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Effect of foliar application of nutrient sources on fruit quality of sapota cv. Kalipatti

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Abstract
The present experiment was conducted during the year 2019-20 and 2020-21 at Instructional Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. The experiment was laid out in Completely Randomized Design with three repetition and eight treatments. Among the different treatments, foliar spray of T_8 [$Ca(NO_3)_2$ @ 0.6% + Boric acid @ 0.2% + NOVEL$^+$ @ 1.5%] was found better with respect to maximum TSS (21.03, 21.33 and 21.18 °Brix), ascorbic acid (18.97, 19.37 and 19.17 mg/100g), total sugars (18.23, 18.94 and 18.58%), reducing sugar (9.93, 10.33 and 10.13%), non-reducing sugar (8.30, 8.60 and 8.45%), shelf life (9.87, 10.07 and 9.97 days), organoleptic evaluation score and lower titrable acidity (0.109, 0.111 and 0.110%) during the year 2019-20, 2020-21 and pooled data, respectively.

Keywords: Sapota, Kalipatti, $Ca(NO_3)_2$, boric acid, NOVEL$^+$, quality

1. Introduction
Sapota botanically known as [*Manilkara achras* (Mill.) Fosberg] belongs to family Sapotaceae. It is popularly known as *chiku* and important fruit crop of the tropical region. It is native to Tropical America especially Southern Mexico or Central America. However, it is commercially cultivated in India, Philippines, Sri Lanka, Mexico, Venezuela, Guatemala and other countries of Central America. It is not much known when it was first introduced in India, but Gholwad village of Maharashtra state is credited to have the first plantation of sapota in 1898 (Chadha, 1992) [8] and it spreaded to the nearer states like Karnataka, Gujarat, Andhra Pradesh, West Bengal, Maharashtra and Tamil Nadu and now it occupies a significant position among the fruit crops in India. However, South Gujarat, Coastal Maharashtra and Karnataka are the major areas where it is extensively cultivated. Fruit of sapota is a fleshy berry. Sapota fruits are variable in shape like round, globular, conical and oval. The fully ripe fruit is delicious and sweet (contains about 12 to 18 per cent sugar) chiefly used for fresh table purpose. Hundred gram of sapota pulp contains 73.7% water, 1.1% fat, 0.7% protein, 5.3 g dietary fibre, 21.4 g carbohydrate, 28 mg calcium, 27 mg phosphorus, 2 mg iron and 6 mg ascorbic acid (Bal, 2006) [2].

The foliar application of nutrients plays a vital role in improving the quality and comparatively more effective for rapid recovery of plants. The foliar feeding of fruit tree has gained much importance in recent years, as nutrients applied through soil are needed in higher quantity because some amount leaches down and some become unavailable to the plant due to complex soil reactions. Boron is involved in physiological and biochemical processes inside the plant cell, altering the concentration and translocation of nutrients (Bergmann, 1984) [4]. Calcium nitrate fertilizer contains nitrogen and calcium, which are two major essential nutrients needed by the plants. Calcium is considered as one of the most important mineral determining the quality of fruit since it is required for cell elongation and cell division. Novel organic liquid nutrient formulation is good source of plant nutrient along with growth promoting substances like cytokinin, gibberellic acid *etc*. (Anon., 2014) [1].

Material and Methods
The present experiment was conducted during the year 2019-20 and 2020-21 at Instructional Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat. The uniform trees of sapota cv. Kalipatti were selected for experimentation. All experimental trees were uniformly treated in respect to fertilizers, irrigation and plant protection measures during the course of investigation as recommended by NAU, Navsari. The experiment was laid out in Completely Randomized Design with eight treatments comprising

of T_1 - Control, T_2 - $Ca(NO_3)_2$ @ 0.6%, T_3 - Boric acid @ 0.2%, T_4 - NOVEL$^+$ @ 1.5%, T_5 - $Ca(NO_3)_2$ @ 0.6% + Boric acid @ 0.2%, T_6 - $Ca(NO_3)_2$ @ 0.6% + NOVEL$^+$ @ 1.5%, T_7 - Boric acid @ 0.2% + NOVEL$^+$ @ 1.5%, T_8 - $Ca(NO_3)_2$ @ 0.6% + Boric acid @ 0.2% + NOVEL$^+$ @ 1.5% and the treatments were repeated thrice. The foliar spray of various nutrient sources was done on twice, first spray was done on fifteenth January and second spray was done on fifteenth February.

Results and Discussion

The results obtained from the present investigation are summarized below:

Total soluble solids (ºBrix)

The significantly higher values of TSS (21.03, 21.33 and 21.18 °Brix) were observed in the treatment T_8 [$Ca(NO_3)_2$ @ 0.6% + Boric acid @ 0.2% + NOVEL$^+$ @ 1.5%], which was statistically at par with treatment T_6 during the year 2019-20, 2020-21 and pooled data, respectively. Further treatment T_7 was also statistically at par with the treatment T_8 during the year 2020-21. The increase in TSS might be due to boron is responsible for sugar metabolism and accumulation of carbohydrates (Sourour, 2000) [17]. Moreover, foliar application of nutrient sources increased accumulation of carbohydrates, enhanced conversion of starch and pectin into soluble sugar. A similar view was also shared by Kumbar *et al*. (2019) [11] in sapota; Patel *et al.* (2018) [13] and Palak Kachhadia *et al.* (2020) [12] in mango; Singh *et al.* (2018) [15] in guava.

Ascorbic acid (mg/100 g)

Data regarding ascorbic acid showed significantly maximum (18.97, 19.37 and 19.17 mg/100g) under the treatment T_8 [$Ca(NO_3)_2$ @ 0.6% + Boric acid @ 0.2% + NOVEL$^+$ @ 1.5%], which was at par with treatment T_6 during both the years and pooled data, respectively. Moreover treatment T_7 was also at par with the same treatment during the year 2020-21. The increase in the ascorbic acid content might be due to respirational demand and adequate supply of nutrients synthesis of invertase and starch splitting enzymes (Ram and Prasad, 1988) [14]. The present observation is in conformity with the results reported by Kumbar *et al*. (2019) [11] 1in sapota; Patel *et al.* (2018) [13] in mango; Singh *et al.* (2018) [15] in guava; and Hadi *et al*. (2018) [10] in ber.

Titrable acidity (%)

Foliar application of treatment T_8 [$Ca(NO_3)_2$ @ 0.6% + Boric acid @ 0.2% + NOVEL$^+$ @ 1.5%] was noted significantly lower titrable acidity (0.109, 0.111 and 0.110%) during the year 2019-20, 2020-21 and pooled data, respectively. This treatment was statistically at par with treatment T_6 during the year 2020-21. The minimum acidity was noted by the application of nutrient sources probably due to increased cell size and intercellular spaces coupled with accumulation of water, sugar and other soluble solids in greater amount as a result of translocation of metabolites towards the fruit which decreased the acidity by increased sugar content of fruit. This was found in agreement with Kumbar *et al*. (2019) [11] in sapota; Patel *et al.* (2018) [13] and Palak Kachhadia *et al.* (2020) [12] in mango; Hadi *et al*. (2018) [10] in ber.

Table 1: Effect of foliar application of nutrient sources on fruit quality characters of sapota cv. Kalipatti

Treatments	TSS (°Brix)			Ascorbic acid (mg/100 g)			Titrable acidity (%)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
T_1	16.87	17.40	17.13	15.03	15.50	15.27	0.123	0.126	0.125
T_2	17.93	18.30	18.12	16.07	16.53	16.30	0.120	0.121	0.120
T_3	17.40	18.13	17.77	15.50	15.87	15.69	0.124	0.125	0.124
T_4	18.60	18.67	18.63	16.70	17.00	16.85	0.119	0.120	0.120
T_5	19.03	19.20	19.12	17.07	17.63	17.35	0.116	0.117	0.117
T_6	20.47	20.53	20.50	18.40	18.90	18.65	0.112	0.113	0.112
T_7	19.40	19.97	19.68	17.77	18.37	18.07	0.114	0.115	0.115
T_8	21.03	21.33	21.18	18.97	19.37	19.17	0.109	0.111	0.110
S.Em. ±	0.44	0.53	0.32	0.31	0.34	0.21	0.001	0.001	0.001
C.D. at 5%	1.32	1.58	0.90	0.94	1.02	0.60	0.002	0.004	0.002
S.Em.± (Y x T)	-	-	0.49	-	-	0.33	-	-	0.001
C.D. at 5% (Y x T)	-	-	NS	-	-	NS	-	-	NS
C.V.%	4.06	4.75	4.43	3.22	3.38	3.30	1.21	1.83	1.55

Total sugars (%)

Significantly the highest total sugars content (18.23, 18.94 and 18.58%) was reported under the treatment T_8 [$Ca(NO_3)_2$ @ 0.6% + Boric acid @ 0.2% + NOVEL+ @ 1.5%] during both the years and pooled data, respectively.

Foliar spray of nutrient sources increased the sweetness of fruits, which was due to more intensive transformation of starch into sugars and its translocation into fruits might have increased both reducing and non-reducing sugars and ultimately total sugars.

Further, boron is also responsible for sugar metabolism and accumulation of carbohydrates (Sourour, 2000) [17] which also have contributed for enrichment of sweetness. Similar observations were also reported Kumbar *et al*. (2019) [11] in sapota; Palak Kachhadia *et al.* (2020) [12] and Patel *et al.* (2018) [13] in mango and Baranwal *et al.* (2017) [3] in guava.

Reducing sugar (%)

Among various treatments, T_8 [$Ca(NO_3)_2$ @ 0.6% + Boric acid @ 0.2% + NOVEL$^+$ @ 1.5%] was recorded the highest reducing sugar content (9.93, 10.33 and 10.13%) during the year 2019-20, 2020-21 and pooled data, respectively. This treatment was found statistically at par with treatment T_6 during the year 2019-20. The increase in reducing sugar content with foliar spray $Ca(NO_3)_2$, Boric acid and NOVEL$^+$ may be attributed to the quick metabolic transformation of starch and pectin into soluble compounds, and rapid translocation of starch and pectin into soluble compounds from leaves to developing fruits and ultimately enhanced conversion of starch and pectin into soluble sugar. The present study also corroborated the findings of Kumbar *et al*. (2019) [11] in sapota; Palak Kachhadia *et al.* (2020) [12] and Patel *et al.* (2018) [13] in mango and Singh *et al.* (2018) [16] in sweet orange.

Non-reducing sugar (%)

Likewise, highest non reducing sugar (8.30, 8.60 and 8.45%) was registered under the treatment T_8 [$Ca(NO_3)_2$ @ 0.6% + Boric acid @ 0.2% + NOVEL$^+$ @ 1.5%] during the year 2019-20, 2020-21 and pooled data, respectively. This treatment was statistically similar with the treatment T_6 and T_7 during the both years. The increase in non-reducing sugar content with foliar application of $Ca(NO_3)_2$, boric acid and NOVEL$^+$ was possibly associated with high metabolic changes in the fruits leading to conversion of complex polysaccharides into simple sugar. Similar results were recorded by Kumbar *et al.* (2019) [11] in sapota; Palak Kachhadia *et al.* (2020) [12] and Patel *et al.* (2018) [13] in mango and Singh *et al.* (2018) [16] in sweet orange.

Shelf life (days)

The maximum shelf life of sapota (9.87, 10.07 and 9.97 days) was recorded due to the imposition of treatment T_8 [$Ca(NO_3)_2$ @ 0.6% + Boric acid @ 0.2% + NOVEL$^+$ @ 1.5%], which was at par with treatment T_6 during the year 2019-20, 2020-21 and pooled data, respectively. Moreover treatment T_7 was at par with the same treatment during both the years. The highest shelf life it may be due to calcium treatments have better shelf life because of it helps in structural integrity of both the cell wall and plasma membrane which delaying ripening and extending storage life.

Moreover, way NOVEL$^+$ contain of gibberellic acid to enhance shelf life due to act as anti-ethylene and ultimately delay ripening process. The finding is in agreement with the results reported by Guvvali *et al.* (2017) [9] and Bhalerao *et al.* (2009) [6] in sapota; Palak Kachhadia *et al.* (2020) [12] and Patel *et al.* (2018) [13] in mango.

Table 2: Effect of foliar application of nutrient sources on fruit quality characters of sapota cv. Kalipatti

Treatments	Total sugars (%)			Reducing sugar (%)			Non-reducing sugar (%)			Shelf life (days)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
T_1	14.90	15.30	15.10	8.00	8.10	8.05	6.90	7.20	7.05	7.00	7.40	7.20
T_2	15.87	16.30	16.08	8.60	8.77	8.68	7.27	7.53	7.40	8.13	8.33	8.23
T_3	15.33	15.87	15.60	8.30	8.53	8.42	7.03	7.33	7.18	7.60	7.80	7.70
T_4	16.13	16.57	16.35	8.80	9.20	9.00	7.33	7.37	7.35	8.47	8.80	8.63
T_5	16.60	17.27	16.93	9.10	9.43	9.27	7.50	7.83	7.67	9.13	8.93	9.03
T_6	17.67	18.17	17.92	9.73	10.00	9.87	7.93	8.17	8.05	9.47	9.87	9.67
T_7	17.13	17.67	17.40	9.33	9.50	9.42	7.80	8.17	7.98	9.33	9.67	9.50
T_8	18.23	18.94	18.58	9.93	10.33	10.13	8.30	8.60	8.45	9.87	10.07	9.97
S.Em. ±	0.19	0.19	0.12	0.13	0.11	0.08	0.20	0.23	0.14	0.22	0.26	0.16
C.D. at 5%	0.56	0.57	0.35	0.39	0.32	0.23	0.59	0.68	0.39	0.65	0.79	0.46
S.Em.± (Y x T)	-	-	0.19	-	-	0.12	-	-	0.21	-	-	0.24
C.D. at 5% (Y x T)	-	-	NS	-	-	NS	-	-	NS	-	-	NS
C.V.%	1.95	1.93	1.94	2.49	2.00	2.25	4.57	5.04	4.82	4.34	5.15	4.77

Organoleptic score

A perusal of the data presented in Table 3 & 4 indicated that organoleptic score of fruit was significantly affected by the foliar application of nutrient sources in sapota. The highest organoleptic score (Colour, flavour, texture, taste, aroma and overall acceptability) was noted in sapota by the impose of treatment T_8 [Ca $(NO_3)_2$ @ 0.6% + Boric acid @ 0.2% + NOVEL$^+$ @ 1.5%] during both the years and pooled data, respectively. The results are in conformity with Bhalerao *et al.* (2009) [6] in sapota; Bhalerao *et al.* (2014) [5] in papaya; Patel *et al.* (2018) [13] in mango and Bhoyar and Ramdevputra (2016) [7] in guava.

Table 3: Effect of foliar application of nutrient sources on organoleptic score of sapota cv. Kalipatti

Treatments	Colour			Flavour			Texture		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
T_1	5.27	5.40	5.33	6.27	6.20	6.23	5.53	5.20	5.37
T_2	5.53	5.67	5.60	6.67	6.60	6.63	6.07	5.93	6.00
T_3	5.33	5.53	5.43	6.53	6.33	6.43	5.73	5.53	5.63
T_4	5.60	5.80	5.70	6.93	6.67	6.80	6.40	6.20	6.30
T_5	5.80	5.93	5.87	7.13	7.07	7.10	6.47	6.47	6.47
T_6	6.13	6.27	6.20	7.53	7.47	7.50	7.27	7.00	7.13
T_7	5.93	6.20	6.07	7.33	7.20	7.27	7.07	6.87	6.97
T_8	6.33	6.60	6.47	8.13	7.87	8.00	7.87	7.47	7.67
S.Em. ±	0.14	0.16	0.10	0.16	0.18	0.11	0.12	0.19	0.10
C.D. at 5%	0.42	0.48	0.28	0.48	0.54	0.32	0.35	0.57	0.30
S.Em.± (Y x T)	-	-	0.15	-	-	0.17	-	-	0.16
C.D. at 5% (Y x T)	-	-	NS	-	-	NS	-	-	NS
C.V.%	4.27	4.67	4.48	3.96	4.53	4.25	3.12	5.20	4.25

Table 4: Effect of foliar application of nutrient sources on organoleptic score of sapota cv. Kalipatti

Treatments	Taste			Aroma			Overall acceptability		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
T_1	6.93	6.67	6.80	6.20	6.10	6.15	6.13	6.00	6.07
T_2	7.40	7.07	7.23	6.60	6.80	6.70	6.53	6.47	6.50
T_3	7.13	6.80	6.97	6.40	6.53	6.47	6.33	6.13	6.23
T_4	7.53	7.13	7.33	6.87	6.93	6.90	6.73	6.60	6.67
T_5	7.67	7.40	7.53	7.07	7.20	7.13	6.93	6.87	6.90
T_6	8.07	7.80	7.93	7.33	7.47	7.40	7.33	7.20	7.27
T_7	7.87	7.60	7.73	7.27	7.20	7.23	7.13	7.07	7.10
T_8	8.33	8.13	8.23	7.80	7.93	7.87	7.73	7.67	7.70
S.Em. ±	0.26	0.16	0.14	0.16	0.20	0.12	0.07	0.08	0.05
C.D. at 5%	0.77	0.49	0.40	0.48	0.59	0.33	0.20	0.23	0.14
S.Em.± (Y x T)	-	-	0.22	-	-	0.18	-	-	0.07
C.D. at 5% (Y x T)	-	-	NS	-	-	NS	-	-	NS
C.V.%	5.82	3.90	4.99	3.99	4.84	4.44	1.68	2.01	1.85

Conclusion

On the basis of findings, it can be concluded that foliar application of T_8 [$Ca(NO_3)_2$ @ 0.6% + Boric acid @ 0.2% + NOVEL$^+$ @ 1.5%] was found effective for increasing total soluble solids, ascorbic acid, total sugar, reducing sugar, non-reducing sugar, shelf life, organoleptic score and minimum acidity of sapota cv. Kalipatti.

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