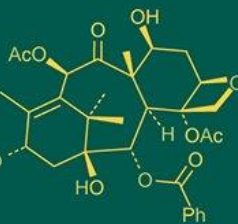
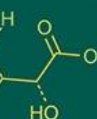
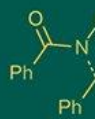


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Nano urea effect on growth of custard apple (*Annona squamosa* L.)

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Abstract

The experiment was conducted to assess nutrient management impact on plant growth, fruit yield, and quality and to determine the optimal nitrogen dose for improved productivity and quality of custard apple (*Annona squamosa* L.) at farmer's field of Shri. Vinayji Bothra at Dhanaj (Khurd), Tq-Karanja, Dist. Washim (Maharashtra State) during the year 2021-2022 and 2022-2023 on 20-year-old custard apple trees spaced 4m x 2.5m. The soil was medium clay with good drainage. The experiment consisted of seven treatments and replicated three times. All the treatments applied in three splits for better utilization of fertilizers.

Custard apple plant supplied with 50% RDF through soil + 50% RDN through nano urea + 50% P, K through irrigation showed maximum shoot length (27.03 cm), number of shoot branches (23.32), maximum leaf area (51.2 cm²), Days to first flower (32.1 days), maximum fruit set (15.25%), Maximum fruit retention (65.04%), Days to flowering to harvest (108.72 days), maximum number of fruits plant⁻¹ (82.6), maximum fruit weight plant⁻¹ (26.81 Kg), maximum fruit yield hectare⁻¹ (22.80 ton ha⁻¹). However, these treatments are at par with each other for above parameters. Combined applications of nano urea foliar spray and fertigation, was found to be the most efficient and cost-effective, enhancing nitrogen use efficiency, plant performance, and profitability in custard apple cultivation.

Keywords: Nano urea, NPK fertilizers, custard apple, fertigation

Introduction

Custard apple is the most favorable fruit crop in India. It belongs to family Annonaceae which consists of 40 genera and 120 species. It has got a pleasant flavour; mild aroma and sweet taste which has universal acceptance. Custard apple is also known as Sugar Apple, Sweetsop, Sharifa, and Sitaphal in different growing regions (Choudhary and Dhakare, 2018) [3].

The custard apple is a rich source of carbohydrates, protein, and fiber, minerals like calcium, phosphorus, iron and vitamin C. They are considered a good energy source with the value of 104 kcal. It contains carbohydrates 23.5 g, protein 1.6 g, mineral 0.9 g, fiber 3.1 g, calcium 17 mg, phosphorus 47 mg, iron 1.5 mg and vitamin (37 mg). These values are based on 100 fruit pulp. The period of availability of the custard apple fruits commences in August and continues up to December, the peak period of availability being October and November. Custard apple is mostly consumed as dessert fruits. They can be preserved as jam, jelly and are also used in ice-cream and other milk products. The edible portion of fruit is creamy, granular with an excellent blend of sweetness and acidity. The immature fruits, seeds, leaves and roots are known for their medicinal use in Ayurveda.

Custard apple has been originated from the West Indies and South America and at present, cultivation of custard apple occurs in Australia, Brazil, Chile, Egypt, India, Israel, Philippines, Spain, Sri-Lanka and USA (Nakasone and Paull, 1998) [7].

Nitrogen present in nano urea effectively meets the crop nitrogen requirement for better growth. Nano urea has better nitrogen use efficiency than conventional urea. It reduces the requirement of conventional urea by 50% or more. Efficacy of one bottle of liquid nano urea (500 ml) is equivalent to 45 kg of urea. It is an eco-friendly product can improve soil, air and water quality thus, help in reducing the global warming.

Nano urea is reduced input cost to farmers, leads to increased farmer income. This study aimed to evaluate the impact of different NPK fertilization methods on the growth, yield, and quality of custard apple.

Materials and Methods

Experiment was conducted on 20 years old, healthy and uniform custard apple plants cv. Balanagar laid out in a Randomized Block Design (RBD) with seven treatments and replicated three times.

The experiment consisted of seven treatments: T₁- 100% RDF through soil application, T₂ -100% RDF through irrigation, T₃- 125% RDN through nano urea foliar + 100% P, K through irrigation, T₄- 100% RDN through nano urea foliar + 100% P, K through irrigation, T₅- 75% RDN through nano urea foliar + 100% P, K through irrigation, T₆- 50% RDF through soil + 50% RDN through nano urea foliar + 50% P, K through irrigation, and T₇- Control. All the treatments applied in five splits for better utilization of fertilizers.

Results and Discussion

Incremental growth parameters

1. Effect of nutrient management practices on shoot length (cm) in custard apple.

The data in respect of length of shoot as influenced by different nutrient management practices were calculated and presented in Table 1.

The data presented in Table 1. Revealed that the results obtained were statistically significant during the year 2022, 2023 and pooled mean.

The data conveyed that in the year 2022, the maximum length of shoot (23.30 cm) was recorded in T₆ and it was at par with T₁ (22.50 cm) and T₂ (21.11 cm), T₅ (20.25 cm) and T₃ (20.16 cm), while, the minimum length of shoot (15.00 cm) recorded in absolute control.

From the data in the year 2023, it is observed that the maximum length of shoot (30.77 cm) was recorded in T₂ and it was at par with T₆ (30.76 cm), T₃ (30.20 cm), T₄ (30.10 cm) and T₁ (28.57 cm) while, the minimum length of shoot (24.53 cm) recorded in absolute control.

Table 1: Effect of nutrient management practices on length of shoot (cm) in custard apple.

Treatment details		Length of shoot (cm)		
		2022	2023	Pooled mean
100% RDF through soil application.	T ₁	22.50	28.57	25.53
100% RDF through fertigation.	T ₂	21.11	30.77	25.94
125% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₃	20.16	30.20	25.18
100% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₄	20.10	30.10	25.10
75% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₅	20.25	25.75	23.84
50% RDF through soil application + 50% RDN through nano urea foliar spray + 50% P and K through fertigation.	T ₆	23.30	30.76	27.03
Absolute control	T ₇	15.00	24.53	19.76
F- test		Sig	Sig	Sig
SE(m) _±		1.78	1.20	1.49
CD at 5%		5.48	3.71	4.59

It was observed that, for the pooled mean, the maximum length of shoot was recorded by the treatment T₆ (27.03 cm) while, the minimum length of shoot (19.76 cm) was recorded in the treatment T₇.

The incremental growth in shoot length appears to be enhanced by the application of nutrients in the present investigation. It is anticipated that the applied mineral fertilizers contributed to an adequate build-up of nutrients in the soil, which were subsequently absorbed by the plant root system and utilized in metabolic processes as growth progressed. The increase in shoot length may be attributed to the accelerated movement of assimilates and enhanced translocation of photosynthates as a result of NPK application.

A similar increase in shoot growth due to NPK application has also been reported by Teatota *et al.* in guava. The findings of the present study are quite consistent with those of Shukla *et al.* (2000)^[9] in Kinnow mandarin, Singh *et al.* (2008)^[11] in guava, and Yadav *et al.* (2011)^[13] in mango.

Dayal *et al.* (2010)^[4] also reported increased shoot length with higher nitrogen application in ber under arid and semi-arid conditions. Similarly, Singh and Singh (1969)^[10] observed a positive correlation between applied nitrogen and growth rate, including increases in shoot length, number of leaves, and flowering shoots in guava.

2. Effect of nutrient management practices on the number of shoot branches per plant in custard apple.

The results pertaining to the effect of nutrient management practices on number of shoot branch⁻¹ is presented in Table 2.

The effect of nutrient management practices influenced significantly number of shoot branch⁻¹.

The data conveyed that in the year 2022, the maximum number of shoot branch⁻¹ (25.33) was recorded in treatment T₆ and it was followed by T₂ (22.83), T₃ (22.83). Treatment T₁ (22.80) and T₄ (21.67). While, the minimum number of shoot branch⁻¹ (20.83) recorded in absolute control T₇.

Table 2: Effect of nutrient management practices on number of shoot branch-1 in custard apple

Treatment details		Number of shoot branch ⁻¹		
		2022	2023	Pooled mean
100% RDF through soil application.	T ₁	22.80	19.64	21.24
100% RDF through fertigation.	T ₂	22.83	19.67	21.24
125% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₃	22.83	19.42	21.13

100% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₄	21.67	18.64	20.10
75% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₅	21.33	18.53	19.99
50% RDF through soil application + 50% RDN through nano urea foliar spray + 50% P and K through fertigation.	T ₆	25.33	21.31	23.32
Absolute control	T ₇	20.83	17.42	19.13
F- test		Sig	Sig	Sig
SE(m)±		0.67	0.54	0.20
CD at 5%		2.01	1.62	0.61

In the year 2023, the maximum number of shoot branch⁻¹ (21.31) was recorded in T₆ and it was followed by T₂ (19.67) and T₁ (19.64) Treatment T₃ (19.42), T₄ (18.64) and T₅ (18.53) while, the minimum number of shoot branch⁻¹ (17.42) recorded in absolute control.

In pooled mean it was observed that, with the application of T₆ treatment the maximum number of shoot branch⁻¹ (23.32) produced. While, the minimum number of shoot branch⁻¹ (19.13) was recorded in the absolute control.

Balanced nutrients applied through fertigation are very important for plant growth, especially at the vegetative growth stage because N is necessary for different plant functioning, including its presence in the structure of amino acid and proteins. Citrus trees produce a high volume of green tissue and hence N fertilization is demanding for the tree (Ashkevari *et al.* 2013)^[1].

The similar result was obtained by Trivedi *et al.* (2012)^[12] reported that, the beneficial effects of nitrogen in promoting growth parameters may be due to enhanced synthesis and

accumulation of protein, amino acid and enzymes which are responsible for cell division and cell elongation hence growth of plant.

Similar results were reported by Goramnagar *et al.* (2000)^[6] in Nagpur orange and Dudi *et al.* (2003)^[5] in Kinnow mandarin

3. Effect of nutrient management practices on leaf area (cm²) in custard apple.) In custard apple.

The results pertaining to the effect of nutrient management practices on leaf area is presented in Table 3

The effect of nutrient management practices influenced significantly on leaf area.

The data conveyed that in the year 2022, the maximum leaf area (50.90 cm²) was recorded with the application of T₆ treatment. Next treatment were T₁ (47.95 cm²), T₃ (47.91 cm²). Treatment T₂ (47.74 cm²) and T₅ (47.60 cm²) these treatment showed similar result. While, the minimum leaf area (cm²) (44.62 cm²) recorded in absolute control.

Table 4: Effect of nutrient management practices on leaf area (cm²) in custard apple.

Treatment details		Leaf area (cm ²)		
		2022	2023	Pooled mean
100% RDF through soil application.	T ₁	47.95	47.67	47.81
100% RDF through fertigation.	T ₂	47.74	49.24	48.49
125% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₃	47.91	47.35	47.63
100% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₄	47.11	46.88	47.00
75% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₅	47.60	45.53	46.57
50% RDF through soil application + 50% RDN through nano urea foliar spray + 50% P and K through fertigation.	T ₆	50.90	51.42	51.16
Absolute control	T ₇	44.62	42.49	43.59
F- test		Sig	Sig	Sig
SE(m)±		0.67	0.69	0.52
CD at 5%		2.05	2.14	1.60

From the data in the year 2023, the maximum leaf area (51.42 cm²) was recorded in T₆, which was closely followed by T₂ (49.24 cm²), T₁ (47.67 cm²). Treatment T₃ (47.35 cm²), T₄ (46.88 cm²) and T₅ (45.53 cm²) were next in order. While, the minimum leaf area (42.49 cm²) recorded in absolute control T₇.

In the pooled mean, the maximum Leaf area was recorded for the treatment T₆ (51.16 cm²). While the minimum leaf area (43.59 cm²) was recorded in the treatment T.

The nutrients applied in combination produced the good plant growth and the response was more visualize when nutrients were combined at higher doses. It was anticipated that the applied mineral fertilizers helped in adequate build-up of nutrients in soil and these nutrients were extracted by the plant root system and used in the metabolic processes as the growth advances. Length of shoot and leaf area were significantly influenced by the different treatment

combinations. The findings of present study are in accordance with Baviskar *et al.* (2018)^[2] in guava.

4. Effect of nutrient management practices on chlorophyll content index in custard apple.

The results concerned to the effect of nutrient management practices on Chlorophyll content index is presented in Table 4. The effect of nutrient management practices influenced significantly on Chlorophyll content index.

During the year 2022, 2023 the maximum Chlorophyll content index (mg g⁻¹) (56.94) (58.31) was recorded in T₆ respectively. While, the minimum Chlorophyll content index (mg g⁻¹) (41.58) (51.05) recorded in absolute control T₇ in both the year respectively.

It was observed that, in the pooled mean, the maximum chlorophyll content (mg g⁻¹) index was recorded by the treatment T₆ (57.62). While, the minimum chlorophyll content index (46.31) was recorded in the treatment T₇.

Table 4: Effect of nutrient management practices on Chlorophyll content index in custard apple.

Treatment details		Chlorophyll content index (mg g ⁻¹)		
		2022	2023	Pooled mean
100% RDF through soil application.	T ₁	47.05	50.03	48.54
100% RDF through fertigation.	T ₂	48.20	54.46	51.32
125% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₃	50.70	54.12	52.41
100% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₄	56.94	58.31	57.62
75% RDN through nano urea foliar spray + 100% P and K through fertigation.	T ₅	47.86	48.85	48.35
50% RDF through soil application + 50% RDN through nano urea foliar spray + 50% P and K through fertigation.	T ₆	48.15	54.73	51.44
Absolute control	T ₇	41.58	51.05	46.31
F- test		Sig	Sig	Sig
SE(m)±		4.04	3.46	3.75
CD at 5%		12.45	10.67	11.56

Nano urea increases chlorophyll content in fruit crops by improving nitrogen availability and nutrient use efficiency. Nitrogen is an essential component of chlorophyll and plays a major role in photosynthesis, chloroplast development, and leaf greenness. The nano-sized particles of nano urea are rapidly absorbed through leaf surfaces, resulting in efficient nitrogen uptake, enhanced chlorophyll synthesis, and increased photosynthetic activity. This ultimately improves plant growth, fruit development, and yield. The findings of present study are in accordance with Raliya *et al.* (2018)^[8] in mango.

Conclusion

The study on nitrogen management in custard apple cultivation reveals the significant benefits of incorporating nano urea foliar spray with traditional nitrogen fertilizers. This combined approach enhances vegetative growth, fruit yield and quality, and better physico-chemical properties. Nano urea improves nitrogen efficiency by reducing losses from leaching and volatilization, promoting better nutrient uptake and contributing to long-term soil fertility and sustainability. The T₆ treatment, using 50% of the recommended dose of fertilizers (RDF) through soil and 50% of the recommended nitrogen dose (RDN) via nano urea, emerged as the most cost-effective and profitable option for farmers, delivering the highest yield and best benefit-cost ratio. Additionally, this method reduces reliance on chemical inputs and saves 50% of conventional urea, minimizing costs and environmental impact. The findings advocate for the broader use of nano urea in custard apple farming, promoting sustainable, efficient and profitable agricultural practices.

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