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Leaf Traits as Indicators of Drought Adaptation in Olive Cultivars

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INTRODUCTION & AIM

I-Mediterranean region

1. Biodiversity hotspot
2. Olive trees
3. Climate change

II-Olive Tree Vulnerability

1. **Growth**
   Increased temperatures can lead to heat stress, **impacting growth**, productivity, and fruit quality.
2. **Genetic diversity**
   Extreme weather events like droughts, floods, and storms can cause significant damage to olive trees, **affecting their survival and long-term viability**.
3. **Productivity**
   Reduced precipitation contributes **to drought conditions**, leading to **water stress** and potentially harming the tree's health and productivity.

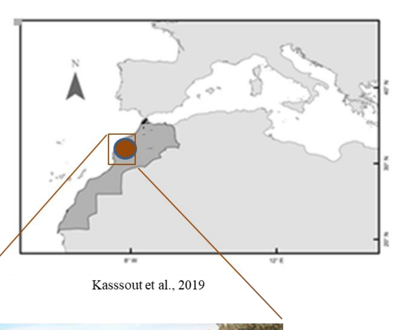
III-Adaptation Strategies of Olive tree

1. **Genetic Diversity**
   Olive trees have evolved a remarkable genetic diversity, enabling them to adapt to various environments.
2. **Physiological Plasticity**
   Olive trees exhibit physiological plasticity, allowing them to adjust to changing conditions.
3. **Phenotypic plasticity**
   Olive trees have a great capacity for phenotype change in response to environmental conditions.

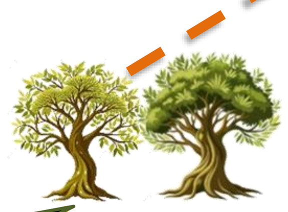
Objectives

1. Investigation of phenotypic variability among the varieties studied, based on leaf functional traits in olive tree.
2. Identification of olive cultivars with superior resistance to drought on the basis of their leaf functional characteristics.
3. Develop a robust phenotyping methodology for olive cultivars, enabling the efficient and accurate assessment of drought resistance. Easy measured traits

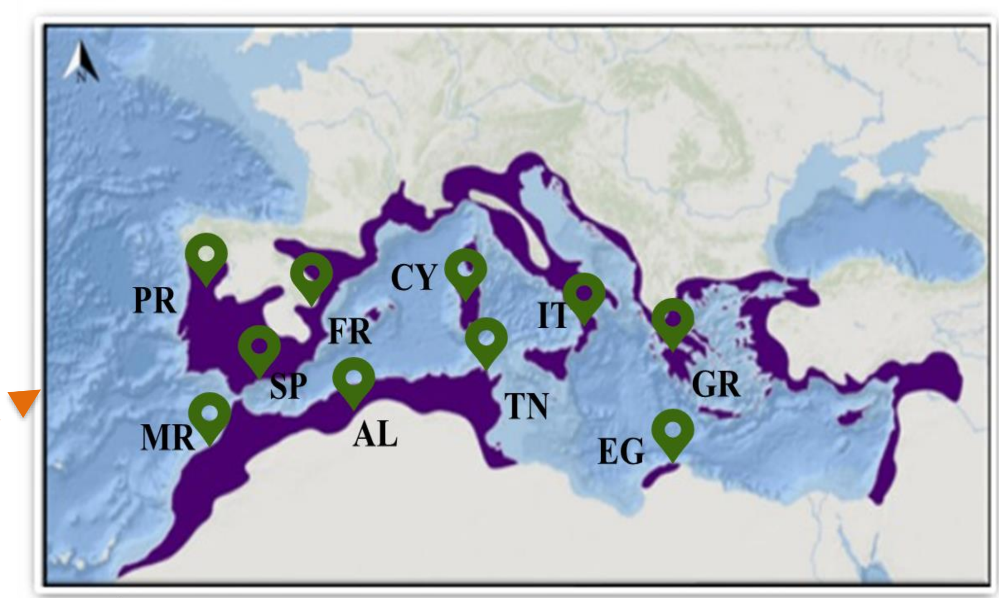
METHOD



The World Olive Germplasm Bank of Taoujat-Meknès Projet, RESGEN-INRA

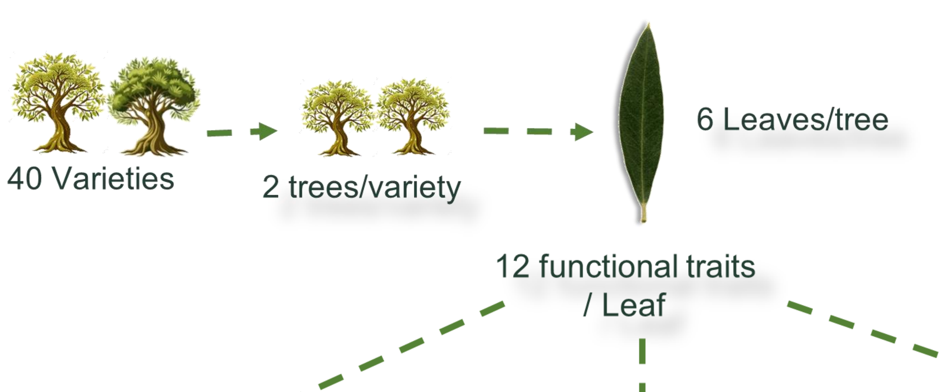


40 varieties



Distribution of olive trees in the Mediterranean region (Fraga et al., 2021).

Origin of selected varieties in the study: MR: Morocco, AL: Algeria, TN: Tunisia, EG: Egypt, Gr: Greece, CY: Cypree, IT: Italy, FR: France, SP: Spain, and PR: Portugal



12 functional traits / Leaf

Four Morphological Traits

- **Leaf Area** (LA) (cm^2)
- **Leaf Length** (LL) (cm)
- **Leaf Width** (LW) (cm)
- **Leaf Shape** (LL/LW)

Three Ecophysiological Traits

- **Stomatal Density** (DS) (N/mm^{-2})
- **Trichome Density** (DT) (N/mm^{-2})
- **Leaf Blade Thickness** (LT) (mm)

Five Structural Traits

- **Leaf Dry Mass** (DM) (g)
- **Leaf Fresh Mass** (FM) (g)
- **Leaf Mass per Area** (LMA) ($g.m^{-2}$)
- **Leaf Specific Area** (SLA) ($cm^2.g^{-1}$)
- **Leaf Dry Matter Content** (LDMC) ($mg.g^{-1}$)

RESULTS & DISCUSSION

	Trait	Min	Max	Mean	CV%	F-ANOVA One-way
Mor-Tr	LA	1.63	11.52	4.83	25.65	8.61***
	LL	3.12	9.19	5.76	14.16	8.37***
	LW	0.74	2.10	1.28	17.53	12.44***
	LL/LW	2.46	7.89	4.58	18.38	14.69***
Ecop-Tr	DS	188.45	575.65	350.04	17.92	4.35***
	DT	75.59	294.12	156.03	16.14	1.94***
	LT	0.32	0.79	0.48	13.17	11.27***
Str-Tr	FM	0.07	0.49	0.23	27.65	9.79***
	DM	0.04	0.24	0.12	28.47	10.54***
	LMA	8.85	50.50	24.68	18.80	5.70***
	LDMC	295.60	965.35	509.30	8.88	3.97***
	SLA	19.80	113.00	41.93	19.22	6.59***

Maximum Values

	Traits	Origin	Variety	Mean
Mor-Tr	LA	FR	Bouteillan	6.17
	LL	AL	Azeradj	6.83
	LW	GR	Pikrolia	1.92
	LL/LW	PR	Lentisca	6.02
Ecop-Tr	LT	TN	Neb jmel	0.63
	DT	SP	Alameno Blanco	185.99
	DS	SP	Hojiblanca	456.18
Str-Tr	FM	TN	Meski	0.34
	DM	AL	Azeradj	0.17
	LMA	TN	Neb jmel	30.73
	LDMC	EG	Baid El Hamam	565.67
	SLA	GR	Pikrolia	48.46

Minimum Values

Traits	Origin	Variety	Mean
LA	PR	Cobrancosa	4.00
LL	AL	Azeradj	6.83
LW	FR	Bouteillan	1.00
LL/LW	GR	Pikrolia	2.91
LT	IT	Nociara	0.43
DT	GR	Koroneiki	125.49
DS	PR	Galega Vulgar	284.69
FM	SP	Arbequina	0.18
DM	SP	Arbequina	0.09
LMA	AL	Bouchouk Lafayette	25.59
LDMC	SP	Lechín de Sevilla	468.80
SLA	TN	Neb jmel	32.98

Traits	Meaning of the trait variation	References	Resistant varieties	Origin
LA, LW, LL/LW DM, FM ↓	Resisting drought conditions	Ayala et al., 2020; Pérez-Harguindeguy et al. (2016)	Cobrancosa, Koroneiki, Arbequina	Portugal Greece Spain
LT ↓	Severely stressed conditions	Pérez-Harguindeguy et al. (2016)	Nociara, Leccino Picholine Marocaine	Italy Morocco
DS ↓	Water stress	Peel et al. (2017)	Galega Vulgar	Portugal
DT ↑	Reduce the rate of perspiration (sweating)	Fernández et al. (2024)	Alameno Blanco	Spain
LMA ↑	Arid climates	Salazar et al. (2021)	Neb jmel	Tunisie
LDMC ↑	resistant to physical risks	Pérez-Harguindeguy et al. (2016)	Baid El Hamam	Egypte
SLA ↑	resistance to drought	Diaz and Cabido (1997)	Pikrolia	Portugal

CONCLUSION

- **Significant variation in leaf functional traits among olive cultivars**. This suggests that specific traits can be used to identify drought-resistant varieties.
- Significant inter-varietal variability in leaf functional traits depending on **the nature of the trait and the origin**
- **All the traits can be used in breeding programs to select varieties, but leaf shape, leaf width, leaf thickness, dry and fresh weight** are the traits that show the most phenotypic variability between varieties.
- **The origin effect on variability of leaf functional traits was greater** than effect of variety. The varieties with the best resistance to adverse conditions are mainly **European varieties.**

FUTURE WORK / REFERENCES

- Extend phenotypic plasticity studies to **other local and introduced varieties for comparison with those covered in this study.**
- Further research is needed to confirm the link between specific leaf functional traits and drought resistance in olive cultivars. **Trials with gradients of water stress to also see the GxE interaction.**
- By understanding the mechanisms of drought adaptation in olive cultivars, we can contribute to **Conducting a variety acclimatization trial on experimental farms in contrasting climates**
- Cross-referencing phenotypic results with genetic data to **identify markers associated with drought tolerance.**

Westerband, A.C., Funk, J.L., Barton, K.E., 2021. Intraspecific trait variation in plants: a renewed focus on its role in ecological processes. Ann. Bot. 127 (4), 397–410.

https://sciforum.net/event/IOCAG2025