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Influence of different irrigation intervals on growth and physical characteristics of peach (*Prunus persica*)

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ABSTRACT

The aim of this experiment was to determine the effect of different irrigation water application levels on growth of three peach (*Prunus persica* L.) cultivars, viz. Florida Prince, Shan-e-Punjab and Early Grande irrigated by basin irrigation. Evapotranspiration and vegetative growth parameters (plant height and volume), physical characteristics (fruit length, fruit diameter, fruit weight, specific gravity, stone weight and pulp weight) of 3-4 year old peach plants were recorded during both the seasons. The plants were subjected to four different irrigation treatments based on evapotranspiration (Et) of 20 mm, 30 mm, 40 mm, 50 mm and rainfed. The maximum plant height (2.74 m and 3.48 m), plant volume (11.34 m^3 and 17.08 m^3), fruit length (4.98 cm and 5.67 cm), fruit diameter (4.31cm and 5.10 cm), fruit weight (85.69 g and 96.11g), specific gravity (0.99 and 1.03), stone weight (4.77g and 5.56g) and pulp weight (80.30g and 91.65g) were recorded at I_{40} (40 mm Et) levels based irrigation levels during 2010 and 2011.

Key words: Basin irrigation, Peach, Growth and physical characteristics

Irrigation scheduling has conventionally aimed to achieve an optimum water supply for productivity, with soil water content being maintained close to field capacity. The advent of precision irrigation method has played a major role in reducing the water required in agriculture and horticultural crops, but has highlighted the need for new methods of accurate irrigation scheduling and control. Peach (*Prunus persica* L.) is most common and economically important fruit of the sub-tropical and temperate regions, affected by drought periods and limited irrigation water at critical stages of fruit growth and development which is one reason for its low productivity. Many studies have been done during orchard experiments to assess the effects of water restriction applied at different phenological stages of peach development (Larson *et al*. 1988, Girona *et al*. 2005). When moderate water restriction was applied early during stage I or II of fruit growth, fruit growth was not reduced compared to control trees; fruit growth stimulation could even be detected in peach (Chalmers *et al*. 1981, Li *et al*. 1989). The main purpose was to recommend appropriate water restriction levels so as to simultaneously save water and promote qualitative fruit production in compliance with sustainable agriculture standards (Girona *et al*. 2003), whereas less sophisticated systems such as flood irrigation scheduling can be benefit from improvements in irrigation scheduling. The scheduling of irrigation adopted in orchards influences the availability of soil moisture to the plant and its distribution in the soil. Keeping in view the commercial importance of peach, the present study was started to understand the influence of various irrigation intervals on growth and quality of peach.

MATERIALS AND METHODS

An experiment was carried out in the Research orchard of Division of Fruit Science, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu at Main campus, Chatha, Jammu, to study the effect of irrigation intervals on growth and quality of three commerically grown peach cultivars, viz. Florida Prince, Shan-e-Punjab and Early Grand. Climate is humid with yearly averages of 1200 mm rainfall. The highest temperature is recorded in the month of June (45°C). Daily maximum and minimum temperature, evaporation rate rises from February onwards. The soil of the field was loamy sand with field capacity 17% and permanent wilting point 5%. There were five treatments, viz. 20 mm evapotranspiration (Et), 30 mm evapotranspiration Et, 40 mm evapotranspiration (Et), 50

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mm evapotranspiration (Et) and rainfed (control). The water requirement in treatments was worked out on the basis of monthly mean evaporation and water received from natural rain was compensated in successive days in all irrigation treatments. The total water requirement works out to be 618 mm and 697 mm in 2010 and 2011, respectively. The observation on plant height (m) was recorded by putting a marked bamboo stick vertically with the tree and mean height was worked out and expressed in meters, plant volume (m^3) was calculated by using the following formula: V= 4/ $3\pi r^2 h$, where r = spread from east-west (m) and north-south (m), h = height of the tree (m), v = volume of the tree (m^3), fruit length of fifteen fruits collected from each replication was measured with the help of vernier caliper and was expressed in centimeters. The fruit diameter was measured with the help of vernier caliper and expressed in centimeters. The fruits were weighed on electronic balance and mean weight per fruit was computed and expressed in grams (g). Specific gravity of fruits was calculated by the following formula: Specific gravity = Weight of fruit/ Volume of water displaced by fruit. Stone weight of fruits were cleaned with the help of sharp knife, washed, dried in shade and were weighed on electronic balance and average stone weight was calculated and expressed in grams (g). Pulp weight was obtained by subtracting the stone weight from the total fruit weight and was expressed in grams (g). The data generated during the investigation were subjected to statistical analysis as prescribed by Panse and Sukhatme (2000). The level of significance was tested for different variables at 5 per cent level of significance.

RESULTS AND DISCUSSION

Vegetative growth characteristics

Irrigation was initiated firstly after the completion of flowering with the ratio of 70%. Peach trees were irrigated from March 2010 to May 2010 and March 2011 to May 2011 during the study. The plant height of all the three peach cultivars was significantly influenced by different irrigation levels (Table 1). In both the (2010 and 2011) seasons maximum plant height of 2.74 m and 3.84 m was recorded at 40 mm Et level of irrigation whereas under rainfed condition minimum plant height of 2.42 m and 3.09 m was recorded during both the seasons. Amongst three cultivars, the maximum plant height of 2.85 m and 3.97 m was recorded in Early Grande when irrigation was given at 40 mm Et and in Florda Prince the minimum plant height of 2.25 m and 2.74 cm was recorded under rainfed condition during both the seasons. The data further revealed that the plant height increased with the increase in the level of irrigation upto 40 mm Et (i e from excessive moisture level to optimum moisture level) however thereafter the plant height significantly decrease at 50 mm Et level of irrigation (imposed water stress condition). Irrespective of different irrigation levels tried, maximum plant height was obtained in Early Grande, followed by Shan-e-Punjab and Florda Prince cultivar of peach. Highest plant height of 341.5 cm was recorded during second season (2011) than plant height of 2.56 m was recorded during the first season (2011). Yangus *et al*. (2006) also reported that maximum plant height and volume of sweet cherry tree was recorded at 1.00 and 1.25 pan evaporation based irrigation level. The plant volume of all the three peach cultivars was also significantly increased by different irrigation levels (Table 2). During both the seasons' maximum plant volume of 11.34 m^3 and 17.08 m^3 was recorded at 40 mm Et level of irrigation whereas minimum plant volume of 8.29 m^3 and 11.15 m^3 was recorded under rainfed condition. The study showed that plant volume of Shan-e-Punjab (11.39 m^3) at 50 mm Et level was statistically at par with 40 mm Et level. Amongst three cultivars, maximum plant volume of 14.02 m^3 and 25.58 m^3 was observed in Shan-e-Punjab when irrigation was given at 40 mm Et and in Florda Prince the plant volume was minimum (6.47 m^3 and 7.80 m^3) under rainfed condition during both the seasons. The data further indicated that the plant volume increased with the irrigation level of 30 mm Et and 40 mm Et level (i e from highly moisture level and optimum moisture level) however the plant volume significantly decreased at 20 mm Et and 50

Table 1 Effect of different irrigation levels on plant height (m) of commercially important cultivars of peach

Irrigation	Season 2010				Season 2011			
	Florida Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_{20}	2.45	2.42	2.83	2.57	2.94	3.35	3.81	3.37
I_{30}	2.36	2.62	2.79	2.59	3.47	3.40	3.92	3.60
I_{40}	2.65	2.71	2.85	2.74	3.78	3.77	3.97	3.84
I_{50}	2.44	2.34	2.70	2.49	2.86	3.09	3.55	3.17
R	2.25	2.54	2.47	2.42	2.47	3.25	3.55	3.09
Mean (C)	2.43	2.53	2.73		3.10	3.37	3.76	
Mean (S)		2.56				3.41		
CD (P=0.05)	I = 4.77, C = 3.69, S = 3.01, I × C × S = 11.68							

Table 2 Effect of different irrigation levels on plant volume (m^3) of commercially important cultivars of peach

Irrigation	Season 2010				Season 2011			
	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_{20}	6.47	12.70	6.87	8.67	9.48	16.67	14.02	13.39
I_{30}	6.82	12.94	8.14	9.39	10.84	19.46	13.61	15.52
I_{40}	7.75	14.02	12.26	11.34	13.50	25.58	14.81	17.08
I_{50}	6.91	11.39	8.31	8.79	11.20	20.12	14.39	15.23
R	6.66	8.94	9.28	8.29	7.80	16.38	9.29	11.15
Mean (C)	6.92	12.00	8.97	10.57	19.64	13.22		
Mean (S)		9.29				14.48		
CD (P=0.05)	I = 1.08, C = 0.84, S = 0.68, I × C × S = 2.67							

mm Et level (excessive moisture level and imposed stress level). Irrespective of different irrigation level tried, maximum plant volume was recorded in Shan-e-Punjab followed by Early Grande and Florda Prince. Plant volume of 14.48 m^3 was recorded during second season and was more than plant volume of 9.29 m^3 was recorded during the first season. Junior *et al*. (2005) observed that Tahiti acid lime showed higher plant height and volume under irrigation based on 100% evapotranspiration, whereas intermediate values of these variables were observed in 50% evapotranspiration based irrigation, compared to unirrigated plants and concluded that development of unirrigated plants was probably impaired by low values of stomatal conductance and CO_2 assimilation.

Physical characteristics

Fruit length of peach cultivars was increased under different irrigation levels. During both the seasons' maximum fruit length of 4.98 cm and 5.67cm was recorded at 40 mm Et level of irrigation, whereas minimum fruit length of 4.25 cm and 3.89 cm was recorded under rainfed condition. The study further showed that fruit length of 4.79 cm was recorded at 30 mm Et level of irrigation was statistically at par with 40 mm Et level. Amongst the three cultivars, maximum fruit length of 5.29 cm was recorded in Florda Prince when irrigation was given at 40 mm Et level and in Early Grande minimum fruit length of 3.89 cm was recorded under rainfed condition during first season, whereas maximum fruit length of 5.74 cm was recorded when irrigation was given at 40 mm Et and minimum fruit length of 5.00 cm was recorded in Florda Prince when irrigation was given at 50 mm Et level during second season. The data further showed that the fruit length increased at 50 mm Et level (i e imposed stress level), however fruit length significantly decreased at 20 mm Et level (excessive moisture level). Irrespective of different irrigation level tried, maximum fruit length was recorded in Florda Prince during first season and in Early Grande during second season. Fruit diameter was also significantly affected by different irrigation level (Table 4). During 2010 and 2011, maximum fruit diameter of 4.31 cm and 5.10 cm was recorded when irrigation was given at 40 mm Et level of irrigation, whereas minimum fruit diameter of 3.45 cm was recorded when irrigation was given at 50 mm Et level and under rainfed condition minimum fruit diameter (4.70 cm) was recorded. Amongst the three cultivars, maximum fruit diameter of 5.15 cm was recorded in Florda Prince when irrigation was given at 40 mm Et level, whereas in Early Grande minimum fruit diameter (3.09 cm) was recorded under rainfed condition during 2010 and maximum fruit

Table 3 Effect of different irrigation levels on fruit length (cm) of commercially important cultivars of peach

Irrigation	Season 2010				Season 2011			
	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_{20}	5.00	4.19	4.13	4.44	5.59	5.22	5.37	5.39
I_{30}	5.24	4.64	4.51	4.79	5.58	5.29	5.65	5.51
I_{40}	5.29	4.80	4.85	4.98	5.74	5.55	5.71	5.67
I_{50}	5.10	4.32	4.18	4.54	5.00	5.20	5.38	5.19
R	4.59	4.25	3.89	4.25	5.06	5.18	5.08	5.11
Mean (C)	5.05	4.44	4.31	5.39	5.29	5.44		
Mean (S)		4.59			5.38			
CD (P=0.05)	I = 0.19, C = 0.16, S =NS, I × C × S = NS							

Table 4 Effect of different irrigation levels on fruit diameter (cm) of commercially important cultivars of peach

Irrigation	Season 2010				Season 2011			
	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_{20}	4.49	4.39	3.55	4.14	4.48	5.08	5.35	4.97
I_{30}	4.44	3.70	3.39	3.84	4.28	5.02	5.15	4.81
I_{40}	5.15	3.67	4.13	4.31	4.56	5.44	5.31	5.10
I_{50}	3.96	4.05	4.08	3.45	4.57	5.06	5.25	4.96
R	3.65	3.30	3.09	3.92	4.16	5.19	4.76	4.70
Mean (C)	4.33	3.82	3.65	4.41	5.10	5.17		
Mean (S)		3.95			4.91			
CD (P=0.05)	I = 0.02, C = 0.01, S = 0.01, I × C × S = 0.06							

diameter of 5.44 cm was recorded in Shan-e-Punjab when irrigation was given at 40 mm Et level and minimum fruit diameter (4.16 cm) was recorded in Early Grande under rainfed condition during 2011. The data further showed that the fruit diameter increased with increase in the 20 mm Et level (i e excessive moisture level) of irrigation, however it decreased at 30 mm Et level (i e high moisture level). Irrespective of different irrigation level tried, maximum fruit diameter was recorded in Florda Prince than Early Grande and Shan-e-Punjab cultivar of Peach during first season and in Early Grande than Florda Prince and Shan-e-Punjab during second season. Better fruit diameter was recorded during second season in comparsion to first season. Nasir and Mian (1993) observed that mango had higher fruit size under irrigation given at 7 days interval followed by 14 days interval as compared to trees irrigated at 21 days intervals. Larger fruit size was primarily the result of a larger number of cells and the positive effect of water availability on the cell division rather than cell expansion (Proietti and Antognozzi 1996). During 2010 and 2011, maximum fruit weight of 85.69 g and 96.11 g was observed when irrigation was given at 40 mm Et level of irrigation, whereas under rainfed minimum fruit weight of 64.98 g and 88.33 g was observed (Table 5). Amongst the three cultivars, maximum fruit weight of 95.68 g was observed in Florda Prince during 2010 and 115.55 g was observed in Early Grande during 2011 when irrigation was given at 40 mm Et level, whereas minimum fruit weight of 44.56 g and 72.55 g was observed in Shan-e-Punjab under rainfed condition during both the seasons. The data further showed that the fruit weight increased with 30 mm Et (i e higher moisture level) and 50 mm Et level (i e imposed stress conditions) however it significantly decreased at 20 mm Et level (i e excessive moisture level). Irrespective of different irrigation level tried, maximum fruit weight was recorded in Florda Prince during first season and Early Grande during second season. Highest fruit weight was recorded during second season than during the first season. Besset *et al*. (2001) observed that Big-Top cv of peach had highest fruit weights under optimum irrigation and light water stress. Different irrigation levels influenced the Specific gravity of three peach cultivars (Table 5). Maximum specific gravity of 0.99 was observed when irrigation was given at 40 mm Et level of irrigation during 2010 and specific gravity of 1.03 was maximum when irrigation was given at 50 mm Et during 2011, whereas under rainfed condition minimum specific gravity of 0.91 and 0.96 was observed during both the seasons. Out of three cultivars, maximum specific gravity of 1.15 was observed in Florda Prince when irrigation was given at 40

Table 5 Effect of different irrigation levels on specific gravity of commercially important cultivars of peach

Irrigation	Season 2010				Season 2011			
	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_{20}	0.93	0.98	0.97	0.96	0.97	0.97	0.99	0.98
I_{30}	0.92	0.93	0.94	0.93	1.06	1.27	0.69	1.01
I_{40}	1.15	0.95	0.87	0.99	1.03	1.13	0.73	0.97
I_{50}	0.88	0.93	0.99	0.93	1.20	1.17	0.73	1.03
R	0.92	0.89	0.91	0.91	0.97	0.94	0.96	0.96
Mean (C)	0.97	0.94	0.96	1.00	1.01	0.88		
Mean (S)		0.94			0.99			
CD (P=0.05)	I = 0.02, C = 0.01, S = 0.01, I × C × S = 0.06							

mm Et level, whereas in Early Grande minimum specific gravity of 0.87 was recorded when irrigation was given at 40 mm Et level. During 2011, maximum specific gravity of 1.27 was recorded in Shan-e-Punjab and minimum specific gravity of 0.69 was obtained in Early Grande when irrigation was given at 30 mm Et. The data further indicate that the specific gravity increased with 20 mm Et level (i e excessive moisture level) and decreased at 30 mm Et (i e higher moisture level) and 50 mm Et level (i e imposed stress condition) during first season, whereas specific gravity increased at 30 mm Et (i e higher moisture level) and decreased at 20 mm Et (i e excessive moisture level) and 40 mm Et level (i e optimum moisture level) during second season. Irrespective of different irrigation level tried, maximum specific gravity was recorded in Florda Prince during first season and in Shan-e-Punjab cultivar of peach during second season. Fruit with higher specific gravity (0.99) was obtained in second season as compared to specific gravity of fruit (0.94) obtained in first season. The results obtained indicate that different irrigation levels have significantly affected the stone weight (Table 6). Maximum stone weight of 4.77 g and 5.56 g was observed at 40 mm Et level of irrigation during both seasons, whereas minimum stone weight of 4.22 g was recorded when irrigation was given at 20 mm Et during first season, while minimum stone weight of 5.19 g was recorded under rainfed condition during second season. Amongst the three cultivars maximum stone weight of 5.03 g and 5.76 g was recorded in Florda Prince cultivar when irrigation was given at 40 mm Et level, whereas in Early Grande cultivar minimum stone weight of 4.07 g was recorded when irrigation was given at 20 mm Et level during first season and 5.08 g was recorded under rainfed condition during second seasons. The data further indicated that the stone weight increased with 30 mm Et (i e high moisture level) and 50 mm Et level (i e imposed stress level) however stone weight was significantly decrease at 20 mm Et level (i e excessive moisture level). Irrespective of different irrigation level tried, maximum stone weight was recorded in Florda Prince than Early Grande and Shan-e-Punjab cultivar of peach. Stone weight of 5.37 g was recorded during second season and was more than stone weight of 4.45 g was recorded during the first season. Toplu *et al*. (2009) reported that olive stone weight was lowest in plant grown under rainfed conditions than plants which received irrigation at 50 per cent and 100 per cent Epan. Under different irrigation levels (Table 7), maximum pulp weight of 80.30 g and 91.65 g was recorded when irriation given at 40 mm Et level of irrigation, whereas under rainfed condition minimum pulp weight of 60.91 g and 82.79 g was recorded.

Table 6 Effect of different irrigation levels on stone weight (g) of commercially important cultivars of peach

Irrigation	Season 2010				Season 2011			
	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_{20}	4.48	4.12	4.07	4.22	5.40	5.10	5.15	5.21
I_{30}	4.55	4.16	4.84	4.51	5.53	5.13	5.46	5.37
I_{40}	5.03	4.49	4.77	4.77	5.76	5.19	5.73	5.56
I_{50}	4.77	4.21	4.46	4.48	5.73	5.14	5.54	5.47
R	4.34	4.12	4.31	4.26	5.39	5.08	5.12	5.19
Mean (C)	4.63	4.22	4.48	5.56	5.13	5.40		
Mean (S)		4.45				5.37		
CD (P=0.05)	I = 0.02, C = 0.02, S =0.01, I × C × S = 0.05							

Table 7 Effect of different irrigation levels on pulp weight (g) of commercially important cultivars of peach

Irrigation	Season 2010				Season 2011			
	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)	Florda Prince	Shan-e-Punjab	Early Grande	Mean (I)
I_{20}	70.49	52.58	82.71	68.59	89.40	70.33	98.05	85.92
I_{30}	87.41	51.34	80.03	72.93	89.56	70.52	96.51	85.53
I_{40}	90.31	71.69	78.30	80.30	91.82	73.36	109.81	91.65
I_{50}	82.14	52.63	80.23	71.58	89.41	72.50	98.11	86.68
R	71.61	40.55	70.56	60.91	87.61	66.47	94.30	82.79
Mean (C)	85.01	62.19	88.86	89.56	70.63	99.35		
Mean (S)		70.83			86.51			
CD (P=0.05)	I = 0.67, C = 0.51 , S = 0.42, I × C × S = 1.82							

Amongst the three cultivars, maximum pulp weight of 90.31 g was recorded in Florda Prince when irrigation was given at 40 mm Et level, whereas in Shan-e-Punjab minimum pulp weight of 40.55 g was recorded under rainfed condition. During 2011, maximum pulp weight of 109.81 g was recorded in Early Grande when irrigation was given at 40 mm Et level and minimum pulp weight of 66.47 g was recorded in Shan-e-Punjab under rainfed condition. The data further indicate that the pulp weight increased with 30 mm Et (i e higher moisture level) and 50 mm Et level (i e imposed stress condition) of irrigation and decreased at 20 mm Et level (i e excessive moisture level) during first season, whereas pulp weight increased at 50 mm Et (i e imposed stress condition) and decreased at 20 mm Et (i e excessive moisture level) and 30 mm Et level (i e higher moisture level) during second season. Irrespective of different irrigation level tried, maximum pulp weight was recorded in Early Grande as compared to Florda Prince and Shan-e-Punjab cultivar of Peach. Higher pulp weight of 86.51 g was recorded during second season in comparison to pulp weight of 70.83 g was recorded during the first season. Nerd and Nobel (2000) who observed that in prickly pear pulp weight increased by 2.8 g/day under well-watered plants and by 3.4 g/day under water-stressed plants, which commenced at 70 days after anthesis and continued until peel weight and pulp weight were almost equal, which occurred at 88 days after anthesis for water-stressed plants and 10 days later under well-watered plants.

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