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Variation of Physicochemical Fruit Characteristics of Different Apple Cultivars in 'Gutingen V' as a Training System

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ABSTRACT

A V-shape system represents an efficient and popular option to increase yield and fruit quality. Therefore, this study attempts to compare some physicochemical fruit characteristics of five apple cultivars grown in the Karaj area of Iran. The concerned apple cultivars were 'Golab-Kohanz', 'Fuji', 'Gala', 'Starking' and 'Delbar estival' that were grafted onto M.9 rootstock trained in a V system. All of these trees were planted in winter 2005. 'Golab-Kohanz' (Iranian cultivar) had the highest pH (4.85). Also 'Delbar estival' had the highest fruit weight (131.30 g), fruit length (5.91 cm), fruit diameter (6.72 cm) and L/D (0.87). In addition, 'Fuji' had the highest dry matter (21.71%) and incidence of fruit sunburn (56.92%). 'Golab-Kohanz' had the most ash (0.66) and TSS (16.12) levels. In addition, 'Starking' had the greatest fruit firmness (13.60 kg cm^{-2}) and titrable acid (0.73).

Keywords: commercial apple cultivar, fruit quality, fruit property, intensive orchard system
Abbreviations: L/D, fruit length to diameter ratio; **TA**, titrable acids; **TSS**, total soluble solids

INTRODUCTION

Small trees of uniform size are the aim for the future so that safer, more efficient spraying practices can be adopted. 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). During planting a grower must make four key decisions about: a) the rootstock, b) the variety, c) the tree spacing and d) the training system. Research on apple trees using dwarf rootstocks in intensive planting systems has been carried out in different countries. 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 planting systems for apple orchards have been developed to attain high early yields and improved fruit quality (Ferree and Warrington 2003). In modern orchards planting systems are based on higher tree densities with 1000-6000 trees/ha and some up to 10000 trees/ha (Robinson 2003). However, increasing planting density alone does not provide an efficient tool to increase yield and improve fruit quality, 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, the V systems have been 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/ha (Hutton *et al.* 1987; Van Den Ende *et al.* 1987; Robinson and Lakso 1989; Robinson 1992; Sosna and Czaplicka 2008), high levels of light interception (Robinson and Lakso 1991; Widmer 2005) and improved fruit quality (Van Den Ende *et al*. 1987). V systems show better light interception than spherical or conic-shaped trees and improved 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. Strikic *et al.* (2007) showed that there are significant differences in growth and productivity between local and foreign cultivars in apricot trained to a high density system.

The aim of this study was to evaluation of the variability of physicochemical fruit properties in five apple cultivars grafted on M.9 in a V training system that are more cultivated in Karaj climate.

MATERIALS AND METHODS

Plant material and experimental design

The present study was conducted during 2006 and 2007 at the experimental field of the Horticultural Research Station of the University of Tehran, Karaj, Iran. This paper presents the results of trials carried out in a 2-year-old apple production V training system include 5 apple cultivars: 'Golab-Kohanz', 'Fuji', 'Gala', 'Starking' and 'Delbar estival' grafted onto M.9 rootstock. The average annual maximum temperature of the Karaj region is 13.7°C with 254 mm annual rainfall. The soil composition at the experimental site was clay-loam. The soil between the rows was mowed, and the strips in the row were fallow with the help of brand-spectrum herbicides (Roundup®) applied in accordance with standard commercial orchardry 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 Duncan's multiple range test was applied at $P < 0.05$.

Fruit properties

Individual fruit length, diameter and length to diameter ratio (L/D) were measured on 5-fruit random samples from each test tree. In fact, fruit length and fruit diameter were measured using a vernier

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caliper; fruit fresh weight was determined using a Mettler PC 8000 scale; fruit firmness was measured using a penetrometer (Instron Universal Machine, Model 1011). Total soluble solids (TSS) were measured with a Bausch and Lomb Abbe 3L refractometer; juice pH was measured using an Accument pH meter 925 (Fisher Scientific, Pittsburgh, PA); dry matter content was determined from fresh and dry weight differences after drying at 70°C for 48 h. Fruit sunburn percentage was measured by number of fruit sunburned in each tree. 1 g of dry matter was ashed in a Gaallankamp furnace at 550°C for 6 h. Titrable acids (TA) were determined using an Aminex HPX-87H column, run at 65°C and 4 mM sulphuric acid as eluent.

RESULTS AND DISCUSSION

The highest fruit weight (131.30 g), fruit length (5.91 cm), fruit diameter (6.72 cm) and L/D (0.87) was recorded in 'Delbar estival', a good cultivar due to its visual appearance (**Fig. 1**). Although fruit number is assumed to be the most relevant component of yield (Derkacz and Norton 2000), in this case greater yields in 'Delbar estival' trees are not due to a greater number of fruits (data not shown), but to generally bigger fruit. 'Delbar estival' had the highest L/D (0.87), which means this cultivar has a greater marketable value than other cultivars although this characteristic is affected by both genetic and environmental factors. L/D (≥1) is a criterion for marketing in apple but fruits of this study had L/D <1, probably due to warm nights in the Karaj region, that resulted to insufficient cell elongation at night. Fruit size is smaller on the most dwarfing rootstock and large with the semi-vigorous and vigorous rootstocks such as M.27, M.26, and P.18 (Barritt *et al.* 1995). The physiological mechanisms of dwarfing rootstocks affecting fruit characteristics can be due to the reduction in transport of nutrients and hormones, especially gibberellins across the scion/rootstock union (Matta 2001). In this research the fruits of 'Delbar estival' have been affected by the dwarf rootstock (M.9) less than other cultivars, which resulted in the largest fruits.

The highest TSS content in 'Gala' (16.12) (**Fig. 1**) may be explained by differences in leaf area, as suggested by Hudina and Stamper (2002); or by a presumably higher degree of shading of other cultivars (Garriz *et al.* 1996, 1998). High exposure of fruit and leaves to light may increase TSS in the fruit, compared to fruit that has poor exposure to light (Tustin *et al.* 1988). 'Fuji' had the highest dry matter (21.71%), suggesting that this cultivar has the highest organic and mineral materials (**Fig. 1**). Total dry matter is related with total light interception (Palmer and Jackson 1974; Monteith 1977). The highest fruit sunburn percentage (56.92%) was shown in 'Fuji' due to a later harvest time (**Fig. 1**). 'Golab-Kohanz' had the lowest fruit sunburn (0%) resulting from an earlier fruit harvest. The highest (13.60 kg cm^{-2}) and lowest (8.05 kg cm^{-2}) firmness were showed in 'Starking' and 'Delbar estival', respectively (**Fig. 1**). Firm fruit in 'Starking' is probably due to small fruit size, confirming findings of a previous study (Drake *et al.* 1988). In addition, difference in firmness may have resulted from genetic traits in each cultivar.

The content of titrable acid differed among cultivars. In 'Fuji' the average TA was 0.69, in 'Golab-Kohanz' 0.44, in 'Delbar estival' 0.64, in 'Gala' 0.57 and in 'Starking' 0.72 (**Fig. 1**). In fact, 'Starking' had the sourest fruits. The greatest ash (0.65%) was obtained in 'Gala' (**Fig. 1**) implying that this cultivar has good nutritional traits resulting in greater nutritional value. 'Golab-Kohanz' had the highest pH (4.85) but the lowest pH was in 'Delbar estival' (3.34) (**Fig. 1**), which may have resulted from morphological differences, confirming a previous study (Platon 2007). In general, juice pH ranged from 3.39 to 3.99 for the rootstock/cultivar combination. These results show that acidity generally varies with cultivar, confirming a previous study (Platon 2007). Also it may have resulted from lower shading in 'Starking'.

These results show that acidity generally varies between cultivars, confirming Platon (2007). '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 Karaj climate condition.

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REFERENCES

Barritt BH, Konishi AS, Dilley MA (1995) Intensive orchard management. performance of three apple cultivars with 23 dwarfing rootstocks during 8 seasons in Washington. *Fruit Varieties Journal* **49**, 158-170

Corelli L, Sansavini S (1989) Light interception and photosynthesis related to planting density and canopy management in apple. *Acta Horticulturae* **243**, 159-174

Derkacz M, Norton D (2000) Effect of training systems and cultivars on selected yield components in pears. In: *Proceedings of the 8th International Pear Symposium*, Ferrara-Bolona, Italy 4-9 September, pp 189-199

Drake SR, Larsen FE, Fellman JK, Higgins SS (1988) Maturity, storage quality, carbohydrate, and mineral content of 'Gold spur' apples as influenced by rootstock. *Journal of the American Society for Horticultural Science* **116**, 261-264

Ferree DC, Warrington IJ (2003) *Apples: Botany, Production and Uses*, CABI Publishing, New York, 660 pp

Garriz PI, Alvarez HL, Alvarez AJ (1996) Influence of altered irradiance on fruits and leaves of mature pear trees. *Biologia Plantarum* **39**, 229-234

Garriz PI, Colavita GM, Alvarez HL (1998) Fruit and spur leaf growth and quality as influenced by low irradiance levels in pear. *Scientia Horticulturae* **77**, 195-205

Hampson CR, Quamm HA, 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

Hudina M, Stamper F (2002) Influence of leaf area on the suger and organic acids content in pear (*Pyrus communis*) fruits cultivar Williamss. *Acta Horticulturae* **596**, 749-752

Hutton RJ, Mcfadyen LM, Lill WJ (1987) Relative productivity and yield efficiency of canning peach trees in three intensive growing systems. *HortScience* **22**, 552-560

Jackson JE (1980) Light interception and utilization by orchard systems. *Horticultural Reviews* **2**, 208-267

Malavolta C, Cross J (2009) Guidelines for integrated production of pome fruits. *IOBC/WPRS Bulletin* **47**, 1-13

Matta FB (2001) Performance of apple cultivar/rootstock combinations grown in Mississippi. *Journal of the Mississippi Academy of Sciences*. Available online: http://www.thefreelibrary.com/Performance+of+Apple+Cultivar%2FRootstock+Combinations+Grown+in...-a077378934

Monteith JL (1977) Climate and efficiency of crop production in Britain. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences* **281**, 277-294

Palmer JW, Jackson JE (1974) Effects of tree population and variations in spacing within and between rows of Golden Delicious on M.9. *Report of the East Malling Research Station* **1973**, 66-68

Platon IV (2007) Preliminary results on planting system and density in apple. *Acta Horticulturae*. **732**, 471-473

Robinson TL (1992) Performance of Y-shaped apple canopies at various angles in comparison with central leader trees. *Acta Horticulturae* **322**, 79-86

Robinson TL (2003) Apple-orchard planting systems. In: Ferree DC, Warrington IJ (Eds) *Apples*, CABI Publishing, Wallingford, UK, pp 345-407

Robinson TL, Lakso AN (1989) Light interception, yield and fruit quality of Empire and Delicious apple trees in four orchard systems. *Acta Horticulturae* **243**, 175-184

Robinson TL, Lakso AN (1991) Bases of yield and production efficiency in apple orchard systems. *Journal of the American Society for Horticultural Science* **116**, 188-194

Sosna I, Czaplicka M (2008) The influence of two training systems on growth and cropping of three pear cultivars. *Journal of Fruit and Ornamental Plant Research* **16**, 75-81

Strikic F, Radunic M, Rosin J (2007) Apricot growth and productivity in high density orchad. *Acta Horticulturae* **732**, 495-500

Tustin DS, Hirst PM, Warrington IJ (1988) Influence of orientation and position of fruiting laterals on canopy light penetration, yield, and fruit quality of 'Granny smith' apple. *Journal of the American Society for Horticultural Science* **113**, 693-699

Van Den Ende B, Chalmers DJ, Jeri PH (1987) Latest developments in train-

ing and management of fruit crops on Tatura Trellis. *Journal of the American Society for Horticultural Science* **105**, 695-699
Weber MS (2001) Optimizing the tree density in apple orchards on dwarf rootstocks. *Acta Horticulturae* **557**, 229-234
Widmer A (2005) The development of Guttingen-V, Mikado and Drilling growing systems: an overview. *OBST-UND WEINBAU* **141**, 14-16

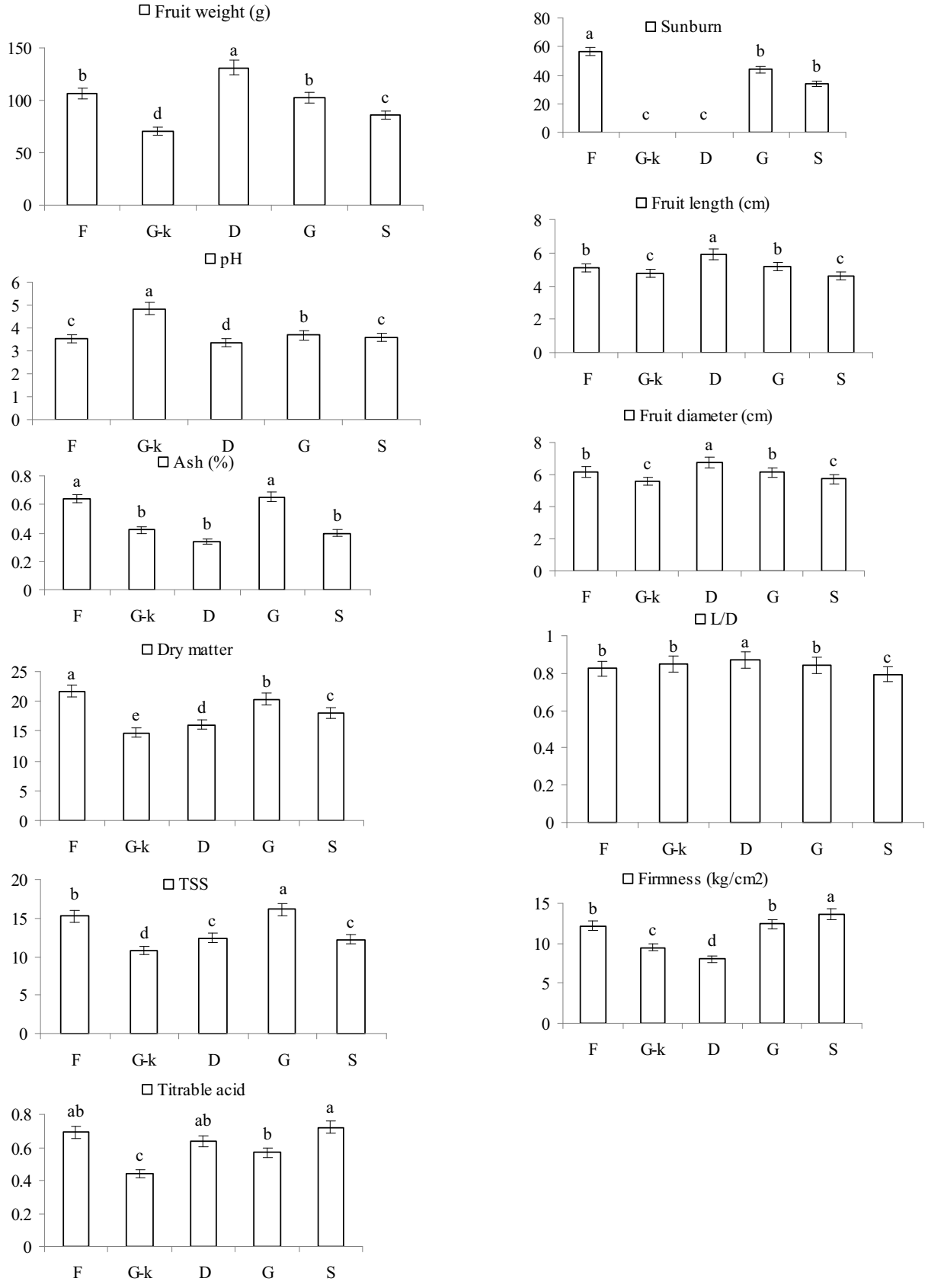

Fig. 1 Effect of cultivars on 11 fruit characteristics. Means with similar letters are not significantly different at $P < 0.01$ using Duncan's multiple range test. F = Fuji; G-k = Golab-Kohanz; D = Delbar estival; G = Gala; S = Starking.