International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 2838-2843

Received: 03-05-2018
Accepted: 08-06-2018

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Effect of organic and inorganic fertilizers on flowering, fruiting and quality parameters of sapota (*Manilkara achras* Forsberg) var. Kalipatti

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Abstract
The present investigation was conducted at Department of Horticulture, Vasantrao Naik Marathwada Agriculture University, Parbhani during the year 2009-10. The experiment was laid out in randomized block design with three replication and ten treatments. In this investigation the sapota tree were applied with different organic and inorganic fertilizers and their combination namely T_1 (100% RDF), T_7 (100 % FYM), T_3 (100 % Vermicompost), T_4 (50% FYM + 50% Vermicompost), T_5 (75%RDF+ 25% FYM), T_6 (50% RDF + 50% FYM), T_7 (25% RDF + 75% FYM), T_8 (75% RDF + 25% Vermicompost), T_9 (50% RDF + 50% Vermicompost) and T_{10} (25% RDF + 75% Vermicompost). The effects of these treatments were noted on vegetative growth, reproductive growth, and yield attributes of sapota. The results of experimentation on confirmed the efficiency of integration of organic and chemical fertilizers for better growth, and yield of sapota. The application of 50% RDF + 50% Vermicompost enhanced the vegetative and reproductive growth as well as yield attributes.

Keywords: Kalipatti, FYM, RBD vermicompost, sapota

1. Introduction
Sapota (*Manilkara achras*), it is a native of tropical America and probably originated in the southern Mexico (Papenoe, 1974) [8]. It is not known when sapota first introduced to India, but sapota cultivation was taken up for the first time in Maharashtra in 1898 in a village named Gholwad & district Thane (Chadha 1993).

Sapota is a good source of digestible sugar which ranges from 12 to 18 percent. Composition of ripe sapota per 100 g of edible portion is moisture 73.7 g, carbohydrates 21.4 g, protein 0.7 g, fat 1.1 g, calcium 28.0 mg and phosphorus 27.0 mg (Shanmugavelu and Srinivasan, 1973) [9]. Area of this fruit is on ascendancy due to high production per unit area, liking to Indian palate, continuous fruiting throughout the year in humid climate and hardy nature of crop against biotic and abiotic stresses. Sapota has become one of the important fruit in southern and western parts of country due to its wild range of adaptability, low production costs and reasonably high economic returns with very low pest and diseases susceptibility (Singh, 1991) [10].

In 1953, the area under this crop was 800 ha. only but now area increases also in non-coastal area of country. India is leading producer of sapota and area under sapota is estimated to be 156 lakh ha. with a production of 1308 million tonnes (Anonymous, 2009) [1]. In Maharashtra an area of sapota is about 65.4 lakh ha. concentrated in coastal region particularly in Thane district. Production of Maharashtra is about 298.7 million tonnes. There is significant increase in area from 1990, an account of implementation of EGS scheme. However, in Marathwada area under this crop is increasing recently at and very rapid rate it is 0.11 lakh ha with production of 41,072 metric tonnes (Anonymous 2009) [1]. Now the sapota crop is included in the scheme of National Horticulture Mission from 2005. The Kalipatti cultivar is the main choice of the farmers and therefore, 99 per cent area under sapota is under this cultivar. Sapota crop is highly responsive to fertilizers (Durrani *et al.*, 1982) [7]. Experiments conducted at the Regional Fruit Research Station, Gujarat Agricultural University, Navsari indicated that sapota crops needs N, P and K nutrients for higher fruits production with better quality (Anon., 1984) [3]. On organic manure for sapota orchardists is 200 kg FYM/tree for getting highest production of fruits and net return (Anon., 2003a) [4]. Sapota fruit demand good nutrition and this dose of chemical fertilizer need to be gradually reduced and balanced by increasing the use of optimum quantity of organic manures particularly FYM, respond well to fertilization.

Among major nutrient, nitrogen is most important element, which influences growth and productivity of sapota. At present condition it is not possible to completely eliminate the use of chemical fertilizers. For sheep manure and poultry manures etc. Organic manures are the soil store house for nitrogen supply to plant. There is very little inorganic nitrogen in soil and much of it is obtained by the conversion of organic forms. Sapota is a major important fruit crop grown in Maharashtra, Gujarat, Karnataka, Tamilnadu, Andhra Pradesh and Kerla. It gives fruits throughout the year. Use of various organic manures and fertilizers is a good practice to obtain higher yield with good quality fruits.

2. Material and Methods

The present was conducted at the Department of Horticulture, Vasantrao Naik Marathwada Agricultural University, Parbhani during the year 2009-10.The experimental trees used were 35 years old grafts of chiku var. Kalipatti on Khirni (*Manilkara hexandra*) root stock spaced at 10x10 metres.

Treatment Details

Treatment details the different treatment combinations of organic and inorganic fertilizer were ten, as given below.

Tr. No.	Treatment details
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)
T_2	100% FYM
T_3	100% Vermicompost
T_4	50% FYM + 50% Vermicompost
T_5	75% RDF + 25% FYM
T_6	50% RDF + 50% FYM
T_7	25% RDF + 75% FYM
T_8	75% RDF + 25% Vermicompost
T_9	50% RDF + 50% Vermicompost
T_{10}	25% RDF + 75% Vermicompost

Recommended dose of fertilizers

1. Recommended dose of N, P and K @ 1000:500:500 g/tree.
2. Dose of FYM application calculated on the basis of their nitrogen content. (NPK of FYM - 0.5:0.2:0.5).
3. Dose of Vermicompost application calculated on the basis of their Nitrogen content. (NPK of Vermicompost - 3; 1.0:1.5).

3. Results and Discussion

3.1 Flowering and Fruiting (Reproductive growth)

The effect of organic and inorganic fertilizers on flowering and fruiting characters such as number of days required for first flower initiation, number of flowers per shoot number of fruits per shoot percentage of flower drop, percentage of fruit set, percentage of fruits drop, final retention of fruits per shoot and number of fruits per tree are presented under appropriate heads.

3.1.1 Days to initiation of flowering from application of treatment

The data in respect of average number of days required for appearance of first flower in various treatments are presented in Table 1

Table 1: Effect of organic and inorganic fertilizers on days to initiation of flowering from application of treatment

Tr. No.	Treatment details	Treatments Initiation of flowering (days)
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)	82.77
T_2	100% FYM	87.25
T_3	100% Vermicompost	86.10
T_4	50% FYM + 50% Vermicompost	86.67
T_5	75% RDF + 25% FYM	84.15
T_6	50% RDF + 50% FYM	81.92
T_7	25% RDF + 75% FYM	85.12
T_8	75% RDF + 25% Vermicompost	83.50
T_9	50% RDF + 50% Vermicompost	80.96
T_{10}	25% RDF + 75% Vermicompost	85.00
	Mean	84.34
	SE+	0.84
	CD at 5%	2.51

The data revealed that there were significant effects of 50 % RDF + 50 % Vermicompost on flowering. The treatment T_9 (50% RDF + 50% Vermicompost) produced significantly earlier initiation of flowering than all other treatments except T_6 and T_1, which were found to be statistically at par with the treatment T_9. The treatment T_8, T_5, T_{10}, and T_7 were statistically similar and at par to each other and significantly superior over the treatment T_3, T_4 and T_2.

The treatment T_9 (50% RDF + 50% Vermicompost) showed earliness in flowering which took minimum number of days for initiation first flower (80.96 days) followed by the treatment T_6-50% RDF + 50% FYM (81.92 days) and T_1 100% RDF (82.77 days). The treatment T_2-100 % FYM recorded late initiation of flowering (87.25 days) as compared to other treatments.

3.1.2 Number of flowers per shoot

The data in respect of number of flowers per shoot as affected by different treatment are presented in Table 2.

The treatment T_9 (50% RDF + 50% Vermicompost) produced significant more number of flowers per shoot. It was at par with T_6, T_1, T_8 and T_5. The treatment T_9 produced significantly more number of flowers per shoot than T_{10}, T_7, T_3, T_4 and T_2.

The treatment T_9-50% RDF + 50% Vermicompost recorded more number of flowers per shoot (9.68) followed by treatment T6-50% RDF + 50% FYM (9.60). Least number of flower produced by treatment T_2- 100% FYM (8.86) and treatment T_4, T_3, T_7, and T_{10} which were found at par to each other.

Table 2. Effect of organic and inorganic fertilizers on number of flowers per shoot

Tr. No.	Treatment details	Treatments Number of flowers per shoot
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)	9.58
T_2	100% FYM	8.86
T_3	100% Vermicompost	8.92
T_4	50% FYM + 50% Vermicompost	8.89
T_5	75% RDF + 25% FYM	9.40
T_6	50% RDF + 50% FYM	9.60
T_7	25% RDF + 75% FYM	8.96
T_8	75% RDF + 25% Vermicompost	9.46
T_9	50% RDF + 50% Vermicompost	9.68
T_{10}	25% RDF + 75% Vermicompost	8.99
	Mean	9.23
	SE+	0.16
	CD at 5%	0.49

3.1.3 Flower drop and fruit set

Data on per cent flower drop and fruit set are presented in Table 3.

All the organic and inorganic fertilizers reduced the flower drop and increased the fruit set. The flower drop was significantly reduced by treatment T_9 (50% RDF + 50% Vermicompost) which ultimately increased fruit set and was found significantly superior over T_4, T_3 and T_7 while treatments T_6, T_1, T_8, T_5 and T_{10} were at par with T_9. The treatment (50% RDF + 50% Vermicompost) found 56.72 per cent flower drop and increased the 43.28 Percent fruit set.

Higher percentage of flower drop was found in treatment T_2-100 % FYM (63.20 Percent), while T_4, T_3 and T_7 were at par with it.

Table 3: Effect of organic and inorganic fertilizers on percent flower drop and fruit set

Tr. No.	Treatment details	Flower drop (%)	Fruit set (%)
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)	57.83	42.17
T_2	100% FYM	63.20	36.80
T_3	100% Vermicompost	62.30	37.70
T_4	50% FYM + 50% Vermicompost	62.70	37.30
T_5	75% RDF + 25% FYM	59.43	40.57
T_6	50% RDF + 50% FYM	56.87	43.13
T_7	25% RDF + 75% FYM	61.20	38.80
T_8	75% RDF + 25% Vermicompost	57.67	42.33
T_9	50% RDF + 50% Vermicompost	56.72	43.28
T_{10}	25% RDF + 75% Vermicompost	59.30	40.70
	Mean	59.72	40.28
	SE+	1.44	1.44
	CD at 5%	4.27	4.27

3.1.4 Number of fruits per shoot

The data pertaining to the mean number of fruits per shoot influenced by various treatments were presented in Table 4. Clearly indicated that significant treatment differences were existed in number of fruits per shoot amongst various treatments.

Table 4: Effect of organic and inorganic fertilizers on number of fruits per shoot

Tr. No.	Treatment details	Treatments Number of fruits/shoot
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)	4.106
T_2	100% FYM	3.340
T_3	100% Vermicompost	3.440
T_4	50% FYM + 50% Vermicompost	3.395
T_5	75% RDF + 25% FYM	3.880
T_6	50% RDF + 50% FYM	4.213
T_7	25% RDF + 75% FYM	3.556
T_8	75% RDF + 25% Vermicompost	4.069
T_9	50% RDF + 50% Vermicompost	4.233
T_{10}	25% RDF + 75% Vermicompost	3.878
	Mean	3.811
	SE+	0.187
	CD at 5%	0.558

The treatment T_9 (50% RDF + 50% Vermicompost) produced significantly more number of fruits per shoot than treatments T_7, T_3, T_4, and T_2. The treatment T_9 was found to be statistically at par with treatments T_6, T_1, T_8, T_5 andT_{10}. The

treatment T_9 (50% RDF + 50% Vermicompost) produced more number of fruits per shoot (4.233) followed by treatments T_6-50% RDF + 50% FYM (4.213), $T_1$100% RDF (4.106) and T_8-75%RDF+25% Vermicompost (4,069). Significantly less number of fruits per shoot was recorded in treatment T_2-100% FYM (3.340). The treatments T_4, T_3, and T_7 which were found at par to each other.

3.1.5 Fruit drop and fruit retention

It is evident from the data presented in Table 5 that the application of organic and inorganic fertilizers influenced the fruit drop and increases the fruit retention.

Table 5. Effect of organic and inorganic fertilizers on percent fruit drop and fruit retention

Tr. No.	Treatment details	Fruit Drop (%)	Fruit Retention (%)
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)	84.09	15.91
T_2	100% FYM	87.10	12.02
T_3	100% Vermicompost	87.03	12.97
T_4	50% FYM + 50% Vermicompost	87.98	12.90
T_5	75% RDF + 25% FYM	84.96	15.04
T_6	50% RDF + 50% FYM	83.03	16.97
T_7	25% RDF + 75% FYM	86.12	13.88
T_8	75% RDF + 25% Vermicompost	84.30	15.70
T_9	50% RDF + 50% Vermicompost	82.83	17.17
T_{10}	25% RDF + 75% Vermicompost	85.15	14.85
	Mean	85.26	14.74
	SE+	0.68	0.68
	CD at 5%	2.03	2.03

The Table 5 Revealed that the treatment T_2 (100 % FYM) has highest fruit drop 87.98 percent and ultimately resulted poor fruit retention 12.02 percent. The treatments T_4, T_3 and T_7 were at par with T_2. The treatment T_9 (50% RDF + 50% Vermicompost) was found significantly superior over T_4, T_3, T_7, T_{10} and T_5. The treatment T_6, T_1 and T_8 were at par with T_9.The treatment T_9 (50% RDF + 50% Vermicompost) has recorded significantly reduced fruit drop (82.83 percent) and increased fruit retention (17.17 percent).

3.1.6 Days required for fruit maturity

Data on number of days required for fruit maturity are presented in Table 6. It is evident from the data that application of organic and inorganic fertilizers had significantly influenced on the number of days required for fruit maturity. The treatment T_9 (50% RDF + 50% Vermicompost) was found significantly superior over T_1, T_8, T_5, T_{10}, T_7, T_3, T_4, and T_2 and at par with T_6.

The treatment T_9 (50% RDF + 50% Vermicompost) recorded early maturity of fruits (248.32 days) followed by T_6-50% RDF + 50% FYM (249.08 days). The treatment T_2-100% FYM required (252.26 days) for fruit maturity. Treatments T_4, T_3, T_7 and T_{10} were at par with treatment T_2.

Table 6. Effect of organic and inorganic fertilizers on days required for fruit maturity

Tr. No.	Treatment details	Days required to fruit maturity
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)	249.96
T_2	100% FYM	252.26
T_3	100% Vermicompost	251.66
T_4	50% FYM + 50% Vermicompost	251.89
T_5	75% RDF + 25% FYM	250.64
T_6	50% RDF + 50% FYM	249.08
T_7	25% RDF + 75% FYM	251.00
T_8	75% RDF + 25% Vermicompost	250.14
T_9	50% RDF + 50% Vermicompost	248.32
T_{10}	25% RDF + 75% Vermicompost	250.91
	Mean	250.59
	SE+	0.47
	CD at 5%	1.39

3.1.7 Number of fruits per tree

The data pertaining to the mean number of fruits per tree as influenced by various treatments were presented in Table 7 clearly indicated that significant treatment differences were existed in number of fruits per tree amongst various treatments.

Table 7. Effect of organic and inorganic fertilizers on total number of fruits per tree

Tr. No.	Treatment details	Total number of fruits per tree
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)	2341.70
T_2	100% FYM	1965.70
T_3	100% Vermicompost	2050.00
T_4	50% FYM + 50% Vermicompost	2028.70
T_5	75% RDF + 25% FYM	2196.00
T_6	50% RDF + 50% FYM	2447.00
T_7	25% RDF + 75% FYM	2102.33
T_8	75% RDF + 25% Vermicompost	2250.33

T_9	50% RDF + 50% Vermicompost	2569.66
T_{10}	25% RDF + 75% Vermicompost	2157.70
	Mean	2210.91
	SE+	93.11
	CD at 5%	276.21

The treatment T_9 (50% RDF + 50% Vermicompost) produced significantly more number of fruits per tree than treatments T_8, T_5, T_{10}, T_7, T_3, T_4 and T_2. The treatment T_9 was found to be statistically at par with treatments T_6 and T_1. The treatment T_9 (50% RDF + 50% Vermicompost) produced more number of fruits per tree (2569.66) followed by treatments T_6-50% RDF + 50% FYM and T_1 100% RDF (2341.70). Less number of fruits per tree was recorded in treatment T_2-100% FYM (1965.70) and was at par with T_4, T_3, T_7, T_{10}, and T_5.

3.2 Quality parameters

The data on effect of organic and inorganic fertilizers on the quality parameters of fruit are presented under separate heads.

3.2.1 Total soluble solids

Significant differences were observed in respect of mean total soluble solid content amongst different treatment of organic and inorganic fertilizers can be seen from the Table 8.

Table 8: Effect of organic and inorganic fertilizers on total soluble solids (°B)

Tr. No.	Treatment details	Total soluble solids (^{0}B)
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)	16.54
T_2	100% FYM	19.20
T_3	100% Vermicompost	20.12
T_4	50% FYM + 50% Vermicompost	19.43
T_5	75% RDF + 25% FYM	16.62
T_6	50% RDF + 50% FYM	17.20
T_7	25% RDF + 75% FYM	17.70
T_8	75% RDF + 25% Vermicompost	16.64
T_9	50% RDF + 50% Vermicompost	17.70
T_{10}	25% RDF + 75% Vermicompost	18.43
	Mean	17.96
	SE+	0.62
	CD at 5%	1.86

Maximum TSS (20.12 °B) was observed in treatment T_3 (100 **%** Vermicompost) was significantly superior over rest of the treatment followed by treatment T_4 (50% FYM + 50% Vermicompost) produced (19.43 °B) and treatment T_2 (100%FYM) produced (19.20 °B) which was significantly superior over treatment T_7, T_9, T_6, T_8, T_5, and T_1 and statistically at par with T_{10} (25%RDF+75% Vermicompost). Significantly minimum TSS was recorded in treatment T_1 100% RDF (16.54 0B).

3.2.2 Total sugar

Data presented in Table 8 revealed that the sugar percentage was significantly influenced by the various organic and inorganic fertilizers. The treatment T_3 (100 % Vermicompost) was found significantly superior in respect of total sugar over treatments T_7, T_9, T_6 T_8, T_5, and T_1. The treatments T_3 was statistically at par with treatment T_4, T_2andT_{10}. The treatment T_3 (100 % Vermicompost) recorded maximum mean total sugar (19.28 per cent) followed by T_4-50% FYM + 50% Vermicompost (18.64 per cent), T_2-100 % FYM (17.74 per cent) and treatment T_{10}-25%RDF+75% Vermicompost (17.39 percent). The lowest total sugar percent was recorded in treatment T_1-100% RDF (11.00 per cent) and was at par with T_5.

Table 8: Effect of organic and inorganic fertilizers on total sugar percentage

Tr. No.	Treatment details	Total sugar percentage
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)	11.00
T_2	100% FYM	17.74
T_3	100% Vermicompost	19.28
T_4	50% FYM + 50% Vermicompost	18.64
T_5	75% RDF + 25% FYM	12.12
T_6	50% RDF + 50% FYM	14.34
T_7	25% RDF + 75% FYM	16.36
T_8	75% RDF + 25% Vermicompost	14.14
T_9	50% RDF + 50% Vermicompost	15.78
T_{10}	25% RDF + 75% Vermicompost	17.39
	Mean	15.68
	SE+	0.76
	CD at 5%	2.28

3.2.3 Reducing sugar

From the data presented in Table 9 found that reducing sugar was significantly influenced by organic and inorganic fertilizers i.e. chemical fertilizers, FYM, Vermicompost and their combination.

Table 9: Effect of organic and inorganic fertilizers on percentage reducing sugar

Tr. No.	Treatment details	Reducing Sugar percentage
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)	8.91
T_2	100% FYM	13.03
T_3	100% Vermicompost	13.98
T_4	50% FYM + 50% Vermicompost	13.59
T_5	75% RDF + 25% FYM	9.96
T_6	50% RDF + 50% FYM	11.15
T_7	25% RDF + 75% FYM	12.47
T_8	75% RDF + 25% Vermicompost	10.98
T_9	50% RDF + 50% Vermicompost	11.95
T_{10}	25% RDF + 75% Vermicompost	12.70
	Mean	11.87
	SE+	0.28
	CD at 5%	0.84

The treatment T_3 (100 *%* Vermicompost) showed significantly highest percentage of reducing sugar than all other treatment except, the treatment T_4 which was found to be statistically at par with the treatment T_3. The treatment T_3-100 % Vermicompost recorded highest percentage of reducing sugar (13.98 per cent) followed by the treatment T_4-50% FYM + 50% Vermicompost (13.59 per cent). However, lowest percentage of reducing sugar was observed in 100% RDF (8.91 per cent) than all other treatments.

3.2.4 Non reducing sugar

Data presented in Table 10 revealed significant differences amongst treatment in respect of percent mean non reducing sugar. The application of 100% Vermicompost recorded highest non reducing sugar (5.30 per cent) and was significantly superior over T_7, T_9, T_6, T_8, and T_5. The treatments T_4, T_2 and T_{10} were at par with T_3. Lowest percentage (2.09 per cent) of reducing sugar observed in treatment T_1 and was at par with T_1.

Table 10: Effect of organic and inorganic fertilizers on percentage non-reducing sugar

Tr. No.	Treatment details	Non Reducing sugar percentage
T_1	100% RDF viz., 1000:500:500 NPK (g/tree)	2.09
T_2	100% FYM	4.71
T_3	100% Vermicompost	5.30
T_4	50% FYM + 50% Vermicompost	5.05
T_5	75% RDF + 25% FYM	2.16
T_6	50% RDF + 50% FYM	3.19
T_7	25% RDF + 75% FYM	3.89
T_8	75% RDF + 25% Vermicompost	3.16
T_9	50% RDF + 50% Vermicompost	3.83
T_{10}	25% RDF + 75% Vermicompost	4.69
	Mean	3.81
	SE+	0.21
	CD at 5%	0.63

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