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Standardization of planting geometry for sapota var PKM 4 under high density planting system

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Abstract
A trial was conducted to optimize spacing for mechanization in Sapota cv. PKM 4 to obtain higher yield per unit area at Department of Fruit Science, Horticultural College and Research Institute, Periyakulam during 2018-2021 under different double hedge row system of planting. The experiment was laid out in randomized block design with four spacing levels of planting system *viz.*, T_1- 8m x 2m x 2m, T_2 -8m x 4m x 2m, T_3- 8m x 4m x 4m and T_4- 8m x 8m (Conventional spacing as control) and was replicated five times. The results revealed that the number of fruits per tree (1078.75) and yield (39.49 t/ha) were significantly higher in double hedge row system with spacing of 8m x 4m x 4m compared with normal (8m x 8m) planting (20.88t/ha). The highest cost: benefit ratio of 1:3.7 was registered in double hedge row system with spacing of 8m x 4m x 4m compared to conventional planting system (1:2.1). The fruit characteristics such as fruit weight (88.00 g), fruit length (13.22 cm) and fruit circumference (18.80 cm) were more in double hedge row system of planting with spacing of 8 m x 4 m x 4m. Hence, the double hedge row system of planting with a spacing of 8 m x 4 m x 4 m is the best planting system for Sapota var. PKM 4 to obtain higher yield per unit area and it could facilitate mechanization in large scale planting.

Keywords: Sapota, PKM 4, double hedge row of planting, HDP, yield

Introduction
Sapota (*Achras zapota*) is one of the important fruit crop belongs to the family Sapota ceae. It is a native of Mexico and Central America and is now grown on a commercial basis in India, Philippines, Sri Lanka, Venezuela, Mexico, Malaysia, Guatemala, and some other Central American countries. It has many names, such as Chikku, Sapota plum, Sapodilla or Prickly pear. India is the largest producer of Sapota fruit with current production area around 97,000 ha, annual production 1175.9 metric tons and productivity is 12.12 MT/ha (NHB, 2018-19) [1]. However, poor yield of Sapota orchards is one of the important problems that can be attributed to traditional system of planting with wide tree spacing and the subsequent time lag in filling the allocated tree space. Therefore, minimizing the yield gap by adopting closer spacing along with suitable system of planting could be the major options for enhancing productivity of Sapota. High density orcharding is a modern method of fruit cultivation involving planting of trees densely, allowing small or dwarf trees with modified canopy for better light interception and distribution and ease of mechanized field operations. In general, planting distance of 8-10 m has been recommended depending on the variety and tree vigour of Sapota. It results in poor utilization of available resources and ultimately low productivity and profitability. This makes Sapota orcharding are unattractive particularly on small holdings because of long gestation period before giving returns. High density orcharding makes maximum use of land to achieve high yields in the early period of orchard life. With growing emphasis on high productivity per unit area, high density planting is already successful in mango (Ram and Sirohi, 1991) [17]. 'Sapota PKM4' is precocious, dwarf, compact canopy, highly regular and cluster bearing variety. It bears spindle shaped fruits suitable for dry flakes production. The fruit contains attractive pulp with light pinkish honey brown colour, rich in sweetness with TSS of 24 -25º Brix for which there is considerable demand in the domestic markets. Therefore, this variety is highly suitable for high density plantation. Hence, having this background of information, an investigation was undertaken to evaluate the growth, yield and fruit quality of Sapota cv. PKM 4 as influenced by different systems of double hedge row p1anting system.

Materials and Methods
A field experiment was conducted at Department of Fruit Science, Horticultural College and

Research Institute, Periyakulam during 2018-2021 on 15 years old Sapota cv. PKM 4, planted in different hedge row planting systems. The total average annual rainfall received during the experiment period was about 579.3 mm. The soil was sandy loam with neutral pH. Of 7.10 and the organic carbon content was 0.75%. The available N, P and K status of the soil was 282, 24 and 296 kg/ ha, respectively. Recommended uniform package of cultural practices and plant-protection measures were followed in the trial. The treatments comprised of four different system of plantings *viz*., T_1- 8 m x 2 m x 2 m (1000p/ha), T_2 -8 m x 4 m x 2 m (500p/ha), T_3- 8 m x 4 m x 4 m (416p/ha) and T_4- 8 m x 8 m (156p/ha) (Conventional spacing as control). The experiment was laid out with randomized block design and replicated five times. In double hedgerow system, two rows of hedges were planted at a distance of 2-4 m, in which plants were adjusted at 2-4 m, and the double rows were separated from other double rose by 8 m spacing. Observations on plant height, East - West spread, North - South spread, trunk girth at 30 cm above the ground, number of fruits/tree/year, yield/tree/year, fruit dimensions, TSS, reducing sugar (%), acidity (%) and ascorbic acid were recorded. Ten Sapota fruits were randomly selected from per plant and harvested from each replication. Total soluble solid (TSS) was determined by portable refractometer of 0-32º Brix range. The acidity was determined by titrating the juice against N/10 NaOH and expressed as per cent as given in AOAC (1995) [2] and total sugars were analyzed as per method given by Lane and Eynon (1943) [11]. The data were statistically analyzed by as described by Panse and Sukhatme (1984) [13].

Results and Discussion

Growth parameters

The results of present investigation on growth character are given in Table 1. Maximum plant height (5.29 m) was recorded in T_1 (8 x 2 x 2 m), followed by T_2 (8 x 4 x 2 m) as 4.92 m, whereas minimum in square system planting T_4 (8 x 8m) as 4.77 m. Maximum increase in trunk girth was reported in T_4 square system (70.00 cm) followed by T_3 double hedge row panting system (8 x 4x 4m) (68.4cm) and minimum trunk girth was reported in T_1 (51.43 cm). It is generally expected that in closer spacing, plants will have tendency to grow tall and the plant in square system (8 m x 8 m) had optimum space for lateral growth which is the tendency of Sapota plants. The maximum plant canopy spread (mean of N-S 6.82 m and E-W 7.65 m) was recorded in square planting system T_4 (8 x8 m), followed by (N-S 5.92 m and E-W 5.28 m) in double hedge row system planting system (8 x 4 x 4m)T_3. Whereas, minimum plant canopy spread (N-S 4.62 m and E-W 4.64 m) in T_1 (8 x 2 x 2 m) was observed. Similar finding were reported by Biswas *et al*. (1989) [5] in Papaya, Singh (2001) [20], Kundu (2007) [9], Lal *et al*. (2007) [10] in Guava.

Table 1: Effect of high-density planting systems on vegetative parameters of Sapota cv. PKM4

Treatments	Plant height (m)	Girth (cm)	Canopy spread (m^2)	
			North-South	East-West
T_1- 8 m x 2 m x 2 m	5.29	51.43	4.62	4.64
T_2- 8 m x 2 m x 4 m	4.92	51.52	5.59	5.22
T_3 – 8 m x 4 m x 4 m	4.77	52.17	5.92	5.28
T_4- 8 m x 8 m	4.56	70.05	6.82	7.65
S.Ed	0.08	1.05	0.12	0.12
CD(P=0.05)	0.20	2.60	0.29	0.29

Yield parameters

Yield parameters as influenced by different plant densities are presented in Table 2. Among the four different planting densities, the maximum number of fruits per plant was recorded in the plants spaced at T_4 - 8 x 8m (1548.11), followed by T_3 (1288.64) and the minimum number of fruits per plant was recorded in T_1 (8 x 2 x 2 m) (414.50). The more fruit setting was found in plants under square planting system (T_4- 8 x 8m) was due to higher canopy volume, greater mobility of nutrients because of exposure of more number of leaves to sun light. Plants grown under lower planting density produced flowers in all quadrants of the canopy, while those grown under increasing planting density produced flowers only in the two quadrants of the canopy between the rows, but not into the rows. Consequently, there was reduction in the number of fruits per plant (Nath *et al.*; 2007) [12]. The fruit size was recorded maximum (10.22 cm × 15.80 cm) in T_3 (8 x 4 x 4m), followed by T_4 (8 x 8 m), with value of 9.50 cm x 15.02 cm. While minimum fruit size (8.71 cm x 13.10 cm) was noted in T_1 (8x 2 x 2m). It might be due to overcrowding of canopies and poor light interception. The maximum fruit size was recorded in paired planting it might be due to low canopy volume which allow the high penetrance of light resulting in to high assimilation light energy in to carbohydrates. (Singh *et al.*, 2010) [19]. among the four different planting densities, the maximum fruit yield (kg/tree) was recorded in the plants spaced at 8 x 8 m of T_4 (133.87 kg/tree), followed by T_3 (94.93 kg/ha). The more fruit setting in plants under square planting system T_4 (8 x 8 m) might be due to higher canopy volume, greater mobility of nutrients because of exposure of more number of leaves to sun light, whereas the minimum fruit yield was recorded in T_1 (20.69 kg/tree). This reason for minimum fruit yield in T_1 may be due to un-availability of proper sunlight into the inner side of the canopy at close spacing becomes a limiting factor and it adversely affected the flowering and fruiting and consequently the yield also. The smaller the area available to plants, the higher the tendency to decrease the number and percentage of flower shoots and yield (Singh *et al*., 2010) [19]. On the basis of productivity per unit area basis the highest yield was recorded in higher density plantation, *i.e* double hedge row system (T_3 8m x 4 m x 4m) (Table 3). This was due to higher plant population per unit area. Maximum yield/plant (113.87 kg) was recorded in square planting system (8 m x 8m). The results clearly revealed that productivity, as a function of individual tree, was higher in normal spacing, *i.e* square system, but by accommodating higher plant population to double hedge row system T_3 (8 x 4 x 4m) significantly increased the productivity per unit area (47.15t/ha). However in case of lower plant densities, limited competition existed among plants for sunlight and nutrients. Lack of the number of plants per unit area resulted in reduced yield in

conventional planting system. Thus it was observed that yield on hectare basis increased with increasing plant population. This may be because under wider spacing plant has comparatively higher vegetation, high leaf fruit ratio. As the productivity per unit area basis is considered, it is clear that yield was higher yield under closer spacing due to higher plant population per unit area. The results clearly revealed that accommodation of more plant population in closer spacing led to more production than wider spacing. Such an increase in production through higher number of plants per unit area has been demonstrated in fruit trees by various authors Ram and Sirohi (1991) [17] in Mango, Chundawat *et al.* (1992) [6] in Guava; Pareek 1998[14] in Pomegranate; Beyhan, 2007 [4]; Nath *et al*. 2007 [12]; Rathor *et al*. 2003 [18]; Joglekar *et al*. (2013 [8]; Rajbhar *et al*., 2016 [16].

Table 2: Effect of high density planting system on yield characters of Sapota cv. PKM4

Treatments	No. of fruits/tree	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Yield / tree (kg)	Yield (t/ha)
T_1- 8 m x 2 m x 2 m	414.50	8.71	13.10	65.91	20.69	20.69
T_2- 8 m x 2 m x 4 m	866.18	9.43	14.55	70.32	53.66	26.93
T_3 – 8 m x 4 m x 4 m	1288.64	10.22	15.80	88.00	94.93	47.15
T_4- 8 m x 8 m	1548.11	9.50	15.02	86.41	133.87	20.88
S.Ed	29.78	0.18	0.29	0.71	2.49	0.96
CD(P=0.05)	74.30	0.46	0.72	1.67	6.21	2.40

Table 3: Effect of high density planting systems on fruit quality of Sapota cv. PKM4

Treatments	TSS (ºBrix)	Total Sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Titrable acidity (%)	Ascorbic acid (mg/100g)
T_1- 8 m x 2 m x 2 m	24.60	13.66	6.75	5.11	0.28	11.61
T_2- 8 m x 2 m x 4 m	24.40	13.81	7.13	6.22	0.26	11.47
T_3 – 8 m x 4 m x 4 m	24.90	14.43	7.97	6.81	0.20	12.14
T_4- 8 m x 8 m	25.35	14.78	7.80	6.63	0.22	11.92
S.Ed	0.44	0.26	0.15	0.13	0.002	0.22
CD(P=0.05)	NS	0.65	0.37	0.32	0.006	NS

NS: Non-significant

Biochemical parameters

It is evident from Table 3 that high density planting systems showed non-significant effect on TSS. Maximum Total Soluble Solid was noticed in square system T_4 (14.78%) followed by 8 m x 4 m x 4 m spacing of double hedge row planting system-T_3 (14.43%) whereas, T_1 exhibited minimum total sugars content (13.66%). These findings are in consonance with the findings of Babu *et al.* (2002) [3] and Patel *et al.* (2011) [15]. High density planting systems had significantly affected the reducing sugars. The maximum reducing sugar (7.97%) was observed under double hedge row system of spacing 8 x 4 x 4m T_3 followed by T_4 with having value of 7.80% while minimum of 6.75% was reported in square planting system T_2 (8 x 8m). The maximum non-reducing sugar of 6.81% was obtained in hedge row planting system (T_3) followed by square planting system (T_1) with having value of 6.63%. The lowest value of 5.11% was noticed under the T_3 (8 x 2 x 2m). The minimum titrable acidity (0.20%) was observed in the plants spaced at 8 x 4 x 4m (T_3), whereas, the maximum value (0.28%) was noted under the treatment of (T_1). These results are in agreement with Babu *et al.* (2002) [3]; Dhaliwal and Dillon (2003) [7]; Patel *et al.* (2011) [15] in Guava. The ascorbic acid content was no significant of different planting systems. However, the highest ascorbic acid content was recorded in the plant spacing of 8 x 4 x 4 m (12.14 mg/100g) and the minimum ascorbic acid content was recorded in the treatment 8 x 2 x 2m (11.47mg/100g).

Conclusion

Double hedge row system of planting technology can be transferred to the farmers through extension agencies so that the farmers can adopt the spacing of 8 m within double rows and 4 m between successive double rows, thus accommodating 416 plants ha^{-1} in Sapota cv. PKM 4 for maximizing the fruit yield. It is also evident from the findings that closely spaced trees yielded significantly higher fruits per unit area than wider spaced trees. Hence, Sapota cv. PKM 4 can be recommended to the farmers for High Density Planting System in Orchards to get more income.

References

1. Anonymous. NHB, Database, Gurgaon, Haryana, 2018-19.
2. AOAC. Official methods of analysis. Association of Official Agricultural Chemists, 16th Edn., Washington. D.C. Allahabad Safeda. Haryana Journal of Horticultural Sciences. 199;26(1-2):89-91.
3. Babu KD, Dubey AK, Yadav DS. Evaluation of guava cultivars for their performance under mid-hill altitude of Meghalaya. Indian Journal of Hill Farming. 2002;15:119-121.
4. Beyhan N. Effects of planting density on yield and quality characteristics of hazelnut (cv. Palaz) in a hedgerow training system. Canadian Journal of Plant Science. 2007;87:595-597.
5. Bishwas B, Sen SK, Maiti SC. Effect of planting density on growth yield and chemical composition of papaya fruits cv. Ranchi. Progressive Horticulture. 1989;21(3-4):280-284.
6. Chundawat BS, Kikani KP, Verma LR, Jadav RG. Studies on hedge row plantation in 'Allahabad Safeda guava. Indian Journal of Horticulture. 1992;49(2):134-137.
7. Dhaliwal GS, Dhillon SK. Effect of Tree size on Physico-chemical characteristics of Fruits of Guava *cv.* Sardar. Indian Journal of Horticulture. 2003;60:312-317.
8. Joglekar V, Chivate D, Pujari KH. High density planting

technique in dry region for 'Kesar' mango cultivation - a Savlaj pattern. Acta Hort. 2013;992:233-235.
9. Kundu S. Effect of high density planting on growth, flowering and fruiting of guava (*Psidium guajava* L.). Acta Horticulture. 2007;735:267-270.
10. Lal S, Tiwari JP, Maharajan AR. Studies on planting systems in guava (*Psidium guajava* L.) cv. Sardar. Acta Horticulturae. 2007;735:263-266.
11. Lane JH, Eynon L. Determination of reducing sugar by means of Fehling's solution with methylene blue as an internal indicator. Journal of Social Chemistry. 1943;42: 327.
12. Nath VB, Das M, Rai. Standardization of high density planting in mango (*Mangifera indica* L.) under sub humid Alfisols of Eastern India. Indian Journal of Agriculture Science. 2007;77:3-7.
13. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers (third ed.) ICAR, New Delhi, India. 1984.
14. Pareek OP. Arid zone fruits research in India. l!tdian Journal of Agricultural Sciences. 1998;68(8):508-14.
15. Patel RK, Maiti CS, Deka BC, Deshmukh NA, Roy D. Variability studies in guava (*Psidium guajava* L.) genotypes for growth, yield and quality attribute at mid - hills of Meghalaya. Indian Journal of Hill Farming. 2011; 24(1&2):24-28.
16. Rajbhar YP, Singh SD, Lal MS, Gopal, Rawat PL. Performance of high density planting of mango (*Mangifera indica* L.) under mid-western plain zone of Uttar Pradesh. International Journal of Agriculture Science. 2016;12(2):298-301.
17. Ram S, Sirohi SC. Feasibility of high density orcharding in Dashehari mango. Acta Horticulture. 1991;291:207-212.
18. Rathor CS, Lal RL, Mishra KK. Effect of planting systems on the performance of litchi (*Litchi chinensis* Sonn.). Progress Horticulture. 2003;35:146-151.
19. Singh SK, Sharma RR, Shrivastav M. Effect of pruning on morpho-physiological parameter and microclimate under high density planting of mango (*Mangifera indica* L.). Indian Journal of Agricultural Sciences. 2010; 79(8):632-635.
20. Singh G. High density planting in guava. Annual Report, Central Institute of Subtropical Horticulture, Lucknow. 2001.