Early bearing and vegetative growth of 153 Sicilian olive accessions

Placido Volo, Silvia Fretto, Riccardo Lo Bianco[1], Laura Macaluso, Tiziano Caruso
Department of Agricultural, Food and Forest Sciences, University of Palermo, Viale delle Scienze, 90128 Palermo, Italy

Abstract

In 2014, an olive germplasm collection was established in south-western Sicily, Italy. The collection included 153 Sicilian accessions and 3 international varieties (reference), each with 7 trees, spaced at 5 x 2 m and trained to hedgerow system . The aim of the trial was to study early growth and yield responses of the accessions to super-high planting density (SHD). Trunk cross sectional area, tree height, pruning weights, shoot positioning, blooming and fruit yield (kg/tree) were measured in 2015 and 2016. Based on trunk growth and amount of prunings, the 153 accessions were separated into four categories of vigor as it follows: very high vigor (6 accesions), high vigor (13), medium vigor (131), and low vigor (3). In 85% of the accessions, the majority of shoots were born on the central part of the main stem, indicating prevalent mesotony. Constant early blooming (100% of trees in trial in both years) was recorded in 7 accessions ('Nebba 1', 'Nocellara di Licata', 'Olivo di Monaci', 'Olivo di Monaci 1', 'Olivo di Mandanici', 'Verdella', and 'Calatina'), with 'Nocellara di Licata' and 'Verdella' bearing no fruit at the end. Accessions in the very high and low vigor categories produced no fruit, determining a lack of relationship between early bearing and tree vigor.

Keywords: blooming, hedgerow, *Olea europaea*, super high density plantings, tree vigor, trunk growth

INTRODUCTION

In Sicily, over 65% of olive trees are grown in rainfed traditional plantings using vigorous trees trained to open canopies and planted at wide spacings (low density plantings). Those groves are characterized by relatively late productions, low fruit and oil yields, biennial bearing and high management costs (mostly hand labor), often generating very low or no income. On the other hand, olive oils from Sicilian cultivars are characterized by unique sensory attributes and generally high quality standards (Galvano et al., 2007).

On the contrary, modern super high density (SHD) plantings are generally characterized by early, constant and high yields per hectare and

1 Email: riccardo.lobianco@unipa.it

can be mechanically harvested (Tous et al., 2005; De Gennaro, 2012; Connor et al., 2014). They are established using low vigor trees at reduced spacings (over 1500 trees/ha) (Del Rio et al., 2002), and the 'Arbequina' olive has proven to be the most suitable (and by far most widely used) cultivar for those planting systems (Connor et al., 2014). Adequate light interception by hedgerows is critical for good and constant bearing as much as for high quality productions. In SDH plantings, the latter can be accomplished by increasing planting densities and training trees to a central leader (Tous et al., 2005). To date, only a very limited number of cultivars have shown regular yields and adequate vigor adapting well to SDH planting systems.

A selection program has been started recently at the Department of Agricultural, Food and Forest Sciences of the University of Palermo to collect and screen several Sicilian olive accessions for vegetative and reproductive traits suitable for hedgerow high density plantings. Ultimately, the aim of the program is to find genotypes that combine together early and constant bearing, growth and fruiting habits suitable for hedgerow high density plantings along with the distinctive olive oil quality typical of the major Sicilian cultivars. For this purpose, experimental plantings have been established to form hedgerows with optimum light interception throughout the canopy (from top to base) to be tested for fruiting efficiency and early/regular bearing.

MATERIALS AND METHODS

The study was conducted in 2014-2016 in an experimental plot located in southwestern Sicily (37° 35' N, 12° 54' E, 58 m a.s.l.) using one-year-old trees of 153 different local olive accessions (Table 1) grafted on 'Nocellara del Belice' clonal rootstock. In fall 2014, seven trees of each accession were planted consecutively at spacings of 5 x 2 m (1000 trees/ha). The plot was managed using proper cultivation practices, including mechanical weed control and irrigation (about 60 mm/year) during summer months. Trees were left unpruned while in the nursery and during the first year in the field. Starting in February 2015, hedgerows were formed by removing inter-row-oriented shoots/branches. Growth was estimated by measuring number of shoots and their position along the main stem, tree height, trunk circumference (10 cm above the grafting point) and by recording pruned biomass. Trunk circumference was used to calculate trunk cross-section area (TCSA) and estimate growth rate across years.

Percentage of blooming trees was recorded in 2015 and 2016; early yields were recorded in 2016. Growth data were analyzed using graphical statistics (analysis of means) and the accessions were separated into four main vigor categories based on pruned biomass and trunk growth rate (AGR).

RESULTS AND DISCUSSION

Field and nursery measurements of plant size and pruned biomass indicated high growth variability and a greater number of Sicilian accessions showing above-average vigor. Considering pruned biomass and trunk growth together, the 153 accessions were separated into four categories of vigor as it follows: very high vigor (6), high vigor (13), medium vigor (131), and low vigor (3). Specifically, BA1, BS, CE4, SPA, VCA, and VLA exhibited very high vigor, while only IM exhibited very low vigor (Figure 1). Similar tendencies were confirmed by shoot positioning along the main stem (Table 1). In particular, the vast majority of the accessions had most of the shoots in the central portion of the main stem (prevalent mesotony), 25 accessions exhibited some tendency toward acrotony, while only six accessions exhibited some tendency toward basitony.

Seven accessions (CAL, NEB1, NOL, ODM, ODM5, OMD, VLA) showed early and constant blooming whereas only 19 accessions developed a detectable amount of fruit in 2016 (Table 1). Absolutely no significant relationship was observed between vegetative growth (AGR, pruning weights or TCSA) and fruit yield (data not shown), indicating that there is good potential for individuating efficient genotypes suitable for high density plantings, with low vigor and good yields. Future years of investigation are needed to confirm these preliminary trends.

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Table 1. Names and abbreviations of the Sicilian olive accessions in trial, percent distribution of one-year-old shoots along the main stem in the nursery (2014), presence/absence (YES/NO) of blooming in the field (YES = 100% of blooming trees) and yield (kg/tree).

		Shoot position (%)			Blooming		Yield
Accession name	**Abbreviation**	**Basal**	**Central**	**Apical**	**2015**	**2016**	**2016**
Abunara	AB	10	51	39	No	No	-
Aitana	AT	24	54	22	No	No	-
Bariddara 1	BA1	21	68	11	No	No	-
Bariddara 2	BA2	32	28	39	No	No	-
Biancolilla caltabellotta	BC	9	65	26	No	Yes	2.84
Biancolilla caltabellotta PC	BCC	15	43	42	No	Yes	1.82
Biancolilla Di Marco	BDM	12	67	21	No	Yes	0
Bottone di gallo	BG	14	60	26	No	No	-
Bottone di gallo 1	BG1	19	58	23	No	Yes	1.23
Biancolilla iacapa	BI	4	78	18	No	No	-
Biancolilla misilmeri	BM	0	53	47	No	Yes	0
Biancolilla napoletana	BN	14	52	34	No	No	-
Biancolilla pantelleria	BP	6	58	36	No	Yes	0
Brandofino	BR	12	44	44	No	Yes	0
Brandofino 1	BR1	11	30	60	No	Yes	0
Biancolilla siracusana	BS	29	55	16	No	No	-
Biancolilla Schimmenti	BSC	10	63	27	No	Yes	2.54
Bella di Spagna	BSP	13	54	33	No	Yes	0
Biancolilla tiziano	BT	6	75	19	No	No	-
Biancuzza	BZ	15	38	47	No	Yes	0
Cacaredda	CA	50	41	9	No	Yes	0
Cacaredda 1	CA1	28	51	21	No	No	-
Cacazzara	CAC	17	48	35	No	No	-
Cacaridduni 1	CAD1	15	69	16	No	No	-
Cacaridduni 2	CAD2	7	76	17	No	No	-
Calatina	CAL	15	52	33	Yes	Yes	1.77
Calamignara	CAM	25	40	35	No	No	-
Castricianella Rapparina	CAR	20	55	25	No	Yes	1.94
Castelluzzo	CAS	30	40	30	No	No	-
Cavalieri	CAV	18	57	24	No	Yes	0
Cacazzana	CAZ	20	52	28	No	No	-
Cerasuola Cappuccia	CC	11	62	27	No	Yes	0
Cerasuola	CE	1	77	22	No	No	-
Cerasuola 1	CE1	2	65	32	No	Yes	0
Cerasuola 2	CE2	8	70	22	No	No	-
Cerasuola 3	CE3	26	60	14	No	Yes	0
Cerasuola 4	CE4	19	62	19	No	No	-
Citrale	CIT	7	73	20	No	No	-
Conservolia	CON	14	45	41	No	No	-
Crastu	CR	23	42	35	No	Yes	2.10
Crastu 1	CR1	21	33	47	No	No	-
Erbano	ER	34	41	25	No	Yes	1.58
Fastucara aragona	FA	4	48	48	No	No	-
Galatina	GA	5	65	29	No	No	-
Giarraffa	GF	20	45	34	No	No	-

Giarraffa 1	GF1	48	35	17	No	No	-
Giarraffa 2	GF2	18	39	42	No	No	-
Giarraffa 3	GF3	20	37	43	No	No	-
Giarraffa 4	GF4	16	66	18	No	No	-
Ghiannuzza	GH	0	79	21	No	No	-
Gordales	GO	16	48	36	No	Yes	0
Iacona	IA	8	54	37	No	No	-
Impressionante	IM	9	83	9	No	No	-
Indemoniata	IND	5	79	17	No	No	-
Leucocarpa	LE	6	52	42	No	No	-
Leucocarpa 1	LE1	11	39	50	No	No	-
Lumiaru	LU	2	56	42	No	Yes	0
Lunga di Vassallo	LUV	28	33	39	No	Yes	0
Marfia	MAF	17	63	20	No	No	-
Marsalesa	MAR	10	68	22	No	No	-
Minna di vacca	MDV	8	76	16	No	Yes	0
Minuta	MN	11	67	22	No	Yes	1.71
Minuta 1	MN1	22	56	22	No	Yes	1.31
Monaca	MO	19	44	37	No	Yes	0
Montonica	MON	16	62	22	No	No	-
Mortillara	MOR	37	37	26	No	No	-
Moresca	MR	3	67	30	No	No	-
Moresca 1	MR1	4	51	44	No	No	-
Moresca 2	MR2	1	60	38	No	No	-
Moresca 3	MR3	0	71	29	No	No	-
Moresca 4	MR4	0	69	31	No	No	-
Moresca di noto	MRN	0	50	50	No	Yes	0
Murtiddara	MU	10	58	32	No	No	-
Murtiddara 1	MU1	7	67	25	No	No	-
Nasitana	NA	24	40	36	No	Yes	0.98
Nebba	NEB	29	38	33	No	Yes	1,18
Nebba 1	NEB1	19	54	27	Yes	Yes	1.67
Nerba	NER	10	58	32	No	No	-
Nerba 1	NER1	11	47	41	No	Yes	0
Nerba sangue dolce	NESD	14	71	16	No	Yes	0
Nocellara del Belice	NOB	10	70	20	No	No	-
Nocellara del Belice 1	NOB1	18	72	10	No	Yes	0
Nocellara del Belice 2	NOB2	22	68	10	No	No	-
Nocellara del Belice 3	NOB3	23	71	6	No	No	-
Nocellara del belice 4	NOB4	22	55	22	Yes	No	-
Nocellara del Belice 5	NOB5	18	70	12	No	Yes	0
Nocellara del Belice 6	NOB6	27	53	21	No	Yes	0
Nocellara del Belice 7	NOB7	28	57	15	No	No	-
Nocellara Castelvetrano	NOC	20	66	14	No	No	-
Nocellara Etnea	NOE	59	16	26	No	No	-
Nocellara licata	NOL	17	60	22	Yes	Yes	0
Nocellara messinese	NOM	17	45	38	No	Yes	0
Nocellara messinese 2	NOM2	2	57	42	No	No	-
Nocellara messinese 3	NOM3	0	58	42	No	Yes	0
Nocellara messinese 4	NOM4	0	86	14	No	Yes	2.53
Nocellara semenzale	NOS	26	38	36	No	Yes	0
Nostrale Terminisa	NOT	9	66	25	No	No	-

Olivo di Monaci	ODM	21	45	34	Yes	Yes	2.08
Olivo di Monaci 1	ODM1	24	40	37	Yes	Yes	2.27
Ogliara	OG	8	57	35	Yes	No	-
Ogliara 1	OG1	10	78	13	No	No	-
Ogliarola licata	OGL	13	78	8	No	No	-
Ogliarola Nostrale	OGN	12	65	23	No	No	-
Oliva Longa	OL	20	61	19	No	No	-
Ogliarola Messinese	OM	33	50	17	No	No	-
Ogliarola Messinese 1	OM1	53	23	24	No	No	-
Ogliarola Messinese 2	OM2	47	36	17	No	No	-
Olivo di Mandanici	OMD	18	65	17	Yes	Yes	1.40
Opera Pia	OP	15	74	10	No	Yes	0
Oliva saracena	OS	0	71	29	No	No	-
Olivo di vicari	OV	17	52	31	No	No	-
Pizzo di corvo	PC	20	57	23	No	No	-
Picholine	PIC	15	55	30	Yes	No	-
Pizzuta D'Olio	PID	24	55	20	No	No	-
Pirunara	PIR	36	51	13	No	No	-
Pirunara 1	PIR1	29	52	19	No	Yes	0
Pizzutella 1	PIZ1	18	63	19	No	Yes	1.16
Pizzutella 2	PIZ2	11	47	42	No	No	-
Pizzutella 3	PIZ3	11	89	0	No	No	-
Piricuddara	PRC	23	50	26	No	Yes	1.16
Passulunara	PS	9	64	27	No	Yes	0
Passulunara 1	PS1	34	60	6	No	No	-
Passulunara 2	PS2	20	46	34	No	No	-
Passulunara 3	PS3	6	49	46	No	No	-
Passulunara 4	PS4	15	39	46	No	No	-
Raitana	RAI	4	79	17	No	No	-
Rizza Caccamo	RIC	28	67	5	No	No	-
Rizzo	RIZ	15	61	24	No	No	-
Rotondella	RO	6	56	38	No	No	-
Santagatese	SA	20	56	24	No	No	-
Sammartinara	SAM	16	57	28	No	No	-
Scognita	SC	5	88	8	No	No	-
Santa Caterina	SCT	26	64	10	No	No	-
Spagnola Aragona	SPA	15	59	26	No	No	-
Salicina vassallo	SV	4	74	22	No	Yes	0
Tonda dolce	TD	34	55	11	No	Yes	0
Tonda Iblea	TI	14	44	42	No	No	-
Tortella Morticiana	TM	9	77	14	No	No	-
Tunnulidda	TU	20	51	29	No	Yes	0
Tunnulidda 1	TU1	28	72	0	No	No	-
Uovo di piccione	UP	20	62	19	No	Yes	0
Vaddarica	VCA	9	55	36	Yes	No	-
Vaddarica 1	VCA1	27	63	10	No	Yes	0
Vetrana	VET	28	46	26	No	Yes	0
Verdella	VLA	13	54	34	Yes	Yes	0
Verdella 1	VLA1	9	65	26	Yes	No	-
Verdello	VLO	22	39	39	No	No	-
Verdello 1	VLO1	14	54	32	No	No	-
Vaddara	VRA	21	55	24	Yes	No	-

Verdese	VSE	24	50	27	No	No	-
Zaituna 1	ZA1	25	49	26	No	No	-
Zaituna 2	ZA2	6	63	31	No	No	-
Zaituna 3	ZA3	10	59	31	No	No	-

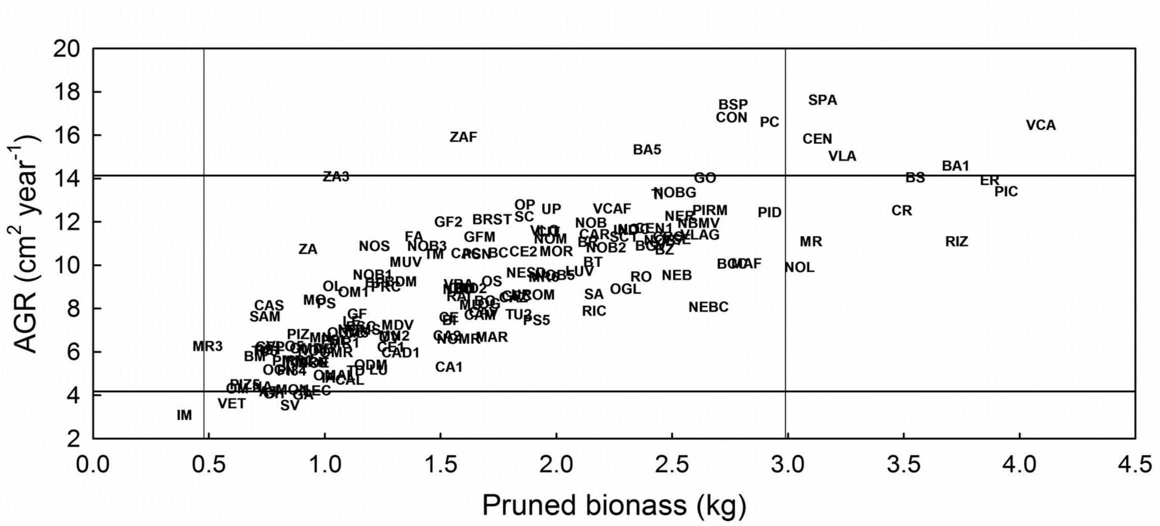

Figure 1. Association between pruned biomass (2016) and trunk growth rate (AGR) in the 153 olive accessions grown in the field. Vertical lines indicate upper and lower decision limits from analysis of means for pruned biomass, horizontal lines indicate upper and lower decision limits for AGR.