Effect of manures and fertilizers on the vegetative and fruit growth and bio-chemical composition of Sapota

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Abstract

The experiments were conducted to evaluate the vegetative growth, fruit growth and bio-chemical changes in fruits of Sapota due to the effect of genetic makeup and management practices. The first experiment comprised two factors namely (i) three Sapota varieties viz. V1= BAU Sapota 1, V2= BAU Sapota 3 and V3= Vietnam Sapota and (ii) different organic and inorganic fertilizers viz. T0= Control, T1= Cowdung: 10 kg/plant, T2= Cowdung: 15kg/plant, T3= Cow dung: 20 kg/plant, T4= Paragon compost: 1 kg/plant, T5= Paragon compost: 2 kg/plant, T6= Urea 100 g, TSP 50 g, MoP 50 g and cowdung 10 kg/plant. The second experiment comprised of single factor with three replications where two Sapota varieties viz. V1= BAU Sapota 1 and V2= BAU Sapota 3 were taken under study. The experiments were laid out in a randomized complete block design (RCBD) with three replications and the means were adjusted by LSD at 1 and 5% level of probability. In case of the first experiment, the tallest plant (49.50 cm), highest canopy volume (11014.765 cm3), more leaves (79.92/plant) and branches (12.00/plant) were significantly higher when T6 (Urea 100 g, TSP 50 g, MoP 50 g and Cowdung 10 kg) was applied in the BAU Sapota 3 (V2) at harvest or 210 DAT while those characters were lowest when manuring or fertilizer was not applied in the Vietnam Saota 27.70 cm, 2899.12 cm3, 13.09/plant and 1.0/plant, respectively). In case of the second experiment, the highest length of fruit (7.12 cm) and TSS of fruits (23.27%Brix) were recorded from BAU Sapota 3 while 5.85 cm length and 22.33% Brix TSS were obtained in BAU Sapota 1 at 119 DAFS. However, BAU Sapota 1 showed the superior performance in respect of fruit breadth (5.36 cm), fruit volume (87.0 ml), fresh and dry weight of fruit (81.55 and 20.85 g/fruit, respectively) and vitamin C content in fruit flesh (9.41 mg/100 g) compared BAU Sapota 3 (4.85 cm, 75.96 ml, 75.93 g, 19.25 g/fruit and 9.20 mg/100 g, respectively). The maximum total sugar, reducing sugar and no- reducing sugar content was recorded maximum 17.57%, 9.21% and 8.2 % respectively in BAU Sapota 3 and 16.52%, 8.8% and 7.7% respectively was recorded from BAU Sapota 1. BAU Sapota 1 contained the highest amount of titrable acidity (0.98%) at the initial stage (35 DAFS) of fruit setting and 0.82% was recorded in BAU Sapota 3 at the same time. The highest sugar acid ratio 70.33 was recorded from BAU Sapota 3 at 119 days after fruit set (DAFS) and 62.23 was recorded from BAU Sapota 1 at 119 DAFS. From the above findings it may be suggested that satisfactory growth of one year Sapota plant could be increased by the application of both organic and inorganic (Urea 100 g, TSP 50, MoP 50 g and cowdung 10 kg) fertilizers. It also may be suggested that the Sapota fruits are more suitable for harvesting at 112 to 119 DAFS in respect of fruit quality.

Keywords: Sapota, vegetative and fruit growth, biochemical composition, manures and fertilizers

Introduction

Sapota (*Manilkara achras*) is one of the prominent fruits belonging to the family Sapotaceae. It is originated from tropical America and now widely cultivated in the tropics, including India, Mexico, Vietnam, Guatemala and Venezuela (Roy and Joshi, 1997). Sapota is a fairly slow growing, long lived tree, upright and elegant, distinctly pyramidical when young. It is strong and wind

resistant, rich in white gummy latex (Rahim *et al.*, 2011). However, Sapota grown throughout the Bangladesh but it is widely grown in Barisal, Khulna, Jessore, Chittagong and Chittagong hill tract districts. Sapota starts bearing early from second or third year of planting and become mature 4–6 months after flowering. Finally the economical yields can be obtained from seventh year onwards. The main season of Sapota in Bangladesh is from December to March (Rahim *et al.*, 2011). The fruit is a fresh berry with a round, oval or conical shape and a sandy or granular texture. Average weight of fruit approximately 70–200 g at maturity, the honey–brown flesh imparts a pleasant, characteristic aroma and is very sweet (Kute and Shete, 1995). Sapota responds greatly to major essential nutrient elements like Nitrogen, Phosphorus, Potassium (NPK) in respect of its growth and yield (Bafna *et al.*, 2002). The growth and production of Sapota also greatly depends on manuring and fertilization along with other management practices. Fertilization is one of the most important intercultural operations that affect directly to the yield of Sapota. So, the manuring and fertilizer are need to applied in Sapota plant at right time for getting the optimum growth and yield (Bashir *et al.*, 2000). BAU–GPC has developed Sapota variety namely BAU Sapota 1, BAU Sapota 2 and BAU Sapota 3 to introduce at home and abroad. In addition, the climacteric nature of Sapota fruits necessitates careful postharvest handling to reduce losses, further hindering the storage and distribution of Sapota fruits. Major changes in the chemical composition of the fruit are strongly associated with its growth and fruit maturity (Shinde, 2003). So, the selection of most developing variety along with appropriate doses of manuring and fertilizer are very essential for getting higher vegetative growth and greater yield of Sapota in home and abroad. Besides, fruit growth and maturity along with agro–climatic condition are also effective for the biochemical changes in fruits. Keeping in view an above attempt, the present study was undertaken to determine the vegetative growth, fruit growth and biochemical changes in Sapota under different management practices to explore the effect of management practices on the growth of Sapota and to investigate the changes in the physical and chemical characteristics of the Sapota fruit.

Materials and Methods

The present experiment was conducted at the 'Bangladesh Agricultural University Germplasm Centre' (BAU–GPC) of Fruit Tree Improvement Program (FTIP), Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from April, 2011 to October, 2011. The soil of experimental area was silty loam in texture belonging to the Old Brahmaputra Flood Plain under the AEZ–9. The soil was medium high land, fertile, well drained, fairly leveled and slightly acidic with pH varying from 5.5 to 6.8. Soil color was dark grey due to rich in organic matter content. The total rainfall of the locality was 155.53 mm during the period from April, 2011 to October; 2011. The average temperature during the period of experiment was 26.80°C. The average humidity observed from April, 2011 to October, 2011 was around 82.73%. The research was two separate experiment where the first experiment was on the effects of management practices on vegetative growth of Sapota plant and the second experimentt was on the effects of variety on growth and physico–chemical changes of Sapota fruit. The first experiment comprised two factors namely (i) three Sapota varieties viz. V1= BAU Sapota 1, V2= BAU Sapota 3 and V3= Vietnam Sapota and (ii) different organic and inorganic fertilizers viz. T0= Control, T1= Cowdung (CD): 10 kg/plant, T2= CD: 15kg/plant, T3= CD: 20 kg/plant, T4= Paragon compost (PC): 1 kg/plant, T5= PC: 2 kg/plant, T6= Urea 100 g, TSP 50 g, MoP 50 g and CD 10 kg/plant. The second experiment comprised of single factor with three replications where two Sapota varieties viz. V1= BAU Sapota 1 and V2= BAU Sapota 3 were taken under study. Fertilizers were applied as per treatment and weeding, insect and pest management, irrigation and other activities were also done as an intercultural operation The data were recorded on various characteristics in respect of vegetative growth at harvest, fruit growth and bio–chemical changes at 7 days interval from 35 DAF to 119 DAF.

Data analysis

The experimental data were analyzed using MSTAT–C computer package program and the means were adjusted by LSD at 1 and 5% level of probability.

Results and Discussion

Experiment 1: Effect of management practices on vegetative growth of Sapota plant Effect s of variety

Effect of Sapota variety was significantly influenced the plant height, canopy volume, number of leaves and branches/plant at harvest. Among the varieties, BAU Sapota 3 showed overall superior performances in respect of vegetative growth. The tallest plant (39.36 cm), highest canopy volume (7631.05 cm^3), more leaves (42.93/plant) and branches (5.27/plant) were obtained in BAU Sapota 3. Similar effect was also found in respect of poorest effect among the above whole characters such as Vietnam Sapota showed the shortest plant (34.16 cm), lowest canopy volume (5642.32 cm^3), lowest number of leaves/plant (28.42) and branches/plant (2.42) in this study (Table 1).

Effects of management practices

A marked variation in vegetative growth such plant height, canopy volume, number of leaves and branches were observed due to influence of different management practices. Among the treatments, Urea 100 g, TSP 50, MoP 50 g and Cowdung 10 kg (T6) applied plant showed the highest performance among the whole vegetative characters such as height (44.06 cm), canopy volume (9907.21 cm^3), leaves/plant (67.66) and branches/plant (9.33) while the plant grown under Control treatment or fertilizer treated plot observed the lowest performance for the above characters (29.33 cm, 3443.54 cm^3, 17.78 and 1.66, respectively). Koller *et al.* (2000) conducted an experiment on 3 years old Vanjet sapota in Guatemala and reported that application of cattle manure and urea gave the highest values of yield, fruit quality and vegetative growth.

Effects of interaction of varieties and management practices

A significant variation due to the effect of interaction was also obtained for the vegetative growth characters of Sapota where plant height, canopy volume, number of leaves and branches were measured highest (49.50 cm, 11014.76 cm^3, 79.92/plant and 1.0/plant, respectively) when Urea 100 g, TSP 50, MoP 50 g and cowdung 10 kg (T6) were applied in BAU Sapota 3 plant. Similarly, without fertilized plant of Vietnam Sapota showed the lowest result among the above whole vegetative characters (27.70 cm, 2899.12 cm^3, 13.09/plant and 1.0/plant, respectively). However, lowest number of branches/plant was also obtained in 10 kg cowdung applied plant of Vietnam Sapota (Table 3).

Experiment 2: Effects of variety on growth and physico–chemical changes of Sapota fruit

Length and breadth of fruits

The length and breadth of the fruit of Sapota varieties were found to increase during the entire period of study from 28th November, 2011 to 21th February, 2011. The average length of fruit increased rapidly up to 105 DAFS while breadth of fruits increased up to 98 DAFS and then the growth was slowly increase up to 119 DAFS (Fig. 1 and 2). Finally, the length and breadth of fruits ranged from 5.85 cm to 7.12 cm and 4.85 to 5.36 cm, respectively. However, BAU Sapota 3 recorded the highest length but breadth was the highest in BAU Sapota 1 compared opposite variety (Fig. 1 and 2). Due to increase in number of cells as well as cell expansion fruit length and breadth was expanded with time. Paralkar *et al.* (2004) studied the fruit growth of sapota cv. Kalipatti and found similar result.

Table 1. Effect of varieties on vegetative growth characteristics of Sapota at harvest

Variety	Plant height (cm)	Canopy volume (cm^3)	Number of leaves/plant	branches/plant
BAU Sapota 1	38.22	6861.33	37.97	4.28
BAU Sapota 3	39.36	7631.05	42.93	5.57
Vietnam Sapota	34.16	5642.32	28.42	2.42
LSD0.05	**1.199**	**218.84**	**1.643**	**0.131**
LSD0.01	**1.602**	**292.44**	**2.195**	**0.175**
Level of significance	**	**	**	**

**= Significant at 1% level of probability

Table 2. Effects of management practices on vegetative growth characteristics of Sapota at harvest

Treatments	Plant height (cm)	Canopy volume (cm^3)	Number of leaves/plant	branches/plant
Control	29.23	3443.54	17.78	1.66
Cowdung (CD): 10 kg/plant	33.35	4007.55	22.33	2.00
Cowdung: 15kg/plant	37.65	7083.77	32.05	3.33
Cowdung: 20 kg/plant	37.67	7735.93	37.53	3.66
Paragon compost: 1 kg/plant	36.11	6309.66	25.43	2.66
Paragon compost: 2 kg/plant	42.66	8691.33	52.30	6.00
Urea 100g, TSP 50g, MoP 50g	44.06	9709.21	67.66	9.33
LSD0.05	**1.827**	**333.46**	**2.503**	**0.200**
LSD0.01	**2.444**	**446.05**	**3.348**	**0.267**
Level of significance	**	**	**	**

**= Significant at 1% level of probability

Table 3. Effects of interaction of variety and management practices on vegetative growth characteristics of Sapota at harvest

Variety × Treatment	Plant height (cm)	Canopy volume (cm^3)	Number of leaves/plant	branches/plant
V1T0	29.00	3435.09	19.57	2.00
V1T1	33.25	4011.54	25.16	2.00
V1T2	38.60	7377.32	35.65	4.00
V1T3	40.70	7977.32	39.82	3.00
V1T4	35.60	6459.33	27.31	3.00
V1T5	43.40	8812.32	52.91	6.00
V1T6	47.00	9956.44	65.39	10.00
V2T0	31.00	3996.43	20.68	2.00
V2T1	34.45	4665.23	27.00	3.00
V2T2	40.45	8176.54	38.34	4.00
V2T3	35.73	8577.42	45.63	6.00
V2T4	38.75	7324.67	29.66	3.00
V2T5	45.70	9662.34	59.25	9.00
V2T6	49.50	11014.76	79.92	12.00
V3T0	27.70	2899.12	13.09	1.00
V3T1	32.35	3345.88	14.83	1.00
V3T2	33.90	5697.45	22.16	2.00
V3T3	36.60	6653.07	27.15	2.00
V3T4	34.00	5144.98	19.33	2.00
V3T5	38.90	7599.34	44.75	3.00
V3T6	41.68	8156.45	57.66	6.00
LSD0.05	**3.174**	**579.29**	**4.348**	**0.347**
LSD0.01	**4.261**	**777.73**	**5.838**	**0.466**
Level of significance	**	**	**	**

**= Significant at 1% level of probability; V1= BAU Sapota 1, V2= BAU Sapota 3 and V3= Vietnam Sapota T0= Control, T1= CD: 10 kg/plant, T2= CD: 15kg/plant, T3= CD: 20 kg/plant, T4= PC: 1 kg/plant, T5= PC: 2 kg/plant and T6= Urea 100 g, TSP 50 and, MoP 50 g and CD (Cowdung) 10 kg/plant

Fresh and dry weight of fruit

Almost all the data recording period in respect of fresh and dry weight of fruit were affected significantly between the varieties. The result showed that the average fresh and dry weight of fruit increased rapidly up to 105 and 98 DAFS, respectively and then it increases slowly up to 119 DAFS (Fig. 4 and 5). In case of fresh weight, two varieties were measured highst (81.55 g/fruit) in BAU Sapota 1 and lowest (75.93

g/fruit) in BAU Sapota 3. Similarly, the highest dry weight (20.85 g/fruit) in BAU Sapota 1 and lowest (19.25 g/fruit) in BAU Sapota 3 (Fig. 3 and 4).

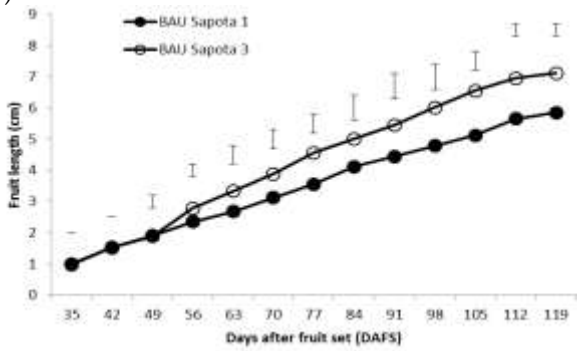

Fig. 1. Varietal difference in relation to fruit length of Sapota at different DAFS. Vertical bars indicate LSD at 1 % level of significance

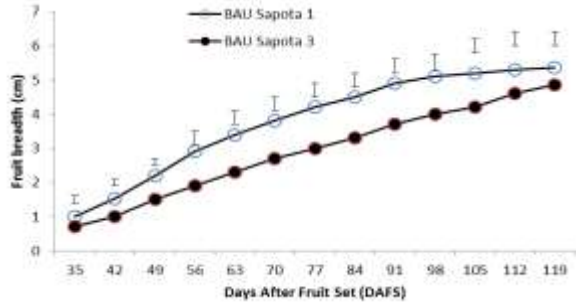

Fig. 2. Varietal difference in relation to fruit breadth of Sapota at different DAFS. Vertical bars indicate LSD at 1 % level of significance

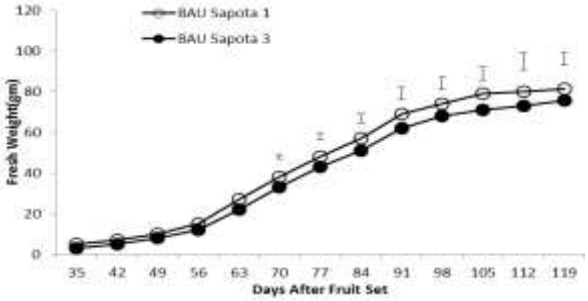

Fig. 3. Varietal difference in relation to fruit fresh weight of Sapota at different DAFS. Vertical bars indicate LSD at 1 % level of significance

Volume of fruit

Volume of fruit showed significant differences during 42 to 119 DAFS between the varieties at different growth stages while insignificant variation was observed during fruit setting to 35 DAFS. The result indicated that the average volume of fruit increased rapidly up to 105 days after fruit set and then it increases slowly up to 119 DAFS (Fig. 5). The average volume of fruit up to maturity stage was recorded maximum 87.0 ml in BAU Sapota 1 at 119 DAFS and 75.96 ml was recorded from BAU Sapota 3 at 119 DAFS.

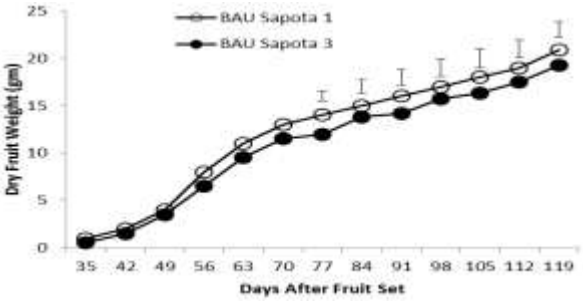

Fig. 4. Varietal difference in relation to fruit dry weight of Sapota at different DAFS. Vertical bars indicate LSD at 1 % level of significance

Total soluble sugar (TSS)

Total soluble solids content of two Sapota varieties were measured at different growth stage and found significant variations. From the result it was observed that the TSS content of both varieties were 0% at 35 DAFS then it was increased rapidly up to 105 DAFS and then it increases slowly up to 119 DAFS (Fig. 6). The highest (23.27 ^{o}Brix) TSS content was found in BAU Sapota 3 and (22.33 ^{o}Brix) was noted from the BAU Sapota 1. Das and Mahapatra (2002), revealed that total soluble solids of Sapota are increased with increasing DAFS and highest TSS content was (23.12 ^{o}Brix).

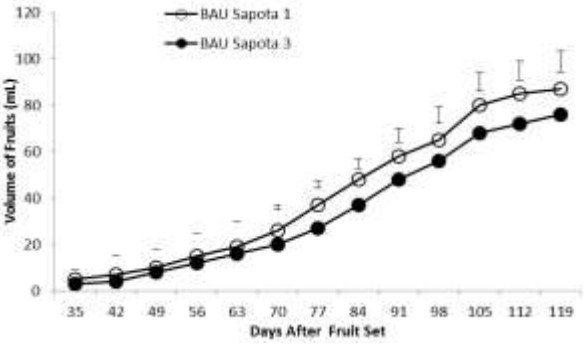

Fig. 5. Varietal difference in relation to fruit volume of Sapota at different DAFS. Vertical bars indicate LSD at 1 % level of significance

Sugar content of fruit

Almost all the data were found to show significant variations in relation to total, reducing and non–reducing sugar while total sugar content

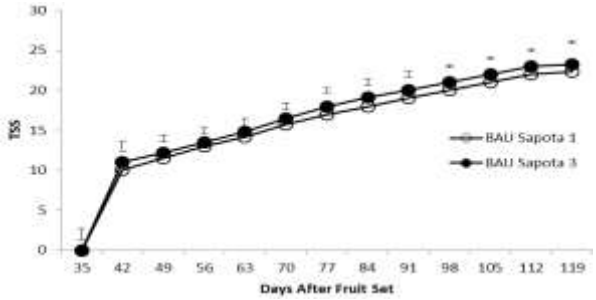

Fig. 6. Varietal difference in relation to fruit TSS of Sapota fruit at different DAFS. Vertical bars indicate LSD at 1 % level of significance

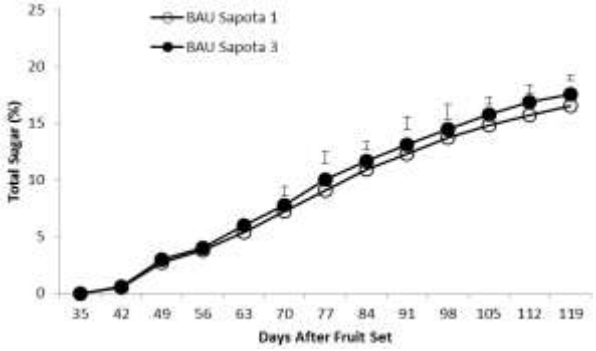

Fig. 7. Varietal difference in relation to total sugar of Sapota fruit at different DAFS. Vertical bars indicate LSD at 1 % level of significance

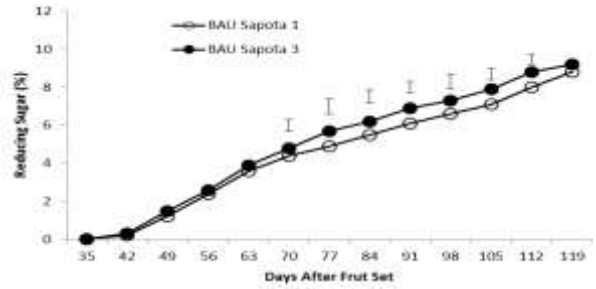

Fig. 8. Varietal difference in relation to reducing sugar of Sapota fruit at different DAFS. Vertical bars indicate LSD at 1 % level of significance

was insignificant during fruit setting to 56 DAFS, reducing sugar content during fruit setting to 70 DAFS. From the result of the present study it was observed that the total, reducing and non–reducing sugar content of both varieties were 0% at 35 DAFS then it was increased rapidly up to 112 DAFS for total and reducing sugar content while non–reducing sugar content up to 105 DAFS. Finally all types of sugar content increase slowly up to 119 DAFS (Fig. 7, 8 and 9). The total, reducing and non–reducing sugar contents at the maturity stage was recorded highest (17.57, 9.21 and 8.20%, respectively) in BAU Sapota 3 compared to BAU Sapota 1 (16.52, 8.80 and 7.70%, respectively). Lakshminarayana and Rivera (2000) also reported that the total sugars increased from the mature green (11.4%) to fully mature (18.0%) stage.

Vitamin C content

Different growth stages of Sapota fruits studied in the present experiment showed significant variation in relation to vitamin C content. The result of the experiment showed that the vitamin C content of fruit decreased rapidly up to 98 DAFS and then it decreases slowly up to 119 DAFS (Fig. 10).The fruit flesh of BAU Sapota 1 contained the highest amount of vitamin C (9.41 mg/100 g) at the initial stage of fruit setting and 9.20 mg/100 g was recorded in BAU Sapota 3(Fig. 10). Wards and Aurand (2000) stated that 100 g of eatable portion of sapota fruit contain at least 6 mg vitamin C.

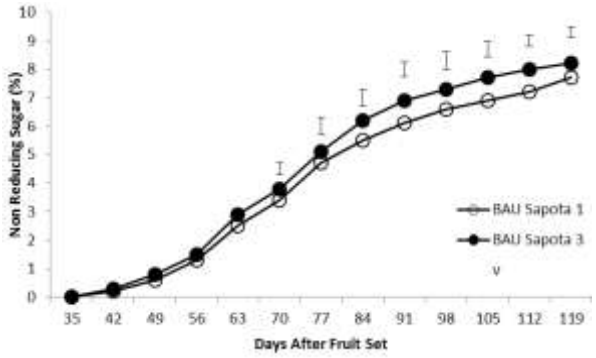

Fig. 9. Varietal difference in relation to non reducing sugar of Sapota fruit at different DAFS. Vertical bars indicate LSD at 1 % level of significance

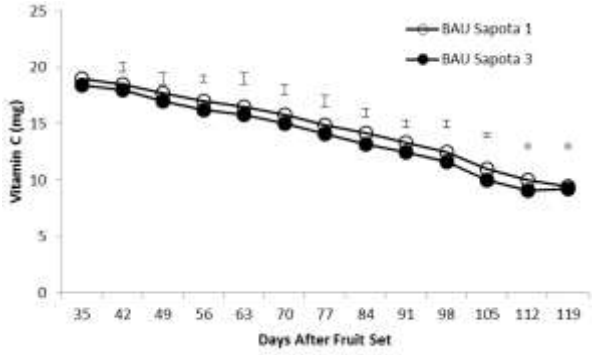

Fig. 10. Varietal difference in relation to vitamin C content of Sapota fruit at different DAFS. Vertical bars indicate LSD at 1 % level of significanc

Titratable acidity

Different growth stages of Sapota fruits studied also showed significant variation in relation to titratable acidity content. Figure showed that the titratable acidity content of fruit decreased rapidly up to 105 DAFS and then it decreases slowly up to 119 days after fruit set (Fig. 11). At the initial stage, both Sapota varieties content highest amount of titrable acidity but it decreased gradually day by day up to the final maturity. The fruit flesh of BAU Sapota 1 contained the highest amount of titratable acidity (0.98%) at the initial stage (35 DAFS) of fruit setting and 0.82 % was recorded in BAU Sapota 3 at the same time.

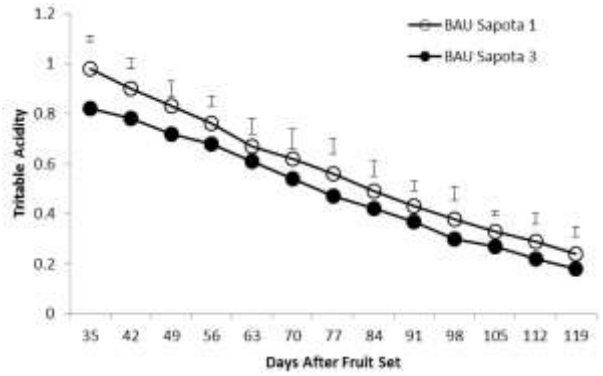

Fig. 11. Varietal difference in relation to titratable acidity content of Sapota fruit at different days after fruit set (DAFS). Vertical bars indicate LSD at 1 % level of significance

Conclusion and Recommendation

The result of the experiment showed that satisfactory growth of one year Sapota plant could be increased by the application of both organic and inorganic (Urea 100 g, TSP 50, MoP 50 g and Cowdung 10 kg) fertilizers. And it may be suggested that, at 112 to 119 DAFS Sapota fruits are more suitable for harvesting in respect of fruit quality. Further experiment may be conducted with the application of organic and inorganic fertilizers in case of Sapota plant more than one year ol**d.**

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