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Tree growth, fruit quality and yield attributes as affected by tree spacing and varieties of peaches/nectarine under temperate climate

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Abstract
The present study was carried out at experimental farm of ICAR-CITH, Srinagar to investigate influence of two different planting densities (2.5 m × 2.5 m and 3.0 m × 3.0 m) on tree growth, fruit quality and yield attributes of four peach/nectarine (Fantasia, Crest Heaven, Red Globe & Gloheaven) during five year period (2009-2013). The results of current study clearly indicated that maximum trunk cross-sectional area (TCSA) of tree (51.96 cm^2), higher number of flowers (428.32), fruit number per plant (257.66), fruit length (54.77 mm), fruit weight (82.88 g), fruit pulp thickness (22.66 mm), fruit shape index (1.02), yield (21.84 kg/tree, 35.12 t/ha) and yield efficiency (21.73 $kgcm^{-2}$), TSS (15.34 ^oB) and TSS/acidity (50.92) were recorded at wider spacing 3 m × 3 m. Whereas, titratable acidity (0.320%) and ascorbic acid content (6.65 mg/100g) was maximum in closer plant spacing (2.5 m × 2.5 m). Among variety, maximum trunk cross-sectional area, yield and yield efficiency was recorded in Gloheaven, maximum number of flowers, fruits, TSS/acidity and lowest acidity in Red Globe, maximum fruit length and diameter in Fantasia, maximum fruit pulp thickness, fruit weight, TSS and ascorbic acid was recorded in Crest Heaven. The spacing and varietal interaction was also found significant for no. of flower, fruit per plant, fruit length, diameter, weight, yield, yield efficiency, TSS, acidity and ascorbic acid.

Keywords: peach, genotype, spacing, high density, temperate

Introduction
Peach (*Prunus persica* L.) Batsch belongs to the *Prunus* genus and Rosaceae family. It is the third most important temperate fruit crop of India with an area (36.40 thousand ha), production (2.43 Lakh tones) and productivity (6.67 t/ha) (FAOSTAT, 2011) [6]. In India peaches are commercially grown in temperate regions (J&K, Himachal Pradesh, Uttarakhand), subtropical regions (Punjab, Haryana, Uttar Pradesh) and parts of Tamil Nadu (Ooty) (Lal *et al*., 2016) [9]. Traditionally peaches are planted in low density (6 × 6 m, 7 × 7 m) resulting low yield per unit area. In present scenario the natural and land resources are dwindling very fast and there is urgent need to opt the judicious and intensive peach production technologies. Although several factors such as climate, cultivar, rootstock, quality of planting material and cultural practices collectively affect the yield potential of fruit trees yet, the planting density is the most important which determines the increase in final yield, (Barone *et al*., 1993 [2]; Furukawa and Monet, 1998 [7]). High density orchards have been reported to have precocious and higher yield (De Jong *et al*., 1999) [5]. Availability of solar radiation in high density planting system is an important factor as it governs photosynthesis and accumulation of carbohydrates, its efficient utilization under abundant availability conditions will determine the final yield to great extent. The low tree density results in poor yield during the early years and the low tree stature results in low mature yields. (Loreti and Massai, 2002) [10]. There is also a strong need for early production and to accelerate achievement of maximum productivity in a species with a short economic cycle such as peach. This must be accomplished without impairing fruit quality. The diversity of a large number of peach and nectarine cultivars provides the possibility of selection of those cultivars which would achieve good production results in a high-density system (Zec, 2010) [19]. Considerable research work on high density planting in peach has been reported in the temperate parts of the world, but only a few studies seem to have been conducted in the temperate and subtropical climate of India where peach cultivation is picking up rapidly. Information on the effects of tree densities on growth, yield and fruit quality is not well documented in the temperate climate of India.

Therefore the current study was under taken with the objective of optimization of tree spacing and varieties for growing peaches and nectarines in high-density orchards in order to achieve higher fruit productivity and quality per unit area.

Materials and Methods

The experiment was conducted at ICAR-Central Institute of Temperate Horticulture, Old Air Field, Rangreth, Srinagar, Jammu & Kashmir during 2008-09 and 2013-14 to investigate the influence of different tree densities and varieties on tree growth, fruit yield, quality attributes of peach/nectarine. The Research farm at Srinagar is situated at a latitude of 34° 05'N and longitude of 74° 50'E and at an altitude of 1640 m above msl. The soils of this experimental field are sandy clay loam (45-55% sand, 10-20% Silt and 20-25% clay; 6.5-7.5 soil pH, 0.50% organic carbon, 462.1 kg N/ha, 9.59 kg P/ha and 278.85 kg K/ha) with poor drainage (Kumar *et al*., 2013) [8]. The experiment was laid out in randomized block design with two factors *i.e.* tree densities (2.5 m × 2.5 m and 3.0 m × 3.0 m) as first factor and four peach/nectarine varieties (Fantasia, Crest Heaven, Red Globe & Gloheaven) which were introduced from USA via NBPGR, New Delhi as second factor treatment with three replication. The planting was done during 2007-08 in the peach experimental field of ICAR-CITH, Srinagar. The plants were raised under uniform growth conditions with timely cultural practices including drip irrigation and application of recommended doses of manures twice a year. Recommended NPK fertilizers were applied and appropriate plant protection measures were adopted as and when required. The experimental farm falls under temperate region having cold conditions from November to February and total average annual rainfall received during the cropping season was 698.9 mm. The plants started flowering during 2008 but fruit set was prevented by deblossoming in order to encourage optimum canopy development through training to open leader system. Observations on tree growth, fruit yield and quality attributes were recorded during the course of study. The trunk cross-sectional area of tree was calculated by using formula TCA = Girth^2/4 π (Westwood *et al.*, 1963) [17]. Fruit was harvested at horticultural maturity and yield per tree was estimated in kilogram. Fruit length and diameter was determined by digital vernier callipers. Ten fruits were randomly selected from each tree and pooled as per replication in all treatments for quality analysis. The total soluble solids (TSS) of fruits was estimated by hand refractometer (0-93 range) and presented in terms of ^{0}Brix. To estimate TSS, fruit pulp was crushed in a pestle and mortar and then squeezed through a muslin cloth for extraction of juice. The titratable acidity and ascorbic acid was estimated as per method suggested by AOAC (1980) [1] and expressed in terms of percentage and mg/100 g of fresh weight of juice, respectively. The data of five years were pooled and analyzed by using SPSS version 17 adopting standard procedures and interpreted using analysis of variance.

Results and Discussion

The statistically analyzed data on tree growth, fruit quality and yield are presented in Table 1-5 as affected by tree spacing and varieties of peaches/nectarine.

The trunk cross sectional area of tree, number of flowers, fruit number and yield increased with decreasing the plant density from 1600 to 1111 plant/ha. The trunk cross-sectional area (TCSA) of plants significantly increased from 48.18 cm^2 at 2.5 m × 2.5 m to 51.96 cm at 3.0 m × 3.0 m. Among varieties, maximum TCSA of 58.87 cm^2 was observed in Gloheaven and minimum 44.45 cm^2 for Crest Heaven. The effect of interaction of spacing and varieties was found to be non-significant. The plants under 3 × 3 m configuration showed significantly higher TCSA as compared to 2.5 × 2.5 m which might be due to wider inter-row space available in the middle of the alleys facilitated maximum water and available nutrients. Similar results were reported by Caruso *et al*. (1999) [3], Kumar *et al*. (2013) [8] and Mir *et al*. (2016) [12] in closely spaced trees of peach, apricot and apple respectively. The number of flowers per plant significantly varied among spacing and varieties. The higher number of flowers (428.32) was recorded at 3.0 m × 3.0 m. The variety Red Globe had maximum number of flowers of 469 which was *at par* with Fantasia. However, variety Crest Heaven had minimum number of flowers (351.83). The interactive effect of the factors was found to be significant observing highest value of 496.89 in $S_1 \times V_1$ which was statistically at par with $S_2 \times V_3$ and lowest (350.00) in $S_2 \times V_2$ which was at par with $S_1 \times V_2$. Similarly, the number of fruits per plant increased from 228.35 to 257.66 from spacing S_1 to S_2. Among varieties, maximum number of fruits (260.83) was found in Red Globe which was *at par* with Gloheaven and minimum (210.27) in Crest Heaven. The interaction of the factors produced significant variation in the number of fruits. The highest and lowest number of fruits of 290.00 and 206.55 was observed in $S_2 \times V_3$ and $S_1 \times V_2$ treatment, respectively. Fruit length and diameter recorded significant variations among different factors and their interactions. Among spacing's, fruit length increased from 49.79 mm (S_1) to 54.77 mm (S_2) reverse trend was observed in fruit diameter. The highest value of fruit length and diameter (55.73 mm, 55.47 mm) among varieties was found in Fantasia and lowest (47.50 mm, 49.46 mm) in Red Globe. The interaction produced maximum and minimum fruit lengths of 60.27 mm and 43.90 mm in $S_2 \times V_1$ and $S_1 \times V_3$, respectively. The fruit diameter among interactions ranged from 48.56-58.95 mm. Fruit pulp thickness increased with increase in the spacing from 16.99 mm to 22.66 mm. Fantasia was found to have highest fruit thickness of 20.85 mm which was at par with Crest Heaven and lowest (18.39 mm) in Red Globe. The variation in fruit physical parameters may be due to the unique genetic constitution of an individual variety. Among interactions the maximum fruit thickness of 24.42 mm was recorded in $S_2 \times V_4$ and minimum (15.00 mm) in $S_1 \times V_4$.

The effect of spacing, varieties and their interaction on fruit weight was found to be significant. Higher fruit weight (86.46 g) was observed in S_2 and lower (82.88 g) in S1. Among varieties, Crest Heaven had the heaviest fruit of 87.47 g which was at par with Gloheaven and Fantasia had the lightest fruit of 81.69 g which was statistically at par with Red Globe. The interaction yielded highest fruit weight of 91.55 g in $S_2 \times V_2$ and lowest (79.57 g) in $S_1 \times V_1$. This may be due to upright shoot growth and compact canopy which interfered with radiation penetration during critical period of fruit development and affected fruit weight adversely. Further studies must be initiated to find out the basis of lower fruit size in closer spacing in peaches and if agronomical practices such as irrigation or fertilization can be modified to improve fruit size. Fruit shape index increased from 0.96 to 1.02 with increase in spacing from S_1 to S_2. The effect of variety and interaction of the two factors failed to produce significant differences in fruit shape index. The yield plant^{-1} was found to be higher in S_2 (21.84 kg) and lower in S_1 (18.65 kg) whereas, yield (tha^{-1}) observed a reverse trend. The variety Gloheaven

recorded maximum yield of 22.74 kg plant^{-1} and 30.63 tha^{-1} and Crest Heaven observed minimum of 17.99 kg plant^{-1} and 24.03 tha^{-1}. Among the interactions the yield plant^{-1} and yield (tha^{-1}) varied from 17.49-23.71 kg and 21.62-35.12 tha^{-1}, respectively. These results might be due to the fact that in higher spacing there were sufficient availability of natural resources which results in higher synthesis of photo-assimilates and more partitioning to the food reserves (Srivastava *et al*., 2017) [16]. These results are in accordance with previous studies of Robinson *et al*. (2007) [13], Marini and Sowers (200) [11] and Singh and Kanwar (2001) [15] in peach which opined that with increase in tree density, yield per tree decreased while yield per hectare increased. The yield efficiency increased with increase in the spacing from 18.70-21.73 kgcm^{-2}. Among varieties, highest yield efficiency of 27.60 kgcm^{-2} was found in Gloheaven and lowest (15.74 kgcm^{-2}) in Crest Heaven. The interactive effect of the factors produced significant differences in yield efficiency ranging from 14.61-29.27 kgcm^{-2}. This is because low density caused lesser competition among the plants for space, CO_2, light and moisture. The current findings are in accordance with the results of Day *et al*. (2005) [4] in peaches and Robinson and Dominguez (2015) [14] in pear. The fruit chemical characteristics were also significantly influenced by tree spacing and varieties. The total soluble solids (TSS) contents of fruits significantly varied among different spacings, varieties and their interactions. The wider spacing (S_2) recorded higher value of 15.34 ^{o}Brix. Crest Heaven was found to have a maximum TSS of 15.44 ^{o}Brix and minimum (13.13 ^{o}Brix) was observed in Fantasia. Among the interactions, highest value of 17.18 ^{o}Brix was recorded in $S_2 \times V_2$ and lowest (12.72 ^{o}Brix) in $S_1 \times V_1$. Probably improved photosynthetic efficiency and higher metabolites formation due to elevated light interception by individual tree might have enhanced fruit quality at broader spacing. Acidity of the fruits decreased from 0.320-0.300% from S_1 to S_2. Among varieties, highest value (0.333%) was recorded for Gloheaven and lowest (0.269%) for Red Globe. Interaction resulted in the significant variation in the acidity ranging from 0.252-0.385%. The wider spacing had higher (50.92) TSS/acidity as compared to closer spacing (43.83). The maximum value of 54.00 among varieties was found in Red Globe and minimum (40.50) in Fantasia. The interactive effect of the factors produced the highest value of 54.67 in $S_1 \times V_3$ which was at par with $S_2 \times V_2$, $S_2 \times V_3$ and $S_2 \times V_4$ whereas, lowest (39.00) in $S_1 \times V_1$. Similar kind of trend has also been noticed by Srivastava *et al*. (2017) [16] and Mir *et al*. (2016) [12] in apple high density plantations. The ascorbic acid decreased with decrease in the spacing from 6.65-6.29 mg/100g. Among varieties highest value of 6.74 mg/100g was recorded in Crest Heaven and lowest (5.83 mg/100g) in Gloheaven. The interaction produced a considerable variation (5.64-7.20 mg/100g) in ascorbic acid. Significant differences in chemical constituents might be due to difference in the genetic base of individual varieties. The results suggest that good fruit quality is achievable with low planting densities as long as shoot growth and tree volume are optimized. Generally higher number of trees per hectare resulted slight reduction in fruit size, soluble solids content and titratable acidity. The fruit quality is more affected by the annual conditions (e.g. yield, weather, harvest time) than by tree density (Widmer and Krebs, 2001) [18].

Thus, it was concluded that a spacing of 2.5 m × 2.5 m having 1111 plants/ha resulted in the higher productivity however, fruit quality and yield efficiency was found better in 3.0 m × 3.0 m irrespective of genotypes under temperate conditions.

Table 1: Effect of spacing, variety and their interaction on trunk girth, number of flowers and fruits in peach/nectarine.

Trunk cross-sectional area (TCSA) (cm^2)						No. of flowers/plant					No. of fruits/plant				
	V_1	**V_2**	**V_3**	**V_4**	**Mean**	**V_1**	**V_2**	**V_3**	**V_4**	**Mean**	**V_1**	**V_2**	**V_3**	**V_4**	**Mean**
S_1	45.18	42.85	47.63	57.09	48.18	496.89	353.66	441.66	407.52	424.93	231.66	206.55	231.66	243.55	228.35
S_2	47.98	46.06	53.16	60.66	51.96	440.00	350.00	496.65	426.65	428.32	254.00	213.99	290.00	272.66	257.66
Mean	46.58	44.45	50.39	58.87		468.44	351.83	469.15	417.09		242.83	210.27	260.83	258.10	
	$CD_{(0.05)}$						$CD_{(0.05)}$					$CD_{(0.05)}$			
S	0.72					S	5.40				S	2.31			
V	1.03					V	7.65				V	3.28			
S*V	NS					S*V	10.83				S*V	4.65			

S_1= 2.5 m × 2.5 m, S_2= 3.0 m × 3.0 m; V_1= Fantasia, V_2= Crest Heaven, V_3= Red Globe, V_4= Gloheaven

Table 2: Effect of spacing, variety and their interaction on fruit length, fruit diameter and fruit thickness in peach/nectarine.

Fruit length (mm)						Fruit diameter (mm)					Fruit thickness (mm)				
	V_1	**V_2**	**V_3**	**V_4**	**Mean**	**V_1**	**V_2**	**V_3**	**V_4**	**Mean**	**V_1**	**V_2**	**V_3**	**V_4**	**Mean**
S_1	51.20	50.11	43.90	53.98	49.79	51.99	50.94	48.56	54.31	51.45	20.35	17.10	15.54	15.00	16.99
S_2	60.27	55.44	51.11	52.26	54.77	58.95	53.97	50.37	50.25	53.38	21.35	23.65	21.25	24.42	22.66
Mean	55.73	52.77	47.50	53.12		55.47	52.45	49.46	52.28		20.85	20.37	18.39	19.71	
	$CD_{(0.05)}$						$CD_{(0.05)}$					$CD_{(0.05)}$			
S	0.80					S	0.74				S	0.25			
V	1.14					V	1.08				V	0.36			
S*V	1.63					S*V	1.52				S*V	0.50			

S_1= 2.5 m × 2.5 m, S_2= 3.0 m × 3.0 m; V_1= Fantasia, V_2= Crest Heaven, V_3= Red Globe, V_4= Gloheaven

Table 3: Effect of spacing, variety and their interaction on fruit weight, fruit shape index and yield/tree in peach/nectarine.

Fruit weight (g)						Fruit shape index					Yield/tree (kg)				
	V_1	**V_2**	**V_3**	**V_4**	**Mean**	**V_1**	**V_2**	**V_3**	**V_4**	**Mean**	**V_1**	**V_2**	**V_3**	**V_4**	**Mean**
S_1	79.57	83.40	80.30	88.25	82.88	0.99	0.98	0.90	0.99	0.96	17.49	16.53	18.66	21.95	18.65
S_2	83.82	91.55	84.19	86.36	86.46	1.02	1.02	1.01	1.03	1.02	20.67	19.46	23.71	23.53	21.84
Mean	81.69	87.47	82.21	87.30		1.01	1.01	0.96	1.02		19.08	17.99	21.18	22. 74	
	$CD_{(0.05)}$						$CD_{(0.05)}$					$CD_{(0.05)}$			

S	1.03					S	0.023				S	0.190			
V	1.46					V	NS				V	0.281			
S*V	2.07					S*V	NS				S*V	0.398			

S_1= 2.5 m × 2.5 m, S_2= 3.0 m × 3.0 m; V_1= Fantasia, V_2= Crest Heaven, V_3= Red Globe, V_4= Gloheaven

Table 4: Effect of spacing, variety and their interaction on yield, yield efficiency and TSS in peach/nectarine.

Yield (t/ha)						Yield efficiency (kgcm^{-2})					TSS (°Brix)				
	V_1	**V_2**	**V_3**	**V_4**	**Mean**	**V_1**	**V_2**	**V_3**	**V_4**	**Mean**	**V_1**	**V_2**	**V_3**	**V_4**	**Mean**
S_1	27.99	26.44	29.85	35.12	29.85	16.23	14.61	18.05	25.93	18.70	12.72	13.70	13.92	14,83	13.79
S_2	22.97	21.62	26.34	26.14	24.26	18.31	16.88	22.48	29.27	21.73	13.54	17.18	15.37	15.29	15.34
Mean	25.48	24.03	28.09	30.63		17.27	15.74	20.26	27.60		13.13	15.44	14.65	15.06	
	$CD_{(0.05)}$						$CD_{(0.05)}$					$CD_{(0.05)}$			
S	0.27					S	0.197				S	0.195			
V	0.38					V	0.279				V	0.277			
S*V	0.55					S*V	0.396				S*V	0.392			

S_1= 2.5 m × 2.5 m, S_2= 3.0 m × 3.0 m; V_1= Fantasia, V_2= Crest Heaven, V_3= Red Globe, V_4= Gloheaven

Table 5: Effect of spacing, variety and their interaction on acidity, TSS/acidity and ascorbic acid in peach/nectarine.

Acidity (%)						TSS/Acidity					Ascorbic acid (mg/100g)				
	V_1	**V_2**	**V_3**	**V_4**	**Mean**	**V_1**	**V_2**	**V_3**	**V_4**	**Mean**	**V_1**	**V_2**	**V_3**	**V_4**	**Mean**
S_1	0.324	0.309	0.252	0.385	0.320	39.00	44.00	54.67	37.67	43.83	6.16	6.29	6.70	6.03	6.29
S_2	0.319	0.319	0.285	0.280	0.300	42.00	54.00	53.33	54.33	50.92	6.96	7.20	6.43	5.64	6.65
Mean	0.322	0.312	0.269	0.333		40.50	49.00	54.00	46.00		6.56	6.74	6.56	5.83	
	$CD_{(0.05)}$						$CD_{(0.05)}$					$CD_{(0.05)}$			
S	0.004					S	0.76				S	0.074			
V	0.006					V	1.07				V	0.106			
S*V	0.008					S*V	1.52				S*V	0.150			

S_1= 2.5 m × 2.5 m, S_2= 3.0 m × 3.0 m; V_1= Fantasia, V_2= Crest Heaven, V_3= Red Globe, V_4= Gloheaven

References

1. AOAC. Official Methods of Analysis of Association of Official Analytical Chemists (13 Edn). Washington, D.C, 1980.
2. Barone E, Caruso T, Di Marco L, Sottile F. Effect of orchard system on fruit quality of four early ripening peach cultivars: Preliminary results. Acta Hort. 1993; 379:49-57.
3. Caruso T, Giovannini D, Marra FP, Sottile F. Planting density, above ground-dry-matter partitioning and fruit quality in greenhouse-grown 'Flordaprince' peach (*Prunus persicae* L. Batsch) trees trained to free-standing Tatura. J Hort. Sci. Botech. 1999; 74:547-552.
4. Day KR, DeJong TM, Johnson RS. Orchard-system configurations increase efficiency, improve profits in peaches and nectarines. Calif. Agri. 2005, 75-79.
5. DeJong TM, Tsuji W, Doyle JF, Grossman YL. Comparative economic efficiency of four peach production in California. Hort. Sci. 1999; 34:73-78.
6. FAOSTAT. 2011. http://faostat.fao.org/site/567/ Desktop Default. aspx? Page ID=567#ancor.
7. Furukawa Y, Monet R. Productivity and tree growth in high density peach orchard. Acta Hort. 1998; 465:615-619.
8. Kumar D, Ahmed N, Verma MK, Dar TA. Growth, yield, quality and leaf nutrient status as influenced by planting densities and varieties of apricot. Indian J Hort. 2013; 70(2):195-199.
9. Lal S, Ahmed N, Verma MK, Sharma OC, Mir JI. Genetic variability, character association and path analysis for yield and yield contributing traits in peach. Indian J Hort. 2016; 73(4):465-469.
10. Loreti F, Massai R. The high density peach planting system: present status and perspectives. Acta Hort. 2002; 592:377-390.
11. Marini RP, Sowers DS. Peach tree growth, yield and profitability as influenced by tree form and tree density. Hort. Sci. 2000; 35:837-42.
12. Mir JI, Ahmed N, Singh DB, Sharma OC, Sharma A, Shafi W, *et al*. Effect of planting densities on productivity of different cultivars in apple (*Malus domestica*). Indian J Agric. Sci. 2016; 86(8):1059-62.
13. Robinson TL, Hoying SA, Andersen RL. Performance of 6 high density peach training systems in the Northeast. Acta Hort. 2007; 732:421-428.
14. Robinson TL, Dominguez L. Yield and profitability of high-density pear production with *Pyrus* rootstocks. Proc. XII International Pear Symposium. T. Deckers and J Vercammen (eds.). Acta Hort. 2015; 1094:247-256.
15. Singh H, Kanwar JS. Possibilities of high density planting of peach in the sub-tropics of North Western India. South Indian J. 2001; 49:47-49.
16. Srivastava KK, Singh DB, Kumar D, Singh SR, Sharma OC, Lal S. Effect of planting densities and varieties on yield and yield associated characters of apple (*Malus* × *dometica*) on semi-dwarfing rootstock. Indian J Agric. Sci. 2017; 87(5):593-6.
17. Westwood MN, Reimer FC, Quackenbush VL. Long term yield as related to ultimate tree size of three pears varieties grown on rootstocks of five *Pyrus* species. Proc. American Soc. Hort. Sci. 1963; 82:103-8.
18. Widmer A, Krebs C. Influence of planting density and tree form on yield and fruit quality of 'Golden Delicious' and 'Royal Gala' apples. Proc. 7th Int. Symp. on Orch. & Plant. Syst. J.W. Palmer and J.N. Wünsche (eds.). Acta Hort. 2001; 557:235-241.
19. Zec G. Biological-productive properties of peaches and nectarines in a dense planting. PhD thesis. University of Belgrade, Faculty of Agriculture, 2010.