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Genotype selection for organic hedgerow olive growing

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Abstract

Agronomic improvements in recent years allow the emergence of high-density hedgerow olive growing systems, nowadays the most widespread growing system in new plantings. In this work, the agronomic behaviour of several traditional cultivars and breeding selections was studied under irrigated organic hedgerow management. Twenty-seven genotypes were evaluated for canopy development, vigor, productivity, and oil content over three years (2022–2024). Several of the traditional cultivar tested ('Arbequina', 'Koroneiki', 'Arbosana'), recently released cultivars ('Martina', 'Sikititа2') and new bred selections (F38A16, F19A60) exhibited a good adaptation to the hedgerow system. Despite yield reductions caused by frost in 2023, the trial confirmed the feasibility of organic hedgerow cultivation and identified promising genotypes for sustainable olive production.

Keywords: cultivar selection, olive breeding, oil content, productivity, vigor

Introduction

High density hedgerow olive growing system has become in the last years the most widespread system in new olive orchard due to the paramount advantage of full mechanization, particularly for harvesting by straddle machines (Lo Bianco et al., 2021). This modern growing system was initiated in Spain in the mid 90's and initially incorrectly labelled as "super-high-density", meaning needing a lot of resources for proper management. However, the system has later developed in different shapes according to availability of resources, as for any other olive growing system. Still, there is little information about the feasibility of organic hedgerow cultivation, and no literature is available regarding the behaviour of different cultivars under this growing system.

One of the main limitations of this system derives from the inability of most traditional cultivars to high orchard densities, because of excessive vigor and/or insufficient bearing when the canopy is pruned to a small volume (Rosati et al., 2013)

In this work, we tested the suitability of different plant materials (traditional cultivars, recently released cultivars and new bred selections) to irrigated organic hedgerow systems to identify according to their agronomic behaviour promising genotypes for sustainable olive production under this growing system.

Material and Methods

The trial was established in 2020 within commercial organic orchards of Luque Ecológico S.L. in Córdoba (Spain). Twenty-seven olive cultivars and breeding selections were included, representing diverse genetic backgrounds from the IFAPA breeding program and the Córdoba World Germplasm Bank.

The soil was clay-loam, with typical Mediterranean climatic conditions (mean annual rainfall ≈ 550 mm). The orchard was established at 4 x 1.5 m planting density and managed according to organic certification standards, with drip irrigation, mechanical weed control,

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and organic fertilization. Canopy volume, fruit yield and oil content were determined annually.

The trial was adversely affected by a severe frost in January and February 2023, with a noteworthy range of variation of the air temperature between minimum and maximum during this period (Figure 1). A visual scoring of frost damage was carried out on a scale 0-3 for a preliminary classification of genotypes.

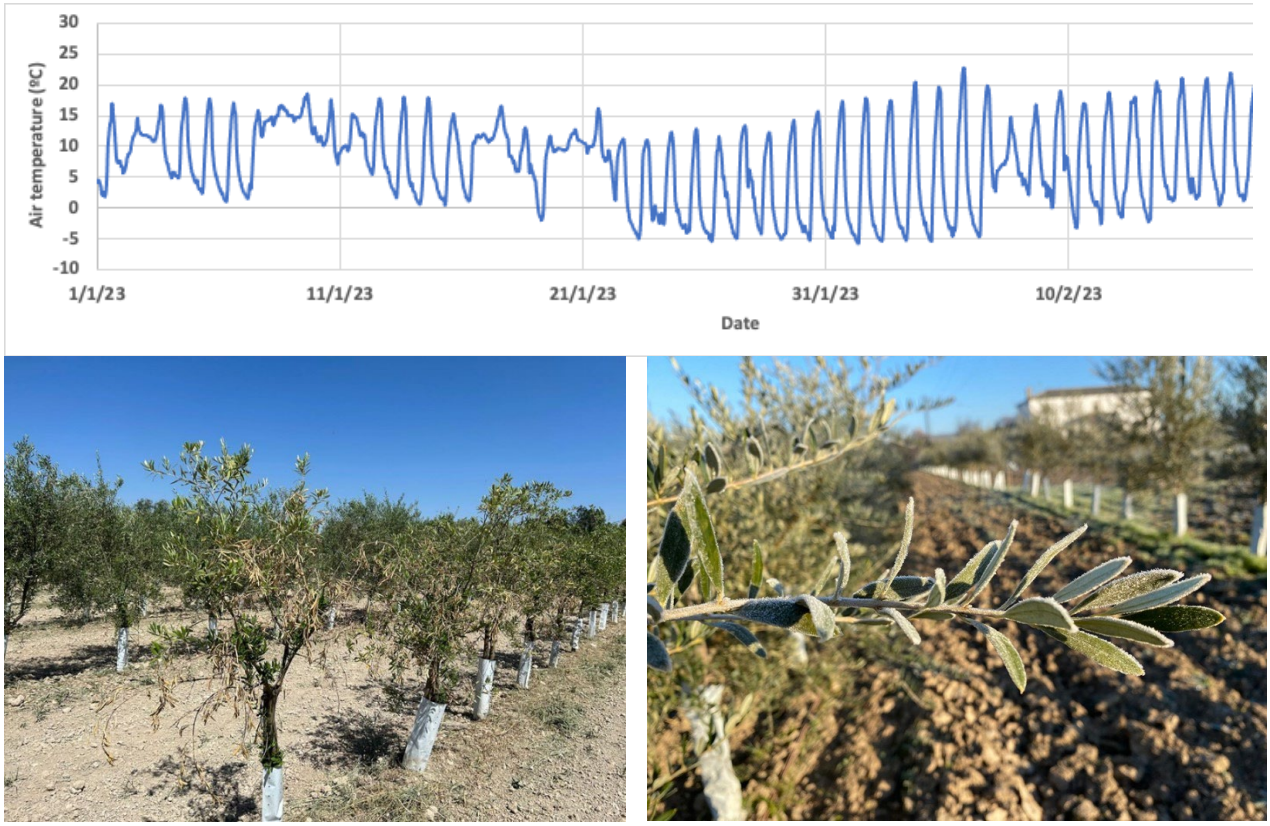

Figure 1: Air temperature in the trial during January and February 2023 and symptoms of frost damage observed.

Results

Substantial variation in canopy volume was observed among genotypes (Table 1). Traditional 'Arbosana', new released 'Sikitita-2' and 'Sikitita' and breeding selections F78A5, F19A60, F114A31 and F42A48 showed the lowest vigor, forming compact canopies suitable for high density hedgerow architecture. On the contrary, traditional 'Coratina' and breeding selections F38A16, F12A85 and F111A69 were characterized as high-vigor genotypes, probably exceeding optimal canopy dimensions.

Fruit yield and oil content showed strong genotype influence, with traditional and new release cultivars 'Arbequina', 'Koroneiki', 'Martina' and 'Sikitita-2' showing the highest values for fruit yield and breeding selections F19A60, F114A31, F120A96 and F38A16 for oil content.

It should be noted that the frost event in 2023 caused visible foliar necrosis and reduced flowering, which decreased yields drastically. Even though a general negative effect was observed in all the trees of the trial, some differences among cultivars were observed. Thus, 'Arbosana' and F19A60 were particularly affected by this climatic incidence. Conversely, other genotypes such as 'Sikitita2' remained unaffected, highlighting genotypic differences in frost tolerance.

Table 1: Average agronomic performance of olive traditional cultivar (TC), recently new released cultivars (NRC) and breeding selections (BS) under organic hedgerow system. Genotypes are ranked by cumulative yield.

Genotype	Group	Origin	Cumulative Yield (Kg/ha)	Canopy volume (m3)	Frost damage (0-3)	Oil content (%)
F110A54	BS	Empeltre o.p.[1]	700	6.92	0.00	46.39
F120A92	BS	Changlot x Dolce Agogia	1006	5.92	1.00	47.09
F117A117	BS	Frantoio x Arbosana	1053	5.93	0.50	40.11
Coratina	TC	Italy	1100	7.90	0.00	42.89
F113A33	BS	Chalkidiki o.p.	1110	6.39	1.50	47.03
F111A55	BS	Manzanilla de Sevilla o.p.	1163	6.33	0.00	46.27
F111A69	BS	Picudo o.p.	1669	8.61	0.50	41.93
F106A64	BS	Blanqueta o.p.	1886	6.30	0.00	46.41
Chorrúo de Castro	TC	Spain	2069	6.93	0.00	43.97
F117A120	BS	Frantoio x Arbosana	2596	7.84	0.50	44.48
F110A39	BS	Ocal o.p.	3220	5.58	1.50	34.99
F114A31	BS	Leccino o.p.	3287	4.74	0.50	50.27
Hojiblanca	TC	Spain	4003	7.44	0.00	41.68
F107A36	BS	Koroneiki o.p.	4260	5.64	0.00	42.08
Sikitita	NRC	Picual x Arbequina	4352	5.11	0.00	44.04
F120A96	BS	Changlot x Dolce Agogia	4615	5.94	1.00	51.05
F78A5	BS	Sikiita x Arbosana	4636	3.67	1.00	42.81
F111A2	BS	Koroneiki o.p.	4900	7.86	0.00	46.52
F38A16	BS	Arbequina x Picual	5168	8.28	0.50	53.47
F19A60	BS	Arbequina x Picual	5614	4.17	2.00	48.58
F12A85	BS	Arbequina x Picual	5923	8.30	1.00	43.40
F42A48	BS	Picual x Arbequina	6530	4.88	1.00	47.05
Arbosana	TC	Spain	7435	3.79	2.00	46.75
Sikitita-2	NRC	Arbequina x Picual	7477	4.48	0.00	46.89
Martina	NRC	Picual x Arbequina	8659	6.76	1.00	47.64
Koroneiki	TC	Greece	10129	7.41	1.50	42.93
Arbequina	TC	Spain	10479	6.17	1.50	46.09
HSD			4065	3.04	1.88	8.11

[1] open pollination

Discussion

Early bearing from the second years after planting was obtained from some cultivars within expected ranges for second year bearing hedgerow orchards. Cumulative yield four years after plantings was however affected by adverse climatic conditions in 2023. This incidence provided an unintended stress test, revealing preliminary information on cultivars' resilience to frost. As a result, cumulative yield four years after plantings showed much lower values than previously reported for these cultivars under conventional cultivation (De la Rosa et al.,

2007; Pérez-Rodríguez et al., 2024), particularly for traditional cultivars such as ‘Arbosana’ previously described as highly productive but also quite sensitive to frost damage.

It should be noted that all the potentially interesting breeding selections as well as new releases share a common parentage ‘Arbequina’ x ‘Picual’ or vice versa, probably because of the genetic basis of reduced vigor and early bearing, both essential for high density hedgerow systems, provided by parental ‘Arbequina’.

In conclusion, the results obtained demonstrates that organic hedgerow olive cultivation under irrigation is both feasible and productive when appropriate cultivars are used. Traditional cultivars such as ‘Arbequina’, ‘Koroneiki’ and ‘Arbosana’ confirms their superior suitability for this growing system, together with new released cultivars 'Martina’ and ‘Sikitita-2’ and breeding selections such as F42A48. All of them displayed a balanced vigor, good yield potential, and high oil content. New trials will be needed to fully understand the potential for high density hedgerow orchards under organic production in terms of yield in absence of climatic incidences. Besides, characterization for other traits such as oil composition and resistance to pests and diseases should be considered before determining the most suitable cultivars under this growing system.

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