

The Spontaneous Growth and Lateral Branch Habit of New Apple Cultivars in Nursery

FATMA AKINCI YILDIRIM¹ AND ABDULLAH KANKAYA

Department of Horticulture, Agriculture Faculty, Suleyman Demirel University, 32260 Isparta, Turkey

¹Corresponding author's e-mail: yfatma@ziraat.sdu.edu.tr

ABSTRACT

A study carried out to determine the spontaneous growth and lateral branch characteristics of apple cvs. Breaburn, Fuji, Galaxy Gala, Granny Smith and Pinova, on M9 dwarfing rootstock in nursery. There were significant differences between cultivars in terms of the number and percentage of lateral branches, tree height, shoot and root length. The stem diameter was between 8.18-11.67 mm, tree height 102-165 cm, root length 37-49 cm, the number of lateral 1.0-3.0 per tree, angle of lateral 47-73 degree, shoot length 22.3-33.7 cm percentage of lateral 6-94%. Breaburn and Granny Smith cultivars naturally tended to show more lateral branching in nursery.

Key Words: Apple (*Malus communis* L.); Lateral branch; Nursery trees

INTRODUCTION

The goal of modern high-density orchard systems is to achieve high yield at early tree age (Cody *et al.*, 1985; Jaumien *et al.*, 1993; Theron *et al.*, 2000). For this purpose the first step is to obtain good caliper trees that are well branched (feathered). The number of lateral branches provides the opportunity to obtain good tree architecture in the future. Moreover the height, location and the wide angle of laterals provide earlier and higher yields (Barrit, 1992; Hrotko *et al.*, 1996a). Several studies have shown that larger caliper trees grow more and produce higher yield in 4-5 years than do smaller caliper trees (Barrit, 1992; Robinson, 2003; Wertheim & Webster, 2003). Mika *et al.* (1998) reported that well feathered trees produced more (3-6 kg/tree) yield in two-year-old orchard than maiden (unfeathered) trees which produced 1 kg/tree. Robinson (2003) recommended that the caliper of trees used in high density planting be a minimum of 15 mm and that have five to ten well-positioned branches on the tree.

Formation of lateral shoots differs among apple cultivars. Many important cultivars produce few feathers in nursery by nature, because of strong apical dominance (Jaumien *et al.*, 1993; Cline, 2000). According to Elfing (1984), a balance between auxin and cytokinin levels controls formation of lateral branches, and the diffusible auxin at a high concentration produced mainly in the apical bud, inhibits growth of lateral shoots. Varieties with weak apical dominance (Cox's Orange Pippin, Golden Delicious, Jonagold) generally show well lateral shoot development in the nursery, while varieties with strong apical dominance (Spartan, Red Delicious) and also spur varieties form few laterals even with promoting treatments (Hrotko *et al.*, 1996a). Hrotko *et al.* (1996b) indicated that the spontaneous feathering of Idared on dwarfing and semi-dwarfing

rootstocks could reach only 11-15%.

A number of new promising apple cultivars are available, however many are untested in a large range of environments. In this study the natural growth habits of new apple cultivars in the nursery were determined in Lake Region growing conditions at the south-west Turkey.

MATERIALS AND METHODS

The research was conducted on Fuji, Pinova, Galaxy Gala, Breaburn and Granny Smith apple varieties on M9 dwarfing clonal rootstock in the Department of Horticulture, at Suleyman Demirel University in Isparta/Turkey. The nursery is located on clay and loamy soil. The average temperature, total sunshine and the average rainfall in a year is 12°C, 7 h/day and 581 mm, respectively.

The rootstocks were planted in early spring of 2002. The nursery spacing was 3 x 0.25 m. After planting in August, the rootstocks were budded (T budding method) at the height 10 cm above ground level. The experiment was planned as a randomized complete block. Each treatment was represented by 12 trees and replicated four times. Drip irrigation was used. Pests, weed control were managed as required. Nutrition was given by drip irrigation application.

The following parameters were: i) root system quality estimated on each tree on a scale from 1 (poor root system) to 4 (good development root system); ii) the length of root per tree measured on each tree; iii) scion diameter measured on each tree at height of 30 cm above soil ground; iv) the number, length and angle of lateral shoots (longer than 10 cm) per tree measured on each tree.

The data were analyzed by one-way analysis of variance using MINITAB program. Differences between means were evaluated separately for varieties using Tukey's comparison test $P < 0.05$ levels.

RESULTS AND DISCUSSION

Stem diameter and plant height. Generally, all cultivars had enough development for stem diameter and plant height. Also, variance analysis showed that there was a highly significant difference between cultivars. The average stem diameter was between 8.18 mm (Galaxy Gala)-11.67 mm (Granny Smith) (Table I). Wojcik (2002) founded that in Jonagold and Elstar cultivars on M9 produced 11.0 and 11.8 mm, respectively. The tallest plants were obtained from Granny Smith cultivar (165 cm). The plants of Pinova cultivar were significantly shorter than the plants of Granny Smith and Beaburn cultivars (Table I). These results are in agreement with previous reports (Hrotko *et al.*, 1996a; Wojcik, 2002; Gastol & Poniedziakle, 2003).

Quality root systems. The highest quality root development was obtained from Breaburn cultivar (3.1), which was significant higher in comparison Galaxy Gala cultivar (2.0) as shown Table I. While the highest root length was measured from Granny Smith (49 cm) variety, the shortest root length was measured from Pinova (37 cm) variety, and there was significant difference between both varieties (Table I). Wojwic (2002) indicated that Jonagold and Elstar varieties had well the quality root systems. Generally, in our research, vigor and quality of root system showed good development.

Lateral branches habit. There was a statistically significant difference between cultivar for the number of

lateral branches, lateral shoot length, branch angle and shoot location height as shown Table I and II.

The biggest number of lateral branches was obtained from Breaburn (3.0 number/tree) variety. The other varieties produced lateral shoot 1-2 number per tree (Table II). Compared to standart well branched nursery tree, this results were not enough (Robinson, 2003). Cody *et al.* (1985) reported that Oregon Spur II variety obtained an average 1.6 numbers of lateral shoots per tree. On the other hand, Hrotko *et al.* (1996b) indicated a similar result. In their trial one-year old Idared nursery trees produces an average of 2.3 lateral shoots per plant.

While the highest percentage of lateral shoots was obtained from Breaburn (94%) variety, the lowest percentage of lateral shoots were obtained from Galaxy Gala (6%) (Table II). Gastol and Poniedzialek (2003) indicated that in Boskoop, Elise and Rubin cultivars on M9 rootstock obtained percentage of feathared trees 14.1%, 2.5% and 2.5%, respectively.

Generally the length of lateral shoots ranged between 22.6 cm to 33.7 cm. Breaburn produced taller lateral shoots than other cultivars. These results are in line with those obtained by Hrotko *et al.* (1996a). They reported that in Idared cultivar produced a total length 29.18 cm shoots per tree. However, Gastol and Poniedzialek (2003) indicated that Boskoop, Elise and Rubin cultivars produced a total length 7.2 cm, 1.1 cm and 8.2 cm shoots per plant, respectively.

Table I. Growth characteristics of one-year old apple cultivars

Varieties	Stem diameter (mm)	Tree height (cm)	Quality root (1-4 scale)*	Root length (cm)
Breaburn	11.50 ^{ab}	131 ^{ab}	3.1 ^a	43 ^{ab}
Fuji	10.75 ^{ab}	109 ^b	2.4 ^{ab}	45 ^{ab}
Galaxy Gala	8.18 ^c	106 ^b	2.0 ^b	42 ^{ab}
Granny Smith	11.67 ^a	165 ^a	2.3 ^{ab}	49 ^a
Pinova	10.37 ^b	77 ^b	2.6 ^{ab}	37 ^b

Means with different superscripts in the same column are statistically significant ($P < 0.05$) *1: poor root system 4: good root system

Table II. Feathering characteristics of one-year old apple cultivars

Varieties	Lateral shoots number/tree	Percentage of laterals	Average lateral shoots length (cm)	Percentage of lateral shoots between 10-30 cm	Percentage of lateral shoots longer 30 cm
Breaburn	3.0 ^a	94	33.7 ^a	42	58
Fuji	1.0 ^c	32	30.5 ^a	41	59
Galaxy Gala	1.0 ^c	6	23.5 ^b	67	33
Granny Smith	2.0 ^b	52	22.6 ^b	85	15
Pinova	1.1 ^c	24	26.3 ^{ab}	69	31

Means with different superscripts in the same column are statistically significant ($P < 0.05$)

Table III. Feathering characteristics of one-year old apple cultivars

Varieties	Lateral branch angle ^{C0}	Average height of located shoots (cm)	Percentage of located shoots under 50 cm	Percentage of located shoots between 50-70 cm	Percentage of located shoots above 70 cm
Breaburn	47 ^b	30.8 ^{ab}	59	41	-
Fuji	72 ^a	26.9 ^b	83	11	6
Galaxy Gala	73 ^a	20.4 ^b	66	34	-
Granny Smith	49 ^b	46.2 ^a	67	33	-
Pinova	62 ^{ab}	23.4 ^b	83	17	-

Means with different superscripts in same column are statistically significant ($P < 0.05$)

For nurseries, it is especially important that there is a significant increase in the number of laterals longer than 30 cm (Robinson, 2003). In this research, the percentages of 10-30 cm lateral shoots were obtained from Granny Smith cultivar, 85%. The biggest percentage of shoots longer 30 cm was measured from Galaxy Gala cultivar, 67% (Table III). Hrotko *et al.* (1996b) founded that in Idared cultivar measured the percentage of 10-30 cm shoots, 4.29%, while it was not obtained shoots longer than 30 cm. Generally, the lateral branches angle was enough and it ranged 47 to 73 degree. These results are in line with the results of Cody *et al.* (1985) and Hrotko *et al.* (1996b). The height of shoot location on tree was observed at mean 30 cm above soil ground, but Breaburn, Galaxy Gala and Granny Smith cultivars showed well percentage of lateral shoots location at 50-70 cm on tree (Table III).

CONCLUSION

At the young tree level, the differential in lateral branching would appear to be an accurate predictor of the time at which a given cultivar will enter production. However a high percentage of fruiting branching over the first two years of growth may be indicative of a risk of alternate bearing at the adult stage (Lauri *et al.*, 2002). The obtained results indicated that each cultivar has specific behavior. Fuji, Galaxy Gala and Pinova cultivars in nursery produced fewer lateral shoots by nature than Breaburn and Granny Smith cultivars. Generally one-year old in nursery trees had enough height and diameter to meet standards, whereas natural-branched enough. It seems that Breaburn and Granny Smith cultivars tend naturally to produce more lateral branching in nursery.

REFERENCES

- Barrit, B.H., 1992. *Intensive Orchard Management*. Good Fruit Grower: a division of Washington State Fruit Commission 1005 Tietion Drive, Yakima Washington
- Cline, M.G., 2000. Execution of the auxin replacement apical dominance experiment in temperate woody species. *American J. Bot.*, 87: 182–90
- Cody, C., F.E. Larsen and R Fritts, 1985. Induction of lateral branches in tree fruit nursery stock with propyl 3-t-butylphenoxy acetate 8MB 25, 105) and promalin (GA₄₊₇+6-benzyladenine). *Scientia Hort.*, 26: 116–8
- Elfing, D.C., 1984. Factors affecting apple tree response to chemical branch-induction treatment. *J. American Soc. Hort. Sci.*, 109: 476–81
- Hrotko, K., T. Buban and L. Magyar, 1996a. Improved feathering on one-year-old 'Idared' apple trees in the nursery. *HortSci.*, 28: 29–34
- Hrotko, K., L. Magyar and T. Buban, 1996b. Improved feathering by benzyladenine application on 'Idared' apple trees in the nursery. *HortSci.*, 28: 49–53
- Jaumien, F., B. Czamecki, T. Mitrut and W. Poiedzialek, 1993. Very similar effects of a mixture of GA₃ and BA (6-benzylaminopurine) and of Ga₄+7 and BA on branching of some apple cultivars in nursery. *Acta Hort.*, 329: 35–42
- Lauri, P.E., E. Costes and A. Beloin, 2002. European pear architecture and fruiting-branch management: Overview of an INRA research program. *Acta Hort.*, 596: 621–6
- Mika, A., A. Krawiec and D. Krzewinska, 1998. Results of planting systems and density trials with dwarf and semi-dwarf apple tree grafted on Malling and Polish rootstock. *Hort. Abst.*, 68: 5585.
- Robinson, T., 2003. Apple orchard planning systems. In: Free, D.C. and I.J. Warrington (eds.), *Apples*, p. 345. Printed and bound in the UK by Bidden Ltd. Guildford and King's Lynn, England
- Theron, K.I., W.J. Steyn and G. Jacobs 2000. Induction of proleptic shoot formation on pome fruit nursery. *Acta Hort.*, 514: 235–43
- Wertheim S.J. and A.D. Webster, 2003. Propagation and nursery quality. In: Free, D.C. and I.J. Warrington (eds.), *Apples*. p. 125. Printed and bound in the UK by Bidden Ltd. Guildford and King's Lynn, England
- Wojcik, P., 2002. Vigor and nutrition of apple trees in nursery as influenced by titanium sparys. *J. Plant Nutr.*, 25: 112–38

(Received 05 March 2004; Accepted 15 April 2004)