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Response of different dose of nitrogen strategies on morphology, yield and quality of mango (*Mangifera indica* L.) cv. Amrapali under high density planting

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Abstract
The field study was conducted at Horticulture Garden, Bihar Agricultural College, Sabour during 2014-15 and 2015-16 to response of different dose of nitrogen strategies on phenology, yield and quality of mango (*Mangifera indica* L.) cv. Amrapali under high density planting (HDP). The experiment was laid out in factorial randomized block design with four levels of nitrogen (60g, 80g, 100g, and 120g/tree) treatments replicated thrice. The results obviously indicated that the every level of nitrogen significantly influenced the morphology, yield and quality of mango. Morphological parameter *i.e.* increase in tree height (29.22%), canopy spread (N-S 14.71%), canopy spread (E-W 13.42%), canopy volume (13.01%) and physical parameters of fruits like highest fruit length (10.35cm), fruit width (6.65cm), fruit weight (190.61g) and fruit volume (188.16cm^3) were observed with the application of 120 g nitrogen per tree, while as regard with yield and quality parameters like maximum fruit set (17.06%), fruit retention (10.03%), minimum fruit drop (90.21%), pulp: peel ratio (4.38), pulp: stone ratio (4.49), pulp per cent (66.44%), fruit yield (11.29 kg/tree), TSS (23.30 ^{0}B), TSS/acidity ratio (147.44), total sugars (18.07%), total carotenoids content (18.46mg/100g pulp) ascorbic acid content (38.47 mg/100g pulp) and minimum acidity (0.164%) were noted with the application of 100g nitrogen per tree. On the other hand, lowest morphological, yield and quality parameters were reported with the application of nitrogen @ 60g/tree.

Keywords: Nitrogen, morphology, yield, quality, mango and high density planting

Introduction
Mango (*Mangifera indica* L.) belongs to family Anacardiaceae, commonly known as national fruit of India. The chromosome number of mango is 2n = 40. Mango is a prized summer fruit crop of India with over one thousand recognized varieties consumed as fresh fruit or in the form of processed products like squashes, nectar, jam, leather, pickles and *amchoor* etc. Nitrogen is one of the most important nutrients for the growth of mango and it has a relevant role in the production of quality fruits. Mangoes adequately nourished with nitrogen regularly develops shoots, when they reach maturity have viable panicles able to bear fruit. Lack of nitrogen causes retarded development, less vegetative growth and reduced production of fruit (Jacob and Uexkull, 1960) [6] on the other hand excess dose of nitrogen causes excessive vegetative growth, difficulty at floral differentiation, loss of yield and fruit quality. The excess dose of nitrogen causes susceptibility to pest and diseases. Therefore, the study was under taken to standardize the dose of nitrogen in mango cv. Amrapali under high density planting (HDP).

Materials and Methods
The present study was undertaken at the Horticulture Garden, Bihar Agricultural College, Sabour during 2014-15 and 2015-16 on five years old trees of mango cv. Amrapali, planted as the distance of 3.0m×2.5m in rectangular planting system. The total of four different dose of nitrogen *viz.*, T_1 - 60g N/tree, T_2 - 80g N/tree, T_3 - 100g N/tree and T_4- 120g N/tree. All the treatments were replicated thrice in randomized block design having two trees per replication. All the cultural practices were provides to all treatment with uniformly except nitrogen application. The morphological parameters like tree height, canopy spreads and canopy volume were recorded by the methods of Arnonymous (1959) [2].
The fruit length and width were noted using the digital vernier callipers, volume was noted by water displacement method and average fruit weight was obtained with the help of electronic weighing balance. The average size, weight and yield of fruits were expressed in cm, g and kg/tree respectively. While the fruiting behaviours were calculated by following formulas:

$$\text{Fruit set (\%)} = \frac{\text{No. of fruits at initial stage}}{\text{No. of flowers in panicle}} \times 100$$

$$\text{Fruit drops (\%)} = \frac{\text{No. of fruits at initial stage} - \text{No. of fruit retained at harvest}}{\text{No. of fruits at initial stage}} \times 100$$

$$\text{Fruit retention (\%)} = \frac{\text{No. of fruits retained till maturity}}{\text{Initial No. of fruit set}} \times 100$$

For the estimation of quality parameters like total soluble solids (TSS), acidity, total sugars, ascorbic acid content and total carotenoids content, five healthy fruit were selected randomly from each replications at full maturity. Digital hand refractometer was used for the estimation of TSS, acidity was recorded with simple acid-alkali method as described in A.O.A.C. (1990) [1], total sugars were estimated by the method as recommended by Lane and Eynone (1923) [8], ascorbic acid was recorded by following the standard methods as described in A.O.A.C. (1990) [1] and total carotenoids content of mango fruit pulp was determined by the method of Roy (1973) [12].

Results and Discussion

Morphological parameters

All the morphological parameters *viz.* tree height, canopy spread (N-S and E-W) as well as canopy volume were significantly influenced by each successive dose (60-120g) of nitrogen (Table-1). The perusal data indicated that the maximum tree height increased (29.22 %), canopy spread N-S (14.71 %) and E-W (13.42 %) as well as canopy volume (13.01 %) was found with the application of nitrogen @ 120g/tree, which was significantly higher over the rest dose of nitrogen. The progressive increase in the morphological characters with increasing levels on nitrogen might be due to the fact that the nitrogen being the constituent of nucleoprotein, amino acids and chlorophyll played a vital role in photosynthesis and enhanced the accumulation of carbohydrates which, in turn, increased the growth of plants. Similar findings have also been reported by Gautam *et al.* (2012) [5] in mango cv. Sunderja and Patil and Shinde (2013) [11] in banana cv. Ardhapuri.

Fruiting behaviour

Application of nitrogen @ 100g/tree resulted to maximum fruit set (17.06%), fruit retention (10.03%) and minimum fruit drop (90.21%). The fruit drop was noted statistically at par with the application of nitrogen @ 120g and 80g/tree. Fruit set intensity was highly dependent on concentration of nitrogen; fruit set at the lowest nitrogen treatment was very low and highest concentrations caused reductions in fruit set. This may have lead due to nitrogen is a constituent of the chlorophyll molecule and involved in nucleic acid synthesis, hence important for cell division and the growth of young tissues like buds, flowers, leaves. Similar results also in Amrapali mango by Yadav *et al.* (2011) [15], in sunderja mango by Gautam *et al.* (2012) [5].

Yield and yield parameters

With respect to the entire yield parameters were significantly influenced with the different dose of nitrogen (Table-2). The increasing levels of nitrogen from 60 to 120 g/tree brought prominent effect on various physiological parameters and recorded maximum value of fruit length (10.35 cm), width (6.65 cm), weight (190.61 g/fruit) and volume (188.16 cm^3) of fruit with the application of nitrogen @ 120 g/tree. Whereas, the maximum pulp stone ratio (4.49), pulp peel ratio (4.38) and yield (11.29 kg/tree) of fruit was recorded with the application of nitrogen @ 100 g/tree. The evident effect of nitrogen on various physiological characters of fruits was due to fact that, it increased the efficiency of metabolic processes of the tree and thus encouraged the growth of the plant in general and therefore the various parts of the plant including fruit. Nitrogen has ability to produce the high rate of photosynthesis results in higher carbohydrate accumulation in fruit so increasing in fruit diameter and weight. These agreement with the findings of Nasreen *et al.* (2014) [10] in mango cv. BARI Aam-1, Satapathy and Banik (2002) [13] in Amrapali mango, Madhavi *et al.* (2008) [9] in mango cv. Banganapalli and Athani *et al.* (2007) [3] in guava.

Quality parameters

All the fruit quality parameters were recorded as significant due to various doses of nitrogen. The data has presented in table-3, the highest value of TSS (23.30 ^{0}B), TSS/Acidity ratio (144.47), Total sugars (18.07%), Total carotenoids (18.46 mg/100 g pulp) and ascorbic acid (38.47 mg/100 g pulp) were recorded with application of nitrogen @ 100 g/tree. Whereas, the lowest value of titratable acidity (0.164 %) was also analysed with the application of nitrogen @ 100 g/tree. Increase in TSS, total sugar, TSS/acid ratio, total carotnoids with nitrogen applications may be attributed to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to the developing fruits. Nitrogen application in form of inorganic nutrient sources might be due to the catalytic activity of several enzymes, which participate in biosynthesis of ascorbic acid and its precursor. These findings are in agreement with the Lal and Dayal (2014) [7] in acid lime, Sharma *et al.* (2016) [14] in guava cv. Sardar and Dudi *et al.* (2005) [4] in Kinnow.

Table 1: Response of different dose of nitrogen on morphological parameters and fruiting behaviours of mango cv. Amrapali under HDP (pooled data of two years)

Treatment	Plant Height increased (%)	Plant Spread N-S (%)	Plant Spread E-W (%)	Canopy volume (m^3)	Fruit set (%)	Fruit drop (%)	Fruit retention (%)
N_1 - Nitrogen @60g/tree	18.63	9.82	8.77	9.34	9.17	93.2	6.80
N_2 - Nitrogen @80g/tree	19.79	11.40	10.11	10.69	12.73	91.73	8.27
N_3 - Nitrogen @100g/tree	22.74	13.14	12.05	11.72	17.06	90.21	10.03
N_4 - Nitrogen @120g/tree	29.22	14.71	13.42	13.01	15.59	89.97	9.82
CD (P=0.05)	0.83	0.41	0.51	0.53	0.40	2.21	0.43

Table 2: Response of different dose of nitrogen on yield and yield parameters of mango cv. Amrapali under HDP (pooled data of two years)

Treatment	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Volume (cm^3)	Pulp: stone ratio	Pulp: peel ratio	Pulp percent	Yield (kg/tree)
N_1 - Nitrogen @60g/tree	9.76	6.07	160.57	157.94	3.66	3.59	61.9	7.37
N_2 - Nitrogen @80g/tree	10.00	6.29	169.04	166.87	4.04	4.00	64.29	8.92
N_3 - Nitrogen @100g/tree	9.59	6.39	146.55	144.23	4.49	4.38	66.44	11.29
N_4 - Nitrogen @120g/tree	10.35	6.65	190.61	188.16	3.96	3.97	64.34	10.71
CD (P=0.05)	0.26	0.23	4.96	5.60	0.19	0.18	2.30	0.41

Table 3: Response of different dose of nitrogen on quality parameters of mango cv. Amrapali under HDP (pooled data of two years)

Treatment	TSS (^{0}B)	Titratable acidity (%)	TSS/Acidity	Total sugars (%)	Total carotenoids (mg/100g pulp)	Ascorbic acid content (mg/100 g pulp)
N_1 - Nitrogen @60g/tree	20.82	0.243	87.62	15.79	16.59	30.76
N_2 - Nitrogen @80g/tree	21.87	0.204	111.62	17.09	17.49	34.14
N_3 - Nitrogen @100g/tree	23.3	0.164	147.44	18.07	18.46	38.47
N_4 - Nitrogen @120g/tree	21.43	0.195	113.15	17.46	17.62	37.08
CD (P=0.05)	0.35	0.003	1.88	0.19	0.20	0.56

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