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Influence of nitrogen, potassium and their interaction on growth and phenology of papaya cv. Pusa dwarf

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ABSTRACT

Papaya is one of the important fruits being grown in Indo- Gangetic plain and is a good source of vitamin A, riboflavin, thiamin and mineral nutrients. The productivity of papaya is low due to lack of nutrient management. Keeping the view a field experiment was made to evaluate the effect of nitrogen, potassium and their interaction on growth and phenology of papaya cv, Pusa Dwarf. Application of 200g nitrogen pit^{-1} increased plant vigour (height and girth). However, N_0 and N_{300} g depicted earlier flowering and fruit set respectively, while application of K_{300}g exhibited significantly greater plant height and delayed flowering along with fruit set and incorporation of K_{500} g per pit showed broader stem girth. Fruit ripening was delayed by both the nutrients providing more time for fruit set. The interaction study revealed that the plant height and stem girth were found significantly maximum for $N_{200}K_{300}$ and $N_{200}K_{500}$ combination respectively, while statistically least values were observed for N_0K_0 interaction. However, significantly least time taken for first flowering and fruit set was noted for N_0K_0 treatment, while maximum days observed for $N_{300}K_{300}$.

Keywords **:** Nutrient management, papaya, phenology, vigour

Papaya (*Carica papaya* L.) belongs to family caricaceae and cultivated almost tropical and sub tropical countries at the temperature between 21 and 33^{0}C. Understanding the interaction of papaya with environmental factors such as light, temperature, wind, relative humidity, nutrients, soil water and soil physical and biological characteristics, is necessary to maximize yield and quality (Compostrini and Glen, 2007). This may provide scientific basis for the development of management strategies to optimize the growth and phenology of papaya.

The productivity of papaya varies from 100-150 t ha^{-1} depending upon cultivar, soil type and fertility, system of cultivation and agro-ecological conditions. Papaya fruit is rich in carotene, vitamin A, thiamine, riboflavin, minerals and a number of proteolytic enzymes. It is consumed as fresh ripen fruit and is also used as vegetable. It is also valued for latex known as 'papain', a proteolytic enzyme widely used in pharmaceutical industry. Consumption of ripen fruit is known to cure chronic constipation, dyspepsia of liver and spleen, piles and various digestive disorders. Papaya being a climacteric fruit has a very short shelf life and need rapid consumption before deterioration of the fruit quality. The chemical changes which takes place during ripening and transportation are increased in sugars, total soluble solids, vitamin A and activities of several enzymes namely cellulose, invertase, protease, polyphenol oxidase, mitochondrial glutamate dehydrogenase and a decrease in the level of amylase.

After achieving food security, it is being increasingly felt to achieve nutritional security for the betterment of the population across developing countries. To achieve nutritional security, our country needs to produce about 92 million metric tons of fruits per annum against the present total fruit production of the country 52.85 million metric tons. Tremendous efforts should be made to enhance the production of fruit crops through a rational and balanced use of inputs including fertilizers. Fruit crops which can be easily grown and are accessible to rural population may be given due attention if nutritional security to millions of poor people is to be addressed.

The success of the commercial cultivation of papaya depends upon balanced nutrient supply, with suitable agro-techniques. The key nutrients required in sufficient quantities for optimum plant growth and productivity are nitrogen, phosphorus and potassium. Nitrogen being the constituent of amino acids, proteins, nucleic acid, chlorophyll and a number of secondary plant metabolites, plays a vital role in regulating metabolic functions of the plant leading to better growth and productivity. Potassium is often referred as a quality element for crop production and it has been widely proven to have a crucial role in many crop quality parameters. Fruit size, appearance, colour, soluble solids, acidity, vitamin content, taste as well as shelf life are significantly influenced by adequate supply of potassium. These characteristics are affected by photosynthesis, regulation of stomatal moment, activation of various enzyme and other anabolic and catabolic processes. Potassium

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regulation of plant water balance and tolerance to various stresses like drought, excess water, salinity, high and low temperature is related to productivity and quality of fruits (Ganeshmurthy *et al.*2011). Other beneficial effects of potassium include high juice content, high vitamin C content, uniformity in ripening and resistance to bruising and physical breakdown during shipping and storage. Susceptibility of plants to diseases and pests due to high use of N fertilizers is effectively counteracted by K nutrition.

However, proper nutrient management studies in Pusa Dwarf cultivar of papaya under Varanasi conditions of eastern Uttar Pradesh are in conclusive. Therefore, the present study was aimed to find out the suitable nitrogen and potassium doses for better growth, development, flowering and fruit set of papaya, which can improve farm economy and farmers livelihood in eastern Uttar Pradesh.

MATERIALS AND METHODS

A field experiment with two treatments consisting of three levels each of nitrogen and potassium was conducted in three replications during two consecutive years in randomised block design (Factorial) at the horticulture farm of Udai Pratap Post graduate college Varanasi, Uttar Pradesh located at 25^0 34' N latitude and 82° 96' E longitude. The field soil was sandy loam (1:2) having pH value of 7.2, medium in organic carbon, available nitrogen and potassium and low in phosphorus with good drainage facilities. The planting pits of size 45 x 45 x 45cm were prepared during last week of September and left for one to two weeks for weathering after which two healthy seedlings of papaya cv. Pusa Dwarf of two months age were planted in each pit in the last week of October at a spacing of 1.5 x 1.5m. A uniform basal dose of phosphorus @ 250g per pit was applied during both the years of experiment. The nitrogen treatment @ N_0 (control), N_{200} (N_1) and N_{300} (N_2) and potassium @ K_0 (control), K_{300} (K_1) and K_{500} (K_2) per pit was applied during both the years, The entire quantity of potassium was mixed initially in the pit soil as basal dose, while nitrogen was applied at three and six months after planting in two equal splits. The fertilizers were placed 20-25cm away from the collar of the plants to avoid much injury to them. Proper irrigation, drainage, inter cultural operations were done to insure optimum growth of the plant. Suitable plant protection measures were also adopted to avoid many insect or disease infestations. Only 10 per cent male plants were allowed in the orchard and the rest were eliminated. Observations on growth, phenology and yield and yield parameters were recorded using standard procedure.

RESULTS AND DISCUSSION

Results revealed that the application of nitrogen and potassium exhibited beneficial effects on growth and phenology of papaya. Nitrogen level @ 200g per pit and potassium @ 300g per pit depicted the best combination for plant height of papaya and produced significantly vigorous plant height (169.60cm) followed by nitrogen (N_{200}) and potassium (K_{500}) (165.10cm), while the higher dose of nitrogen (N_{300}) and potassium (K_{500}) were statistically superior over control but was less than N_{200} and K_{300}, respectively (Table 1). Similar results have also been reported by Kumar *et al.*, (2006). However, the average stem girth was measured maximum (38.90cm) with N_{200}g followed by N_{300} (37.23cm), while K_{500}g treatment produced significantly maximum stem girth (37.70cm) over other treatment of potassium followed by K_{300} (35.80cm) with mean of control (K_0) was 33.60cm. Lower dose of potassium and higher dose of nitrogen was relatively less effective but was still statistically superior to control (Table 2). However, interaction of N_{200} and K_{500} combination depicted significantly greater stem girth (40.20cm) over other combination of nitrogen and potassium followed by 39.2cm for N_{200} K_{300}, while statistically least value (28.90cm) was noticed for N_0K_0.

There was no linear effect of nitrogen treatment on flowering and fruit set was seen since first flowering and first fruit set 155.8 and 163.3 days after transplanting were recorded for N_{200} N_0 treatment while maximum days was taken (157.50 and 186.10 days) for N_{300} treatment respectively for both the characters. However, significantly delayed fruit set by 4.7 and 7.2 days was noticed for K_{300} over the control $K_{0.}$ The effect of mineral nutrition especially potassium and nitrogen on flower formation is most likely caused by changes in phytohormone balance expression of regulation of sink-source relationships that is necessary to ensure proper completion of the reproductive phase even under the limited supply of mineral nutrients (Marschner, 1995). Nutrients are known to modulate not only the level but also the balance among auxin, gibberellins, cytokines and ABA in plants which is turn affect growth and development (Marschner, 1995). Earliness in flowering in response to nitrogen has also been reported by Anonymous(2007). The source sink balance is critical for flowering, fruit set, development and photo assimilate for about three fruits. The photosynthetic capacity also influences papaya fruit quality (Kumar *et al.*, 2006).

Table 1: **Influence of nitrogen, potassium and their interaction on plant height of papaya cv. Pusa Dwarf (Two year of pooled data).**

Potassium treatment (g pit-1)	Nitrogen treatment (g pit-1)			Mean
	N_0	N_{200}	N_{300}	
K_0	139.9	160.6	150.7	150.4
K_{300}	147.9	169.6	156.8	158.1
K_{500}	144.7	165.1	153.9	154.6
Mean	**144.16**	**165.10**	**153.80**	——
LSD(0.05)	**N=0.77**	**K=0.77**	**N x K=1.34**	

Table 2: **Influence of nitrogen, potassium and their interaction on Stem girth (cm) of papaya cv. Pusa Dwarf (Two year of pooled data).**

Potassium treatment (g pit-1)	Nitrogen treatment (g pit-1)			Mean
	N_0	N_{200}	N_{300}	
K_0	28.9	37.3	34.6	33.6
K_{300}	30.1	39.2	38.1	35.8
K_{500}	33.9	40.2	39.0	37.7
Mean	**30.96**	**38.90**	**37.23**	——
LSD(0.05)	**N=0.161**	**K=0.161**	**N x K=0.280**	

Interaction effects of nitrogen and potassium on plant height stem girth, days to flowering and days to first fruit set was quite apparent.

The best interaction with respect to plant height was N_{200} x K_{300}, while for stem girth was N_{200} x K_{500} (Table 2). Higher dose of nitrogen with higher dose of potassium showed declining trend with respect to stem girth and plant height to the effects were still for superior to control. Unlike main effect of nitrogen; the interaction between nitrogen and potassium delayed flowering in all the treatments. The maximum delay of 8.5 days was noted with N_{300} x K_{300} g per pit. Increase in potassium level to K_{500} g per pit reduced the delay in flowering at both the level of nitrogen. Days to first fruit set on the other hand was delayed in all the interactions of nitrogen and potassium as compared to control. The maximum days (189.2) was taken for N_{200} K_{300} treatment combination (Table 2). Higher dose of potassium with both the levels of nitrogen showed delay tendency relative to its lower dose and was taken maximum days than control (154.20). It is clear from these observations that proper nutrient management can effectively modulate nutrient status and inter play among growth hormones which may influence photosynthesis and other metabolic processes for better growth and productivity. Similar findings have also been reported by Jeyakumar *et al.* (2008), Kumar *et al*. (2006), Oliveira and Caldas (2004) and Yadav *et al.* (2011).However extensive studies are needed in combination with bio-fertilizers for formulation of economically viable nutritional package for papaya cultivation.

Therefore, the present experiment might be concluded that papaya production in Eastern Uttar Pradesh can be augmented with suitable nutrient management strategies. Further it is also advocated that indiscriminate use of higher doses of nutrients could be unviable and may create soil and water pollution problem in long run.

Table 3: **Influence of nitrogen, potassium and their interaction on days to first flowering of papaya cv. Pusa Dwarf (Two year of pooled data).**

Potassium treatment (g pit-1)	Nitrogen treatment (g pit-1)			Mean
	N_0	N_{200}	N_{300}	
K_0	152.5	155.3	154.8	154.2
K_{300}	157.5	158.3	160.8	158.9
K_{500}	160.0	153.7	156.8	156.8
Mean	**156.7**	**155.8**	**157.5**	——
LSD(0.05)	**N=0.527**	**K=0.297**	**N x K=0.517**	

Table 4: Influence of nitrogen, potassium and their interaction on days to first fruit set of papaya cv. Pusa Dwarf (Two year of pooled data).

Potassium treatment (g pit-1)	Nitrogen treatment (g pit-1)			Mean
	N_0	N_{200}	N_{300}	
K_0	158.7	166.0	182.5	169.1
K_{300}	164.3	175.5	189.2	176.3
K_{500}	166.8	169.4	186.5	174.2
Mean	**163.3**	**170.3**	**186.1**	——
LSD(0.05)	**N=0.297**	**K=0.527**	**N x K=0.915**	

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