**Standardization of stage wise requirement of nutrients in sapota**

**ABSTRACT**

The present investigation was conducted during year 2017-2021 at Agricultural Research Station, Palghar, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, to find out the optimum stage wise nutrient requirement of sapota for higher fruit production under north Konkan condition of Maharashtra. Treatment T2 at four different growth stages *i.e* at vegetative stage in June (20-40-32% NPK), at fruit set in September (20-0-16% NPK), at fruit pea stage in November (20-40-16% NPK) and at fruit growth stage in February (20-0-16% NPK) with application of vermicompost, biofertilizers and micronutrients recorded significantly highest plant canopy volume (125.84m3), number of fruits per tree (1768.31), highest yield per tree (144.89 kg) and per hectare (14.49 t/ha). While, treatment T1 recorded maximum plant height (6.78 m) and average fruit weight (81.44 g) whereas, lowest values recorded in treatment T5 (Control).

**Key words :** *Biofertilizers*, *Micronutrient, NPK, Vermicompost, Sapota, Yield*.

**INTRODUCTION**

Sapota (*Manilkara achras* Mill Forsberg) is the one of the most important irrigated tropical fruit crop in Maharashtra. The area under this crop in Maharashtra is around 18,000 hectares, out of which 70 per cent area under Palghar and Thane district. It has unique importance in the economy of the farmers in the district. It was not known when it was first introduced in India. The sapota cultivation was first introduced in 1898 in a village Gholwad, Dist. Thane, Maharashtra (Chaddha 1993). The Sapota fruits of Gholwad pockets of Palghar district are very famous in India as ‘Gholwad Chikoo’

Now a days sapota become a most important remunerative fruit crop which is grown successfully since beginning of the 20th century. It is an evergreen tree. Time of Sapota harvesting span is too long as compare to other fruit crops. Market price and shelf life of sapota fruit more in the winter season crop as compare to summer season crop. Therefore, there is need to increase winter season yield by splitting the nutrient doses. Sapota having the highest flowering during the month of December to February and their after requirement of nutrients was round the year. Application of organic and inorganic source of nutrient may be helpful in increase vegetative and reproductive growth of sapota. Micronutrients can tremendously boost horticultural crop yield and improve quality and post-harvest life of horticultural produce (Raja, 2009). Konkan region situated at costal lowland that gets about 2072-3800 mm annual average rainfall (Dakhore *et al.,* 2017). Under tropical conditions, soil nutrients are leached or lost rapidly due to high rainfall and various factors like soil texture and structure. Therefore, it is important to apply nutrients at the critical stages of tree growth at small doses, at short intervals, to minimize loss of nutrients and cost of production which is helpful for improving nutrient use efficiency and expected yield.

**MATERIAL AND METHODS**

The field experiment was carried out at NARP Farm, Agricultural Research Station, Palghar, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli during year 2017-2021. The selected orchard is located in Northern Konkan region of Maharashtra state at latitude 19°73ˈ and longitude 72°76ˈ at an altitude of 52.9 metres above the mean sea level. The experiment was laid out in Randomized Block Design with four replications. The experiment was imposed on twenty year old Kalipatti variety with spacing of 10 X 10 m and divided with 5 treatment plots having four plants per unit.

**Table 1**: The treatment details

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 80% dose of RDF (3:3:3 kg NPK/ tree) | | | | |
| Treatments | Stages of crop growth | | | | Common dose  (Remaining 20% RDF) |
| I Vegetative flush (June) | II Fruit set (September) | III Fruit pea stage (November) | IV Fruit growth (February) |
| N-P-K | N-P-K | N-P-K | N-P-K |
| T1 | 32-40-20 | 16-0-20 | 16-40-20 | 16-0-20 | \*15 kg Vermicompost + Azotobacter 100g and PSB 100g per tree (108cfu/mg) in June.  Micronutrient spray in October (ZnSO4-0.6%, Fe SO4-0.4%, Mn SO4-0.2%,  CuSO4-0.2%,  Borax-0.2%) |
| T2 | 20-40-32 | 20-0-16 | 20-40-16 | 20-0-16 |
| T3 | 20-80-20 | 20-0-20 | 20-0-20 | 20-0-20 |
| T4 | 20-40-20 | 20-0-20 | 20-40-20 | 20-0-20 |
| T5 (Control) | 50-100-50 | 25-0-25 | 25-0-25 | 0-0-0 |

The soil type of experimental plot was black cotton soil with good drainage capacity having initial soil and nutrient status namely pH-6.21, soil EC- 0.29dsm-1, soil organic carbon 5.21 g/Kg-1, available N-264.25 kg ha-1, available P-39.91 kg ha-1, available K-339.50 kg ha.-1

Total five treatments were tried in comparison to control. The four treatments comprising the four stages based on RDF application were tested with control. The chemical fertilizers as per treatment were applied at four stages (June, September, November and February) considering 3 kg N + 3 kg P2O5 + 3 kg K2O/plant/year as recommended dose of fertilizer (RDF) in the region. 80% of RDF will be given through fertigation and the rest 20% was compensated through vermi-compost, bio-fertilizers through ring method in June and spraying of micronutrient in October. The irrigation should be given by drip. The observations on growth were recorded twice in a year, while the recording of observations on yield and yield attributes is continue with each harvesting of fruits. The data were recorded on plant height (m), plant canopy volume (m3), number of fruits per tree, average fruit weight (g), yield per tree (kg) and yield per hectare (t). The analysis of variance (ANOVA) of different variables and treatments was statistically calculated at the 5% level of significance (Panse and Sukhatme, 1985).

**RESULTS AND DISCUSSION**

The analysis of variance for design of experiment indicated significant differences among nutrients for all the treatments.

**Growth parameters:**

**Plant height :**

Data presented in Table 2 revealed that, the plant height varied significantly among all the treatments of sapota under study during the course of investigation. Significantly the highest plant height was recorded in treatment T1 – (32-40-20, 16-0-20, 16-40-20, 16-0-20 N-P-K respectively) in the month of June, September, November and February. Further the treatment T1 was at par with the treatment T2, However, lowest plant height was recorded in treatment T5. These findings confirm with the findings of Kaul Bhatnagar (2006) who observed that, increase in growth of fruit plants by the application of N (Nitrogen) in Kinnow mandarin. Mirji *et al.* (2023) reported that Nitrogen, phosphorus and potassium are most indispensable of all mineral nutrients for growth and development of the plant as these are the basis of fundamental constituents of all living matter, these properties of fertilizer causes an increase in photosynthesis and increased leaf area there by it might have increased the plant height.

**Canopy volume**

From the data presented in Table 2 observed that, the Canopy volume (m3) of sapota in different treatment varied significantly. The treatment T2 -(20-40-32, 20-0-16, 20-40-16, 20-0-16 N-P-K respectively) recorded maximum canopy volume throughout the experimental years. Further it was noticed that treatment T1 was at par with the treatment T3 during study. The minimum plant canopy volume was recorded in treatment T5. The accurate combination of FYM and higher dose of nitrogen resulted easy and readily available of nitrogen from urea which increase the growth and canopy of sapota plant. Similar result reported by Devashi V. (2012), Singh *et. al*. (2000), Boora and Singh (2000) and Singh *et. al.* (2003).

**Yield attributes characters:**

**Number of fruits:**

Significant variation in number of fruits, average fruit weight and fruit yield might be due to equal dose of fertilizer application. The data indicated in Table- 3 represent significantly maximum number of fruits per tree in treatment T2 –(20-40-32, 20-0-16, 20-40-16, 20-0-16 N-P-K). Further, the treatment T1 – (32-40-20, 16-0-20, 16-40-20, 16-0-20 N-P-K) was at par with the treatment T3. However, lowest number of fruits was noticed in treatment T5- (50-100-50, 25-0-25, 25-0-25, 0-0-0). Zn is an essential element required by plants for different metabolic process and play vital part in enzyme activation and biosynthesis of specific growth hormones. Similarly, B is also involved in metabolism and translocation of carbohydrate, hormonal activities and pollen tube elongation. It also enhances flower initiation, fruit production, N absorption, growth of plants and indirectly influences fruit set. (Pawar *et al*. 2024)

**Fruit weight:**

The data in Table. 3 represented that, fruit weight was recorded significantly varied among all the treatments under study. The treatment T1 – (32-40-20, 16-0-20, 16-40-20, 16-0-20 N-P-K) recorded significantly maximum fruit weight and the treatment T1 was at par with the treatment T2 –(20-40-32, 20-0-16, 20-40-16, 20-0-16 N-P-K) during study. While, the minimum fruit weight was recorded in treatment T5- (50-100-50, 25-0-25, 25-0-25, 0-0-0).

**Fruit yield kg / tree and T/ha**

Data presented in Table 4 revealed that, the highest average fruit yield per tree and fruit yield per hectare was significantly recorded in treatment T2 –(20-40-32, 20-0-16, 20-40-16, 20-0-16 N-P-K) during study. While, treatment T4 was at par with treatment T5 in year 2019-20 and 2020-2021. However, the lowest fruit yield per tree and fruit yield per hectare was recorded in treatment T5- (50-100-50, 25-0-25, 25-0-25, 0-0-0). Increase in yield may be due to improvement in morphological trails such as plant height, plant canopy volume, number of fruits and uptake higher nutrients by plants of treatment (T2). Increase yield due to proper supply and translocation of nutrients at the time of vegetative growth, flowering, fruit setting and fruit development. In fact, combine application of organic and chemical fertilizers might have better influence on synthesis and translocation of metabolites ultimately accumulated towards the tissue and thus resulted into better fruit yield. These results are in consistent with Meena *et al.* (2019), Anusha *et. al* (2021) Hedge and Shrinivas *et al.* (2001), Boora *et. al.* (2002), Baviskar *et.al.* (2011), Cheena *et al.* (2018).

**CONCLUSION**

The application of fertilizers (NPK) at four different growth stages ie.,(20-40-32 % NPK in June, 20-0-16 NPK in September, 20-40-16 % NPK in November and 20-0-16 % NPK in February) 80% recommended dose of chemical Fertilizers (3:3:3 kg NPK/tree) and application of 20% RDF through 15 kg Vermicompost + Azotobacter 100g and PSB 100g per tree (108cfu/mg) in June. Spraying of micronutrients in October (ZnSO4-0.6%, FeSO4-0.4%, MnSO4-0.2%, CuSO4-0.2%, Borax-0.2%) can be recommended to get optimum growth and highest yield under north Konkan region of Maharashtra condition.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (Chat GPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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**Table 2.** Effect of stage wise fertilizer application on plant height (m) and canopy volume (m3) of Sapota during the year 2017-2021

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Plant height (m)** | | | | | | | **Canopy volume (m3)** | | | | | | |
| **2017-18** | **2018-19** | **2019-20** | **2020-21** | **2021-22** | **Pooled mean** | **% Increase over control** | **2017-18** | **2018-19** | **2019-20** | **2020-21** | **2021-22** | **Pooled mean** | **% Increase over control** |
| **T1** | 5.90 | 6.21 | 6.64 | 7.28 | 7.87 | 6.78 | 20.43 | 83.16 | 91.33 | 108.77 | 126.02 | 149.05 | 111.67 | 34.87 |
| **T2** | 5.77 | 6.11 | 6.48 | 7.21 | 7.68 | 6.65 | 18.12 | 91.05 | 103.43 | 123.98 | 144.89 | 165.84 | 125.84 | 51.98 |
| **T3** | 5.19 | 5.37 | 5.51 | 6.41 | 6.94 | 5.88 | 04.44 | 80.84 | 87.90 | 102.50 | 119.46 | 138.09 | 105.76 | 27.73 |
| **T4** | 5.09 | 5.24 | 5.42 | 6.18 | 6.71 | 5.73 | 01.78 | 68.14 | 75.80 | 86.51 | 101.18 | 119.17 | 90.16 | 08.89 |
| **T5** | 4.97 | 5.15 | 5.33 | 6.14 | 6.56 | 5.63 | - | 63.11 | 69.46 | 81.39 | 94.60 | 106.47 | 82.80 | - |
| **‘F’ test** | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** |  | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** |  |
| **S. Em. ±** | 0.13 | 0.14 | 0.13 | 0.20 | 0.20 | 0.16 | 2.59 | 3.02 | 3.83 | 3.54 | 4.12 | 3.52 |  |
| **C.D. at 5%** | 0.42 | 0.42 | 0.40 | 0.61 | 0.62 | 0.49 | 7.80 | 9.06 | 11.49 | 10.62 | 12.36 | 10.27 |  |

**Table 3:** Effect of stage wise fertilizer application on number of fruits/tree and Avg. fruit weight (g) of Sapota during the year 2017-2021

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **No. of Fruits/tree** | | | | | | | **Avg. fruit weight (g)** | | | | | | |
| **Treatments** | **2017-18** | **2018-19** | **2019-20** | **2020-21** | **2021-22** | **Pooled mean** | **% Increase over control** | **2017-18** | **2018-19** | **2019-20** | **2020-21** | **2021-22** | **Pooled mean** | **% Increase over control** |
| **T1** | 1517.20 | 1580.51 | 1694.91 | 1617.35 | 1701.86 | 1622.37 | 22.04 | 75.10 | 79.03 | 82.02 | 83.35 | 87.70 | 81.44 | 16.59 |
| **T2** | 1587.73 | 1671.39 | 1843.88 | 1796.05 | 1942.50 | 1768.31 | 33.02 | 70.92 | 77.96 | 83.29 | 84.30 | 86.11 | 80.52 | 15.28 |
| **T3** | 1406.16 | 1497.45 | 1609.69 | 1573.45 | 1630.73 | 1543.50 | 16.11 | 68.21 | 72.65 | 75.33 | 74.10 | 79.12 | 73.88 | 05.77 |
| **T4** | 1344.39 | 1369.77 | 1425.33 | 1464.17 | 1485.54 | 1417.84 | 06.65 | 71.21 | 71.52 | 72.65 | 73.09 | 74.34 | 72.56 | 03.87 |
| **T5** | 1269.85 | 1294.17 | 1317.62 | 1375.70 | 1389.55 | 1329.38 | - | 66.08 | 68.17 | 70.67 | 71.92 | 72.42 | 69.85 | - |
| **‘F’ test** | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** |  | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** |  |
| **S. Em. ±** | 32.18 | 18.97 | 35.12 | 36.80 | 23.41 | 29.30 | 1.79 | 1.70 | 1.32 | 1.88 | 1.45 | 1.63 |  |
| **C.D. at 5%** | 96.54 | 56.95 | 108.12 | 110.41 | 70.25 | 88.45 | 5.42 | 5.10 | 4.18 | 5.65 | 4.36 | 4.94 |  |

**Table 4:** Effect of stage wise fertilizer application on yield (kg/tree) and yield (t/ha) of Sapota during the year 2017-2021

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Yield (kg/tree)** | | | | | | | **Yield (t/ha)** | | | | | | |
| **Treatments** | **2017-18** | **2018-19** | **2019-20** | **2020-21** | **2021-22** | **Pooled mean** | **% Increase over control** | **2017-18** | **2018-19** | **2019-20** | **2020-21** | **2021-22** | **Pooled mean** | **% Increase over control** |
| **T1** | 113.94 | 125.02 | 139.03 | 141.88 | 142.39 | 132.45 | 42.42 | 11.39 | 12.50 | 13.90 | 14.19 | 14.24 | 13.24 | 41.60 |
| **T2** | 121.60 | 130.34 | 153.67 | 151.59 | 167.26 | 144.89 | 55.03 | 12.16 | 13.03 | 15.37 | 15.16 | 16.73 | 14.49 | 54.97 |
| **T3** | 102.92 | 108.74 | 121.26 | 116.63 | 128.97 | 115.70 | 23.80 | 10.29 | 10.87 | 12.13 | 11.66 | 12.90 | 11.57 | 23.74 |
| **T4** | 95.71 | 97.95 | 103.97 | 106.28 | 110.45 | 102.87 | 10.07 | 9.57 | 9.79 | 10.40 | 10.63 | 11.05 | 10.29 | 10.05 |
| **T5** | 86.64 | 88.17 | 93.02 | 98.89 | 100.60 | 93.46 | - | 8.66 | 8.82 | 9.30 | 9.89 | 10.06 | 9.35 | - |
| **‘F’ test** | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** |  | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** | **Sig** |  |
| **S. Em. ±** | 2.53 | 2.77 | 3.88 | 2.95 | 2.83 | 2.99 | 0.32 | 0.35 | 0.20 | 0.26 | 0.28 | 0.28 |  |
| **C.D. at 5%** | 7.60 | 8.52 | 11.94 | 8.85 | 8.50 | 9.08 | 0.96 | 1.05 | 0.60 | 0.78 | 0.85 | 0.85 |  |