DOI : 10.5958/0974-0112.2016.00106.7

Indian J. Hort. 73(4), December 2016: 502-505

Growth and quality of low chilling peach cultivars under different irrigation and rainfed conditions

Gaganpreet Kour*, V.K. Wali and Parshant Bakshi

Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, Faculty of Agriculture, Main Campus, Chatha 180009, Jammu, J&K

ABSTRACT

Sub-tropical peach requires large amount of water during growth and development, but with the decreasing monsoon rainfall and dwindling irrigation water and higher demand of water for fruit tree due to increased temperature had affected the growth and quality of peach. This experiment was undertaken to study the effect of low chilling peach cultivars to different irrigation scheduling during 2010 and 2011. The results revealed that irrigation applied at 40 mm evapotranspiration was optimum for growth and development of peach under sub-tropical conditions.

Key words: Peach, cultivars, irrigation, growth, quality.

INTRODUCTION

It has become essential to manage the water as the amount of water throughout the world for horticultural use is decreasing day by day (Moretti *et al*., 12). Water need of the peach tree is governed by the annual phenological and soil-water-plant relationship. The water needs of the fruit trees vary with species and even within the species during different stages of the growing season. Peach also require frequent irrigation during fruit development and mismanagement of water supply to peach trees at critical stages leads to fruit drop, reduced fruit size and quality. Besides, the level of irrigation depends on the environment factors that drive evaporative demand and transpiration, the resistance of soil to root penetration, moisture transport and soil aeration and the tree hydraulic architecture (Naor, 13).

Peach (*Prunus persica* (L.) Batsch) trees are frequently cultivated in dry countries and are often subjected to water stress, whereas, applying insufficient irrigation water results in drought stress and reduced fruit size and quality (Black *et al*., 5). The objective of this experiment was to standardize the irrigation schedule for young bearing low chilling peach cultivars and provide information to orchardists for successful management under decreased water and adverse climate conditions.

MATERIALS AND METHODS

A field experiment was conducted during spring-summer season of 2010 and 2011 at Research Orchard of Division of Fruit Science, SKUAST-J, Chatha on three peach cultivars, *viz*., Florda Prince, Early Grande and Shan-e-Punjab. Uniform, healthy and disease-free, 3-year-old trees of uniform age and vigour were selected for the investigation. The experimental orchard is situated in the sub-tropical zone at latitude of 32°39' North and longitude of 74°58' East. The altitude of the place is 332 m above mean sea level. Annual rainfall is about 1,110 mm, out of which most of the rains are received during July to October. The mean annual maximum and minimum temperatures are 29.7° and 16.3°C, respectively. Summer months are hot with temperature and humidity ranging from 23.5° to 35.5°C and 53.0 to 73.5%, respectively. Daily maximum and minimum values of temperature, evaporation rate rises from February onwards up to June drop during July to September with a slight peak in October and then drop progressively up to December. Irrigation provided (modified basin system) based on four levels: I_1 = 20 mm evapotranspiration, I_2 = 30 mm evapotranspiration, I_3 = 40 mm evapotranspiration, I_4 = 50 mm evapotranspiration and I_5 = control, *i.e.* rainfed with three replications for each variety. The optimal level of irrigation was calculated with the CROPWAT code, based on the Penman-Monteith's equation for calculation of reference evapotranspiration (Et_o) and water requirement was calculated by subtracting effective rainfall from Et_c (FAO, 6).

The effect of irrigation was observed on trunk girth, which was measured 60 cm above the ground level. The leaf number, irrespective of their size, on the marked plant per shoot tagged in all the four directions were counted from the top and average

*Corresponding author's E-mail: gaprit05@gmail.com

was recorded. The fruits were weighed on electronic balance and mean weight per fruit was computed, fruit volume was measured by water displacement method and expressed in cubic centimetre (cc). The fruit pulp was separated from the stone and the ratio between weights of pulp and stone was worked out for different irrigation levels. All the data were subjected to a two-way analysis of variance (ANOVA) using OPSTAT software.

RESULTS AND DISCUSSION

The performance of fruit tree in terms of growth and quality and long term productivity is highly dependent on irrigation and different species respond to it differently. Tree response to various irrigation levels in terms of trunk girth showed a positive relationship during the study wherein trunk girth reduced in plants grown under rainfed conditions during second year (Table 1). The reduction in trunk girth due to deficit water availability to the plants can be attributed to the fact that the reduced water potential might have resulted low uptake of water and the nutrients. This study is in conformity with the findings of Johnson *et al*. (8) who also recorded reduced trunk radial growth when no irrigation was provided. The pistachio trunk growth was maximum in 75 per cent Etc based irrigation as compared to no irrigation (Monastra *et al*., 11).

Number of leaves significantly increased in plants irrigated at I_2 and I_3 level, which might be due to better root establishment, efficient photosynthesis and production of more assimilates. Plants grown under rainfed conditions had reduced number of leaves due to leaf abscission as observed during the experimental period (Table 2). Similar observations were made by Lecoeur *et al*. (10). Khalil *et al*. (9) in citrus also support the findings of the present study. Among cultivars, Early Grande plants had the maximum trunk girth, while Shan-e-Punjab plant had maximum number of leaves during both the years (due to more vegetative growth).

Heavier fruits were harvested from plants irrigated at I_3 level during both the years (Table 3). The fluctuation in the weight amongst the fruits harvested from plants might be due to difference in the water content accumulated in the fruit during the 3rd and final stage of fruit development. Berman and Dejong (3)

Table 1. Effect of different irrigation levels on trunk girth (cm) of peach cultivars.

Cultivar / Irrigation	2010				2011			
	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_1 (20 mm Et)	4.19	4.44	4.61	4.45	4.86	5.46	5.58	5.30
I_2 (30 mm Et)	4.12	4.43	4.54	4.48	5.28	5.55	5.51	5.45
I_3 (40 mm Et)	4.69	4.58	4.72	4.62	5.51	5.68	5.76	5.66
I_4 (50 mm Et)	4.48	4.31	4.55	4.27	4.68	5.32	5.44	5.15
I_5 (Rainfed)	3.55	4.15	4.45	4.11	4.25	5.12	5.42	4.93
Mean (C)	4.20	4.38	4.57		4.92	5.43	5.54	
Mean (Y)		4.39				5.29		

CD at 5% Irrigation (I) = 1.51, Cultivar (C) = 1.17, Year (Y) = 0.90, I × C × Y = N.S.

Table 2. Effect of different irrigation levels on number of leaves per shoot of peach cultivars.

Cultivar / Irrigation	2010				2011			
	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_1 (20 mm Et)	25.60	33.20	23.53	27.45	28.25	36.25	27.80	30.76
I_2 (30 mm Et)	27.53	38.20	25.27	30.33	32.67	45.50	31.90	36.69
I_3 (40 mm Et)	24.60	33.70	31.27	29.86	28.25	39.25	29.60	32.37
I_4 (50 mm Et)	22.30	28.87	22.50	24.56	25.12	34.38	25.40	28.30
I_5 (Rainfed)	22.13	25.80	19.60	22.51	19.12	35.59	23.20	25.97
Mean (C)	24.43	31.96	24.43		26.67	38.19	27.58	
Mean (Y)		26.94				30.81		

CD at 5% Irrigation (I) = 1.36, Cultivar (C) = 1.05, Year (Y) = 0.86, I × C × Y = 3.32

Table 3. Effect of different irrigation levels on fruit weight (g) of peach cultivars.

Cultivar / Irrigation	2010				2011			
	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_1 (20 mm Et)	74.80	56.70	86.84	72.78	94.80	75.43	103.29	91.18
I_2 (30 mm Et)	91.96	55.49	84.87	77.44	95.09	75.65	101.97	92.70
I_3 (40 mm Et)	95.68	76.28	85.10	85.69	97.58	78.55	115.55	96.11
I_4 (50 mm Et)	86.90	56.84	84.69	76.14	95.14	77.63	103.65	91.46
I_5 (Rainfed)	75.72	44.68	74.53	64.98	93.01	72.55	99.42	88.33
Mean (C)	85.01	58.00	83.21		95.12	75.96	104.78	
Mean (Y)		75.41				91.96		

CD at 5% Irrigation (I) = 1.26, Cultivar (C) = 0.98, Year (Y) = 0.79, I × C × Y = 3.08

postulated that fruit growth depend on the accumulation of large quantities of osmotically active solutes and massive cell expansive growth and these processes require carbohydrates and its restriction under water-stressed crop decrease ability to accumulate water. Thus, the results obtained in the present investigation are in line with their hypothesis. Behboudian and Lawes (2) observed reduction in weight of kiwifruit in late stress conditions compared to the well watered tree, whereas Besset *et al*. (4) reported highest fruit weight under optimum irrigation and light water stress in Big-Top cv. of peach. Similar results were recorded by Gaturuku and Isutsa (7) in purple passion fruit and Ojeda *et al*. (14) in pineapple. Differential response of peach plant to different irrigation levels in terms of fruit volume may be attributed to the corresponding increase or decrease in length and diameter of fruits harvested under particular level of irrigation (Table 4). In fig, Al-Desouki *et al*. (1) reported that fruit volume increased about the double with supplement irrigations as compared with those obtained from plants grown under rainfed conditions.

Irrigation increased pulp: stone ratio as compared to plants grown under rainfed conditions (Table 5). This was because of irrigation alongwith abundant rain that occurred at the end of two years, might cause these different responses in pulp: stone ratio. In *Ascolana* tenera cultivar of olive pulp: pit ratio increased under irrigation as compared to rainfed (Proietti and Antognozzi, 15). Toplu *et al*. (16) also observed increased pulp: stone ratio with additional water in Gemlik the olive. Florda Prince had highest fruit weight, volume and pulp: stone ratio than other cultivars. However, the differences obtained in physical traits within these cultivars might be because of their adaptation to particular environment and soil conditions. It is thus concluded that irrigation applied at 40 mm Et level seems to be the optimum irrigation level, wherein better vegetative growth and fruit quality was achieved.

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Table 4. Effect of different irrigation levels on fruit volume (cc) of peach cultivars.

Cultivar / Irrigation	2010				2011			
	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_1 (20 mm Et)	80.00	55.00	89.67	74.89	98.43	78.00	104.49	93.63
I_2 (30 mm Et)	88.33	60.00	89.90	83.30	97.60	77.03	113.09	95.91
I_3 (40 mm Et)	100.00	80.00	98.05	88.79	98.80	84.10	106.88	96.59
I_4 (50 mm Et)	100.00	61.33	85.00	82.11	96.30	81.60	104.00	93.98
I_5 (Rainfed)	82.00	50.00	81.70	71.23	96.10	77.00	104.33	92.48
Mean (C)	90.07	61.27	88.86		97.44	79.56	106.56	
Mean (Y)		80.07				94.51		

CD at 5% Irrigation (I) = 1.89, Cultivar (C) = 1.46, Year (Y) = 1.19, I × C × Y = 4.61

Table 5. Effect of different irrigation levels on pulp: stone ratio of peach cultivars.

Cultivar / Irrigation	2010				2011			
	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_1 (20 mm Et)	15.18	12.38	17.23	14.93	14.29	13.79	16.71	14.93
I_2 (30 mm Et)	18.10	12.70	16.50	15.76	16.17	13.72	17.67	15.86
I_3 (40 mm Et)	19.07	15.95	16.42	17.15	15.94	14.13	19.14	16.40
I_4 (50 mm Et)	17.67	12.09	18.04	15.93	15.60	14.09	17.71	15.80
I_5 (Rainfed)	16.50	9.83	16.38	14.23	16.23	13.08	16.46	15.26
Mean (C)	17.30	12.59	16.91		15.65	13.76	17.54	
Mean (Y)		15.60				15.65		

CD at 5% Irrigation (I) = 0.07, Cultivar (C) = 0.05, Year (Y) = 0.04, I × C × Y = 0.18

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Received : May, 2014; Revised : August, 2016;
Accepted : September, 2016