UDC 575:634.11
DOI: 10.2298/GENSR1101153T
Original scientific paper

FRUIT QUALITY IN FIVE APPLE CULTIVARS TREES TRAINED TO INTENSIVE TRAINING SYSTEM: GENEVA Y-TRELLIS

Alireza TALAIE, Mona SHOJAIE-SAADEE, Ahmad DADASHPOUR, and Mohammad Ali ASGARI-SARCHESHMEH

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

Talaie A., M. Shojaie-Saadee, A. Dadashpour and M. Ali Asgari-Sarcheshmeh (2011): *Fruit quality in five apple cultivars trees trained to intensive training system: geneva y-trellis* . - Genetika, Vol 43, No. 1, 153-161.

Orchard intensification is motivated by the desire to produce fruit early in the life of the orchard to rapidly recover establishment costs. Intensification is possible by using dwarfing rootstocks that control tree size, induce early cropping, and produce large quantities of fruit relative to the amount of wood produced. Therefore, this study attempts to compare some yield and fruit properties of five apple cultivars grown in the Karaj area of Iran. The concerned apple cultivars were 'Golab-kohans' (Iranian cultivar), 'Fuji', 'Starking', 'Delbar estival' and 'Prime rose' (commercial

Corresponding author: Ahmad Dadashpour, Department of Horticulture, University College of Agriculture & Natural Resources, University of Tehran, Karaj, 31587-77871, IRAN,email: dadashpour@can.ut.ac.ir**,** Mobile: +989125677083

foreign cultivars) that were grafted on M.9 rootstock which were trained in Geneva Y-trellis system. All of these trees were planted in winter 2004. The trees were irrigated from the second year after planting and the method of irrigation was drip irrigation. pH (4.07) and Humidity Content (85.96 %) were the highest with the 'Golab-kohans' (Iranian cultivar). Also 'Delbar estival' had the highest fruit length (6.13 cm), L/D (0.87) and TSS (15.77). 'Starking' had the highest fruit weight (145.24 gr), fruit diameter (6.91 cm) and Ash (0.71 %). In addition, the most dry matter (20.13 %), fruit firmness (13.13 kg/cm^2) and titrable acid (0.72 %) were recorded with 'Fuji'.

Key words: apple cultivars, fruit properties, Geneva Y-trellis system

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 (BARRITT *et al*., 1995). The switch to smaller trees and higher tree planting densities has allowed significant improvements in fruit quality (ROBINSON, 2007). 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). The Geneva Y-trellis system is a V-shaped system, uses a Y shaped trellis to support the trees and to divide the canopy into 2 single plane trained by selecting 8-10 branches on the trunk at a height of 60 cm and the other half to the other side. One each arm of the Y the 4-6 branches were equally spaced along the wires to fill in the space between trees giving a fan-shaped arrangement of branches on each arm of the Y. 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 (FERREE and WARRINGTON, 2003). 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 first benefit of V systems is high yields/ha (HUTTON *et al.,* 1987; 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 (ENDE *et al*., 1987). Fruit quality is a combination of appearance, flavour, texture and nutritional value. It is affected by pre-harvest factors such as climatic conditions and cultural methods (KADER, 2000; LICZNAR, 2006). Orchard trials with V-shaped canopies have shown them to be highly productive and highly efficient at converting light energy into fruit (FERREE and WARRINGTON, 2003). Previous studies (DADASHPOUR *et al.,* 2010; STRIKIC *et al*., 2007) showed that there are significant differences in growth and productivity between local and foreign cultivars in apple trained to a high density system.

The aim of this study was to evaluation of the variability of physicochemical fruit properties and fruit set in five apple cultivars grafted on M.9 in a Geneva Y-trellis system that are more cultivated in Karaj climate.2

MATERIALS AND METHODS

Plant material and experimental design

The present study was conducted during 2007 and 2008 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 3-year-old apple production Geneva Y-trellis system include 5 apple cultivars: 'Golab-kohans', 'Fuji', 'Starking', 'Delbar estival' and 'Prime rose' 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 SPSS software and the Duncan mean separation test procedure was applied.

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 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. 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 length (6.13 cm), fuit diameter (6.91 cm), L/D (0.87) and TSS (15.77) was recorded in 'Delbar estival', a good cultivar due to its visual appearance (Tab. 1; Fig. 1 A-D). Although fruit number is assumed to be the most relevant component of yields (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 trait is affected by both genetic and environmental factors. L/D ($\geq$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).

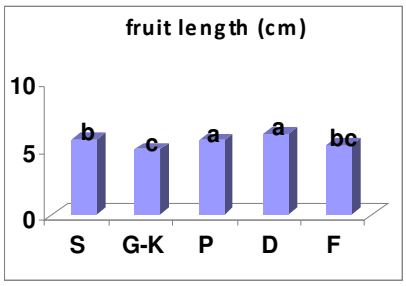
Table 1. Effect of Geneva Y-trellis system on fruit properties in five apple cultivars in 2007 and 2008.

Cultivar / Trait	Fruit Firmness (kg/cm^2)	Fruit Weight (gr)	Fruit Diameter (cm)	Fruit Length (cm)	L/D	TSS	TA (%)	pH	Dry Matter (%)	Ash (%)	Humidity Content (%)
Starking	11.40b	145.24a	6.85a	5.66b	0.81b	15.13a	0.29b	3.81b	17.83a	0.71a	82.16b[1]
Golab-kohans	8.98d	84.67c	5.80b	4.94c	0.84ab	11.81c	0.2c	4.07a	14.04b	0.16b	85.96a
Prime rose	9.98c	103.107 bc	6.37a	5.64b	0.85ab	13.01b	0.23bc	3.89b	16.71 ab	0.16b	83.28ab
Delbar estival	8.46d	142.36a	6.91a	6.13a	0.87a	15.77a	0.25bc	3.42c	18.37a	0.2b	81.37b
Fuji	13.13a	115.69b	6.39a	5.27bc	0.82b	15.27a	0.72a	3.53c	20.13a	0.1b	79.86b

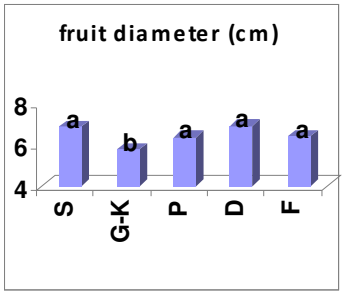
[1]Means separation by Duncan multiple range test ($p<0.01$).

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 'Starking' have been affected by the dwarf rootstock (M.9) less than other cultivars, which resulted in the largest fruits. The highest TSS content in 'Delbar estival' (15.77) 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). In addition, The high TSS content with 'Delbar estival' and 'Fuji' indicates that these cultivars were not over-cropped, whereas, the smaller sugar content of other cultivars indicates these cultivars were slightly over-cropped.

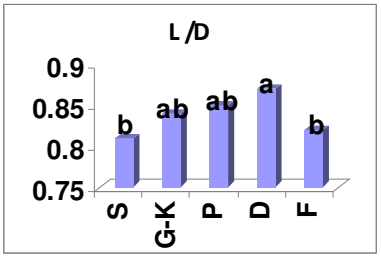
The heaviest fruits were found with 'Starking' (Tab.1; Fig. 1E) that can be affected from genetical differences in cultivars. 'Fuji' had the highest dry matter (20.13%), suggesting that this cultivar has the highest organic and mineral materials (Tab. 1; Fig. 1F). Total dry matter is related with total light interception (PALMER and JACKSON, 1974; MONTEITH, 1977) while fruit quality is a function of light distribution within the canopy (JACKSON, 1980; ROBINSON and LAKSO, 1989). The highest (13.13 kg/cm^2) and lowest (8.46 kg/cm^2) firmness were showed in 'Fuji' and 'Delbar estival', respectively (Tab. 1; Fig. 1G).


fruit length (cm)
10
5
0
b
c
a
a
bc
S
G-K
P
D
F

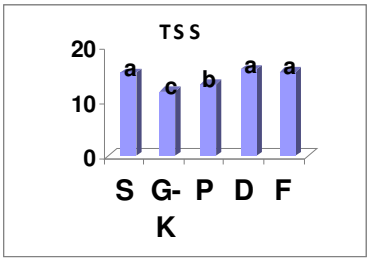
(A)


fruit diameter (cm)
8
6
4
a
b
a
a
a
S
G-K
P
D
F

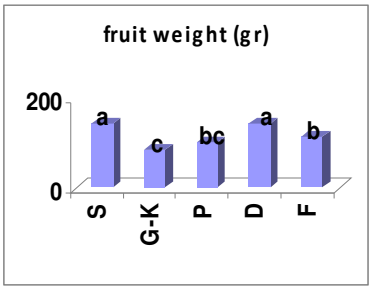
(B)


L/D
0.9
0.85
0.8
0.75
b
ab
ab
a
b
S
G-K
P
D
F

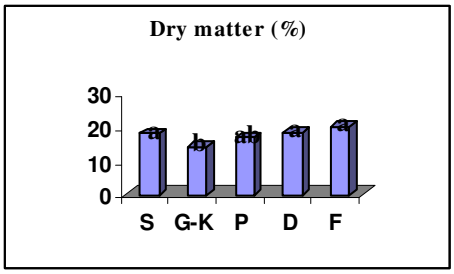
(C)


TSS
20
10
0
a
c
b
a
a
S
G-K
P
D
F

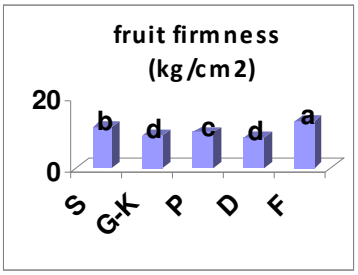
(D)


fruit weight (gr)
200
0
a
c
bc
a
b
S
G-K
P
D
F

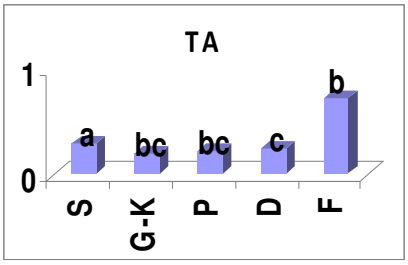
(E)


Dry matter (%)
30
20
10
0
S
G-K
P
D
F

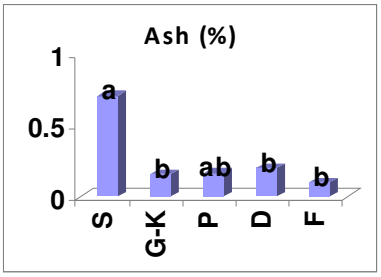
(F)



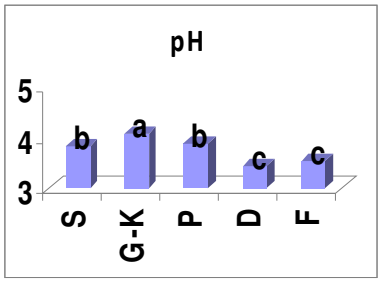
(G)



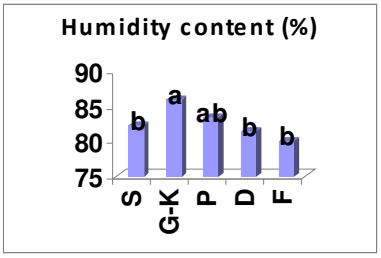
(H)



(I)



(J)



(K)

Figure 1 (A-B). Effect of cultivars on 11 fruit characteristics.

Means with similar latters are not significantly different at $P < 0.01$ using Duncan's multiple range test. S =Starking; G-K = Golab-kohans; P= Prime rose; D = Delbar estival; S = Starking.

Firm fruit in 'Fuji' 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 (TA) differed among cultivars. In 'Fuji' the average TA was 0.72, in 'Golab-kohans' 0.2, in 'Delbar estival' 0.25, in 'Prime rose' 0.23 and in 'Starking' 0.29 (Tab. 1; Fig. 1H). In fact, 'Fuji' had the sourest fruits. The greatest Ash (0.71%) was obtained in 'Starking' (Tab. 1; Fig. 1I) implying that this cultivar has good nutritional traits resulting in greater nutritional value. 'Golab-kohans' had the highest pH (4.07) and humidity content (85.96 %) but the lowest pH (3.42) and humidity content (79.86 %) were in 'Delbar estival' and 'Fuji, respectively (Tab. 1; Fig. 1J-K), which may have resulted from morphological differences, confirming a previous study (PLATON, 2007). In general, juice pH ranged from 3.42 to 4.07 for the rootstock/cultivar combination. These results show that acidity generally varies among cultivars, confirming previous studies (DADASHPOUR *et al*., 2010; PLATON, 2007). Also it may have resulted from lower shading in 'Delbar estival'.

'Delbar estival' and 'Starking' trees represent a generally more efficient portion, at least in the primary years of orchard life, for apple cultivation using Geneva Y-trellis system in Karaj climate conditions. In contrast, 'Prime rose' isn't a promising cultivar for intensive planting systems in Karaj region.

ACKNOWLEDGMENTS

We would like to gratefully thank all the members of the Department of Horticulture, University College of Agriculture and Natural Resources, University of Tehran, for providing the facilities to carry out this work and for their suggestions.

Received, December 04th2010
Accepted, March 14th 2011

REFERENCES

BARRITT, B. H., A. S. KONISHI and M. A. DILLEY (1995): Intensive Orchard Management. Performance of three apple cultivars with 23 dwarfing rootstocks during seasons in Washington. Fruit Var. J. *49* (3), 158-170.

DADASHPOUR, A., A. R. TALAIE and A. SHAHI (2010): Effect of Gutingen V as an intensive training system on agromorphlogical characters on some apple cultivars in Karaj region of Iran. Genetika-Belgrade. *42* (2), 331-338.

DERKACZ and NORTON (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, S.R., F. E. LARSEN, J.K. FELLMAN and S.S. HIGGINS (1988): Maturity,storage quality, carbohydrate, and mineral content of 'Gold spur' apples as influence by rootstock. J. Amer. Soc. Hort. Sci. *116*, 261-264.

ENDE, V. D., D. J. CHALMERS and P. H. JERI (1987): Latest developments in training and management of fruit crops on Tatura Trellis. J. Amer. Soc. Hort. Sci. *105*, 695-699.

FERREE, D. C. and I. J. WARRINGTON (2003): Apples: Botany, Production and Uses.CABI Publishing, Wallingford, 660 pp.

GARRIZ, P. I, H.L. ALVAREZ and A.J. ALVAREZ (1996): Influence of altered irradiance on fruits and leaves of mature pear trees. Biologia Plantarum. *39*, 229-234.

GARRIZ, P.I., G.M. COLAVITA and H.L. ALVAREZ (1998): Fruit and spur leaf growth and quality as influenced by low irradiance levels in pear. HortScience. *77*, 195-205.

HUDINA, M. and F. STAMPER (2002): Influence of leaf area on the sugar and organic acids content in pear (*Pyrus communis*) fruits cultivar Williamss. Acta Hort.*596*, 749-752.

HUTTON, R.J., L.M. MCFADYEN and W.J. LILL (1987): Relative productivity and yield efficiency of canning peach trees in three intensive growing systems. Hort Science. *22*, 552-560.

JACKSON, J.E. (1980): Light interception and utilization by orchard systems. Horticultural reviews. *2*, 208-267.

KADER, A. A. (2000): Quality of horticultural products. PROC. XXV IHC-PART 7, Acta Hort. *517*, 17-18.

LICZNAR, M. (2006): Training system and fruit quality in the apple cultivar Jonagold'. J. Fruit ornam. Plnt Res. *14* (2), 213-218.

MALAVOLTA, C. and J. CROSS. (2009): Guidelines for integrated production of pome fruits. IOBC/wprs Bulletin. *47*, 1-13.

MATTA, F.B. (2001): Performance of apple cultivar/rootstock combinations grownin Mississippi. J. Missi Acad. Sci. Available online: http://www.thefreelibrary.com/Performance+of+Apple+Cultivar%2 FRootsto ck+Combinations+Grown+in...-a077378934.

MONTEITH, J.L. (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, J.W. and J.E. JACKSON (1974): Effects of tree population and variations in spacing within and between rows of Golden Delicious on M.9. Report of East malling Research Station. *1973*, 66-68.

PLATON, I.V. (2007): Preliminary results on planting system and density in apple. Acta Hort. *732*, 471-473.

ROBINSON, T.L. (1992): Performance of Y-shaped apple canopies at various angles in comparison with central leader trees. Acta Hort. *322*, 79-86.

ROBINSON, T.L. (2003): Apple-orchard planting systems. In: Ferree DC, WarringtonIJ (Eds) *Apples*, CABI Publishing, Wallingford, UK, pp 345-407.

ROBINSON, T.L. (2007): Recent advances and future directions in orchard planting systems. Acta Hort.*732*, 367-380.

ROBINSON, T.L. and A.N. LAKSO (1989): Light interception, yield and fruit quality of Empire and Delicious apple trees in four orchard systems. Acta Hort. *243*, 175-184.

ROBINSON, T.L. and A.N. LAKSO (1991): Bases of yield and production efficiency in apple orchard systems. J. Amer. Soc. Hort. Sci. *116*, 188-194.

SOSNA, I. and M. CZAPLICKA (2008): The influence of two training systems on growth and cropping of three pear cultivars. J. Fruit ornam. Plnt Res. *16*, 75-81.

STRIKIC, F., M. RADUNIC and J. ROSIN (2007): Apricot growth and productivity in high density orchard. Acta Hort. *732*, 495-500.

TUSTIN, D.S., P.M. HIRST and I.J. WARRINGTON (1988): Influence of orientation and position of fruiting laterals on canopy light penetration, yield, and fruit quality of 'Granny smith' apple. J. Amer. Soc. Hort. Sci. *113*, 693-699.

WIDMER, A. (2005): The development of Guttingen-V, Mikado and Drilling growingsystems: an overview. *OBST-UND WEINBAU. 141*, 14-16.

KVALITET PLODA KOD PET KULTIVARA JABUKE GAJENIH U INTENZIVNOM SISTEMU: GENEVA Y-TRELLIS

Alireza TALAIE , Mona SHOJAIE-SAADEE, Ahmad DADASHPOUR*, and Mohammad Ali ASGARI-SARCHESHMEH

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

I z v o d

Intenzivranje sistema gajenja biljaka u voćnjacima je motivisano proizvodnjom ranijih sorata jabuka što je moguće korišćenjem za kalemljenje podloge čiji korenov sistem kontroliše veličinu stable, indukuje rano formiranje prinosa i proizvodnju velike količine plodova u odnosu na veličinu stabla. U ovim ispitivanjima vršeno je poređenje određenih osobina prinosa i osobina plodova pet sorata jabuka gajenih u region Karaj u Iranu, 'Golab-kohans' (Iranian cultivar), 'Fuji', 'Starking', 'Delbar estival' i'Prime rose' – komercijalna strana sorta, u Geneva Y-trellis sistemu. Ispitivane sorte (komercijalne strane sorte) su kalemljene na M9 podlozi koje su gajene u navedenom sistemu. Sva stable su zasađena u zimi 2004. godine. Vršeno je navodnjavanje sistemom kap – po - kap od druge godine posle sadnje. Iranska sorta 'Golab-kohans' je imala najvišu vreednos pH 4.07 i sadržaj vlage 85.96. 'Delbar estival' sorta je imala najveću dužinu ploda. 6.13 cm, L/D (0.87) and TSS (15.77) dok je 'Starking' imao najveću težinu ploda, 145.24 grama, diameter ploda , 6.91 cm i Ash 0.71 procent. Najveći sadržaj suve materije, 20.13 procenata, najteži plod, 13.13 kg/cm i titar kiseline, 0.72 procenta su utvrđeni kod sorte 'Fuji'.

Primljeno 04. XII. 2010.
Odobreno 14. III. 2011.