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Effect of nitrogen, phosphorus and potassium fertilization scheduling on soil parameters 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 scheduling on soil parameters 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, minimum soil pH, electrical conductivity, organic carbon, available nitrogen, available phosphorus and available potassium showed with the application of 350 g nitrogen, 175 g phosphorus and 175 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. However, in most of the orchard, poor nutrition is one of the major causes of low productivity. Plants need sufficient nutrients in proper balance for normal growth and development. There is a continuous removal of nutrients from the soil owing to regular and not of balance dose of nutrition. Depletion soil nutrients pose a major threat to sustainability of crop production and underline the need for maintaining it by tapping other plant nutrient sources. 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 scheduling on soil parameters 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.
Soil samples were collected at two stages i.e. before applying first dose of fertilizer and manures referred it as an initial stage soil analysis and at the time of harvesting of fruits.
A representative soil sample at 15-30 cm depth was collected from a four location per tree. The collected samples were mixed and air dried grounded using wooden mortar and pestle and passed through 2 mm sieve. The sieved samples were stored for further chemical analysis.

1) Soil pH
Soil reaction was determined by pH meter using glass or calomel electrode after equilibrating soil: water suspension in the ratio of 1:2 for 30 minutes (Piper, 1966) [7].

2) Organic Carbon (%)
Organic carbon in soil was determined by Walkley and Black rapid titration method. For this purpose 1 g of soil sample was taken in500 ml conical flask and 10 ml potassium dichromate ($K_2Cr_2O_7$) and 20 ml commercial sulphuric acid (H_2SO_4) were added in this and mixed. The mixture was kept as such for about half an hour thereafter 200 ml of distilled water, 10 ml sodium fluoride (NaF) and 2 ml diphenylamine indicators was added into the content of the flask. The colour of the solution turned into ink blue. Then this solution was titrated against 0.5 *N* ferrous ammonium sulphates till the colour of the solution became light green which indicated the end point of the titration. The value at end point was noted down from the burette and organic carbon content was estimated by using the following formula (Nelson and Sommer, 1982) [5].

$$\text{Organic carbon (\%)} = (B - T) \times N \times 0.003 \times \frac{10}{\text{Wt. of soil}}$$

Where,
B = ml of standard $FeSO_4$ required for blank
T = ml of standard $FeSO_4$ required for soil sample
N= Normality of standard $FeSO_4$solution

3) Available Nitrogen (kg/ha**)**
Available nitrogen in soil was determined in kg/ha by alkaline potassium permanganate method as described by Subbiah and Asija (1956) [9]. The soil was oxidized by $KMn0_4$ in the presence of NaOH in Kjeldahl distillation flask. The ammonia released was absorbed in boric acid and was titrated with std. H_2SO_4 (0.02N).

4) Available Phosphorous (kg/ha**)**
It was determined in kg/ha by Olsen's method using 0.5 M sodium bicarbonate (pH 8.5) as extracting solution. Darco G 60 free from soluble phosphorous was used to absorb the dispersed organic matter and make the filtrate colourless for further colorimetric analysis (Olsen *et al*. 1954) [6].

5) Available Potassium (kg/ha)
It was determined in kg/ha by flame photometer using 1 *N* neutral ammonium acetate (pH 7.0) solution as an extracting (Jackson, 1973) [3].

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.

Soil pH
It didn't influence by different nutrients levels at harvest stage in both the trials. Though not significant, soil pH recorded slightly decreased in different nutrients levels treatment combinations. The decrease in soil pH value can happen as a result of base cation leaching K, Ca, Mg and their replacement in the soil adsorption complex with hydrogen ions. Decline in pH might have resulted from build-up of organic matter with time in fertilizer plots. The present investigations are in confirmation with Waghmare *et al.*, (2018[a]) [10] in custard apple and Belton and Goh (1992) [1] in apple tree.

Electrical Conductivity (dSm^{-1})
Data revealed that electrical conductivity of soil was noticed normal (0.14 dSm^{-1}) at initial however, it didn't influence by different treatment combinations at final stage in both the trials. The $N_2P_2K_2$ combination with N_2-350 g N/plant, P_2-175 g P_2O_5/plant and K_2-175 g K_2O/plant which recorded slight increased electrical conductivity (0.21 dSm^{-1}) of soil at final stage of second trial. The EC values were less than (0.8 dSm^{-1}), which is considered safe for growth of all crops. The increase in soil electrical conductivity as impacted by inorganic and organic fertilizers addition might be due to the amount of dissolved salts in the manures. Increasing manure rate also increased the soil EC with the application of P and N-based manure application. The present investigations are in confirmation with Waghmare *et al.*, (2018[a]) [10] in custard apple.

Organic Carbon (%)

The organic carbon content of soil was high in status (0.65%) at initial and it did not find any change in status due to different treatments at harvest of the both year. In addition, the higher application rate of manure produced the higher SOM content.

The mineralization of SOC is an important part of carbon cycle in the terrestrial ecosystem, and it is directly related to the nutrient cycling and utilization in the soil, crop productivity, greenhouse gases emission, and SOC storage. This was also supported by Hati *et al.*, (2007) [2] who indicated that increase in SOC after 28 yr among fertilizer treatments was due to addition of carbon source through farmyard manure, root biomass, and crop residues.

Available Nitrogen

The available nitrogen showed insignificant impact by different NPK interaction during initial stage of year 2017, whereas, it was significantly higher during final stage of the year 2017 and 2018. The $N_2P_2K_2$ combination with N_2-350 g N /plant, P_2-175 g P_2O_5/plant and K_2-175 g K_2O/plant recorded higher available nitrogen (182.11 kg/ha) and (183.56 kg/ha) during final stages of both the years, respectively. The $N_2P_2K_2$ combination was observed to be at par with $N_2P_2K_1$, $N_2P_1K_1$ and $N_2P_1K_2$, whereas, the $N_0P_2K_1$ with N_0-0 g N /plant, P_2-175 g P_2O_5/plant and K_1- 125 g K_2O/plant recorded significantly lower available nitrogen (164.77 kg/ha) and (159.67 kg/ha) during final stages of both the years, respectively.

Decrease in soil nitrogen levels might be caused due to translocation of soil nitrogen to leaf and fruit which get reflected by elevated levels of leaf and fruit N content. During leafing out, The reserves are drawn on until later in season, the supply of newly produced or absorbed nutrients exceeds the demand and replenishment occurs. Fertilizers promoted nitrogen translocation into deeper soil layers, which could result in the migration of this nutrient to waters. The application of NPK in combination with organic fertilizers enabled to increase the nitrogen content of soil by 15% on average. The best results were achieved when mineral fertilizers were combined with farmyard manure (Sadej and Przekwas, 2008) [8]. The present investigations are in confirmation with Waghmare *et al.*, (2018[a]) [10] in custard apple.

Table 2: Effect of nitrogen, phosphorus and potassium fertilization scheduling on soil pH, electrical conductivity, organic carbon of custard apple

Treatments	Soil pH		Electrical Conductivity (dSm-1)		Organic carbon (%)	
	1st yr.	2nd yr.	1st yr.	2nd yr.	1st yr.	2nd yr.
$N_0 P_0 K_0$	8.21	8.19	0.15	0.16	0.64	0.62
$N_0 P_0 K_1$	8.22	8.20	0.15	0.16	0.64	0.63
$N_0 P_0 K_2$	8.21	8.19	0.15	0.16	0.64	0.64
$N_0 P_1 K_0$	8.22	8.20	0.15	0.16	0.64	0.63
$N_0 P_1 K_1$	8.22	8.20	0.15	0.17	0.64	0.63
$N_0 P_1 K_2$	8.21	8.19	0.16	0.18	0.64	0.63
$N_0 P_2 K_0$	8.22	8.20	0.15	0.16	0.63	0.63
$N_0 P_2 K_1$	8.21	8.19	0.15	0.17	0.63	0.62
$N_0 P_2 K_2$	8.22	8.20	0.16	0.18	0.63	0.63
$N_1 P_0 K_0$	8.21	8.19	0.16	0.17	0.64	0.64
$N_1 P_0 K_1$	8.21	8.19	0.16	0.17	0.63	0.63
$N_1 P_0 K_2$	8.22	8.20	0.16	0.18	0.64	0.63
$N_1 P_1 K_0$	8.22	8.20	0.15	0.17	0.64	0.63
$N_1 P_1 K_1$	8.21	8.19	0.17	0.19	0.63	0.63
$N_1 P_1 K_2$	8.22	8.20	0.16	0.20	0.64	0.65
$N_1 P_2 K_0$	8.22	8.20	0.15	0.18	0.64	0.65
$N_1 P_2 K_1$	8.21	8.19	0.16	0.18	0.62	0.65
$N_1 P_2 K_2$	8.22	8.20	0.16	0.18	0.63	0.65
$N_2 P_0 K_0$	8.22	8.20	0.16	0.17	0.64	0.65
$N_2 P_0 K_1$	8.21	8.19	0.16	0.18	0.63	0.64
$N_2 P_0 K_2$	8.22	8.20	0.16	0.18	0.63	0.64
$N_2 P_1 K_0$	8.22	8.20	0.16	0.18	0.63	0.64
$N_2 P_1 K_1$	8.22	8.20	0.17	0.20	0.63	0.66
$N_2 P_1 K_2$	8.21	8.19	0.16	0.20	0.62	0.65
$N_2 P_2 K_0$	8.21	8.19	0.15	0.18	0.63	0.64
$N_2 P_2 K_1$	8.22	8.20	0.17	0.20	0.62	0.65
$N_2 P_2 K_2$	8.22	8.20	0.17	0.21	0.62	0.66
SE(m) ±	0.01	0.01	0.01	0.01	0.01	0.01
CD 5%	NS	NS	NS	NS	NS	NS
GM	8.21	8.19	0.16	0.18	0.63	0.64

Table 3: Effect of nitrogen, phosphorus and potassium fertilization scheduling on available nitrogen, available phosphorus and available potassium in soil of custard apple field

Treatments	Available N (kg ha1)		Available P (kg ha1)		Available K (kg ha1)	
	1st yr.	2nd yr.	1st yr.	2nd yr.	1st yr.	2nd yr.
$N_0 P_0 K_0$	164.99	160.89	13.21	12.81	244.36	234.72
$N_0 P_0 K_1$	165.19	160.09	13.31	12.91	244.55	234.96
$N_0 P_0 K_2$	165.08	161.48	13.53	13.13	244.46	234.80
$N_0 P_1 K_0$	165.11	161.01	14.14	13.74	244.54	235.36
$N_0 P_1 K_1$	164.71	160.11	13.99	13.59	245.12	235.57
$N_0 P_1 K_2$	164.61	160.01	14.01	13.61	246.28	235.93
$N_0 P_2 K_0$	165.05	160.45	14.12	13.72	243.81	234.92
$N_0 P_2 K_1$	164.77	159.67	14.11	13.71	251.32	237.73
$N_0 P_2 K_2$	165.05	159.95	14.60	14.20	251.59	237.54
$N_1 P_0 K_0$	173.79	175.44	14.04	13.71	245.96	236.35
$N_1 P_0 K_1$	174.12	175.77	13.97	13.64	248.74	236.45
$N_1 P_0 K_2$	174.65	176.31	14.10	13.77	249.55	236.53
$N_1 P_1 K_0$	174.37	176.02	14.78	14.56	247.17	237.11
$N_1 P_1 K_1$	179.57	181.67	14.82	14.60	253.04	243.77
$N_1 P_1 K_2$	179.55	181.65	14.90	14.69	253.17	244.30
$N_1 P_2 K_0$	174.08	176.18	14.59	14.37	248.35	236.81
$N_1 P_2 K_1$	179.88	181.98	14.93	14.71	254.43	244.95
$N_1 P_2 K_2$	180.39	182.49	14.96	14.75	254.84	245.00
$N_2 P_0 K_0$	173.82	175.11	14.05	13.73	247.51	237.15
$N_2 P_0 K_1$	175.73	177.02	14.12	13.80	251.61	242.25
$N_2 P_0 K_2$	176.37	177.66	14.22	13.91	252.22	242.87
$N_2 P_1 K_0$	173.13	174.42	13.63	13.42	248.32	238.97
$N_2 P_1 K_1$	181.45	182.90	15.08	14.87	255.04	246.18
$N_2 P_1 K_2$	181.84	183.29	15.08	14.87	255.24	246.89
$N_2 P_2 K_0$	175.02	176.47	14.82	14.61	251.61	242.25
$N_2 P_2 K_1$	182.10	183.55	15.16	14.95	255.59	247.15
$N_2 P_2 K_2$	182.11	183.56	15.19	14.98	255.92	247.46
SE(m) ±	0.63	0.61	0.09	0.09	0.44	0.56
CD 5%	1.76	1.72	0.24	0.25	1.24	1.56
GM	173.20	172.78	14.35	14.05	249.79	239.77

Available Phosphorus

The NPK interaction was insignificant in respect of available phosphorus during initial stage of year 2017, whereas, it was significantly higher during final stage of the year 2017 and 2018. The $N_2P_2K_2$ combination with N_2-350 g N /plant, P_2-175 g P_2O_5/plant and K_2-175 g K_2O/plant recorded higher available phosphorus (15.19 kg/ha) and (14.98 kg ha) during final stages of both the years, respectively. The $N_2P_2K_2$ combination was observed to be at par with $N_2P_2K_1$, $N_2P_1K_1$, $N_2P_1K_2$ and $N_1P_2K_2$. Whereas, the $N_0P_0K_0$ with N_0-0 g N /plant, P_0-0 g P_2O_5/plant and K_0- 0 g K_2O/plant recorded significantly lower available phosphorus (13.21 kg/ha) and (12.81 kg/ha) during final stages of both the years, respectively.

Increasing available mineral nitrogen in soils leads to enhanced N_2O formation and emission *via.* increased nitrification and denitrification. Nitrogen addition stimulated the sequestration of P in both plant and litter biomass. This may result in a significant decrease in soil phosphorus (Mosier and Zhu, 2000) [4]. The present investigations are in confirmation with Waghmare *et al.*, (2018[a]) [10] in custard apple.

Available Potassium

The NPK interaction was insignificant in respect of available potassium during initial stage of year 2017, whereas, it was significantly higher during final stage of the year 2017 and 2018. The $N_2P_2K_2$ combination with N_2-350 g N /plant, P2-175 g P_2O_5/plant and K_2-175 g K_2O/plant recorded higher available potassium (255.92 kg/ha) and (247.46 kg/ha) during final stages of both the years, respectively. The $N_2P_2K_2$ combination was observed to be at par with $N_2P_2K_1$, $N_2P_1K_2$ and $N_2P_1K_1$. Whereas, the $N_0P_0K_0$ with N_0-0 g N /plant, P_0-0 g P_2O_5/plant and K_0- 0 g K_2O/plant recorded significantly lower available potassium (244.36 kg/ha) and (234.72 kg/ha) during final stages of both the years, respectively.

Increase in soil potassium as compared to other treatments combination might be due to scheduling of potassium throughout the growth period of crop. Decrease in soil potassium levels in all treatment combination as compared to initial stage might be due to translocation of soil potassium to leaf and fruit which get reflected by elevated levels of leaf and fruit N content in both trials. The present investigations are in confirmation with Waghmare *et al.*, (2018[a]) [10] in custard apple.

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