

CLUB OF BOLOGNA

*strategies for the development of agricultural
mechanisation*



34th Members' Meeting of the «Club of Bologna

Mechanisation and Technologies for New Farmers Needs

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**Global Olive Cultivation: Between Tradition and Innovation to
Preserve Oil Quantity and Quality in a Changing World**

EDDO RUGINI eddorugini@gmail.com



Eddo Rugini
Vice-president of National Academy of Olive and Oil

The term **‘Changing World’** refers here to:

Climate Change

Altered phenology, reduced yields, new pests/diseases, oil quality shifts

Policy Reforms

Evolving legislation to support and modernize the olive sector

Technological Advances

Innovation in propagation, cultivation, and oil extraction processes

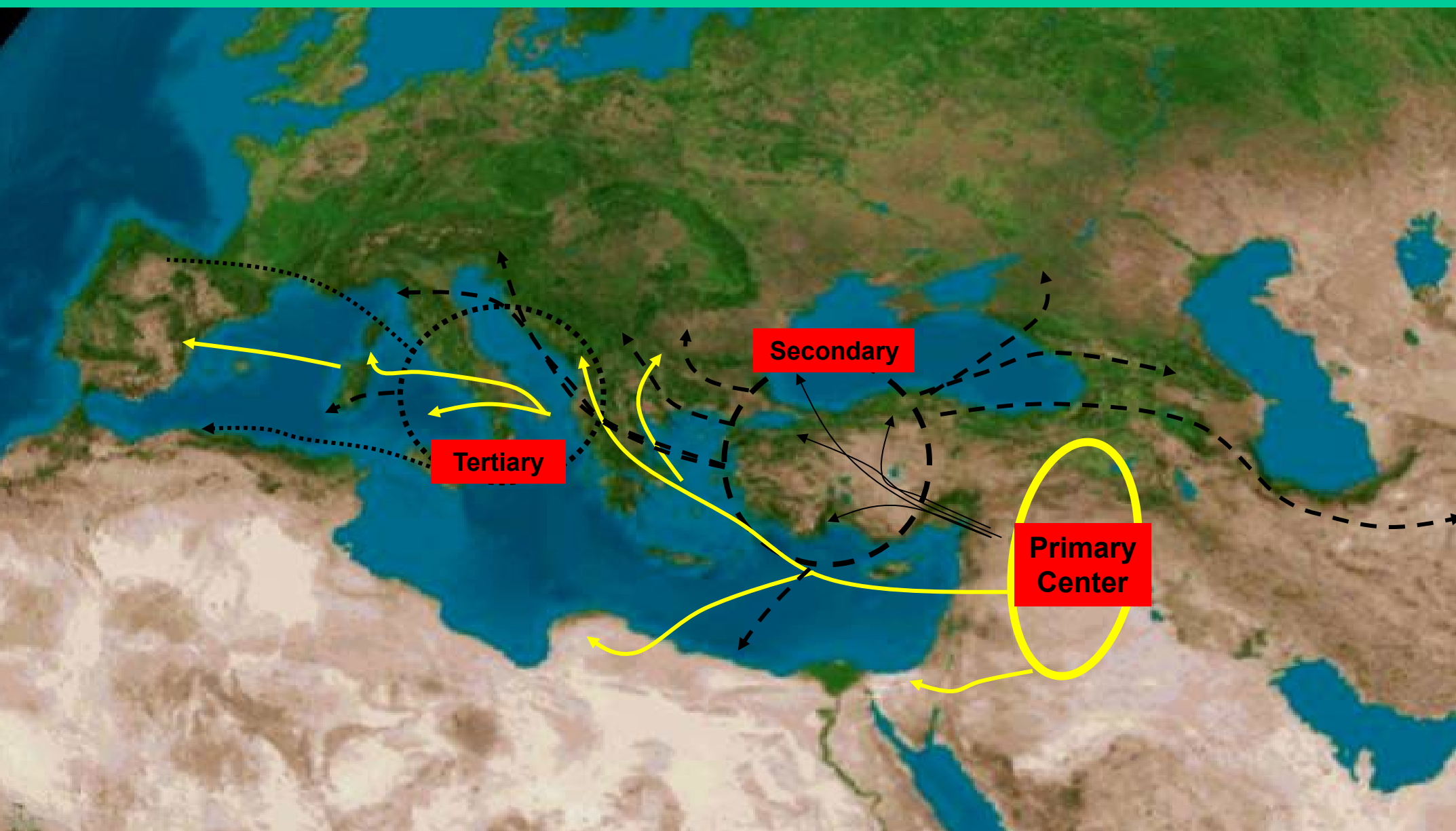
Market & Consumer Trends

Increasing global demand for authenticity, sustainability, and health-oriented high-quality olive products

This presentation examines how global olive cultivation combines tradition and innovation to address challenges, ensuring high yields, quality oil, and the olive tree’s multifunctional role.

More details and explanations can be found later in these slides on YouTube.

The olive tree, originated to modern-day Palestine and Lebanon, was domesticated 6,000–7,000 years ago and spread across the Mediterranean to Italy and Spain through the Phoenicians, Greeks, and Romans



TWO FORMS

O. Europaea Sativa

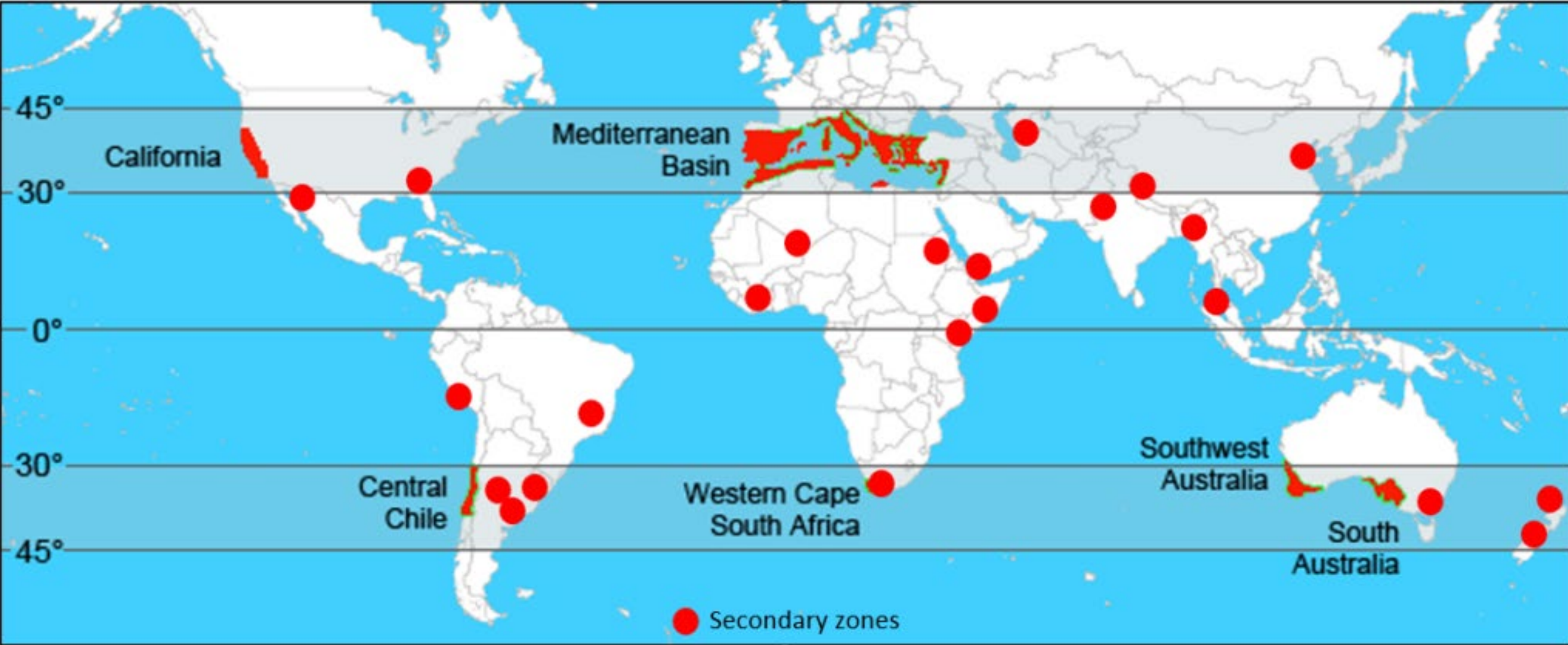
Cultivated but susceptible to:
-verticillium ,
-peacock eye ,
- Xilella ,
-

O. europaea sylvestris

Wild in the bush:
-small drupes,
- resistant to diseases
- contributes to domestication

About 90% of global production comes from the Mediterranean Basin (Spain, Italy, Greece, Morocco, Tunisia, Turkey)

The other part comes from OTHER COUNTRIES with similar climates (dry summers, mild winters (above -7 °C), California (USA), Argentina, Chile, Australia, as well as parts of China, South Africa, etc



In the Mediterranean Basin were identified over 1,500 varieties – but few are cultivated-

PDOs Protected Designations of Origin, *PGI* Protected Geographical Indications

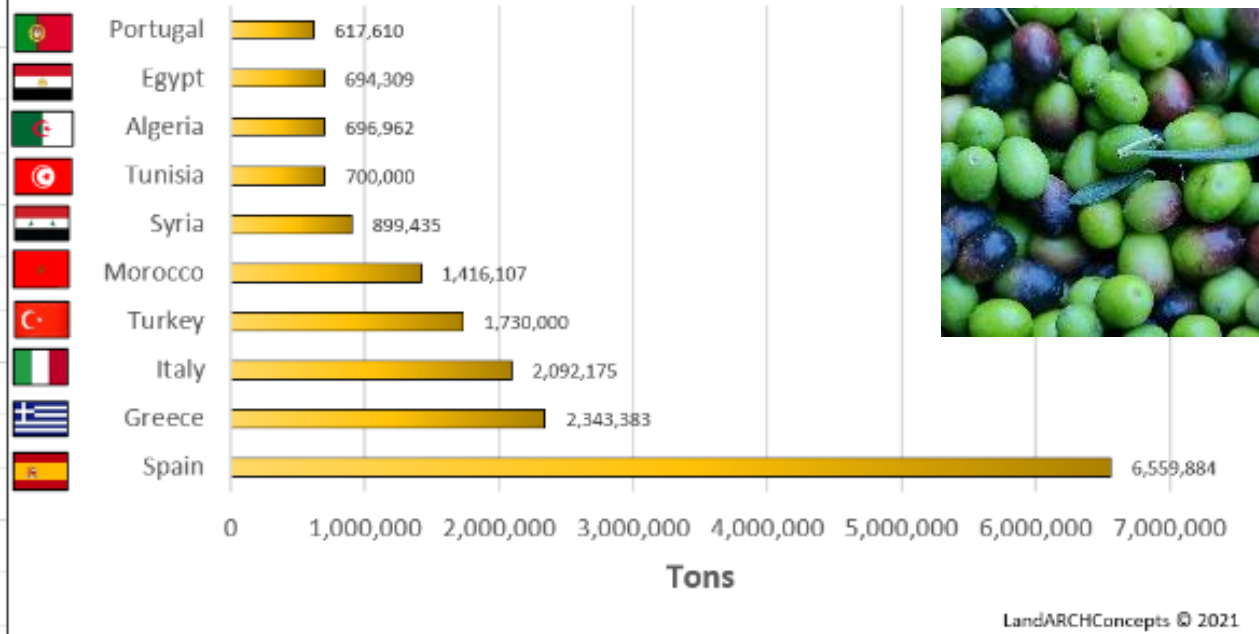
	Total varieties (n)	Main cultivated varieties	Incidence % of the main cultivated varieties on total Cultivated Area
Spain 33 PDOs	272	Picual, Cornicabra, Hojiblanca, Manzanilla de Sevilla, Arbequina, Morisca de Badajoz, Empeltre, Manzanilla Cacereña, Lechin de Sevilla, Picudo,.....	24 cv  95,7%
Italy 45 +5 PDOs 8 PGI	538	Coratina, Ogliarola Salentina, Cellina di Nardò, Carolea, Frantoio, Leccino, Ogliarola Barese, Moraiolo, Bosana, Cima di Mola,.....	24 cv  100 cv  42.7%
Greece	52	Koroneiki, Kalamon (Kalamata), Mastodois	3 cv  90,0%
Portugal	24	Galega Vulgar, Cobrancosa, Cordovil de Serpa	3 cv  96,0%
Tunisia	44	Chemlali de Sfax, Chetoui, Oueslati	2 Cv  85%
Morocco	6	Picholine Marocaine, Haouzia, Menara	1 cv  96,0%
Algeria	36	Chemlai de Kabylie, Siguase, Azeradj, Limli	4 cv  70,0%
Turckey	80	Memecik, Ayvalik, Gemlik	3 cv  75,0%
Siria	> 70	Zaity, Sorani, Doeblí Khodeiri	4 cv  85,0%

Outside the Mediterranean (2015-2025) the major producers are:

Country	2015 ha	2020 ha	2025 ha ()	CAGR (%)
Argentina	70.000	85.000	100.000	+3.5
China	30.000	50.000	65.000	+8.0
Iran	40.000	50.000	65.000	+4.9
Australia	30.000	35.000	40.000	+2.8
Chile	20.000	24.000	27.000	+3.0
Saudi Arabia	5.000	10.000	24.000	+19.2
USA	10.000	13.000	14.500	+3.7
Brasil/Uruguay	5.000	8.000	12.000	+7.8

- **They use advanced agronomic techniques** (intensive & super-intensive) - **Automation ensure high-quality oil production**
- Furthermore new **terroirs** give oils with **unique aromatic profiles** particularly with **Cultivar different** than international varieties (e.g., Arbequina, Arbosana, Koroneiki)
- ✓ Domestic consumption often exceeds production capacity
- ✓ Climate and water limitations in some regions (e.g., Chile, South Africa)

Total OLIVE FRUIT production (table+oil) = 7 million t



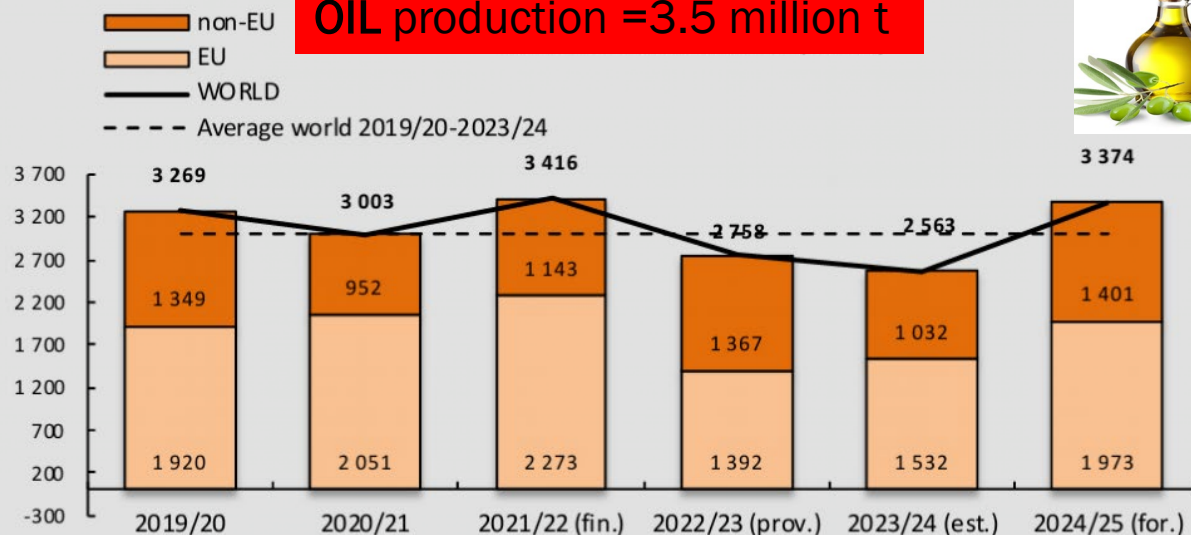
World **OLIVE FRUITS** are increasing for:

- Intensive plantation in non-traditional areas
- Improved cultivation techniques

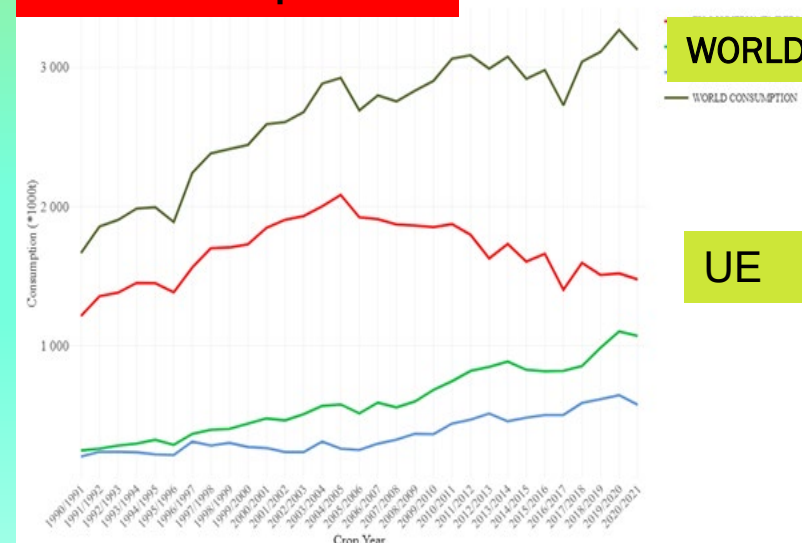
Traditional countries exhibits fluctuating yields over the years due to:

- climate change,
- alternate bearing,
- agricultural management adopted,
- socio-economic conditions (rising production costs, abandonment of marginal groves),
- lack of new plantations

OIL production = 3.5 million t



OIL consumption



The PRICE of EVOO ? *depends on various factors*

Price € / liter (varies from 5 -40 ?)



Types and Characteristics

- **Novel Oil** – *Early Harvest- pungent (PFF)*
- **Suit Oil** – *Late Harvest- sweet -milder taste*
- **Typical oil (Regional)** – *distinct aroma – terroir-*
- **Monovarietal Oil**

□ **Cultural factors** History, Art, Landscape, Tradition

□ **Productive factors** PDO, PGI, ORGANIC,

□ **Official Quality parameters**

□ **Hedonistic factors** flavor, aroma (Pitted, Fruity, origin) which affect consumer preferences

The olive tree is a multifunctional plant that offers significant ecological, cultural, and economic benefits.

- Integral part of the landscape
- Protect the territory



Assisi-Spoleto olive landscape — pending UNESCO World Heritage status- Italy's first FAO GIAHS site;



- Integral part of History & Culture

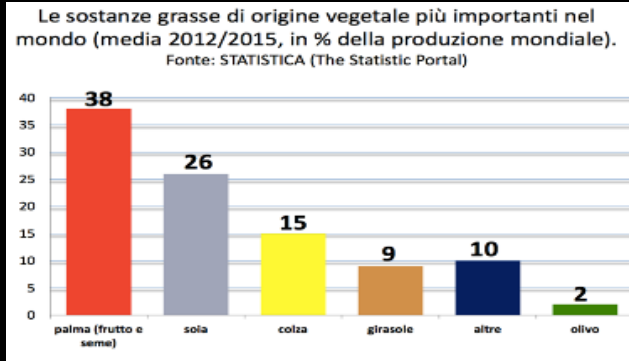


- Basis of the Diet and Health

it's not a condiment but it's a real food

- Important part of the Economy

although is 2% of vegetable fats



Today, 3 distinct types of olive groves. All need to be improved in terms of climate resilience, innovation, and socio-economic sustainability.

Traditional (Extensive)



< 200 plants/ha

Yield < **2** t/ha

Intensive



300-600-1000 plants/ha
Low, medium, high density
(vase, globe, palmetta,.....

Yield ~ **5- 10?** t/ha

Super-intensive (SHD)



>1000 plants/ha

Yield > **10** t/ha

Traditional groves

- ✓ Old plants
 - ✓ Large, irregular plantation
 - ✓ Located in High hills, deserts ..
 - ✓ Steep terrains
 - ✓ Low productivity
 - ✓ low mechanization
 - Multi-stemmed plants,
 - High number of cultivars
 - Small farms
 - we have a duty to maintain and improve
- ✓ **Variability in oil quality (HIGH-LOW)**
- **REFORM PRUNING** often is necessary to facilitate the transition to mechanization



Reform pruning



Intensive groves -low, -medium, -high density

- ✓ Regular Planting with a single trunk
- ✓ Achievable with all cultivars
- ✓ Full production 7-10 years after planting; high production (5/6 – 8/12 t/ha)
- ✓ Pruning and Harvesting mostly are mechanized (Trunk or branch shakers----trunk vibrators equipped with interceptor frame--- Comb/Vibrating Rakes --.....)
- ✓ Mostly are irrigated
- ✓ Subjected to modern agronomic practices (fertigation, biostimulants, sensors, etc.)



Super-intensive (SHD) groves

- ✓ High initial planting costs
- ✓ Formation of a continuous hedge-like canopy
- ✓ Early productivity: starts at 2nd–3rd year
- ✓ Mechanical harvesting with straddle harvesters: 1–4 ha/h
- ✓ Requires large-capacity mills for rapid olive processing
- ✓ Absolutely requirement of irrigation

- Full yield in 3–6 years: 8–13 t/ha
- Use of 40–50 cm tall nursery plants

✓ Requires suitable cultivars with:

- Reduced growth habit
- Disease resistance
- Drought tolerance

NO or FEW suitable cultivar at present

from: Camposeo S.



Planting



Pruning



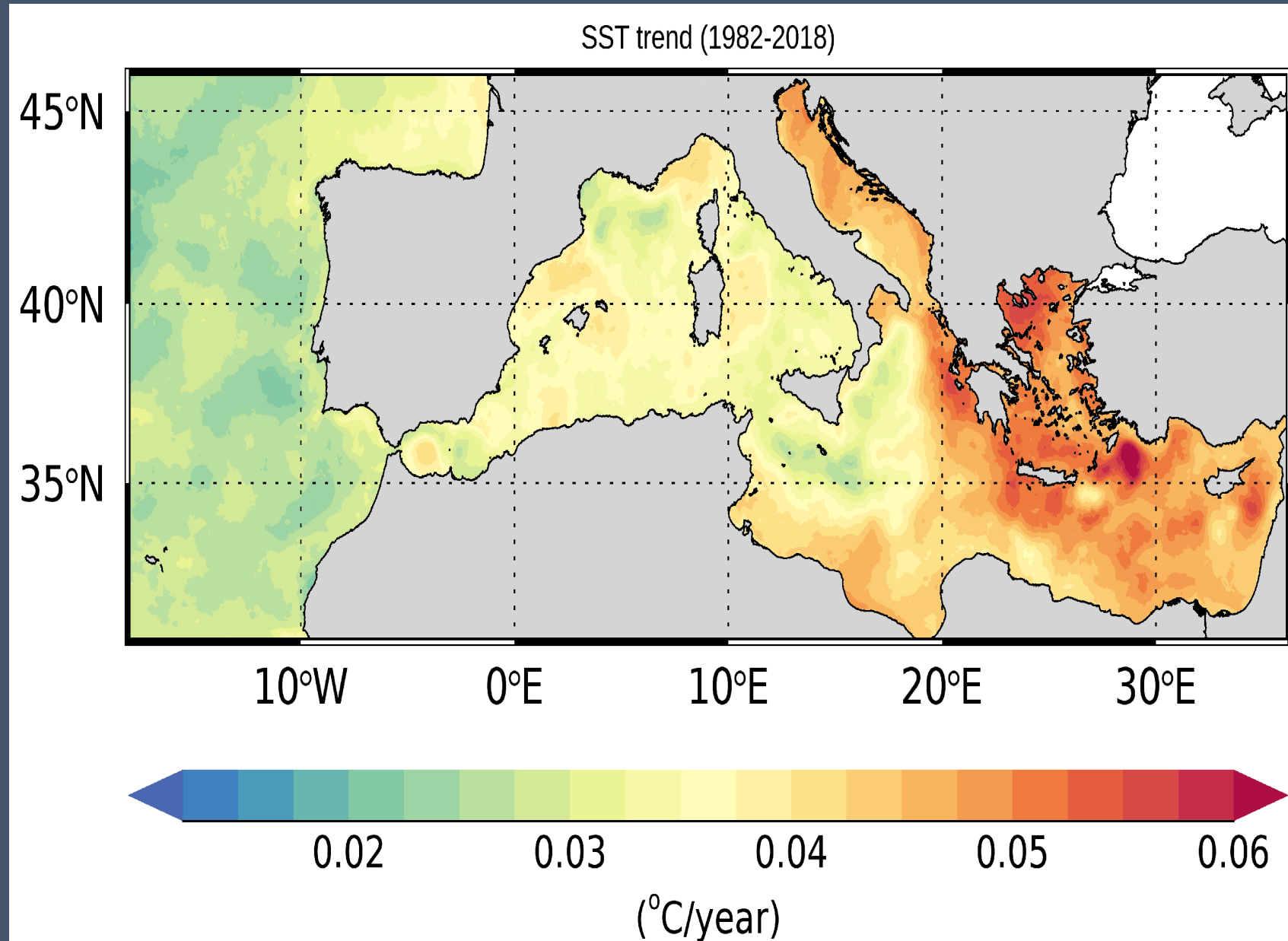
Harvesting

Climate Change Negatively Affects All Olive Cultivation Systems

especially in the Mediterranean Basin, T° increase faster than other areas

...Summer temperatures have risen ~20% faster than the global average since 1980, with well known consequences:

- High frequency of long dry period
- High frequency of heavy rain
- Severe water shortages
- Fires
- Ecosystem stress



The Temperatures Negatively Affect Olive Plants and Oil Quality

on PLANT

WINTER

-the low T° not sufficient in Satisfying Chilling Requirements: reduction flowering differentiation

SPRING

- Earlier bud-break & flowering are at risk of frost (10–15 days) (less pollen, ovary abortion)
- High T° reduced fruit set and increased fruit and leaf drop

SUMMER

- The Ozone formation (O₃) induce Cellular dead-
- The early ripening Reduce Oil content for (up to –30%)
 - *photosynthesis inhibition*
 - *shorter period of fruit exposure on the tree*



on OIL

- Accelerate fruit ripening → early senescence, lower oil quality
- Reduce polyphenol content → lower antioxidant value & shelf life -
- Increase both acidity and oxidative degradation
- Alter volatile compounds → diminished aroma and flavor complexity
- Alter fatty acid composition (oleic, linoleic, linolenic)



Two examples of Effect of high T° on Oil composition

(fatty acids) Oleic acid (%) variation

- The same cultivars grown in hot regions produce oil with low Oleic acid

Variation of fatty acids :

Oleic acid (show)

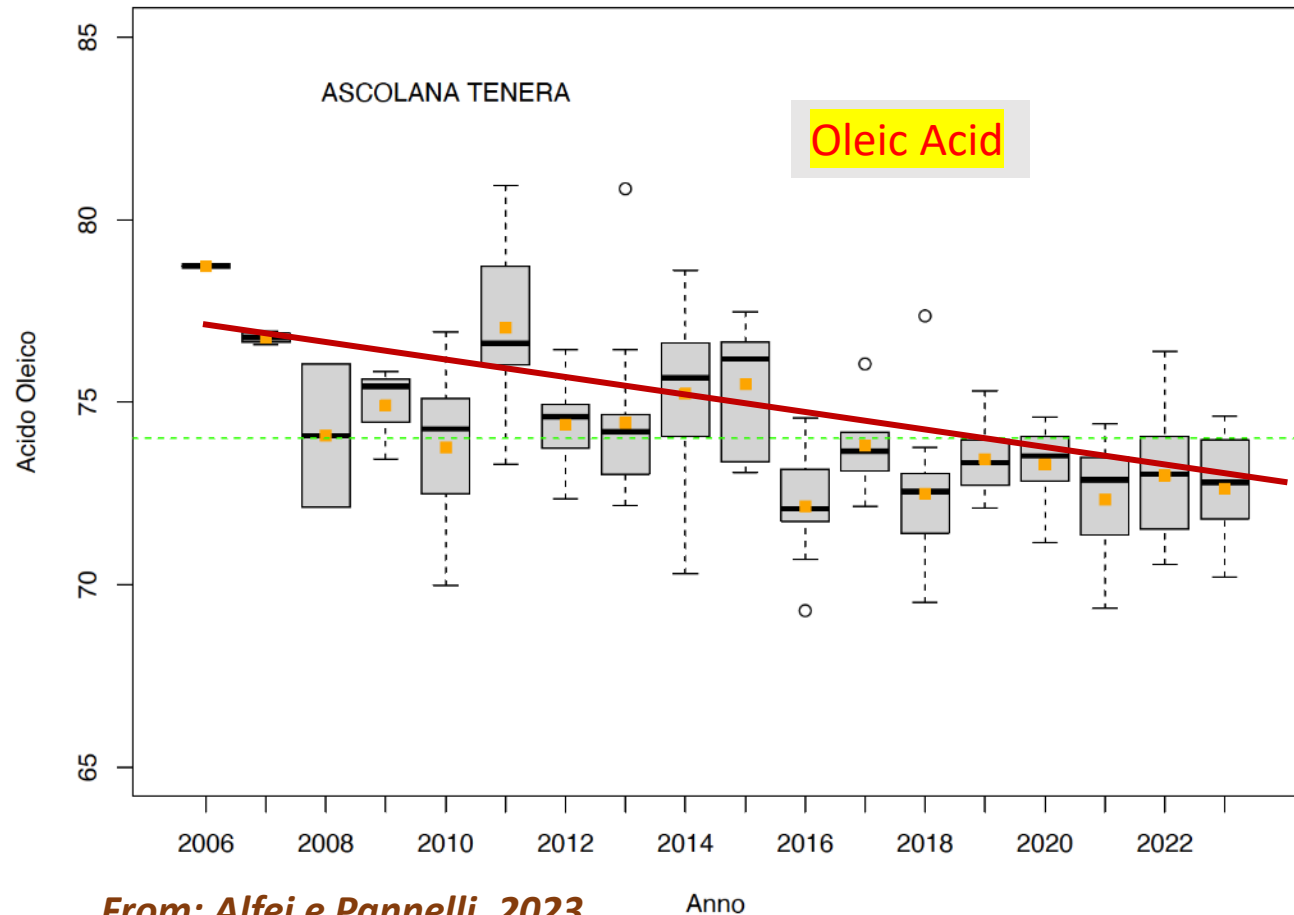


hot fresh

Cultivar	Origine	Palmitico C16:0	Palmitoleico C16:1	Stearico C18:0	Oleico C18:1	Linoleico C18:2	Linolenico C18:3
Arbequina	Argentina	20.66	3.69	1.53	53.39	18.72	1.16
Biancolilla	Argentina	16.31	1.81	1.80	70.47	7.34	1.12
Biancolilla	Italia	11.61	0.52	2.23	74.10	9.81	0.69
Cerasuola	Argentina	13.75	0.51	1.87	70.98	10.84	1.12
Cerasuola	Italia	9.86	0.22	2.54	76.83	9.34	0.51
Coratina	Argentina	16.29	0.67	1.77	71.50	7.99	1.27
Coratina	Italia	12.36	0.51	2.1	75.43	7.94	0.72
I-77	Argentina	15.34	0.91	1.52	70.52	9.54	1.45
I-77	Italia	9.82	0.50	1.58	80.54	5.82	0.70
Frantoio	Argentina	17.19	1.65	1.63	63.55	14.03	1.23
Frantoio	Italia	12.34	1.01	1.65	75.77	8.04	0.55
Kalamata	Argentina	12.93	1.46	1.78	65.79	16.04	1.33
Kalamata	Italia	9.87	0.61	1.52	78.95	6.56	0.72
Leccino	Argentina	17.39	1.16	1.71	68.45	9.19	1.43
Leccino	Italia	13.23	1.25	1.53	77.96	4.54	0.68
Peranzana	Argentina	18.16	1.79	2.21	62.57	13.08	1.37
Peranzana	Italia	12.27	0.80	1.86	76.45	7.21	0.58

From: Caruso T. et al. 2023

- Panel and Test Commission registered a progressive decline in oleic acid content in Ascolana Tenera olive oil samples over a 20-year period



High T° adversely affect also SOIL

1. Structure

- Increased evaporation
- Drying and compaction
- Alteration of soil profile temperature
- Increased soil erosion down hill for a heavy & sudden rains

2. Chemistry

- Acceleration of organic matter mineralization.
- Increased salinization
- Nitrogen volatilization

•3. Microbiology

- Reduced microbial activity
- Selection of microorganisms more resistant to heat and drought,
- Loss of soil biodiversity

Promote a rapid decline of organic matter and a loss of soil fertility



Several Strategies Can Be Adopted to Protect Olive Cultivation

-Traditional groves

-New groves (intensive – super intensive)



Agronomic & Cultural Practices

- Regulated deficit irrigation (RDI)
- Mulching → reduces soil temperature & evaporation
- Balanced pruning → avoid overexposure
- Soil organic matter improvement
- Shading nets / agrovoltaics



Technological & Innovative Solutions

- Propagation method
- Precision agriculture (sensors, drones, AI monitoring)
- Antitranspirants & biostimulants
- Kaolin & particle films → reflect light,
reduce leaf temp & sunburn



Genetic & Breeding Approaches

- Selection of heat-tolerant cultivars
- Breeding programs for thermotolerance & efficiency
- Biotechnological tools (somaclonal variation, CRISPR, GMOs)



Policies supporting sustainable income growth

- Price Premiums,
- Sustainability Credits (e.g., Carbon Credits), and Incentives for Low-Impact Producers
- Promote efficient use of all olive products (wood, leaves, fruits) and **by-products** (pomace, leaves, wastewater, olive kernel)

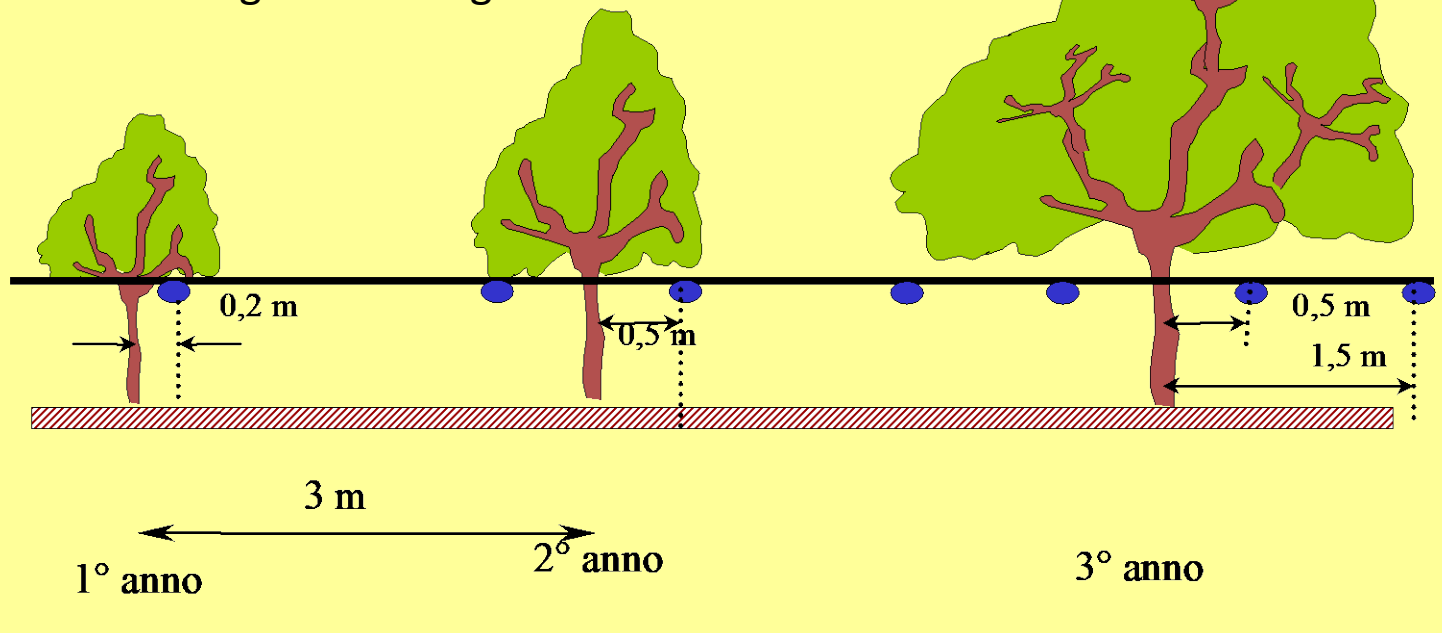
PRIZE FUNDINGS from ? **nothing goes to waste-**

- savings due to landslides caused by abandoned olive groves,
- more income from tourism
- animals raised among the trees



Sufficient a Partial Restoration (40–60%) of Evapotranspired Water to prevent water stress

a. Micro-flow irrigation systems: represent the most efficient and ecologically sustainable method for water management in agriculture



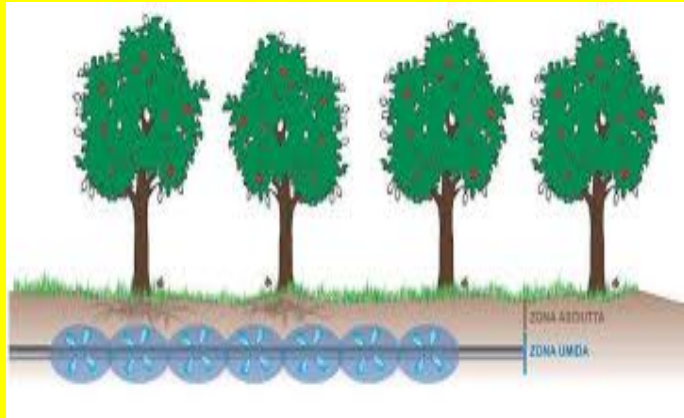
Potential Negative Effects of Irrigation:

- Higher incidence of *Verticillium dahliae* due to increased soil moisture?
- Increased olive fruit fly (*Bactrocera oleae*) pressure: larger fruits may support more generations?
- Reduced polyphenol content in the oil?
- Increased oil acidity?
- Lower oil yield during extraction (possibly due to technological limitations, not actual oil content)?

From Famiani et al..., Gucci R. et al.

b. Sub-surface irrigation represents the best option, although its adoption is still limited and only gradually expanding

water is delivered directly to the root zone through a network of buried pipes or drip lines. This system minimizes surface evaporation and runoff, enhances water-use efficiency, and reduces weed growth and disease incidence by keeping the soil surface dry. It is particularly suitable for high-value crops and areas with limited water availability



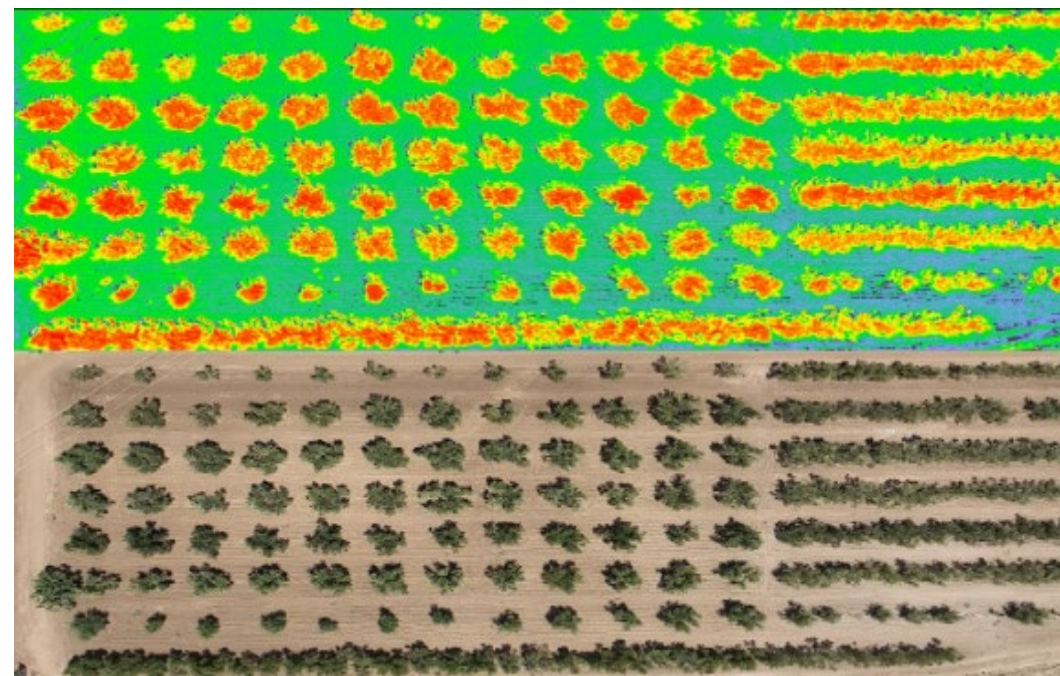


- **optimize inputs**
- **maximize efficiency**

- irrigation
- plant nutrients
- Early Disease Detection
- ...



- Several Devices are Available
- Multispectral drones
- Thermal drones
- Laser scanning 3D
- ❖ World view3 (satellite)
- Georadar





Cover cropping or **Mulching** -permanent grass cover
-temporary forage crop

- *Increase organic matter,*
- *Prevent erosion,*
- *Improve soil health,*
- *Enhances ecological balance (microbes..)*
- *Allow machinery to pass after rainfall.*

Chipping olive pruning branches

- *Increase organic matter*

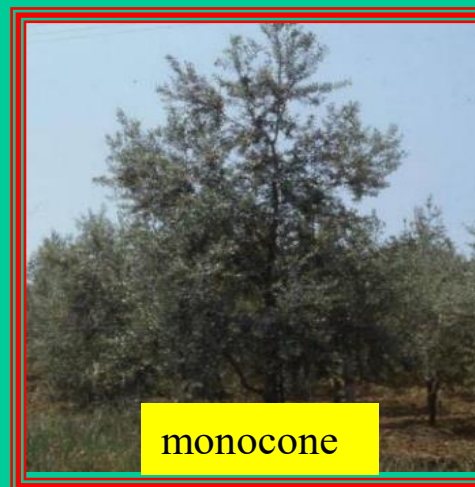
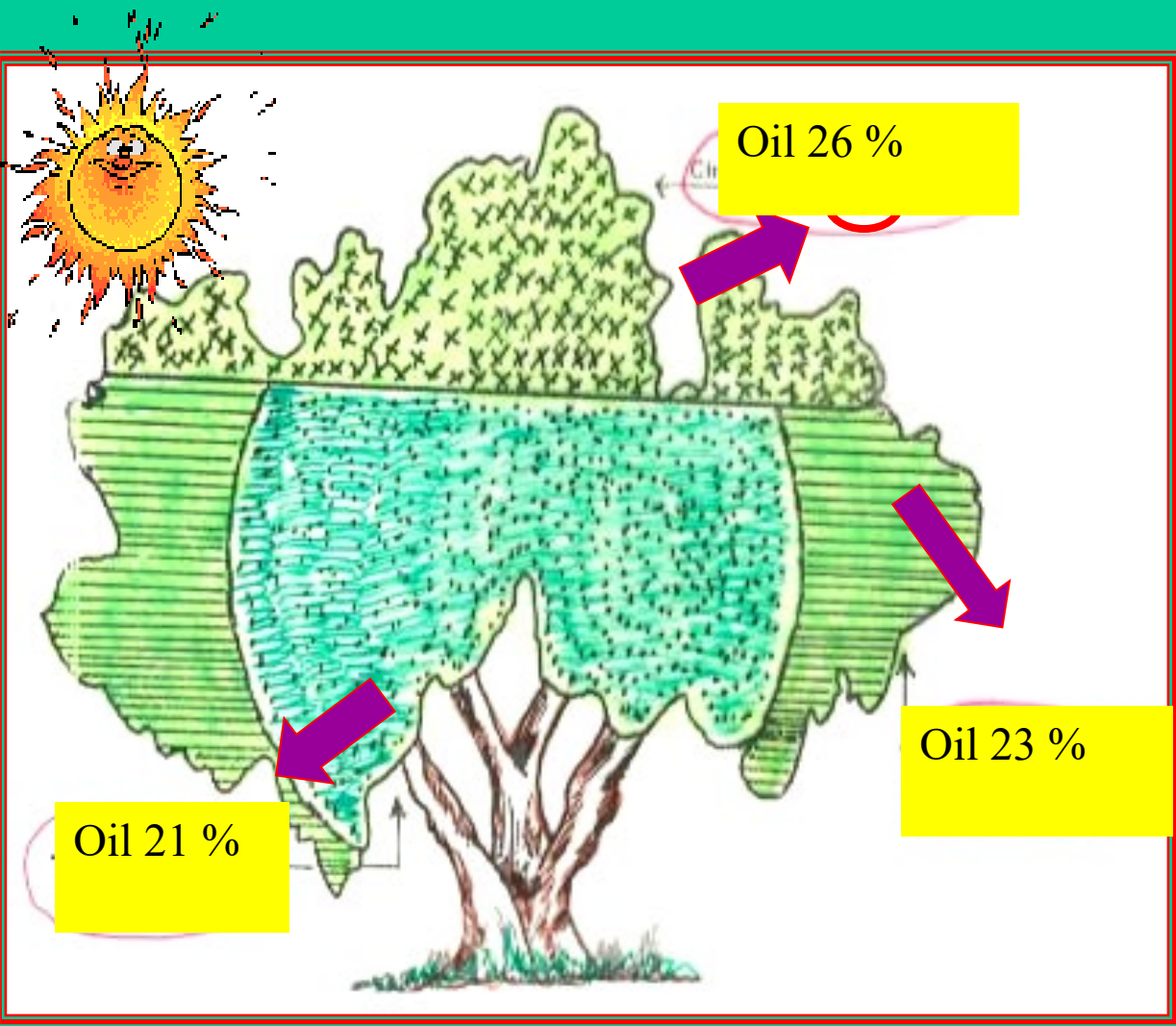
Application of

- mature manure
- compost
- biochar
-



Olive tree requires plenty of light throughout its canopy to enhancing oil yield, improving oil quality, reducing disease pressure, and maintaining branch balance - this can be achieved through an appropriate training system and rational pruning.

In the shaded areas of the canopy, fruit weight, oil content and quality tend to decrease





Manual (every year) – **Mechanical** (periodically) - **Balanced pruning** promotes good yield and plant health



No pruning



Light



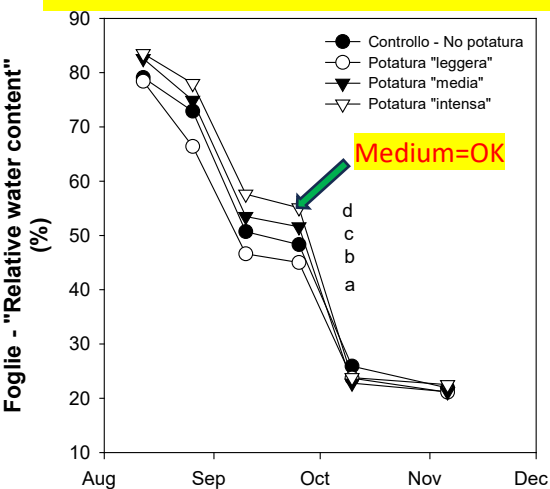
Medium

increases



Intense

"Relative water cont. LEAVES"



"volatile compounds"

Pruning intensity	(E)-2-hexanal (µg/Kg oil)	total aldehydes C5 - C6 (µg/Kg oil)
No pruning	20985 a	21907 a
Light	20034 a	21296 a
medium	23022 b	24178 b
heavy	24233 b	25234 b

"phenolic compounds"

Total phenolics (mg/Kg oil)
810 d
708 c
566 b
470 a

"OIL yield"

OIL (kg/plant)
2,4 b
2,4 b
2,9 c
1,9 a



Benefits:

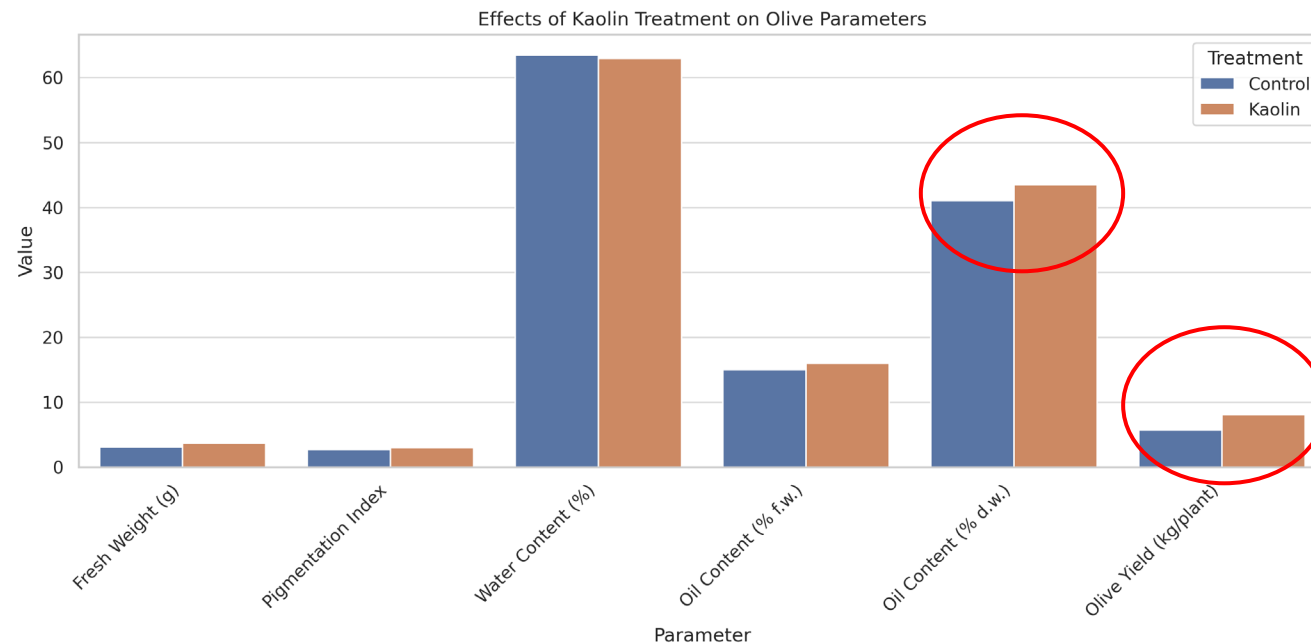
- Reduces canopy temperature by 3–5°C
- Decreases water loss through transpiration
- Improves photosynthesis under high temperature
- Protects from solar radiation stress

Limitations:

- Effectiveness varies with climate and cultivar
- Cost of repeated applications

Effects of Kaolin results

+ oil content on dw
+ Olive yield

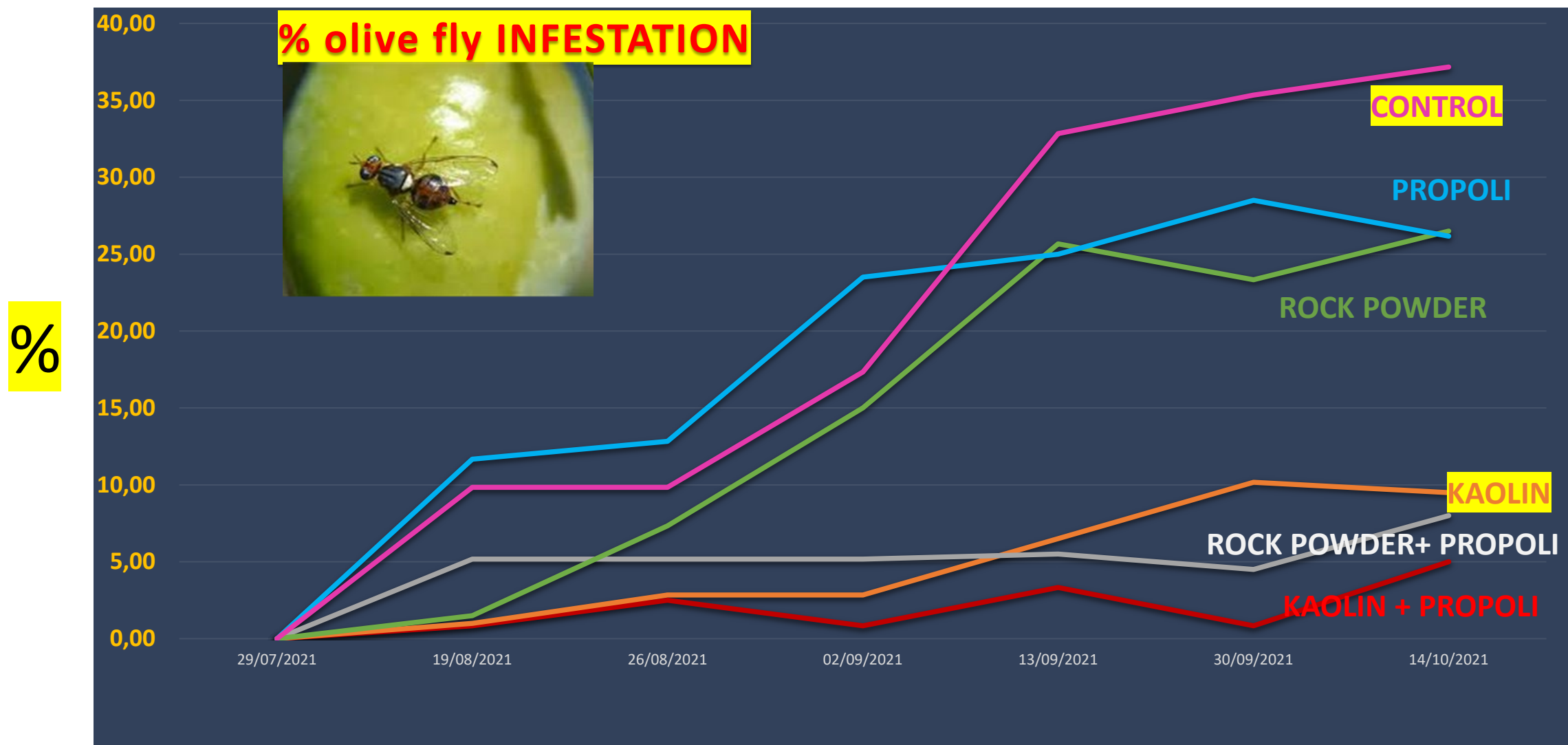


Conclusion: Kaolin and rock powders are promising low-impact tools to enhance the resilience of olive trees to climate stress, but require tailored management and economic evaluation.

Adapted from Famiani F."



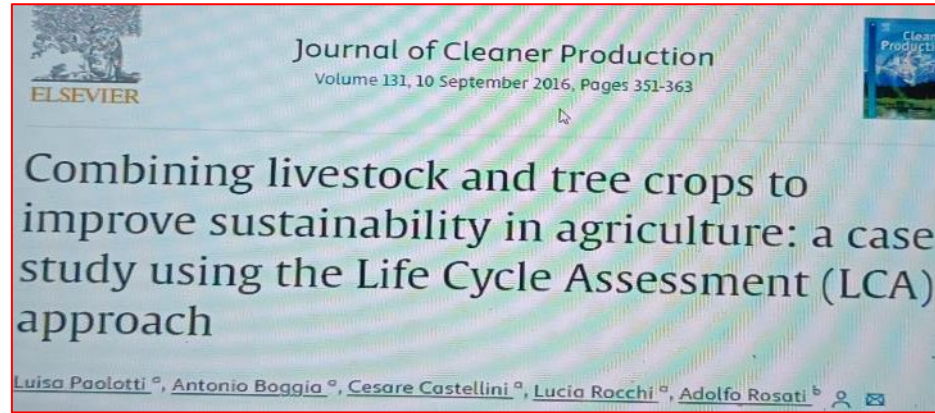
by interfering with host recognition





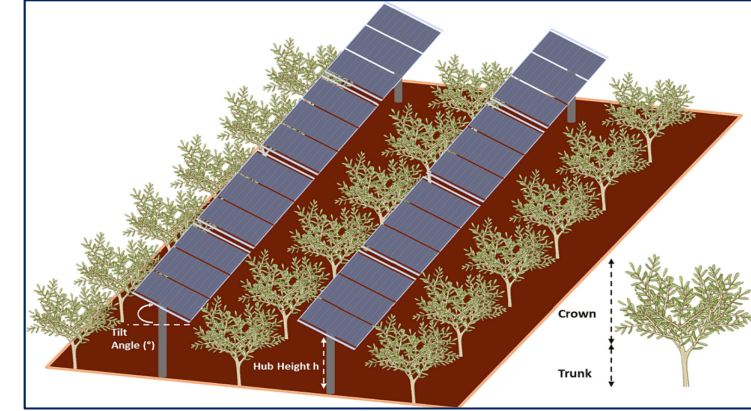
Agronomic & Cultural Practices : adopting **SUSTAINABLE MIXED FARMING**

(Grazing sheep, poultry, cattle)



Goal: higher quality, lower environmental impact:
Positive for animals and for Olive

- **Livestock**
 - produce *better meat, milk, cheese*
 - *fertilize,*
 - control *weed, pest*
- **Complementary crops** (e.g. asparagus, fodder grass.....)
- **Agrovoltaics** (solar panels + crops)



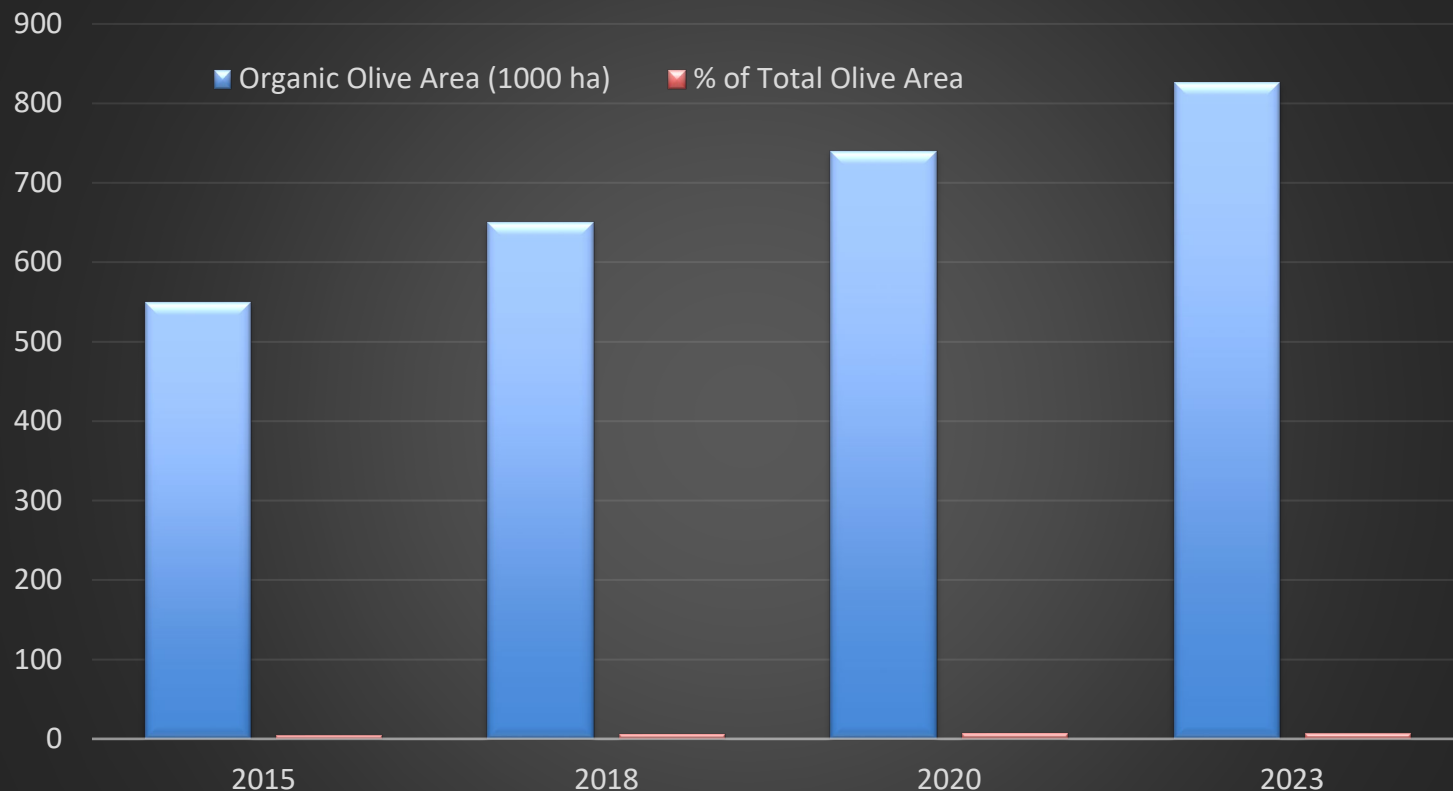
Adapted from Rosati A. et al

  Agronomic & Cultural Practices : adoption of **ORGANIC OLIVE cultivation** to * reduce environmental impact
* meet growing market demand

Olive is best suited to organic cultivation (its high tolerance to water scarcity)

In 10 years, an increase of about 32% (2022)."

Evolution of Organic Olive-Growing Area Worldwide (2015–2023)



Total area of organic olive cultivation worldwide (2023)
~825,000 hectares.

Spain: ~262,379 ha;
Italy: ~243,089 ha;
Tunisia: ~173,171 ha;
Greece: ~58,840 ha;
Turkey: ~56,014 ha;
Portugal: ~25,633 ha.

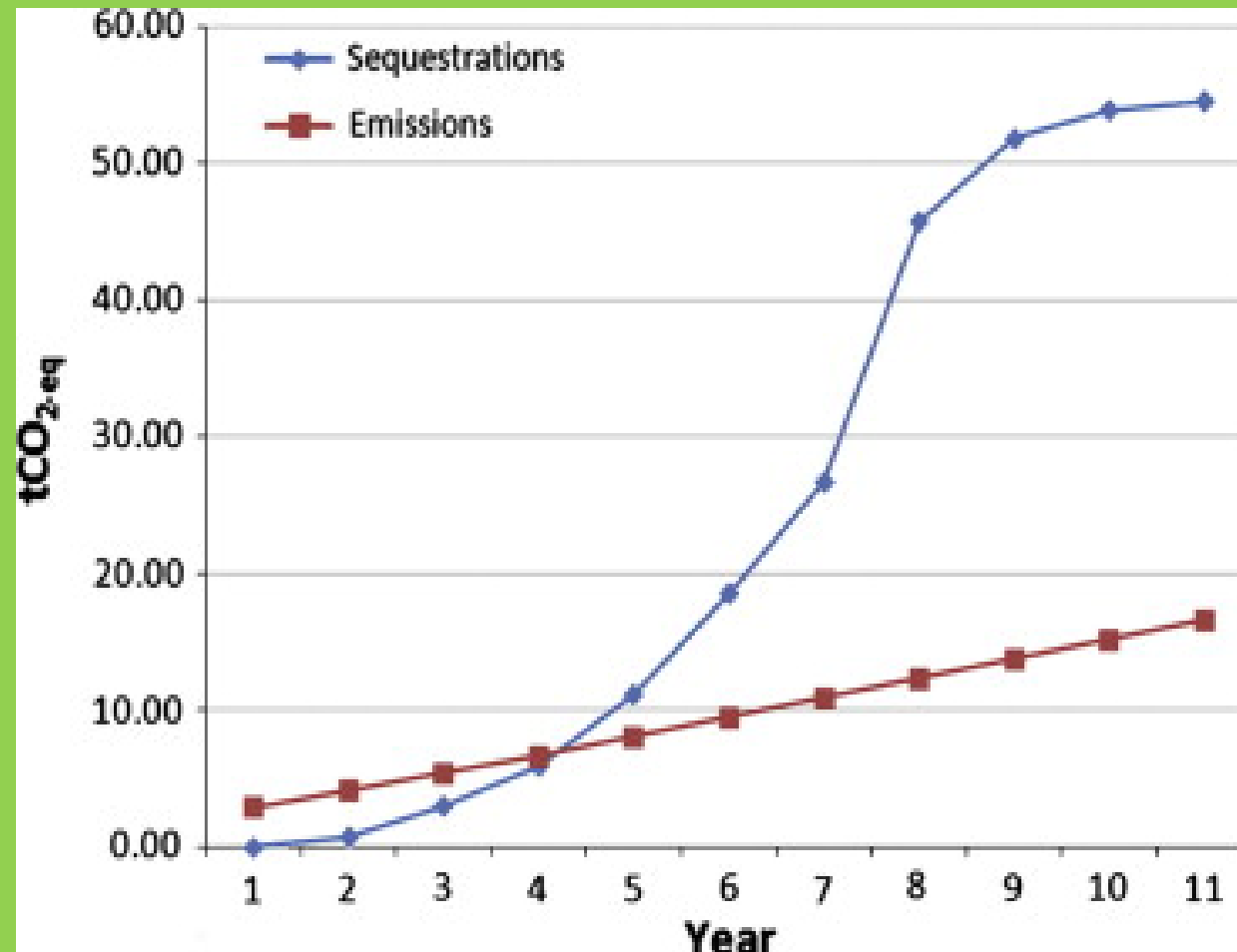


Policies supporting sustainable income growth — **ADDED VALUE** -

CARBON CREDIT

- OLIVE OIL TURISM

Olive groves is ideal plant for **CARBON CREDIT** because has a **POSITIVE Carbon sequestration/emission** balance



OLIVE OIL TURISM as a Strategic Opportunity



- provides an additional source of income
- promotes environmental awareness and sustainable practices.
- combines innovation with cultural heritage.
- means transforming olive groves into cultural and educational landscapes

Comparison between olive grove cumulative CO_{2eq} emissions and sequestrations.

from: Proietti et al., 2014

For the New Olive Orchards?

- **Apply Correct Orchard Design**

- ✓ Select planting density based on: mechanization, land slope, terrain, water availability, soil fertility,
- ✓ Align orchard goals with market demands (oil quality, certifications).
- Use precision farming to optimize resources (promote water-saving practices)
- Apply regenerative, low-input practices to reduce chemicals and assess carbon footprint/sequestration.
- Implement monitoring systems for adaptive management.
- Consider labor availability and preserve cultural landscapes when relevant.

- **Choose high quality plants**

- Use Certified plants
- Cutting, grafted , micropropagation (preferable)

- **Select cultivars of high-quality, well-adapted, preferably local varieties to preserve biodiversity.**

- ✓ Choose among international germplasm collections (28 active local and international Center - 2,280 ? olive varieties preserved in major IOC-partner banks).
- ✓ with high and stable yield, oil quality,
- ✓ pest and disease resistance
- with high tolerance to water and heat stress and rainfall-adapted
- suitable for mechanical pruning and harvesting –low vigor-).



Technological & Innovative Solutions – **PROPAGATION METHODS-**

High quality plants in the market



For
establishing new
intensive and
super-intensive
olive orchards

For
eventually
interplanting
young olive
trees to increase
density in old
groves



highest guarantee for
propagation material



CAC Plants (Conformitas Agraria Communitatis) (orange label)

- Plants that meet basic EU requirements
- Tru to type and basic health checks.
- No specific certification program

Certified Plants (are marked with blu label)

- From an **official certification program**.
- Guarantee **genetic** and **sanitary** controls (virus free).
- Propagation under officially controlled conditions
- Guarantee of high quality, authenticity, traceabil



Agronomic innovation *(Propagation method)*

-Semihard-cutting (2-5 nodes) easy-to-root cultivars in use since the 1970s (In Italy 70%)

-Grafting on seedling- rootstocks *dry well-drained loose soils or windy soils to improve anchorage (taproot)*

-Grafting on clonal- rootstocks *Currently few specific rootstocks are available (to reduce size- resistance to Verticillium)*

- Micropropagation - emerging technique - The technique has been available since more than 40 years (Rugini 1984) but has only been adopted in recent years and has several advantages

Combines advantage of grafting on seedlings with cutting



Cutting
Uniform Plants



Grafting on seedl.
Non-uniform Plants



Micropropagation
Uniform Plants

OLIVE MEDIUM FORMULATION	
All the compounds are reported as mg/L.	
Macroelements	
• KNO ₃	1100
• NH ₄ NO ₃	412
• Ca(NO ₃) ₂ · 4H ₂ O	600
• CaCl ₂ · 2H ₂ O	440
• KCl	500
• MgSO ₄ · 7H ₂ O	1500
• KH ₂ PO ₄	340
Microelements	
• FeSO ₄ · 7H ₂ O	27.8
• Na ₂ EDTA	37.5
• MnSO ₄ · 4H ₂ O	22.3
• H ₃ BO ₃	12.4
• ZnSO ₄ · 7H ₂ O	14.3
• Na ₂ MoO ₄ · 2H ₂ O	0.25
• CuSO ₄ · 5H ₂ O	0.25
• CoCl ₂ · 6H ₂ O	0.025
• KI	0.83
Vitamins	
• Myo-inositol	100
• Thiamine. HCl	0.5
• Pyridoxine. HCl	0.5
• Nicotinic acid	5.0
• Biotin	0.05
• Folic acid	0.5
Amino acids	
• Glycine	2
• Glutamine	2194

OM (Rugini, 1984) -
DUCHEFA- PhyTech
- Lab hygenera

Advantages of Micropropagation in greenhouse



1. In vitro production
Apical shoots



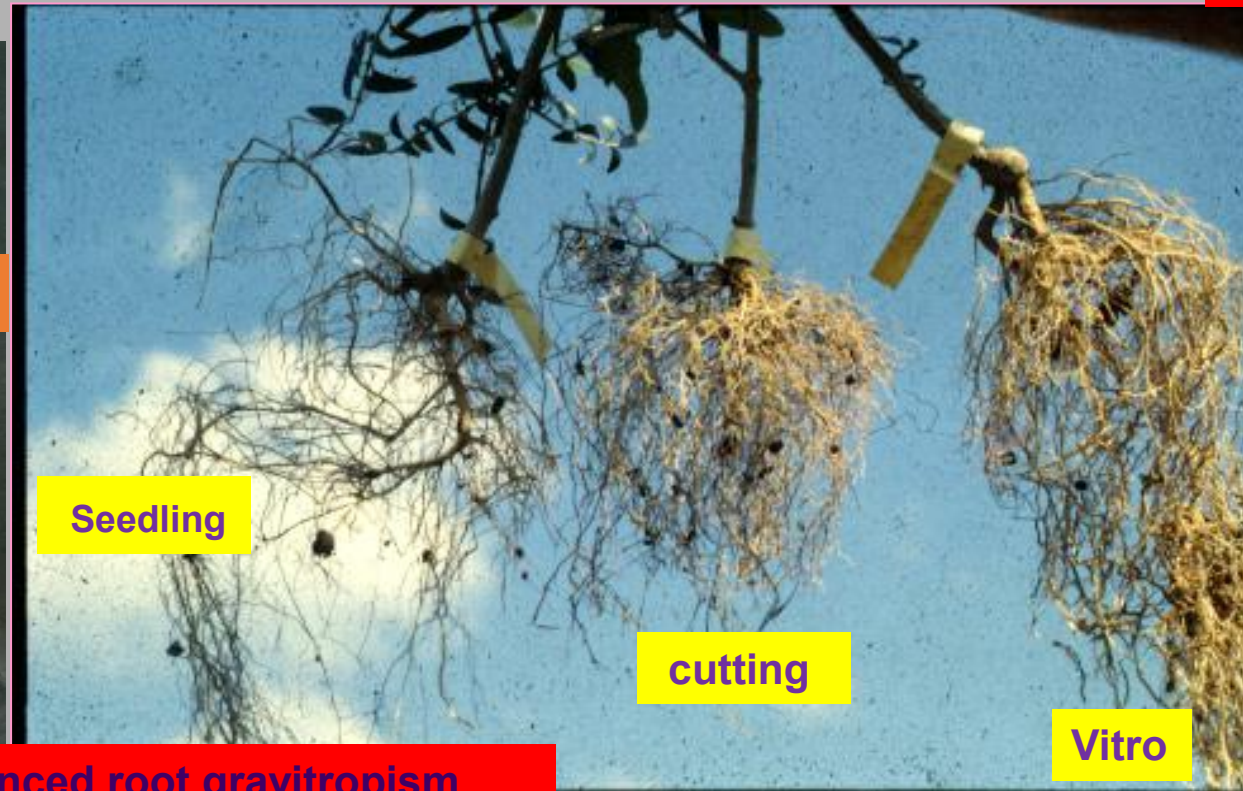
2. Greenhouse rooting almost all cultivar



3. NO tutor in nursery



4. Pronounced root gravitropism
dense root system Tending downwards



Rugini et al 2000; Zuccherelli –Neri 2020

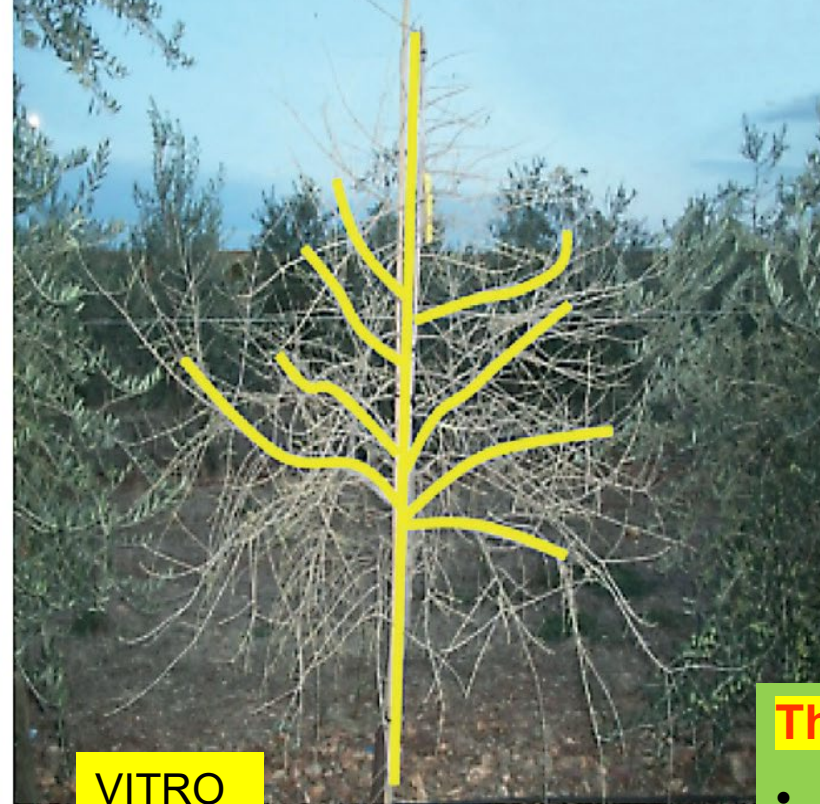


5. Regular canopy

Advantages of Micropropagation in the field



CUTTING



VITRO



The Micropropagation ensures:

- Genetic and sanitary uniformity
- Large quantitative in short time period
- Deep roots adapted to dry, windy soils
- Uniform, regular canopy structure
- High yield from second year due to **“reinvigoration”** which speed up initial growth



K= Control

vs

M1, M2, M3,...



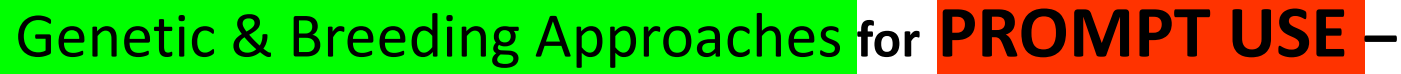
Cv Moraiolo



Cv Canino

Remarkable growth of mycorrhizal plants

From Rugini E.

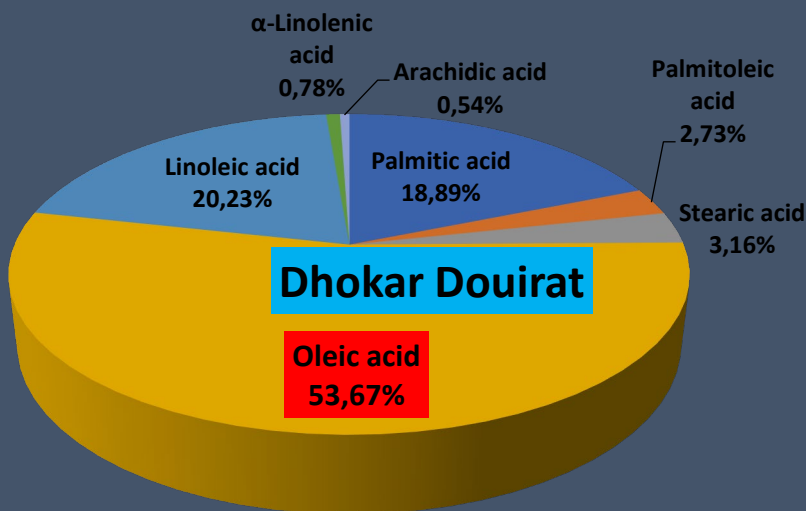
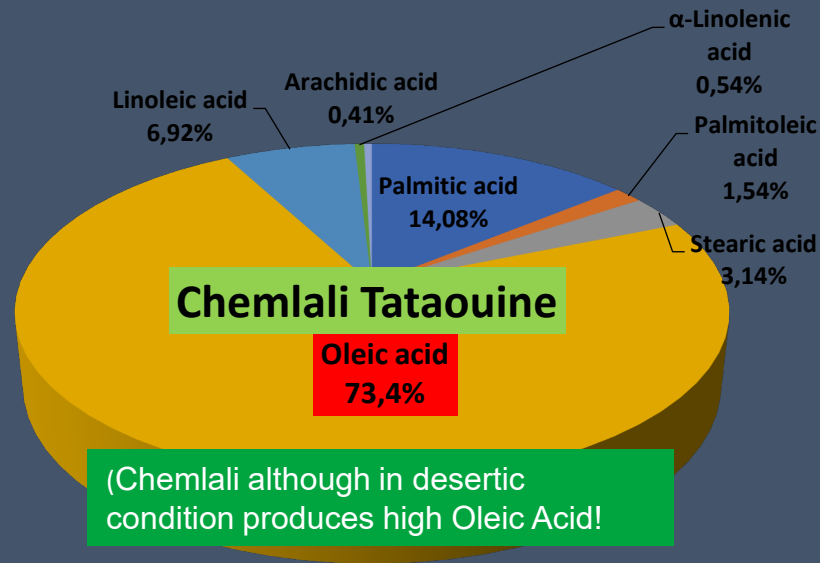


- **Cultivars resilient to stresses**
- **High consistent fruiting;**
- **Reduced vigour**
- **Diversified ripening times** (to ensure a continuous supply to the mill)
-

[illegible]

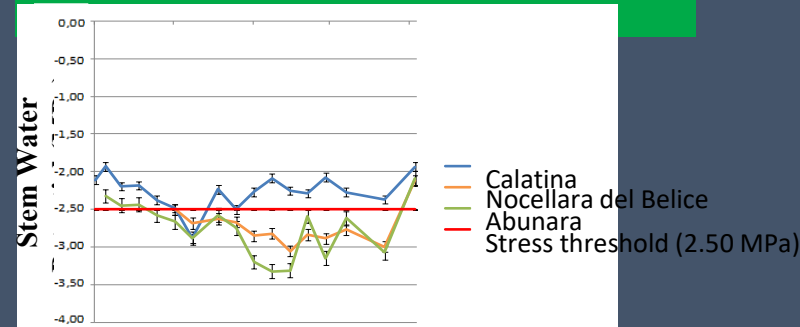


Genetic & Breeding Approaches: Examples of existing varieties found in Field Collections



Drought resistance

- I-15 - Koroneiki
- Moraiole - Calatina...



Low vigour

- Piantone di Moiano
- Leccio del Corno
- Calatina
-

high Total Phenols

Koroneiki - Meski-Picoline M – Picudo - Coratina...

high Tocopherols

Chemlali – Cipressino- Manzanilla-Arbosana...

Verticillium dahliae tolerant

- Frantoio
- Koroneiki
- FrxAr_5",
- "FrxAr_6"
- "KorOp_48"

Xylella fastidiosa tolerant

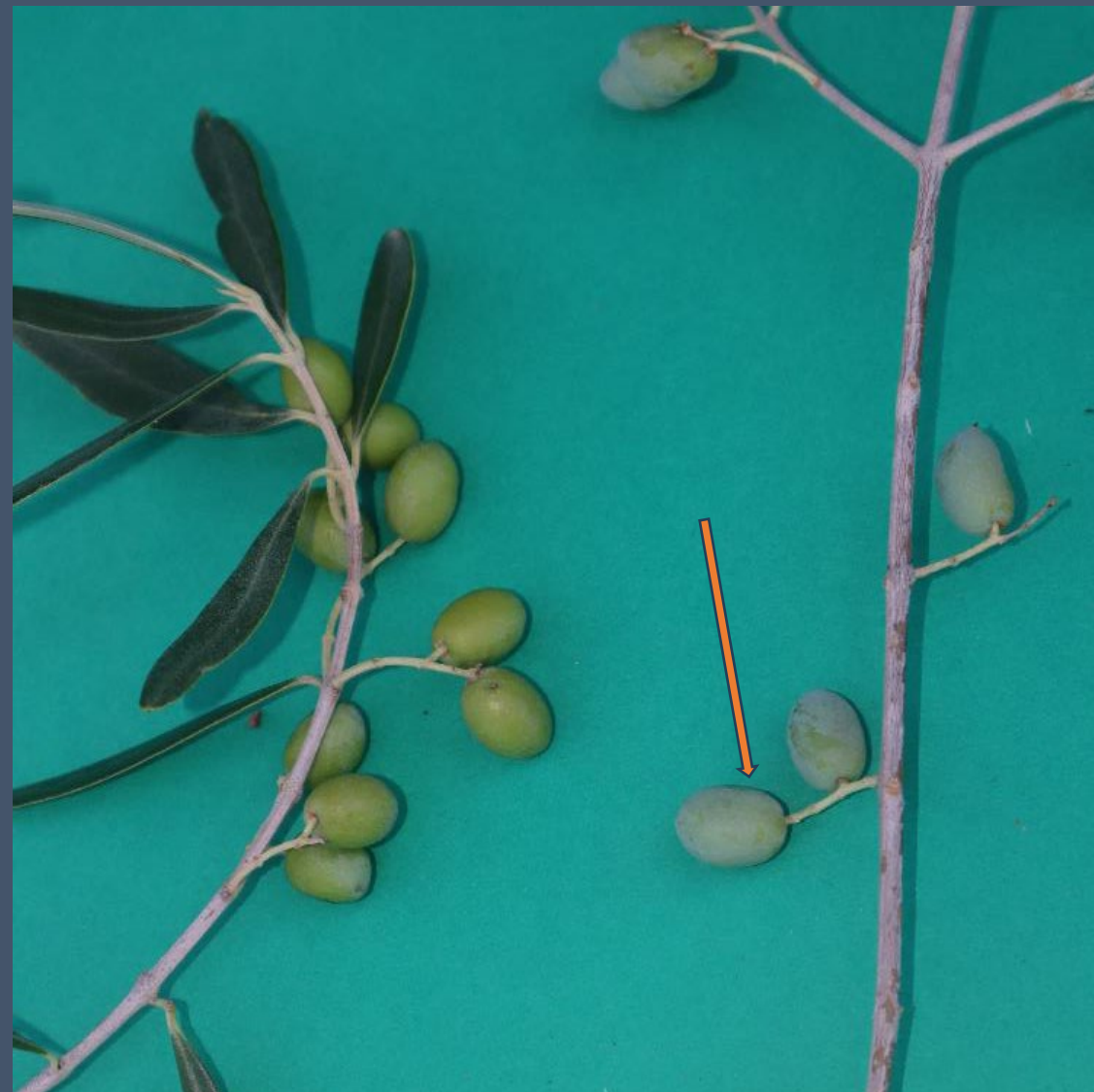


- Leccino
- Favolosa
- (Lecciana)
- ..



Genetic & Breeding Approaches - (from recent program)- tolerance to OLIVE FLY

Tuscialba (from Rugini - Tuscia University)



NORMAL

TOLERANT TO OLIVE FLY



No cleaned

Artificial cleaned



TOLERANT TO OLIVE FLY note the **pruine**



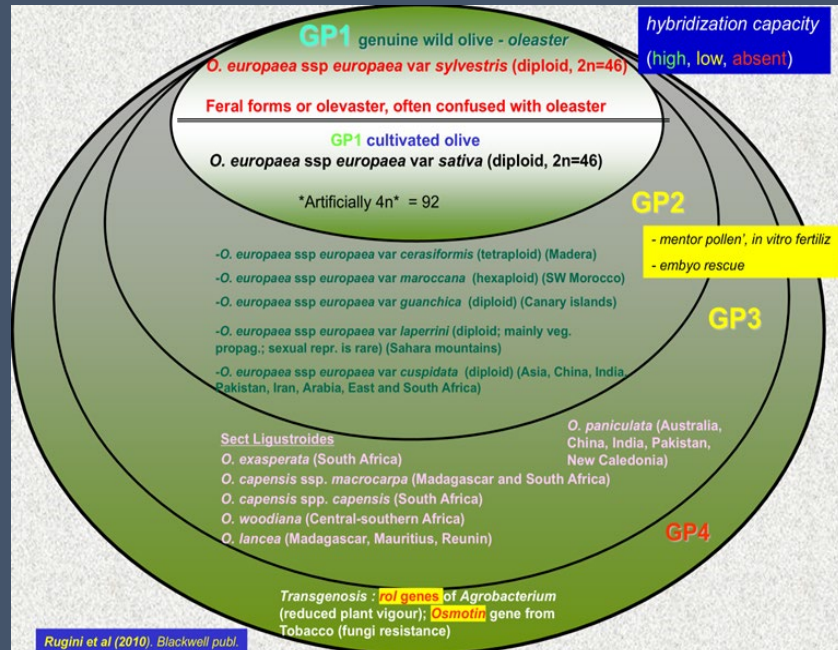
Genetic & Breeding Approaches for **FUTURE USE** (ex novo Multi-Trait Superior Cultivars)

BY USING ALL KNOWN TECHNOLOGIES

1- NEW CULTIVAR ? - Combining:

- **TRADITIONAL BREEDING** (gene pool “method”) with
- **BIOTECHNOLOGICAL TECHNIQUES**

- marker-assisted selection
- (Gene Transformation and Genome editing)



- Drought
- High T°
- Low T°
- Salts
- Pests and Diseases
- Self-fertility
- Plant architecture
- Oil quality, quantity
-

2- ELITE CULTIVAR ?

Correct the defects
by

“gene therapy.”



Should include:

- ✓ monumental plants
- ✓ wild sub-species (*Olea cuspidata*, *Olea ferruginea*,.....)
- ✓ plants already improved through biotechnologies



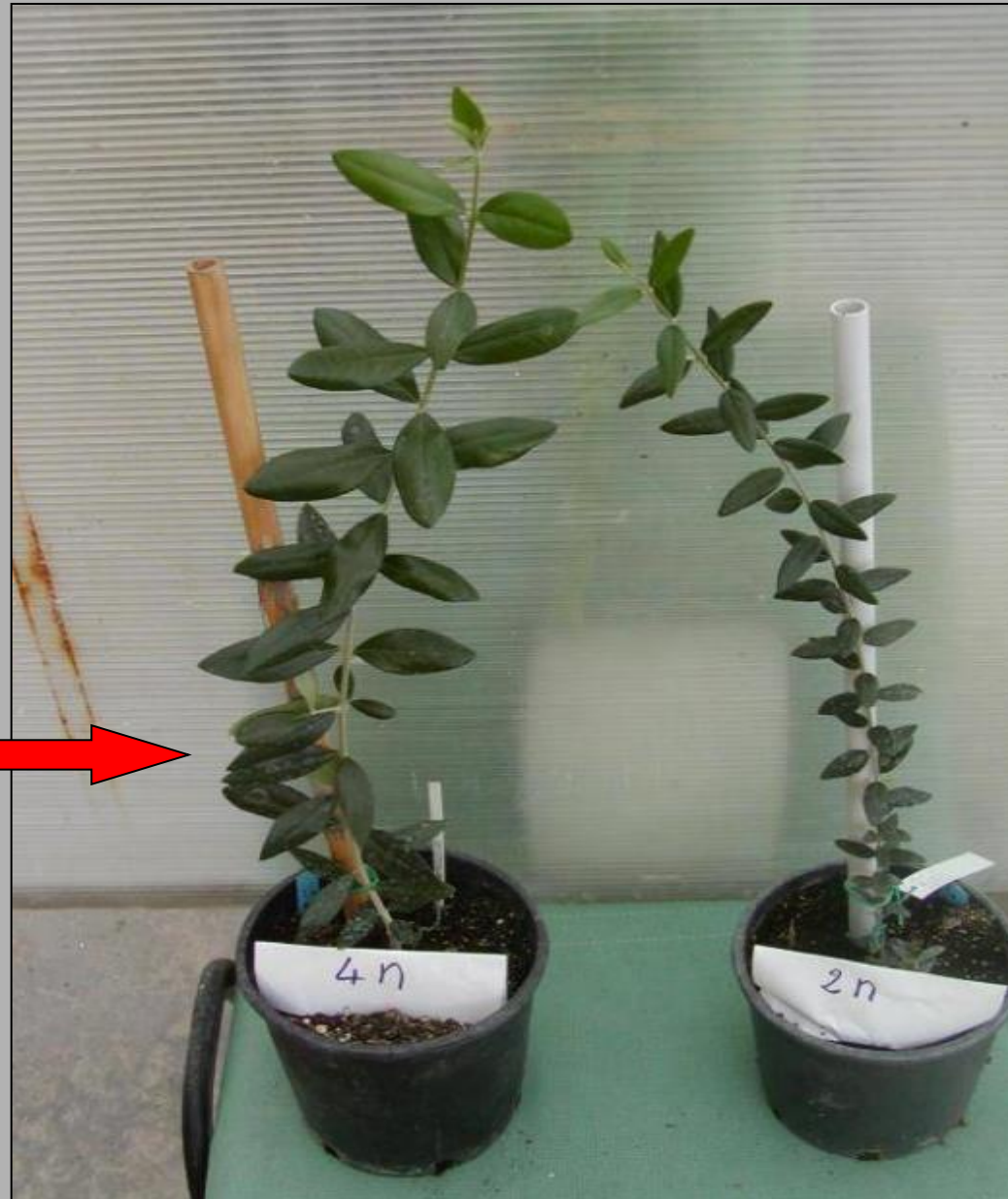
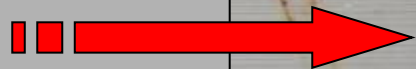
We Achieved many results?

- Micropropagation, somatic embryogenesis from cultivars (1995)
- Cryopreservation
- Some Molecular markers for variety identification
- Genes upregulated/downregulated in response to: *Verticillium dahliae*, *Xylella*, drought, heat, cold, salinity,
- Gene of oil biosynthesis (2017).
- **Genome sequence** of the olive tree, cv Farga (2016) and **cv Leccino (2025)**.
- **Some Genetically modified (GMO) olive plants of cultivar have been also developed**
-

What Do We Expect in the Near Future?

- **Extensive germplasm characterization** (metabolomic, genomic, physiology,...)
- **Extensive breeding improvement activities** (by using existing germplasm and wild olive subspecies).
- **More Gene isolation and characterization**
- **Broad application of advanced technologies — *gene transfer and genome editing* (currently hindered)**
-

by **Biotechnology**: In Vitro **Tetraploid** cv Frantoio and Leccino ($4n$ olive tree do not exist in nature)



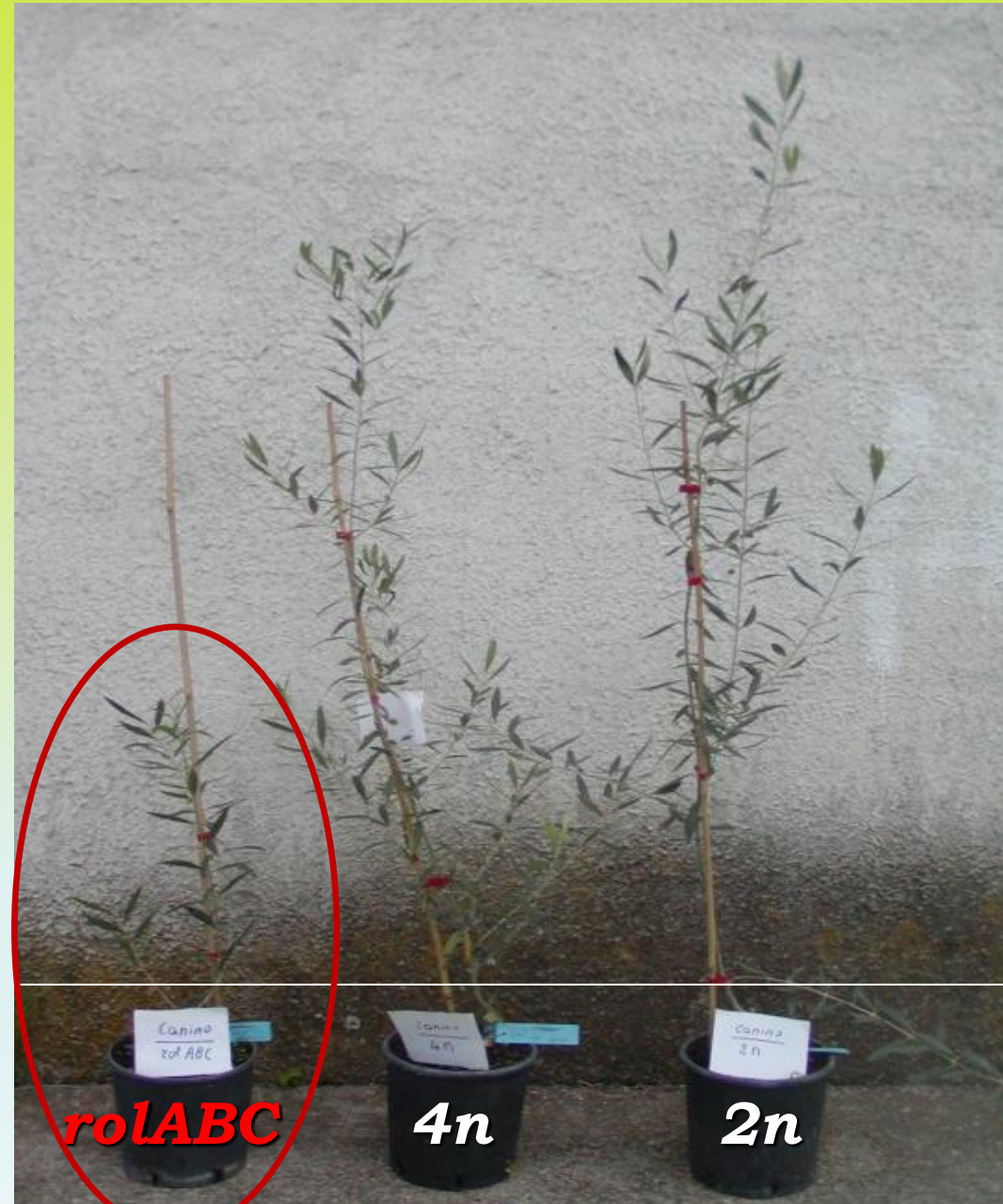
- Tetraploid ($4n$) drupes exhibit an oil content about 20% greater than that of diploid ($2n$) controls.
- Plant shows less vigour
- As rootstock (reduces vigour)

GMO dwarf rootstocks (*rol ABC*) reduces scion vigor & promotes an expanded root system

Cv Canino scion



Different rootstocks with GMO rootstock



Rugini et al 2000
Tuscia University

GMO cv Canino (*osmotin*) drought-resistant/tolerant

Rugini 2015,
Tuscia University



control

GMO



CONTROL

rolABC
CONTROL

OSM 1

OSM 2

OSM 3

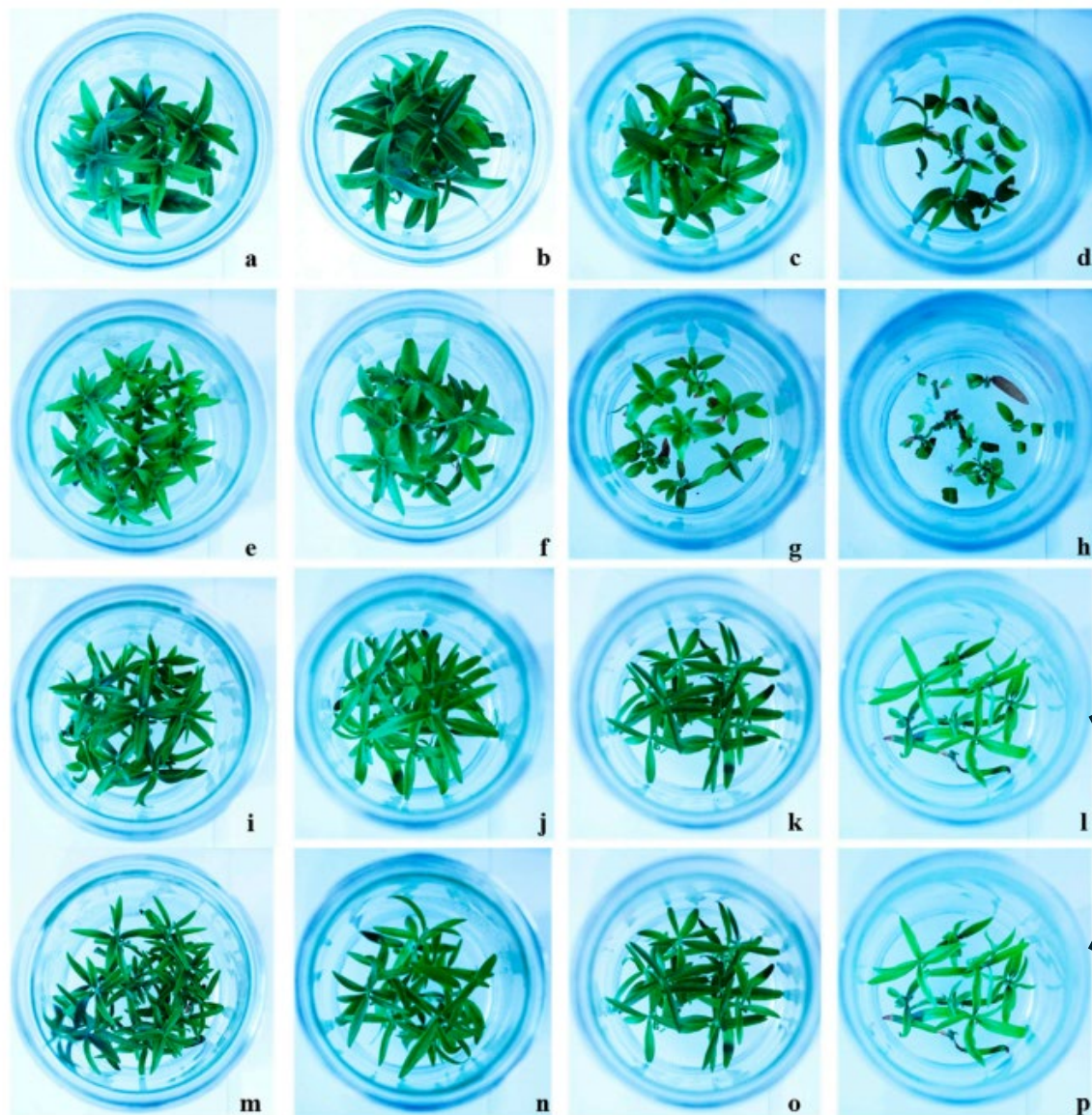
mM 0 50 100 200

Cv Canino

Cv Sirole

Cv Canino OGM 1

Cv Canino OGM 2



GMO cv Canino -*Osmotin*- for **SALT** tolerance

(Tuscia University) Plants 2021, 10, 350.
<https://doi.org/10.3390/plants10020350>

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Home > Acta Physiologiae Plantarum > Article
Olive (*Olea europaea* L.) plants transgenic for tobacco osmotin gene are less sensitive to in vitro-induced drought stress

Original Article | Published: 13 September 2017
 Volume 10, article number 229, (2017) [View this article](#)



Acta Physiologiae Plantarum

Aims and scope >

Submit manuscript >

200 mM NaCl

(sea water 580mM = 3,5% NaCl)

Figure 1. Effect of different concentrations of NaCl on different olive cultivars Canino (a–d) at 0, 50, 100, and 200 mM NaCl, respectively, Sirole (e–h) at 0, 50, 100, and 200 mM NaCl, respectively, along with two transgenic Canino AT17-1 (i–l) at 0, 50, 100, and 200 mM NaCl, respectively and Canino AT17-2 (m–p) at 0, 50, 100, and 200 mM NaCl, respectively.

Our desired ultimate goal?

cultivation by the sea, on saline soils, or using saline water for irrigation.



YEAR 2012 -Tuscia University -

"Science tried - Ideology said No"



©FreshPlaza

Our dreams collapsed when we received the order from our government to destroy all the plants because in Italy it is forbidden to experiment with GMOs in open fields.

***The plants were sold to a U.S. company: the kiwi leaves overexpressing the same OSMOTIN gene used in olive, are now in a clinical trial in Genoa for multiple sclerosis.



What we expect in the near future to reduce labor and costs, increase quality?

1. Robotisation application for micropropagation



2. Optimization of somatic embryogenesis in olive cultivars to enhance **propagation efficiency** and also **enable gene transfer** or **gene modification**



+ /- 



Somatic embryos
Cv Canino

CONCLUSION and "TAKE HOME MESSAGE"

In a rapidly changing world, we can protect the olive's productivity, quality, and sustainability by pairing innovation with cultivation practices adapted to each territory

Not a single olive-growing system, but more than one.

Research is vital and must remain FREE from ideological constraints, pseudoscience, and unqualified influence, so that the olive can reach its full potential

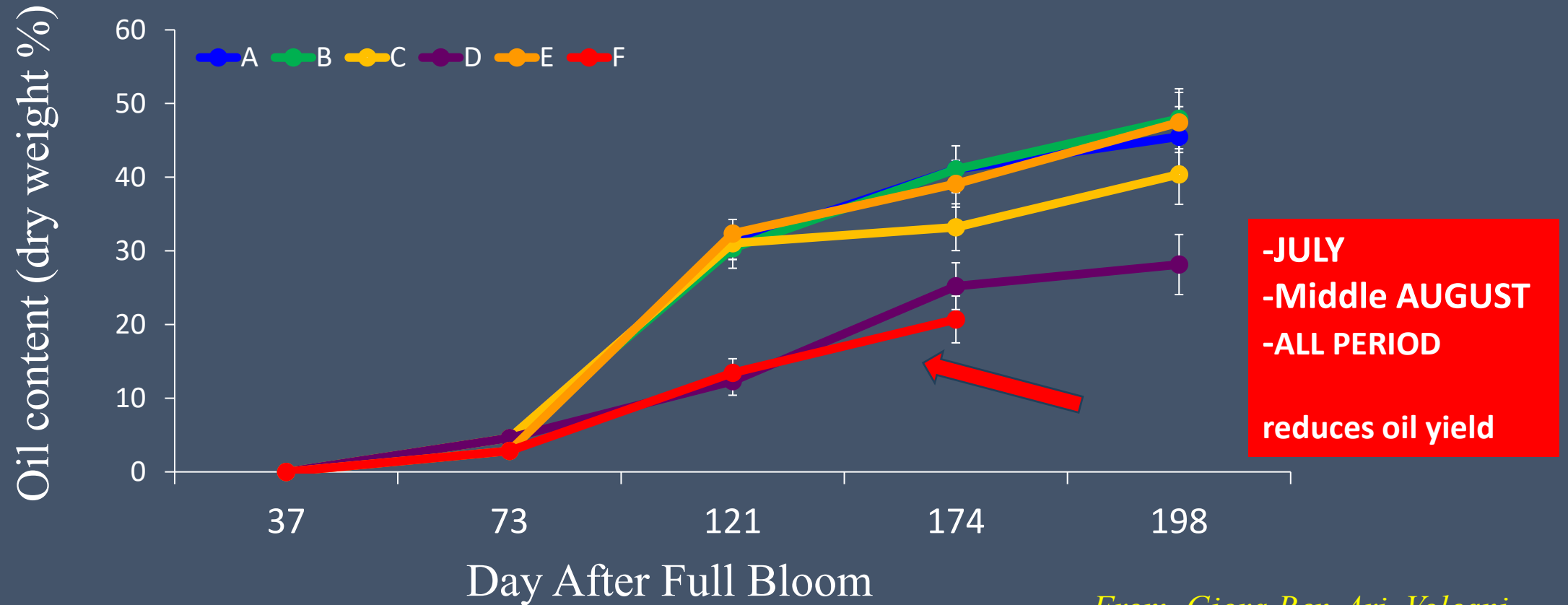


Oil content decreased in dw in Israel

Group	May	June		July		August		September		October	
A											
B											
C											
D											
E											
F											

(HT)

(MT)



From. Giora Ben-Ari, Volcani
Institute, Israel



- PRUNING strategy-

to expose leaves to light and air

Manual (every year)

Mechanical (periodically)



Pruning residues should
shredded and buried

to increse
Carbon Sequestration
to reduce
Carbon Emission

