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INFLUENCE OF BRANCH ANGLES ON GRADIENTS OF SHOOT EXTENSION, SHOOT DIAMETER AND YIELD IN APRICOT (*PRUNUS ARMENIACA* L.) CULTIVARS

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SUMMARY

Apricot 8 cultivars were planted in the field was trained at 30^0, 60^0 and 90^0. angle each. Branch trained at 30^0 angle resulted minimum shoot extension. Cultivars Conian Italy showed least shoot extension and minimum growth upto September (104.5mm). Interaction of cultivars, branch angle and growth period exhibited significant effect. Cultivars Charmagz trained at 30^0 angle upto September resulted minimum shoot extension (84.0 cm) followed by Conian Italy (90.7 cm) trained. Similarly 30^0 angle showed minimum (7.6mm) diameter. Conian Italy had minimum (7.0mm) shoot diameter. Cultivars angle and period influenced significantly on the shoot diameter. Conian Italy at 60^0 and 90^0 angle had least shoot diameter upto September. Maximum number of fruits (42.1) per branch were noticed in the cultivars Conian Italy, lowest number of fruit (11.2) was noted in Amba, irrespective of branch angles . Branch trained at 60^0 resulted minimum number of fruit (28.7) of fruits. Cultivars Conian Italy at 60^0 resulted maximum (84.5) fruits while cultivar Amba at 60^0 angle had minimum fruit per branch.

Key words: **Apricot, branch angle, crotch angle, fruit yield, shoot extension.**

INTRODUCTION

Apricot (*Prunus armeniaca* L.) is a important stone fruit occupies third position in order to importance, area, production and productivity grown in Kashmir. Leh and Kargil are principle area for dry apricot production, and it is main stay of their livelihood. Central leader and conventional vase trees usually grow faster and carry most of their crop in the upper periphery and thus reduce cropping efficiency. In apricot, if it is not properly trained large number of upright growing shoot emerged with narrow crotch angle left the tree weak. Appropriate crotch angle is very important to strengthen the branch and increasing cropping efficiency. The aim was to minimize environmental influence by training trees to increase uniformity of light interception within the canopy, as the angle of shoot influenced the shoot growth and fruiting (Hamzakheyl *et al*. 1976, Myers and Ferree 1983). Further increasing the shoot angle by re-orientation to the horizontal position is known to increase the number of lateral flower in apple (Wareing 1970). Hence, the present experiment was conducted to study the effect of cultivars and branch angle and growth rate over the shoot extension, shoot diameter and yield.

MATERIALS AND METHODS

The experiment was conducted during 2006-07 and 2007-08 at Experimental Farm of Division of Pomology, SKUAST-K, Shalimar, Srinagar. The plantation was done in the 2002-03 at square system with spacing of 5x5 meter. Planting of eight cultivars of apricot namely

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Charmagz, Quetta, Roundel, Conian Italy, Amba, Gilgit Sweet, Australian and Kaisha were used for creating specific branch angle. The branch angle was created by tying the branch with nylon thread and fixing the clothpin between the main branch and lateral branch and further the tied branch was kept at desired angles at 30°, 60° and 90° respectively. The crotch angle was fixed with the help of geometrical protector. Four branches from each tree were trained in similar manner. Overall, the tree was trained to open center system. All the cultural practices were kept uniform in all the studied trees. The prunning in all the experimental trees were done by cutting the 1/3rd shoots growth of current season. The experiment was laid in the Randomized block design (Factorial). Four branches in all directions i.e. North, South, East and West were trained in a single tree replicated thrice. The shoot extension and shoot diameter was recorded at monthly interval upto ceasing of growth with the help of digital Vernier Caliper of the trained branches. Fruit yield per trained branch recorded at maturity. The data recorded on growth and yield parameters for two years were analyzed statistically by DAS software for interpretation of the results.

RESULTS AND DISCUSSION

Shoot extension: The data pertaining to shoot extension as influenced by cultivars and branch angle were presented in the Table 1. Mean shoot extension as influenced by the branch angle was recorded significantly

Table 1. Interaction of cultivar, branch angle and period on shoot extension (mm).

Cultivar	Branch angle	Period				
		May	June	July	August	September
Charmagz	30º	48.2	53.4	58.4	64.0	84.0
	60º	58.1	59.9	61.45	68.5	109.5
	90º	71.3	76.9	80.0	87.9	123.5
Quetta	30º	56.5	63.7	64.9	68.0	109.5
	60º	62.4	76.0	80.4	84.0	132.0
	90º	68.9	85.0	92.0	98.4	142.0
Roundel	30º	44.7	48.5	52.0	57.0	99.5
	60º	64.9	72.5	75.0	78.9	108.0
	90º	72.0	80.5	85.0	100.0	127.5
Conian Italy	30º	43.1	46.0	52.4	58.0	90.7
	60º	41.3	48.0	53.9	83.0	98.4
	90º	41.9	52.0	59.5	83.0	124.0
Amba	30º	66.7	71.0	77.0	79.8	102.0
	60º	80.9	88.5	93.8	98.9	112.7
	90º	84.0	91.7	97.5	99.8	123.0
Gilgit Sweet	30º	61.8	66.5	71.8	102.0	113.0
	60º	104.0	107.9	112.7	126.5	141.0
	90º	102.0	110.0	117.0	123.0	159.0
Australian	30º	51.2	55.7	59.8	63.0	105.7
	60º	70.5	73.0	75.9	82.5	123.8
	90º	90.8	93.5	107.0	119.8	143.8
Kaisha	30º	45.7	50.8	54.5	63.5	93.7
	60º	54.5	62.5	76.7	82.5	112.4
	90º	75.0	78.9	86.7	97.0	151.6

LSD (p=0.05): Cultivar* Branch angle*Period = 4.5, SE (mean difference): Cultivar* Branch angle*Period = 2.2

highest (97.2 cm) in 90° crotch angle, least shoot extension (66.7 cm) noted when branch was trained at 30 ° angle. Shoot extension was registered significantly maximum in Gilgit sweet (102.7 cm) followed by Amba (91.0 cm), whereas cultivar Conian Italy resulted least (64.8cm) shoot increment. The growth in Quetta and Australian was statistically at par in shoot increment. At 30° branch angle Kaisha exhibited minimum (59.8 cm) shoot increment, which was statistically at par with Roundel however, cultivar Amba registered maximum (79.0 cm) shoot extension at 30° angle. Gilgit Sweet showed maximum shoot increment (112.6 cm, and 122.1 cm) at 60° and 90° angle respectively. Cultivar Conian Italy exhibited minimum shoot increment (59.9 cm) and (72.1 cm) respectively at 60° and 90° branch angle. Growth was registered in increasing trend from May to September; maximum shoot extension was registered between August and September, however, Cultivar Gilgit Sweet exhibited maximum (134.1 cm) shoot extension upto September followed by Quetta (128.0 cm), whereas minimum shoot extension increment (104.5 cm) was registered with Conian Italy, which was statistically at par with Charmagz (105.7 cm) .The interaction effect between branch angle and period was found significant. Irrespective of period, the shoot increment was recorded highest when the branch was trained at 90° angle, least shoot extension was registered in the 30° crotch angle. However, in all the branch angle growth in shoot extension showed increasing trend from May to September. Branch trained at 30° angle registered (97.2 cm) shoot increment followed by 60° (116.9 cm), whereas maximum shoot increment recorded in the branch which was trained at 90° crotch angle (137.1 cm). The cultivar, branch angle and period of growth interacted significantly. Cultivar Charmagz when trained at 30°exhibited minimum (84.0 cm) growth followed by Conian Italy (90.7 cm) and Kaisha (93.7 cm) on same angle. As branch angle increased the shoot increment also increased in all the cultivars from 30° to 90° angle. The cultivar Gilgit Sweet registered maximum (159.0 cm) shoot increment at 90° branch angle followed by Kaisha (151.6 cm), however, cultivar Amba experienced minimum (123.0 cm) shoot extension which was statistically at par with Charmagz (123.5 cm) and Roundel (127.5 cm) at 60° angle and Conian Italy (124.0 cm) at 90° crotch angle.

Shoot diameter: Shoot diameter was influenced significantly by cultivars and branch angles. Mean shoot diameter was recorded maximum (10.0 mm) in Gilgit Sweet followed by Kaisha (8.6 mm) and minimum (7.0 mm) noted in Conian Italy (Table 2). The diameter was found statistically at par with Quetta and Roundel and Roundel and Australian Shoot diameter was recorded maximum (9.4 mm) in Gilgit Sweet at 30° angle, followed by Australian (8.4 mm). The diameter was registered statistically at par with Quetta and Roundel and Conian Italy and Amba at 30° angle. Similarly maximum shoot diameter (11.23 mm) was recorded in Gilgit Sweet followed by Kaisha (8.5 mm) which was statistically equal with Australian (8.2 mm), Amba (8.6 mm) and Quetta (8.3 mm) and Roundel with Australian. At 90° branch angle cultivar Kaisha exhibited maximum diameter (9.8 mm), which was statistically at par with Amba, Gilgit Sweet and Quetta. The cultivar Australian showed reverse trend in shoot diameter, at 90° resulted minimum diameter (7.1 mm) followed by 60° and 30° respectively. Cultivar Conain Italy experienced minimum (6.5 mm) growth at 90° branch angle. The combined effect of cultivar and period of growth was found significant on shoot diameter. Maximum mean shoot diameter was recorded highest in September which was superior over rest of the period.Gilgit Sweet cultivar registered significantly highest (14.44 mm) shoot diameter followed by charmagz (12.9) in September, whereas cultivars Kaisha and Amba, and Kaisha and charmagz are statically at par in shoot diameter and least growth (10.01 mm) was registered in Conian Italy. Interaction of branch angle and period of growth was found significant (Fig 6). Maximum shoot diameter (12.7 mm) was registered in 90° angle followed by (12.1 mm) in 60° and least growth (11.1 mm) in 30° branch angle. Interaction of cultivar, branch angle and growth period has been depicted in Table 2. Maximum mean shoot diameter (12.8 mm) in 30° branch angle was recorded in Gilgit Sweet whereas Roundel registered minimum (10.2 mm) shoot diameter which was statically at par with shoot diameter recorded in 60° branch angle. Cultivar Gilgit Sweet experienced maximum shoot diameter in the entire angle. However, Conian Italy cultivar showed highest shoot diameter. Cultivar Quetta, Rounded, Conian Italy, Amba and Kaisha exhibited shoot growth statically at par in 30° branch angle.

Table 2. Interaction effect of cultivar, branch angle and period on shoot diameter (mm).

Cultivar	Branch angle	Growth at monthly intervals				
		May	June	July	August	September
Charmagz	30º	3.7	3.8	4.4	7.3	11.1
	60º	3.6	3.9	5.2	8.3	12.8
	90º	5.9	6.0	7.3	8.9	14.6
Quetta	30º	3.5	4.7	6.8	7.6	10.7
	60º	5.0	6.9	8.0	9.7	11.9
	90º	5.8	8.4	9.8	10.9	12.2
Roundel	30º	4.4	5.8	6.5	7.7	10.2
	60º	4.9	6.8	7.6	8.8	10.9
	90º	6.5	8.2	9.0	10.0	12.2
3.68	30º	5.0	6.8	7.7	9.3	11.2
	60º	3.6	5.7	6.7	7.4	9.9
	90º	3.6	5.2	6.9	7.7	8.9
Amba	30º	5.0	6.7	7.5	8.6	10.3
	60º	5.2	7.2	8.3	10.2	12.1
	90º	6.1	8.1	9.3	11.2	14.1
Gilgit Sweet	30º	6.1	7.8	9.2	11.2	12.8
	60º	8.1	9.9	11.0	12.2	14.8
	90º	5.4	7.0	7.9	11.7	15.6
Australian	30º	5.4	6.6	7.7	10.1	12.3
	60º	5.1	7.0	8.3	9.2	11.7
	90º	4.3	5.8	7.1	7.9	10.4
Kaisha	30º	4.6	6.2	7.1	8.1	10.6
	60º	6.0	6.9	8.0	9.1	12.7
	90º	6.9	7.8	9.1	11.3	14.0

LSD (p=0.05): Cultivar* Branch angle*Period = 1.02, SE (mean difference): Cultivar* Branch angle*Period = 0.56

Fruit yield: Cultivars effect was found significant in fruit yield per branch. Conian Italy resulted significantly highest (42.1) fruits per branch which was significantly highest, followed by Roundel (24.1), minimum number of fruit was registered in cultivars Amba (11.2). Branch trained at 60^0 resulted maximum (28.7) fruits per branch followed by 90^0 (15.1) which was statically at par to 30^0 angle. Interaction effect of branch angle and cultivars had significant effect. Maximum fruit number (84.5) per branch registered in cultivars Conian Italy at 60^0 branch angle. Minimum number of fruit (9.0) was recorded in cultivars Amba at 60^0 branch angle (Table3).

The aim of branch angle is to minimize shading, large variability in shoot growth, flowering and fruiting between angles with horizontal position. The pre-requisite for fruit set is the development of the so called strong flower buds that takes place during previous fall and requires a certain level of photosynthates and nitrogen supply. Most of these differences were response to endogenous factors rather than environmental factors. Keeping the branch into horizontal position helps in changing the hormonal make up of the tree or decreases the GA producing sites. Dann *et al*. (1990) report that horizontal branch would be more fruitful on peach and other

Table 3. Influence of cultivar and branch angle on fruit yields

Treatment	Number of fruits per branch
Cultivars Effect	
Charmagz (A_1)	13.00
Quetta (A_2)	13.87
Roundel (A_3)	24.17
Conian Italy (A_4)	42.17
Amba (A_5)	11.20
Gilgit Sweet (A_6)	16.34
Australian (A_7)	17.50
Kaisha (A_8)	19.00
LSD (p=0.05)	**2.96**
S.E (mean diff.)	**1.25**
Branch Angle Effect	**Mean**
30º (B_1)	15.06
60º (B_2)	28.70
90º (B_3)	15.19
LSD (p=0.05)	**1.77**
S.E (mean diff.)	**0.84**
Interaction of cultivars and branch angle	**Mean**
A_1B_1	14.0
A_1B_2	13.5
A_1B_3	11.5
A_2B_1	16.0
A_2B_2	13.5
A_2B_3	12.0
A_3B_1	15.0
A_3B_2	46.0
A_3B_3	11.5
A_4B_1	16.5
A_4B_2	84.5
A_4B_3	24.5
A_5B_1	25.9
A_5B_2	9.0
A_5B_3	15.0
A_6B_1	9.5
A_6B_2	9.5
A_6B_3	19.0
A_7B_1	20.5
A_7B_2	16.7
A_7B_3	13.9
A_8B_1	21.7
A_8B_1	18.5
A_8B_1	16.3
C D (p=0.05)	**5.02**
S.E (mean diff.)	**2.37**

vigorous species. Strong growth near the base would be troublesome and weak growth near the tip would create renewal problems. Growth on vertical branch would be more uniform, as it would be less fruitful; hence, intermediate angle seems to be more appropriate in peach. Further stated that less vigorous spur bearing fruit species near horizontal branch may be favored. Sharma and Jindal (1992) observed in non-vertical Royal Delicious apple, shoot growth reduced proportionally to increasing planting angles from vertical to horizontal position and hence, minimum extension shoot growth was noted in 30° tree plantation. Tromp (1986), reported reduced extension growth in horizontal apple shoot and seedling. Hamzakheyal *et al*. (1976) further reported that growth reduction increased with the increasing branch orientation from vertical to horizontal position. Sharma and Jindal (1992), reported radial growth of current seasons shoot depend to a large extent, upon its extension growth thus reduced shoot diameter may be due to reduction in linear growth of geotropically stimulated trees. In the horizontally growing apple shoots as compared to upright have lower auxin content (Kato and Ito, 1962). Luckwill (1968), reported that the supply of nutrient to the apex is controlled by auxin in the top meristem. Sharma and Jindal (1992) also noted reduced radial shoot growth in Royal Delicious apple. The apical dominance impaired when shoot were re-oriented thus weight increment and floral development in lateral buds enhanced (Ito *et al*. 1999, Wareing 1970). Further Ito *et al*. (1999) floral development progresses more rapidly on horizontal than on vertical shoots. In the horizontal shoots apical dominance impaired as dominance is controlled by the ratio of cytokinin to auxin, lateral out growth is promoted when auxin was seen to decrease and cytokinin in increase (Cline *et al*. 1997). Fruit density was greater on the low angled rods, low branch angle might be helpful for shy bearing cultivar. In peach producing on wide angle branches also have very limited bud dormancy (apical dormancy). All buds of this peach break which may indicate that the tree is high in cytokinin or low in IAA. A narrow crotch angle is associated with relatively high IAA content, which is a contrast to wide angle tree.

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