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Impact of integrated nutrient management on the growth and yield of sugar apple (*Annona squamosa* L.) cv. Sindhan

Rikshita R Gondaliya, ND Polara, Yukta J Patel, Sandip Makhmale and Shivani R Patel

Abstract
The investigation entitled "Impact of Integrated Nutrient Management on the Growth and Yield of Sugar apple (*Annona squamosa* L.) cv. Sindhan" was carried out between 2022 and 2023 at the Fruit Research Station, Madhadi Baugh Farm, under the direction of the Department of Fruit Science at the College of Horticulture, Junagadh Agricultural University, Junagadh. A total of three replications and nine treatments were implemented in the experiment's Randomized Block Design. The results showed that the custard apple (*Annona squamosa* L.) cv. Sindhan's growth and yield metrics had been significantly affected by the use of various Integrated Nutrient Management (INM) treatments.
Application of 2.5 kg of vermicompost, 50 ml of Azotobacter, and 50 ml of PSB per plant, along with 75% the recommended fertilizer dose (RDF), resulted in the highest incremental plant height (66.00 cm), incremental canopy spread (north-south) (84.33 cm), incremental canopy spread (east-west) (90.67 cm), and maximum fruit weight (224.10 g), fruit length (7.58 cm), fruit girth (7.50 cm), the maximum number of fruit per tree (129.83), fruit yield per tree (27.87 kg) and fruit yield per hectare (7.72 tons).

Keywords: Custard apple, INM, RDF, *Azotobacter*, growth and yield

1. Introduction
The main dry land fruit crop in India is the custard apple (*Annona squamosa* L.), commonly referred to as the sugar apple or Sitaphal. It is part of the Annonaceae family, with over 120 species and 40 genera, only five of which are edible. Among the Annonas, the Sugar apple (*Annona squamosa* L.) holds greater value. Other species include *Annona reticulata* (*Ramphal*), *Annona cherimola* (*Laxmanphal*), and *Annona atemoya* (*Hanumanphal*). The custard apple is often referred to as the "poor man's fruit".
Different species of Annona originated in various regions. *Annona squamosa* L. originated in Central America and later spread to Mexico and Tropical America. In India, custard apple is cultivated on approximately 47 thousand hectares of land, with a production of 407 thousand metric tons and a productivity of 8.66 metric tons per hectare. In Gujarat state, which contributes significantly to custard apple cultivation, the area under cultivation is 7289 hectares, with a production of 73.498 thousand metric tons and a productivity of 10.08 metric tons per hectare. Junagadh district in Gujarat accounts for 650 hectares of custard apple cultivation and production of 6.110 thousand metric tons.
By ensuring the availability of nutrients in the soil for succeeding crop seasons, integrated nutrient management strategies foster long-term sustainability in production. It is normal practice to utilize organic fertilizers to increase fruit crop yields while avoiding the usage of chemicals and unfavourable environmental effects. Because organic manures are more environmentally benign and have favourable impacts on both ecosystems and fruit crops, these are preferred over chemical fertilizers due to their high cost and restricted purchasing power. (Kumar *et al*., 2017)

2. Materials and Methods
The experiment titled "Impact of integrated nutrient management on the growth and yield of sugar apple (*Annona squamosa* L.) cv. Sindhan" was conducted in 2022 at the Fruit Research Station, Madhadi Baugh Farm, within the Department of Fruit Science at the College of Horticulture, Junagadh Agricultural University, Junagadh.

The experiment was carried out in Randomized Block Design with three replications and 10 treatments comprised of 100% RDF per plant (T_1), 75% RDF + 2.5 kg Vermicompost per plant (T_2), 50% RDF + 5 kg Vermicompost per plant (T_3), 75% RDF + 50 ml *Azotobacter* + 50 ml PSB per plant (T_4), 50% RDF + 100 ml *Azotobacter* + 100 ml PSB per plant (T_5), 75% RDF + 2.5 kg Vermicompost + 50 ml *Azotobacter* + 50 ml PSB per plant (T_6), 50% RDF + 5 kg Vermicompost + 100 ml *Azotobacter* + 100 ml PSB per plant (T_7), 75% RDF + Seaweed extract @ 1.5% per plant (T_8) and 50% RDF + Seaweed extract @ 3% per plant (T_9). The plants were spaced at a distance of 6 meters by 6 meters. Various growth and yield parameters, including incremental plant height (in centimeters), incremental tree canopy spread (north-south and east-west) (in centimeters), fruit weight (in grams), fruit length (in centimeters), fruit girth (in centimeters), number of fruits per tree, fruit yield per tree (in kilograms), and fruit yield per hectare (in tons), were observed. The collected data were subjected to statistical analysis following the method outlined by Panse and Sukhatme (1985). The appropriate standard error of the mean (S. Em.±) and the critical difference (CD) were calculated at a 5% level of probability.

3. Result and Discussion

The results presented in Tables 1 and 2 demonstrate that the application of Integrated Nutrient Management (INM) had a significant impact on the growth, yield and yield-attributing parameters of custard apple in this experiment.

3.1 Plant growth parameters

The data obtained from the investigation clearly indicated that the application of various Integrated Nutrient Management (INM) treatments had a significant influence on the growth parameters of the plants, including the incremental plant height and the incremental tree canopy spread in both the north-south and east-west directions.

The maximum incremental plant height (66.00 cm) was noted effective with the application of 75% RDF + 2.5 kg Vermicompost + 50 ml *Azotobacter* + 50 ml PSB per plant (T_6), which was at par with T_1, T_2, T_4 and T_7 treatments (56.83 cm, 60.00 cm, 57.83 cm and 65.33 cm, respectively). Similarly, maximum incremental canopy spread (N-S) (84.33 cm) was noted with the application of 75% RDF + 2.5 kg Vermicompost + 50 ml *Azotobacter* + 50 ml PSB per plant (T_6) and it was at par with treatment T_7 (71.86 cm). The maximum incremental canopy spread (E-W) (90.67 cm) was noted with the application of 75% RDF + 2.5 kg Vermicompost + 50 ml *Azotobacter* + 50 ml PSB per plant (T_6). It was at par with treatment T_2, T_3, T_4 and T_7 (83.67 cm, 79.33 cm, 80.67 cm and 87.00 cm, respectively).

The synergistic effects of using bio-fertilizers, inorganic and organic manure, and both can be blamed for the reported outcomes. This integration enhanced the soil's biological and physical properties, improving its fertility and the plant's availability of nutrients. Similar findings have been reported by Bhatnagar and Singh (2015) [1], Sharma *et al.* (2016) [9], and Sharma *et al.* (2014) [20] in custard apple; Bakshi *et al.* (2018) [3] in mandarin; Talang *et al.* (2017) [23] in mango; Godage *et al.* (2013) [7] in guava and Vasava *et al.* (2023) [24] in Brinjal, further validating the positive effects of these practices on plant growth and yield.

3.2 Yield and yield attributing parameters

The collected data clearly indicated that the application of various Integrated Nutrient Management (INM) treatments had a significant impact on important yield parameters, including fruit weight, fruit length, fruit girth, number of fruits per tree and fruit yield.

Significantly, the application of 75% RDF + 2.5 kg Vermicompost + 50 ml *Azotobacter* + 50 ml PSB per plant (T_6) resulted in the highest fruit weight (224.10 g), fruit yield per tree (27.87 kg), and fruit yield per hectare (7.72 tons). Additionally, this treatment also led to the maximum fruit length (7.58 cm), which was comparable to treatments T_4 (6.81 cm) and T_7 (6.94 cm). The maximum fruit girth (7.50 cm) was noted in T_6, while treatments T_4, T_5 and T_7 showed girths of 6.92 cm, 6.68 cm, and 6.99 cm, respectively. The highest number of fruits per plant (129.83) was recorded with T_6, which was on par with T_7 (122.33).

The constant availability of vitamins and nutrients, which encouraged cell division and expansion, finally led to greater fruit production, which could be responsible for the marked improvement in fruit output and yield attributes. The application of organic sources of nutrients and bio-fertilizers improved fertilizer use efficiency, leading to enhanced fruit length, diameter, and weight, thereby maximizing fruit yield per tree. Similar findings have been reported by Raut *et al.* (2020) [17], Parasana *et al.* (2021) [12] and Parsana *et al.* (2023) [13] in custard apple; Kanwar *et al.* (2020) [8] in papaya; Singh and Varu (2013) [21] in papaya; Musmade *et al.* (2010) [10] in acid lime; Ramamurthy *et al.* (2006) [16] in mandarin; Reddy and Swami (1986) [18], Dheware and Waghmare (2009) [6], and Patel *et al.* (2009) [11] in sweet orange; Ram *et al.* (2012) [15] and Sutariya *et al.* (2018) [22] in phalsa and Baviskar *et al.* (2011) [4] in sapota.

Table 1: Effect of INM on plant growth parameters of sugar apple (*Annona Squamosa* L.) cv. Sindhan

Sr. No.	Treatments	Incremental plant height (cm)	Incremental canopy spread (N-S), (cm)	Incremental canopy spread (E-W) (cm)
T_1	100% RDF per plant	56.83	60.83	71.00
T_2	75% RDF + 2.5 kg Vermicompost per plant	60.00	66.67	83.67
T_3	50% RDF + 5 kg Vermicompost per plant	51.67	65.00	79.33
T_4	75% RDF + 50 ml *Azotobacter* + 50 ml PSB per plant	57.83	61.67	80.67
T_5	50% RDF + 100 ml *Azotobacter* + 100 ml PSB per plant	52.67	65.83	74.00
T_6	75% RDF + 2.5 kg Vermicompost + 50 ml *Azotobacter* + 50 ml PSB per plant	66.00	84.33	90.67
T_7	50% RDF + 5 kg Vermicompost + 100 ml *Azotobacter* + 100 ml PSB per plant	65.33	71.86	87.00
T_8	75% RDF + Seaweed extract @ 1.5% per plant	54.57	60.00	70.67
T_9	50% RDF + Seaweed extract @ 3% per plant	49.50	57.50	68.33
S.Em.±		3.566	4.244	4.849
C. D. at 5%		10.69	12.72	14.54
C. V. %		10.81	11.14	10.72

Table 2: Effect of INM on yield and yield attributing parameters of sugar apple (*Annona squamosa* L.) cv. Sindhan

Sr. No.	Treatments	Fruit Weight (g)	Fruit Length (cm)	Fruit Girth (cm)	Number of fruit per tree	Fruit yield (kg/tree)	Fruit yield (t/ha)
T_1	100% RDF per plant	162.12	5.47	5.70	69.00	11.15	3.09
T_2	75% RDF + 2.5 kg Vermicompost per plant	173.88	6.18	6.30	92.83	15.72	4.35
T_3	50% RDF + 5 kg Vermicompost per plant	171.10	5.93	6.41	84.00	14.33	3.97
T_4	75% RDF + 50 ml *Azotobacter* + 50 ml PSB per plant	194.16	6.81	6.92	112.50	20.82	5.77
T_5	50% RDF + 100 ml *Azotobacter* + 100 ml PSB per plant	181.76	6.72	6.68	104.00	17.68	4.90
T_6	75% RDF + 2.5 kg Vermicompost + 50 ml *Azotobacter* + 50 ml PSB per plant	224.10	7.58	7.50	129.83	27.87	7.72
T_7	50% RDF + 5 kg Vermicompost + 100 ml *Azotobacter* + 100 ml PSB per plant	200.18	6.94	6.99	122.33	23.95	6.63
T_8	75% RDF + Seaweed extract @ 1.5% per plant	167.55	5.82	6.10	80.17	13.00	3.60
T_9	50% RDF + Seaweed extract @ 3% per plant	163.31	6.02	6.16	76.83	12.40	3.43
S. Em.±		4.885	0.272	0.292	4.103	1.246	0.346
C. D. at 5%		14.65	0.82	0.88	12.30	3.74	1.04
C. V. %		4.65	7.38	7.75	7.34	12.38	12.38

4. Conclusion

Based on the results obtained from the present investigation, it can be concluded that application of 75% RDF + 2.5 kg Vermicompost + 50 ml *Azotobacter* + 50 ml PSB per plant as a basal dose resulted in enhanced all plant growth parameters and yield and yield attributing parameters. In conclusion, the application of 75% RDF (11.25 kg FYM and 150:75:150 g NPK per plant) + 2.5 kg Vermicompost + 50 ml *Azotobacter* + 50 ml PSB proved to be advantageous for achieving higher yields in custard apple under the agro-climatic conditions of South Saurashtra.

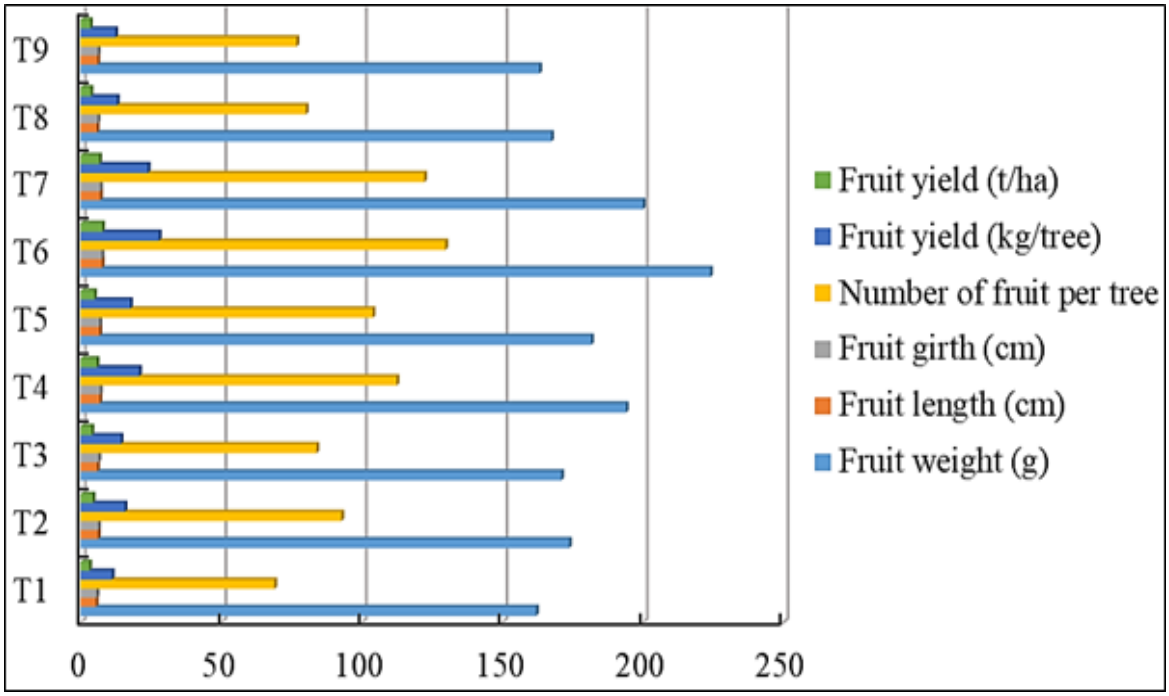

Fig 1: Effect of INM on yield and yield attributing parameters of sugar apple (*Annona squamosa* L.) cv. Sindhan

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