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Pushpa Kumari
Department of Horticulture (Fruit & Fruit Technology), Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

M Feza Ahmad
Department of Horticulture (Fruit & Fruit Technology), Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Manoj Kundu
Department of Horticulture (Fruit & Fruit Technology), Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

AK Jha
Department of Food Science and Postharvest Technology, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Rajiv Rakshit
Department of Soil Science & Agricultural, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Correspondence
Pushpa Kumari
Department of Horticulture (Fruit & Fruit Technology), Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Fertilizer requirement of papaya (*Carica papaya* L.) for commercial cultivation under Bihar condition

Pushpa Kumari, M Feza Ahmad, Manoj Kundu, AK Jha and Rajiv Rakshit

Abstract
An experiment entitled "Fertilizer requirement of papaya (*Carica papaya* l.) for commercial cultivation under Bihar condition" was conducted during the year 2016-17 at Horticulture garden, Bihar Agricultural University, Sabour, Bhagalpur (Bihar). The experiment contains twenty seven treatment with three replication under Randomised Block Design (RBD factorial). Treatment includes three levels of each calcium nitrate, neem coated urea (both @ of 0, 100 & 200 g/plant) and muriate of potash (0, 200 & 400 g/plant) were applied in four equal split starting at 2 month of planting. The results showed that, number of flowers and fruits/plant ranged from 19.19 – 20.89 and 14.97 – 18.14 respectively, fruit weight from 0.889 – 0.927 kg among different fertilizer application, the TSS content ranged from 7.76 – 8.80 °Brix and acidity content from 0.33 – 0.36%. Neem coated urea showed best result in increasing the no. of flowers and fruit weight than calcium nitrate. Application of higher dose (400 g/plant) of muriate of potash results best in increasing quality of papaya fruits.

Keywords: Papaya, fertilizer, potash, nitrogen, quality

Introduction
Papaya (*Carica papaya* L.) is widely grown fruit crops of tropical and subtropical region, originated in tropical America. These are grown as backyard as well as at commercial level due to early bearing and dwarfing nature. It belongs to family Caricaceae with chromosome numbers 2n =2X =18. They grow well under temperature range of 21 to 33 °C with well distributed rainfall of 110-120 cm during entire growth period. Growth and yield of papaya mainly influenced by various environmental factors like light, temperature, rainfall, nutrient status of soil and other soil properties (Compostrini and Glen, 2007) [3].
Nowadays, papaya cv. Red Lady has gained maximum popularity due to gynodioecious nature and its easy cultivation, quick return with good yield and quality fruits. It starts bearing fruit at a height of 75-85 cm with 20-25 numbers of fruit per plants in each fruiting season. Fruits are rich source of vitamin A content along with several other nutritive quality.
There are shallow root system in papaya that needs proper maintenance of nutrient and water uptake in plant efficiently. Proper cultural practices encourage root growth in the surface (25-30 cm) and thick root in 30-60 cm, depth (Reddy and Dinesh, 2013) [8]. Nutrient management is one of the most important cultivation practices for enhancing per unit fruit yield of papaya. Productivity has adversely affected if plant does not get optimum fertilizer doses. Over or insufficient fertilizer application reduces the yield potential of plant along with deteriorating soil fertility. Therefore, in this paper effects of nitrogenous and potash fertilizer on reproductive and quality parameters of papaya cv. Red Lady are studies.

Materials and Methods
An experiment entitled "Fertilizer requirement of papaya (*Carica papaya* L.) for commercial cultivation under Bihar condition" was conducted during the year 2016-17 at Horticulture garden, Bihar Agricultural University, Sabour, Bhagalpur (Bihar). The experiment consist of twenty seven treatment with three replication under factorial Randomised Block Design (RBD). Uniform basal doses of phosphorus @ 100 g per plant are given. Treatment consist with three levels of nitrogen (0g, 100g & 200g/plant) and potash (0, 200 & 400 g/plant) alone and in combinations to each other in 4 equal splits (July, September, February and March).

Neem coated urea and calcium nitrate were used as source of nitrogen and muriate of potash as source of potash. Fertilizer were placed 15-20 cm away from the plant in ring basin and mixed properly in soil. The reproductive and quality parameters of papaya cv. Red Lady were evaluated and statistically analysed.

Results and Discussion

Effects on number of Flowers/plant

It would be evident from table that the total no. of flowers increased significantly with increasing level of both the nitrogenous fertilizers (Table 1.). The maximum observation (20.83; 20.78) was found with the application of either as neem coated urea or $CaNO_3$ @ 200 g/plant. Number of flowers increased significantly with the increasing dose of MOP. The interaction of 200 g/plant neem coated urea in combination with 100 g/plant $CaNO_3$ showed maximum value (21.17) which is similar to $CaNO_3$ @ 200 g/plant and lowest value recorded in control (18.17). However, application of MOP @ 400g and $CaNO_3$ @ 200 g/plant gave maximum no. of flowers (21.67).

Effects on number of Fruits/plant and Fruit weight

Observations regarding fruit number and fruit weight is presented in table 1. Number of fruits/plant increases with increasing the levels of both the applied nitrogenous fertilizer. The highest data recorded with the application of neem coated urea (17.50) and $CaNO_3$ (18.14) @ 200 g/plant over control (16.42; 14.97 respectively). However, MOP results maximum no. of fruits (18.06) with 200 g/plant and is statistically similar to 400 g/plant applied doses of MOP. The combination of neem coated urea and calcium nitrate @ 200 g/plant each results more no. of fruits/plant (18.67) while, MOP @ 200 g and $CaNO_3$ @ 100 g/plant showed maximum fruits no. (19.33) over control (14.17). Neem coated urea in combination with MOP @ 200 g/plant each showed highest no. of fruits/plant (18.83) but not differ significantly with other interaction. However, these fertilizer exerts significant effects on fruit weight. The maximum fruit weight is related with MOP @ 400 g/plant (0.927 kg) which is at par with 100 g/plant application of neem coated urea and/or $CaNO_3$ (0.927; 0.926 respectively). The highest fruit weight under interaction of different fertilizer combination was observed with MOP @ 200 g and $CaNO_3$ @ 100 g/plant (0.947 kg).

The maximum no. of flowers recorded under treatment of 400g K_2O and 200g N_2 per plants while other parameters showed good result @ 100g N_2 and 200g K_2O applied plants. The similar finding in papaya cv. Pusa Dwarf was observed under interaction of 200g nitrogen and 300g potassium for fruit number (31.1) and fruit weight (825.8 g) (Singh *et al*. 2012).

Effects on Total Soluble Solids and Titratable Acidity of fruit

The data pertaining to TSS and Titratable acidity of fruit is presented in table 2. All the fertilizer significantly affect the TSS content of fruit. The highest TSS and lowest acidity content was found when plant treated with 400 g MOP (8.8 °Brix and 0.33 %) over control (7.76 °Brix and 0.36 %). Interaction of MOP @ 400 g/plant with 0 g $CaNO_3$ results best (8.97°Brix) among all other combinations of fertilizer.

The different climatic factors viz. light, temperature, water, nutrient, soil and CO_2 governed the fruit quality by influencing growth rate and sugar content in leaves and fruits, productivity and development of fruit (Costa and Costa, 2003). TSS was not influenced with different doses of nitrogen, while highest dose (500g/plant/year) of potash results highest TSS content in papaya fruits (Akinyemi and Akanda, 2008; Kumar and Gho, 2003) [1, 4]. Similarly, Bindu and Bindu, 2017 also found that nitrogen has no significant effect on fruit TSS content. Marshner, 2012 told that potassium promote the sugar translocation in plant and thus it increases the TSS in fruits. These are in conformity with Kumar *et al*. 2010 and Souza *et al*. (2009) [5, 10].

Conclusion

The production parameters viz. flower number, fruit number and fruit weight significantly affected by different fertilizer application. From this research finding it is concluded that application of both the nitrogenous fertilizer @ 200 g/plant singly is sufficient for more no. of flower and fruit production while, MOP @ 400 g//plant is best for maximum fruit weight and no. of flowers/plant. The higher dose of muriate (@ 400 g/plant) of potash governed better fruit quality in terms of TSS and acidity. These findings will be beneficial and economically viable for grower to increase the growth and production of papaya under Bihar condition.

Table 1: Effects of different fertilizers on number of flowers, fruits per plant and fruits weight

	number of flowers/plant				number of fruits per plant				fruits weight (kg)			
Treatments	**C0**	**C1**	**C2**	**Mean**	**C0**	**C1**	**C2**	**Mean**	**C0**	**C1**	**C2**	Mean
N0	18.17	18.67	21.17	19.33	13.75	18.17	17.33	16.42	0.806	0.943	0.919	0.889
N1	18.67	19.33	20.58	19.53	15.83	17.50	18.42	17.25	0.934	0.914	0.932	0.927
N2	20.75	21.17	20.58	20.83	15.33	18.50	18.67	17.50	0.935	0.920	0.896	0.917
Mean	19.19	19.72	20.78	19.90	14.97	18.06	18.14		0.892	0.926	0.915	0.911
M0	17.42	18.83	19.92	18.72	14.17	16.42	16.83	15.81	0.861	0.903	0.924	0.896
M1	19.33	20.17	20.75	20.08	16.00	19.33	18.83	18.06	0.906	0.947	0.874	0.909
M2	20.83	20.17	21.67	20.89	14.75	18.42	18.75	17.31	0.909	0.926	0.948	0.928
	M0	M1	M2	Mean	M0	M1	M2	Mean	M0	M1	M2	Mean
N0	17.83	19.17	21.00	19.33	14.92	17.50	16.83	16.42	0.863	0.894	0.911	0.889
N1	18.67	19.50	20.42	19.53	16.33	17.83	17.58	17.25	0.905	0.937	0.937	0.927
N2	19.67	21.58	21.25	20.83	16.17	18.83	17.50	17.50	0.920	0.896	0.935	0.917
Mean	18.72	20.08	20.89		15.81	18.06	17.31		0.896	0.909	0.928	
	Sem (±)	CD			Sem (±)	CD			Sem (±)	CD		
N	0.3394	0.9865			0.3582	1.0412			0.0171	0.0496		
C	0.3394	0.9865			0.3582	1.0412			0.0171	0.0496		
M	0.3394	0.9865			0.3582	1.0412			0.0171	0.0496		
NC	0.5879	1.7087			0.6205	NS			0.0295	0.0858		
NM	0.5879	NS			0.6205	NS			0.0295	0.0858		
CM	0.5879	NS			0.6205	NS			0.0295	NS		
C.V	7.24				8.91				7.94			

N0=0g, N1=100g, N2= 200g N for neem coated urea, C0=0g, C1=100g, C2=200g C for calcium nitrate, M0=0g, M1=200g, M2=400g K_2O and M for muriate of potash

Table 2: Effects of different fertilizers on TSS (°Brix) and Acidity (%) of fruit

	TSS (°Brix)				Acidity (%)			
Treatments	**C0**	**C1**	**C2**	**Mean**	**C0**	**C1**	**C2**	**Mean**
N0	8.40	8.08	8.30	8.26	0.36	0.35	0.34	0.35
N1	7.98	8.59	8.57	8.38	0.34	0.35	0.33	0.34
N2	8.23	8.63	8.28	8.38	0.34	0.34	0.34	0.34
Mean	8.21	8.44	8.39	8.34	0.35	0.34	0.34	0.34
M0	7.27	8.05	7.98	7.76	0.37	0.36	0.35	0.36
M1	8.38	8.52	8.48	8.46	0.34	0.34	0.34	0.34
M2	8.97	8.74	8.70	8.80	0.34	0.33	0.32	0.33
	M0	M1	M2	Mean	M0	M1	M2	Mean
N0	7.83	8.37	8.58	8.26	0.37	0.33	0.34	0.35
N1	7.61	8.63	8.91	8.38	0.36	0.34	0.33	0.34
N2	7.85	8.38	8.91	8.38	0.35	0.34	0.33	0.34
Mean	7.76	8.46	8.80		0.36	0.34	0.33	
	Sem (±)	CD			Sem (±)	CD		
N	0.0958	0.2785			0.0036	0.0105		
C	0.0958	0.2785			0.0036	NS		
M	0.0958	0.2785			0.0036	0.0105		
NC	0.1660	0.4824			0.0063	0.0182		
NM	0.1660	NS			0.0063	NS		
CM	0.1660	NS			0.0063	NS		
C.V	4.87				4.48			

N0=0g, N1=100g, N2= 200g N for neem coated urea, C0=0g, C1=100g, C2=200g C for calcium nitrate, M0=0g, M1=200g, M2=400g K_2O and M for muriate of potash

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