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Short communication

Effect of training system and in row spacing on yield and fruit quality of peach in the sub-tropical regions

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ABSTRACT

Information on the use of different training systems in peach under the sub-tropics is inadequate. Trees of Shan-i-Punjab peach were planted at two spacings, *viz.*, 5 m x 2 m and 5 m x 3 m and were trained to four training systems, *viz.*, Y shaped, Hedge row, Espalier and V trellis. The fruits harvested from Espalier and V trellis trained trees were superior in fruit quality in terms of fruit size, weight, colour and TSS as compared to fruit harvested from other training systems. Fruit yield was found to be maximum from V trellis trained trees. Trees planted at 5 m x 3 m gave higher fruit yield and better quality fruits as compared to 5 m x 2 m planted trees irrespective of training systems.

Key words: Fruit quality, peach, spacing, training system.

Peach is the third most widely cultivated fruit after apple and pear in the temperate zone of India. Its cultivation is gaining popularity in the north Indian sub-tropics due to higher returns on unit area basis and availability of suitable low chilling cultivars. Considerable research work on high density planting using different training systems in peach has been reported in the temperate parts of the world, but only few studies seem to have been conducted in the subtropical climate. Information on the effects of different training systems and spacings on yield and fruit quality are not well documented in the sub-tropical climate of north India. Therefore, present study was undertaken at PAU, Ludhiana during 2014 and 2015. Peach trees of cv. Shan-i-Punjab were planted in January 2011 at two spacings, viz., 5 m x 2 m and 5 m x 3 m and were trained to four training systems, *viz.*, Y shaped, Hedge row, Espalier and V trellis. There were four replications and each replication consisted of two trees in a randomized block design. Trees were pruned every year in winter and it consisted of a combination of heading back and selective thinning out of fruitful branches. Observations on fruit size, weight, firmness, total soluble solids, acidity, total sugars and yield were recorded as per the standard methods. Fruit colour was estimated with the help of colour meter (Colour Flex, Hunter Lab, USA) and expressed as *L*, *a* and *b* values. The data was analyzed using statistical SAS software.

Data in Table 1 show that maximum mean fruit size over a two year period was found in trees trained to Espailer system (5.96 cm length and 5.68 cm dia.), which was significantly higher than the trees trained to other systems. It was followed by fruit size recorded in V trellis (5.78 cm length and 5.44 cm dia.) trees. Minimum fruit size was recorded in Hedge row trees (5.42 cm in length and 5.07 cm dia.). Mean fruit weight was also found to be maximum (91.85 g) in Espailer trained trees followed by V trellis trees (89.42 g) and minimum (85.04 g) in Hedge row trees. More fruit size and weight in Espalier and V trellis trained trees was apparently due to better radiation interception and distribution within the tree canopy. The data further shows that spacings also affected fruit size and weight significantly. Trees planted at wider spacings (5 m x 3 m) recorded higher fruit size and weight as compared to closely planted trees (5 m x 2 m), irrespective of training system. This may be due to more competition for metabolites and water at closer spacings. Earlier, McDermott and Sherman (10) reported that upright and compact canopy interfered with light penetration during critical periods of fruit development resulting in smaller sized fruits.

Data in Table 2 show that maximum "*a*" value was recorded in fruits harvested from Espailer trained trees system (25.50) and minimum from Hedge row trees (20.57). The maximum "*L*" and "*b*" values were found in fruits of Hedge row (57.85 and 28.79, respectively) trained trees and minimum in Espailer (48.77 and 21.51, respectively) trained trees. More redness and low brightness and greenness in Espailer and V trellis trained fruits may be due to canopy architecture, which did not allow the light to fall on ground and allows maximum light to penetrate even in inner parts of the tree canopy as compared

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Table 1. Effect of training systems and spacings on fruit size and fruit weight of peach cv. Shan-i-Punjab

Training system	Spacing (m)	Fruit length (cm)			Fruit dia. (cm)			Fruit wt. (g)		
		2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
Y-shaped	5 x 2	5.54	5.60	5.57	5.19	5.27	5.23	86.78	87.82	87.30
	5 x 3	5.68	5.74	5.71	5.28	5.40	5.34	87.84	88.76	88.30
	Mean	5.61^{c}	5.67^{c}	5.64^{c}	5.23^{c}	5.34^{c}	5.29^{c}	87.31^{c}	88.29^{c}	87.80^{c}
Hedge row	5 x 2	5.22	5.43	5.33	4.92	5.06	4.99	84.84	84.39	84.62
	5 x 3	5.44	5.60	5.52	5.06	5.23	5.15	85.59	85.36	85.47
	Mean	5.33^{d}	5.52^{d}	5.42^{d}	4.99^{d}	5.14^{d}	5.07^{d}	85.35^{d}	84.74^{d}	85.04^{d}
Espailer	5 x 2	5.87	5.95	5.91	5.58	5.72	5.65	91.28	91.47	91.37
	5 x 3	5.98	6.07	6.02	5.61	5.82	5.71	92.23	92.44	92.33
	Mean	5.92^{a}	6.01^{a}	5.96^{a}	5.59^{a}	5.77^{a}	5.68^{a}	91.75^{a}	91.95^{a}	91.85^{a}
V trellis	5 x 2	5.69	5.76	5.72	5.32	5.45	5.39	88.66	89.34	89.00
	5 x 3	5.81	5.88	5.84	5.44	5.56	5.50	89.72	89.97	89.84
	Mean	5.75^{b}	5.82^{b}	5.78^{b}	5.38^{b}	5.51^{b}	5.44^{b}	89.19^{b}	89.66^{b}	89.42^{b}
Spacing mean	5 x 2	5.60^{b}	5.70^{b}	5.65^{b}	5.25^{b}	5.38^{b}	5.31^{b}	87.93^{b}	88.22^{b}	88.07^{b}
	5 x 3	5.73^{a}	5.82^{a}	5.77^{a}	5.35^{a}	5.50^{a}	5.42^{a}	88.87^{a}	89.10^{a}	88.98^{a}
$LSD_{0.05}$	Training system	0.05	0.04	0.05	0.06	0.04	0.06	0.47	0.29	0.32
	Spacing	0.03	0.03	0.03	0.04	0.03	0.02	0.33	0.20	0.23
	TS x spacing	0.07	0.06	0.07	0.09	0.06	0.08	0.66	0.41	0.46

Table 2. Effect of training systems and spacing on fruit colour, firmness and yield of peach cv. Shan-i-Punjab.

Training system	Spacing (m)	Fruit colour			Fruit firmness (kg/cm^2)			Fruit yield (kg/tree)		
		L	*a*	*b*	2014	2015	Mean	2014	2015	Mean
Y-shaped	5 x 2	55.69	23.20	25.62	6.10	6.11	6.10	19.07	12.25	15.66
	5 x 3	53.31	23.70	25.08	5.97	6.03	6.00	21.02	15.09	18.06
	Mean	54.50^{b}	23.45^{c}	25.35^{b}	6.03^{b}	6.07^{c}	6.05^{b}	20.04^{b}	13.67^{b}	16.86^{b}
Hedge row	5 x 2	59.27	20.68	28.49	6.63	6.52	6.57	17.12	10.03	13.57
	5 x 3	56.42	20.46	29.10	6.41	6.33	6.37	19.33	12.01	15.67
	Mean	57.85^{a}	20.57^{d}	28.79^{a}	6.52^{a}	6.42^{a}	6.47^{a}	18.22^{d}	11.02^{d}	14.62^{d}
Espailer	5 x 2	50.86	24.78	21.74	5.93	5.74	5.84	18.68	11.03	14.86
	5 x 3	44.67	26.23	21.28	5.81	5.61	5.71	20.01	14.06	17.04
	Mean	48.77^{d}	25.50^{a}	21.51^{d}	5.87^{c}	5.68^{d}	5.77^{c}	19.35^{c}	12.55^{c}	15.95^{c}
V trellis	5 x 2	51.88	24.30	22.86	6.03	6.27	6.15	22.04	17.01	19.52
	5 x 3	48.03	24.45	22.04	5.93	6.14	6.03	24.99	18.89	21.94
	Mean	49.96^{c}	24.37^{b}	22.45^{c}	5.98^{b}	6.20^{b}	6.09^{b}	23.51^{a}	17.95^{a}	20.73^{a}
Spacing mean	5 x 2	54.43^{a}	23.24^{b}	24.68^{a}	6.17^{a}	6.16^{a}	6.17^{a}	19.23^{b}	12.58^{b}	15.90^{b}
	5 x 3	50.61^{b}	23.71^{a}	24.37^{b}	6.03^{b}	6.03^{b}	6.03^{b}	21.34^{a}	15.01^{a}	18.17^{a}
$LSD_{0.05}$	Training system	1.09	0.43	0.22	0.07	0.07	0.05	0.27	0.20	0.16
	Spacing	0.77	0.30	0.15	0.05	0.05	0.03	0.19	0.14	0.11
	TS x spacing	1.54	0.61	0.31	0.10	0.11	0.07	0.38	0.28	0.23

to other training systems. Heinicke (7) found that fruits which received less than 30% of full sunlight were less coloured, had less dry matter and sugars as compared to fruits which received full sunlight in apple. Decrease in fruit colour in a three row system in apples due to poor illumination has also been reported by various workers (Loreti and Massai, 9; Keppel, 8). Data further shows that maximum mean "*a*" values were found in fruits of 5 m x 3 m planted trees and maximum "*L*" and "*b*" values were observed in fruits in the trees planted at 5 m x 2 m spacing. Mika *et al*. (11) reported that mutual shading of densely planted trees, insufficient illumination and tree competition lead to lower percentage of good coloured fruits in apple. McDermott and Sherman (10) also observed that trees in high density orchards contained less coloured fruits than those from standard spaced trees.

Maximum mean firmness was recorded in fruits harvested from Hedge row (6.47 kg/ cm^2) trees and minimum (5.77 kg/ cm^2) in fruits of Espailer trained trees. Higher firmness in Hedge row fruits was apparently due to reduction in receiving radiant energy, which may attribute to delay in ripening. The reason of low firmness in Espailer fruit might be due to earliness in maturity, since firmness has been reported to decrease with the advancement of fruit maturity in fruit crops. Similar findings were observed by Deell (5) in apple. Maximum mean fruit firmness (6.17 kg/ cm^2) was recorded in 5 m x 2 m planted trees as compared to those planted at 5 m x 3 m (6.03 kg/ cm^2) irrespective of the training systems. Lower firmness in widely spaced plants may be due to higher radiation penetration and canopy temperature recorded in such plants, which advanced maturity.

Data in Table 3 show that fruits, which were harvested from Espalier trees had significantly higher mean total soluble solids (12.21%) and total sugars (7.49%) as compared to the fruits harvested from other training systems. Minimum total soluble solids (11.05%) and total sugars (6.96%) were recorded in fruit harvested from Hedge row trees. The total soluble solids and total sugars content in fruit harvested from V trellis and Y shaped trees were found to be statistically at par. The mean acid content of the fruits harvested from Espailer, V trellis and Y shaped system were found to be statistically at par and significantly lower than those from Hedge row trees. Higher total soluble solids and lower acidity in the fruit harvested from Espalier and V trellis trained trees was apparently due to more exposure of fruits to sunlight, which helps in the degradation of malic acid. These results are in close conformity with those of other workers (Cortell and Kennedy, 4; Ristic *et al.*, 12) who also found that fruits in exposed portion

Table 3. Effect of training systems and spacings on TSS, acidity and total sugars of peach cv. Shan-i-Punjab.

Training system	Spacing (m)	TSS (%)			Acidity (%)			Total sugars (%)		Mean
		2014	2015	Mean	2014	2015	Mean	2014	2015	
Y shaped	5 x 2	11.63	11.78	11.70	0.75	0.73	0.74	7.11	7.33	7.22
	5 x 3	11.73	11.92	11.83	0.74	0.72	0.73	7.38	7.45	7.42
	Mean	11.67^{b}	11.84^{b}	11.75^{b}	0.75^{a}	0.73^{bc}	0.73^{b}	7.25^{b}	7.39^{c}	7.32^{c}
Hedge row	5 x 2	10.89	11.02	10.96	0.78	0.76	0.77	6.87	6.94	6.90
	5 x 3	11.09	11.2	11.15	0.77	0.75	0.76	6.98	7.06	7.02
	Mean	10.99^{c}	11.11^{c}	11.05^{c}	0.77^{a}	0.76^{a}	0.77^{a}	6.92^{c}	7.00^{d}	6.96^{d}
Espailer	5 x 2	12.11	12.19	12.15	0.74	0.71	0.73	7.34	7.42	7.38
	5 x 3	12.21	12.32	12.27	0.73	0.71	0.72	7.54	7.64	7.59
	Mean	12.16^{a}	12.26^{a}	12.21^{a}	0.74^{b}	0.71^{c}	0.72^{b}	7.44^{a}	7.53^{a}	7.49^{a}
V trellis	5 x 2	11.71	11.91	11.81	0.76	0.72	0.74	7.26	7.37	7.31
	5 x 3	11.86	12.05	11.95	0.74	0.72	0.73	7.45	7.53	7.49
	Mean	11.78^{b}	11.98^{b}	11.88^{b}	0.75^{a}	0.72^{c}	0.73^{b}	7.36^{a}	7.45^{b}	7.40^{b}
Spacing mean	5 x 2	11.58^{a}	11.72^{a}	11.65^{a}	0.76^{a}	0.73^{a}	0.75^{a}	7.14^{b}	7.26^{b}	7.20^{b}
	5 x 3	11.72^{a}	11.87^{a}	11.80^{a}	0.75^{a}	0.73^{a}	0.74^{a}	7.34^{a}	7.42^{a}	7.38^{a}
LSD 0.05	Training system	0.18	0.24	0.18	0.02	0.02	0.02	0.08	0.05	0.06
	Spacing	0.13	0.17	0.13	0.01	0.01	0.01	0.06	0.03	0.04
	TS x Spacing	0.26	0.34	0.26	0.03	0.03	0.02	0.12	0.07	0.08

of canopy exhibit higher concentration of sugars as compared to shaded fruits. Robinson (13) and Erez (6) also found that greater light interception with angled canopy improved fruit quality. Data further shows that spacings did not affect total soluble solids, total sugars and acid content significantly. These results are in line with those of Bargioni *et al.* (1) who found no appreciable effects of planting density on soluble solids content or acids in peach and nectarine fruits.

Maximum mean fruit yield/ tree of 20.73 kg, over a two year period, was recorded in trees trained to V trellis, which was significantly more than the trees trained to Y shaped, Espalier and Hedge row systems where yield of 16.86, 15.95 and 14.62 kg/ tree, respectively were recorded. The general effect of the training system on fruit yield/ tree was true for year wise effects in 2014 and 2015. Highest fruit yield in V trellis system was due to higher shoot number and canopy volume. Lower yield in Espailer trained trees was due to heavy pruning done to restrict the trees for intersecting with each other as a result of which these trees had lower shoot number and canopy volume. Spacing also affected the fruit trees significantly. Highest fruit yield (18.17 kg) was recorded in 5 m x 3 m planted trees, which was significantly more than the trees planted at 5 m x 2 m (15.90 kg). This may be due to the reason that trees planted at closer spacings had to compete with each other for light, water and nutrients as a result of which yield decreased (Mika *et al*., 11). These results are in agreement with those of Cepoiu and Muravi (3) who reported that wider spacings were helpful in increasing yield due to higher tree volume and reduced competition for metabolites among plants. From these studies, it is concluded that V trellis training system was found to be better for growing high density peaches in terms of yield and fruit quality under sub-tropics of north India.

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