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# Effects of $M_9$ and $MM_{106}$ Rootstocks on Agromorphological Characteristics of 'Golab Kohanz' and 'Delbarstival' Cultivares Apple in Abhar Region of Iran

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**Abstract:** Using of the dwarf rootstocks in apple produce industry amount to the intensive orchards planting system, control tree size, produce precocious crop and then yield increasing in unit area that is a strategical solution for population increasing from day and lack land in the world. Therefore, in order 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, grown at orchard in Abhar, Iran. Results showed that the 'Golab-kohanz' on the $MM_{106}$ rootstock had the most mean shoot length 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 current year was depending to $MM_{106}$ rootstock (5.12 cm). And '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 achieve to the largest of yield cropping in intensive planting orchards system in Abhar climatic conditions.

**Key words:** 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 [1]. 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 labour are very inexpensive, in most apple producing areas of the world some reduction in this natural vigour is desired [2]. Vigour rootstocks such as $M_9$ reduce 20-30% tree size compared with seedling rootstock [3]. However, the final size of trees grown on $M_9$ will depend greatly on the inherent vigour of the scion cultivar, the soil fertility and the management system adopted by the grower [2]. 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 [4]. 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 [5]. However, increasing planting density alone does not provide an efficient tool to 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 [6, 7]. Clonal dwarfing apple rootstocks control scion growth by the reduction 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 $MM_{106}$ cause high yield efficiency and fruit size can be smaller than $M_9$ [2]. More reduction shoots growth, nods number, trunk diameter and trunk cross sectional area are inductive effects vegetative dwarfing rootstock in comparison with semi-dwarf or seedling rootstock [8-10]. Thus our objective in this study was to

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consideration of the influence of vegetative $M_9$ and $MM_{106}$ rootstock 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 repeat 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 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.

**Agromorphological Characteristics:** In order to measuring of shoot growth, average current season growth of four branches in each tree in late of seasonal growth was recorded in cm. Also average length of current seasonal internode was measured in middle of each branch in cm. For measure the tree height, distance between graft unions to end of highest branch in main trunk was recorded in cm. 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 based on amount of fruit in each tree in harvest time and so yield in area unit, multiplication of yield per tree at the number tree in hector was calculated. 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 [11]. In this study result showed, $M_9$ rootstock induced the lower shoot growth (36.39 cm), length of current shoot growth internode (4.11 cm), tree height (170.67 cm),

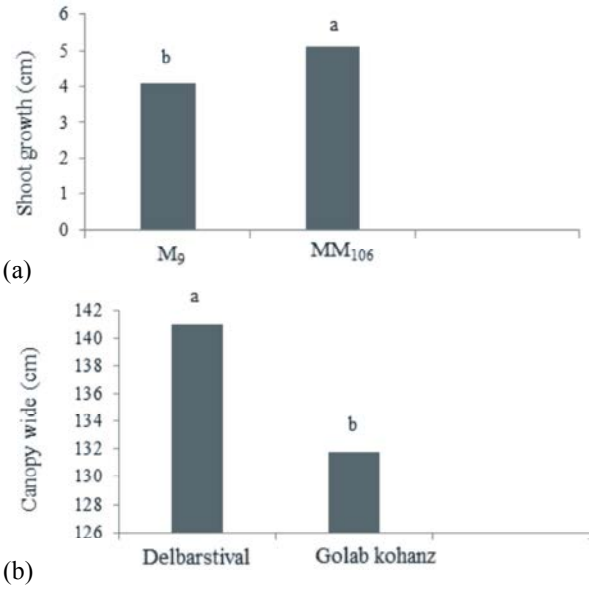
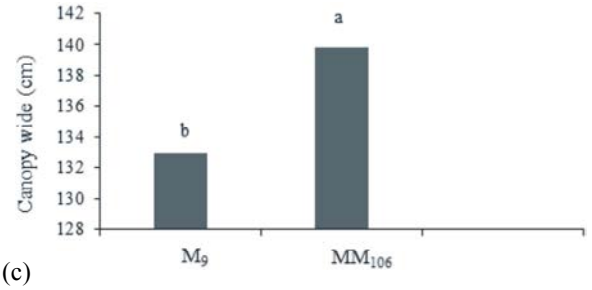



Fig. 1 (a,b): Effect of cultivar on vegetative traits

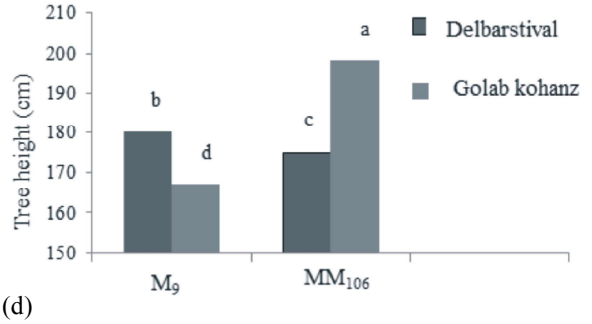
canopy wide (133 cm), trunk diameter (6.11 cm) and TCSA (30.92 $cm^2$), on cultivar grafted in comparison with MM106 rootstock, (Figure 1 and 2), confirming previous studies [12, 13]. The hypothesis is that dwarfing rootstock, or possibly its graft union alters the ratios and concentrations of the growth promoting and maybe also inhibiting hormones which are translocated within the tree [2, 14]. That rates of basipetal auxin translocation 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 [2]. Thus, reduction of auxin translocating in $M_9$ bark cause of reducing root growth, subsequently less translocation of gibberellin and cytokinin to scion and finally reduce in vegetative growth [15].

In comparison with invigorating rootstock, dwarfing rootstock reduces the speed of extension shoot growth 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 [16] together account for the effect of the dwarfing rootstock in reducing the size of apple-scion trees.

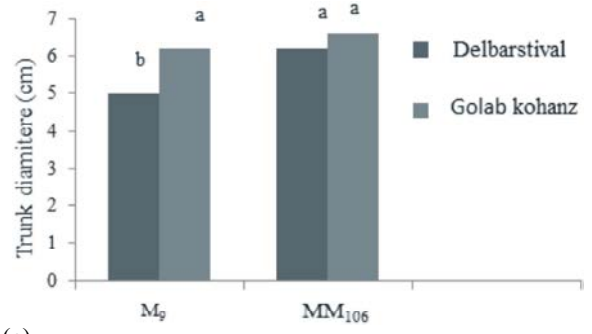
**Yield Characteristics Cultivars Grafted on $M_9$ and $MM_{106}$ Rootstock:** The beneficial effects of dwarfing rootstock on the precocity and efficiency of tree yields have often been attributed to a change in the partitioning of the dwarfed trees assimilate from shoot




(c)




(d)

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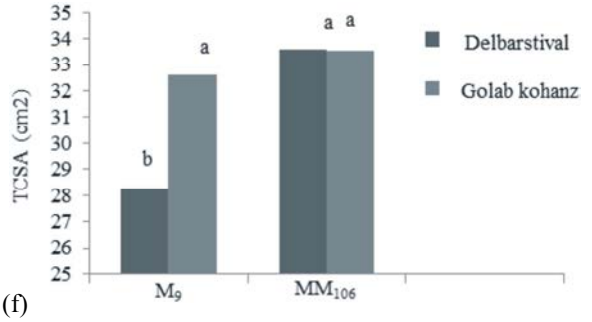
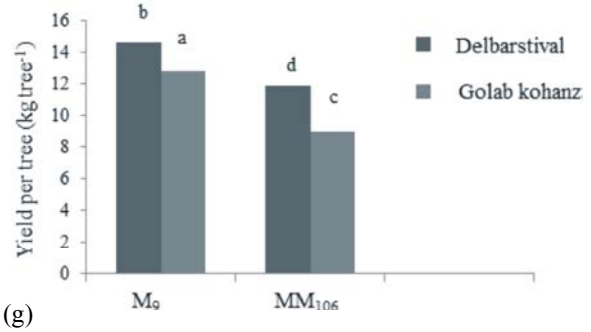


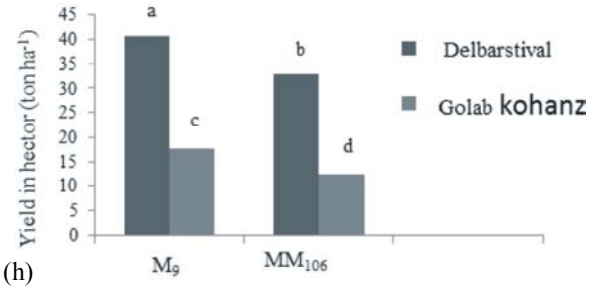

(f)

Fig. 2(c, d, e, f): Effect of interaction cultivar and rootstock on vegetative traits (means, with similar letters are not significantly different at the 1% probably level using Duncan multiple range test).

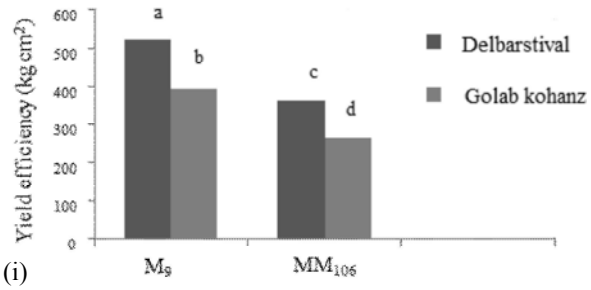
growth to fruit production. However semi-invigorating clonal rootstocks, such as $MM_{106}$, induce improved yield precocity and efficiency in comparison with seedling




(g)




(h)




(i)

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

rootstocks inducing the same level of scion vigour [17]. Results showed that (Figure 3) 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 $MM_{106}$. Increasing of 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 [7, 10, 15] and then increase setting [13, 18]. Although it is assumed that tree on dwarf rootstocks have limited vegetative growth resulting to higher yield [19].

Differences in TCSA indicate that rootstock control the tree size [20]. In fact in this study the $M_9$ rootstock has controlled the tree size of 'Delbarstival' more than 'Golab kohanz' cultivar resulted to the lowest TCSA (28.24 $cm^2$) and the greatest 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 size [11]. Small TCSA produced by 'Delbarstival' may be a genetic trait transferred from the rootstock to the scion [21]. '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 the more vegetative growth; produce the lower yield, confirming previous study [22]. Although, rootstock influence 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 [2].

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