

**EFFECT OF ‘GUTINGEN V’ AS AN INTENSIVE TRAINING SYSTEM ON  
AGROMORPHOLOGICAL CHARACTERS OF SOME APPLE CULTIVARS  
IN KARAJ REGION OF IRAN**

Ahmad DADASHPOUR\*, Alireza TALAEI and Ali SHAHI-GHARAHLAR

Department of Horticulture, University College of Agriculture & Natural Resources,  
University of Tehran, Karaj, 31587, IRAN

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V-shape systems represent an efficient and popular option to increase yields and fruit quality in fruit trees. Hence, this paper attempts to compare some vegetative and yield characteristics of five apple cultivars grown at horticultural research station in Karaj, Iran. The selected apple cultivars were included: ‘Golab-kohans’ (Iranian cultivar), ‘Fuji’, ‘Gala’,

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*Corresponding author:* Ahmad Dadashpour, Department of Horticulture, University College of Agriculture & Natural Resources, University of Tehran, Karaj, 31587, IRAN, Tel.: +98 9125677083, e-mail: [ahmad.dadashpour@gmail.com](mailto:ahmad.dadashpour@gmail.com)

'Starking' and 'Delbar estival' (commercial foreign cultivars) that were grafted on M.9 rootstock which were trained in a V system. All of these trees were planted in winter 2005. The time of irrigation started from the second experimental year after planting and the method of irrigation was drip irrigation system. Results showed that the 'Golab-kohans' had the most tree height (278.63 cm), trunk cross sectional area (7.308 cm<sup>2</sup>) and mean shoot length (100.58 cm). Also 'Delbar estival' had the most yield (0.98 kg), yield efficiency (0.550 kg/cm<sup>2</sup>). Consistently, Results revealed that among the investigated cultivars, 'Delbar estival' can be introduced as a prone and productive cultivar for V system in Karaj's climatic conditions.

*Key words:* apple, V system, vegetative and reproductive traits.

## INTRODUCTION

Trees must be trained and pruned to achieve a manageable uniform size, a balance between growth and regular yields, and to allow good penetration of light and spray to the tree centre (MALAVOLTA and CROSS, 2009). Dwarfing rootstocks have become widely accepted by the industry as a tool for increasing orchard efficiency because they influence the size of the tree, yield and planting density per unit area (BARRITT *et al.*, 1995). Over the last 30-40 years, several training systems for apple orchards have been developed to attain high early yields and improved fruit quality (FERREE and WARRINGTON, 2003). 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 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 (CORELLI and SANSAVINI, 1989; WEBER, 2001; HAMPSON *et al.*, 2002). The Gutingen V is a V-shaped system, with individual conic-shaped trees, that allows high tree densities within multiple rows (FERREE and WARRINGTON, 2003). Dwarfing rootstocks, such as M.9 and M.27, are used and trees are planted at 0.9 m in-row spacing and 3.5 m. Over the last 25 years, V systems have become increasingly popular and account for a significant portion of new fruit plantings in developed countries. The primary advantage of V systems is high yields per hectare (HUTTON *et al.*, 1987; VAN DEN ENDE *et al.*, 1987; ROBINSON and LAKSO, 1989; ROBINSON, 1992), high levels of light interception (ROBINSON and LAKSO, 1991) and improved fruit quality (VAN DEN ENDE *et al.*, 1987). V systems show better light interception than spherical or conic-shaped trees and improve light distribution within the canopy due to their two-dimensional light exposure (ROBINSON, 2003). Remarkable research has gone into the identification of the bases of productivity in different apple orchards. Early studies offered that perhaps tree density, percent ground cover; canopy volume or tree surface area may be related to orchard productivity (ROBINSON and LAKSO, 1991). Another research showed that there are significant differences in growth and

productivity between local and foreign cultivars in apricot trained to high density system (STRIKIC *et al.*, 2007).

Thus our objective in this study was to evaluation of the influence of V system on behavior of five apple cultivars grafted on M.9 rootstock in Karaj climate condition that is an important commercial apple production region in Iran.

## MATERIALS AND METHODS

### *Plant material and experimental design*

This study was carried out during the growth years of 2006 and 2007 at the experimental field of Horticultural Research Station of University of Tehran, Karaj, Iran. So that, this paper presents the results of trials carried out in a 2-year-old apple production V system with five apple cultivars included 'Golab-kohans', 'Fuji', 'Gala', 'Starking' and 'Delbar estival' grafted on dwarfing M.9 rootstock. The average annual maximum temperature of the region is 13.7 °C with an annual rainfall of 254 mm. Soil at the station is classified as clay-loam. The soil between the rows was mowed, and the strips in the row were fallow with the help of brand-spectrum herbicides were applied in accordance with standard commercial orchard procedures. Twenty representative trees within each replicate were selected for sampling and data collection. The four replicates were arranged in a randomized completely block design (RCBD). The data obtained from field measurements and laboratory observations were subjected to an analysis of variance using SAS software and the Duncan mean separation test procedure was applied.

### *Agromorphological traits*

For calculating the Trunk Cross Sectional Area (TCSA), trunk circumference (20 cm above the graft union) was measured with a hand caliper at the end of the growing season in November and then converted to Trunk Cross Sectional Area (TCSA) in cm<sup>2</sup>. Moreover, shoot growth was measured by average current season growth of 5 branches in each tree (cm). Also, in order to measure the tree height, distance between graft unions to end of highest branch in main trunk was recorded in cm. In addition, yield per tree was recorded at harvest in each tree. Yield efficiency was measured as yield per tree divided to TCSA in November (yield per tree/ TCSA in November), as well.

## RESULTS

### *Tree height, TCSA and shoot growth*

In the investigated cultivars, the greatest tree height (278.63 cm), shoot growth (100.58 cm) and TCSA (7.308 cm<sup>2</sup>) were obtained in 'Golab-kohans' that means this cultivar was generally more vigorous than other trees which may be result of a higher degree of shading than other cultivars (Figure 1a,b,c). Short-term shade at the time period causes an enhanced retention of assimilates in vegetative sinks, reduction in carbohydrate availability to the fruitlets, limited fruit growth rates and eventually

fruit shedding (BYERS *et al.*, 1991; KONDO and TAKAHASHI, 1987). In addition, Golab-kohans probably because of its early fruit harvest (the earliest harvesting of fruits) had longer period for vegetative growing, resulted to more vegetative characteristics. Also this research implies that trees with the highest vegetative growth generally produce the lowest yield per tree, confirming previous study (STRIKIC *et al.*, 2007).

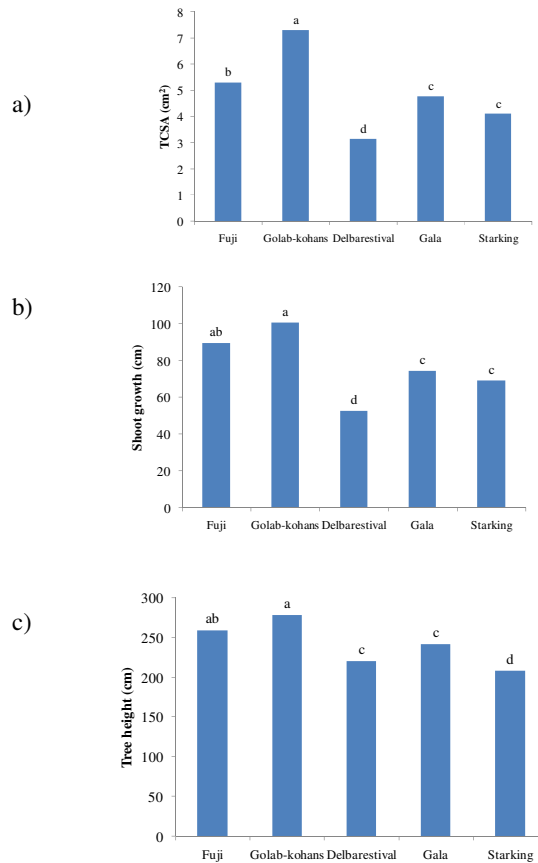


Figure 1 (a,b,c). Effect of cultivars on vegetative and reproductive characteristics (means, with similar letters are not significantly different at the 1% probability level using Duncan multiple range test).

Tree growth and development can be markedly influenced by both cultivar and rootstock (HIRST and FERREE, 1995). Differences in TCSA indicate that rootstock

controls the tree size (DOLP and PROEBSTING, 1989). In fact in this study the rootstock (M.9) has controlled the tree size of 'Delbar estival' more than other cultivars resulted to the lowest TCSA (3.140) and the greatest yield (1.482 kg). Previous studies also found scion and rootstock interaction for the size and attributed rootstock to be the predominant factor controlling size (HIRST and FERREE, 1995). Small TCSA produced by 'Delbar estival' may be a genetic trait transferred from the rootstock to the scion.

#### *Yield characteristics*

The first production was obtained one year after planting, but this was relatively poor (data not shown). By the secondary year after planting, the greatest yield per tree (1.482 kg tree<sup>-1</sup>) and yield efficiency (0.550 kg cm<sup>-2</sup>) were related to 'Delbar estival'. So that, the yield ranging was between 0.287-1.482 kg tree<sup>-1</sup> (Figure 1d,e).

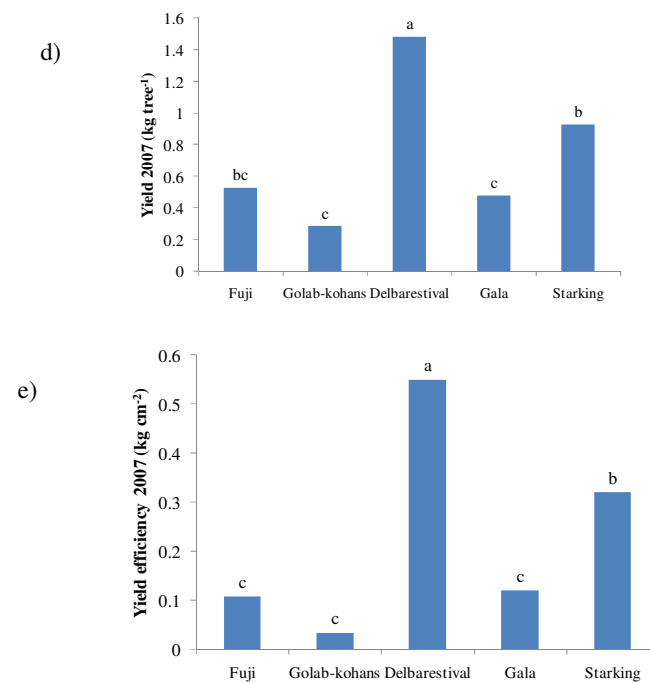


Figure 1(d,e). Effect of cultivars on vegetative and reproductive characteristics (means, with similar letters are not significantly different at the 1% probability level using Duncan multiple range test).

This research by 'Golab-kohans', 'Fuji', 'Gala', 'Starking' and 'Delbar estival' cultivars grafted on M.9 showed that trees began to bear fruit in the second year, with yield increasing in the subsequent year. In fact, the 'V system/M.9' combination permitted early fruiting, confirming previous studies (PLATON, 2007; HAMPSON *et al.*, 2002). In addition, the most TCSA and the lowest yield resulted to the lowest yield efficiency in 'Golab-kohans' (Figure 1a). Although it is assumed that trees on dwarf rootstocks have limited vegetative growth resulting to higher yield (ROBINSON, 2007) but may be differences between cultivars in this study (with a same rootstock) has been resulted from different morphological traits, confirming study by BARRITT *et al.* (1995).

Researches show that yield linearly is related to light interception (ROBINSON and LAKSO, 1989; ROBINSON, 2007) but the best time for calculating the light interception (ROBINSON and LAKSO, 1989; ROBINSON, 2007) but the best time for calculating the light interception is in the 4<sup>th</sup> or more year (HAMPSON *et al.*, 2002). ELFVING and SCHECHTER (1993) reported that annual yields per tree for 'Starkspur Supreme Delicious' trees on nine dwarfing rootstocks were related linearly to the number of fruits per tree at harvest, independent of rootstock. They concluded that there is a linear relationship between yield and fruit count per tree and suggested that the sink strength of an apple crop is almost proportional to the number of fruit per tree.

According to the results, 'Delbar estival' trees represent a generally more efficient portion, at least in the early stages of orchard life, for apple cultivation using V-shape systems in Iran's climate conditions.

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**EFEKAT "GUTINGEN V" KAO INTENZIVNOG SISTEMA ISPITIVANJA  
AGROMORFOLOŠKIH KARAKTERISTIKA NEKIH SORTI JABUKE U  
KARAJ REGIONU IRANA**

Ahmad DADASHPOUR\*, Alireza TALAEI i Ali SHAHI-GHARAHLAR

Odeljenje za hortikulturu fakulteta za poljoprivredu i prirodne resurse Univerziteta u  
Teheranu, Karaj, 31587, Iran

I z v o d

Sistem "Gutingen V" ispitivanja predstavlja popularnu opciju za povećanje prinosa i kvaliteta ploda kod voćnih vrsta. U radu su prikazani rezultati poređenja nekih vegetativnih i karakteristika prinosa pet sorata jabuka gajenih u istraživačkoj stanici za hortikulturu u Karaju, Iran. U istraživanja su uključene sorte: "Golab-kohans" (iranska sorta), "Fuji", "Gala", "Starking" I "delbar estival" (komercijalne inostrane sorte) kalemljene na M9 podlogu i ispitivane u "V" sistemu. Sva stable su zasađena u toku zimskog perioda 2005. Navodnjavanje je vršeno a početkom druge godine eksperimenta. Sistem navodnjavanja je bio kap-po-kap.

Dobijeni rezultati pokazuju da je sorta "Global-kohans" imala najviše stablo (278.63 cm), najveću površinu poprečnog preseka stable (7.308 cm<sup>2</sup>) i prosečnu dužinu mladice (100.58 cm). "Delbar estival" je imao najveći prinos (0.98 kg) odnosno efikasnost prinosa (0.550 kg/cm<sup>2</sup>). Dobijeni rezultati ukazuju da, od ispitivanih sorata, "Delbar estival" može da se introdukuje kao produktivna sorta za gajenje u "V" sistemu u klimatskim uslovima Karaja, Iran.

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