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Growth of dragon fruit as influenced by inorganic (NPK) fertilization under arid- irrigated conditions

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ABSTRACT

Balanced fertilization with appropriate levels of nitrogen, phosphorus and potassium (NPK) is essential for maximizing nutrient use efficiency, improving plant growth and ensuring sustainable productivity in dragon fruit cultivation. The present investigation was conducted during the year 2025 at R.K. Goyal Dragon Fruit Farm, Ganesgharh, Sri Ganganagar, Rajasthan, with the objective of evaluating the effect of different levels of inorganic fertilizers on the growth of dragon fruit. The experiment was laid out in a Randomized Block Design (RBD) comprising eight treatments with three replications using four-year-old plants. A uniform dose of 20 kg FYM per pole was applied to all treatments except the absolute control. Among the different fertilizer levels, T_4 (450 g N + 350 g P + 300 g K per pole) proved to be the most effective treatment. It recorded the maximum vine length (3.36 m), number of cladodes (68.42), cladode length (67.61 cm) and cladode girth (24.92 cm). Areoles diameter was not significantly influenced by the treatments. while the maximum distance between areoles (37.44 mm) was observed under T_5 . Therefore, application of 450 g N + 350 g P + 300 g K per pole along with 20 kg FYM per pole is recommended for obtaining better growth attributes of dragon fruit under the agro-climatic conditions of Sri Ganganagar, Rajasthan.

Keywords: Dragon fruit, *Hylocereus undatus*, Inorganic fertilizers, NPK, Growth, Cladode, Cladode girth, Growth attributes, Areoles

1. Introduction

Dragon fruit is a perennial climbing cactus characterized by succulent triangular stems and large nocturnal flowers. The crop exhibits Crassulacean Acid Metabolism (CAM), a specialized photosynthetic pathway that enhances water-use efficiency and enables successful cultivation under arid and semi-arid conditions. This unique characteristic makes dragon fruit a promising crop for regions facing water scarcity and climate variability (Balaji *et al.*, 2025). The fruit is highly valued for its nutritional and medicinal properties. Dragon fruit plants generally begin bearing fruits within two to three years after planting and continue productive fruiting for many years. The fruits are consumed fresh and are also processed into juice, squash, jam, jelly, wine, ice cream and other value-added products. Its increasing popularity in domestic and international markets has enhanced its commercial significance and created new opportunities for growers and entrepreneurs (Balaji *et al.*, 2025).

The growth and productivity of dragon fruit are influenced by several factors including climatic conditions, planting density, training system, irrigation management and nutrient availability. Among these factors, nutrient management plays a pivotal role because nutrient availability directly affects vegetative growth, flowering behaviour, fruit development and overall crop performance. Nutrients are essential components of plant metabolic processes and their adequate supply ensures proper physiological functioning throughout the growth cycle. Deficiency or imbalance of nutrients may adversely affect growth and reproductive development, ultimately reducing yield and fruit quality.

Nitrogen is considered one of the most important macronutrients required by plants. It forms an integral part of amino acids, proteins, nucleic acids and chlorophyll molecules. Adequate nitrogen supply promotes vigorous vegetative growth, stem development, chlorophyll synthesis and photosynthetic activity. Phosphorus plays a critical role in ATP synthesis and various biochemical reactions associated with plant growth and development. Adequate phosphorus availability promotes strong root systems, enhances flowering and improves fruit set. In fruit crops, phosphorus has been reported to influence reproductive efficiency and overall crop productivity. Potassium is often referred to as the “quality nutrient” because of its significant influence on fruit development and quality attributes. It regulates osmotic balance, enzyme activation, carbohydrate metabolism and translocation of assimilates from source to sink tissues.

Nutrient requirements vary with soil type, climatic conditions, plant age and management practices, making location-specific fertilizer recommendations essential. With the rapid expansion of dragon fruit cultivation in India, there is an increasing need to develop region-specific nutrient management practices for achieving

higher productivity, superior fruit quality and greater profitability. Since information on optimum NPK requirements under different agro-climatic conditions is still limited, further research is necessary to standardize fertilizer doses for commercial cultivation.

Therefore, considering the growing economic importance of dragon fruit and the need for scientific nutrient management, the present investigation entitled “Growth, Yield and Quality of Dragon Fruit as Influenced by Inorganic (NPK) Fertilization” was undertaken to evaluate the effect of different NPK levels on the growth, yield and quality of dragon fruit under agro-climatic conditions of Sriganganagar district, Rajasthan.

2. Materials and Methods

2.1 Experimental site

The experiment was conducted during 2025 at R K Goyal Dragon Fruit Farm located at Manfool Singh Road, Ganeshgarh, 26 LNP, Sri Ganganagar district of Rajasthan. The experimental site represents the arid-irrigated agro-climatic conditions of north-western Rajasthan.

2.2 Experimental design and layout

The experiment was laid out in a Randomized Block Design (RBD) comprising eight treatments and three replications, resulting in a total of 96 experimental poles. Each experimental pole has 4 vines of dragon fruit, spacing of poles 4.6×3.0 m. Three representative vines were randomly selected and tagged in each pole for recording observations throughout the experimental period.

2.3 Planting and crop management

The experiment was carried out during the period from June to September, 2025 on an already established dragon fruit orchard. All recommended cultural and plant protection practices were followed uniformly throughout the experimental period to ensure healthy growth and development of the crop.

2.4 Treatments and their application

Eight treatments were evaluated in the experiment as follows:

Treatment	N, P&K g/pole (4 vines)
T_1	300, 200 & 150
T_2	350, 250 & 200
T_3	400, 300 & 250
T_4	450, 350 & 300
T_5	500, 400 & 350
T_6	550, 450 & 400
T_7	Control (only FYM- 20 kg/pole)
T_8	Absolute control (Native fertility)

(Note -20 kg FYM per pole was common to all treatments except treatment T_8 .)

Nitrogen, phosphorus and potassium were supplied through urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. Phosphorus and potassium were applied as a full basal dose at the beginning of the experiment along with the first split of nitrogen. Nitrogen was applied in two equal splits, wherein the first half was applied during early June to promote vegetative growth and the remaining half was applied during late July to early august at the peak flowering and fruit development stage. The treatments were applied uniformly according to the prescribed concentrations and experimental protocol.

2.5 Observations recorded

Observations were recorded on the following six growth attributes:

1. Vine length (m)
2. Number of cladodes
3. Length of cladode (cm)

4. Cladode girth (cm)
5. Distance between areoles (mm)
6. Areole diameter (mm)

The observations were recorded from the tagged representative plants of each experimental plot, and treatment-wise values were used for statistical analysis.

2.6 Statistical analysis

The experimental data were statistically analyzed using the analysis of variance (ANOVA) appropriate for a Randomized Block Design. The significance of treatment effects was tested using the *F*-test. Treatment means were compared using the Critical Difference (CD) at the 5% level of significance. The statistical analysis was carried out separately for each growth and yield parameter.

3. Results

3.1 Effect on growth parameters of dragon fruit

The growth of dragon fruit was influenced by different levels of inorganic fertilizers applied during the course of investigation (Table 1 and Table 2). Vine length varied among treatments. T_4 recorded the highest vine length (3.36 m), followed by T_6 (2.86 m), T_5 (2.85 m) and T_2 (2.83 m), whereas T_8 recorded the lowest vine length (2.42 m). On comparison with the absolute control (T_8), T_4 increased vine length by approximately 38.84%. However, the effect of treatments on vine length was non-significant (NS).

A noticeable variation in No. of cladodes was observed among the different treatments. T_4 recorded the highest number of cladodes (68.42), followed by T_5 (63.01), T_6 (60.23) and T_2 (59.40), whereas T_8 recorded the lowest number of cladodes (50.21). On comparison with the absolute control (T_8), T_4 increased the number of cladodes by approximately 36.27%. The difference between T_4 and T_8 (18.21 cladodes) was considerably greater than the reported CD (5%) of 1.688 cladodes.

Treatment-wise variation was clearly observed in the length of cladodes. T_4 recorded the highest cladode length (67.61 cm), followed by T_6 (64.94 cm), T_5 (62.63 cm) and T_2 (60.67 cm), whereas T_8 recorded the lowest cladode length (52.15 cm). On comparison with the absolute control (T_8), T_4 increased cladode length by approximately 29.65%. The difference between T_4 and T_8 (15.46 cm) was considerably greater than the reported CD (5%) of 0.936 cm.

Table 1. Effect of inorganic fertilization treatments on vine length (m), No. of Cladodes and Length of Cladode (cm)

Treatment	Vine length (m)	No. of Cladodes	Length of Cladode (cm)
T_1	2.68	53.12	55.82
T_2	2.83	59.40	60.67
T_3	2.69	54.02	56.08
T_4	3.36	68.42	67.61
T_5	2.85	63.01	62.63
T_6	2.86	60.23	64.94
T_7	2.64	52.15	54.08
T_8	2.42	50.21	52.15
CD (5%)	NS	1.688	0.936
<i>SEm</i> [±]	0.469	0.556	0.309

The treatments produced clear differences in the girth of cladodes. T_4 recorded the highest cladode girth (24.92 cm), followed by T_6 (22.36 cm), T_5 (21.64 cm) and T_2 (17.37 cm), whereas T_8 recorded the lowest cladode girth (13.75 cm). On comparison with the absolute control (T_8), T_4 increased cladode girth by approximately 81.24%. The difference between T_4 and T_8 (11.17 cm) was considerably greater than the reported CD (5%) of 1.404 cm.

A wide range of values was recorded for the distance between areoles across the treatments. T_5 recorded the highest distance between areoles (37.44 mm), followed by T_6 (37.12 mm), T_2 (32.18 mm) and T_1 (31.93 mm), whereas T_8 recorded the lowest distance (29.39 mm). On comparison with the absolute control (T_8), T_5 increased the distance between areoles by approximately 27.39%. The difference between T_5 and T_8 (8.05 mm) was considerably greater than the reported CD (5%) of 1.671 mm.

The recorded values of areoles diameter showed numerical variation among the different treatments. T_4 recorded the highest areoles diameter (4.73 mm), followed by T_3 (4.48 mm), T_5 (4.40 mm) and T_6 (4.38 mm), whereas T_8 recorded the lowest areoles diameter (3.64 mm). On comparison with the absolute control (T_8), T_4 increased areoles diameter by approximately 29.95%. However, the difference between T_4 and T_8 (1.09 mm) was not considered significant as the treatment effect was non-significant (NS).

Table 2. Effect of inorganic fertilization treatments on cladode girth (cm), Distance between areoles (mm) and Areoles diameter (mm)

Treatment	Cladode girth (cm)	Distance between areoles (mm)	Areoles diameter (mm)
T_1	15.98	31.93	3.70
T_2	17.37	32.18	3.80
T_3	16.64	31.60	4.48
T_4	24.92	31.63	4.73
T_5	21.64	37.44	4.40
T_6	22.36	37.12	4.38
T_7	14.83	29.88	4.03
T_8	13.75	29.39	3.64
CD (5%)	1.404	1.671	NS
$SEm^{\pm}$	0.463	0.551	0.309

The treatments showed noticeable variation in the growth characters of dragon fruit, with T_4 recording the highest vine length, number of cladodes, cladode length and cladode girth. The maximum distance between areoles was recorded under T_5 , while T_4 recorded the highest areoles diameter. Overall, T_4 showed better performance for most of the vegetative growth parameters, whereas T_8 recorded the lowest values for most of the characters. The effect on vine length and areoles diameter was non-significant, while the remaining growth parameters showed significant differences among treatments.

4. Discussion

The present study revealed substantial variation in the growth performance of dragon fruit in response to inorganic fertilization (NPK) treatments.

The better growth under T_4 may be due to the balanced supply of nitrogen, phosphorus and potassium. Nitrogen plays an important role in vegetative growth and helps in formation of chlorophyll and plant tissues. Phosphorus is associated with root development, energy transfer and better utilization of nutrients, whereas potassium helps in movement of food materials, enzyme activity and overall plant vigour. Due to the combined effect of these nutrients, the plants under T_4 with better length and girth as compared to the control treatments. However, since the present experiment was not factorial in design, the observed response should not be interpreted as statistical synergism among N, P and K. Rather, T_4 performed favorably among the treatments evaluated under the specific experimental conditions of the study. Further investigations involving factorial combinations, different nutrient concentrations and application schedules would help to clarify individual nutrient contributions and nutrient interactions. Top of Form Bottom of Form

5. Practical implications

The findings indicate that inorganic fertilization management can be considered as a potential component of nutrient management for dragon fruit under arid-irrigated conditions. The treatment combination evaluated as T_4 showed favourable growth responses in the present experiment. However, its broader commercial recommendation requires validation across seasons, locations and contrasting soil and production conditions. Optimization of basal doses of inorganic fertilizers and application time is also necessary to ensure adequate nutrient supply without causing injury.

6. Conclusion

The findings of the present investigation revealed that inorganic NPK fertilization had a noticeable effect on the vegetative growth characteristics of dragon fruit under the agro-climatic conditions of Sri Ganganagar, Rajasthan. Among the treatments evaluated, T_4 comprising 450 g N + 350 g P + 300 g K per pole recorded the most favourable overall response, with higher vine length, number of cladodes, cladode length and cladode girth, while the maximum distance between areoles was observed under T_5 . The improved vegetative growth may be attributed to the complementary roles of nitrogen, phosphorus and potassium in plant growth, nutrient uptake, photosynthetic activity and translocation of assimilates, although the present experimental design does not permit their individual effects to be separated. Therefore, the tested NPK treatment showed potential for improving the vegetative growth of dragon fruit under the conditions of the present study. Further multi-season and multi-location studies are required to validate the consistency of these responses and to determine the most suitable NPK fertilization schedule for dragon fruit production.

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