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Influence of Different Levels of Nitrogen, Phosphorus and Potassium (NPK) on Vegetative Growth of Dragon Fruit (*Hylocereus Costaricensis*)

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ABSTRACT

The present investigation was carried out during 2024 at the Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, to evaluate the influence of different levels of nitrogen, phosphorus and potassium (NPK) on the vegetative growth of dragon fruit (*Hylocereus costaricensis*) under subtropical climatic conditions. The experiment was conducted in a Randomized Block Design (RBD) with 8 treatments viz. T_1 (N-850, P-950, K-475), T_2 (N-800, P-900, K-450), T_3 (N-750, P-825, K-425), T_4 (N-700, P-800, K-400), T_5 (N-650, P-750, K-375), T_6 (N-600, P-700, K-350), T_7 (N-550, P-650, K-325) and T_8 (Control) and 3 replications during the year 2024, focusing on the application of varying doses of Nitrogen, Phosphorus and Potassium via Urea, Single Super Phosphate, and Muriate of Potash, ensuring uniform plant health and spacing throughout. Observations on morphological and physiological parameters such as plant length, stem circumference, number of spines per areole, number of segments per plant, and chlorophyll content were recorded at regular intervals up to 225 days after treatment. Results revealed significant differences among treatments, with T_2 (N-800, P-900, K-450 g/pole/year) exhibiting maximum improvement in plant length (70 cm), stem circumference (1.62 cm), number of segments per plant (2.33), and highest chlorophyll content (0.76 mg/g). The superior response under T_2 treatment is attributed to balanced nutrient availability that enhanced photosynthetic efficiency and vegetative growth. The findings suggest that applying NPK at 800:900:450 g/pole/year in six split doses (April, May, June, August, September and November) through soil application optimally supports growth and physiological performance of dragon fruit under the subtropical conditions of Lucknow. This study emphasizes the importance of region-specific nutrient management to improve productivity and sustainability of dragon fruit cultivation in North India.

Keywords Nutrient management, Fertilizer scheduling, Dragon fruit, Growth.

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INTRODUCTION

Dragon fruit (*Hylocereus spp*. Syn. *Selenicereus* spp.), also known as "pitaya," "strawberry pear," and "Eden fruit," is a vibrant cactus fruit with significant agricultural, nutritional and market potential. Originating from the tropical forests of Mexico and Central America, it is now cultivated in over 20 countries, particularly gaining prominence in Vietnam and Southeast Asia (Wakchaure *et al.* 2021). The fruit, associated with cultural symbolism due to its striking beauty and nocturnal blooming, is characterized by its scaly, dragon-like appearance (Perween and Hasan 2018). Dragon fruit plants have triangular, fleshy stems that utilize aerial roots for support and are essential for photosynthesis and water storage. It is also known as Belle of the Night. Nutritionally, it is rich in minerals, natural sugars, dietary fiber and bioactive compounds such as betanins, which are antioxidants that support immune function and stabilize blood sugar levels (Omidizadeh *et al.* 2014). Studies indicate that dragon fruit may improve insulin sensitivity and assist in managing diabetes and heart disease. Its bioactive constituents include nitrogen-based pigments that combat oxidative stress, making dragon fruit a valuable addition to a balanced diet (Pradhan *et al.* 2025). Recognizing the economic potential and health benefits of dragon fruit, the Indian Government has implemented several initiatives to bolster its cultivation and trade (Karunakaran *et al.* 2024). Financial support includes subsidies for establishing farms, acquiring planting materials, and infrastructure development. Investments in cold storage facilities aim to preserve fruit quality and extend shelf life while minimizing post-harvest losses. The government also promotes exports by facilitating trade agreements and equipping farmers with market insights to foster international trade. Additionally, awareness and training programs have been established to educate farmers on cultivation best practices, pest management, and effective marketing strategies (Perween *et al.* 2018).

Its growth is influenced by genetic, environmental, physiological, and agronomic factors, with nutrient management being critical for both vegetative and reproductive growth. Balanced fertilization is essential for optimal yield, as the precise nutrient requirements remain inadequately defined (Mizrahi *et al.* 1996) in India. Inorganic fertilizers, particularly NPK, significantly enhance growth and yield; deficiencies in primary nutrients can adversely affect fruit development and harvests. Urea, high in nitrogen, is vital for vegetative growth and fruit development, impacting leaf expansion, stem growth and overall vigor. Controlled-release urea formulations improve nutrient efficiency and are particularly effective in soilless systems, where nitrogen demand peaks from vegetative growth to pre-flowering. Similarly, Single Super Phosphate (SSP) plays an important role in root development and photosynthesis, enhancing nutrient uptake, root growth, and ultimately leading to better fruit yields and quality.

Muriate of Potash (MOP) plays a vital role in the growth of dragon fruits by supplying potassium, which is essential for various plant physiological processes such as cell elongation, enzyme activation, and nutrient mobility. Potassium regulates osmotic pressure, supporting both root and shoot growth, and facilitates nitrogen and micronutrient absorption. However, excessive application of potassium can impede calcium and magnesium uptake, adversely affecting plants and soil fertility.

For optimal growth and productivity, a balanced fertilization strategy that combines nitrogen (N), phosphorus (P), and potassium (K) is advocated, ensuring that plants benefit from nitrogen for vegetative growth and phosphorus for robust root development and energy efficiency. This approach promotes healthy plant growth, improved yields, and better fruit quality while also supporting sustainable farming practices and increasing the economic viability of dragon fruit production. Notably, similar nutrient management strategies have been beneficial for strawberries, where growth, yield, and nutrient interactions were enhanced (Rabelo *et al*. 2020).

Despite significant research on dragon fruit the effects of varying doses of nitrogen, phosphorus, and potassium, particularly during the vegetative stage in India and South Asia, remain under-researched. The absence of region-specific studies presents gaps in understanding the impact of nutrient application on vegetative growth. The lack of comprehensive research regarding optimal nutrient dosages leads to uncertainty about the precise fertilization needs necessary to maximize growth while preventing deficiencies or toxicities. Addressing these issues it is critical for establishing effective fertilization strategies that enhance vegetative growth, improve nutrient absorption, and ensure sustainable cultivation of dragon fruit. Thus, the present study was conducted at Lucknow subtropical condition.

MATERIALS AND METHODS

The experiment was conducted during the year 2024 in the Dragon Fruit Innovation and Demonstration Center, situated near B. Voc. Field, Department of Horticulture, Babasaheb Bhimrao Ambedkar University (BBAU), Lucknow, Uttar Pradesh (26°76'N latitude and 80°92'E longitude, 124 meters above MSL). The experimental site has a subtropical climate with distinct hot and dry summer (March-June) above 40°C; a rainy monsoon period (July-September) with 900–1000 mm of rainfall and cool, dry winter (November - February) with temperatures below 7°C. Relative humidity varies significantly from 30% in summer to over 85% during monsoon, supporting dragon fruit growth. Soil is slightly alkaline having pH about 8 with sandy loam texture. The study consists of 8 treatments and 3 replications following Randomized Block Design (RBD), focusing on the application of varying doses of Nitrogen (850, 800, 750, 700, 650, 600, 550 & 0 g/pole/year) Phosphorus (950, 900, 850, 800, 750, 700, 650 & 0 g/pole/year) and Potassium (475, 450, 425, 400, 375, 350, 325 & 0 g/pole/year) via Urea (46% N), Single Super Phosphate (16% P_2O_5) and Muriate of Potash (60% K_2O), respectively ensuring uniform plant health and spacing throughout. Fertilizers were applied in 6 split doses from April to November. To ensure uniform growth and reliable results, standard agronomic practices and intercultural operations were followed uniformly across all treatments during the entire crop period. The vegetative growth parameters were recorded at: 0, 45, 90, 135,180 and 225 days after treatment (DAT). Plant length (cm) was measured from the base to the apex of the main stem using a measuring tape. Stem circumference (cm) was measured at the mid portion of marked stem segment using a flexible measuring tape. Number of spines per areole was also counted visually and manually. Number of segments per plant was counted manually for each selected plant by counting the segmented joints of the stem. Chlorophyll content analysis was done in following leaf extracted in 80% acetone and centrifuged at 5000 rpm for 5 minutes and absorbance was measured using a spectrophotometer at wave lengths 645 nm and 663 nm and Chlorophyll a, b and total chlorophyll were calculated as per the method stated by Thimmaiah (1999). The observed data was statistically analyzed in OPSTAT (Sheoran *et al.* 1998) program and treatment means were compared at 5% level of significance.

RESULTS AND DISCUSSION

The present data (Table 1) showed there was a significant change in plant length at 45, 90, 135, 180, 225 DAT and overall increase from 0 to 225 DAT. The maximum increase of 16.67 cm was seen in T_2 (N-800, P-900, K-450 g/pole/year) at 225 DAT (180 to 225). Considering the total increase from 0 to 225, maximum increase of 70 cm was seen in T_2 (N-800, P-900, K-450 g/ pole/year). The increase in length of the plant is possibly due to improved nutrient availability and physiological process that aids in stem elongation. Perween *et al.* (2018) reported that increase in length is significantly influenced by NPK fertilizers applications in dragon fruit plant. Similar finding was also reported by Kumar *et al.* (2018).

It was observed that there was a significant difference in circumference of the stem at 45, 90, 135, 180, 225 DAT. The maximum increase of 0.39 cm was seen in both T_1 (N-850, P-950, K-475 g/pole) and T_2 (N-800, P-900, K-450 g/pole/year) at 0-45 DAT and 180 to 225 DAT respectively. Considering the overall increase (from 0 to 225 DAT), maximum increase of 1.62 cm was seen in T_2 (N-800, P-900, K-450 g/pole/year). This might be due to enhanced availability of nutrients by the treatment as reported by Chakma *et al.* (2014) and Kumar *et al.* (2018) who found that application of NPK helps in increment of circumference of the plant.

Number of spines per areole (Table 2) showed no significant changes due to the treatments of various N, P, K doses. However, highest increment (0.33) was seen in T_3 (N-750, P-850, K-425 g/pole/year) and T_5

Table 1. Effect of fertilizer scheduling on increase of plant height and stem circumference of dragon fruit.

Treatments	At 0 DAT	Increase in plant height (cm)						
		Increase (0-45 DAT)	Increase (45-90 DAT)	Increase (90-135 DAT)	Increase (135-180 DAT)	Plant length at 225 DAT	Increase (180-225 DAT)	Total increase (0-225 DAT)
T_1 (N-850, P-950, K-475)	59.00	15.67	14.67	10.33	13.00	126.33	13.67	67.33
T_2 (N-800, P-900, K-450)	39.33	14.33	11.33	12.00	15.67	139.33	16.67	70.00
T_3 (N-750, P-825, K-425)	54.00	16.33	13.00	10.33	12.67	116.00	9.67	62.00
T_4 (N-700, P-800, K-400)	45.67	15.33	12.67	11.33	12.00	105.67	8.67	60.00
T_5 (N-650, P-750, K-375)	78.00	12.67	10.33	8.67	11.33	133.00	12.00	55.00
T_6 (N-600, P-700, K-350)	97.33	9.67	9.33	9.33	11.67	149.33	12.00	52.00
T_7 (N-550, P-650, K-325)	34.67	9.00	8.67	7.00	10.00	83.00	13.67	48.33
T_8 (Control)	39.00	7.33	6.33	4.67	7.67	75.33	10.33	36.33
SEm (±)	2.652	1.114	1.46	0.751	1.161	1.162	1.162	2.652
CD (p=0.05)	8.121	3.41	4.473	2.299	3.555	3.557	3.557	8.121

Table 1. Continued.

Treatments	At 0 DAT	Increase in stem circumference (cm)						
		Increase (0-45 DAT)	Increase (45-90 DAT)	Increase (90-135 DAT)	Increase (135-180 DAT)	Circum-ference at 225 DAT	Increase (180-225 DAT)	Total increase (0-225 DAT)
T_1 (N-850, P-950, K-475)	9.82	0.32	0.32	0.27	0.28	11.39	0.39	1.57
T_2 (N-800, P-900, K-450)	12.06	0.39	0.33	0.29	0.29	13.68	0.32	1.62
T_3 (N-750, P-825, K-425)	12.30	0.28	0.29	0.23	0.25	13.58	0.23	1.28
T_4 (N-700, P-800, K-400)	11.53	0.26	0.25	0.21	0.22	12.73	0.26	1.20
T_5 (N-650, P-750, K-375)	12.52	0.23	0.23	0.20	0.19	13.57	0.20	1.05
T_6 (N-600, P-700, K-350)	7.69	0.24	0.21	0.19	0.18	8.71	0.21	1.02
T_7 (N-550, P-650, K-325)	9.95	0.22	0.19	0.18	0.19	10.89	0.16	0.93
T_8 (Control)	10.89	0.20	0.15	0.13	0.14	11.76	0.25	0.87
SEm (±)		0.019	0.013	0.018	0.013		0.015	0.033
CD (p=0.05)		0.059	0.04	0.054	0.04		0.046	0.102

Table 2. Effect of different doses of NPK on number of spines per areoles and number of segments per plant of drag.

Treatments	At 0 DAT	Number of spines per areoles						
		Increase (0-45 DAT)	Increase (45-90 DAT)	Increase (90-135 DAT)	Increase (135-180 DAT)	Number of spines at 225 DAT	Increase (180-225 DAT)	Total increase (0-225 DAT)
T_1 (N-850, P-950, K-475)	5.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
T_2 (N-800, P-900, K-450)	4.33	0.00	0.00	0.00	0.00	4.33	0.00	0.00
T_3 (N-750, P-825, K-425)	4.00	0.00	0.00	0.00	0.33	4.67	0.33	0.67
T_4 (N-700, P-800, K-400)	4.33	0.00	0.00	0.00	0.00	4.33	0.00	0.00
T_5 (N-650, P-750, K-375)	3.33	0.00	0.00	0.00	0.00	3.67	0.33	0.33
T_6 (N-600, P-700, K-350)	3.00	0.00	0.00	0.33	0.00	3.33	0.00	0.33
T_7 (N-550, P-650, K-325)	2.67	0.00	0.00	0.33	0.00	3.00	0.00	0.33
T_8 (Control)	3.67	0.00	0.00	0.00	0.00	3.67	0.00	0.00
SEm(±)		0.118		0.154	0.118		0.271	0.292
CD (p=0.05)		NS	NS	NS	NS		NS	NS

Table 2. Continued.

Treatments	At 0 DAT	Increase (0-45 DAT)	Increase (45-90 DAT)	Increase (90-135 DAT)	Increase (135-180 DAT)	Number of segments at 225 DAT	Increase (180-225 DAT)	Total increase (0-225 DAT)
	Number of segment per plant							
T_1 (N-850, P-950, K-475)	1.33	0.00	0.33	1.00	0.00	3.33	0.67	2.00
T_2 (N-800, P-900, K-450)	1.67	0.00	0.00	0.67	0.33	4.00	1.00	2.33
T_3 (N-750, P-825, K-425)	1.33	0.00	0.00	0.00	0.34	2.33	0.67	1.00
T_4 (N-700, P-800, K-400)	1.67	0.00	0.00	0.67	0.33	2.67	1.00	1.00
T_5 (N-650, P-750, K-375)	3.33	0.00	0.00	0.33	0.00	4.00	0.33	0.67
T_6 (N-600, P-700, K-350)	2.33	0.00	0.00	0.00	0.67	3.00	0.00	0.67
T_7 (N-550, P-650, K-325)	2.67	0.00	0.00	0.33	0.00	3.33	0.33	0.67
T_8 (Control)	2.67	0.00	0.00	0.00	0.33	3.00	0.00	0.33
SEm (±)	0.194		0.118	0.299	0.248		0.194	0.401
CD (p=0.05)	0.595	NS	NS	NS	NS		0.595	1.228

Table 3. Effect of different doses of NPKon chlorophyll content in dragon fruit stem.

Treatments	Chlorophyll a (mg/g)	Chlorophyll b(mg/g)	Total Chlo-rophyll (mg/g)
T_1 (N-850, P-950, K-475)	0.43	0.28	0.68
T_2 (N-800, P-900, K-450)	0.45	0.31	0.76
T_3 (N-750, P-825, K-425)	0.38	0.25	0.64
T_4 (N-700, P-800, K-400)	0.37	0.24	0.61
T_5 (N-650, P-750, K-375)	0.37	0.23	0.61
T_6 (N-600, P-700, K-350)	0.33	0.22	0.56
T_7 (N-550, P-650, K-325)	0.23	0.19	0.44
T_8 (Control)	0.22	0.17	0.39
SEm (±)	0.013	0.015	0.014
CD (p=0.05)	0.039	0.047	0.043

(N-650, P-750, K-375) at 90-135 DAT. However, highest increase in number of spines (0.67) (from 0 to 225 DAT) was seen in T_3 (N-750, P-850, K-425 g/pole/year). Maurya *et al.* (2017) indicated that there is a slight increase in the number of spines per areole due to efficacy of nano urea in dragon fruit plant.

Effect of different treatments of N, P, K at different time intervals also showed no statistical influences on change in stem segment number of dragon fruit, however, maximum increase of number of segments was seen in T_1 (N-850, P-950, K-475 g/pole/year), T_2 (N-800, P-900, K-450 g/pole/year) and T_3(N-750, P-850, K-425 g/pole/year) at 90-135 DAT and 180-225 DAT. And considering the overall increase (from 0 to 225 DAT), highest increase in number of segment (2.33) was observed in T_2 (N-800, P-900, K-450 g/pole/year) from 0 to 225 DAT. Result also corroborated with the findings of Goncalves *et al.* (2020) and Chakma *et al.* (2014) who reported that higher dose of N along with P and K resulted in increment of cladode length in dragon fruit.

Table 3 showed that the newly grown shoots of dragon fruit taken for chlorophyll analysis shows changes in chlorophyll a, chlorophyll b and total chlorophyll. Chlorophyll a 0.45 mg/g was recorded as maximum in T_2 (N-800, P-900, K-450 g/pole) while the minimum chlorophyll a content was seen in T_8 (control). The Chlorophyll b (0.31 mg/g) was seen maximum in T_2 (N-800, P-900, K-450 g/pole/year) and the minimum chlorophyll a content was seen in T_8 (control). Similarly, maximum total Chlorophyll (0.76 mg/100 g) was estimated in T_2 (N-800, P-900, K-450 g/pole/year) while the minimum total chlorophyll content was seen in T_8 (control). It was mentioned by Goncalves *et al.* (2020) that increasing the doses of NPK results in improvement of chlorophyll content in dragon fruit and the possible reason might be direct involvement of nitrogen in chlorophyll formation along with role of potassium in preserving the content. However, it was clearly mentioned by Hariyanto *et al.* (2023) that increasing nitrogen and phosphorus doses improved growth parameters upto certain point and then don't respond to higher doses.

CONCLUSION

Plants under the present investigation exhibited notable improvement in vegetative growth characteristics including length of the plant, circumference of the stem, number of segments per plant, stem thickness, number of spines per areole, number of areoles per segment under soil nutrient management practices. Among the various nutrient scheduling practices T_2 (N-800, P-900, K-450 g/pole/year at six split doses) was the most effective in promoting the growth in terms of plant's length, circumference, number of segments per plant, stem thickness, number of areoles per segment, distance between areoles and chlorophyll content. Thus, NPK fertilizer application i.e. N-800, P-900, K-450 g/pole/year in six split doses in the month of April, May, June, August, September and November through soil application may be suggested for better growth of dragon fruit grown under subtropical climate of Lucknow.

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