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Nutrient Requirement of Papaya (*Carica papaya* L.) for Yield Optimization and Commercial Cultivation Under Kerala Conditions

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ABSTRACT

Papaya has gained commercial importance over the years because of its varied uses, mainly for table purpose. One of the reasons for low production in papaya is inadequate nourishment. As the export of papaya from India is rapidly increasing, there is a pressing need to enhance its productivity and improve the fruit quality. The present experiment was undertaken to study the response of major plant nutrients *viz.*, nitrogen, phosphorus and potassium on growth, yield and quality of papaya and also to find out the optimum dose of NPK for commercial cultivation of papaya under Kerala conditions. The trial was conducted in confounded factorial randomized block design. Different levels of nitrogen, phosphorus and potassium (200, 250 and 300) gram per plant per year were tried in six equal splits. Results revealed that application of nitrogen, phosphorus and potassium at the rate of 250:250:500g per plant per year in six equal splits, at two months interval was economically viable and improved the growth, yield and quality of papaya.

Key Words: Papaya, Nitrogen, Phosphorus, Potassium, Yield.

INTRODUCTION

Papaya (*Carica papaya* L.) has gained commercial importance over the years because of its varied uses. In Kerala it is grown in an area of 16,640 ha with an annual production of 1,03,420t and with average productivity of 6.2t/ha (FIB, 2016). The major production constraint encountered in papaya is difficulty in maximizing yield with in unit time. Balanced nutrition plays a vital role on plant growth, yield and fruit quality. Papaya is very responsive to the application of inorganic fertilizes along with organic manures. One of the reasons for low production in papaya is inadequate nourishment. Understanding the interrelationships among vegetative growth, yield and nutrient uptake will help to exploit the high yielding potential of papaya plants. As the export of papaya from India is rapidly increasing, there is a pressing need to enhance its productivity and improve the fruit quality. However under Kerala conditions, no systematic attempts have been made on the requirement of nutrition of papaya. The experiment was carried out to study the response of balanced nutrition on yield and yield attributes of papaya and also to find out the optimum dose of NPK for commercial cultivation of papaya under Kerala conditions.

MATERIALS AND METHODS

The study was carried out at College of Agriculture, Vellayani, using papaya variety CO-2. The experiment was conducted in confounded factorial randomized block design. Three different levels of nitrogen (200 (n0), 250 (n1), 300 (n2) gram per plant per year), phosphorus (200 (p0), 250 (p1), 300 (p2) gram per plant per year) and potassium (300 (k0), 400 (k1), 500 (k2) gram per plant per year)] were applied to papaya plants in six equal split doses at two months interval. Two month old seedlings were used for transplanting. Fertilizer application started thirty days after transplantation of seedlings to the main field. Urea, rock phosphate and muriate of potash were used as sources of Nitrogen, Phosphorus and Potassium.

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Table 1. Influence of nitrogen, phosphorus and potassium on biometric characters of papaya

Treatment	Plant height (6MAP) (cm)	Plant height (12MAP) (cm)	Leaf number (6MAP)	Leaf number (12MAP	Time for first flowering (days)	Time for harvest (days)
T1 (n0p0k0)	82.2	236.9	17.4	30.3	208.9	239.5
T2 (n0p0k1)	86.0	242.8	14.0	25.9	172.9	226.7
T3 (n0p0k2)	163.9	267.8	23.5	37.6	204.6	252.1
T4 (n0p1k0)	93.2	227.1	12.6	22.1	151.2	254.6
T5 (n0p1k1)	105.6	207.5	17.9	28.9	137.5	231.8
T6 (n0p1k2)	161.6	266.8	19.3	33.3	208.4	260.3
T7 (n0p2k0)	153.4	231.6	12.2	27.4	163.3	253.7
T8 (n0p2k1)	105.5	240.1	15.9	29.3	194.4	241.3
T9 (n0p2k2)	198.8	291.1	19.8	32.6	154.8	246.4
T10 (n1p0k0)	145.3	262.6	13.2	27.2	147.3	252.6
T11 (n1p0k1)	129.8	210.6	19.2	31.6	185.7	257.6
T12 (n1p0k2)	180.5	273.9	20.8	28.1	127.6	231.5
T13 (n1p1k0)	190.9	265.7	15.4	24.8	197.1	259.6
T14 (n1p1k1)	132.8	235.4	17.9	30.5	146.7	234.9
T15 (n1p1k2)	147.6	280.6	14.9	34.1	119.5	211.8
T16 (n1p2k0)	122.4	248.8	22.2	30.7	169.0	250.1
T17 (n1p2k1)	163.6	279.5	14.9	26.4	153.9	233.3
T18 (n1p2k2)	175.2	197.1	21.4	35.7	121.9	224.0
T19 (n2p0k0)	129.9	250.6	15.6	37.5	219.6	253.1
T20 (n2p0k1)	106.2	254.2	17.4	30.5	163.2	233.7
T21 (n2p0k2)	139.4	246.7	24.4	37.1	141.3	241.9
T22 (n2p1k0)	150.4	282.4	16.1	28.5	212.8	249.0
T23 (n2p1k1)	120.3	230.4	12.5	24.7	172.6	256.7
T24 (n2p1k2)	162.9	261.4	25.6	40.0	149.5	239.4
T25 (n2p2k0)	153.7	268.2	20.4	28.7	139.7	222.2
T26 (n2p2k1)	134.1	258.4	17.2	31.8	216.7	241.2
T27 (n2p2k2)	133.1	262.8	19.5	38.5	153.8	250.9
T28Control	69.8	163.2	11.2	21.7	224.3	266.5
SE	3.2	3.5	0.3	0.6	2.7	1.8
CD (0.05)	6.6	7.3	0.7	1.3	5.7	3.7

MAP- Months after planting

The treatments involved 27 different combinations of Nitrogen, Phosphorus and Potassium at different levels, their interactions and control. Biometric characters like height of plants, girth of plants, number of leaves, time of first flowering and time of harvest were noted. Yield characters like number of fruits per plant, fruit weight, fruit length and girth, fruit volume, pulp percentage, total yield per

Table 2. Influence of nitrogen, phosphorus and potassium on yield characters of papaya.

Treatment	Number of fruits per plant	Total fruit yield per plant (kg)	Papain yield (Kg/ ha)	Fruit length (cm)	Fruit girth (cm	Fruit weight (g)	Benefit: cost ratio
T1 (n0p0k0)	29.3	32.3	356.8	25.9	40.6	1163.7	2.1
T2 (n0p0k1)	21.3	19.8	415.9	21.9	38.1	959.2	1.8
T3 (n0p0k2)	16.8	22.5	397.6	26.7	42.9	1207.3	1.4
T4 (n0p1k0)	30.6	35.6	251.9	24.9	37.0	835.1	2.4
T5 (n0p1k1)	20.9	17.4	264.9	25.9	34.4	855.9	1.3
T6 (n0p1k2)	26.2	28.2	392.5	25.4	42.5	999.2	1.8
T7 (n0p2k0)	21.3	27.1	300.6	25.3	26.4	866.8	1.7
T8 (n0p2k1)	28.05	17.8	323.6	20.2	34.1	708.3	1.1
T9 (n0p2k2)	17.7	23.5	266.2	27.9	42.1	920.5	1.4
T10 (n1p0k0)	24.1	24.5	318.9	21.6	24.3	895.8	1.6
T11 (n1p0k1)	15.9	37.1	314.3	25.3	41.5	1246.7	2.3
T12 (n1p0k2)	35.0	27.7	605.6	23.7	36.9	899.5	1.8
T13 (n1p1k0)	26.1	19.2	323.5	22.7	33.8	1116.9	1.2
T14 (n1p1k1)	19.5	26.4	377.8	24.9	36.4	1018.8	1.6
T15 (n1p1k2)	43.6	59.8	674.6	32.9	42.3	1338.7	3.6
T16 (n1p2k0)	36.0	28.8	541.7	22.4	27.6	453.7	1.7
T17 (n1p2k1)	24.5	31.9	420.7	25.1	26.1	1238.2	1.9
T18 (n1p2k2)	32.2	20.6	569.0	23.4	29.4	927.5	1.2
T19 (n2p0k0)	20.0	32.6	390.10	22.8	35.3	1190.8	2.0
T20 (n2p0k1)	15.6	22.8	258.9	22.4	38.9	1152.5	1.4
T21 (n2p0k2)	28.7	27.5	268.7	20.9	32.8	719.5	1.6
T22 (n2p1k0)	24.2	21.8	346.2	23.9	35.4	936.2	1.3
T23 (n2p1k1)	29.5	39.1	272.9	24.3	27.4	854.7	2.3
T24 (n2p1k2)	24.7	36.2	339.9	23.6	35.3	849.1	2.2
T25 (n2p2k0)	30.8	27.7	402.4	27.6	30.9	911.6	1.7
T26 (n2p2k1)	34.5	35.4	276.4	22.1	29.4	658.2	2.1
T27 (n2p2k2)	26.7	27.7	347.3	26.6	42.1	1171.4	1.6
T28 Control	11.2	5.9	58.7	16.1	23.5	395.6	0.5
SE	1.4	1.7	21.7	2.	2.71	23.1	
CD (0.05)	2.9	3.4	45.1	NS	5.6	47.9	

plant and papain yield were recorded. Fruit quality characters were also recorded during the study. Benefit: Cost ratio was worked out. Shelf life of fruits was noted. Soil samples from the experimental area were analyzed before and after experiment for available nitrogen, phosphorus and potassium Nitrogen, Phosphorus and Potassium content of leaf petioles were also assessed. Tissue samples were collected from recently matured petiole.

RESULTS AND DISCUSSION

NPK interaction had significant influence on plant height at all stages of growth. N0p2k2 gave maximum plant height in papaya (Table 1). The result of the present study was in conformity with the observations of Auxilia *et al* (2008) who observed that in papaya, lower dose of nitrogen combined with higher dose of phosphorus and potassium showed synergistic effect, thus resulting in increased height of plants. Potassium probably stimulated the efficiency of nitrogen utilization in respect of growth. Also it was seen that n2p1k2 resulted in maximum number of leaves. Lowest duration of flowering and harvesting was observed with nop1k1while control plants registered maximum number of days for harvest.

N1p1k2 had increased the number of fruits/plant by way of mean effect as well as interaction effect of nutrients (Table 2). This result was in conformity with the findings of Cruz *et al* (2004) who observed that in papaya application of 500g potassium gave significantly more number of fruits/plant. Similar result was also reported by Garcia *et al* (2003) that in papaya variety Ranchi maximum number of fruits were obtained by applying nitrogen 200g, phosphorus 300g and potassium 500g per plant.

Maximum fruit girth was obtained from n0p0k2. Similar results were observed with fruit weight and papain yield. The possible explanation for higher yield in treatment n1p1k2 could be a favourable combination of NPK which provided better vigour to the plants. There is a close relationship between vigour of plant and yield. Canesin and Correa (2006) also reported that in papaya application of potash increased yield significantly. Highest benefit: cost ratio (3.55) was obtained from the combination of n1p1k2.

Nitrogen and phosphorus application had no significant influence on TSS content of fruits. This finding is in conformity with the observations of Akinyemi and Akanda (2008) and Kumar and Gho (2003) who observed that in papaya, TSS was not affected by different levels of nitrogen. But potassium application had significant influence on TSS content of fruits. Highest dose of potassium (500 g/plant/year) gave highest TSS content of fruits. Highest carotenoid content was reported by the application of n0p2k2. The results from the experiment showed that nitrogen and phosphorus application had no significant influence on ascorbic acid content. While application of highest dose of potassium (500g/plant/year) resulted in highest ascorbic acid content in fruits. Highest total sugar and reducing sugar was obtained with application of n0p2k2. In the studies it was also observed that highest shelf life of fruits was obtained from combined application of n2p0k0.

CONCLUSION

The study revealed that application of nitrogen, phosphorus and potassium increased plant height and number of leaves. Plants receiving a dose of nitrogen at 250 g, 300 g phosphorus and 500g potassium per plant took the shortest time for flowering. Combined application of nitrogen at 250 g/plant, phosphorus at 250 g/plant and potassium at 500g/plant considerably shortened the time for harvesting the first fruit increased fruit weight, number of fruits per plant , yield per plant and papain yield. Levels of nitrogen and phosphorus had no significant influence on TSS and ascorbic acid content of fruits. Nitrogen at 200g, phosphorus at 250 g and potassium at 500g/plant was found to increase the shelf life of fruits. The overall assessment of the effect of major plant nutrients on papaya indicated that the application of nitrogen,

Table 3. Influence of nitrogen, phosphorus and potassium on fruit quality characters of papaya.

Treatment	TSS (per cent)	Acidity (per cent)	Total carote-noids (mg 100g-1)	Ascorbic acid (mg 100g-1)	Total sugars (per-cent)	Reducing sugars (percent)	Non reducing sugars (per cent)	Shelf life (days)
T1 (n0p0k0)	11.6	0.1	2.2	41.9	12.3	10.4	1.9	5.2
T2 (n0p0k1)	10.6	0.3	2.6	38.9	10.6	8.6	2.0	6.9
T3 (n0p0k2)	13.8	0.2	1.5	42.8	14.6	11.7	2.8	4.1
T4 (n0p1k0)	10.8	0.2	2.1	40.4	8.7	7.2	1.5	5.4
T5 (n0p1k1)	10.8	0.2	2.3	40.6	9.7	7.3	2.4	6.1
T6 (n0p1k2)	14.4	0.2	2.54	42.3	14.3	12.7	1.6	6.3
T7 (n0p2k0)	13.9	0.3	1.3	43.8	10.9	8.8	2.0	4.1
T8 (n0p2k1)	12.4	0.1	2.3	39.4	11.4	9.5	1.9	5.3
T9 (n0p2k2)	16.7	0.1	3.7	51.7	15.4	13.9	1.6	7.2
T10 (n1p0k0)	14.8	0.2	1.8	47.6	12.7	9.7	2.9	4.0
T11 (n1p0k1)	11.7	0.3	2.9	41.8	8.2	5.1	3.2	6.8
T12 (n1p0k2)	12.0	0.4	1.6	44.5	13.0	12.1	1.6	5.6
T13 (n1p1k0)	12.7	0.2	1.8	36.7	12.1	10.9	1.3	4.7
T14 (n1p1k1)	10.8	0.2	1.6	43.4	7.7	6.4	1.3	3.4
T15 (n1p1k2)	14.9	0.3	3.1	42.9	11.0	9.2	1.8	7.0
T16 (n1p2k0)	12.6	0.3	1.6	44.9	8.5	6.5	2.0	3.7
T17 (n1p2k1)	12.4	0.2	2.0	39.2	11.2	9.5	1.9	6.5
T18 (n1p2k2)	10.0	0.3	2.4	48.9	12.8	10.1	2.8	4.1
T19 (n2p0k0)	12.2	0.3	2.4	48.9	8.3	7.0	1.3	7.3
T20 (n2p0k1)	10.0	0.2	2.3	44.6	11.2	9.1	2.2	4.0
T21 (n2p0k2)	15.2	0.2	2.6	41.3	12.7	10.2	2.5	5.2
T22 (n2p1k0)	11.4	0.1	2.2	41.2	10.5	8.3	2.1	6.7
T23 (n2p1k1)	12.5	0.3	2.6	47.4	9.9	7.5	2.3	3.9
T24 (n2p1k2)	11.5	0.1	1.6	41.2	13.3	12.1	1.3	5.7
T25 (n2p2k0)	12.3	0.15	2.5	45.9	9.6	8.4	1.2	4.2
T26 (n2p2k1)	9.9	0.2	2.1	39.3	8.6	6.4	2.3	6.3
T27 (n2p2k2)	13.0	0.2	1.9	47.2	13.5	11.7	1.8	4.9
T28 Control	7.5	0.4	0.8	31.8	5.6	4.4	1.3	3.2
SE	1.0	0.1	0.3	2.5	0.2	0.4	0.3	0.1
CD (0.05)	NS	0.08	0.7	NS	0.5	0.2	NS	0.2

phosphorus and potassium at the rate of 250 : 250 : 500 g/ plant/ year in six equal splits at two months interval was economically viable and improved growth, yield and quality of papaya under Kerala conditions.

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