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Effects of M_9 and MM_{106} rootstocks on agromorphological characteristics of 'Golab kohanz' and 'Delbarstival' apple cultivars in Abhar region of Iran

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Abstract

Dwarf rootstocks find use to increase yield in a unit area. Therefore, the aim of the study is to compare and examine M_9 dwarf and MM_{106} semi-dwarf rootstocks on some vegetative and yield traits of 'Golab-kohanz' (Iranian) and 'Delbarstival' (commercial foreign) cultivars of apple, grown at orchard in Abhar, Iran. Results showed that the 'Golab-kohanz' on the MM_{106} rootstock had the most mean shoot length of the current year (39.97 cm) and tree height (198.33 cm). Also 'Golab-kohanz' (6.40 cm), (33.58 cm^2) and MM_{106} rootstock (7.39 cm), (33.09 cm^2) had the most trunk diameter and trunk cross sectional area respectively. The most internode length of the current year belonged to MM_{106} rootstock (5.12 cm). 'Delbarstival' (141 cm) and M_9 Rootstock (133 cm) had the most canopy width tree. Then, 'Delbarstival' on M_9 rootstock had the most yields of trees (14.61 kg $tree^{-1}$), yield in hectare (40.56 ton ha^{-1}) and yield efficiency (519.33 kg cm^2). Pursuant to results, among experimented rootstocks and cultivars, 'Delbarstival' on M_9 rootstock is the proper compound for achieving the largest yield cropping in intensive planting orchards system in Abhar climatic conditions.

Keywords: Apple, dwarf and semi-dwarf rootstock, vegetative and reproductive traits.

Introduction

Trees must be trained and pruned to achieve a manageable uniform size, a balance between growth and regular yield, and to allow good penetration of light and spray to the tree center (Malavolta & Cross, 2009). Most apple scion cultivars grown on their own roots or on seedling rootstocks produce large standard trees of 7-10 m in height and spread. Whilst such trees are acceptable in countries where land and labor are very inexpensive, in most apple producing areas of the world some reduction in this natural vigor is desired (Ferree & Warrington, 2003; Ahmad Dadashpour *et al*., 2012). Vigorous rootstocks such as M_9 reduce 20-30% tree size compared with seedling rootstock (Fazio & Baldo, 2005). However, the final size of trees grown on M_9 will depends greatly on the inherent vigor of the scion cultivar, the soil fertility and the management system adopted by the grower (Ferree & Warrington, 2003). Dwarfing rootstocks have become widely acceptable by the industry as a tool for increasing orchard efficiency because they influence the size of tree, yield and planting density per unit area (Barritt *et al*., 1995). Modern orchards planting systems are based on higher tree densities with a range from 1000 to 6000 trees per hectare and some up to 10000 trees per hectare (Robinson, 2003). However, increasing planting density alone does not increase yield, as planting density and yield are not linearly related and a threshold can be found beyond which a further increase in density may not result in greater yield (Webster, 2001; Hampson *et al*., 2002). Clonal dwarfing apple rootstocks control scion growth by the reduction of canopy spread, branches compression and tree height. M_9 introduced as a dwarf that induces excellent yield, precocity, efficiency and large fruit size. Although semi-dwarfing MM_{106} causes high yield efficiency and fruit size can be smaller than M_9 (Ferree & Warrington, 2003). More reduction in shoot growth, nods number, trunk diameter, and trunk cross sectional area are inductive effects vegetative dwarfing rootstock in comparison with semi-dwarf or seedling rootstock (Blanco *et al*., 2008; McAfee & Rom, 2003; Neem *et al*., 2006). Thus, our objective was to study the influence of vegetative M_9 and MM_{106} rootstocks on reaction of two apple cultivars to achieve large quantities of fruit relative to the amount of wood produce in Abhar region of Iran.

Materials and Methods

Plant material, experimental design, sample collection

Field experiments were carried out in 2008-09 at an orchard of applied plant research at Abhar, Iran. The experiment was done on four year old apple cultivars consist of 'Golab-kohanz' and 'Delbarstival' grafted on M_9 dwarf and MM_{106} semi-dwarf rootstock. The trees were planted in 2005 in four replications at a distance 3×1.25 for M_9 and 3×2.40 m for MM_{106} rootstock. Twenty four representative trees within each replication and then four uniform branches in the cardinal points of each tree were selected for sampling and data collection. The split plot design based on a randomized complete block (RCBD) with four replications was used for statistical analysis. Analysis of variance (ANOVA) and mean separations by Duncan's multiple range test (DMRT) were carried out using the procedure of the MSTATC software.

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Agromorphological characteristics

In order to measure the shoot growth, average current season growth of four branches in each tree at the end of the seasonal growth was recorded in cm. Also average length of the current seasonal internode was measured in middle of each branch in cm. To measure the tree height, distance between graft unions to end of the highest branch in main trunk was recorded in cm. For calculating the Trunk Cross Sectional Area (TCSA), trunk circumference about 20 cm above the graft union was measured with a hand caliper at the end of the growing season and converted to Trunk Cross Sectional Area (TCSA) in cm^2. Yield per tree was based on the amount of fruit in each tree at harvest time. Finally, yield efficiency was measured as yield per tree divided to TCSA in late growing season (yield per tree/TCSA).

Result and discussion

Vegetative characteristics cultivars grafted on M_9 and MM_{106} rootstock

Tree growth and development can be markedly influenced by both cultivar and rootstock (Hirst & Ferree, 1995). In this study, results showed that M_9 rootstock lowered the shoot growth (36.39 cm), length of the current shoot growth internode (4.11 cm), tree height (170.67 cm), canopy wide (133 cm), trunk diameter (6.11 cm) and TCSA (30.92 cm^2), on cultivar grafted compared to that of MM106 rootstock (Fig. 1 & 2), confirming the previous studies (Castes & Villanneva, 2007; Amiri & Fallahi, 2009). The hypothesis is that dwarfing rootstock, or possibly its graft union alters the ratios and concentrations of the growth promoting and may also be

Fig.1 (a,b). Effect of cultivar on vegetative traits

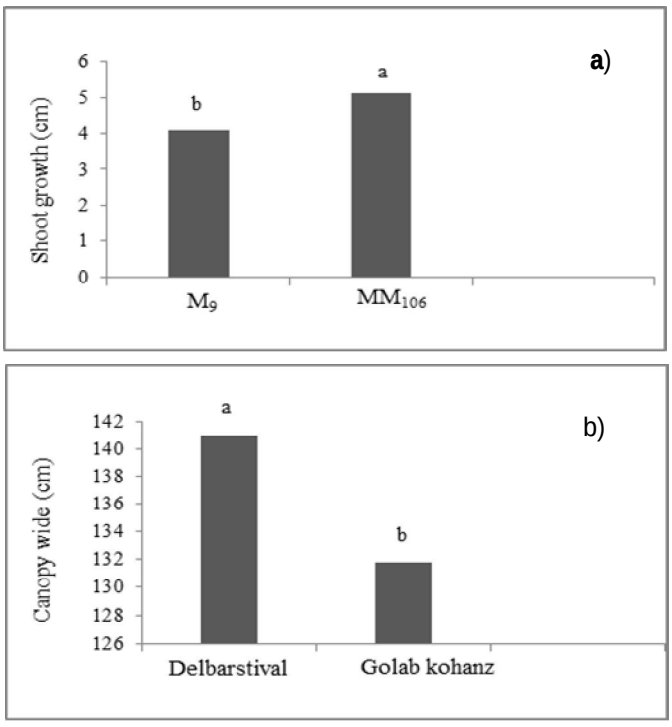
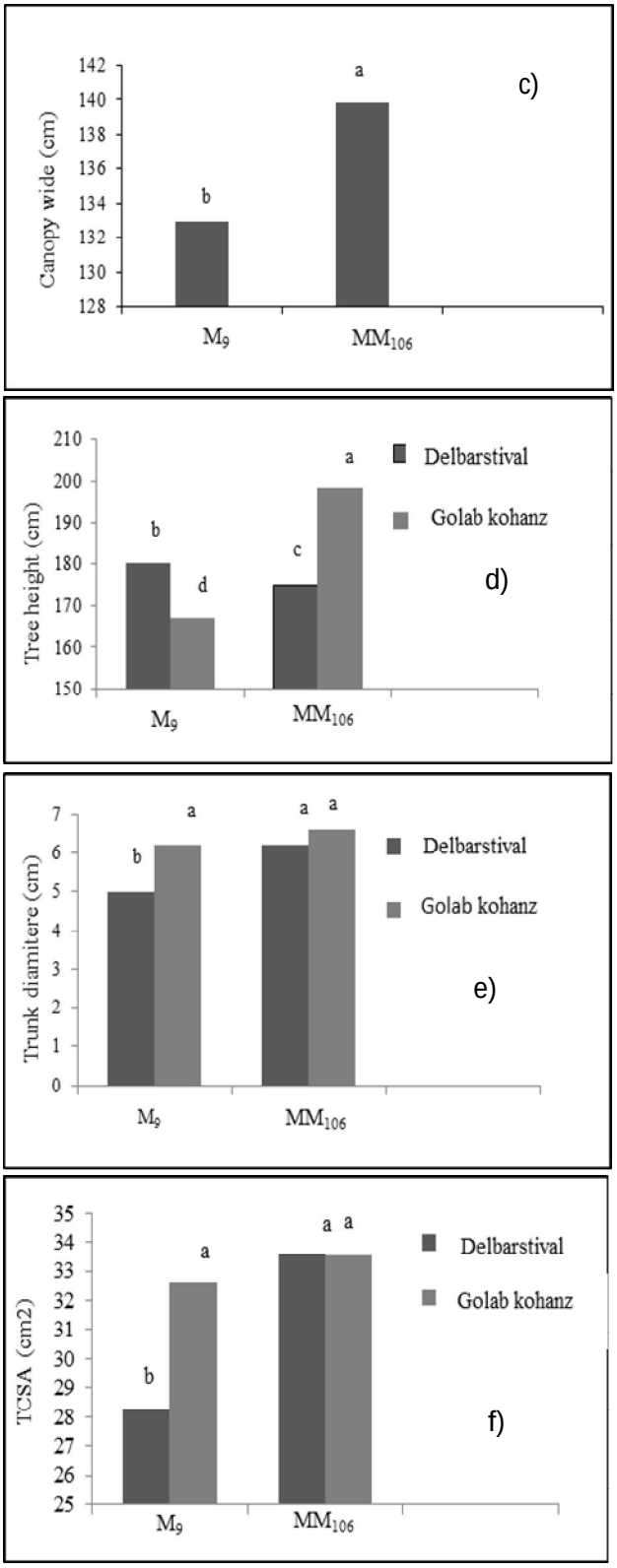


Fig. 2 (c, d, e, f). Effect of interaction of cultivar and rootstock on vegetative traits (means, with similar letters are not significantly different at P≤0.01according to Duncan multiple range test).



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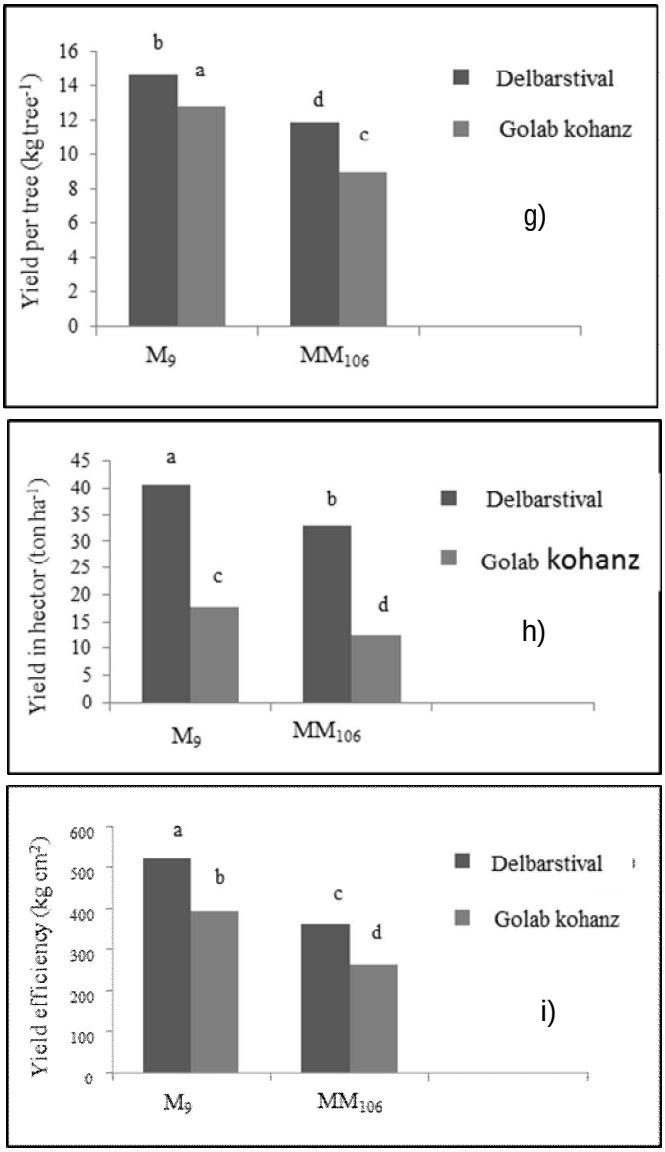
inhibiting hormones which are translocated within the tree (Ferree & Warrington, 2003; Michael, 2009). The rate of basipetal auxin translocations were less in dwarfing than in invigorating rootstock, also indicated that the ratio of abscisic acid to auxin content were higher in the bark of dwarfing rootstock (Ferree & Warrington, 2003). Thus, reduction of auxin translocationg in M_9 bark causes reduction of root growth, subsequently less translocation of gibberellin and cytokinin to scion and finally reduces the vegetative growth (Avery, 1970). Compare to invigorating rootstock, dwarfing rootstock reduces the speed of shoot growth extension throughout the season and often brings about an earlier termination of this shoot extension in the late summer or early autumn. This effect and changes in tree habit towards more horizontal branch orientation (Warner, 1991) together account for the effect of the dwarfing rootstock in reducing the size of apple-scion trees.

Yield characteristics cultivars grafted on M_9 and MM_{106} rootstock

The beneficial effects of dwarfing rootstock on the precocity and efficiency of tree yields have often been attributed to a change in the partitioning of the dwarfed trees assimilate from shoot growth to fruit production. However, semi-invigorating clonal rootstocks, such as MM_{106}, induce improved yield precocity and efficiency in comparison with seedling rootstocks inducing the same level of scion vigor (Wertheim & Callesen, 2000). Results showed that cultivars grafted on M_9 had a more yield per tree (13.23 kg tree^{-1}), yield in hector (36.69 ton ha^{-1}) and yield efficiency (440.45 kg cm^2) than MM_{106} (Fig.3). Increased photosynthesis and yield efficiency in grafted cultivars on dwarfing rootstock deriving from reduction of shoot growth vegetative, competition between vegetative and productive growth, more light penetration in canopy and intensity in area unit (Avery, 1970; Webster, 2001; McAfee & Rom, 2003) and then increase setting (Castes & Villanneva, 2007; Seleznyova *et al*., 2008). Although it is assumed that tree on dwarf rootstocks have limited vegetative growth resulting higher yield (Robinson, 2007).

Differences in TCSA indicate that rootstock controls the tree size (Dolp & Proebsting, 1989). In fact in this study the M_9 rootstock has controlled the tree size of 'Delbarstival' more than 'Golab kohanz' cultivar resulting in the lowest TCSA (28.24 cm^2) and the highest yield per tree (14.61 kg tree^{-1}), yield in hector (40.56 ton tree^{-1}) and yield efficiency (519.33 kg cm^2). Previous researches also indicated rootstock and scion interaction for the size and attributed rootstock to be the predominant factor controlling the size (Hirst & Ferree, 1995). Small TCSA produced by 'Delbarstival' may be a genetic trait transferred from the rootstock to the scion (Dadashpour *et al*., 2010). 'Golab kohanz' probably is the earliest harvesting of fruits that had longer period for vegetative growing, resulted to more vegetative traits. Therefore, this study presented those trees with more vegetative growth; produce the lower yield, confirming the previous study

Fig. 3 (g,h,i). Effect of interaction of cultivar and rootstock on reproductive traits



(Strikic *et al*., 2007). Rootstock influenced apple yield productivity. One hypothesis is that trees on dwarfing rootstocks terminate shoot growth earlier in the summer than trees on more invigorating rootstocks and thereafter partition more of their available assimilates towards the sites of floral primordia and less towards further shoot growth (Ferree & Warrington, 2003).

References

1. Ahmad Dadashpour, Mohammad Javad Shakouri and Zahra Fallah Shojaie (2012) Evaluation of growth, yield and fruit characteristics of five apple cultivars on "Gutingen V" system during 2006-2008. *Indian J. Sci. Technol*. 5 (1). This issue. http://www.indjst.org
2. Amiri M and Fallahi E (2009) Potentional of mineral uptake efficiency by some apple rootstock. In: The Proc. of the Intl. Plant Nutrition Colloquium. XVI UC Davis.

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3. Avery DJ (1970) Effects of fruiting on the growth of apple trees on four rootstock varieties. *New Phytologist* . 69 (1), 19-30.
4. Barritt BH, Konishi AS and Dilley MA (1995) Intensive orchard management performance of three apple cultivars with 23 dwarfing rootstock during 8 seasons in Washington. *Fruit Var. J*. 49 (3), 158-170.
5. Blanco A, Mqta AP, lasasosa A and Val J (2008) The P16 rootstock inhibits the growth but enhances the fruit quality of 'Jonagored' apples when grown under warm summer conditions. *Spanish J. Agric*. Res. 6 (3), 412-421.
6. Castes and Villanneva EG (2007) Clarifying the effects of dwarfing rootstock on vegetative and reproductive growth during tree development. A study on apple trees. *Ann. Bot*. 100 (2), 347-357.
7. Dadashpour A, Talaei A and Shahi-Gharahlar A (2010) Effect of 'Gutingen V' as an intensine training system on agromorphological characters of some apple cultivars in Karaj region of Iran. *Genetika*. 42 (2), 331-338.
8. Dolp CA and Proebsting EL (1989) Root confinement effects growth and physiology of sweet cherry and apple. *50th ASHS Ann. Meeting, Tulsa, Oklahoma, Prog. & Abstract.* pp:99.
9. Fazio U and Baldo AM (2005) Placement of apple rootstock cultivars within the *Malu*s germplasm. Plant & Animal Genomes X_3 Conference, North Street, Geneva, NY,USA.
10. Ferree DC and Warrington IJ (2003) Apples: Botany, Production and Uses. CABI Publ.
11. Hampson CR, Quamm HA and Brownlee RT (2002) Canopy growth, yield and fruit quality of Royal Gala apple trees grown for eight years in five tree training systems. *HortScience*. 37, 627-631.
12. Hirst PM and Ferree DC (1995) Effect of rootstock and cultivar on the growth and precocity of young apple tree. *J. Amer. Soc. Hort. Sci*. 120, 622-634.
13. Malavolta C and Cross J (2009) Guidelines for integrated production of pome fruits. *IOBC/wprs Bull.* 47, 1-13.
14. McAfee JD and Rom CR (2003) Evaluation of size-Controling apple rootstock for high density 'Gala' apple orchards in Arkanass Horticultural studies. Department of Horticulture, University of Arkanass. pp:21-23.
15. Michael BH (2009) The physiological basis of vigor control by apple rootstocks-on unresolved paradigm. Massey University, Palmerston North, New Zealand.
16. Neem U, Univer T and Tiirma K (2006) Effect of five rootstocks on growth and Yield of four apple cultivars in Young orchard. Scientific works of the Lithuanian Institute of Horticulture and Lithuanian University of Agriculture. 25 (3), 192-198.
17. Robinson TL (2003) Apple-orchard planting system. In: Apples (eds.), Ferree DC & Warrington IJ (Eds), Cabi Publ., Wallingford, UK. pp:345-407.
18. Robinson TL (2007) Recent advances and future direction in orchard planting. *Acta Hort*. 732, 367-382.
19. Seleznyova AN, Stuart D and Thorp TG (2008) Apple dwarfing rootstocks and interstocks affect the type of growth units produced during the annual growth type cycle: precocious transition to flowering affects the composition and Vigor of annual shoots. *Ann. Bot*. 101 (5), 679-687.
20. Strikic F, Radunic M and Rosin J (2007) Apricot growth and productivity in high density orchard. *Acta Hort*. 732, 495-500.
21. Warner J (1991) Rootstock affects primary scaffold branch crotch angle of apple trees. *HortScience*. 26, 1266-1267.
22. Webster AD (2001) Rootstocks and temperate fruit crops: current uses, future potenial and alternative. *Acta Hort*. 557, 25-34.
23. Wertheim SJ and Callesen O (2000) Result of multi-site interstem trials with apple. *Gartenbauwissenschaft*. 65 (6), 251-259.