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Effect of different nitrogenous fertilizers on growth, flowering and Yield parameters of Custard apple (*Annona squamosa* L.)

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Abstract
An experiment was conducted to evaluate the "Effect of different nitrogenous fertilizers on growth, flowering and yield of Custard apple (*Annona squamosa* L.)"at the Demonstration-cum-Research Farm, Manjra, KVK, Latur during 2018-19. The experiment was carried out on the 8 years old Balanagar Custard apple with seven different sources of nitrogenous fertilizes *viz*. Urea (T_1), Ammonium sulphate (T_2), Sodium nitrate (T_3), Ammonium chloride (T_4), Neem coated urea (T_5), Calcium ammonium nitrate (T_6) and Calcium nitrate (T_7) as treatments and replicated thrice and laid out in RBD. The maximum increase in plant height (0.96 m, 53.03%), stem girth (6.43 cm, 48.56%), plant spread (1.82 m^2, 96.80% East-West and 1.92 m^2, 96.96% North- South) and plant volume (3.80 m^3, 376.23%) were recorded with the N application through neem coated urea per tree (T_5). The minimum number of days (39.33) required for flowering, days required for fruit set (22.33) and days required from fruit set to maturity (71.67) were recorded with the application of N through ammonium sulphate (T_2). Yield and yield contributing characters were *viz*. total number of fruits per tree (93.00), number of marketable fruits per tree (89.00), total yield (21.15 kg/tree and 8.46 t/ha) and marketable yield (20.24 kg/tree and 8.10 t/ha) were recorded with the N application through ammonium sulphate (T_2).

Keywords: Nitrogenous fertilizers, parameters, *Annona squamosa* L.

Introduction
Custard apple (*Annona squamosa* L.) is a delicious and important fruit crop which is cultivated in tropical and subtropical climate. It comes under family Annonaceae and native of the West Indies and cultivated since early times throughout Central America to Southern Mexico (Popenoe, 1974) [12]. The fruit is also popularly known as "Sugar apple", "Monkey fruit" and "Sweetsop". Custard apple is an important dry land fruit crop of India. Custard apple has slightly granular, creamy, yellow or white sweet pulp with good flavour and low acidity, thus it is considering the sweetest fruits among other Annonas (Annon, 1990) [2]. Its diploid chromosome number is 2n=14.

This crop is becoming popular and commercial now-a-days. Productivity of custard apple is very low. Low productivity is due to imbalanced nutrition, incidence of pest and diseases and lack of adoption of advanced technology or improved production techniques. Imbalanced use of chemical fertilizers is a common practice adopted by the farmers. Large scale use of chemical fertilizers causes problem of ground water and environmental pollution through leaching, volatilization and denitrification in addition to wastage of nutrients through costly fertilizers. The disproportionate use of chemical fertilizers has widened the soil imbalance in terms of NPK ratio. The occurrence of multinutrient deficiencies and overall decline in productive capacity of the soil has been widely reported due to non-judicious fertilizer use (Chhonkar, 2008) [5]. The low productivity of custard apple is mainly due to less adoption of improved technology in respect of planting system, nutrition, plant protection etc. Among several other factors, probably nutrition is a key factor affecting the productivity of custard apple trees. Among the different nutrients needed by the plants, nitrogen is most essential for the vegetative growth of the plant. Potassium increases root growth and improves drought tolerance. This plant requires adequate soil moisture during the growing season, and to achieve higher fruit yields, the soil must be fertilized generously, with nitrogen, which is the nutrient most required by the custard apple (Pleguezuelo *et al.* 2011; Cavalcante *et al*. 2012) [11, 4]. Nitrogen uptake by plant roots is directly affected by soil, plant and environmental factor. The nitrogen is most crucial element in plant growth with as much as 78% in the atmosphere and

98% in the soil organic matter, nitrogen is abundant in nature. Yet, it is most deficient in all cultivable soils. Nitrogen deficiency symptoms are most prevalent and easiest to identify. Young plants exhibit yellowish green foliage and stunted growth while older plants show yellowing or falling of leaves. Nitrogen deficiency impedes good yield. An effective, integrated approach employs organic manures, biofertilizers, chemical fertilizers, nitrification inhibitors, coated and long-persisting nitrogen fertilizers, which are the key to sustainable agriculture (Gowarikar, 2005) [6]. The information on utility of these nitrogenous fertilizers in fruit crops is very scanty. Under prevailing conditions it is the need of the day to generate the information on effectiveness and economics of available nitrogenous fertilizers in dryland fruit crop like custard apple. Hence the present investigation entitled "Effect of different nitrogenous fertilizers on growth, yield and quality of custard apple (*Annona squamosa* L.)" is planned.

Material and Methods

An experiment was conducted at the Demonstration-cum-Research Farm, Manjra, KVK, Latur during 2018-19. The experiment was carried out on the 8 years old Balanagar Custard apple with seven different sources of nitrogenous fertilizes *viz*. Urea (T_1), Ammonium sulphate (T_2), Sodium nitrate (T_3), Ammonium chloride (T_4), Neem coated urea (T_5), Calcium ammonium nitrate (T_6) and Calcium nitrate (T_7) as treatments and replicated thrice and laid out in RBD. The experiment was conducted in a well established orchard of eight years age Balanagar custard apple trees planted at 5.0 x 5.0 m spacing.

Table 1: Treatment details

Treatment No.	Dose nitrogen/tree	Source of nitrogen
T_1	250 g	Urea
T_2	250 g	Ammonium sulphate
T_3	250 g	Sodium nitrate
T_4	250 g	Ammonium chloride
T_5	250 g	Neem coated urea
T_6	250 g	Calcium ammonium nitrate
T_7	250 g	Calcium nitrate

The selected trees in the experimental orchard were pruned as per the recommendation during second week of May 2018. All diseased, dried and criss-cross branches were removed. The basins were prepared by digging the soil around tree trunk. The FYM @ 20 kg/tree was applied in first week of June 2018. The recommended dose of fertilizers for custard apple as per the recommendation of V.N.M.K.V, Parbhani is 250 g N: 125 g P_2O_5: 125 g K_2O per tree and half dose of N through different sources as per treatments *viz*; Urea, Neem coated urea, Ammonium sulphate, Calcium nitrate was applied as per the treatments on 11/06/2018 along with full dose of phosphorus and potash. The remaining half dose of nitrogen as per the treatments was applied during fruit development stage on 10/08/2018.

Results and Discussion

It is observed that, the maximum values of increase in vegetative growth parameters of custard apple trees *viz*. plant height (0.96 m, 53.03%), stem girth (6.43 cm, 48.56%), plant spread (1.82 m E-W and 1.92 m N-S, 96.80% and 96.96% respectively) and plant volume (3.80 m^3, 376.23%) were recorded with the application of N through neem coated urea per tree (T_5) and it was closely followed by the application of N through ammonium sulphate per tree (T_2). While, minimum increase in plant height (0.25 m, 15.43%), stem girth (1.43 cm, 10.61%), E-W spread (1.35 m, 71.80%), N-S spread (0.83 m, 48.43%) and plant volume (0.89 m^3, 109.87%) was noticed with the application of sodium nitrate per tree (T_3).

The results of application of different nitrogenous fertilizers on vegetative growth parameters of custard apple trees indicated that, the application of N through neem coated urea has produced beneficial effect on increasing the vegetative growth parameters like plant height, stem girth, plant spread and plant volume. This could be attributed to the supply of required quantity of nitrogen required for various growth attributes at proper time as well as due to its slow releasing property, the required quantity of N was supplied as per the need of the tree which probably might have lead to production of maximum height in the plants treated with neem coated urea. The increase in stem girth, plant spread and plant volume could be due to increase in the rate of synthesis of various metabolites, production of more quantum of carbohydrates and their translocation towards the stem and developing branches. These findings can be very well supported with the findings of Ram *et al.* (1999) [14] in guava and Kumar *et al.* (2011) [8] in custard apple.

The results revealed that, the minimum (39.33 days) number of days required for flowering, flowering to fruit set (22.33 days) and fruit set to maturity (71.67 days) were recorded with the application of N through ammonium sulphate per tree (T_2). It was statistically at par for days required for flowering (39.33 days) and flowering to fruit set (22.33 days) with the treatment of application of N through urea per tree (T_1) and was closely followed for days required to maturity with the application of N through urea per tree (T_1).While, the maximum number of days required for all these attributes were observed with the application of N through sodium nitrate per tree (T_3).

The minimum number of days were required for flowering, fruit set and maturity with the application of 250 g N through ammonium sulphate. This might be due to fact that, ammonical nitrogen of ammonium sulphate does not leached out easily and it is an acid forming fertilizer, hence used in neutral or alkaline soils. The additional benefit of ammonium sulphate is that it supplies sulphur which is also an essential nutrient for plants. As it is resistant to leaching, because it is absorbed on soil colloids, clay and humus replacing the calcium and hence it is more beneficial than nitrate fertilizers. As absorbed portion is slowly released in about a month, hence required quantity of nitrogen might be available as it converted into nitrate form which might have used by the plants for growth, development and production. Thus, the application of ammonium sulphate might have helped for producing beneficial effects on reproductive growth characters of custard apple in terms of minimum days required for flowering, days required for flowering to fruit set and days for fruit set to maturity, Gowarikar *et al.* (2005) [6]. These findings are in agreement with the findings of Marzouk (2011) [9] in date palm, who reported that, application of N through ammonium sulphate and neem coated urea was responsible for production of more number of flowers and higher fruit set. Maximum days for reproductive growth required with the application of sodium nitrate per tree (T_3), this may be due to its inherent basic residual effect might not have provided required quantum of nutrient at proper time. Thus delay in the reproductive growth parameters of custard apple trees.

It is observed that, the maximum values of yield parameters of custard apple trees *viz*. total number of fruits per tree (93.00), number of marketable fruits per tree (89.00), total yield per tree (21.15 kg), marketable yield per tree (20.24 kg), yield per hectare (8.46 t), marketable yield per hectare (8.10 t) and minimum number of unmarketable fruits per tree (4.00) were recorded with the application of N through ammonium sulphate (T_2), which was statistically at par with the application of N through neem coated urea per tree (T_5) and application of N through urea (T_1). The treatment of application of ammonium sulphate recorded 27.55 per cent and neem coated urea application recorded 6.92 per cent increase in yield over urea application. However, other sources of nitrogen showed reduction in yield. While, the minimum values of these parameters like total number of fruits per tree (62.33), number of marketable fruits per tree (55.00), total yield per tree (10.57 kg), marketable yield per tree (9.33 kg), total yield per hectare (4.22 t), marketable yield per hectare (3.73 t) and maximum number of unmarketable fruits per tree (7.33) were observed with the application of N through sodium nitrate per tree (T_3).

The results of the present study with respect to yield contributing characters and yield of custard apple influenced due to application of N through different fertilizer indicated that, maximum values of yield contributing characters and yield of custard apple were recorded due to application of N through ammonium sulphate and at par results are also seen in the treatment of N application through neem coated urea and was followed by urea application (T_1). While, minimum values were recorded with N application through sodium nitrate (T_3). The production of higher number of fruits per tree and consequently the higher yield per tree and per hectare due to N application through ammonium sulphate and neem coated urea could be due to availability of nutrients for longer period and improving the physical and chemical condition of the soil. Thereby, making the availability of nutrients at proper time needed for fundamental processes like photosynthesis which might have resulted in production of more carbohydrates and that have resulted in production of more number of fruits with higher weight leading to high yield per tree. Similar findings has also been reported by Sarwar *et al.* (2007) [20] in tea and Marzouk *et al.* (2011) [9] in date palm. Meskhibze (1985) [18] also showed that, the ammonium sulphate produced higher yield response in tea. Besides improving the yield the ammonium sulphate reduces the soil PH which might have helped in increasing the availability of other macro and micro elements. Thus, increase in growth and productivity of custard apple trees with the application of ammonium sulphate. Annonymous (1959) [1] also reported that, the application of ammonium sulphate has produced better results in tea when compared with urea. At par results are obtained with the nitrogen application through neem coated urea. This could be due to as neem cake is rich in plant nutrients and in addition to that, it contains alkaloids like nimbin and nimbidin, which might have helped for slow release of nitrogen. Thus, apart from nutrient content in neem coated urea, the retention capacity of neem coated urea to a prolonged period and its balanced availability might have resulted in producing better yield as compared to other nitrogenous fertilizers. Similar results were observed by Ram *et al.* (1998) [13], Ram and Rajput (2000) [15] in guava, Ingle *et al.* (2003) [7] in Nagpur mandarin and by Vedamani *et al.* (2006) [17] and Musmade *et al.* (2009) [19] in acid lime. Ram *et al.* (1999) [14] and Ram *et al.* (2006) [16] reported highest yield with the application of neem coated urea in guava.

Table 2: Influence of different nitrogenous fertilizers on plant height and stem girth of custard apple trees.

Tr No.	Source of nitrogen	Plant height (m)				Stem girth (cm)			
		Initial	At harvest	Increase in height	Per cent increase in height	Initial	At harvest	Increase in stem girth	Per cent increase in stem girth
T_1	Urea	1.77	2.42	0.65	36.72	14.37	18.35	3.98	27.69
T_2	Ammonium sulphate	1.81	2.53	0.72	39.77	13.31	18.62	5.31	39.89
T_3	Sodium nitrate	1.62	1.87	0.25	15.43	13.47	14.90	1.43	10.61
T_4	Ammonium chloride	1.64	2.00	0.36	21.95	14.84	17.97	3.13	21.09
T_5	Neem coated urea	1.81	2.77	0.96	53.03	13.24	19.67	6.43	48.56
T_6	Calcium ammonium nitrate	1.71	1.98	0.27	15.78	13.30	17.33	4.03	30.30
T_7	Calcium nitrate	1.93	2.31	0.38	19.68	13.28	18.31	5.03	37.87
	S.E. m +	0.09	0.11	---	---	0.97	0.44	---	---
	C. D. at 5% level	N.S	0.34	---	---	N.S	1.38	---	---

Table 3: Influence of different nitrogenous fertilizers on plant spread of custard apple trees.

Tr. No.	Source of nitrogen	Plant spread (m^2) (East-West)				Plant spread (m^2) (North- South)			
		Initial	At harvest	Increase in plant spread	Per cent increase in plant spread	Initial	At harvest	Increase in plant spread	Per cent increase in plant spread
T_1	Urea	1.94	3.59	1.65	85.05	1.82	3.67	1.71	93.44
T_2	Ammonium sulphate	1.88	3.65	1.77	94.14	1.94	3.74	1.80	95.74
T_3	Sodium nitrate	1.88	3.23	1.35	71.80	1.87	2.70	0.83	48.43
T_4	Ammonium chloride	1.83	3.40	1.57	85.79	1.84	3.02	1.18	57.06
T_5	Neem coated urea	1.88	3.70	1.82	96.80	1.90	3.90	1.92	96.96
T_6	Calcium ammonium nitrate	1.82	3.35	1.53	84.06	1.92	2.83	0.91	44.17
T_7	Calcium nitrate	1.81	3.42	1.61	88.95	1.95	3.28	1.33	68.20
	S.E. m +	0.09	0.08	---	---	0.07	0.15	--	---
	C. D. at 5% level	N.S	0.25	---	---	N.S	0.46	--	---

Table 4: Effect of different nitrogenous fertilizers on plant volume of custard apple trees.

Tr. No	Source of nitrogen	Plant volume (m^3)			
		Initial plant volume	Plant volume at harvest	Increase in plant volume	Per cent increase in plant volume
T_1	Urea	0.96	3.52	2.56	266.66
T_2	Ammonium sulphate	1.02	3.88	2.86	271.86
T_3	Sodium nitrate	0.81	1.70	0.89	109.87
T_4	Ammonium chloride	0.81	2.12	1.31	161.72
T_5	Neem coated urea	1.01	4.81	3.80	376.23
T_6	Calcium ammonium nitrate	0.89	2.00	1.11	124.71
T_7	Calcium nitrate	1.15	2.96	1.81	157.39
	S.E. m +	0.02	0.10	---	---
	C. D. at 5% level	0.06	0.30	---	---

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