Environment and Ecology 38 (2) : 178—182, April—June 2020
ISSN 0970-0420

Training System and in Row Spacing Effect on Growth and Yield of Peach in the Sub-Tropics of India

Yamini Sharma, Harminder Singh

Received 15 January 2020; Accepted 16 March 2020; Published on 4 April 2020

ABSTRACT

Investigation was conducted to study the effect of spacing and training systems on growth and yield of sub-tropical peach. Peach trees of cv Shan-i-Punjab were planted at two spacings i.e. 5 m × 2 m and 5 m × 3m and were trained to four training system viz., Y-shaped, Hedge row, Espailer and V-trellis. Tree girth was found to be maximum (43.69 cm) in V-trellis system whereas, Hedge row trees recorded maximum trees height (4.73 m) and canopy volume (25.52 m^3) as compared to trees trained to other training systems. Maximum number of fruits (239.99) was recorded in trees trained to V- trellis system and lowest fruit number was found in espalier system. Similarly maximum fruit yield/ha was recorded in v-trellis trees (17.07 tonnes yield/ha) and minimum yield was recorded in Hedge row trees (12.01 tonnes/ha). The 5 m ×3 m planted trees recorded higher vegetative growth and fruit yield as compared to trees planted at 5 m × 2 m irrespective of training systems during the present studies.

Keywords Training systems, Spacing, Peach, Growth, Yield.

Yamini Sharma*, Harminder Singh
Punjab Agricultural University, Ludhiana 141004, India
Email : vaminisharma811@gmail.com
vaminisharma811@pau.edu
*Corresponding author

INTRODUCTION

Peach can be grown quite successfully in the sub-tropics of North India due to availability of suitable cultivars and their production technology. The growth and fruiting potential of peach is quite different in the temperate and sub-tropical climate. Peach trees produce strong vegetative growth under sub-tropical climate, but in commercial orchard tree with small dimensions is always desired. Traditionally, peach trees have been grown using moderate or open center system at densities of 350-400 trees/ha. In peach, high density orchard depends on the choice of an appropriate training system rather than on the use of dwarfing rootstock or cultivar which are not yet available. Various training systems like open-vase, espailer, palmette, fusetto, free spindle, Y-shaped are used in peach. High density is one simple way to increase the productivity in fruit crops. As tree density increases, inter plant competition is quite

obvious which is likely to be reflected in the pattern of plant growth and yield potential of the tree. Dense orchards frequently become uneconomical comparatively earlier than the standard orchards because the tree size, although reduced by competition, cannot be controlled sufficiently to prevent light competition, internal shading and barrenness. Moderate vigour is the grower's goal because extremely vigorous growth also reduces fruitfulness. Keeping this in view, the present investigations were conducted to study the pattern of growth and productivity of trees planted at different planting densities and training systems in peach.

MATERIALS AND METHODS

The present study was conducted at Fruit Research Farm of the Department of Fruit Science, Punjab Agricultural University, Ludhiana during the years 2014 and 2015. Peach trees of cv Shan-i-Punjab were planted at two spacings i.e. 5 m × 2 m and 5 m × 3 m and were trained to four training system viz., Y-shaped, Hedge row, Espalier and V-trellis. Trees were pruned every year in winter and it consisted of a combination of heading back and selective thinning out of fruitful branches. The orchard soil was deep, well drained and loamy sand. All the trees received recommended doses of fertilizers (500g N, 120 g P_2O_5 and 500 K_2O) and other cultural practices during the course of these investigations. The observations on vegetative growth (tree girth, height, canopy volume and shoot length) and fruit number were recorded as per the standard procedure used in such studies. The data were subjected to analyses of variance (ANOVA) using statistical software SAS. The mean separations was done using least significant difference (Fisher's LSD) at ≤0.05 following significant F test.

RESULTS AND DISCUSSION

Tree girth

Training system and spacing had a significant effect on tree girth in peach. Data on that aspect in Table 1 show that the maximum mean girth of 43.69 cm, over a two year period, was recorded in trees trained to V-trellis which was significantly more than the trees trained to Hedge row (41.83 cm) and Y-shaped system (41.70 cm) It was closely followed by 42.71 cm girth recorded in trees trained to Espailer system. However, the difference in tree girth of V-trellis and Espailer trained trees were statistically at par. This general effect of training system on tree girth was true for year wise effects in 2014 and 2015 also. These findings are in accordance with those of Choi et al. (2014) who observed maximum tree girth in Tatura trellis as compared to other system. Rufato et al. (2004) also found that girth of peach trees trained to

Table 1. Effect of training systems and spacings on tree girth and tree height of peach cv Shan-i-Punjab.

Training systems	Spacings	Tree girth (cm) 2014	2015	Mean	Tree height (m) 2014	2015	Mean
	5 × 2	37.22	45.33	41.28	4.28	5.19	4.74
	5 × 3	38.11	46.14	42.12	4.04	4.99	4.51
Y-shaped	Mean	37.66^{b}	45.74^{c}	41.70^{b}	4.16^{a}	5.09^{a}	4.63^{a}
	5 × 2	38.01	44.58	41.29	4.31	5.31	4.81
	5 × 3	39.07	45.67	42.37	4.17	5.12	4.64
Hedge row	Mean	38.54^{ab}	45.12^{c}	41.83^{b}	4.24^{a}	5.21^{a}	4.73^{a}
	5 × 2	38.33	45.47	41.90	3.40	4.25	3.83
	5 × 3	39.94	47.11	43.53	3.29	4.19	3.74
Espailer	Mean	39.13^{a}	46.29^{ab}	42.71^{a}	3.34^{c}	4.22^{c}	3.78^{c}
	5 × 2	39.04	46.24	42.64	4.04	4.84	4.44
	5 × 3	41.03	48.45	44.74	3.88	4.69	4.28
V-trellis	Mean	40.03^{a}	47.34^{a}	43.69^{a}	3.96^{b}	4.76^{b}	4.36^{b}
	5 × 2	38.15^{b}	45.40^{b}	41.78^{b}	4.01^{a}	4.90^{a}	4.45^{a}
Spacing mean	5 × 3	39.54^{a}	46.84^{a}	43.31^{a}	3.84^{b}	4.74^{b}	4.29^{b}
	Training system	1.63	1.08	0.94	0.19	0.20	0.14
	Spacing	1.15	0.76	0.67	0.13	0.14	0.10
LSD 0.05	TS × Spacing	2.31	1.53	1.34	0.27	0.29	0.20

Table 2. Effect of training systems and spacings on shoot length and canopy volume of peach cv Shan-i-Punjab.

Training system	Spacings	Shoot length (cm) 2014	2015	Mean	Canopy volume (m^3) 2014	2015	Mean
Y-shaped	5 × 2	42.82	44.97	43.90	14.85	26.64	20.74
	5 × 3	44.51	46.66	45.58	18.92	31.16	25.04
	Mean	43.66[b]	45.81[b]	44.73[b]	16.88[a]	28.90[b]	22.89[b]
	5 × 2	44.92	47.73	46.32	16.75	29.61	23.18
	5 × 3	46.04	49.48	47.76	22.23	33.51	27.87
Hedge row	Mean	45.47[a]	48.60[a]	47.03[a]	19.49[a]	31.56[a]	25.52[a]
	5 × 2	39.23	42.6	40.91	8.27	15.50	11.88
	5 × 3	41.74	44.36	43.05	10.87	19.41	15.14
Espailer	Mean	40.48[d]	43.48[d]	41.98[d]	9.57[b]	17.46[c]	13.51[c]
	5 × 2	41.96	44.04	43.00	15.42	25.35	20.39
	5 × 3	42.91	45.33	44.12	19.94	28.66	24.30
V-trellis	Mean	42.43[c]	44.68[c]	43.56[c]	17.68[a]	27.00[b]	22.34[b]
	5 × 2	42.23[b]	44.83[b]	43.53[b]	13.82[b]	24.28[b]	19.05[b]
Spacing mean	5 × 3	43.80[a]	46.45[a]	45.13[a]	17.99[a]	28.19[a]	23.09[a]
	Training system	0.54	0.99	0.56	3.55	2.32	2.01
	Spacing	0.38	0.70	0.39	2.51	1.64	1.42
LSD 0.05	TS × Spacing	0.77	1.40	0.79	5.02	3.29	2.85

Y-shaped structure were significantly lower than the trees trained to central leader system. Spacings also affected the tree girth significantly. Trees planted at 5 m × 3 m recorded significantly higher mean trunk girth (43.31 cm) as compared to trees planted at 5 m × 2 m (41.78 cm), irrespective of training systems. Similar trend was observed during the year 2014 and 2015. The decrease in tree girth at closer plantings may be due to availability of lesser amount of photosynthates going into the reserve tissue of the plants. It may also be due to more competition for water, light and nutrients in the closely planted trees as reported by Mika et al. (2001) in plum.

Tree height

Maximum mean tree height (4.73 m) over a two year period was recorded in trees trained to Hedge row system and it was found to be statistically at par with Y-shaped trees (4.63 m). It was closely followed by V-trellis with a mean tree height of 4.36 m. However, minimum height was found in plants trained to Espailer system (3.78 m). Data also show that spacings also affected the tree height significantly. Maximum mean height was recorded at a spacing of 5 m × 2 m (4.45 m) whereas, minimum was recorded in 5 m × 3 m planted trees (4.29 m) during the present investigations (Table 1). It may be due to the reduction in expression of apical dominance due to more light interception at the wider canopy. It was also observed that in wider spacing sufficient space is left for the spread of plants and moreover the greater competition for light may be another factor. This condition results in more lateral growth at the expense of apical growth (Mohammed et al. 1984). Present results and those of Chalmers et al. (1981) suggested that competition for light caused partial etiolation at higher tree density inducing the branches to grow high for intercepting light for photosynthesis.

Shoot length

Data on that aspect in Table 2 showed that maximum mean shoot length was recorded in Hedge row system (47.03 cm) and it was closely followed by Y-shaped tree with a value of 44.73 cm. Minimum mean shoot length was obtained in Espailer system (41.98 cm) which was significantly lower than all the training system. This was apparently due to restriction of shoots and enhanced competition within trees trained to Espailer system. Choi et al. (2014) also observed lowest shoot length in pear trees trained to Tatura trellis system. Data further shows that spacing also affected shoot length significantly. Trees planted at 5m × 3 m recorded significantly higher shoot length (45.13 cm) than 5 m × 2 m planted trees (43.13 cm). The reduction in shoot length may be due to enhanced

Table 3. Effect of training systems and spacings on number of fruit/tree and yield/ha (tonnes) in peach cv Shan-i-Punjab.

Training systems	Spacings (m)	No. of fruit/tree			Yield/ha		
		2014	2015	Mean	2014	2015	Mean
Y-shaped	5 × 2	233.42	158.61	196.01	19.07	12.25	15.66
	5 × 3	257.57	187.1	222.34	14.02	10.06	12.04
	Mean	245.50^{b}	172.85^{b}	209.17^{b}	16.54^{b}	11.16^{b}	13.85^{b}
Hedge row	5 × 2	215.88	141.41	178.65	17.12	10.03	13.57
	5 × 3	231.63	160.75	196.19	12.89	8.01	10.45
	Mean	223.75^{c}	151.08^{c}	187.42^{bc}	15.00^{d}	9.02^{d}	12.01^{d}
Espailer	5 × 2	205.87	138.25	172.06	18.68	11.03	14.86
	5 × 3	222.94	157.83	190.38	13.35	9.38	11.36
	Mean	214.40^{d}	148.04^{c}	181.22^{c}	16.01^{c}	10.20^{c}	13.11^{c}
V-trellis	5 × 2	261.01	201.11	231.06	22.04	17.01	19.52
	5 × 3	281.19	216.68	248.93	16.67	12.59	14.63
	Mean	271.10^{a}	208.89^{a}	239.99^{a}	19.35^{a}	14.80^{a}	17.07^{a}
Spacing mean	5 × 2	229.04^{b}	159.85^{b}	194.44^{b}	19.23^{a}	12.58^{a}	15.90^{a}
	5 × 3	248.33^{a}	180.59^{a}	214.46^{a}	14.23^{b}	10.25^{b}	12.24^{b}
LSD 0.05	Training system	5.23	4.71	24.28	0.24	0.18	0.14
	Spacing	3.69	3.33	17.17	0.17	0.12	0.10
	TS × Spacing	7.39	6.66	34.34	0.35	0.25	0.21

competition for substrate in closer plantings. Similar results were found by Mika et al. (1981) in apple.

Canopy volume

It was observed from the data in Table 2 that maximum mean canopy volume (25.52 m^3) was obtained in Hedge row trees which was significantly higher than trees trained to all other training system, whereas, minimum canopy volume was found in trees trained on Espailer system (13.51 m^3). However, the trees trained to Y-shaped (22.89 m^3) and V-trellis (22.34 m^3) were statistically at par with each other. Lowest canopy volume in Espailer system may be due to lesser vegetative growth in terms of tree height and spread during the present studies. Choi et al. (2014) found lowest canopy area in pear trees trained toTatura trellis. As far as the canopy volume in different spacing is concerned, the data shows that trees planted at wider spacing (5 m × 3m) has more canopy volume (23.09 m^3) as compared to 5 m × 2 m planted tress (19.05 m^3) irrespective of training systems. It was apparently due to intermingling and overlapping of shoots in closer canopy as well as competition for nutrient uptake which probably affected availability of photosynthates in closer canopy. These results are in accordance with those reported by Loreti et al. (1989), Cepoiu and Murvai (1988), Dyankov (1995), Kiprijanovski et al. (2009) in apple.

Number of fruits per tree

Training system significantly affected number of fruits per tree during the present investigations (Table 3). Peach trees trained to V-trellis recorded maximum mean fruit number (239.99) and it was significantly higher than the trees trained to Y-shaped and Hedge row systems which recorded mean fruit number of 209.17 and 187.42, respectively. However, minimum mean fruit number was recorded (181.22) in Espailer system. The general effect of training system on fruit number was true for year wise effect also. Lower number of fruits per tree in Espailer system was due to less number of bearing shoots on the arms of these trees. On the other hand, the V-trellis trees were healthier, had higher canopy volume and number of shoots as compared to trees trained to other systems. Loreti et al. (1996) obtained maximum number of large sized fruits under Tatura trellis system in peach. Spacing also affected the number of fruits per tree significantly. Maximum fruit number (214.46) was recorded in 5 m × 3 m planted trees and it was significantly higher than the trees planted at 5m × 2 m (194.44) irrespective of training systems. Lower number of fruits at closer plantings may be due to less fruit bearing area and smaller canopy volume (Table 2). Callesen and Wagenmakers (1989) reported that higher number of fruits per tree at wider spacing was due to higher tree volume and flowering which is in

support of present findings.

Fruit yield per hectare

Data in the Table 3 shows that training systems significantly affected fruit yield on unit area basis. Maximum fruit yield/ha was recorded in V-trellis trees (17.07 tonnes yield/ha) and it was significantly higher than the trees trained to other training systems. Minimum yield was recorded in Hedge row trees (12.01 tonnes/ha). Lowest yield in Hedge row trees might be due to less number of bearing shoots and poor light interception due to dense canopy (Lavee et al. 2012). Caruso et al. (2008) reported that increased amount of light interception and more uniformly distribution of light within the tree canopy increased yield in systems like Y, V and tatura trellis. These results are in accordance with the work of various workers (Nuzzo et al. 2002, Kiprijanovski et al. 2009). Data further shows that spacing also affected the productivity significantly. Highest yield (15.90 tonnes/ha) was recorded in trees planted at 5 × 2 m and it was significantly higher than the 5 m × 3 m planted trees (12.24 tonnes/ha). Rana et al. (1998) also found that with increase in tree density, yield per tree decreased while the yield per hectare increased. Higher yield per hectare at closer spacings was due to increased number of plants and foliage per hectare. This observation has a particular advantage under the experimental conditions in translating the available radiant energy into fruit yield and thereby increasing the income of already much stressed farmers, especially in the early years of peach tree.

REFERENCES

Callesen O, Wagenmakers OS (1989) Effect of tree density, tree height and rectangularity on growth, flowering and fruit production. Acta Hort 243 : 141—148.

Caruso T, Dejong, Micelic D, Vaio D, Guarino F, Marra FP, Musso O, Reginato GH (2008) Economical strategies and horticultural management of peach planting systems in Mediterranean climate zones. Atti del vi convegno nazionale sulla peschicoltura meridionale 6 : 127—149.

Cepoiu N, Murvai M (1988) Effect of rootstock and planting density on the growth and fruiting of some apple cultivars. Lucrasi-Stiintifice-Institutal-Agronomic-Nicolae-Balcescu-Bucuresti-seria-b-Horticulturae. 31 : 61—68.

Chalmers DJ, Mitchell PD, Herek LV (1981) Control of peach tree growth and productivity by regulated water supply, tree density and summer pruning. J Am Soc Hort Sci 106 : 307—312.

Choi JJ, Gu MM, Choi J, Han J, Yim S, Kim Y, Jung S, Choi H (2014) Growth and fruit production of asian pear trees on Y, T and vase-training systems. Hort Environ Biotech 55 (1) : 1—8.

Dyankov D (1995) Effect of planting distance on the development of some early apple cultivars. Rasteniev dni Nauki 32 : 71—74.

Kiprijanovski M, Ristevski B, Arsov T (2009) Influence of planting distance to the vegetative growth and bearing of 'Jonagold' apple cultivar on 'MM106' rootstock. Acta Hort 825 : 453—458.

Lavee S, Haskal A, Avidan B (2012) The effect of planting distances and tree shape on yield and harvest efficiency of cv Manzanillo table olives. Sci Hort 142 : 166—173.

Loreti F, Massai R, Morini S (1989) Further observations on high density nectarine plantings. Acta Hort 243 : 353—360.

Loreti F, Tellini A, Muleo R, Morini S, Masetti C, Fideghelli C, Grass F (1996) Light environment at harvest time in two different nectarine training systems. Acta Hort 374 : 103—112.

Mika A, Buler Z, Chlebowska D (2001) Effects of within row spacing and training systems of plum trees grafted on vigorous and semidwarf rootstocks. Acta Hort 557 : 275—280.

Mika A, Chlebowska D, Kosmala J (1981) Effects of long-term spacing trials with apple trees. Fruit Sci Rep 8 : 101—113.

Mohammed S, Wilson LA, Prendergast N (1984) Guava meadow orchard : Effect of ultra high density planting and growth regulators on growth, flowering and fruiting. Trop Agric 61 (4) : 297—301.

Nuzzo V, Dichio B, Xiloyannis C (2002) Canopy development and light interception in peach trees trained to transverse Y and delayed vase in the first four years after planting. Acta Hort 592 : 405—412.

Rana HS, Awasthi RP, Sharma RM, Jha A (1998) Effect of training system on canopy physiology, fruit yield and quality of peach. J Hill Rec 11 (1) : 38—42.

Rufato L, Rossi AD, Picolotto L, Parizoto E, Fachinello JC (2004) Evaluation of vegetative and productive responses of two peach training system (Y-system and Central leader) in an ICM orchards. Acta Hort 636 : 711—715.