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PCPM (*Prunus cerasifera X Prunus microcarpa*) hybrid rootstock candidate: Identification and production possibilities with hardwood cutting

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Abstract

This study was conducted in the laboratories and greenhouses of Eastern Mediterranean Transitional Zone Agricultural Research Institute between 2018 and 2020 to identify botanical characteristic of *PCPM* (*Prunus cerasifera* X *Prunus microcarpa*), which is natural hybrid of *Prunus cerasifera* (PC) *and Prunus microcarpa* (PM), and to investigate slip production opportunities of it at different IBA 1000 mg L^{-1}, 2000 mg L^{-1}, 3000 mg L^{-1}, 4000 mg L^{-1}. *PCPM* which was noticed in its natural environment, was followed in botanical terms for 3 years. It was determined that the average fruit weight, fruit width, and fruit length values of PCPM were 1.33 g, 11.93 mm and 12.50 mm, respectively.The soluble solid contents (SSC) values were measured as 15.03 brix in *PC*, 25 brix in *PM*, and 27.66 brix in *PCPM.* It was determined that the annual shoot development was 124.98, 8.41, and 26.15 cm, and the leaf lengths were 64.99, 21.18, and 41.93 mm in *PM, PC,* and *PCPM,* respectively. It was also determined that *PCPM* showed a botanic characteristic between *PM* and *PC*, which are its parents in general botanical terms. In rooting with hardwood cutting for *PCPM*, it showed similar values with Myrobolan 29C, which was the control rootstock, and had average rooting percentage as %80.11, and the average number of roots as 5.27 pcs/slip. The results had a positive effect on rooting increase in hormone application of 2000 mgL^{-1} concentration with IBA compared with other applications.

Keywords: Rootstock, Hardwood cutting, Hybrid, *Prunus*

Introduction

Prunus is a genus spreading widely in the northern temperate zone and Anatolia as one of the member of 250 different species of the Rosacea family, and some of which are still not identified in botanical terms (Demirsoy and Demirsoy, 2004). Another important characteristic of *Prunus* or its interspecies natural hybrids is that they can have important rootstock characteristics for other *Prunus* species (Bouhadida et. al., 2009). Prune is one of the most important fruit in the world, and many seedlings and clonal (vegetative) rootstocks are widely used in recent years (Cociu, et al., 1999; Gundesli, 2018). Also, in many countries, *Prunus* species are also used in breeding programs to obtain new tree fruit crops and rootstocks. All around the world like GF 677 (*P.persica* X *P.amygdalus*) important rootstocks formed by natural hybridization ways used extensively in modern orchards are also known. *Prunus microcarpa* (PM) is a wild fruit species that attracts attention with its scrub development in hard-seed *prunus* genus. *and Prunus cerasifera* (PC) has a wide range of use as fresh and dried fruit, and also has a wide range of usage area as rootstock (Ugur et al., 2019). It was reported in previous studies that natural hybrids occur in the nature between *P.cerasifera* X

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P.armeniaca, *P. microcarpa X P.cerasifera, P. cerasifera X P.avium* (Mirabdulbaghi,et al., 2011; Atli et al., 2019).

This study was aimed to identify some botanical characteristic of PCPM (*P. cerasifera X P.microcarpa*)which is a hybrid rootstock candidate found coincidentally during rootstock breeding studies, by comparing its characteristics with its parents *PM* and *PC* and to determine the possibility of it for being used as a rootstock.

Material and Method

Plant Material

The material of the study was PCPM hybrid rootstock candidate and Myrobolan 29C rootstock (*P.cerasifera*) was used as the control rootstock in hardwood cutting trials.

Morphological and pomological determination

The PCPM hybrid rootstock candidate was examined in terms of pomological and morphological characteristics between 2018 and 2020. Each year, fruit, shoot, and leave samples, including PM and PC were taken and analyzed in the laboratory. All the fruit and leaf sample works were carried out for 3 years on 10 leaf and 30 fruit samples, and the mean were noted (Table 1). Weighing of the samples was made with precision scales (Dikomsan FGH 0.001 g), and the measurements were made with precision caliper (0.01 mm Gomax GMX1017020) on millimetric paper (Yılmaz, 2010).

Propagation with hardwood cutting

PCPM and Myrobolan 29C rootstocks have been taken to the production trial with hardwood cutting, which is the basic study for propagation. Annual shoots 20-25 cm in length, in the dormant period, were taken for rooting. Hardwood cuttings were kept in water with fungicide solution (% 80 Fosetyl-Al) for a day before rooting try. For the hardwood cutting, a total of 3 m^2 rooting pool and 3-4 mm thick medium size perlite was used. The hardwood cuttings were taken to rooting by applying IBA in four different mg.L-1 doses (1000-2000-3000-4000 mgL^{-1}) to the rooting pools in the greenhouse (Atli et. al., 2019).

Statistical analysis

Propagation trial was established in a factorial-random parcel trial pattern with 3 repetitions and 20 plants in each repetition. Variance Analysis at %5 significance level in JMP 5.0 Statistical Program, and the multiple comparisons were made with the LSD test at the same significance level (Table 2-3).

Result and Discussion:

It was found that the average fruit weight values ranged between 0.29 g *PM* and 25.36 g *PC* and the average fruit weight was 1.31 g in *PCPM*. Equatorial fruit width values of *PC, PM* and *PCPM* were 35.25 mm, 7.19 mm and 11.93 mm, respectively, and *PM* had a more homogeneous fruit width (Table 2 and Figure 1). Similar to the findings of this finding support the work of (Moreira et al., 2009Maghsudlu et al.,2013) who observed hardwood cuttings of *PC* that fruit height values to be 34.03 mm, 8.31 mm, 12.50 mm. Although the shape index was close to "round" in the fruits of all three species, *PM* fruits were slightly oval, and PCPM mostly had round fruits. It was found that *PC* had a fruit pulp color in yellow tones, *PM* had orange pulp color, and PCPM was between light brown and claret red color. However, Nas, et al. (2011) indicated that there has been also *PM* genotypes in different colors between red and purple. It was determined that the highest SSC value was in PCPM (27.66), and the lowest value was in *PC* (15.03). Fruit development values of *PC, PM* and PCPM were evaluated, *PM*'s fruit development was more homogeneous than *PC*, and PCPM created a full intermediate form in terms of these characteristics, as expected in a hybrid. It was determined that *PM* had a more homogeneous seed structure; however, the pulp/seed ratio was highest in *PC* (29.23), *PM* had the lowest pulp/seed ratio (2.62), and these values were similar to the results reported by (Demirsoy and Demirsoy, 2004; Mohammadi, et al., 2011). In terms of leaf width and leaf length values, PCPM was distributed between the two species, and the inter-nod distance on annual shoots was low in *PM* (12.45 mm), followed by PCPM and *PC* with 25.71 and 35.03 mm, respectively. These results were similar to the results reported by Rakonjac, et. al., (2010) (Table 1). Our results show that there is a significant difference between rooting percentages of IBA application according to variance analysis (Table 2, 3 and 4). It was observed in studies applying different IBA hormone doses that the highest percentage of rooting was in the doses of 2000 mg.L-1 (%91.07), and the lowest rooting rate was in 4000 mg.L-1 dose (%70.95) unlike expected. It was determined that the PCPM rootstock had similar characteristics in terms of rooting rate with Myrobolan 29C rootstock, which was the control rootstock (Table 2). Sulusoglu et al., (2010) conducted a study on the rooting possibilities of *Prunus laurocerasus*, which may be considered in the same category with PCPM and PM in our study, at different IBA doses, and reported that 2000 mg.L-1 IBA application yielded higher rooting results than the other (1000-4000-6000-8000 mg.L-1) applications. The increase of IBA concentration was accompanied by the decreased rooting percentage, suggesting high IBA concentrations were not suitable for the root formation process (Ercisli, 2004; Mohammadi et al., 2019; Ugur et al., 2018). Kurd, et al., (2010) reported that IBA doses, unlike what was expected, did not provide a considerable increase in rooting rates, and even there was a decrease after 2000 mg.L-1 dose. Tworkski and Takeda (2007) reported that increased IBA doses prevented rooting after a certain rate. It is possible to estimate that even the lowest results detected in our study (%70.95) were close to the highest results of these studies, and this would be considered PCPM as a great rootstock candidate (Table 3). Macmahon et al., (2015) reported that in their study that the average rooting rates were around %40-45, while Moreira et al., (2009) achieved rooting rates around %70-75. The 2000 application mg.L-1 that had the highest root length value (52.88 mm) was followed by 3000 mg.L-1 application with 47.86 mm. The 4000 and 1000 mg.L-1 IBA applications yielded close values. Although root length values were detected at higher values in Myrobolan 29C rootstock (47.52 mm), it was also noted that the PCPM results were not low. In general, both rootstocks yielded high results in root length values in 2000 mg.L-1 IBA application (Table 3). The root length values varied between approximately 40 and 50 mm in our study. In the studies conducted by Sulusoglu and Cavusoglu, (2010), Macmahon et al., (2015) and Tworkoski and Takeda, (2007)

they achieved average root length values between 10 and 25 mm. Compared to these values, it could be argued that the root length value of the PCPM have been good. It was found that applying IBA to Myrobolan 29C rootstock and PCPM rootstock did not yield a different result in terms of the root count, but both rootstocks had promising root counts. In addition, it was also found in the present study that the highest root count was also in 2000 mg.L-1 IBA application. Other applications did not increase the root counts at significant levels (Table 3).

Table 1. Some botanic characteristics of PCPM hybrid rootstock candidate in comparison with *P.cerasifera (PC)* and *P.microcarpa (PM)*

No	Parameters	PC	PM	PCPM
1	Fruit weight (g)	25.36 ±0.88	0.29 ±0.02	1.33 ±0.02
2	Fruit width (mm)	35.25 ±1.03	7.19 ±0.05	11.93 ±0.16
3	Fruit length (mm)	34.03 ±0.95	8.31 ±0.01	12.50 ±0.10
4	Fruit shape index	1.04 ±0.05	0.87 ±0.01	0.95 ±0.01
5	Fruit color (L)	35.38 ±0.88	36.09 ±0.87	31.59 ±0.56
6	Fruit color (a)	15.82 ±0.30	15.39 ±0.07	9.42 ±0.44
7	Fruit color (b)	49.96 ±0.77	43.91 ±0.74	51.45 ±0.58
8	Fruit flesh thickness (mm)	12.06 ±0.45	1.36 ±0.01	2.71 ±0.02
9	SSC	15.03 ±0.28	25.00 ±0.10	27.66 ±0.32
10	Core weight (g)	0.87 ±0.03	0.12 ±0.01	0.32 ±0.01
11	Core length (mm)	15.92 ±0.56	7.26 ±0.02	10.08 ±0.06
12	Core width (mm)	18.34 ±0.43	4.53 ±0.06	6.55 ±0.32
13	Meat-core ratio	29.23 ±0.83	2.62 ±0.12	4.12 ±0.09
14	Pedile length (mm)	12.75 ±0.23	9.46 ±0.02	16.50 ±0.14
15	Pedicular diameter (mm)	1.11 ±0.07	0.75 ±0.01	0.47 ±0.03
16	Leaf width (mm)	43.38 ±0.72	14.00 ±0.04	31.10 ±0.09
17	Leaf length (mm)	64.99 ±0.83	21.18 ±0.48	41.93 ±0.30
18	Petiole length (mm)	15.56 ±0.58	6.58 ±0.07	11.02 ±0.16
19	Annual shoot length (cm)	124.98 ±0.24	8.41 ±0.11	26.15 ±0.19
20	Distance between nodes (mm)	35.03 ±0.49	12.45 ±0.05	25.71 ±0.58
21	Leaf color (L)	33.46 ±0.43	37.34 ±0.43	32.51 ±0.54
22	Leaf color (a)	11.67 ± 0.91	15.23 ± 0.58	26.54 ±0.97
23	Leaf color (b)	32.59 ± 0.80	37.97 ±0.40	37.44 ±0.53
24	Flowering date	16-23 March	14-19 March	14-21 March
25	Ripening date	June 19-22	06-10 June	June 15-18

*Each value is expressed as mean ± standart deviation.

Table 2. Rooting percentage of PCPM hybrid rootstock candidate (%)

	Hormone Applications (mgL^{-1})				
Rootstocks	1000	2000	3000	4000	Rootstock Average
PCPM	84.59	90.79	75.28	69.81	80.11
Control	86.25	92.62	73.27	72.10	81.06
Application average	85.42B	91.07A	74.27C	70.95D	
$LSD_{Rootstock\ 0.05}$: NS		$LSD_{hormone\ 0.05}$: 2.91*		$LSD_{rootstock\ x\ hormone\ 0.05}$:NS	

NS: No significant

Distinct letters in the row indicate significant differences according to Tukey's test ($P \leq 0.05$).

Table 3. Average root length (mm) and root number (mm) values of PCPM hybrid rootstock candidate

Rootstocks Root length	Hormone Applications (mgL^{-1})				Rootstock Average
	1000	2000	3000	4000	
PCPM	44.72b	51.72a	42.98bc	39.63c	44.76B
Control	40.12bc	54.03a	52.74a	43.18bc	47.52A
Hormone Application	42.42C	52.88A	47.86B	41.40C	
$LSD_{Rootstock\ 0.05}$: 2.44**		$LSD_{hormone\ 0.05}$: 3.46**		$LSD_{rootstock\ x\ hormone\ 0.05}$: 4.89**	
Root number					
PCPM	5,52	6,10	5,27	4,80	5.27
Control	5,12	6,31	5,08	5,05	5.53
Hormone Application	5.32B	6.20A	5.17B	4.92B	
$LSD_{Rootstock\ 0.05}$: NS		$LSD_{hormone\ 0.05}$: 0.65*		$LSD_{rootstock\ x\ hormone\ 0.05}$:NS	

NS: No significant

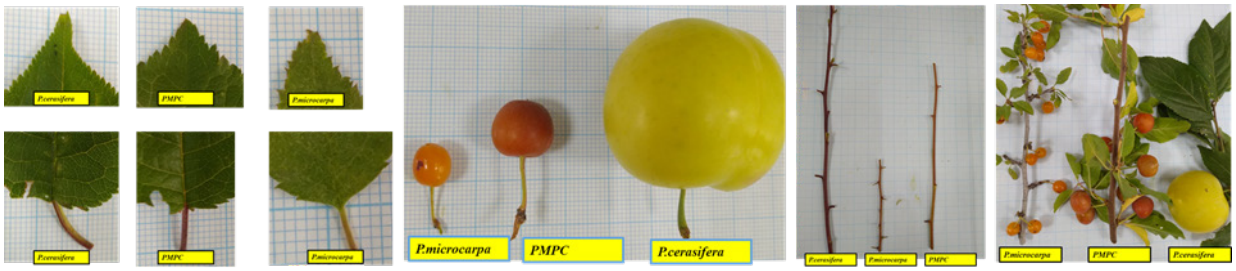

Figure 1. Shoot, Leaf and Fruit characteristics of PCPM hybrid rootstock candidate

Conclusion

As a result, it is considered that hybrids occur spontaneously in the nature among prunus species, and can be made use of for different purposes. Considering the identifications of wild plums and all the botanical characteristics of *PCPM*, it was demonstrated that it is the hybrid of *PC* and *PM* (Tables 1-2-3). In general terms, when it is considered that between %1-10 of seeds are achieved in interspecies hybridization works, the value of hybrid genotypes occur naturally and survive extrem natural conditions like this becomes clear in breeding investigations (Table 2 and 3). The importance of natural hybrids can be better understood when it is considered that the GF-677 clone rootstock, which is the hybrid of *Prunus persica* X *Prunus amygdalus*, found by chance in France, and is now widely used in modern fruit orchards. In this study, the *PCPM* rootstock candidate genotype attracted the attention as a natural hybrid between *PC* and *PM*, its botanical examinations were completed, and the possibilities of slip production were investigated. It was concluded in the study that the fruits of PCPM's *prunus* may have the positive characteristics of being a rootstock. In the future, it will be beneficial to investigate the rootstock characteristics of this rootstock candidate for different *Prunus* types.

Compliance with Ethical Standards

Conflict of interest.

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author contribution

The contribution of the authors is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before

Ethical approval

Not applicable.

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Data availability

Not applicable.

Consent for publication

Not applicable.

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