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Effect of nitrogen, phosphorus and potassium fertilization on growth of custard apple CV. balanagar

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Abstract
A study was conducted during 2017 to 2018 and 2018 to 2019 to find out Effect of nitrogen, phosphorus and potassium fertilization on growth of custard apple Cv. Balanagar (*Annona squamosa* L.) The custard apple plants were treated with three levels of nitrogen (0,250,350 g N/plant/year), phosphorus (0,125,175 g P_20_5/plant/year) and potassium (0,125,175 g K_20/plant/year) in all possible 27 combinations was split in different growth stages, were replicated two times in Factorial Randomized Block Design. Experimental findings revealed that, plant growth was significantly influenced by applied nutrients. Plant height, plant spread E-W, plant spread S-N, plant canopy volume, leaf area and chlorophyll content showed significant improvement with the application of 350 g nitrogen, 125 g phosphorus and 125 g potassium per plant during both the years of experimentation.

Keywords: Custard apple, Balanagar, fertilizers, nutrients, plant growth, fruit

Introduction
Custard apple occupies an important place among minor fruit crops grown in India. Custard apple is also known as sugar apple, sweetsop, *Sharifa* and *sitaphal* in different parts of growing regions. Fruits are good source of sugar (20%), iron, calcium, phosphorus and ascorbic acid. It is a hardy and potential crop for commercial growing in marginal soils and degraded lands, such as dry and salt affected soils. Custard apple can tap a considerable volume of soil with its extensive root system under natural habitat. However, the natural fertility of soils is rarely sufficient to give economic yields. The area under custard apple is increasing in India on commercial scale and no work has been done with respect to fertilization of custard apple 'Cv. Balanagar'. Nutrition is one of the most important aspects of fruit production and accounts for 30 per cent of its total cost of cultivation. Therefore, the present study was carried out to find out the requirement of NPK levels for commercial cultivation of custard apple 'Cv. Balanagar'.

Research Methods
The experimental entitled Effect of Nitrogen, Phosphorus and Potassium Fertilization on Growth of Custard apple Cv. Balanagar (*Annona squamosa* L.) was conducted during the year 2017-18 and 2018-19 at Instructional Cum Research Orchard Arid Zone Fruit Project, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.). The present study was conducted on ten year old plants of cultivar Balanagar. One hundred and eight plants of uniform size, vigour and productivity were selected for study having planting distance 5 m × 5 m. All plants were given uniform cultural practices. The experiment was laid out in a factorial randomized block design with 27 treatments combination and each treatment was replicated twice. Nitrogen, phosphorus and potassium were applied in the form of urea, single superphosphate and muriate of potash respectively. The application of different nutrients fertilizer treatments were applied during June, 2017.

Table 1: Details of the different treatments used in the study.

Treatments	Details of treatment		
	N (g/plant)	P_2O_5 (g/plant	K_2O (g/plant)
N_0 P_0 K_0	0	0	0
N_0 P_0 K_1	0	0	125
N_0 P_0 K_2	0	0	175
N_0 P_1 K_0	0	125	0
N_0 P_1 K_1	0	125	125
N_0 P_1 K_2	0	125	175
N_0 P_2 K_0	0	175	0
N_0 P_2 K_1	0	175	125
N_0 P_2 K_2	0	175	175
N_1 P_0 K_0	250	0	0
N_1 P_0 K_1	250	0	125
N_1 P_0 K_2	250	0	175
N_1 P_1 K_0	250	125	0
N_1 P_1 K_1	250	125	125
N_1 P_1 K_2	250	125	175
N_1 P_2 K_0	250	175	0
N_1 P_2 K_1	250	175	125
N_1 P_2 K_2	250	175	175
N_2 P_0 K_0	350	0	0
N_2 P_0 K_1	350	0	125
N_2 P_0 K_2	350	0	175
N_2 P_1 K_0	350	125	0
N_2 P_1 K_1	350	125	125
N_2 P_1 K_2	350	125	175
N_2 P_2 K_0	350	175	0
N_2 P_2 K_1	350	175	125
N_2 P_2 K_2	350	175	175

These nutrient doses were applied in four application stage with split dose at basal application stage in the month of June (first irrigation) 50% N, 50% P_2O_5 and 50% K_2O were applied, at fruit set stage thirty days after first irrigation 20% N, 50% P_2O_5 and 25% K_2O were applied, at lemon size fruit stage ninety days after first irrigation 20% N and 25% K_2O were applied, remaining 10% N were applied in one month before harvesting stage 120 days after first irrigation. The data on plant height (m), plant spread (m) in east-west and north-south directions were recorded with meter scale. Plant canopy volume (m^3) was calculated by formula Canopy volume (m^3) = 0.5236 * canopy height (m) * mean of EW and NS spread (m^2) formula given by Castle (1983) [3]. Leaf area (cm^2) of ten randomly selected fully grown leaves from tagged shoot was measured with the help of digital leaf area meter. Chlorophyll content (mg g^{-1}) of the leaves was measured by the method of (Arnon, 1948). For recording quality attributing characters four shoots were tagged on each observational plant and data were recorded on total soluble solid and acidity of fruit.

Research Findings and Discussion

The results pertaining to the effect of N, P and K are depicted as the average values obtained during two years i.e., 2017 to 2018.

Growth Parameters

Application of nitrogen, phosphorus and potassium exhibited a significant effect on plant height, plant spread E-W, Plant spread N-S, plant canopy volume and non significant effect on leaf area and chlorophyll content (Table 2, 3). A linear effect of N doses has been noted on plant growth like plant height, canopy spread, leaf area and chlorophyll content that increased significantly with increasing levels of nitrogen.

Table 2: Effect of nitrogen, phosphorus, potassium and their interactions on the plant height, plant spread E-W and plant spread N-S (m).

Treatments	Plant Height (m)		Plant Spread E-W (m)		Plant Spread S-N (m)	
	1st yr.	2nd yr.	1st yr.	2nd yr.	1st yr.	2nd yr.
N_0 P_0 K_0	2.71	2.75	2.65	2.71	2.67	2.73
N_0 P_0 K_1	2.72	2.76	2.66	2.72	2.68	2.74
N_0 P_0 K_2	2.72	2.76	2.66	2.72	2.68	2.74
N_0 P_1 K_0	2.72	2.77	2.66	2.73	2.68	2.75
N_0 P_1 K_1	2.74	2.79	2.68	2.75	2.70	2.77
N_0 P_1 K_2	2.73	2.79	2.67	2.75	2.69	2.77
N_0 P_2 K_0	2.72	2.76	2.66	2.72	2.68	2.74
N_0 P_2 K_1	2.74	2.80	2.68	2.76	2.70	2.78
N_0 P_2 K_2	2.76	2.82	2.70	2.78	2.72	2.79
N_1 P_0 K_0	2.88	2.94	2.82	2.90	2.84	2.92
N_1 P_0 K_1	2.89	2.97	2.83	2.93	2.85	2.95
N_1 P_0 K_2	2.89	2.97	2.83	2.93	2.85	2.95
N_1 P_1 K_0	2.90	2.98	2.84	2.94	2.86	2.96
N_1 P_1 K_1	2.92	3.02	2.86	2.98	2.88	3.00
N_1 P_1 K_2	2.90	3.02	2.84	2.98	2.86	3.00
N_1 P_2 K_0	2.90	2.99	2.84	2.95	2.86	2.97
N_1 P_2 K_1	2.92	3.02	2.86	2.98	2.88	3.00
N_1 P_2 K_2	2.92	3.03	2.86	2.99	2.88	3.01
N_2 P_0 K_0	2.92	3.03	2.86	2.99	2.88	3.01
N_2 P_0 K_1	2.93	3.06	2.87	3.02	2.89	3.04
N_2 P_0 K_2	2.93	3.07	2.87	3.03	2.89	3.05
N_2 P_1 K_0	2.92	3.03	2.86	2.99	2.88	3.01
N_2 P_1 K_1	2.96	3.13	2.90	3.08	2.92	3.10
N_2 P_1 K_2	2.93	3.07	2.89	3.03	2.91	3.05
N_2 P_2 K_0	2.93	3.02	2.87	2.98	2.89	3.00
N_2 P_2 K_1	2.94	3.08	2.88	3.04	2.90	3.06
N_2 P_2 K_2	2.95	3.11	2.87	3.08	2.89	3.10
SE(m) ±	0.003	0.007	0.003	0.007	0.003	0.007
CD 5%	0.008	0.019	0.008	0.018	0.008	0.018
GM	2.85	2.94	2.80	2.90	2.81	2.92

Table 3: Effect of nitrogen, phosphorus, potassium and their interactions on the plant canopy volume (m^3), leaf area (cm) and chlorophyll content (mg $g^{-1}$of fresh plant tissue).

Treatments	Plant Canopy Volume		Leaf Area		Chlorophyll Content	
	1st yr.	2nd yr.	1st yr.	2nd yr.	1st yr.	2nd yr.
N_0 P_0 K_0	10.04	10.65	70.30	71.65	1.43	1.45
N_0 P_0 K_1	10.15	10.77	70.85	71.75	1.49	1.52
N_0 P_0 K_2	10.15	10.77	71.10	71.85	1.51	1.54
N_0 P_1 K_0	10.15	10.89	71.25	71.80	1.47	1.50
N_0 P_1 K_1	10.38	11.13	71.55	71.90	1.51	1.53
N_0 P_1 K_2	10.27	11.13	71.65	71.95	1.49	1.52
N_0 P_2 K_0	10.15	10.77	71.35	71.85	1.49	1.52
N_0 P_2 K_1	10.38	11.25	71.85	71.90	1.55	1.58
N_0 P_2 K_2	10.61	11.45	72.05	72.00	1.59	1.61
N_1 P_0 K_0	12.08	13.04	71.85	71.95	1.84	1.85
N_1 P_0 K_1	12.14	13.44	72.15	72.10	1.92	1.98
N_1 P_0 K_2	12.21	13.44	72.30	72.15	1.95	1.98
N_1 P_1 K_0	12.33	13.58	73.15	73.75	2.01	2.05
N_1 P_1 K_1	12.59	14.14	74.65	75.15	2.10	2.10
N_1 P_1 K_2	12.33	14.07	74.55	75.05	2.10	2.18
N_1 P_2 K_0	12.33	13.65	74.25	74.95	2.03	2.10
N_1 P_2 K_1	12.53	14.14	74.75	75.10	2.13	2.16
N_1 P_2 K_2	12.59	14.28	74.75	75.15	2.18	2.24
N_2 P_0 K_0	12.57	14.21	73.45	74.05	1.94	1.99
N_2 P_0 K_1	12.73	14.64	73.75	74.25	2.00	2.04
N_2 P_0 K_2	12.66	14.78	73.95	74.45	2.02	2.07
N_2 P_1 K_0	12.59	14.21	75.35	75.75	2.21	2.26
N_2 P_1 K_1	13.06	15.60	76.25	77.05	2.31	2.34
N_2 P_1 K_2	12.92	14.86	76.15	76.95	2.36	2.44
N_2 P_2 K_0	12.66	14.14	75.55	75.95	2.22	2.27
N_2 P_2 K_1	12.79	14.93	76.15	77.00	2.34	2.41
N_2 P_2 K_2	12.73	15.52	76.20	77.00	2.37	2.43
SE(m) ±	0.03	0.09	1.61	1.46	0.01	0.02
CD 5%	0.09	0.26	NS	NS	NS	NS
GM	11.78	13.17	73.38	73.87	1.91	1.95

Plant height

Interaction effect between different nitrogen, phosphorus and potassium levels were found non-significant in respect of plant height during initial stage of experiment, whereas it was found to be significant at final stages of both the years study. The $N_2P_1K_1$ combination N_2-350 g N /plant and phosphorus level P_1-125 g P_2O_5/plant and potassium level K_1-125 g K_2O/plant recorded highest plant height (2.96 m) and (3.13 m) during final stages of 2017 and 2018, respectively. The $N_2P_1K_1$ was at par with $N_2P_2K_2$. However, the lowest plant height of (2.71 m) and (2.75 m) were recorded in $N_0P_0K_0$ during final stages of 2017 and 2018, respectively. Among various nutrient levels, higher doses showed better vegetative growth of the plant and ultimately the height of the plant. The nutrients applied in combination produced the good plant growth and the response was more visualize when nutrients were combined at higher doses. The growth parameters seem to be enhanced by the application of nutrients in present investigation. 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. The findings of present study are in accordance with Baviskar *et al.*, (2018) [2] in guava, Kumar *et al.*, (2011) [5] in custard apple and Mahalle *et al.*, (2001) [6] in custard apple.

Plant canopy volume

The $N_2P_1K_1$ combination N_2-350 g N /plant and phosphorus level P_1-125 g P_2O_5/plant and potassium level K_1-125 g K2O/plant recorded highest plant spread and plant canopy (13.06 m^3) and (15.60 m^3) during final stages of 2017 and 2018, respectively which was at par with $N_2P_2K_2$. However, the lowest plant canopy of (10.04 m^3) and (10.65 m^3) were recorded in $N_0P_0K_0$ during final stages of 2017 and 2018, respectively. The plant canopy volume increased significantly with increase in NPK levels during both the years. This increment in vegetative growth may be due to more absorption of nitrogen, phosphorus and potassium by plant, which combined with carbohydrates in the leaves leading to formation of amino acids, proteins, chlorophyll and other amides. These effects increase the photosynthetic activity of the plants and greater synthesis of carbohydrates, which is responsible for building up of new tissue and are associated with a number of metabolic processes, which in turn favours better development of plants, hence enhanced the plant canopy. Similar growth response due to application of NPK levels were obtained by Kumar *et al.*, (2011) [5] in custard apple. The present investigations are in confirmation with Baviskar *et al.*, (2018) [2] in guava, Mahalle *et al.*, (2001) [6] in custard apple and Khan *et al.*, (2018) [4] in guava.

Leaf area

The NPK interaction was not significant during 2017-18 as well as in the pooled analysis. Maximum leaf area was observed in treatment combination $N_2P_2K_2$ (76.65cm^2) and minimum leaf area recorded in treatment combination $N_0P_0K_0$ (70.98cm^2). 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. Plant volume, 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.

Chlorophyll content of leaves

The NPK interactions were not significant during 2017-18 highest total chlorophyll content was observed in $N_2P_2K_2$ which was at the same level significance with $N_2P_1K_1$. Significantly minimum total chlorophyll content recorded in $N_0P_0K_0$. 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. The possible reason for the above trend might be due to the fact that nitrogen is component of chlorophyll and potash help in chlorophyll formation. The findings of present study are in accordance with Baviskar *et al.,* (2018) [2] in guava.

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