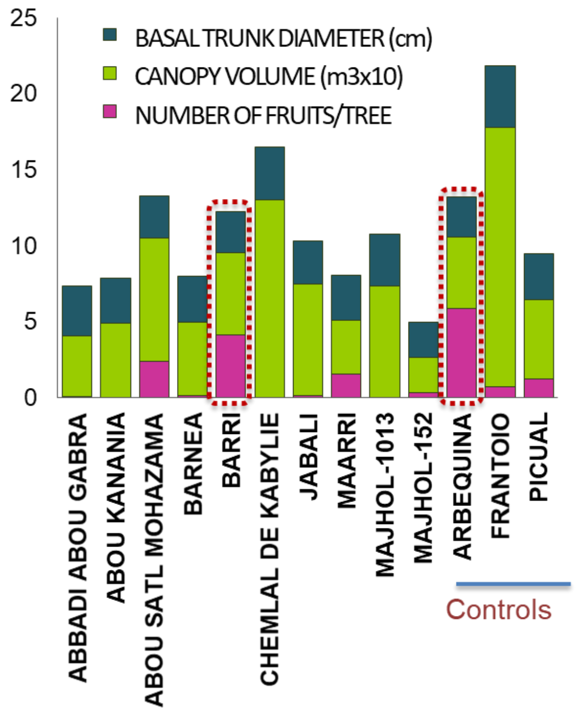


The environmental suitability of the olive gene pools of the eastern, central and western Mediterranean and in the Asian area (Iran) has been verified during three periods of time. It has been possible to observe that the West Med and the Iranian populations were the most suitable to survive under regimes of high temperatures and low water availability.

Olive trees growing into very arid conditions in different Iranian provinces.

Suitability of cultivars native to the arid or desertic areas to grow under temperate areas and in intensive cultivation systems

Some varieties of the arid or desertic areas of the East and South Mediterranean were compared in central Italy with the best international varieties in terms of plant growth and fruit production.



The study, conducted withing the lifespan of the O4C project, has allowed to verify that some varieties from the arid areas show a similar performance to the most outstanding international varieties used as controls.

Among them, Barri resulted as early bearing as the cv, Arbequina, meanwhile cv. Abou Sath Mohazama and Maarri produced more than control varieties. The Israeli cv. Barnea has shown low vigour but also very low fruit production at first years after planting.

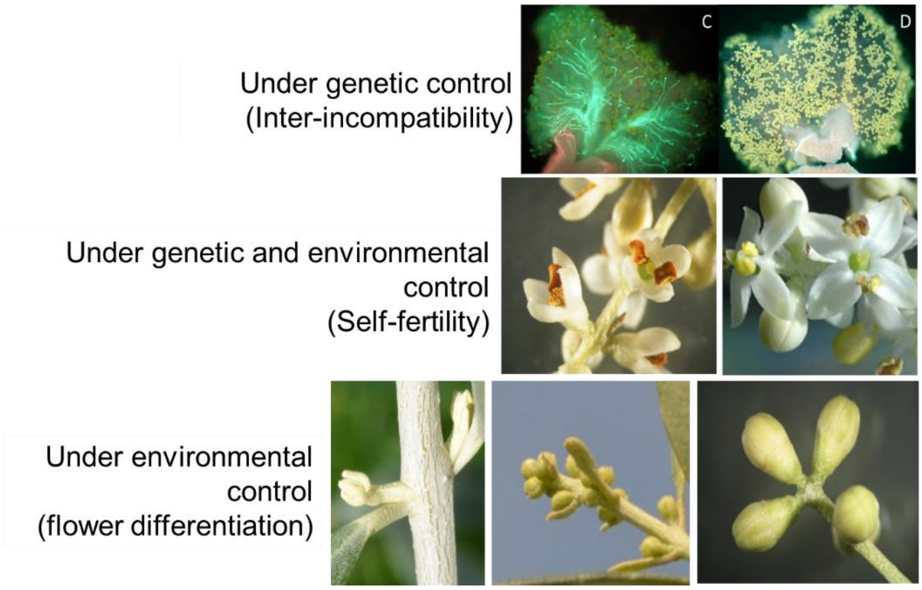
Reproductive barriers

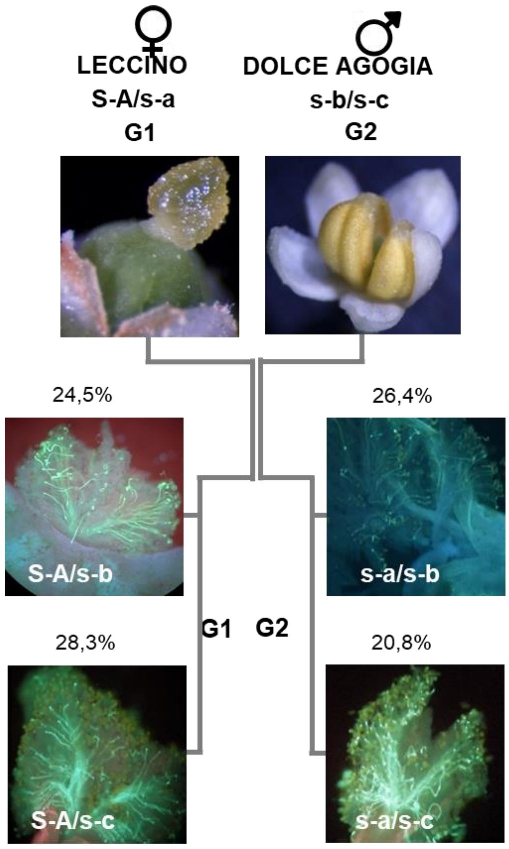
The most unpredictable consequences of climate change refer to the effects on plant reproduction.

In the olive species, being a self-incompatible, inter-incompatible, wind pollinated tree requiring a precise regime of low-winter temperatures to flower, it is particularly sensitive to the effects of the climatic trend.

Questions arise about how to ensure flower differentiation, fertilization and fruit set in different environments.

The reproductive barriers among olive cultivars have been analysed for a large set of cultivars deriving from different environments, considering that some of them, such as inter-incompatibility, are strictly related to the cultivars (genetic control), others (self-fertility) are controlled either by genetic and environmental factors, and finally, flower differentiation is mostly due the climate (temperature).





It has been shown that all cultivars are divided into two groups of incompatibility and only combinations between cultivars of the opposite groups are compatible, meanwhile all intra-group combinations are totally incompatible.

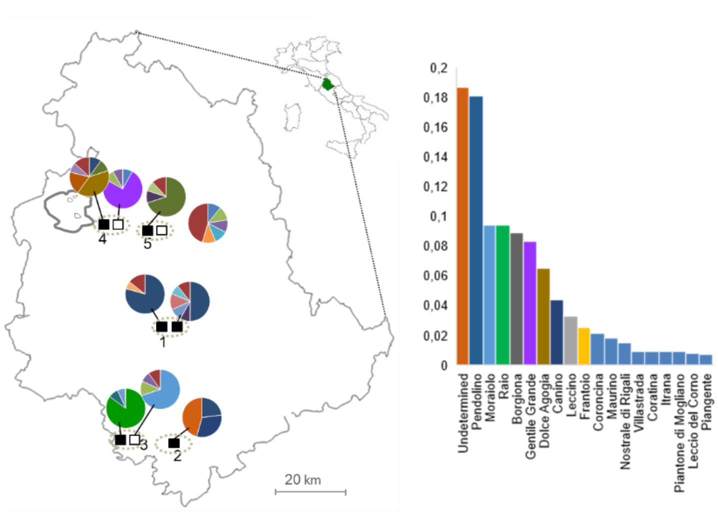
Table showing a list of main cultivars distinguished by the group of incompatibility (Mariotti et al., 2020).

Group G1 Cultivars	Country of diffusion	Group of incompatibility
Leccino	Italy	G1
Dritta di Muscufo	Italy	G1
Gentile di Montone	Italy	G1
Gentile Grande	Italy	G1
Sirole	Italy	G1
Frantoio	Italy	G1
Leccio del Corno	Italy	G1
Moraiolo	Italy	G1
Moresca	Italy	G1
Orbetana	Italy	G1
Piantone di Falerone	Italy	G1
Vera Umbra	Italy	G1
Arbequina	Spain	G1
Cornicabra	Spain	G1

Gordal Sevillana	Spain	G1
Cornezuelo de Jaen	Spain	G1
Hojiblanca	Spain	G1
Lechin de Sevilla	Spain	G1
Sevillenca	Spain	G1
Verdial de Badajoz	Spain	G1
Group G2 Cultivars	**Country of diffusion**	**Group of incompatibility**
Bottone di Gallo	Italy	G2
Borgiona	Italy	G2
Bosana	Italy	G2
Canino	Italy	G2
Capolga	Italy	G2
Carolea	Italy	G2
Coratina	Italy	G2
Dolce Agogia	Italy	G2
Fecciaro	Italy	G2
Gentile di Chieti	Italy	G2
Gnacolo	Italy	G2
Grappuda	Italy	G2
Itrana	Italy	G2
Maurino	Italy	G2
Mignola	Italy	G2
Nocellara del Belice	Italy	G2
Nostrale di Rigali	Italy	G2
Passalunara	Italy	G2
Pendolino	Italy	G2
Piangente	Italy	G2
Raio	Italy	G2
Sant'Emiliano	Italy	G2
Semidana	Italy	G2
Tombareddu	Italy	G2
Machorron	Spain	G2
Manzanilla Cacerena	Spain	G2
Mollar de Cieza	Spain	G2
Picual	Spain	G2
Picudo	Spain	G2
Manzanilla de Sevilla	Spain	G2
Arbosana	Spain	G2
Koroneiki	Greece	G2
Mastoidis	Greece	G2
Morrut	France	G2
Verdale	France	G2
Arauco	Argentina	G2
Picholine Marocaine	Morocco	G2

Among compatible cultivars, there is also a gradient of fertility and some of them may work as pollinators better than others.

The best pollinators of the Umbrian varieties (considering their group of incompatibility) are shown in the following figure. As an example, the two G2 cultivars Pendolino and Dolce Agogia show a strong different ability to fertilize cultivars of the opposite G1 group, based on their pollen occurrence.



How the environment may affect fruit oil content and fatty acid composition of the olive cultivars

Until now, it has been very difficult to compare the performance of different cultivars under different climate conditions, due to the lack of certainty on cultivar identity and on their local distribution. The access to data on the cultivar collections distributed over a wide range of environments has allowed to unravel deep unprecedent information on the cultivar response to different environmental scenarios.

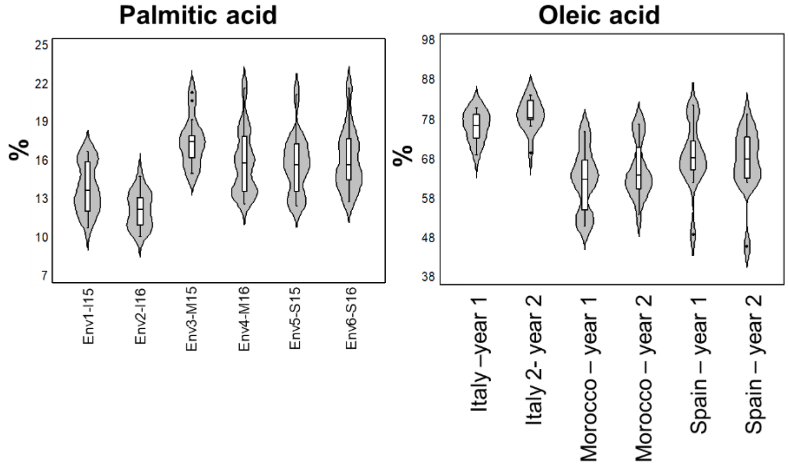
Data have been collected and analysed on five different environments and for a wide range of olive cultivars:

- Enna, Sicily, Italy - 63 cultivars
- Cordova, Spain - 57 cultivars
- Marrakech, Marocco - 65 cultivars
- Tiro, Lebanon - 33 cultivars
- San Juan, Argentina - 12 cultivars

2 years data

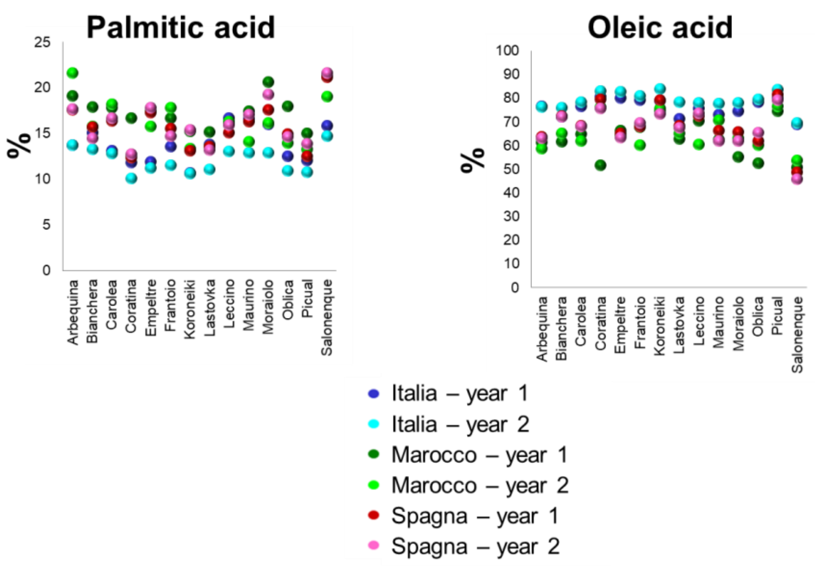
2 trees/cultivar

Effect of different environments (combination of site and year) on two fatty acids on 14 cultivars.



The climate regimes may strongly affect the oleic acid percentage. In the Cordoba environment, cultivars may produce very different percentages of oleic acid when compared to the Italian environment for the same cultivars that always show the highest levels of oleic acid.

Cultivars response to different environments.



Data demonstrated that some cultivars may show a very low plasticity (differences) among different environments for both fatty acids. For the most important oleic acid, high percentages were shown by cvs. Picual and Koroneiki, and a wide range with very low values for cv. Salonenque.

Tree architecture may affect cultivar suitability to plant density and grove planning

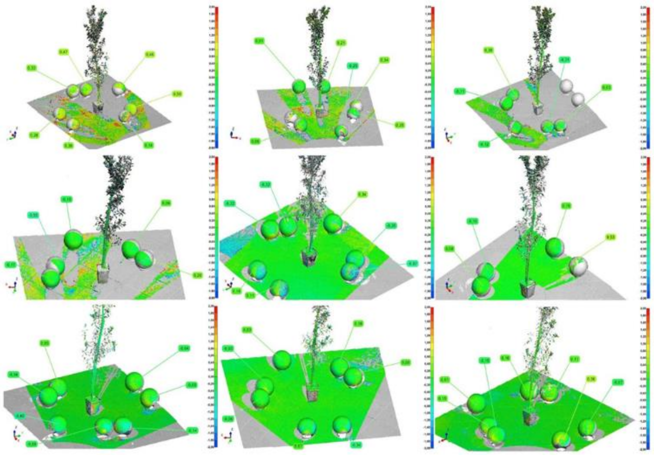
Tree architecture include plant habit, plant vigour and plant bearing. All these aspects strongly determine the suitability of cultivars to grow under different planting density and environmental conditions.

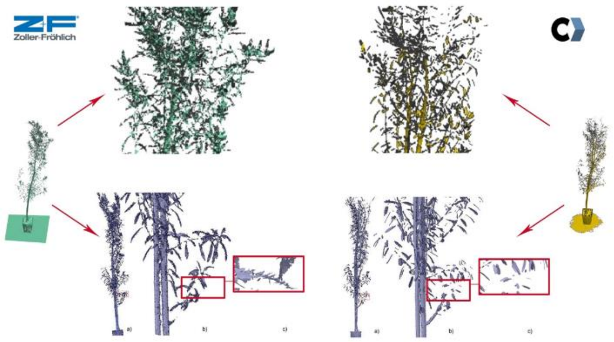
For this reason, it is very important to analyse natural tree architecture (no pruning regime) of different cultivars under different environments.

The study is very complex and involves the use of modern image capture and analysis systems.

Different methods are under evaluation and preliminary data have been obtained.

A critical analysis of tools and techniques for measuring tree architecture has been performed. The ability of Laser scanning and structured light scanning to capture some canopy aspects, such as 1-year shoot diameter, length and density, were considered.





Detail view of the meshes generated by Z + F IMAGER 5010X (left) and Go! SCAN 50 (right)

Wild or cultivated rootstocks, weed species and cover crops

Most of the traditional olive groves were made up by plants propagated by grafting on wild trees or, more recently, on cultivar seedlings. The ability of these rootstocks to determine the behavior of the whole plant in terms of tolerance to environmental stresses is very difficult to determine, because each rootstock is different from all the others and because the populations of wild olive trees are different from one environment to another.

As a general remark, we may assume that wild olives, growing in areas under specific environmental conditions, have been naturally selected for their adaptation to these conditions, thus, their use as rootstocks can play an important role in increasing the tolerance of the rootstock-scion combination to local environmental constraints.

A similar assumption may be considered for the role played by the weeds present in the olive orchards in improving the general conditions of the olive trees or the olive grove system as a whole. A list of the most common weeds present in some Italian orchards has been provided.

Concluding remarks

Based on the numerous studies conducted on different varietal sets under different climate constraints, it was possible to verify that the olive germplasm includes cultivars able to satisfy the growing conditions imposed by the changing scenarios due to climate change.

In particular, it was demonstrated that varieties from Western Mediterranean and from the West-center Asia (Iran) are the most suitable to be cultivated under high temperature and low water regimes.

Among the cultivars presently cultivated into arid areas and tested in temperate regions, some have shown very good adaptation and good ability to grow and produce. Among other, the cultivars Barri, Maarri and Abou Satl Mohazama from Syria demonstrated a performance similar to that of the most outstanding international cultivars such as Arbequina in terms of tree architecture, early bearing and fruit production.

For what concerns olive reproduction, a list of cultivars belonging to the two opposite groups of incompatibility is provided, as well as a preliminary list of best pollinators.

Olive cultivars may show a very different plasticity (differences) among different environments for fatty acid content. Information on cultivar response to the environment is particularly important for the spreading of olive growing into new areas of cultivation, or to face new climate scenarios.

Plant habit, plant vigour and plant bearing are main aspects of the olive cultivars to take under consideration to determine the suitability of cultivars to grow under different planting density and environmental conditions. Some methods of tree architecture evaluation are being tested.

The role played by wild olive rootstocks and the weeds present in the olive orchards in improving the general conditions of the olive trees and the olive grove system as a whole have been considered.

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