



Response of Different Levels of N, P and K on Growth and Yield of Mango (*Mangifera indica* L.) cv. Kesar

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ijpss/2025/v37i45416>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://pr.sdiarticle5.com/review-history/134713>

Original Research Article

Received: 14/02/2025

Accepted: 16/04/2025

Published: 19/04/2025

ABSTRACT

The experiment was conducted at the Fruit Research Station, Sakkarbaug, Junagadh Agricultural University, Junagadh, over two years, 2021-22 and 2022-23. The experiment followed a Randomized Block Design with Factorial concept (FRBD), consisting of 18 treatment combinations, each with three replications. The treatments included three nitrogen levels N₁ (500 g/tree), N₂ (750 g/tree), N₃ (1000 g/tree), two phosphorus levels P₁ (100 g/tree), P₂ (150 g/tree) and three potassium levels K₁ (500 g/tree), K₂ (750 g/tree), K₃ (1000 g/tree). The experimental results indicated that significantly highest plant growth, including plant height (0.27 m), plant spread on east-west (0.27

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m) and north south (0.32 m), and number of panicles (236.97), was observed in pooled result under the application of nitrogen N3 (1000 g/tree), In terms of yield attributes, the treatment N3 (1000 g/tree) recorded the highest fruit set at pea stage (12.93) and marble stages (3.06), with maximum number of fruit per tree (165.19), fruit yield per tree (40.50 kg) and fruit yield (7.26 t/ha) in pooled result. Regarding phosphorus levels, the application of phosphorus P2 (150 g/tree) significantly influenced various growth, yield and quality parameters and resulted in the highest number of panicles per plant (236.39), length of panicle (26.47 cm) along with an increased number of fruits per tree (164.94) and highest fruit yield per tree (40.43 kg). In potash treatments, K2 (750 g/tree) significantly influenced various growth and yield parameters like maximum number of panicle per plant (237.53), highest length of panicle (26.53 cm) and highest fruit yield per tree (39.68 kg/tree). On the basis of two years studies and results obtained from the present investigation bring the conclusion that growth, yield and quality parameters of mango were influenced by different levels of N, P and K. It seems quite logical to conclude that fertilizer application of 1000 g/tree nitrogen, 150 g/tree phosphorus and 750 g/tree potash has been found optimum fertilizer dose which improved growth and yield with higher net realization in mango cv. Kesar.

Keywords: Mango; kesar; nitrogen; phosphorus; potassium.

1. INTRODUCTION

Mango (*Mangifera indica* L.), belonging to the family Anacardiaceae, is one of the most cherished fruit crops in tropical and subtropical regions worldwide. Celebrated as the 'King of Fruits', mango is widely cultivated due to its adaptability, rich nutritional profile, pleasant aroma, and exquisite taste. In India, it holds a special place as the national fruit and has been grown for over 4,000 years. Indigenous to the Indo-Myanmar region, mangoes are deeply rooted in Indian history and culture, referenced in ancient scriptures and art.

Globally, there are 69 recognized species of *Mangifera*, with around 11,595 cultivars. India, being the world's largest mango producer, boasts about 1,000 cultivars and contributes significantly to global mango production. It is estimated that mango area about 23.16 lakh ha and production of about 203.86 lakh MT with 8.8 MT/ha productivity in India. (Anon., 2021) The major mango-producing states in India are Uttar Pradesh, Andhra Pradesh, Karnataka, Gujarat, Bihar, Tamil Nadu, and Telangana. In Gujarat, districts like Valsad, Navsari, Surat, and Junagadh are prominent due to their favourable agro-climatic conditions. Gujarat itself produces 11.15 lakh MT of mango from 1.77 lakh ha area with 6.28 t/ha productivity. (Anon., 2023).

Mangoes are nutritionally rich: 100 g of pulp contains about 81.7 g water, 16 g carbohydrates, 0.7 g protein, and is a good source of vitamins A, B, C, calcium, phosphorus, iron, and antioxidants. Green mangoes are used in products like pickles and chutneys, while ripe

ones are consumed fresh or processed into juice, jam, candy, and pulp.

Among the many cultivars, 'Kesar' stands out for its flavor and vibrant saffron-colored pulp. Native to Gujarat and historically linked to the Nawab era of Junagadh and Mangrol, Kesar mangoes are referred to as 'Gir Kesar' due to their origin near the Gir forest. Known for their excellent taste and aroma, Kesar mangoes mature between April and May, with a shelf life of 15–20 days. They are oblong, weigh around 250–300 g, and contain 69% pulp, which is fiberless and high in total soluble solids (18–32 °Brix). In 2011, Kesar mango was granted a Geographical Indication (GI) tag—Gujarat's first GI-recognized fruit (Anonymous, 2011).

One of the major challenges in mango cultivation is fruit drop, with sometimes only 0.1% of fruits reaching maturity. Enhancing fruit set, yield, and quality requires strategic management, particularly in terms of nutrition. Fertilizers play a vital role in ensuring balanced nutrition by supplementing essential macro and micronutrients that may be deficient in the soil.

Nitrogen (N), phosphorus (P), and potassium (K) are the most crucial nutrients for mango tree development. Each contributes uniquely to tree growth, flowering, fruit set, and quality.

Nitrogen is essential for vegetative growth, as it supports the production of chlorophyll and proteins, enhancing photosynthesis and overall tree vigor. It also influences flower initiation and

fruit development. Studies have shown that proper nitrogen application can significantly increase yield and fruit size, but excess nitrogen may reduce fruit quality.

Phosphorus is vital for root development, energy transfer, and flower bud initiation. It supports the development of new tissues and plays a key role in metabolic processes, such as photosynthesis and respiration. Adequate phosphorus enhances fruit set, flavor, and structural strength, improving resistance to diseases and environmental stresses.

Potassium enhances fruit size, color, flavor, and shelf life. It maintains cell turgor and regulates water use efficiency. Potassium influences sugar and acid metabolism in mangoes, contributing to better taste and firmness. Research has shown that potassium fertilization improves yield and fruit quality across various climates.

Several studies underscore the importance of balanced NPK application in mango cultivation. For example, Bhuiyan and Irabagon (1992) and Reddy et al. (2000) reported improved fruit size and yield with nitrogen application. Potassium's contribution to firmness and storage life was also noted in trials by Fouad *et al.* (2003) and Neilsen *et al.* (2008).

Proper fertilization practices not only enhance fruit production but also improve the economic sustainability of mango orchards. Nutrient deficiencies, especially in nitrogen and phosphorus, lead to poor flowering, low fruit retention, and decreased yield. Therefore, it is essential to adopt a site-specific, balanced fertilizer strategy tailored to the crop's needs at various growth stages.

In conclusion, to optimize mango production—especially in high-value cultivars like Kesar—it is crucial to understand the crop's nutritional requirements. Judicious application of nitrogen, phosphorus, and potassium can significantly enhance tree health, yield, and fruit quality, ensuring economic viability and consumer satisfaction. Research aimed at identifying the ideal NPK levels for specific cultivars will continue to play a vital role in sustainable mango production.

2. MATERIALS AND METHODS

The current study was conducted at the Fruit Research Station Sakkarbaug, College of

Horticulture, Junagadh Agricultural University Junagadh, during the year 2021-22, 2022-23. The experiment was set up using Randomized Block Design with a Factorial concept (FRBD), involving three factors with three replications and eighteen treatment combinations. The different treatment combinations are as follow (1) N₁P₁K₁ (500: 100: 500 g/tree), (2) N₁P₁K₂ (500: 100: 750 g/tree), (3) N₁P₁K₃ (500: 100: 1000 g/tree), (4) N₁P₂K₁ (500: 150: 500 g/tree), (5) N₁P₂K₂ (500: 150: 750 g/tree), (6) N₁P₂K₃ (500: 150: 1000 g/tree), (7) N₂P₁K₁ (750: 100: 500 g/tree), (8) N₂P₁K₂ (750: 100: 750 g/tree), (9) N₂P₁K₃ (750 : 100 : 1000 g/tree), (10)N₂P₂K₁(750: 150: 500 g/tree), (11)N₂P₂K₂ (750: 150: 750 g/tree),(12) N₂P₂K₃ (750: 150: 1000 g/tree), (13) N₃P₁K₁ (1000: 100: 500 g/tree) (14) N₃P₁K₂ (1000: 100: 750), (15) N₃P₁K₃ (1000: 100: 1000 g/tree), (16) N₃P₂K₁ (1000: 150: 500 g/tree) (17) N₃P₂K₂ (1000: 150: 750), (18) N₃P₂K₃ (1000: 150: 1000 g/tree). The experimental material comprised 12 year old grafted mango trees of the Kesar cultivar, which is considered the most significant commercial cultivar in Saurashtra region. These trees were spaced at 8m x 8m distance. A total of 54 uniform Kesar tree were selected for the experiment. Nitrogen, phosphorus and potassium were applied in the form of Ammonium Sulphate, Urea, Single super phosphate and Muriate of potash, respectively in two splits, first in June-July (with onset of monsoon) with half dose of nitrogen and full dose of phosphorus and potassium. And remaining dose of nitrogen was applied when fruit attain mustard size (February-March). Fertilizers were applied as per the treatment combinations in ring method. The manures and fertilizer were applied by preparing ring one-meter diameter as basal dose. Two inflorescences were selected and tagged on each direction (North-South-East-West) which was arisen from the earlier tagged twigs. The tagging was done on each tree. So, total twenty inflorescences were selected per tree and tagged. Observations on growth and yield characters of each treatment were recorded and statistically analysed.

3. RESULTS AND DISCUSSION

The outcomes of different treatments were documented and the results obtained during the investigation were thoroughly discussed, supported by reasoning and relevant references. The entirety of the results and discussion has been presented under the following headings.

3.1 Effect of Different Levels of N, P and K on Growth Parameters

3.1.1 Effect of nitrogen

For the results of present study, it was seen that the application of N₃ (1000 g/tree) were significantly recorded highest increment in plant height (0.28, 0.27, 0.27 m), highest plant spread in east-west direction (0.27, 0.28 and 0.27 m) and highest plant spread in north-south direction (0.32, 0.32 and 0.32 m) during both the year and pooled result respectively. While application of nitrogen N₁ (500 g) was resulted the minimum increments in the height of plant (0.22, 0.23 and

0.23 m) minimum plant spread in east-west direction (0.19, 0.19 and 0.19 m) and minimum plant spread in north-south direction (0.25, 0.24 and 0.24 m) in both the year and pooled data respectively (Tables 1 and 2). These results would be attributed to favourable effect of nitrogen in increasing cell wall material resulted in production of large cell with thinner cell wall and its contribution in cell division and cell elongation. Also as meristematic tissues have very active protein metabolism, photosynthetic transport to site of growth are used predominantly in the synthesis of nucleic acid and protein, which promoted vegetative growth and ultimately increased in expansion plants in

Table 1. Effect of different levels of N, P and K on plant height and plant spread (E-W) of mango cv. Kesar

Treatments	Incremental plant height (m)			Plant spread - E-W (m)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Level of Nitrogen (N)						
N ₁ (500 g)	0.22	0.23	0.23	0.19	0.19	0.19
N ₂ (750 g)	0.26	0.26	0.26	0.22	0.23	0.23
N ₃ (1000 g)	0.28	0.27	0.27	0.27	0.28	0.27
S.Em.±	0.003	0.004	0.003	0.006	0.006	0.004
C.D at 5 %	0.01	0.01	0.01	0.02	0.02	0.01
Level of Phosphorus (P)						
P ₁ (100 g)	0.25	0.25	0.25	0.22	0.23	0.23
P ₂ (150 g)	0.25	0.26	0.26	0.23	0.24	0.24
S.Em.±	0.003	0.003	0.002	0.005	0.005	0.003
C.D at 5 %	NS	NS	NS	NS	NS	NS
Level of Potash (K)						
K ₁ (500 g)	0.25	0.25	0.25	0.22	0.23	0.23
K ₂ (750 g)	0.25	0.25	0.25	0.23	0.24	0.23
K ₃ (1000 g)	0.26	0.25	0.26	0.24	0.24	0.24
S.Em.±	0.003	0.004	0.003	0.006	0.006	0.004
C.D at 5 %	NS	NS	NS	NS	NS	NS
Interaction (N x P)						
S.Em.±	0.005	0.006	0.004	0.008	0.009	0.006
C.D. at 5%	NS	NS	NS	NS	NS	NS
Interaction (N x K)						
S.Em.±	0.006	0.007	0.005	0.010	0.011	0.007
C.D. at 5%	NS	NS	NS	NS	NS	NS
Interaction (P x K)						
S.Em.±	0.005	0.006	0.004	0.008	0.009	0.006
C.D. at 5%	NS	NS	NS	NS	NS	NS
Interaction (N x P x K)						
S.Em.±	0.008	0.010	0.007	0.014	0.015	0.010
C.D. at 5%	NS	NS	NS	NS	NS	NS
CV%	5.77	6.79	6.30	10.57	11.12	10.86
	S.Em.±	C.D. at 5%		S.Em.±	C.D. at 5%	
Year (N x P)	0.005	NS		0.008	NS	
Year (N x K)	0.007	NS		0.010	NS	
Year (P x K)	0.005	NS		0.008	NS	
Year (N x P x K)	0.009	NS		0.015	NS	

terms of plant height and plant spread. The increase in plant height and plant spread under higher level of nitrogen treatments during the present study might be due to the availability of major nutrients at optimum level in the soil and assimilation of food material within the plants. Similar results were also reported by Reddy *et al.* (2000) found that nitrogen application had marked influence on growth of the trees in mango. Sharma *et al.* (2000) reported that the combination of NPK increased the plant height, stem girth, and spread of mango. Hasan *et al.* (2006) for tree spread in mango. Rajbir Singh *et al.* (2000) reported that increasing the N fertilizer rate increased the sapota tree growth in terms of height and spread significantly.

3.1.2 Effect of phosphorus

In case of effect of different levels of phosphorus have no any significant result against plant height, plant spread in east-west, plant spread in north-south and number of coppery shoot during both the year and pooled result.

3.1.3 Effect of potash

The data recorded that the effect of different levels of potash has produced non-significant result on growth parameters like plant height, plant spread in east-west, plant spread in north-south and number of coppery shoot during both the year and pooled result.

Table 2. Effect of different levels of N, P and K on plant spread (N-S) of mango cv. Kesar

Plant spread - N-S (m)			
Treatments	2021-22	2022-23	Pooled
Level of Nitrogen (N)			
N ₁ (500 g)	0.25	0.24	0.24
N ₂ (750 g)	0.30	0.29	0.29
N ₃ (1000 g)	0.32	0.32	0.32
S.Em.±	0.006	0.006	0.004
C.D at 5 %	0.02	0.02	0.01
Level of Phosphorus (P)			
P ₁ (100 g)	0.28	0.28	0.28
P ₂ (150 g)	0.29	0.28	0.29
S.Em.±	0.005	0.005	0.004
C.D at 5 %	NS	NS	NS
Level of Potash (K)			
K ₁ (500 g)	0.29	0.28	0.28
K ₂ (750 g)	0.29	0.29	0.29
K ₃ (1000 g)	0.28	0.28	0.28
S.Em.±	0.006	0.006	0.004
C.D at 5 %	NS	NS	NS
Interaction (N x P)			
S.Em.±	0.009	0.009	0.006
C.D. at 5%	NS	NS	NS
Interaction (N x K)			
S.Em.±	0.011	0.011	0.008
C.D. at 5%	NS	NS	NS
Interaction (P x K)			
S.Em.±	0.009	0.009	0.006
C.D. at 5%	NS	NS	NS
Interaction (N x P x K)			
S.Em.±	0.015	0.015	0.011
C.D. at 5%	NS	NS	NS
CV%	9.14	9.18	9.16
	S.Em.±	C.D. at 5%	
Year (N x P)	0.009	NS	
Year (N x K)	0.011	NS	
Year (P x K)	0.009	NS	
Year (N x P x K)	0.015	NS	

Table 3. Effect of different levels of N, P and K on number of fruits set at pea stage and marble stage per panicle of mango cv. Kesar

Treatments	Number of fruit set at pea stage per panicle			Number of fruit set at marble stage per panicle		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Level of Nitrogen (N)						
N ₁ (500 g)	11.96	11.94	11.95	2.43	2.72	2.58
N ₂ (750 g)	13.08	12.68	12.88	3.01	3.10	3.06
N ₃ (1000 g)	12.51	12.93	12.72	2.97	2.99	2.98
S.Em.±	0.190	0.143	0.119	0.060	0.065	0.044
C.D at 5 %	0.55	0.41	0.34	0.17	0.19	0.12
Level of Phosphorus (P)						
P ₁ (100 g)	12.28	12.39	12.33	2.69	2.85	2.77
P ₂ (150 g)	12.76	12.65	12.70	2.93	3.02	2.97
S.Em.±	0.155	0.117	0.097	0.049	0.053	0.036
C.D at 5 %	0.45	NS	0.27	0.14	0.15	0.10
Level of Potash (K)						
K ₁ (500 g)	12.11	12.24	12.17	2.57	2.75	2.66
K ₂ (750 g)	12.63	12.72	12.67	2.90	3.08	2.99
K ₃ (1000 g)	12.82	12.60	12.71	2.94	2.97	2.96
S.Em.±	0.19	0.14	0.12	0.060	0.065	0.044
C.D at 5 %	0.55	NS	0.34	0.17	0.19	0.12
Interaction (N x P)						
S.Em.±	0.269	0.202	0.168	0.085	0.091	0.062
C.D. at 5%	NS	NS	NS	NS	NS	NS
Interaction (N x K)						
S.Em.±	0.330	0.248	0.206	0.104	0.112	0.076
C.D. at 5%	0.95	NS	0.58	0.30	0.32	0.22
Interaction (P x K)						
S.Em.±	0.269	0.202	0.168	0.085	0.091	0.062
C.D. at 5%	NS	NS	NS	NS	NS	NS
Interaction (N x P x K)						
S.Em.±	0.466	0.350	0.292	0.147	0.158	0.108
C.D. at 5%	NS	NS	NS	NS	NS	NS
CV%	6.45	4.85	5.71	9.07	9.34	9.21
	S.Em.±	C.D. at 5%		S.Em.±	C.D. at 5%	
Year (N x P)	0.238	NS		0.088	NS	
Year (N x K)	0.292	NS		0.108	NS	
Year (P x K)	0.238	NS		0.088	NS	
Year (N x P x K)	0.412	NS		0.153	NS	

3.1.4 Interaction effect

The interaction effect of different levels of N, P and K on plant height, plant spread in east-west, plant spread in north-south and number of copperty shoot was found non-significant during both the year as well as in pooled analysis.

3.2 Effect of Different Levels of N, P and K on Yield Parameters

3.2.1 Effect of nitrogen

The result indicated that maximum number of fruit set at pea stage per panicle was observed

(13.08 and 12.88) in the treatment N₂ (750 g/tree) in first year and pooled data, whereas (12.93) in the treatment N₃ (1000 g/tree) during second year (Table 3), while maximum number of fruit set at marble stage per panicle (3.01, 3.10 and 3.06) was observed in the treatment N₂ (750 g/tree) during both the year and pooled data (Table 3), minimum days to fruit harvesting (122.94, 121.28 and 122.11), maximum number of fruits per tree (160.67, 169.72 and 165.19), highest fruit yield (38.56, 42.43 and 40.50 kg/tree) and highest fruit yield (6.85, 7.67 and 7.26 t/ha) were significantly recorded in the treatment N₃ (1000 g/tree) during both the year

and pooled result (Tables 4 and 5). Application of nitrogen N₁ (500 g/tree) were observed minimum number of fruits set at pea stage per panicle (11.96, 11.94 and 11.95), minimum number of fruits set at marble stage per panicle (2.43, 2.72 and 2.58), maximum days to fruit harvesting (128.17, 126.44 and 127.31), minimum number of fruits per tree (135.72, 148.56 and 142.14), lowest fruit yield (32.57, 37.14 and 34.86 kg/tree), lowest fruit yield (5.76, 6.47 and 6.11 t/ha) during both the year and pooled analysis, respectively (Table 3, 4 and 5). Nitrogen plays a crucial role in promoting healthy vegetative

growth in mango trees, which in turn, can influence the number of fruit set and overall fruit yield in mango. Balanced nitrogen levels encourage optimal flowering time, which is crucial for fruit set. Nitrogen helps improve the transition from flowering to fruiting. By promoting robust flowering and fruit set, nitrogen can directly increase the number of fruits produced by the tree. With proper nitrogen application the mango tree is able to balance its energy production between vegetative growth and reproductive growth. This balance is critical for achieving high fruit yields.

Table 4. Effect of different levels of N, P and K on days to fruit harvesting and number of fruits per tree of mango cv. Kesar

Treatments	Days to fruit harvesting			Number of fruits per tree		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Level of Nitrogen (N)						
N ₁ (500 g)	128.17	126.44	127.31	135.72	148.56	142.14
N ₂ (750 g)	127.17	125.33	126.25	151.22	159.33	155.28
N ₃ (1000 g)	122.94	121.28	122.11	160.67	169.72	165.19
S.Em.±	0.503	0.406	0.323	3.245	3.018	2.216
C.D at 5 %	1.45	1.17	0.91	9.33	8.67	6.25
Level of Phosphorus (P)						
P ₁ (100 g)	127.00	125.07	126.04	137.07	149.85	143.46
P ₂ (150 g)	125.19	123.63	124.41	161.33	168.56	164.94
S.Em.±	0.411	0.332	0.264	2.649	2.465	1.809
C.D at 5 %	1.18	0.95	0.75	7.61	7.08	5.11
Level of Potash (K)						
K ₁ (500 g)	126.11	124.00	125.06	144.17	154.61	149.39
K ₂ (750 g)	124.72	123.44	124.08	158.11	165.67	161.89
K ₃ (1000 g)	127.44	125.61	126.53	145.33	157.33	151.33
S.Em.±	0.503	0.406	0.323	3.245	3.018	2.216
C.D at 5 %	1.45	1.17	0.91	9.33	8.67	6.25
Interaction (N x P)						
S.Em.±	0.711	0.575	0.457	4.589	4.269	3.134
C.D. at 5%	NS	NS	NS	NS	NS	NS
Interaction (N x K)						
S.Em.±	0.871	0.704	0.560	5.620	5.228	3.838
C.D. at 5%	NS	NS	NS	16.15	15.03	10.83
Interaction (P x K)						
S.Em.±	0.711	0.575	0.457	4.589	4.269	3.134
C.D. at 5%	NS	NS	NS	NS	NS	NS
Interaction (N x P x K)						
S.Em.±	1.232	0.995	0.792	7.948	7.394	5.428
C.D. at 5%	NS	NS	NS	NS	NS	NS
CV%	1.69	1.39	1.55	9.23	8.04	8.62
	S.Em.±	C.D. at 5%		S.Em.±	C.D. at 5%	
Year (N x P)	0.647	NS		4.432	NS	
Year (N x K)	0.792	NS		5.428	NS	
Year (P x K)	0.647	NS		4.432	NS	
Year (N x P x K)	1.120	NS		7.676	NS	

Regular supply of nitrogen to plants increased yield and yield attributing characters because it is directly related to the synthesis of protein to amino acids (Hussain, 1970). Similar results were also obtained by Suriyapananont and Subhadrabandhu (1992) reported the highest total yield in mango cv. Nam Dok content with 1.0 kg N, 0.2 kg P and 1.5 kg K/tree. Singh *et al.* (1984) reported maximum number of fruit set and yield in mango Bahadur *et al.* (1998) produced highest fruit yield and Sharma *et al.* (2000) maximum yield in mango.

3.2.2 Effect of phosphorus

The result indicated that maximum number of fruit set at pea stage per panicle was observed (12.76 and 12.70) in the treatment P2 (150 g/tree) for first year and pooled data respectively, whereas minimum number of fruits set at pea stage per panicle (12.28 and 12.33) was reported in application of phosphorus P1 (100 g/tree) during the year 2021-22 and pooled result respectively, the result found non-significant during second year (Table 3). Maximum number

Table 5. Effect of different levels of N, P and K on fruit yield per tree (kg) and Fruit yield (t/ha.) of mango cv. Kesar

Treatments	Fruit yield per tree (kg)			Fruit yield (t/ha.)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Level of Nitrogen (N)						
N ₁ (500 g)	32.57	37.14	34.86	5.76	6.47	6.11
N ₂ (750 g)	36.29	39.83	38.06	6.31	7.22	6.76
N ₃ (1000 g)	38.56	42.43	40.50	6.85	7.67	7.26
S.Em.±	0.779	0.755	0.542	0.137	0.113	0.089
C.D at 5 %	2.24	2.17	1.53	0.39	0.32	0.25
Level of Phosphorus (P)						
P ₁ (100 g)	32.90	37.46	35.18	5.82	6.61	6.21
P ₂ (150 g)	38.72	42.14	40.43	6.79	7.64	7.21
S.Em.±	0.636	0.616	0.443	0.112	0.092	0.072
C.D at 5 %	1.83	1.77	1.25	0.32	0.26	0.20
Level of Potash (K)						
K ₁ (500 g)	34.60	38.65	36.63	6.02	6.93	6.47
K ₂ (750 g)	37.95	41.42	39.68	6.73	7.55	7.14
K ₃ (1000 g)	34.88	39.33	37.11	6.17	6.89	6.53
S.Em.±	0.779	0.755	0.542	0.137	0.113	0.089
C.D at 5 %	2.24	2.17	1.53	0.39	0.32	0.25
Interaction (N x P)						
S.Em.±	1.101	1.067	0.767	0.194	0.159	0.125
C.D. at 5%	NS	NS	NS	NS	NS	NS
Interaction (N x K)						
S.Em.±	1.349	1.307	0.939	0.237	0.195	0.153
C.D. at 5%	3.88	3.76	2.65	0.68	0.56	0.43
Interaction (P x K)						
S.Em.±	1.101	1.067	0.767	0.194	0.159	0.125
C.D. at 5%	NS	NS	NS	NS	NS	NS
Interaction (N x P x K)						
S.Em.±	1.908	1.848	1.328	0.335	0.276	0.217
C.D. at 5%	NS	NS	NS	NS	NS	NS
CV%	9.23	8.04	8.61	9.21	6.71	7.92
	S.Em.±	C.D. at 5%		S.Em.±	C.D. at 5%	
Year (N x P)	1.084	NS		0.177	NS	
Year (N x K)	1.328	NS		0.217	NS	
Year (P x K)	1.084	NS		0.177	NS	
Year (N x P x K)	1.878	NS		0.307	NS	

of fruit set at marble stage per panicle (2.93, 3.02 and 2.97), minimum days to fruit harvesting (125.19, 123.63 and 124.41), maximum number of fruits per tree (161.33, 168.56 and 164.94), highest fruit yield (38.72, 42.14 and 40.43 kg/tree) and highest fruit yield (6.79, 7.64 and 7.21 t/ha) was significantly recorded in the treatment P2 (150 g/tree) during both the year and pooled result respectively (Tables 3, 4 and 5). Application of phosphorus P1 (100 g/tree) resulted minimum number of fruits set at marble stage per panicle (2.69, 2.85 and 2.77), maximum days to fruit harvesting (127.00, 125.07 and 126.04), minimum number of fruits per tree (137.07, 149.85 and 143.46), lowest fruit yield (32.90, 37.46 and 35.18 kg/tree), lowest fruit yield (5.82, 6.61 and 6.21 t/ha) during both the year and pooled result respectively (Tables 3, 4 and 5). These indicate that phosphorus contributes to energy transfer within the plant through its role in ATP production which is necessary for the processes of pollination and fruit set. Adequate phosphorus supply promotes the early formation of flowers and flower develop earlier in the season have a higher chance of maturing into fruits in short period of time. Phosphorus is essential for increasing fruit yield by promoting fruit set, fruit development, improve fruit size, quality and enhancing energy transfer and photosynthesis. Proper phosphorus management is crucial for maximizing fruit yield and quality in mango cultivation. Similar results are in agreement with findings of Singh *et al.* (1984) revealed that application of 175.5 g phosphorus given maximum number fruits and yield per tree in thirteen-year mango cv. Dasher. Sharma *et al.* (2000) revealed that maximum yield of mango per tree was recorded with 200 g P₂O₅ which was 90% more than control. Dalal *et al.* (2005) for maximum number of fruits and fruit yield in Kesar mango. Syamal and Mishra (1989) for maximum fruit set.

3.2.3 Effect of potash

For the results of present study, it was seen that there was an increase in maximum number of fruit set at pea stage per panicle was observed (12.82 and 12.71) in the treatment K3 (1000 g/tree) for first year and pooled data respectively, whereas the result found non-significant during second year (Table 3). Maximum number of fruit set at marble stage per panicle (2.94) for the first year in the treatment K3 (1000 g/tree) and (3.08 and 2.99) for second year and pooled data (Table 3) in the treatment K2 (750 g/tree). Minimum days to fruit harvesting (124.72, 123.44

and 124.08), maximum number of fruits per tree (158.11, 165.67 and 161.89), highest fruit yield per tree (37.95, 41.42 and 39.68 kg/tree), highest fruit yield per ha (6.73, 7.55 and 7.14 t/ha) were observed in the treatment K2 (750 g/tree) during both the year and pooled data respectively (Table 4 and 5). Minimum number of fruits set at pea stage per panicle (12.11 and 12.17) was recorded with the application of potash (500 g/tree) K1 during the year 2021-22 and pooled analysis respectively (Table 3). Application of potash (500 g/tree) K1 resulted minimum number of fruits set at marble stage per panicle (2.57, 2.75 and 2.66), minimum number of fruits per tree (144.17, 154.61 and 149.39), lowest fruit yield (34.60, 38.65 and 36.63 kg/tree), lowest fruit yield (6.02, 6.93 and 6.47 t/ha) during both year and pooled data respectively (Table 3, 4 and 5). Application of potash (1000 g/tree) K3 was resulted maximum days to fruit harvesting (127.44, 125.61 and 126.53) during both year and pooled analysis respectively (Table 4). This indicates that a proper supply of potassium ensures that there are sufficient energy reserves available for fruit set and early development. Potassium is crucial for initiation and development of flowers, which are the precursor to fruit. By improving the number of flowers and their quality potassium directly contributes to a higher fruit set, which in turn increase the final fruit yield. The results are in agreements with Singh *et al.* (1984) in mango, Bahadur *et al.* (1998) in mango, Sharma *et al.* (2000) in mango, Randhawa and Iyer (1978) in banana, Mitra and Bose (1985) in guava. Weider (1997) and Umashankar *et al.* (2002) in guava.

4. CONCLUSION

On the basis of two years studies and results obtained from the present investigation bring the conclusion that growth, yield parameters of mango were influenced by different levels of N, P and K.

It seems quite logical to conclude that fertilizer application of 1000 g/tree nitrogen, 150 g/tree phosphorus and 750 g/tree potash has been found optimum fertilizer dose which improved growth, yield and yield attributing parameters with higher net realization in mango cv. Kesar.

5. FUTURE SCOPE

The study of the response of different levels of Nitrogen (N), Phosphorus (P), and Potassium (K) on the growth and yield of mango cv. Kesar

holds promising future scope in several areas—especially in the context of sustainable agriculture, precision farming, and increasing productivity of high-value horticultural crops. Balanced fertilization improves not just the quantity of mangoes but also their quality parameters like TSS, sugar content, acidity, shelf life, etc. Helps in achieving export-quality produce, especially relevant for Kesar mango, which is a GI-tagged variety. Minimizing excessive use of fertilizers protects soil health and the environment. Reduces the risk of nitrate leaching and eutrophication, contributing to eco-friendly farming.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Languages Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing manuscript.

ACKNOWLEDGEMENT

I would like to extend my sincere gratitude to the Fruit Research Station, Sakkarbaug and the College of Horticulture, Junagadh Agricultural University, Junagadh for providing land, inputs and man power for conducting the experiment. Additionally, I would like to express my deep appreciation to Dr. A. M. Butani my proper advisor, as well as to the members of my advisory committee, for their invaluable guidance and constant support throughout the course of study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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