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Intercropping of Tuber Crops in Young Orchard of Sapota Cv. Kalipatti

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ABSTRACT

The present investigation was carried out at the Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during the year 2012-13 to study the feasibility of intercropping of tuber crops in sapota orchard. The experiment was laid out in Randomized Block Design with nine treatments *viz*., T_1 = sapota + cassava; T_2 = sapota + greater yam; T_3 = sapota + tannia; T_4 = sapota + turmeric; T_5 = control i.e. sole sapota; T_6 = sole cassava; T_7 = sole greater yam; T_8 = sole tannia; T_9 = sole turmeric. The sole crops of intercrops were grown outside the experimental plot. There was no significant effect of intercrops on the tree height, tree girth, canopy spread as well as yield of sapota. Comparatively higher sapota yield was recorded in association with turmeric as an intercrop (7.75 tha^{-1}) and least in association with intercrop of cassava (7.37 tha^{-1}). The highest sapota equivalent yield was recorded from the treatment of sapota with turmeric (67.39 tha^{-1}) which was followed by tannia (58 tha^{-1}). The lowest value was obtained from the treatment sapota alone (7.65 tha^{-1}). In view of the LER, significantly the highest value was recorded from intercropping with tannia (2.28) which was followed by turmeric (1.98), cassava (1.9) and greater yam (1.79) and significantly lowest from sole crops (1). From the economic point of view, highest net return per ha was obtained from intercrop turmeric (Rs. 4,74,451 ha^{-1}) followed by tannia (Rs. 4,14,744 ha^{-1}) and lowest from control sapota (Rs. 49,074 ha^{-1}).

Keywords:
Intercropping, tuber crops, young orchard, sapota, Kalipatti

INTRODUCTION

In Gujarat, intercropping with fruits like banana, papaya, pineapple, cocoa and vegetable like French bean, tomato, cole crops, cucurbits and flower crops like spider lily are common in young sapota plantations. In South Gujarat, intercropping tomato followed by cluster bean in mango cv. 'Rajapuri' was found profitable without any adverse effect on the growth and yield of mango (Bhuva et al. 1988). Cauliflower, tomato and cabbage are also recommended as intercrops in sapota orchards of 'Kalipatti' for higher returns (Patel et al. 2013).

Intercropping is commonly carried out with vegetables and is found economically remunerative. Nowadays, intercropping fruit

crops with tuber crops is also becoming popular. Cultivation of crops such as elephant foot yam, ginger and turmeric in coconut gardens is a profitable proposition (Manjunath et al. 2002; Girijadevi and Nair 2003). Although cassava is widely grown in mixed culture throughout the world (Ghosh et al. 1987). Yams are also one of the promising intercrops. Tannia is a shade tolerant crop which performs well under coconut gardens as an intercrop (Sheeba and Pushpakumari 2000). Much research has been done on fruit based intercropping system. However, very little information is available regarding intercropping studies in sapota. Therefore, the present investigation is carried out to study the effect of tuber crops like cassava (*Manihot esculenta*), greater yam (*Dioscorea alata*), tannia (*Xanthosoma sagittifolius*) and turmeric (*Curcuma longa*) in sapota orchard.

MATERIALS AND METHODS

The present investigation entitled 'Intercropping of tuber crops in young orchard of sapota cv. Kalipatti', was carried out with the object to assess the influence of intercrops on growth and yield of sapota and to find out the best intercrop in sapota orchard of cv. Kalipatti' at Regional Horticultural Research Station, ASPPE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during the year 2012-13. The experiment was laid out in Randomized Block design with four replications and nine treatments *viz*., T_1 = sapota + cassava; T_2 = sapota + greater yam; T_3 = sapota + tannia; T_4 = sapota + turmeric; T_5 = control *i.e.* sole sapota; T_6 = sole cassava; T_7 = sole greater yam; T_8 = sole tannia; T_9 = sole turmeric. The sole crops of intercrops were grown outside the experimental plot.

The details of experiment are as below

Plot size: 72.36 sq. m

Inter crops:

1. Cassava cv. Cm9966
2. Greater yam cv. Local Round
3. Tannia cv. Local
4. Turmeric cv. GNT-1

Time of sowing: Second week of May, 2012

Spacing

1. Cassava - 90 cm x 90 cm
2. Greater yam - 90 cm x 90 cm
3. Tannia - 60 cm x 30 cm
4. Turmeric - 45 cm x 45 cm

Age of tree: 15 Years

Spacing: 10 m x 10 m

Observations recorded

Sapota

Tree height: The tree height was measured at the time of planting of intercrops, at 4 months after planting and then at the time of harvest of intercrops. It was measured from ground level to the tip of the apical bud of the stem with the help of 'Ravi Altimeter'.

Tree girth: Tree girth was measured in centimeters at 3 months interval from the time of planting upto the harvest of intercrops using vernier calipers.

Tree canopy: The canopy spread of the tree was measured by measuring the horizontal distance from the base of the tip of the longest shoot in both the directions (North-South and East-West) at right angle to the tree. It was measured at planting, 4 months after planting and at the time of harvest of inter crops.

Land Equivalent Ratio (LER): Land Equivalent Ratio denotes the relative land area under sole crops that is required to produce the same yield as obtained under intercropping system at the same management level. It is calculated by the following formula

$$LER = \frac{Yij}{Yii} + \frac{Yji}{Yjj}$$

Where, Yij and Yji = Yields of crops 'I' and 'j' respectively in the intercropping from unit area and

Yii and Yjj = Yield of pure stands of 'i' and 'j' crops, respectively

Equivalent yield: Yield of intercrops were converted in terms of yield of main crop. Sapota equivalent yield (SEY) for all the treatments was worked out by the following formula

$$SEY = Y_0 + \frac{(Y_1 \times P_1)}{P_0}$$

Where, Y0 = Yield of sapota, Y1 = Yield of intercrop, P0 = Selling price of sapota and P1 = Selling price of the intercrop

Statistical analysis: The data collected for all the characters were subjected to statistical analysis for proper interpretation. For the main crop, standard method of analysis of variance for RBD was used. The treatment differences were tested by 'F' test at five per cent level of significance. For comparing intercrops with sole crop, 't' test was employed at five per cent level of significance.

Economics: The economics of intercropping system was worked out by considering the prevailing market prices for different inputs and produces. The total cost of production was worked out by ivation from considering the prices of planting materials, fertilizers, labours employed and other miscellaneous inputs like bamboo and ropes for staking. The gross income in terms of of Rs. Per hectare was worked out on the basis of mean yield for each treatment considering prevailing local market price. Net income was obtained by deducting cost of cultivation from gross income per hectare. The benefit cost ratio (BCR) was worked out using the following formula

$$BCR = \frac{\text{Net income}}{\text{Total cost of production}}$$

RESULTS AND DISCUSSION

Effect of intercrops on growth characters and yield of sapota

Tree height of sapota: The results revealed that tree height was not affected by different intercrops. However, the highest height was recorded from the plots with cassava (Table 1). On the basis of per cent increase, highest increase in tree height was recorded in plots with greater yam and lowest in plots with tannia.

Table 1. Effect of different intercrops of tuber crops on tree height of sapota

Treatments	Tree height (m)			Per cent increase	
	At planting	4 MAP	At harvest	4 MAP	At harvest
T_1 = Sapota + Cassava	4.44	4.48	4.52	0.90	1.80
T_2 = Sapota + Greater yam	4.02	4.06	4.12	0.99	2.49
T_3 = Sapota + Tannia	4.10	4.13	4.16	0.73	1.46
T_4 = Sapota + Turmeric	4.32	4.36	4.40	0.92	1.85
T_5 = Sapota alone	3.98	4.01	4.05	0.75	1.76
S. Em. +	0.167	0.169	0.17	-	-
C.D. at 5%	NS	NS	NS	-	-
C.V.%	8.03	8.07	8.19	-	-

Tree girth and canopy spread: The highest tree girth was recorded from plots with tannia, while lowest tree girth was recorded from plots with greater yam. The influence of intercrops was non-significant on tree girth of sapota (Table 2). Largest E-W and N-S canopy spread was recorded in turmeric, though it was non-significant. Incremental increase in E-W and N-S canopy spread of sapota was found maximum with turmeric and lowest from sapota alone.

Table 2. Effect of different intercrops of tuber crops on tree girth and canopy spread of sapota

Treatments	Tree height (m)				Canopy spread E-W (m)			Canopy spread N-S (m)		
	At planting	4 MAP	6 MAP	At harvest	At planting	4 MAP	At harvest	At planting	4 MAP	At harvest
T_1 = Sapota + Cassava	14.53	14.91	15.29	15.64	6.65	6.86	7.23	7.28	7.51	7.78
T_2 = Sapota + Greater yam	12.97	13.47	13.96	14.54	6.76	7.05	7.36	7.04	7.24	7.61
T_3 = Sapota + Tannia	16.92	17.38	17.98	18.77	6.88	7.19	7.42	7.17	7.52	7.78
T_4 = Sapota + Turmeric	15.99	16.63	16.93	17.18	6.86	7.39	7.58	7.28	7.52	7.94
T_5 = Sapota alone	16.13	16.62	16.79	17.28	6.28	6.55	6.67	6.39	6.64	6.85
S. Em. +	0.87	0.94	0.97	0.93	0.33	0.34	0.35	0.37	0.37	0.43
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	11.45	11.91	11.79	11.26	9.84	9.85	9.71	10.41	10.08	11.43

Yield of intercrops: The sole cropping of cassava and greater yam, turmeric was found better with respect to yield as compared to intercrop. However, maximum leaf yield and corm yield of tannia was obtained from intercropping as compared to sole crops (Table 3)

Table 3. Comparison of yield of intercrops under sole cropping and intercropping system

Yield characteristics	Sapota + cassava	Sole cassava	T value
Yield (t ha^{-1})	23.17	24.53	-2.24
	Sapota + greater yam	Sole greater yam	
Yield (t ha^{-1})	7.48	9.15	-2.79
	Sapota + tannia	Sole tannia	
Leaf yield (t ha^{-1})	10.56	8.38	5.64
	Sapota + turmeric	Sole turmeric	
Rhizome yield (t ha^{-1})	23.99	24.90	-2.20

Yield of sapota: Comparatively higher sapota yield was recorded in association with turmeric as an intercrop (7.75 t ha^{-1}) and least in association with intercrop of cassava (7.37 t ha^{-1}). However, this difference was not found to be significant (Table 4). Intercropping also had profound influence on the intercrops. Intercrops of tannia and turmeric performed better under shade as compared to greater yam and cassava which performed better in abundant sunlight. The overall growth as well as yield of tannia was found to be more in the intercropping system. The productivity of tannia under shade was found to be significantly higher than in the open. The overall growth parameter was also more in case of intercropped turmeric than the sole crop though the rhizome yield was more in the sole crop but did not at significant level. For cassava and greater yam, no significant difference in yield under sapota canopy and open condition was observed though yield was somewhat more in open condition.

Table 4. Effect of different intercrops of tuber crops on the yield of sapota

Treatments	Yield/plot (kgtree^{-1})	Yield (t ha $^{-1}$)
T_1 = Sapota + Cassava	73.7	7.37
T_2 = Sapota + Greater yam	74.7	7.48
T_3 = Sapota + Tannia	74.4	7.44
T_4 = Sapota + Turmeric	77.53	7.75
T_5 = Sapota alone	76.4	7.64
S. Em. +	1.2589	0.13
C.D. at 5%	NS	NS
C.V.%	3.34	3.34

Sapota equivalent yield: The highest sapota equivalent yield (Table 5) was recorded from the treatment of sapota with turmeric (67.39 t ha^{-1}) which was followed by tannia (58 t ha^{-1}). The lowest value was obtained from the treatment sapota alone (7.65 t ha^{-1}).

Land equivalent ratio (LER): In view of the LER, significantly the highest value was recorded from intercropping with tannia (2.28) which was followed by turmeric (1.98), cassava (1.9) and greater yam (1.79) and significantly lowest from sole crops (1). This reflects the profitability of intercropping over sole cropping (Table 5). This result is in conformity with the findings of Rahman et al. (2006) in banana. Singh (2010) also reported higher equivalent yield in all the intercropping situations compared to the sole crop of banana. This variation in the equivalent yield is due to the difference in the yield of the intercrops. Even though the individual yield of cassava was comparable to that of turmeric, cassava recorded lowest equivalent yield among the intercrops due to low market value of the fresh tuber in this region.

Table 5. Effect of intercropping on equivalent yield and LER

Treatments	Sapota Equivalent yield (t ha^{-1})	LER
T_1 = Sapota + Cassava	30.54	1.90
T_2 = Sapota + Greater yam	37.4	1.79
T_3 = Sapota + Tannia	58.0	2.28
T_4 = Sapota + Turmeric	67.39	1.98
T_5 = Sapota alone	7.65	1
T_6 = Cassava alone	-	1
T_7 = Greater yam alone	-	1
T_8 = Tannia alone	-	1
T_9 = Turmeric alone	-	1
S. Em. +	0.65	0.02
C.D. at 5%	2.00	0.06
C.V.%	3.23	2.84

Economics: From the economic point of view, highest net return per ha was obtained from intercrop turmeric (Rs. 4,74,451ha^{-1}) followed by tannia (Rs. 4,14,744 ha^{-1}) and lowest from control sapota (Rs. 49,074 ha^{-1}). This is also in line with their LER values. Profitability of turmeric can be attributed to its high equivalent yield in combination with the good market price of the produce. In terms of performance on the basis of LER and profitability, which was our main concern, tannia was found to be the best intercrop, greater yam was the least profitable as indicated by its low BCR (Table 6). All the intercropping situations showed higher monetary returns than that of sole cropping. The net income per ha was higher from sapota intercropped with turmeric. This may be due to higher sapota equivalent yield and better price of turmeric. Mathew et al. (1987) and Chundawat et al. (1982) also reported similar findings where maximum total income per ha was obtained from banana intercropped with turmeric. Income obtained from cassava was less compared to other intercrops due to its highly perishable nature and lesser demand in this region. Greater yam also gave good return because of its high market value. In past, Chundawat et al. (1982) also found minimum net return from greater yam as intercrop. However, Opoku-Ameyaw et al. (2011) reported profitability of yam when intercropped with cashew seedlings compared with other intercrops like maize, groundnut and sorghum. Profitability in intercropping system has been reported by many workers viz. Rajput et al. (1988) and Bhuva et al. (1988) in mango orchard; Rahman et al. (2006); Singh (2010) banana. In his review, Singh (1996) also presented the profitability of intercropping in commercial fruit crops.

Table 6. Economics of tree - crop combination

Treatments	Yield (t ha^{-1})		Value individual crop (Rs. ha^{-1})		Gross income	Gross expenditure	Net income	BCR
	Sapota	Intercrop	Sapota	Intercrop	(Rs. ha^{-1})	(Rs. ha^{-1})	(Rs. ha^{-1})	
T_1	7.37	23.17	73700	231700	305400	136240	169160	1.24
T_2	7.48	7.48	74800	299200	374000	175328	198672	1.13
T_3	7.44	313847 Nos. (leaf) 5.93 (corm)	74400	209200 296500	580132	165388	414744	2.51
T_4	7.75	23.99	77500	599750	677250	202799	474451	2.34
T_5	7.64	-	76400	-	76400	27326	49074	1.79

Cost of cultivation			Selling price		
Urea	:	Rs 289/50 kg	Sapota	:	Rs. 10/kg
SSP	:	Rs 340/50 kg	Cassava	:	Rs. 10/kg
MOP	:	Rs 879/50 kg	Greater yam	:	Rs. 40/kg
Labour	:	Rs 120/ day	Tannia (corm)	:	Rs. 50/kg
			Tannia (leaf)	:	Rs. 10/15 leaves
			Turmeric	:	Rs. 25/kg

CONCLUSION

The present investigation shows the feasibility of intercropping of tuber crops in sapota orchard. No adverse effect on growth and yield of sapota was observed due to intercropping suggesting that such crops can be taken up as

intercrops along with sapota. In terms of performance on the bases of LER as well as from the profitability point of view, tannia was found to be the best intercrop followed by turmeric while greater yam was the least profitable. Thus from our investigation we can conclude that tannia is the best intercrop in sapota orchard. Looking at the profitability and their effect on the main crop, farmers are suggested to take up intercropping of tuber crops in the orchard of sapota while at the same time keeping in mind to choose such intercrops as per their objectives.

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