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Studies on the effect of integrated nutrient management on growth and yield of sapota (*Achras sapota* L.) cv. Kalipatti

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Abstract
The field experiment was conducted during the year 2011-2015 at JVR Horticulture Research Station, Malyal, Mahabubabad district Sri Konda Laxman Telangana State Horticulture University, Rajendranagar, Hyderabad. The present experiment was carried out to study the effect of integrated nutrient management on growth and yiled of sapota (*Achras sapota* L.). The experiment was laid out randomized block design with ten treatments and three replications. In this investigation significant results were recorded on growth and yield attributes. The highest plant height and plant spread were recorded in T_4 - 40 kg FYM + 350 g N/Plant (4.79 m) and T_9 (10 kg Vermicompost + 350 g N/Plant) however lowest was noticed in T_5 - 40 kg FYM alone (3.83 m) and T_{10} (10 kg Vermicompost) respectively. The highest fruit weight and no fruits were recorded in T_9 - 10 kg Vermicompost + 350 g N/Plant (112.16 g) and T_3 - 40 kg FYM + 300 g N/Plant (384.21), however lowest was observed in T_1 - 40 kg FYM + 200 g N/Plant (96.72 g) and T_{10} - 10 kg Vermicompost (269.35) respectively. The highest average fruit yield per tree (42.91 kg/tree) and hectare (6.69 t/ha) were recorded in T_4 (40 kg FYM + 350 g N/Plant), however lowest fruit yield per tree (28.27 kg) and yield per hectare (4.40 t/ha) recorded in T_5 (40 kg FYM alone).

Keywords: Sapota (*Achras sapota* L.) integrated nutrient management, growth and yield

Introduction
Sapota (*Manilkara achras* (Mill) Fosberg) syn. (*Achras sapota* L.) which is commonly called as Chiku or Sapodilla. This species is native to tropical America, especially southern Mexico and Central America. It is one of the important fruit crop of tropical and subtropical regions of the country. India is considered to be largest produces and is mainly grown in the humid tropical coasted region Maharashtra is the largest state in area and production of Sapota followed by Karnataka, Gujarat, Tamilnadu and Andhra Pradesh. The total area under Sapota cultivation in India is 1.56 lakh ha with a production and productivity of 17.44 lakh MT and 10 MT/ha respectively. The productivity of Sapota is highest in Tamilnadu with 32.8 MT/ha [1]. Telangana state occupied 7th plkace in sapota production.

Area under this fruit crop is in ascendancy due to high production per unit area and hardy nature of crop against biotic and abiotic stresses. Like any other fruit crops it, also requires nutrition for healthy growth and good quality of fruits. But due to continuous use of chemical fertilizers has hazardous effect on overall soil health. This has resulted in deterioration of soil physical and chemical properties resulting in stagnation in yield of the crop and if the trend continues, will have disastrous consequences [2]. Therefore, chemical fertilizers must be integrated with sources of organic manure which are eco-friendly for sustaining productivity without deteriorating effects on soil health and the environment. The yield can be increased or sustained, but the quality is improved through the balanced application of organic and inorganic fertilizers [3]. The information of use of FYM, Vermicompost in combination in Nitrogen at different rates in the form of urea is not standardized in Telangana conditions.

Keeping in view of above points the present investigation was designed to find out the optimum dose of Nitrogen and best combination of inorganic fertilizers and organic manure for obtaining higher growth and yield of Sapota cv. Kalipatti.

Material and Methods
The present investigation was carried out at JVR-Horticultural Research Station, Malyal, S. K. L. T. S Horticultural University. The treatments were imposed on 6 years old Kalipatti

variety planted at a spacing of 8x8 m in the year 2010–11. The experiment consists of 10 treatments, laid in Randomized block design in three replication with 4 trees per each treatment.

The treatment details are represented in Table-1

Table 1

T_1	40 kg FYM + 200 g N/Plant
T_2	40 kg FYM + 250 g N/Plant
T_3	40 kg FYM + 300 g N/Plant
T_4	40 kg FYM + 350 g N/Plant
T_5	40 kg FYM alone
T_6	10 kg Vermicompost + 200 g N/Plant
T_7	10 kg Vermicompost + 250 g N/Plant
T_8	10 kg Vermicompost + 300 g N/Plant
T_9	10 kg Vermicompost + 350 g N/Plant
T_{10}	10 kg Vermicompost

The Soil of the experimental site was with good drainage capacity, having P^H of 6.28, Ec of 0.60 d/m, organic carbon 0.94 %, available P–10.21 kg/acre, and K-123 kg/acre. The chemical fertilizers like P_2O_5 and K_2O were applied at N-400 gm., U-880 gm., P-160 gm., SSP -1000 gm., K-450gm., MOP–750 gm., per tree as basal dose. Nitrogen was applied in the form of Urea, FYM and Vermicompost. FYM and Vermicompost were applied as basal dose @ 40 kg and 10 kg per plant respectively. Nitrogen was applied in two split doses @ N-400 gm., U-880 gm., P - 160 gm., SSP -1000 gm.,K-450 gm., MOP–750 gm., stages of crop growth. The experiment was continued for 5 years from 2010-11 to 2014-15.

The growth parameters like plant height(m) plant spread(m) in E-W and N-S, fruit parameters like average fruit weight (g), average no. of fruits per plant and yield parameters like average yield per tree (kg) and average yield per hectare were recorded for five years. Data was analyzed using analysis of variance as described by Pansa and Sukhatme (1985) [4].

Results and Discussion

Growth parameters

The data presented in table -2 represents the influence of INM on plant height, in the initial three years the plant height was found non-significant due to treatments. This might be due to 4 years age of plant. However, significant results were recorded on plant height the hieghest plant height was recorded in T_7 – 10 kg Vermicompost + 250 g N/Plant (4.79 m), However lowest plant height (3.83 m) was noticed in T_5 – 40 kg FYM/Plant (3.83 m). The similar results were reported in Guava cv. L-49 [5] and similarly increase in growth of fruit plants by the application of N (Nitrogen) has also been reported in Kinnow mandarin [6].

Table 2: Effect of different INM treatments on plant height (m) of Sapota during the year 2011-15

Treatments	2010-11	2011-12	2012-13	2013-14	2014-15	Pooled
T_1	3.60	4.36	4.73	4.95	5.28	4.58
T_2	3.86	4.00	4.11	4.42	5.55	4.39
T_3	3.23	3.33	3.78	4.73	5.56	4.13
T_4	3.40	4.46	4.86	5.30	5.93	4.79
T_5	3.13	3.40	3.79	4.10	4.73	3.83
T_6	3.13	4.36	4.82	5.14	5.24	4.54
T_7	3.48	4.36	4.84	5.24	5.37	4.66
T_8	3.23	4.00	4.22	4.62	5.24	4.26
T_9	3.70	4.03	4.23	5.23	5.54	4.55
T_{10}	3.56	4.25	4.45	4.66	4.79	4.34
CD 5%	N.S.	N.S.	N.S	0.30	0.52	0.35
SEM						0.12

Table 3: Effect of different INM treatments on plant spread (m) of Sapota during the year 2011-15

Treat-ments	2010-11		2011-12		2012-13		2013-14		2014-15		Pooled	
	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S	E-W	N-S
T_1	3.53	3.21	4.16	4.13	4.26	4.2	3.69	3.64	4.24	4.20	3.98	3.88
T_2	3.30	3.10	3.83	3.66	4.12	3.98	4.01	3.91	4.51	4.56	3.95	3.84
T_3	4.45	3.26	3.66	3.53	3.96	3.72	3.64	3.43	4.86	4.73	4.11	3.73
T_4	3.06	3.30	3.73	3.53	3.82	3.67	3.78	3.83	5.09	5.23	3.90	3.91
T_5	3.20	3.21	3.80	3.83	3.94	3.74	4.08	4.11	4.03	4.06	3.81	3.79
T_6	3.18	3.25	4.06	3.96	4.16	4.04	3.84	3.88	4.11	4.12	3.87	3.85
T_7	3.16	3.13	4.16	3.83	4.26	4.12	3.77	3.70	4.17	3.96	3.90	3.75
T_8	3.10	3.23	4.23	4.03	4.8	4.2	3.99	3.93	4.63	4.66	4.15	4.01
T_9	3.18	3.50	4.43	4.03	4.3	3.98	4.28	5.25	5.39	5.42	4.32	4.44
T_{10}	3.48	3.40	4.03	3.53	4.21	4.02	3.67	3.90	4.08	4.17	3.89	3.80
CD 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S	0.27	0.47	0.44	NS	NS
SEM												

The plant spread was found non-significant during the years from 2010-11 to 2013-14. However, the highest plant spread (E-W- 5.39, N-S 5.42) was recorded in T_9 –10 kg vermicompost + 350 g N/Plant and lowest (N-S-4.06, E-W-4.03) was recorded in T_{10}–10kg Vermicompost.

The increased plant height with T_5 and increased plant spread with T_9 might be due to the balanced application of inorganic and organic nutrients to each plant and also due to easy and ready availability of nitrogen from Urea.

On the other hand the poor results in T_5 might be due slow availability of nitrogen from above application of FYM alone.

Yield attributes

Significant variations in fruit weight, the number of fruit per tree and fruit yield due to different sources of nitrogen were observed.

The data indicated in the Table-4 represents the significant results were recorded in fruit weight due to the influence of

INM treatments. The highest fruit weight (112.16 g) was recorded in T_9-(10 kg Vermicompost + 350 g N/Plant) which was on par with T_4 (40 kg FYM + 350 g N/Plant) (111.21 g). However, lowest fruit weight (96.72 g) was noticed in T_1 (40 kg FYM + 200 g N/Plant).

Table 4: Effect of different INM treatments on average fruit weight (g) of Sapota during the year 2011-15

Treatments	2010-11	2011-12	2012-13	2013-14	2014-15	Pooled
T_1	101.20	84.33	86.32	103.30	108.44	96.72
T_2	118.80	86.00	90.00	113.43	114.44	104.53
T_3	108.80	96.00	98.77	103.33	119.71	105.32
T_4	116.73	97.33	98.90	116.46	126.65	111.21
T_5	95.13	82.00	84.50	107.89	104.32	94.77
T_6	110.60	90.66	94.60	103.76	104.97	100.92
T_7	108.40	95.66	97.45	105.20	105.25	102.39
T_8	112.66	88.66	90.77	120.23	117.21	105.91
T_9	120.73	98.66	100.10	127.63	113.70	112.16
T_{10}	116.46	89.00	90.12	125.16	108.01	105.75
CD 5%	N.S.	5.00	5.20	2.14	8.25	6.94
SEM						2.42

The results pertaining to average number of fruits per tree was depicted in Table-5. The INM treatment significantly influenced number of fruits per tree, the highest (384.21) no. of fruits per tree was observed in T_3 – (40 kg FYM + 300 g N/Plant) which was on par with T_4 – (40 kg FYM + 350 g N/Plant), T_5 (40 kg FYM alone) and T_6 (10 kg Vermicompost + 200 g N/Plant). The lowest (269.35) number of fruits per tree was recorded in T_{10} (10 kg Vermicompost).

Table 5: Effect of different INM treatments on average no. of fruits per tree of Sapota during the year 2011-15

Treatments	2010-11	2011-12	2012-13	2013-14	2014-15	Pooled
T_1	221.06	290.66	310.60	350.86	375.40	309.72
T_2	167.13	285.00	295.80	362.30	475.59	317.16
T_3	243.06	395.00	410.50	381.36	491.11	384.21
T_4	237.53	382.00	395.40	339.40	552.17	381.30
T_5	168.73	288.00	305.50	378.15	357.29	299.53
T_6	260.33	233.33	277.40	338.50	458.23	313.56
T_7	202.06	283.00	308.50	357.74	489.45	328.15
T_8	221.26	312.66	337.66	362.56	540.19	354.87
T_9	211.66	284.00	295.00	418.03	431.40	328.02
T_{10}	171.73	223.00	240.50	325.85	385.66	269.35
CD 5%	N.S.	N.S.	N.S.	6.76	28.13	47.73
SEM						16.64

The data presented in Table - 6 indicates the influence of INM treatments on average fruit yield per tree (kg) and yield (tones per hectare). The highest average fruit yield per tree (42.91 kg per tree) and fruit yield per hectare (6.69 t/ha) was significantly recorded in T_4 – (40 kg FYM-350 g N/Plant) and on par with T_3 (40 kg FYM + 300 g N/Plant). However, the lowest fruit yield per tree (28.27 kg) and fruit yield per hectare (4.40 t/ha) was noticed in T_5 (40 kg FYM alone).

Table 6: Effect of different INM treatments on average yield per tree (kg) of Sapota during the year 2011-15

Treat- ments	2010-11	2011-12	2012-13	2013-14	2014-15	Cum- yield /tree (kg) 2010-15	Pooled
T_1	22.18	24.49	26.81	35.27	40.74	149.49	29.90
T_2	22.62	31.31	27.62	39.50	54.46	175.52	35.10
T_3	26.39	37.98	41.50	41.04	58.78	205.69	41.14
T_4	29.68	37.17	38.10	39.66	69.96	214.57	42.91
T_5	15.99	23.58	25.62	38.89	37.27	141.35	28.27
T_6	28.36	21.12	26.50	35.44	48.06	159.48	31.90
T_7	22.15	27.11	29.50	38.75	50.23	167.75	33.55
T_8	25.37	27.59	29.50	43.96	63.24	189.67	37.93
T_9	26.42	27.90	28.50	44.66	48.51	175.99	35.20
T_{10}	19.87	19.89	21.60	40.53	41.54	143.43	28.69
CD 5%	N.S.	N.S.	N.S.	N.S	5.04		5.78
SEM							2.01

The highest yield and maximum number of fruits per tree were noticed in higher dose of N (350 g N/Plant) along with 40 kg FYM, might be the optimum dose for sapota trees compared to lower doses. The perfect combination of FYM and higher dose of N resulted in ready availability of Nitrogen from Urea, which increased growth and ultimately improved the yield. Similar results were also reported [7, 8, 9, 3] in Sapota.

The increased on number basis and weight basis might be attributed due to the fact that, increasing levels of nutrients in assimilating area of crop due to which the rate of dry matter production was enhanced. Similarly, due to rational partitioning of dry matter to economic sink, the yield attributes were improved. The above results are in conformity with the findings in sapota [10].

Table 7: Effect of different INM treatments on average yield (t/ha) of Sapota during the year 2011-15

Treatments	2010-11	2011-12	2012-13	2013-14	2014-15	Pooled
T_1	3.50	3.82	4.18	5.49	6.35	4.67
T_2	3.52	4.88	4.31	6.18	8.49	5.48
T_3	4.11	5.92	6.48	6.39	9.15	6.41
T_4	4.62	5.79	5.95	6.18	10.93	6.69
T_5	2.49	3.67	4.0	6.06	5.80	4.40
T_6	4.42	3.29	4.14	5.52	7.49	4.97
T_7	3.45	4.23	4.60	6.04	7.76	5.22
T_8	3.95	4.30	4.60	6.85	9.86	5.91
T_9	4.11	4.35	4.45	6.95	7.56	5.48
T_{10}	3.09	4.35	3.37	6.29	6.47	4.71
CD 5%	N.S.	1.37	1.25	N.S	1.13	0.91
SEM						0.32

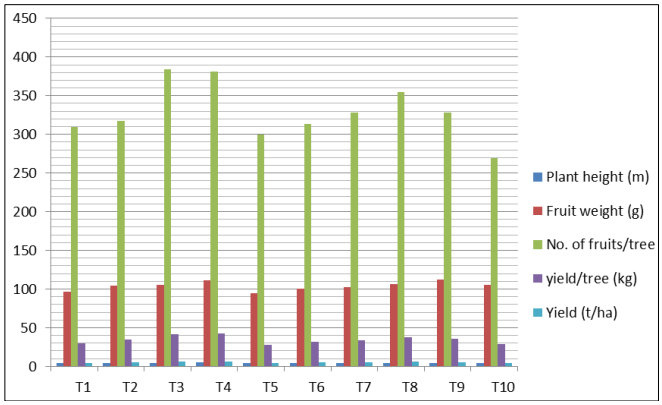

Fig 1: Effect of different INM treatments on growth and yield attributes of sapota during 2011-2015.

Conclusion

From this investigation it can be concluded that to Telangana region 40 kg of FYM along with 350 g N / Plant can be recommended to get optimum tree growth and highest yield.

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