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Selection for Ornamental Purposes of 'Angela' Myrtle (*Myrtus communis* L.) Cultivar with Unpigmented Fruit

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Abstract: Myrtle species includes the *melanocarpa* (with pigmented fruit when ripe) and the *leucocarpa* varieties (with unpigmented fruit). Myrtle-bearing pigmented fruit is more common as a wild or cultivated plant for red liqueur production, while genotypes with unpigmented fruit are rare. Myrtle is also appreciated in the international market of ornamental plants as a garden shrub, a flowering and fruiting potted plant, and for the production of cut leafy branches. Varieties with pigmented fruit, compact habitus and small leaves like *microcarpa* and *tarentina* are mostly propagated for this purpose. Contrarily, the *leucocarpa* variety is a strongly vigorous plant, with big leaves, large internodes, and long fruit peduncles. These unique characteristics together with the long persistence of immature fruit in the winter months may represent a new potential specimen for ornamental plant production. This innovative concept of ornamental myrtle was developed with the selection of the cultivar 'Angela' here described for its morphological traits, good nursery management, and performance in agamic propagation.

Keywords: white myrtle; ornamental cultivar; biometric description; softwood cutting propagation

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1. Introduction

The Mediterranean area demonstrates an extraordinary plant biodiversity and abundance of shrubs and other species with multifunctional value [1]. Many species are appreciated in the international market of ornamental plants both as garden bushes and potted plants. The strawberry tree (*Arbutus unedo* L.), lentisk (*Pistacia lentiscus* L.), rosemary (*Rosmarinus officinalis* L.), and myrtle (*Myrtus communis* L.) are probably the most representative species of the "Mediterranean garden". In these evergreen plants, the characteristics of resistance are associated with aromatic properties and easy management [2,3].

The myrtle is mainly known as a valuable aromatic and medicinal plant in Mediterranean countries. It belongs to the Myrtaceae family and to the order *Myrtales*. Moreover, two subspecies are identified: the *communis* and the *tarentina*, which hold different morphological traits [4]. *M. communis* L. is the only species native to Europe. Myrtle genotypes may have pigmented (dark blue or dark red) or unpigmented (white) fruit at the ripe stage. The plants with pigmented fruit belong to the *melanocarpa* variety while the *leucocarpa* have unpigmented fruit [5,6]. The *melanocarpa* variety, widespread as a wild and as a cultivated plant, is used to produce berries employed as raw materials for the red myrtle liqueur industry [7,8].

Some characteristics of the myrtle shrub, such as abundant summer flowering, green leaf color, fruit persistence, the existence of variegated mutations, and possible assurgent habitus make the species suitable for ornamental uses [9,10]. Actually, myrtle is often available in nurseries to be used as garden shrubs, hedge plants, potted plants, and bonsai [11,12]. Due to its resprouting ability, it can be used as a foliage species for cutting [13].

The *tarentina* subspecies suits this destination while the *Myrtus communis* var. *microphylla* can be found in nurseries as flowering potted plants [14]. Other Myrtaceae species like *Luma apiculata* (sin. *Myrtus luma*) are widespread as ornamental plants. This plant, endemic to the temperate areas of South America [15], is a hermaphrodite evergreen tree 12 to 15 m tall, with axillary flowers arranged in groups of three to five, and black edible berries [16]. Most of these genotypes are seed propagated. Therefore, the definition of cultivar standards is not always easy.

In the last decades, the market value of myrtle-derived products in Sardinia gave rise to a domestication and selection program for myrtle cultivars [4,10,17]. This entailed the exploration of the natural phenotypic variability of the species and the selection and propagation by softwood cuttings of different genotypes with pigmented and unpigmented fruit. The predominance of pigmented genotypes with respect to unpigmented ones became evident during the study [17]. Only six out of one-hundred-thirty selections had unpigmented berries and were collected at the same site. Each of these had high vegetative vigor and developed as relatively big plants with medium-upright or upright habitus associated with good green biomass production and fruit yields, and apparent low susceptibility to phytoplasma symptoms. In the selection program, the cultivar 'Grazia' stood out from the other cultivars for its high productivity of 4.5 kg/plant of white-yellowish early-ripening (October) berries, good sugar accumulation, easy fruit detachment, and good aptitude to industrial transformation into white liqueur by hydroalcoholic infusion. On the contrary, the cultivar 'Angela' showed white-greenish berries with very late ripening time (January) and low sugar content, and was subsequently unsuitable for berry liqueur production.

However, some of the typical morphological characteristics of the *leucocarpa* variety, such as plant vigor, big leaf size, peduncle length, and fruiting shoot length, were enhanced in this genotype. Further investigations have been planned to verify the ornamental use and global aptitude of the cultivar 'Angela', with the aim of suggesting its ornamental use as a new proposal with respect to the existing standards of the ornamental myrtle. A synthetic report of the morphological analyses, phenological behavior, and aptitude for agamic propagation of this cultivar is presented using two pigmented-berry myrtle cultivars ('Antonella' and 'Barbara') as comparisons. The 'Barbara' cultivar belongs to subspecies *communis*, like 'Angela', while 'Antonella' is a cultivar of the *tarentina* subspecies.

2. Materials and Methods

2.1. Sampling, Morphological and Biometric Analysis, and Phenology Study of Myrtle Cultivar

The cultivar 'Angela' was selected at the Rumanedda site (North-West Sardinia, 40°41′10.18″ N, 8°21′29.38″ E) and grown in the collection field of the University of Sassari (Central Western Sardinia 39°54′12″ N, 8°37′19″ E). Two myrtle cultivars, namely 'Barbara' and 'Antonella', grown in the same collection field, were analyzed for comparison. The cultivar 'Barbara' belongs to the subspecies *communis* and was selected in Capoterra (39°10′30.67″ N 8°58′15.07″ E). It (Figure 1) is an interesting selection because it has a compact vegetative habitus and starts producing fruit early. The other reference cultivar, 'Antonella' (Figure 2), belongs to the subspecies *tarentina* and was selected in Sassari (40°43′36″ N 8°33′33″ E). This plant is a shrub with an assurgent bushy habitus and a medium vegetative vigor.

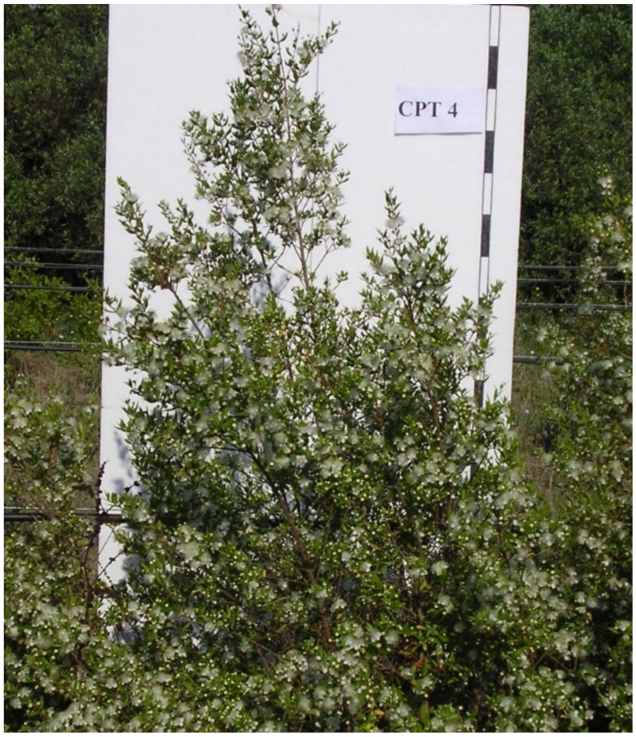

Figure 1. Vegetative habitus during flowering time of 'Barbara' cultivar.

Figure 2. Vegetative habitus during flowering time of 'Antonella' cultivar.

'Angela', 'Barbara', and 'Antonella' were grown in three plots containing twenty plants each obtained by agamic propagation. The plants were managed with a free shrub shape and planting distances of 3 m between rows and 1 m along the row. The field was managed with a no-tillage system and supplementary irrigation (about 1200 m^3) with a drip distribution system.

The morphological and biometric parameters were analyzed on 30 floriferous and 30 fruiting shoots, randomly sampled from each plot, using the descriptor list created

for the myrtle species [17]. The floriferous shoots were observed in the third decade of June and the fruiting shoots during fruit development and ripening time. The following phenological stages were considered: the presence of sprouts in the growth phase, the presence of flower buds and open flowers (beginning, full, and end of flowering), fruit setting, developing fruit, color-break, and ripening. Moreover, the plants' phytosanitary statuses were visually evaluated by observing the phytoplasma-symptom severity [4]. All the above observations were carried out for three consecutive years, from 2018 to 2020.

2.2. Trials of Agamic Propagation of Myrtle Cultivar

The suitability for the agamic propagation of the three cultivars was evaluated on leafed softwood cuttings, approximately 12–15 cm in length, collected in July 2018, August 2019, September 2019, and October 2019. The cuttings were taken from the apical portions of the new vegetation and prepared by removing the leaves from the shoot base.

About 50% of the leaves were removed to avoid the dehydration of the cuttings and to promote rooting. The cuttings were then treated with 1% indolebutyric acid (powder mixture in talc), and placed in rooting benches filled with perlite substrate and equipped with a mist irrigation system and basal heating at 28 °C. The cuttings were allowed to root for 4 weeks, then they were removed and analyzed for the number of rooted and unrooted cuttings and for viable and unviable tissues. Rooted cuttings were placed into plastic pots, regularly watered, and kept under shade in the warmest period and in a greenhouse during the winter months. To verify the ornamental potential of the cultivar, trials for cultivation in pots and as a cut frond species were carried out.

2.3. Statistical Analyses

The results of the morphological and phenological analyses and the rooting test for each year were expressed as means and standard deviations of three replicates. The results were submitted for two-way ANOVA analysis with cultivars and years as the main source of variability, and to separate the means according to Duncan's Multiple Range Test ($p \leq 0.05$) by way of the MSTAT-C software to compare the significance of the differences among the cultivar x year values.

3. Results

3.1. Morphological and Biometric Analysis and Phenology of Myrtle Cultivars

Table 1 reports the biometric characters of blooming shoots of 'Angela', 'Barbara' and 'Antonella'. Among the cultivars, 'Angela' was that with the highest number of flowers per blooming shoot and per cm (8.70 and 0.93, respectively). 'Antonella', on the other hand, showed the highest blooming shoot length and internode number, two typical traits of the *tarentina* subspecies, followed by 'Angela' and then 'Barbara'.

Table 1. Biometric characters of blooming shoots of three myrtle cultivars as observed in the same collection field. Data in the same column showing the same letter are not statistically different for $p \leq 0.05$.

Cultivar	Year	Blooming Shoot Length (cm)	*n* of Internodes per Blooming Shoot	*n* of Flowers per Blooming Shoot	*n* of Flowers per cm
Angela	2018	9.40 ± 0.95 b	7.97 ± 1.81 b	8.70 ± 0.82 a	0.93 ± 0.07 a
	2019	9.77 ± 0.15 b	8.63 ± 0.40 b	8.23 ± 0.15 a	0.91 ± 0.07 a
	2020	9.50 ± 0.60 b	9.13 ± 0.45 b	8.63 ± 0.45 a	0.91 ± 0.04 a
Barbara	2018	8.39 ± 0.52 c	7.68 ± 0.16 b	4.57 ± 0.50 b	0.55 ± 0.09 b
	2019	8.17 ± 0.69 c	7.67 ± 0.23 b	4.53 ± 0.31 b	0.56 ± 0.05 b
	2020	8.17 ± 0.34 c	7.57 ± 0.30 b	4.48 ± 0.20 b	0.55 ± 0.03 b
Antonella	2018	10.67 ± 1.06 a	24.12 ± 0.36 a	3.25 ± 0.15 c	0.30 ± 0.02 c
	2019	11.60 ± 0.67 a	23.94 ± 0.67 a	3.61 ± 0.05 c	0.32 ± 0.02 c
	2020	11.30 ± 0.17 a	24.28 ± 0.73 a	3.47 ± 0.28 c	0.31 ± 0.02 c

The corolla diameter and the number and length of the petals of the flowers gathered in the collection field showed no significant differences across cultivars and study years (Table 2). The two cultivars of *M. communis* var. *communis* ('Angela' and 'Barbara') showed larger petal width than the *tarentina* cultivar, while the floral peduncle length (an average of 2.49 cm among the three years) and style length were enlarged in the 'Angela' cultivar with respect to the reference cultivar (Table 3).

Table 2. Biometric characters of flowers of three myrtle cultivars as observed in the same collection field. Data in the same column showing the same letter are not statistically different for $p \leq 0.05$.

Cultivar	Year	Corolla Diameter (cm)	*n* of Petals	Petals Length (cm)	Petals Width (cm)	Floral Peduncle Length (cm)
Angela	2018	1.94 ± 0.34 a	5.30 ± 0.17 ab	0.87 ± 0.27 a	0.64 ± 0.07 a	2.48 ± 0.10 a
	2019	1.67 ± 0.73 a	5.20 ± 0.10 b	0.87 ± 0.20 a	0.65 ± 0.04 a	2.47 ± 0.15 a
	2020	2.02 ± 0.16 a	5.27 ± 0.15 ab	0.90 ± 0.20 a	0.68 ± 0.05 a	2.53 ± 0.08 a
Barbara	2018	1.91 ± 0.03 a	5.27 ± 0.15 ab	0.78 ± 0.04 a	0.62 ± 0.02 b	1.29 ± 0.02 b
	2019	1.96 ± 0.03 a	5.33 ± 0.25 ab	0.74 ± 0.04 a	0.65 ± 0.03 a	1.26 ± 0.02 b
	2020	1.95 ± 0.03 a	5.37 ± 0.15 ab	0.77 ± 0.02 a	0.63 ± 0.01 ab	1.27 ± 0.03 b
Antonella	2018	1.88 ± 0.04 a	5.53 ± 0.32 ab	0.83 ± 0.03 a	0.57 ± 0.03 cd	0.72 ± 0.01 c
	2019	1.85 ± 0.03 a	5.70 ± 0.10 a	0.84 ± 0.03 a	0.57 ± 0.02 cd	0.70 ± 0.05 c
	2020	1.85 ± 0.04 a	5.70 ± 0.26 a	0.84 ± 0.04 a	0.54 ± 0.03 d	0.70 ± 0.03 c

Table 3. Biometric characters of flower organs of three myrtle cultivars as observed in the same collection field. Data in the same column showing the same letter are not statistically different for $p \leq 0.05$.

Cultivar	Year	Style Length (cm)	Stamen Length (cm)	*n* of Stamens per Flower
Angela	2018	1.22 ± 0.10 ab	0.83 ± 0.21 c	154.63 ± 30.16 ab
	2019	1.24 ± 0.04 a	0.88 ± 0.10 c	146.00 ± 11.00 ab
	2020	1.26 ± 0.02 a	0.86 ± 0.15 c	164.00 ± 10.54 a
Barbara	2018	0.99 ± 0.02 e	0.94 ± 0.02 a	146.00 ± 4.58 ab
	2019	1.00 ± 0.03 de	0.96 ± 0.02 a	145.33 ± 4.04 ab
	2020	0.99 ± 0.04 de	0.94 ± 0.02 ab	149.00 ± 2.65 ab
Antonella	2018	1.11 ± 0.02 c	0.86 ± 0.02 c	138.00 ± 1.00 b
	2019	1.09 ± 0.03 cd	0.88 ± 0.02 bc	140.33 ± 3.06 b
	2020	1.12 ± 0.02 bc	0.86 ± 0.02 c	138.00 ± 2.65 b

The cultivars' fruiting shoots during the berry ripe stage are presented in Figures 3–5.

Figure 3. Fruiting shoots of 'Angela' at ripening time.

Figure 4. Fruiting shoots of 'Barbara' at ripening time.

Figure 5. Fruiting shoots of 'Antonella' at ripening time.

The results of the morphological analysis of fruiting shoots and fruits are reported in Tables 4 and 5. The 'Angela' fruit has a white-green peel, white flesh, and a rounded shape while both reference cultivars have a dark-blue berry peel. The spring shoots at the fruit ripening time of the cultivar 'Angela' showed a higher number of fruits per twig with an average of 5.20 (Table 4). The 'Angela' cultivar has fruit with a higher weight, volume, width, and length than the other cultivars (Table 5). Moreover, the peduncle length was oversized in the 'Angela' cultivar (1.90 cm) than in 'Barbara' (1.36 cm) and 'Antonella' (0.62 cm). In contrast, no significant differences were observed in the Angela twig length with that of 'Antonella', although the latter has a higher number of internodes per twig (Table 4).

Table 4. Biometric characters of fruiting shoots and leaves of three myrtle cultivars as observed in the same collection field. Data in the same column showing the same letter are not statistically different for $p \leq 0.05$.

Cultivar	Year	Twig Length (cm)	*n* Internodes per Twig	*n* Fruit per Twig	Leaf Length (cm)	Leaf Width (cm)
Angela	2018	11.52 ± 1.31 a	9.26 ± 1.07 b	6.16 ± 0.40 a	3.30 ± 0.18 a	1.35 ± 0.08 b
	2019	11.30 ± 0.56 a	9.46 ± 0.55 b	6.30 ± 0.20 a	3.32 ± 0.03 a	1.40 ± 0.03 ab
	2020	11.00 ± 0.36 a	9.13 ± 0.25 bc	6.10 ± 0.26 a	3.45 ± 0.03 a	1.44 ± 0.05 a
Barbara	2018	8.58 ± 0.64 b	8.33 ± 0.31 cd	3.83 ± 0.97 b	2.09 ± 0.09 b	0.89 ± 0.05 b
	2019	8.37 ± 0.64 b	7.93 ± 0.15 d	3.70 ± 0.20 b	2.08 ± 0.08 b	0.91 ± 0.02 b
	2020	8.33 ± 0.42 b	7.73 ± 0.21 d	3.67 ± 0.25 b	1.97 ± 0.03 b	0.88 ± 0.04 b
Antonella	2018	11.81 ± 0.97 a	25.30 ± 0.44 a	2.57 ± 0.35 c	1.23 ± 0.12 c	0.57 ± 0.02 c
	2019	11.97 ± 0.42 a	24.83 ± 0.31 a	2.67 ± 0.15 c	1.19 ± 0.05 c	0.59 ± 0.02 c
	2020	11.60 ± 0.20 a	25.06 ± 0.32 a	2.33 ± 0.25 c	1.26 ± 0.02 c	0.57 ± 0.02 c

Table 5. Biometric characters of fruits of three myrtle cultivars as observed in the same collection field. Data in the same column showing the same letter are not statistically different for $p \leq 0.05$.

Cultivar	Year	Fruit Weight (g)	Fruit Volume (mL)	Fruit Width (cm)	Fruit Length (cm)	Peduncle Length (cm)
Angela	2018	0.52 ± 0.03 a	0.66 ± 0.05 a	1.03 ± 0.02 a	1.24 ± 0.03 a	2.64 ± 0.03 a
	2019	0.53 ± 0.03 a	0.64 ± 0.03 a	1.05 ± 0.02 a	1.26 ± 0.02 a	2.71 ± 0.02 a
	2020	0.53 ± 0.03 a	0.67 ± 0.03 a	1.03 ± 0.02 a	1.25 ± 0.03 a	2.71 ± 0.03 a
Barbara	2018	0.37 ± 0.01 b	0.44 ± 0.02 b	0.84 ± 0.01 b	1.15 ± 0.01 b	1.36 ± 0.09 b
	2019	0.36 ± 0.03 b	0.44 ± 0.02 b	0.84 ± 0.02 b	1.15 ± 0.01 b	1.32 ± 0.08 b
	2020	0.37 ± 0.02 b	0.43 ± 0.03 b	0.85 ± 0.03 b	1.15 ± 0.03 b	1.35 ± 0.07 b
Antonella	2018	0.17 ± 0.03 c	0.18 ± 0.03 c	0.70 ± 0.02 c	0.79 ± 0.02 c	0.69 ± 0.05 c
	2019	0.16 ± 0.01 c	0.18 ± 0.01 c	0.71 ± 0.02 c	0.81 ± 0.03 c	0.72 ± 0.02 c
	2020	0.18 ± 0.01 c	0.18 ± 0.02 c	0.70 ± 0.02 c	0.80 ± 0.04 c	0.69 ± 0.03 c

'Angela' showed larger-sized leaves than the other two cultivars (Table 4), particularly of the cultivar 'Antonella' that, belonging to the *tarentina* subspecies, showed the leaves with the lowest length and width.

The phenology observation highlighted extensive vegetative activity in 'Angela'. It started in January with a vegetative stasis between February and March, and restarted vigorously from May until November. The flowering time occurred in June (intermediate flowering time) with possible re-flowering in August, December, and January. The fruit set started at the beginning of July, while the fruit ripening of the late spring flowering flow was late (January) and gradual. The fruit can persist on the plant until the month of March. In the 'Barbara' cultivar, the fruit set began in July, and ripening occurred in November without harvest scaling. Vegetative activity began in November and went on until November, while flowering started in June and lasted until August.

3.2. Agamic Propagation of Myrtle Cultivars

The propagation test of the softwood cuttings was carried out on four different dates for 'Angela' and the reference cultivars. Results were reported in Figure 6. In the 'Angela' cultivar, the rooting percentage was significantly higher than the reference cultivars, ranging from a minimum of 17.33% in the cuttings rooted in July 2019 to a maximum of 84% in those rooted in September 2019.

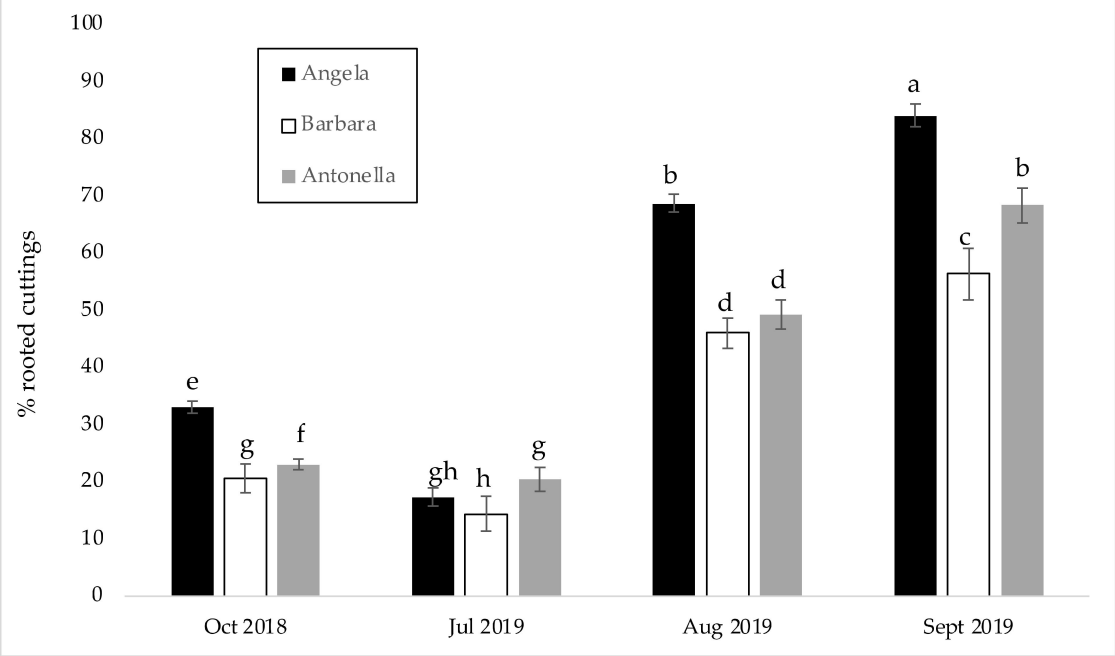

Figure 6. Rooted softwood cuttings of three myrtle cultivars as observed in different seasons. Histograms labeled with the same letter are not statistically different for $p \leq 0.05$.

4. Discussion and Conclusions

Many studies were performed with the aim of evaluating the potentiality of the myrtle genotypes bearing unpigmented fruit. The chemical composition of the fruit and leaves [18–23], possible use as fresh fruit products [19], genetic characterization [6,24], and antioxidant properties [25,26] were the main issues focused on in previous studies. The possibility of proposing some selected cultivars for ornamental purposes had not been consistently evaluated among the *Myrtus communis* selections. The myrtle *tarentina* subspecies is more widely used for ornamental purposes due to its compact vegetative habitus, discrete branch length, and short internodes.

During the myrtle domestication process, some potential cultivars suitable for ornamental use were previously selected [17]. Among these, 'Angela' seems to be one of the most promising (Figure 7).

Figure 7. 'Angela' myrtle cultivar freely growing.

According to the morphological and biometric data and the comparison with the other two cultivars, some characteristics emerged attributing to 'Angela' a clear ornamental value. The high vegetative vigor, the large size of the leaves, the large size of the fruit, and the long peduncle of the fruit were some of these features. Moreover, this cultivar, unlike others, has berries that remain white-greenish without abscission for a long time. Generally, the cultivar is suitable for growing in parks, gardens, and other types of public and private urban green areas. Cut fronds for floral compositions and potted plants are another two possibilities. From our trials, it was possible to obtain myrtle fronds in the open field or in potted plants growing in a shaded greenhouse, cutting the branches after appropriate shape pruning all year long. The fruit-bearing fronds acquire commercial interest because this cultivar has white berries with a very long peduncle that makes the frond very appreciated by customers (Figure 8). The aromatic nature of myrtle leaves is an added value for this purpose.

Figure 8. Fronds with fruit of the 'Angela' cultivar in July.

Moreover, saleable plants can be obtained in pots in about one year by vegetative propagation. The cultivation was carried out under shadow with a reduction of 50% of radiation to avoid excessive heating.

The semi-woody cuttings rooting percentage showed the high aptitude of the 'Angela' cultivar for agamic propagation, which is frequently used for ornamental purposes to keep the peculiar characteristics of the cultivar. Due to the growing consumer demand for Mediterranean maquis shrub species like myrtle for ornamental use, it is necessary to select more cultivars suitable and agronomically valuable for the ornamental market.

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