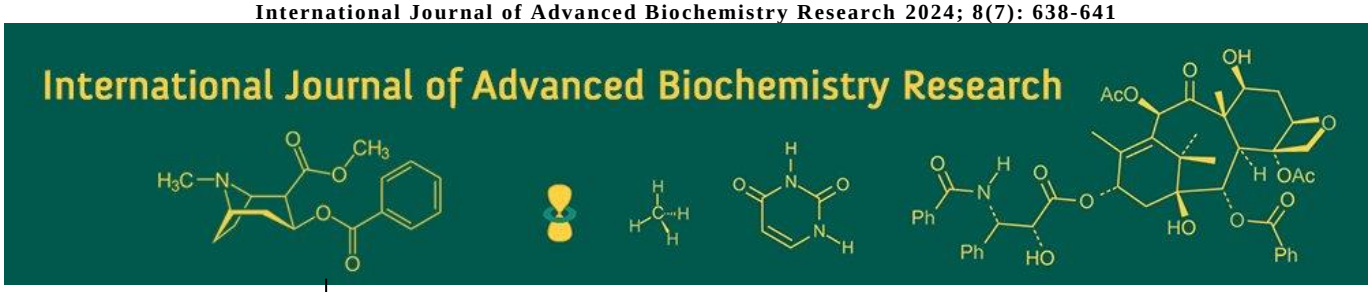

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Effect of foliar application of nano urea on growth and yield of custard apple (*Annona squamosa* L.) CV. GJCA-1

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Abstract
A field experiment was conducted to study the effect of foliar application of nano urea on growth and yield of custard apple (*Annona squamosa* L.) cv. GJCA-1 during the year 2023-2024 at Madhadibaug, Fruit Research Station, Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh. The experiment that uses a randomized block design (RBD) with eleven treatments and three replications. The results revealed that the variation due to different treatments of nano urea was found significant and highest incremental tree height (87.00 cm), incremental tree canopy spread N-S (90.83 cm) and incremental tree canopy spread E-W (88.50 cm), chlorophyll content index (50.03 CCI) and leaf area (90.20 cm^2) was found in treatment 100% RDN + 0.5% Nano urea (T_5). While, maximum number of fruits per tree (86.93), fruit yield per tree (15.27 kg), fruit yield per hectare (4.23 tonnes) was noted in 100% RDN + 0.4% Nano urea (T_4). Therefore, concluded that using nano urea enhances the growth and yield of custard apple.

Keywords: Custard apple, urea, nano urea, growth, yield, GJCA-1

Introduction
Custard apple (*Annona squamosa* L.) is one of the most important dry land fruit crops in India. It's popularly called as Sitaphal in the South and Sharifa in the North India. It's extensively distributed throughout the tropical and sub-tropical region. The custard apple is part of the Annonaceae family, which includes 40 genera and 120 species, with only five of them are edible. The origin of different species of Annona is reported to be at various regions. *Annona squamosa* L., commonly known as the sugar apple, originated in Central America. From there, it was distributed to Mexico and other parts of Tropical America (Popenoe, 1974) [18]. This species is well-adapted to warm climates and has become a popular fruit in many tropical regions worldwide. "Sindhan" is a local variety set up in most of Girnar hills of Junagadh quarter in Gujarat state. Gujarat Junagadh Custard apple-1 (GJCA-1) is new variety named from Sindhan released by JAU, Junagadh. In India, it's cultivated on an estimated area of 45 thousand hectares with 387 thousand MT production with productivity 8.45 MT/ha. In Gujarat, it is cultivated on an estimated area of 7289 hectares with 73.50 thousand MT of production with productivity 10.08 MT/ha. The plant of custard apple is shrub or small trees in general, with fairly short and smooth trunk reaching height of 5.0 to 7.5 cadence. Due to hard nature, tree escape from animal damage. Custard apple is a drought tolerant, hardy and grows well even in shallow soil without much care. It's deciduous in nature which sheds leaves during winter. New growth flush comes during spring with the inauguration of flowers. It's erect, with a round or spreading crown. Plant height ranges from 4.50-6.00 m and trunk size is 25.00-35.00 cm. The leaves are arranged alternatively oblong or narrow lanceolate having 10.00-20.00 cm length and 2.00-5.00 cm width with conspicuous veins.

Foliar application refers to the process of supplying essential nutrients to plants by spraying their solutions onto the vegetative parts of the plants. Foliar application is practiced specific concertation's and time, allowing the plant to absorb the nutrients through the stomata of the leaves or through the cell walls and membrane. (Bolashetti *et al.,* 2023) [6]. Plant nutrition plays a vital role in agricultural production and crop quality. For fruit crops, proper fertilization during growth phase can significantly enhance both the yield and the quality of

the harvest. Nitrogen plays important roles in plant growth and development as well as in fruit yield and quality, being required for chlorophyll and enzyme conflation and constituting a component of proteins, metabolites, and nucleic acids (Barker and Pilbeam, 2007; Titus and Kang, 1982) [4, 22]. Regarding N fertilizers, the application of nanotechnology can provide fertilizers that release N leaching and emissions and long-term incorporation by soil microorganisms. (Naderi and Danesh-Shahraki, 2013) [15].

Materials and Methods

The present investigation was carried out during the year 2023-2024 at Madhadibaug, Fruit Research Station, Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh. Junagadh is located in Gujarat's South Saurashtra Agro-climatic Region. Geographically, this location is located at 21.50° N latitude and 70.50° E longitude, at an elevation of 60 meters above mean sea level and 80 kilometers west of the Arabian Sea Coast near the foothills of Mount 'Girnar.' The trail was set up in a Randomized Block Design with three replications and eleven treatments. Treatments details like T_1 (Absolute control), T_2 [RDF% (NPK 200:100:200 g/plant)], T_3 (100% RDN + 0.3% Nano urea) T_4 (100% RDN + 0.4% Nano urea), T_5 (100% RDN + 0.5% Nano urea), T_6 (75% RDN + 0.3% Nano urea), T_7 (75% RDN + 0.4% Nano urea), T_8 (75% RDN + 0.5% Nano urea), T_9 (50% RDN + 0.3% Nano urea), T_{10} (50% RDN + 0.4% Nano urea), T_{11} (50% RDN + 0.5% Nano urea). The present study used 6-year-old custard apple trees of the variety GJCA-1 (Gujarat Junagadh Custard Apple-1). The treatment was applied with foliar spray of nano urea at before flowering stage and then two weeks later. In RDF phosphorus and potash were apply as a basal dose and nitrogen apply through urea. Various growth and yield parameters were observed. The collected data were subjected to statistical analysis following the method outline by Panse and Sukhatme (1985). The appropriate standard error of mean (S. Em.±) and critical difference (CD) were worked out at 5 percent level of significance.

Result and Discussion

The data presented in Table 1 and 2 observed that, nano urea was significant effect on growth and yield parameters in custard apple studied in this experiment.

Growth parameters

Effect of different levels of foliar spray of nano urea on incremental tree height, incremental tree canopy spread (N-S and E-W), chlorophyll content index and leaf area of custard apple was depicted in Table 1. The maximum incremental tree height (87.00 cm), incremental tree canopy spread N-S (90.83 cm) and incremental tree canopy spread E-W (88.50 cm), chlorophyll content index (50.03 CCI) and leaf area (90.20 cm^2) were noted in tree treated with 100% RDN + 0.5% Nano urea (T_5) which was found at par with T_3, T_4, T_7, T_8 treatments. However, minimum incremental tree height (41.00 cm), incremental tree canopy spread N-S (69.00 cm) and incremental tree canopy spread E-W (65.67 cm), chlorophyll content index (38.73 CCI) and leaf area (72.52 cm^2) were recorded under absolute control (T_1). The higher incremental tree height and canopy might be due to application of nano urea and control releasing fertilizer, reducing nitrogen losses, improve nutrient use efficiency and providing balanced crop nutrition as needed during crop growth period. Hasaneen *et al.* (2016) [9] and Kaviani *et al.* (2016) [10] observed the beneficial effect of nano fertilizers and adequate supply of nutrients, which increases the activity of enzyme and metabolism, resulting in cell enlargement and cell elongation, ultimately responsible for the tree height increases. This might be due to the nano urea ability to enter through stomata when sprayed on leaves is due to its samller particle size compared to conventional urea. This characteristic allows it to penetrate more easily into the plant tissues and be assimilated by the plant cells, enhancing its efficiency in providing nitrogen nutrition to the plants. It is easily distributed through the phloem from source to sink according to the plants per needs. This result is in accordance with the findings of Bhatti *et al*. (2023) [5] and Singh *et al.* (2023) [20] in guava, Meena *et al.* (2023) [12] in ber, Mustafa and Salah (2023) [14] in citrus, Mishra and Varu (2022) [13] in pomegranate, Al-Asally and Al-Hijemy (2022) [1] in mandarin, Shankrayya and Makali (2022) [19] in mulberry, Varu and Chovatia (2017) [24] in guava.

Table 1: Effect of foliar application of nano urea on growth parameters of custard apple cv. GJCA-1

Sr. No.	Treatments	Incremental tree height (cm)	Incremental tree canopy spread (cm)		Chlorophyll content index (CCI)	Leaf area (Cm^2)
			N- S	E- W		
T_1	Absolute Control	61.00	69.00	65.67	38.73	72.57
T_2	RDF% (NPK 200:100:200 g/plant)	67.33	71.33	68.50	39.13	74.68
T_3	100% RDN + 0.3% Nano urea	82.00	86.17	82.50	46.57	84.64
T_4	100% RDN + 0.4% Nano urea	83.00	89.00	84.17	47.33	88.01
T_5	100% RDN + 0.5% Nano urea	87.00	90.83	88.50	50.03	90.20
T_6	75% RDN + 0.3% Nano urea	73.67	76.67	76.33	42.33	78.21
T_7	75% RDN + 0.4% Nano urea	77.62	79.33	79.33	44.67	80.61
T_8	75% RDN + 0.5% Nano urea	78.57	82.67	79.50	45.63	82.12
T_9	50% RDN + 0.3% Nano urea	68.67	72.67	70.00	41.17	76.15
T_{10}	50% RDN + 0.4% Nano urea	70.00	74.83	72.33	42.20	78.57
T_{11}	50% RDN + 0.5% Nano urea	73.00	75.83	74.00	43.83	80.29
S. Em.±		4.061	4.120	3.200	2.042	2.631
C. D. at 5%		11.99	12.16	9.45	6.12	7.75
C. V.%		9.42	9.04	7.25	8.06	5.65

Yield parameters

The variation due to different treatments of nano urea was found significant in yield parameters such as number of fruits per tree, yield per tree, yield per hectare. Significantly maximum number of fruits per tree (86.93), fruit yield per tree (15.27 kg), fruit yield per hectare (4.23 tonnes) was obtained in 100% RDN + 0.4% Nano urea (T_4) which was at par with T_3 and T_5. This might be due the fact that nano nitrogen fertilization can be attributed to the physiological and metabolic roles of nitrogen in flowering and fruit set, including supplying carbohydrates, which are necessary for flower bud growth, flower initiation and development, ovule lifespan, effective pollination and fertility. The results are in accordance with the finding of Lovatt (1994) [11] in avocado, Stiles (1999) [21] and Etehadnejad and Aboutalebi (2014) [8] in apple. This result is in accordance with the findings of Varu (2020) [25, 26] and Varu *et al.* (2020) [25, 26] in papaya, Butani *et al.* (2020) [7] and Parsana *et al.* (2023) [17] in custard apple, Bhatti *et al*. (2023) [5] in guava.

Table 2: Effect of foliar application of nano urea on yield parameters of custard apple cv. GJCA-1

Sr. No.	Treatments	Number of fruits/tree	Fruit yield (kg/tree)	Fruit yield (t/ha)
T_1	Absolute Control	65.40	9.00	2.49
T_2	RDF% (NPK 200:100:200 g/plant)	67.53	9.50	2.63
T_3	100% RDN + 0.3% Nano urea	80.53	13.56	3.75
T_4	100% RDN + 0.4% Nano urea	86.93	15.27	4.23
T_5	100% RDN + 0.5% Nano urea	79.80	13.23	3.67
T_6	75% RDN + 0.3% Nano urea	72.27	11.38	3.16
T_7	75% RDN + 0.4% Nano urea	76.13	12.42	3.44
T_8	75% RDN + 0.5% Nano urea	74.20	11.81	3.27
T_9	50% RDN + 0.3% Nano urea	73.53	12.01	3.33
T_{10}	50% RDN + 0.4% Nano urea	71.07	11.68	3.23
T_{11}	50% RDN + 0.5% Nano urea	68.27	10.46	2.90
S. Em.±		4.061	0.762	0.211
C. D. at 5%		11.97	2.25	0.62
C. V.%		9.47	11.12	11.16

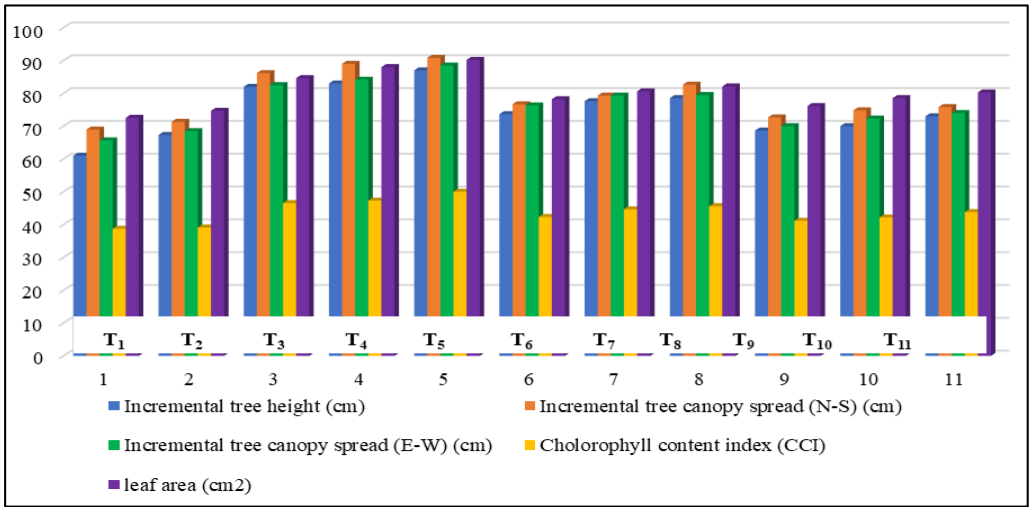

Fig 1: Effect of foliar application of nano urea on growth parameters of custard apple cv. GJCA-1

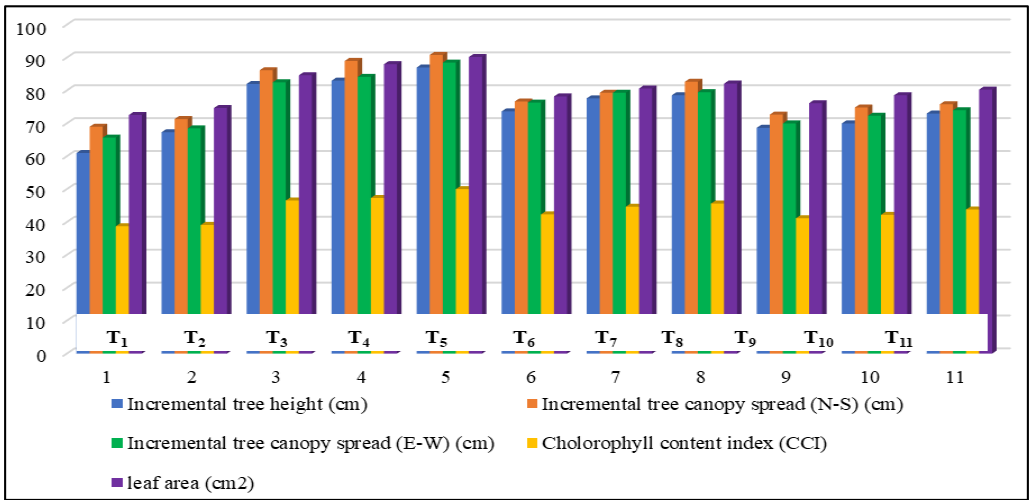

Fig 2: Effect of foliar application of nano urea on yield parameters of custard apple cv. GJCA-1

Conclusion

On the basis of experimental results, it can be concluded that application of 100% RDN + 0.5% Nano urea sprayed on the tree once during flowering stage and then two weeks later proved to be efficient for cultivation of custard apple by enhancing growth parameters *viz.* incremental tree height, incremental tree canopy spread (N-S and E-W), chlorophyll content index and leaf area. While yield parameters *viz.* number of fruits per tree, yield per tree, yield per hectare were observed highest in 100% RDN + 0.4% Nano urea.

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