Effect of Nano NPK Fertilizers on Growth, Yield and Fruit Quality of Sapota [*Manilkara achrus* (Mill.). Fosberg] Cv. Kalipatti

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Authors Contribution

Priyanka Mirji : Data collection and data analysis;
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Abstract

The study was conducted in the Department of Horticulture, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru during the year 2020-2022 to investigate the 'Effect of nano NPK fertilizers on growth and quality of sapota [*Manilkara achrus* (Mill.). Fosberg] Cv. Kalipatti'. The experiment was planned with randomized complete block design (RCBD) consisting of 12 treatments and 3 replications. The maximum plant height (3.78 m) was noticed in the treatment T_{10} (50% RDF + 0.3% Nano NPK fertilizer foliar spray), maximum chlorophyll content (2.30 mg/ g) was noticed in the treatment T_9 **(**50% RDF + 0.2% Nano NPK fertilizer foliar spray) and maximum fruit length (6.53 mm), fruit width (5.43 mm), pulp weight (26.67g), TSS (22.33 °Brix), reducing sugar (9.31%) and total sugars (22.18%) were noticed in treatment T_9 (50 per cent of RDF and foliar application of 0.2% of nano NPK fertilizer). Among all the different treatments T_9 (50 per cent of RDF and foliar application of 0.2% of nano NPK fertilizer) and T_8 (50 per cent of RDF and foliar application of 0.1 per cent of nano NPK fertilizer) were proved significant improvement for plant growth, yield and quality of sapota fruits.

Keywords : Nano NPK, RDF, Sapota, Kalipatti, Foliar spray

Sapota [*Manilkara achras* (Mill.) Fosberg] native of Mexico belongs to the botanical family Sapotaceae. It is mainly introduced for its delicious fruits. Many fruit growers were attracted to the cultivation of sapota on account of its better adaptation to diverse soil and climatic conditions. It is getting popular in countries *viz*., India, Sri Lanka, Jamaica, Burma, Philippines, Central Asia and Southern Florida (USA).

It is gaining more importance in the tropical, sub-tropical and semiarid climate. It can also sustain in waste land and marginal lands, but fruit set, yield and the economy were inferior due to improper nutrition. This crop also suffers from a malady called mummification or stone fruit, is very severe in old orchards in certain areas of hill zones. The severity leads to a loss of crop to the tune of more than 70 per cent (Satish, 2003).

The successful commercial cultivation of this crop depends on many factors such as climate, soil, irrigation, fertilizer, spacing and season of growing *etc.* Among the different management practices, nutrient management plays an important role in growth, yield and economy of fruit crop. To perform sustainable yield and economy, it needs high amount of nutrients (Mishra, 2014).

The intensive and exploitative agriculture with high inputs and high yielding varieties and improved technologies, have helped for better fruit production. But, competition for water and nutrients and the major nutrients usually supplied through straight fertilizers in large quantities for improving fruit set, productivity and to meet nutritional requirement of the fruit trees. But, application of straight fertilizers leads to evaporation, leaching and run off of nutrients. Hence, the experiments have been conducted to reduce the nutrient losses and increase the nutrient use efficiency of fertilizers through use of nano-fertilizers. These nano-fertilizers shown significantly improved yield in different fruit crops. Therefore, based on the possible benefits of soil and foliar application of nano-fertilizers (NFs) seems to be benificial.

Nano-fertilizers (NFs) are widely used in fruit crop nutrition as soil based and spray based applications (Pruthviraj *et al.,* 2022) that provide nutrients with high efficiency and low waste due to their faster and higher translocation to different parts of plants. After penetrating the leaf or root cuticle tissue, NFs move through different pathways (apoplastic, symplastic, lipophilic and hydrophilic), which influence their effectiveness, final fate and may also change their properties and reactivity, delivery and translocation inside plant tissues, which may result in various responses of different plant parts to the same NP (Nano Particle).

NFs are much smaller than conventional materials and due to a greater surface area to weight ratio, different shapes and higher penetrability, they may have more significant effects on growth and developmental processes and can directly enter leaf tissues through stomata. The concentration and consumption time of NFs can influence their effects on plants and different plant processes (Rame Gowda *et al.,* 2022). Due to their tiny scale, NPs have high penetrability into plant tissues and high concentrations of NFs may negatively affect growth and development. To prevent these negative effects, they are generally applied in very low concentrations at the mg L^{-1} level. Therefore, to achieve higher yield and lower damage applied in lower concentration to reach required nutrients by the plants, also reduce the use of large amount of inorganic fertilizers (50%) in conventional method and reduce the cost of about 10 per cent compared to conventional fertilizers.

Material and Methods

A field study on 'Effect of nano NPK fertilizers on plant growth and quality of sapota fruits Cv. Kalipatti' was initiated during 2020-2022. The experiment was conducted in the Department of Horticulture, UAS, GKVK, Bengaluru. The experiment site is situated in Eastern dry zone (Zone-5) of Karnataka State at 13° 05" North latitude and 77° 34" East longitude with an elevation of about 924 meters above mean sea level. The major rainfall received from South-West monsoon between June to September months and North-East monsoon between October to December months. The soil type of experimental site is red sandy to lateritic with clay content. The available nitrogen, phosphorous and potassium in soil were 94.08, 333.45 and 135.74 kg ha^{-1} respectively, which indicate that the soil is medium in available P while deficient in available N and K content.

The experiment was laid out in Complete Randomized Block Design (RCBD) with twelve treatments and three replications consisting of different concentrations of nano fertilizers and RDF application for sapota trees. Sapota trees were planted at distance of 10 x 10m (Standing crop) 30 years old trees. The treatments were T_1- Control (RDF 400: 160: 150 g/plant), T_2- Water soluble normal NPK fertilizers foliar spray (NPK fertilizer), T_3- 25 per cent RDF (100: 40: 37 g/plant) + 0.1 per cent Nano NPK fertilizer foliar spray, T_4- 25 per cent RDF + 0.2 per cent Nano NPK fertilizer foliar spray, T_5- 25 per cent RDF + 0.3 per cent Nano NPK fertilizer foliar spray, T_6- 25 per cent RDF + 0.4 per cent Nano NPK fertilizer foliar spray, T_7- 25 per cent RDF + 0.5 per cent Nano NPK fertilizer foliar spray, T_8- 50 per cent RDF (200: 80: 75 g/plant) + 0.1 per cent Nano NPK fertilizer foliar spray, T_9- 50 per cent RDF + 0.2 per cent Nano NPK fertilizer foliar spray, T_{10}- 50 per cent RDF + 0.3 per cent Nano NPK fertilizer foliar spray, T_{11}- 50 per cent RDF + 0.4 per cent Nano NPK fertilizer foliar spray, T_{12}- 50 per cent RDF + 0.5 per cent Nano NPK fertilizer foliar spray.

The treatments were imposed to sapota trees in split application and first imposition was done through foliar application of nano NPK fertilizers for three times-first at the end of last season harvest, second spray at one month after the first spray and third spray when fruit lets were at pea size and soil application of RDF was at a once. Other cultural operations were attended to keep the plot clean and plant protection measures were carried out at regular intervals.

Selected tree for each treatment with three replications were tagged for recording observations on various parameters of plant growth, yield and quality. The mean value of the data was taken to represent a particular treatment with respect to character. Fruits were randomly selected from tagged shoots in each treatment to study the quality and postharvest parameters.

Results and Discussion

Tree Height

Tree height of sapota, influenced by different treatments consisting of different concentrations of RDF and nano NPK fertilizers was recorded and the values for plant height were significantly higher in treatment T_{10} (3.78m), however it was on par with T_9 (3.73m), T_7 (3.67m) and T_8 (3.62m). The treatment T_1 (2.93m) recorded significantly lower values for plant height (Table 1). This might be due to the fact that nano fertilizer has unique properties due to its more surface area with high absorption, which causes an increase in photosynthesis and increased leaf area hence, increased the plant height (Sekhon, 2014). The results are in conformity with the findings of Sabir *et al*. (2014) in blueberries and Mohasedat *et al*. (2018) in apple.

Chlorophyll Content

Chlorophyll content of sapota leaves significantly differed among the treatments and was recorded highest chlorophyll content of leaf in treatment T_9 (2.30 mg/ g) depicted in Table 1. which was on par with the treatment T_8 (2.20 mg/ g) and T_{10} (2.10 mg/g). This might be due to foliar spray of nano formulations enhanced the availability of nutrients by easy penetration through stomata of leaves *via* gas exchange. Nitrogen fertilizer activates the enzymes associated with chlorophyll formation hence it increases the chlorophyll content in the leaves. The same observations were made by Roshdy and Refai (2016) in date palm and Abdelaziz *et al*. (2019) in mango.

Table 1

Effect of nano NPK fertilizers on plant height and chlorophyll content of sapota

Treatments	Tree Tree height (m)	Chlorophyll content (mg/g)
T_1	2.93	1.98
T_2	3.00	1.98
T_3	3.10	1.93
T_4	3.53	1.97
T_5	3.60	2.05
T_6	3.67	2.03
T_7	3.55	2.03
T_8	3.62	2.20
T_9	3.73	2.30
T_{10}	3.78	2.10
T_{11}	3.53	1.98
T_{12}	3.30	1.82
Mean	3.45	2.03
F test	*	*
SEm±	0.05	0.06
CD @ 5%	0.17	0.20
CV	2.85	5.95

Yield and Quality Parameters

Fruit length, width and number of seeds per fruit : The results revealed that there was a significant difference among the treatments. Maximum length and width of fruit was observed in the treatment T_9 (6.53 mm and 5.43 mm respectively), however which was on par with treatment T_8 (6.43mm and 5.27mm respectively) and lowest fruit length and width was observed in T_1 (5.30mm and 4.23mm respectively) depicted in Table 2. This may be due to nano fertilizers which are unique in behaviour and characteristic delivery the nutrients throughout the plant growth period and especially potassium has a positive effect on the process of dividing and expanding the cells by stimulating the expansion of cell wall, thus increased fruit length and width. The

TABLE 2

Effect of nano NPK fertilizers on fruit length and width and number of seeds per fruit of sapota

Treat-ments	Length of fruit (cm)	Width of fruit (cm)	Number of seeds per fruit	Fruit pulp weight (g)	Rind weight (g)
T_1	5.30	4.23	1.00	16.67	16.67
T_2	5.47	4.83	1.67	18.33	15.67
T_3	5.50	5.13	1.00	22.67	15.00
T_4	5.93	5.10	1.67	25.00	13.00
T_5	5.60	5.13	2.00	25.33	14.00
T_6	5.50	5.13	1.33	25.33	13.67
T_7	5.43	4.70	1.33	25.67	13.67
T_8	6.43	5.27	1.67	25.67	13.00
T_9	6.53	5.43	1.33	26.67	12.33
T_{10}	5.73	4.50	1.67	26.00	14.33
T_{11}	5.33	4.37	1.67	22.67	13.00
T_{12}	5.53	4.33	1.67	23.33	14.00
Mean	5.69	4.85	1.50	23.61	14.03
F test	*	*	NS	*	NS
SEm±	0.15	0.084	-	1.19	-
CD@5%	0.45	0.25	-	3.50	-
CV	4.72	2.095	-	8.75	-

similar results are in conformity with the findings of Sabir *et al.* (2014) in blue berries, Kamiab and Zamanibahramabadi (2016) in almond and Mohamad Gad *et al.* (2021) in mango. The values for number of seeds per fruit among all the treatments were non-significant.

Fruit Pulp Weight and Rind Weight

The results revealed that values for fruit pulp weight differed significantly among the treatments. The highest fruit pulp weight was recorded in the treatment T_9 (26.67 g) followed by T_8 (25.67 g) and lowest fruit pulp weight was recorded in T_1 (16.67 g). The value for rind weight was non-significant among all the treatments (Table 2.). There was increase in pulp weight may be due to highest fruit size, Except TSS content of Table 3, other contents have to be merged in Table 2 along with fruit weight. TSS content is to be depicted in Table 3 for understanding of fruit and biochemical contents.

TSS of Fruit

The results revealed that values for TSS of fruit differed significantly among the treatments (Table 3.). The highest TSS of fruit recorded in the treatment T_9 (22.33 °Brix) followed by T_8 (21.67 °Brix) and TSS of fruit was recorded in T_1 (17.33 °Brix respectively). There was increased TSS of fruit pulp may be due to nano-fertilizers application confirms the importance of nanoparticles as unique in behavior and characteristics, such as the small size, delivery of nutrients and highly active area, which increased the rapidity of fruit chemical reactions. These results are in consistent with Roshdy and Refaai (2016) in date palm and Mohamad Gad *et al*. (2021).

Sugar Content

Reducing, Non-reducing and Total sugars content in fruit pulp was estimated and it was found statistically

TABLE 3

Effect of nano NPK fertilizers on TSS of sapota fruits

Treatments	TSS °Brix
T_1	17.33
T_2	17.67
T_3	19.00
T_4	19.67
T_5	21.67
T_6	19.67
T_7	19.33
T_8	21.67
T_9	22.33
T_{10}	19.67
T_{11}	18.67
T_{12}	20.33
Mean	19.75
F test	*
SEm±	0.65
CD @ 5%	1.92
CV	5.75

significant among the treatments. The highest value for reducing sugar was observed in T_9 (9.31%) which was on par with T_8 (9.28%). Similarly, the value for total sugars was observed highest in T_9 (22.18) however which was on par with T_8 (22.16%) and T_{10} (21.19%). The lowest values for both reducing sugar and total sugars were observed in T_1 (7.40% and 17.37% respectively). Non- significant results were obtained for non-reducing among the treatments (Table 4). This might be due to the fact that important regulatory effect of nano fertilizers in activating metabolic enzymes, biosynthesis and translocation of sugars, water absorption and nutrient transport which might have increased the sugar level in the fruit. These results are in consistent with Abdelaziz *et al.* (2019) in almond, Wassel *et al.* (2017) in grape and Mosa *et al.* (2021) in peach.

On the basis of present investigation it may be concluded that 50 per cent of RDF with foliar application of 0.2 per cent nano NPK fertilizer and 50 per cent of RDF with foliar application of 0.1 per cent of nano NPK fertilizer were proved significant for improved tree tree growth, yield and quality of sapota fruit when compared with other treatments especially with respect to obtaining maximum tree tree height, chlorophyll content and quality attributes (Fruit length, width, number of seeds per fruit, fruit pulp weight, rind weight, TSS of fruit, reducing, non-reducing and total sugars).

TABLE 4

Effect of nano NPK fertilizers on reducing sugar, non reducing sugar and total sugars in sapota pulp

Treat-ments	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
T_1	7.40	16.67	17.37
T_2	8.20	15.67	18.40
T_3	8.02	13.33	19.30
T_4	8.22	13.00	19.60
T_5	9.07	15.00	18.92
T_6	6.06	13.67	16.93
T_7	9.20	13.67	19.15
T_8	9.28	14.00	22.16
T_9	9.31	12.33	22.18
T_{10}	8.40	14.33	21.19
T_{11}	7.82	13.00	17.67
T_{12}	8.13	14.00	18.34
Mean	8.26	14.06	19.27
F test	*	NS	*
SEm±	0.14	-	0.53
CD @ 5%	0.42	-	1.56
CV	3.05	-	4.79

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