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Branching of 'Galaxy Gala' Apple Scion on Selected 'Tahar' Apple Rootstocks (*Malus sylvestris spp. orientalis*)

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Abstract: ***In this study the effect of three selected rootstock genotypes from the dwarf 'Tahar' apple population (Malus sylvestris ssp. orientalis), grown in nature in the center of Asia Minor, on the growth and branching of 'Galaxy Gala' apple scion were investigated. Nine rooted plants from each genotype were planted and chip budded. Morphological measurements were done on the nursery trees scion after two years of growth in the nursery. The three rootstock genotypes produced different growing habit and branch architecture. ıt was concluded that they could be nominee for developing new dwarf apple rootstocks in areas where water is scarce.***

Keywords: *Malus communis*, Tree architecture, Nursery tree, Drought

1. Introduction

Dwarf apples have been known for centuries. According to *Theophrastus*, one of the early Greek historian, a small, low growing type of apple was being sent back to Greece which was among the plants collected during the conquest of Alexander the Great in Asia Minor in the 3rd Millenium BC (Tukey, 1983). Was it one of the contributers of modern apple rootstocks? In the center of Asia Minor, there is still naturally growing a genetic dwarf apple population *(Malus sylvestris spp. orientalis),* locally called as 'Tahar' apples. They make low vigor small bushes with a maximum height of 1.5 meters when mature and bear poor quality small fruits in the middle of July. 'Tahar' apples thrive well in poor soils and bear fruit without irrigation under about 400 mm precipitation (Çağlar, 1997). The observed tolerance to unfavorable conditions of 'Tahar' apples probably comes from their miniature status and evolutional process.

Climatic studies suggest severe and widespread droughts in the next 30-90 years over many land areas resulting from either decreased precipitation and/or increased evaporation (Dai, 2013). That is, one of the biggest issue due to to global warming is the decrease in amount of irrigation water. Thus, drought resistant plants with ability to produce crop with minimum loss in water deficit environment relative to water free management are of main area of recent agricultural research and genetics (Mitra, 2001). Low vigor 'Tahar' apples growing without irrigation can be a nominee for developing a new dwarfing rootstock for commercial apple orchards where water is scarce.

Through a previous rootstock selection study twelve unique types among the 'Tahar' apple population had been characterized according to UPOV criteria and then grouped via molecular analysis (Boyacı, 2014). Three of them had good characteristics to be used as rootstocks. However, their effect on scion growth and horticultural characteristics when budded with commercial apple scions are unknown. Especially branching of apple nursery trees is an important criteria for obtaining early yield advantage in high density plantings (Quinlan and Tobutt, 1990).It has been shown that rootstocks affect the scion growth and branching habit of a given apple cultivar (Warner, 1991; Tworkoski and Miller, 2007). Modification of nursery tree architecture with apple rootstocks was also considered as a breeding technique (Fazio and Robinson, 2008). Here we report the effect of three selected rootstock genotypes from "Tahar" apples on the growth and branching of 'Galaxy Gala' apple scion after two years of growth in the nursery.

2. Materials and Methods

Three promising 'Tahar' apple rootstock genotypes (50TE01, 50TE02, 50TE12) from a selection study (Boyacı, 2014) were propagated by mound layering and nine rooted plants from each genotypes were planted 50 cm apart in early March and chip budded with dormant buds of 'Galaxy Gala' scion in mid April in 2015. The trees were grown under rutin cultural practices without pruning for two growing season in the nursery. Stem length and diameter (10 cm above the budding point) of the scion were measured and the branch numbers were counted, and their lengths, diameters as well as angles from vertical were determined. Mean separation among the values was done with LSD test.

3. Results and Discussion

Rootstock genotypes produced different growing habit on 'Galaxy Gala' scion after two years of growth in the nursery (Table 1). The genotype 50TE12 had a strongest tree growth with highest mean stem length and diameter followed by 50TE01 and 50TE02 respectively. However, the number of branches of strong growing genotype 50TE12 was only 11 while the other two genotypes had an average of 20 branches. Mean length of branches was significantly higher in strong growing genotype 50TE12 (44.2 cm) than that of 50TE01 (15.4 cm) and 50TE02 (10.7 cm). The angles of branches from vertical were differed significantly according to genotypes, ranging from 85^0 to 55^0. Although Gala apples naturally has more branches in the orchard than most other

apple cultivars, the early branching in the nursery is considered an important criteria for early yield in high density orchards (Quinlan and Tobutt, 1990). For that reason some chemicals such as Promalin or mechanically leaf removal or both are used to improve branching of apple cultivars which produce few or no branches in the modern nurseries. However, as seen in this study the rootstock genotypes produced considerable number of good (wide angles) branches on the scion cultivar.

Table 1: Some morphological characteristics of Galaxy Gala apple scion budded on three selected 'Tahar' dwarfing rootstocks

Genotype	Mean stem length (cm)	Mean stem diameter (cm)	Mean branch number	Mean branch lenght (cm)	Mean branch diameter (mm)	Mean branch angle (^{0})
50TE01	130 b	2.0 ab	20 a	15.4 b	15 a	65
50TE02	110 c	1.6 b	20 a	10.7 b	10 b	85
50TE12	157 a	2.5 a	11 b	44.2 a	12 b	55

Mean separation within columns by least significant differences at $P \leq 0.05$.

Each rootstock had different effect on the branch architecture of the 'Galaxy Gala' scion (Figure 1). Two of the rootstocks (50TE01 and 50TE12) produced longer and branches which oriented basitonically. This was consistent with the natural habit of the low vigor, multi-stemmed 'Tahar' apples. But 50TE02 had small sized branches curled along the stem axis. The first two rootstocks produced a long empty stem piece starting from the upper longer branch up to top two shoots. This empty stem needs to be amended by corrective pruning after planting in the orchard. The third rootstock (50TE02) produced very different habit which can be suitable for super- mini spindle system.

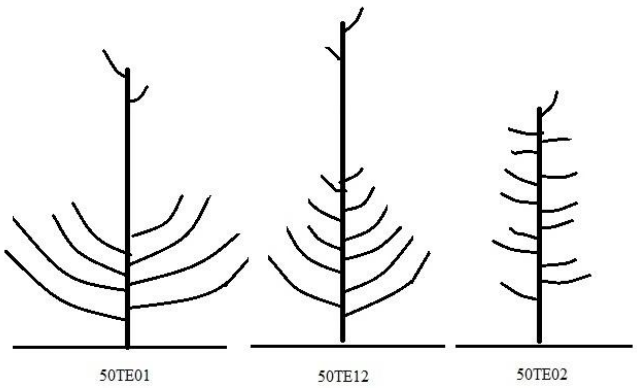

Figure 1: Schematic branch architecture of 'Galaxy Gala' apples budded on three selected 'Tahar' dwarfing apple rootstocks

The different branching habit of the same cultivar on different rootstocks was reported for apples (Fazio and Robinson 2008). This effect might be genetically controlled. In a recent study with 'Royal Gala' apples budded on several rootstock, the dwarfing affected indicated the limited supply of root-produced GA_{19} to shoot apices of the scion, where GA19 may be a precursor of bioactive gibberellin A_1 required for shoot extension growth (van Hooijdonk *et al*, 2011). After two years of growth in the nursery, the scions on three rootstock selections formed fruiting spurs. This was an apparent behavior of a dwarfing rootstocks. Also, the apical buds of all branches turned into fruit buds which indicated that the growth of the trees both horizontally and vertically could be limited if not pruned. Rootstocks can not only influence the vigor, habit and cropping of the scion cultivar, but also affect its resistance/tolerance to soil or to unfavourable climatic or edaphic conditions (Webster, 2005). The rootstock selections used in this study can endure hot and dry summers without irrigation in nature which is a good characteristic for developing drought tolerance rootstocks. However, fruit quality of commercial apple scions on the studied rootstock remains a question.

4. Conclusion

In this study it appeared that the selected 'Tahar' rootstocks are genetically different from each other, since they produced different branch architecture on the same apple scion in the nursery. This also confirmed the results of molecular analysis which had been done during the selection process. The wide branch angle of scions obtained from the rootstock selections is important for early yield. It was expected that these genetically dwarf selections could be developed as promising rootstocks for super high density planting systems in areas where water is scarce.

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