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EFFECT OF NPK LEVELS ON GROWTH, YIELD AND FRUIT QUALITY OF CHILLI (*Capsicum annuum* L.)

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ABSTRACT

A field experiment was conducted during the *Rabi* season of 2025–26 at the Research Field, Department of Horticulture, National P.G. College, Barhalganj, Gorakhpur, Uttar Pradesh, to evaluate the effect of different NPK levels on growth, yield and fruit quality of chilli (*Capsicum annuum* L.) cv. Pusa Jwala. The experiment was laid out in a Randomized Block Design with eight treatments and three replications. Significant variation was observed among the treatments for growth, yield and quality attributes. Treatment T_4 (140:90:80 kg NPK ha^{-1}) recorded the maximum plant height (17.83, 52.20 and 80.83 cm at 30, 60 and 90 DAT, respectively), number of flowers $plant^{-1}$ (42.87), number of fruits $plant^{-1}$ (47.33), fruit length (10.67 cm), fruit girth (5.63 cm), average fruit weight (5.63 g), yield $plant^{-1}$ (0.64 kg) and fruit yield (23.97 t ha^{-1}). The highest number of branches $plant^{-1}$ (9.80) was recorded under T_6 (110:80:80 kg NPK ha^{-1}), while T_3 (130:80:80 kg NPK ha^{-1}) was the next best treatment for most yield attributes. Treatment T_4 also produced superior fruit quality, recording the highest total soluble solids (5.70 °Brix), ascorbic acid (137.67 mg 100 g^{-1}), capsaicin content (0.80%) and shelf life (9.67 days). The results indicated that application of NPK at 140:90:80 kg ha^{-1} was most effective in improving growth, productivity and fruit quality of chilli cv. Pusa Jwala under the agro-climatic conditions of eastern Uttar Pradesh.

Key words : *Capsicum annuum* L., Chilli, NPK, Growth, Yield, Fruit quality, Capsaicin, Ascorbic acid.

Introduction

Chilli (*Capsicum annuum* L.) is an important vegetable and spice crop of the family Solanaceae, widely cultivated in tropical and subtropical regions for its green and dried fruits. It is predominantly self-pollinated, with some natural cross-pollination under field conditions, and has a chromosome number of 2n = 24 (Lemma, 1998). The crop is valued for its pungency, colour, flavour and aroma and is consumed in fresh, dried and processed forms. Chilli fruits are also important sources of oleoresin, natural colour compounds and bioactive constituents, particularly capsaicin, which contributes to their nutritional and functional value (El-Ghorab *et al*., 2013; Deshpande, 2004).

India is a major producer, consumer and exporter of chilli, and the crop is cultivated extensively across diverse agro-climatic regions. Its productivity and fruit quality are influenced by genotype, climate, soil fertility, irrigation and nutrient management. Among these factors, balanced nutrient management is particularly important for achieving optimum growth and productivity. Chilli is a relatively long-duration crop with a shallow root system and requires an adequate supply of nutrients throughout its growth and reproductive stages (Bidari, 2000). Nutrient deficiency or imbalance can adversely affect vegetative growth, flowering, fruit set and fruit development, whereas indiscriminate fertilizer use may increase production costs and adversely affect soil health and environmental quality (Virmani, 1994).

Nitrogen (N), phosphorus (P) and potassium (K) are major nutrients governing growth, reproductive development and yield formation in chilli. An adequate and balanced supply of NPK promotes vegetative growth, root development, flowering, fruit setting, assimilating translocation and fruit development, thereby influencing yield and quality. However, the response to NPK

application varies with cultivar, soil fertility, agro-climatic conditions and crop management practices. Hence, evaluation of appropriate NPK levels under specific production environments is essential for efficient nutrient management and improved crop performance.

Singh and Singh (2023) reported that NPK application at 140:90:80 kg ha^{-1} significantly improved plant height, number of branches, fruit yield and quality attributes of chilli under the agro-climatic conditions of Prayagraj. However, nutrient requirements may vary across locations and production conditions. Therefore, the present investigation was undertaken to evaluate the influence of different NPK levels on growth, yield and fruit quality of chilli (*Capsicum annuum* L.) under the prevailing agro-climatic conditions.

Materials and Methods

Experimental site and design

The experiment entitled "Effect of Different Levels of NPK on Growth, Yield and Quality of Chilli (*Capsicum annuum* L.)" was conducted during the *Rabi* season of 2025–26 at the Research Field of National P.G. College, Barhalganj, Gorakhpur, Uttar Pradesh, India. The experimental site is situated in the sub-tropical climatic region of eastern Uttar Pradesh at approximately 26°17′ N latitude and 83°31′ E longitude, with an elevation of about 72 m above mean sea level. The experiment was conducted on a relatively uniform, well-drained field using chilli variety Pusa Jwala. The treatments were arranged in a Randomized Block Design (RBD) comprising eight NPK treatments and three replications, resulting in 24 plots. Each plot measured 3.0 × 5.0 m (15 m²), with a spacing of 60 × 45 cm and a seed rate of 1.5 kg ha^{-1}. The net experimental area was 360 m² and the gross experimental area was 498.4 m². The treatments comprised T_1 : 120:80:80, T_2 : 140:70:80, T_3 : 130:80:80, T_4 : 140:90:80, T_5 : 100:70:80, T_6 : 110:80:80, T_7 : 120:90:80 and T_8 : 130:60:80 kg ha^{-1} N:P_2O_5 :K_2O, respectively. The experimental layout was maintained with a 1.0 m main irrigation channel, 0.5 m sub-irrigation channels and 0.3 m bunds.

Observations recorded

Observations on growth, yield and quality attributes were recorded during the crop period. Five healthy and representative plants were randomly selected and tagged in each treatment in every replication. Plant height was recorded at 30, 60 and 90 days after transplanting (DAT) from ground level to the tip of the main shoot and expressed in cm, while the number of primary branches and flowers was recorded and expressed as branches plant^{-1} and flowers plant^{-1}, respectively. Yield and yield-attributing parameters included number of fruits plant^{-1}, fruit length (cm), fruit girth (cm), average fruit weight (g), yield plant^{-1} (kg) and yield hectare^{-1} (t ha^{-1}). Fruit length was measured from base to tip using a measuring scale, fruit girth at the middle portion using a vernier caliper, and fruit weight using an electronic balance. Fruit quality was assessed in terms of total soluble solids (TSS, °Brix), ascorbic acid (mg 100 g^{-1}), capsaicin content (%) and shelf life (days). TSS was determined using a hand refractometer, while ascorbic acid and capsaicin contents were estimated using the respective standard laboratory procedures. Shelf life was recorded as the number of days fruits remained fresh and marketable under normal storage conditions.

Statistical analysis

The recorded data were subjected to analysis of variance (ANOVA) appropriate for Randomized Block Design following the procedure described by Panse and Sukhatme. Statistical analysis was carried out using OPSTAT software. Treatment differences were tested at the 5% level of significance, and the critical difference (CD) was calculated wherever the treatment effect was significant.

Results and Discussion

Effect of different levels of NPK on growth parameters of chilli

The application of different NPK levels influenced the growth and flowering attributes of chilli (Table 1 and Fig. 1). Treatment T_4 (140:90:80 kg NPK ha^{-1}) recorded the maximum plant height at 30, 60 and 90 days after transplanting (DAT), measuring 17.83, 52.20 and 80.83 cm, respectively, followed by T_3 (130:80:80 kg NPK ha^{-1}), whereas the minimum plant height was recorded under T_1 (120:80:80 kg NPK ha^{-1}). The maximum number of branches plant^{-1} (9.80) was recorded under T_6 (110:80:80 kg NPK ha^{-1}), followed by T_5 (9.00) and T_4 (8.50), while the minimum (6.45) was observed under T_8 (130:60:80 kg NPK ha^{-1}). Similarly, the maximum number of flowers plant^{-1} (42.87) was recorded under T_4, followed by T_3 (39.43), whereas the minimum (33.90) was recorded under T_1. The improved growth and flowering under the better-performing NPK treatments may be attributed to adequate nutrient availability and efficient nutrient utilization, which support vegetative development, photosynthetic activity and reproductive growth. Nitrogen promotes vegetative growth and chlorophyll formation, phosphorus contributes to root development and reproductive processes, while potassium supports enzyme activity and assimilate translocation. The observed response therefore indicates the importance of balanced

Table 1 : Effect of different NPK levels on growth yield and quality parameters of chilli (*Capsicum annuum* L).

Tr. no.	NPK Level (kg/ha)	Growth parameters				Yield Parameters					Quality parameters			
		Plant height (cm)			Number of branches Plant^{-1}	Number of flowers Plant^{-1}	Number of fruits Plant^{-1}	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	Yield per plant (kg)	TSS (°Brix)	Ascorbic acid (mg/ 100g)	Capsaicin (%)	Shelf Life (days)
		30 DAT	60 DAT	90 DAT											
T_1	120:80:80	11.13	40.63	67.33	6.90	33.90	38.87	7.00	2.20	2.83	0.36	3.67	109.67	0.49	6.37
T_2	140:70:80	14.50	35.43	71.83	7.00	35.77	39.33	7.30	3.00	3.00	0.42	4.37	117.00	0.57	7.20
T_3	130:80:80	15.77	47.10	77.00	7.10	39.43	44.30	10.33	4.57	4.57	0.58	5.03	129.67	0.71	8.97
T_4	140:90:80	17.83	52.20	80.83	8.50	42.87	47.33	10.67	5.63	5.63	0.64	5.70	137.67	0.80	9.67
T_5	100:70:80	15.03	45.33	72.00	9.00	36.10	41.07	9.00	3.43	3.37	0.44	4.50	120.00	0.61	7.50
T_6	110:80:80	13.90	36.93	71.33	9.80	35.70	38.77	7.67	3.80	3.80	0.44	4.97	123.00	0.65	8.00
T_7	120:90:80	13.93	41.07	74.50	6.60	34.77	38.87	8.07	3.33	3.33	0.39	4.50	119.00	0.59	7.40
T_8	130:60:80	14.47	39.43	71.17	6.45	36.00	39.53	7.17	3.17	3.17	0.38	3.90	113.00	0.53	6.90
SEm±		**0.123**	**0.223**	**0.062**	**0.250**	**0.080**	**0.075**	**0.025**	**0.040**	**0.037**	**0.002**	**0.025**	**0.231**	**0.002**	**0.020**
CD (P=0.05)		**0.377**	**0.682**	**0.191**	**0.850**	**0.245**	**0.230**	**0.076**	**0.123**	**0.113**	**0.006**	**0.076**	**0.709**	**0.007**	**0.070**

NPK nutrition for optimum growth and flowering in chilli. Similar beneficial effects of NPK fertilization on growth and flowering of chilli have been reported by Vitkar *et al*. (2007), Narkhede *et al*. (2011), Pariari and Khan (2013), Rani *et al*. (2015), Shabir *et al*. (2016), Das *et al*. (2017), Sharma *et al*. (2017) and Gokul *et al*. (2020).

Effect of different levels of NPK on yield parameters of chilli

Different levels of NPK influenced the yield and yield-attributing characters of chilli (Table 1 and Fig. 2). Treatment T_4 (140:90:80 kg NPK ha^{-1}) recorded the maximum number of fruits plant^{-1} (47.33), followed by T_3 (44.30) and T_5 (41.07), whereas the minimum (38.77) was recorded under T_6; T_1, T_2, T_7 and T_8 recorded 38.87, 39.33, 38.87 and 39.53 fruits plant^{-1}, respectively. Fruit length was also highest under T_4 (10.67 cm), followed by T_3 (10.33 cm) and T_5 (9.00 cm), while the minimum (7.00 cm) was recorded under T_1. Similarly, T_4 recorded the maximum fruit girth (5.63 cm), followed by T_3 (4.57 cm) and T_6 (3.80 cm), whereas the minimum (2.20 cm) was observed under T_1. Average fruit weight followed a similar trend, with the highest value under T_4 (5.63 g), followed by T_3 (4.57 g) and T_6 (3.80 g), while the lowest (2.83 g) was recorded under T_1. Consequently, T_2 recorded the maximum yield plant^{-1} (0.64 kg), followed by T_3 (0.58 kg), whereas the minimum yield (0.36 kg plant^{-1}) was recorded under T_1; T_2, T_5, T_6, T_7 and T_8 recorded 0.42, 0.44, 0.44, 0.39 and 0.38 kg plant^{-1}, respectively. The superior yield performance under T_4 may be attributed to the favourable nutrient supply that supported plant growth, flowering, fruit setting and fruit development, resulting in greater fruit number and size and consequently, higher fruit yield. Balanced NPK nutrition may have enhanced nutrient uptake and assimilate production and facilitated their translocation towards developing fruits. The present findings are in agreement with the reports of Vitkar *et al*. (2007), Singh *et al*. (2010), Rani *et al*. (2015), Kashem *et al*. (2015), Kumar *et al*. (2016), Shabir *et al*. (2016), Jamir *et al*. (2017), Chouhan *et al*. (2018), Islam *et al*. (2018), Behera *et al*. (2020) and Shilpa *et al*. (2022), who reported improvement in fruit number, fruit size, fruit weight and yield of chilli with appropriate nutrient management.

Effect of different levels of NPK on quality parameters of chilli

Different levels of NPK significantly influenced the quality attributes of chilli fruits (Table 3 and Fig. 3). Treatment T_2 (140:90:80 kg NPK ha^{-1}) recorded the highest total soluble solids (TSS) of 5.70 °Brix, followed

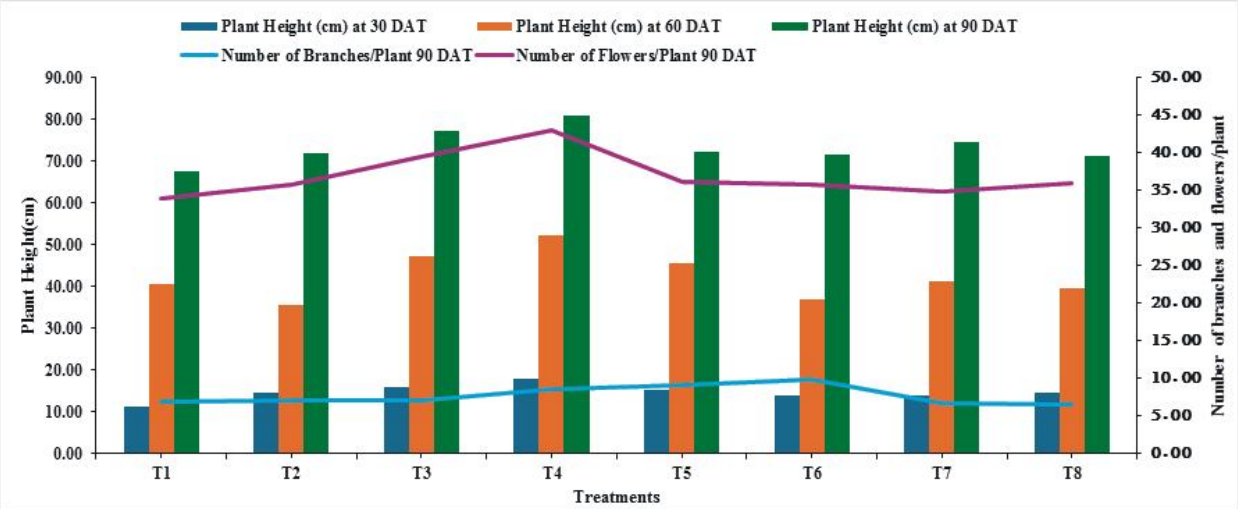


Fig. 1 : Effect of different NPK levels on growth and flowering parameters of chilli (*Capsicum annuum* L).

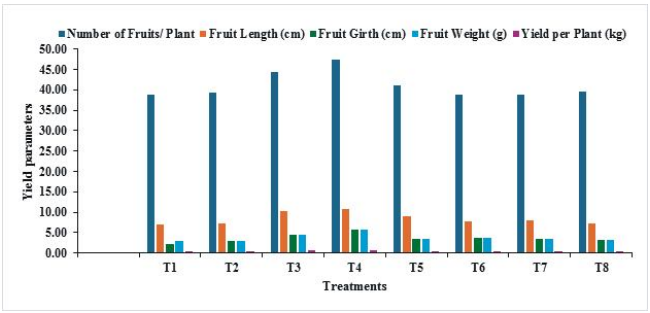


Fig. 2 : Effect of different NPK levels on yield parameters of chilli (*Capsicum annuum* L).

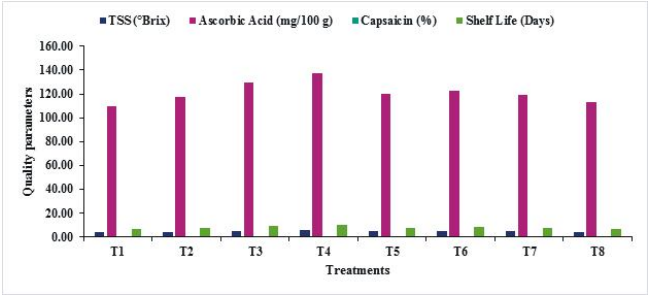


Fig. 3 : Effect of different NPK levels on quality parameters of chilli (*Capsicum annuum* L).

by T_3 (5.03 °Brix) and T_6 (4.97 °Brix), whereas the lowest TSS (3.67 °Brix) was recorded under T_1; T_5 and T_7 recorded identical values of 4.50 °Brix, while T_2 and T_8 recorded 4.37 and 3.90 °Brix, respectively. Similarly, the highest ascorbic acid content (137.67 mg 100 g^{-1}) was recorded under T_4, followed by T_3 (129.67 mg 100 g^{-1}) and T_6 (123.00 mg 100 g^{-1}), whereas the lowest value (109.67 mg 100 g^{-1}) was observed under T_1. Capsaicin content was also maximum under T_4 (0.80%), followed by T_3 (0.71%) and T_6 (0.65%), while the minimum (0.49%) was recorded under T_1. The shelf life of fruits followed a similar trend, with the maximum duration under T_4 (9.67 days), followed by T_3 (8.97 days) and T_6 (8.00 days), whereas the minimum (6.37 days) was recorded under T_1. The improvement in quality attributes under T_2 may be associated with a favourable nutrient supply that supported assimilate production, translocation and accumulation of soluble and bioactive compounds in the fruits. The higher shelf life may further be related to improved fruit quality and maintenance of physiological integrity under adequate nutrient availability. Overall, T_4 consistently recorded the highest values for all the quality attributes studied, indicating the favourable effect of 140:90:80 kg NPK ha^{-1} on the quality and post-harvest keeping ability of chilli fruits. The present findings are in agreement with Singh and Singh (2023), who also reported improved TSS and other quality attributes of chilli with NPK application at 140:90:80 kg ha^{-1}.

Conclusion

The present investigation demonstrated that different levels of NPK influenced the growth, yield and quality attributes of chilli (*Capsicum annuum* L.) cv. Pusa Jwala. Among the treatments evaluated, T_4 (140:90:80 kg NPK ha^{-1}) showed the most favourable overall performance, recording the highest plant height, number of flowers $plant^{-1}$, number of fruits $plant^{-1}$, fruit length, fruit girth, average fruit weight, yield $plant^{-1}$ and fruit yield, along with superior fruit quality in terms of total soluble solids, ascorbic acid, capsaicin content and shelf life. Treatment T_6 (110:80:80 kg NPK ha^{-1}) recorded the maximum number of branches $plant^{-1}$, while T_3 (130:80:80 kg NPK ha^{-1}) generally remained the next best treatment for several growth, yield and quality attributes. Overall, application of 140:90:80 kg NPK ha^{-1} was found to be the most effective treatment under the agro-climatic conditions of the study area and may be considered a suitable nutrient level for improving productivity and fruit quality of chilli cv. Pusa Jwala.

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