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The Rootstock Influences Growth and Development Of 'Deveci' Pear

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Abstract

The vegetative and reproductive performance of the 'Deveci' pear (*Pyrus communis* L.) grown on three rootstocks [Quince BA 29, EMC (*Cydonia oblonga*) and a seedling of *P. communis*] were compared between 2012 and 2013. Vegetative growth characteristics such as the rootstock and trunk diameter, leaf lamina width, leaf lamina length, leaf area, leaf petiole length and thickness, plant height and canopy volume were examined. Phenological characteristics such as the time of first flowering, full flowering, days from full flowering to maturity, harvest date and fruit weight and yield were also investigated. Phenological characteristics were seen in the EMC earlier than in the BA 29 or in the seedling. The most vigorous trees were on the BA 29 followed by the EMC and the seedling. The highest leaf lamina width, length, area and leaf petiole length were obtained from trees on the BA 29 rootstock followed by the EMC and seedling. EMC had a lower leaf petiole thickness than the others. The trees grafted on the BA 29 rootstock had a higher rootstock diameter, trunk diameter, plant height, and plant width and canopy volume than the others. The highest fruit weight and yield per tree were obtained from the trees on the BA 29 (405.7 g and 8.33 kg, respectively) and the EMC (157.6 g and 2.37 kg, respectively) followed by the seedling (62.6 g and 0.69 kg, respectively). As a result of this growing period, we suggest that the 'Deveci' pear should be grown on the BA 29 quince rootstock because of the more vigorous growth and the higher yield.

Keywords: Pear, 'Deveci', growth, rootstock, yield, fruit weight

Introduction

The pear is one of the most commonly consumed pome fruit species in Europe (Ozcagıran et al., 2004). In Turkey, pears are the second most important pome fruit after the apple and they are grown in almost all parts of the country. The most common pear species in Turkey is the *P. communis* (Ercisli, 2004).

In pear production, quince rootstocks have been recommended for growing because they have provided good fruit quality, maintenance and harvesting is easy and the size of the tree is small compared to the one grown from a seedling. Commercial pear varieties elsewhere in the world are usually grafted on rootstocks of *Pyrus* and *Cydonia*. Quinces rootstocks have been widely used due to some beneficial characteristics like size reduction, yield precocity and improvements in food quality and size. *Pyrus* rootstock produces a large tree but it is slow to bear fruit and in most cases causes alternate bearing (Browning and Watkins, 1991; Jackson 2003; Francescatto et al. 2010). Most rootstocks aimed at controlling excessive growth in pear trees, particularly in European varieties, are of different species, for instance quince rootstocks (*Cydonia oblonga* L) (Webster, 1998).

World pear production reached 23.5 million tonnes in 2013 with Turkey producing 439.656 tonnes ranking second, after apples, among global production of deciduous fruit tree species. Turkey is in 5th place in pear production in the world with 439.656 tonnes of annual production and Turkey is one of the major pear producing countries in Europe being ranking second after Spain (FAO 2014). Pear production in Turkey has been increasing year by year with such cultivars as 'Deveci', 'Santa Maria' and 'Williams' extensively used in pear production in Turkey. The 'Deveci' pear cultivar, the main one in Turkey, is one of the best winter-type pear cultivars, originating from Anatolia, gaining in popularity during the last few years in Turkey because of high fruit quality, production and storage capacity (Şen et al. 2009).

The aim of this study was to determine the effects of different rootstocks on vegetative growth, precocity and yield efficiency for `Deveci' pears during the first three year period.

Materials and methods

Materials

Pear trees, grafted on three rootstocks, were planted in May 2010 with 1-year-old scions, at the farmer orchard in Samsun (41°22'N; 36°10'E; altitude 182 m), located in the Black Sea Region on the north coast of Turkey. Samsun has a warm and humid climate in summer, and winters are cool and damp. Precipitation is heaviest in late autumn and early winter. According to long term climatic data of Samsun, the mean maximum temperature is 26.2°C; the mean minimum is 3.3°C, and the mean annual temperature is 14.1°C (Anonymous, 2014). The soil traits of experimental area based on the result of soil samples taken from 20cm are clay (83%), low lime (0.50%), salt-free (0.105%), pH (6.6), phosphorus (63.2 kg da^{-1}), potassium (236 kg da^{-1}) and high organic matter (5.76%).

Methods

The following three rootstocks were tested: quince BA 29, quince EMC (*Cydonia oblonga*) and a seedling of *Pyrus communis*, obtained from local wild pear genotype. The plants grafted on the BA 29 and EMC rootstocks were spaced at 3.5 m x 1.2 m intervals, the plants grafted on the seedling was spaced at 4m x 4m, headed at 80 cm and trained according to the modified leader system. The plants grafted onto quince rootstocks were tied from three wires at 0.5, 1.0 and 1.5 m in the training system and seedlings were not wired. Pruning was done regularly every year, when the trees had grown to occupy their allotted space. Drip irrigation was conducted with pressure-compensating drippers, placed at 1.20 m intervals along the rows, one pipe per row. Irrigation was done at one week intervals in response to the plant's water needs. NPK solution was applied through the irrigation system based on the development of the orchard (up to 40N–$10P_2O_5$–$60K_2O$ in the last two years).

The plant material was in the same condition for all rootstocks. Trunk circumferences and canopy dimensions; height (h), length (l) and width (w) were measured, and canopy volumes were calculated by $V = \pi \times h \times l \times w/3$. Trunk circumferences were measured 20 cm above the graft union and the rootstock diameter was measured 5 cm below the graft union (Kappel and Quamme, 1988; Stern and Doron, 2009; Hudina et al., 2014). Three hundred leaf samples were randomly taken from each replication (75 leaf samples) for each rootstock. The leaf lamina width (cm), leaf lamina length (cm) and leaf petiole length (mm) were measured with a 20 cm ruler and the leaf petiole thickness (mm) was measured with a digital caliper (Mitutoyo CD-20CPX). Each leaf was placed on an A4 sheet and copied (at a 1:1 ratio) with a photocopier. The leaf area (cm^2) was measured from the copy with a placom digital planimeter (Sokkisha Planimeter Inc., Model KP-90).

The dates of first flowering and full flowering, days from full flowering to maturity and harvest date were recorded as outlined by Buyukyılmaz and Bulagay (1983). The number of fruit was counted for each tree in each rootstock combination. Thirty fruit samples were randomly collected from the sun-exposed outside parts of each replication. The weight of the fruit was determined using a digital balance (± 0.01g) and the mean fruit weight was then calculated. The yield per tree was calculated by multiplying the number of fruit with the mean fruit weight and is expressed as $kgtree^{-1}$.

The experimental design was a randomized complete block with 4 replications and 5 trees per replicate. Measurements were made on the center tree of each replication. Statistical significance was determined by the one-way analysis of variance (ANOVA) using the SPSS (Version 16.0) program (SPSS Inc. Chicago, USA).The Duncan multiple range test was used to compare treatments when an analysis of variance showed significant differences among means. Means were presented as an average of two years in Tables.

Results and Discussion

Phenological observations;

In the pear, flowering time is an important characteristic due to the need to synchronize bloom with pollinating varieties and the need to avoid damage in late spring frosts (Kıprjanovski and Ristevski, 2009). In terms of all phenological characteristics such as the date of bud burst, first flowering, full flowering, fruit set, harvest, leaf fall and number of days from full flowering to maturity, the EMC rootstock was earlier than the seedling and BA 29 (Table 1). These findings were in accordance with Ertürk et al. (2009), who reported that the full flowering and harvest date were 26 April and 24 October, respectively, for the 'Deveci' pear grafted on the Quince A rootstock. Osmanoğlu et al. (2013) cited that the full flowering date varied from 27 March (2011 year) to 27 April (2012 year) for the 'Deveci' cultivar grafted on the seedling in Bingöl. The phenological characteristics were changed according to rootstocks in the following increasing order: EMC, seedling and BA 29. Jackson (2003) reported that the rootstock had a direct effect on the time of flowering and fruiting.

Table 1. Phenological characteristics of the 'Deveci' pear, as influenced by different rootstocks

Rootstocks	Phenological Characteristics						
	Bud Burst	First Flowering	Full Flowering	Fruit Set	Harvest Date	Days from Full Flowering to Harvest	Leaf Fall
2012							
BA 29	25 March	03 April	06 April	25 April	14 Sept.	162	15 Nov.
EMC	20 March	25 March	30 March	23 April	07 Sept.	162	10 Nov.
Seedling	23 March	-	-	-	-	-	13 Nov.
2013							
BA 29	21 March	30 March	01 April	22 April	20 Sept.	173	31 Oct.
EMC	18 March	26 March	29 March	20 April	13 Sept.	169	25 Oct.
Seedling	23 March	31 March	04 April	21 April	15 Sept.	165	27 Oct.

Pomological and morphological characteristics

The effects of different rootstocks on the yield and fruit size of the 'Deveci' pear in the first three years are shown in Figure 1. The average fruit weight varied from 62.6 g to 405.7 g and yield varied from 0.69 kg/ plant to 8.33 kg/plant, with significant differences according to the rootstocks. The highest fruit weight and yield per plant were obtained from the trees on the BA 29 (405.7 g and 8.33 kg, respectively) and the EMC (157.6 g and 2.37 kg, respectively) followed by the seedling (62.6 g and 0.69 kg, respectively) (Figure 1).

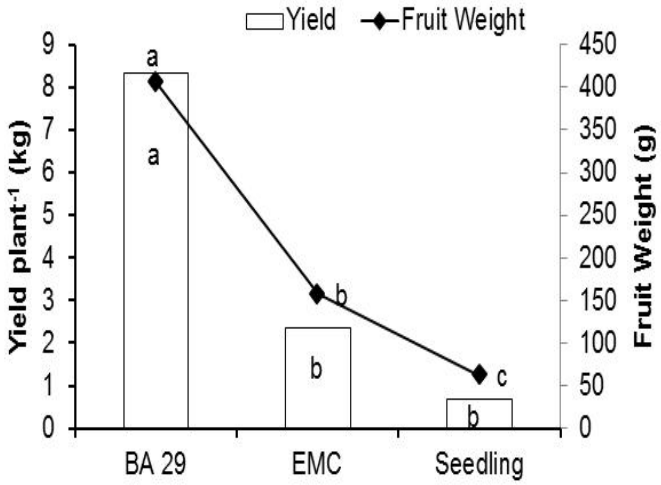

Figure 1. The effect of different rootstocks on the yield and fruit weight of the 'Deveci' pear. [Different letters show significant differences between means (Duncan's Multiple Range Test, P> 0.05)]

The fruit weight and yield per plant were higher in the quince rootstocks than in the seedling. These results are slightly higher than the findings of Erdem and Öztürk (2012) who reported that the mean fruit weight and yield of the 'Deveci' pear on BA 29 were 243.8 g and 6.31 kg/tree, respectively and Ertürk et al. (2009), who reported that the mean fruit weight and yield were 302.2 g and 7.84 kg/plant, respectively, on Quince A rootstock. Akçay et al. (2009) and Ozturk et al. (2009) reported that the average fruit weight of the 'Deveci' pear is 323.5 g and 289.8 g respectively.

Rootstock diameter, trunk diameter, plant height and width and canopy volume of the 'Deveci' pear was significantly affected by the different rootstocks (Table 2). The highest rootstock diameter was obtained from BA 29 (39.07 mm), followed by seedling and EMC. BA 29 had a higher trunk diameter than the EMC and Seedling. These findings were in accordance with Francescatto et al. (2010) and Giacobbo et al. (2010), who reported that BA 29 had a higher rootstock and trunk diameter than the EMC rootstock. Our findings were slightly higher than those outlined by Ertürk et al. (2009), who reported that the trunk diameter of the 'Deveci' pear was 12.91 mm grafted onto Quince A rootstock.

Table 2. Rootstock diameter, trunk diameter, plant height and width and canopy volume of 'Deveci' pear, as influenced by different rootstocks

Rootstock	Rootstock Diameter (mm)	Trunk Diameter (mm)	Plant Height (m)	Plant Width (m)	Canopy volume (m^3)
BA 29	39.07±1.12 a*	44.11±2.20 a	2.52±8.16 a	1.13±1.93 a	1.87±0.82 a
EMC	24.79±2.22 c	30.37±2.85 b	1.82±6.99 b	0.69±2.01 b	0.38±0.13 b
Seedling	29.07±4.09 b	24.91±3.65 c	1.71±9.25 b	0.54±1.52 b	0.37±0.27 b

*:Means within a columns followed by different lower-case letters differ significantly according to Duncan's Multiple Range Test, P> 0.05.

Plant height and plant width and canopy volume were the highest in the BA 29 rootstock, followed by EMC and seedling. Giacobbo et al. (2010) cited that BA 29 had a higher tree height than the EMC. Akçay et al. (2009) cited that plant height and plant width of the Deveci pear cultivar on Quince A rootstock are 2.25 m and 1.84 m, respectively. Regarding the canopy volume, BA 29 had the highest (1.87 m^3), followed by EMC and seedling (0.38 m^3 and 0.37 m^3, respectively) (Table 2). These results were lower than those found by Hudina et al. (2014), who reported that canopy volume changed from 1.05 to 3.43 m^3 (BA 29), 1.53 to 2.15 m^3 (Quince A) and 2.12 to 3.69 m^3 (Seedling). Previous studies have reported that the tree canopy volume are affected by the year and the cultivar (Urbina et al. 2003; Stern and Doron 2009; Hudina et al. 2014).

Statistically significant differences were observed for the characteristics of the leaves of the 'Deveci' pear grafted onto different rootstocks. BA 29 had a higher leaf lamina width, leaf lamina length, and leaf area and leaf petiole length than the others. EMC had a lower leaf petiole thickness than the BA 29 and seedling (Table 3). The highest leaf lamina length was BA 29, followed by the seedling and EMC.

Table 3. The leaf characteristics of the 'Deveci' pear, as influenced by different rootstock

Rootstock	Leaf Lamina Width (cm)	Leaf Lamina Length (cm)	Leaf Area (cm^2)	Leaf Petiole	
				Length (cm)	Thickness (mm)
BA 29	3.44±0.12 a*	7.13±0.34 a	16.31±1.43 a	4.43±0.26 a	0.76±0.02 a
EMC	3.02±0.09 b	6.17±0.37 c	12.57±1.08 b	3.79±0.24 b	0.58±0.07 b
Seedling	2.99±0.07 b	6.64±0.18 b	13.25±0.59 b	3.35±0.59 b	0.70±0.06 a

*:Means within a columns followed by different lower-case letters differ significantly according to Duncan's Multiple Range Test, P> 0.05.

When the plants were grafted on the stronger rootstocks, BA 29 showed the highest leaf area (16.31 cm^2). When the plants were grafted on weaker rootstock, such as EMC, the leaf area was small. These findings are in accordance with Jackson (2003), who reported that particularly in tree leaf size they begin to differ and the main effect of rootstock on photosynthetic potential is through its effect on leaf area. This author cited that the rootstock has a very large effect on leaf area and the other leaf dimensions.

In the present study, plant growth and development, fruit weight and yield were influenced by various rootstocks differently in the first three year growing period. The BA 29 showed a stronger growth and development than the EMC and seedling rootstock. This situation may be resulted from different growth and development characteristics of the rootstocks. Plant growth and development are affected by the grafted rootstocks (Yılmaz 1994; Jackson 2003).

Conclusion

Results in this study indicate that the BA 29 rootstock performed better in the first three years (first two bearing years) than the EMC and seedling. BA 29 was found to have a positive effect on fruit quality and fruit size and yield efficiency. EMC was found to be an earlier rootstock in terms of phenological characteristics. Due to the relatively young age of the trees in this study it is difficult to give any accurate indication of optimal rootstocks. Additionally, under the conditions of this experiment quince rootstocks (BA 29 and EMC) were desirable for better fruit quality and precocity and higher fruit production of the 'Deveci' pear cultivar.

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