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Influence of balanced nutrient integration on productivity and quality of dragon fruit (*Hylocereus* spp.)

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Abstract

A field experiment was conducted during *Kharif* 2023 at the Botanical Garden of Babasaheb Bhimrao Ambedkar University, Lucknow, to evaluate the effect of Integrated Nutrient Management (INM) on the yield and quality attributes of dragon fruit (*Hylocereus* spp., Red variety). The study comprised twelve treatments, including combinations of NPK, Azotobacter, and PSB, laid out in a Randomized Block Design with three replications. Results revealed that the maximum number of fruits per pole (8.67) and fruit yield (2.31 kg/pole) were recorded under T₆ (NPK 75% + Azotobacter + PSB), although differences were statistically non-significant. Quality parameters, including total soluble solids, fruit juice pH, ascorbic acid, and sugars, were significantly enhanced under integrated nutrient application, with T₆ showing the highest values for ascorbic acid (8.57 mg/100 g), reducing (9.80%), non-reducing (1.98%), and total sugars (11.79%). The study indicates that INM, particularly the combination of 75% NPK with bio-fertilizers, improves the growth, yield, and bio-chemical quality of dragon fruit, promoting sustainable production under subtropical conditions.

Keywords: INM, PSB, NPK, biofertilizers and bio-chemical

Introduction

Dragon fruit (*Hylocereus* spp.) has emerged as a high-value fruit crop owing to its nutritional richness, medicinal importance, and adaptability to tropical and subtropical climates, with Mondol *et al.* (2025) ^[5] highlighting its abundance of antioxidants, dietary fiber, and bioactive compounds that have enhanced consumer demand and commercial expansion. Nutrient management plays a decisive role in determining growth, yield, and quality attributes, as demonstrated by Satish (2023) ^[6], who emphasized the influence of inorganic fertilizers on crop performance while underscoring the need for balanced nutrient application to sustain soil health. In this context, Integrated Nutrient Management (INM), involving the combined use of inorganic fertilizers, organic manures, and bio-fertilizers, has gained prominence as a sustainable approach, with Siddiqua (2022) ^[8] showing improvements in plant growth, yield, fruit quality, and storage behavior under integrated nutrient application. The beneficial role of organic manures and bio-fertilizers in enhancing vegetative growth and field establishment has also been emphasized by Hussian *et al.* (2024) ^[3], while Chauhan *et al.* (2024) ^[1] demonstrated higher yield and improved quality parameters such as fruit weight and total soluble solids under integrated nutrient application in Indian conditions. Further support for INM was provided by Shukla *et al.* (2025) ^[7], who highlighted enhancement in fruit quality attributes, including sugars and antioxidant content, under combined nutrient management practices. Despite these positive findings, comprehensive evaluation of integrated nutrient management on yield and quality attributes under varying agro-climatic conditions remains limited, warranting the present investigation.

Materials and Methods

A field experiment was carried out for the *kharif* season of 2023 at the Botanical Garden of Baba Saheb Bhimrao Ambedkar University, Lucknow (U.P.), India. The experiment was laid out in a Randomized Block Design (RBD) consisting of twelve treatments and replicated thrice and treatment consisted of T₁ Control, T₂ Azotobacter, T₃ PSB, T₄ NPK (75%) +

Azotobacter, T₅ NPK (75%) + PSB, T₆ NPK (75%) + Azotobacter + PSB, T₈ NPK (50%) + PSB, T₉ NPK (50%) + Azotobacter + PSB, T₁₀ NPK (25%) + Azotobacter, T₁₁ NPK (25%) + PSB, T₁₂ NPK (25%) + Azotobacter + PSB. And the sowing was done at a spacing of 3x3 m. Variety was used in Red (*Hylocereus polyrhizus*). The experimental site (26°46'18" N latitude, 80°55'10" E longitude, 129 m above MSL) is located in the subtropical zone and experiences extreme weather conditions. Summers are hot with temperatures ranging from 29.3 to 46 °C, while winters are cold with a minimum range of 3.5 to 12 °C. The region receives an annual average rainfall of about 730 mm, predominantly during July to September, with occasional showers in winter. Relative humidity varies between 50 and 70%. January is the coldest month, whereas May and June are the hottest.

The soil of the experimental field had uniform topography, was well-drained, and classified as saline-alkaline with inherently poor fertility status. It was low in organic matter and deficient in available nitrogen, phosphorus, and

potassium. The soil had a pH below 8.2, higher electrical conductivity, and an exchangeable sodium percentage (ESP) below 15.

Results and Discussion

1. Yield

The data on Number of fruits per poles, Fruit yield (Kilograms per pole) was influenced by integrated nutrient management during the years 2023-24. Yield data are presented in Table 1.

1.1 Number of fruits per poles

The data on the number of fruits per pole of dragon fruit as influenced by integrated nutrient management during the years 2023-24. Results revealed that the number of fruits was not significant among all the treatments. The maximum number of fruits per pole of dragon fruit was recorded (8.67) in the treatment T₆-NPK (75%) + Azotobacter + PSB. However, the minimum number of fruits per pole of the dragon was recorded in the treatment T₁control (2.67).

Table 1: Effect of integrated nutrient management on number of fruits (per poles) and fruit weight (kg poles⁻¹) of dragon fruit

	Number of fruits (per poles)	Fruit weight (kg ⁻¹ poles)
T ₁ -Control	2.67	0.13
T ₂ -Azotobacter	3.67	0.75
T ₃ -PSB	3.33	1.03
T ₄ -NPK (75%) + Azotobacter	5.67	1.19
T ₅ -NPK (75%) + PSB	6.67	1.23
T ₆ -NPK (75%) + Azotobacter + PSB	8.67	2.31
T ₇ NPK (50%) + Azotobacter	8.00	2.26
T ₈ -NPK (50%) + PSB	7.33	2.26
T ₉ -NPK (50%) + Azotobacter + PSB	5.67	2.26
T ₁₀ -NPK (25%) + Azotobacter	5.33	1.19
T ₁₁ -NPK (25%) + PSB	4.67	2.05
T ₁₂ -NPK (25%) + Azotobacter + PSB	3.67	2.16
C.D.	0.90	0.23
SE(m)	0.31	0.08

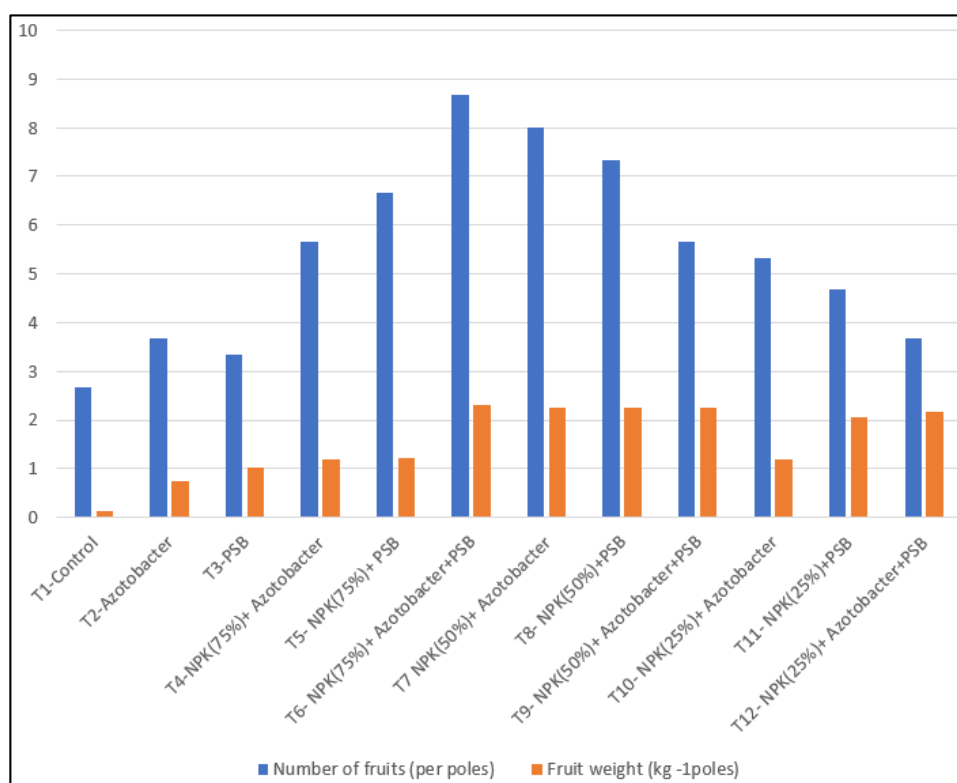


Fig 1: Effect of integrated nutrient management on number of fruits (per poles) and fruit weight (kg poles⁻¹) of dragon fruit

This may be due to a higher dose of integrated nutrient management, which promotes early fruiting but is not effective for yield in the first year afterwards; yield was increased gradually. Similar findings were reported by Hariyanto *et al.* (2023) ^[2] in dragon fruit.

1.2 Fruit yield (Kilograms per pole)

The data on fruits yield kilograms per pole of dragon fruit as influenced by integrated nutrient management during the years 2023-24. Results found that fruit yield kg per pole was very low among all the treatments and no significant yield was noticed. The maximum fruit kilogram per pole was recorded (2.31) in the treatment T₆-NPK (75%) + Azotobacter + PSB. However, the minimum fruit yield kilograms per pole was recorded in the treatment T₁ control (0.13).

This might be because of balanced nutrition application in the yield target approach, which increases the uptake of essential nutrients and accelerates the activities of cell elongation and cell multiplication as well as metabolic activities, resulting in an increase in all the growth attributes. Similar results were reported by Pratap & Tripathi (2025) ^[10]

2. Quality parameters

The data on total soluble solids, fruit juice pH, ascorbic acid, reducing, non-reducing and total sugars was influenced by integrated nutrient management during the years 2023-24 here. Quality parameters are presented in Table 2 and graphically depicted in Figure 1.

2.1 Total soluble solids (°B)

The data on total soluble solids of dragon fruit as influenced

by integrated nutrient management during the years 2023-24. Results revealed that total soluble solid was found to be non-significant among all treatments. Where the maximum total soluble solids of dragon fruit was recorded (15.49) in the treatment T₆-NPK (75%) + Azotobacter + PSB, which were statistically at par with T₅ (15.08). while the minimum total soluble solids were recorded in T₁control (13.92).

From the above results, it seems that the integrated nutrient plays an important role in T.S.S. formation of the fruit. They have a more beneficial effect on T.S.S. content than inorganic fertilizers. Organic and inorganic fertilizer combination reduced the T.S.S. content of dragon fruit. Organic sources provide all essential elements and biochemical reactions of them resulted in higher T.S.S. content. Negative correlation of nitrogen with fruit T.S.S. has been reported by Yadav *et al.* (2011) ^[12] in guava, Khayyat *et al.* (2007) ^[4] in date palm.

2.2 Fruit juice pH

The data on the fruit juice of dragon fruit as influenced by integrated nutrient management during the years 2023-24. Results revealed that Fruit juice pH was found to be non-significant among all treatments. The maximum fruit juice pH of dragon fruit was recorded (5.83) in the treatment T₆-NPK(75%) + Azotobacter + PSB, while the minimum fruit juice pH of dragon fruit was recorded in the treatment T₁control (5.36).

There was no significant effect of integrated nutrient management on dragon fruit. This might be due to the presence of organic acids. Similer results are finding by Zhang *et al.* (2023) ^[13]

Table 2: Effect of integrated nutrient management on total soluble solids, fruit pH, ascorbic acidity, reducing sugar, non-reducing sugar and total sugar of dragon fruit.

Treatments	TSS (°B)	Fruit Juice pH	Ascorbic acid (mg 100 g ⁻¹)	Reducing sugar (%)	Non reducing sugar (%)	Total sugar (%)
T ₁ -Control	13.92	5.36	8.07	8.84	1.73	10.57
T ₂ -Azotobacter	14.23	5.36	8.07	8.88	1.76	10.64
T ₃ -PSB	14.21	5.38	8.13	8.86	1.79	10.65
T ₄ -NPK (75%) + Azotobacter	14.87	5.52	8.31	9.16	1.92	11.08
T ₅ -NPK (75%) + PSB	15.08	5.46	8.41	9.36	1.97	11.33
T ₆ -NPK (75%) + Azotobacter + PSB	15.49	5.83	8.57	9.80	1.98	11.79
T ₇ -NPK (50%) + Azotobacter	14.82	5.52	8.47	9.13	1.85	10.98
T ₈ -NPK (50%) + PSB	14.60	5.51	8.46	9.18	1.82	11.01
T ₉ -NPK (50%) + Azotobacter + PSB	14.59	5.60	8.41	9.34	1.81	11.15
T ₁₀ -NPK (25%) + Azotobacter	14.06	5.58	8.19	9.08	1.77	10.85
T ₁₁ -NPK (25%) + PSB	14.19	5.65	8.18	9.22	1.81	11.03
T ₁₂ -NPK (25%) + Azotobacter + PSB	14.22	5.68	8.22	8.78	1.82	10.60
C.D.	0.14	0.12	0.05	0.21	0.07	0.22
SE(m)	0.05	0.04	8.07	0.10	0.01	0.08

2.3 Ascorbic acid (mg 100⁻¹ g)

The data on ascorbic acid of dragon fruit as influenced by integrated nutrient management during the years 2023-24. Results revealed that significantly higher ascorbic acid of dragon fruit was recorded (8.57) in the treatment T₆-NPK (75%) + Azotobacter + PSB, which was statistically at par with T₇ (8.47) and T₈ (8.46). while the minimum ascorbic acid of dragon fruit was recorded in the treatment T₁control and T₂ having (8.07).

The increased ascorbic acid content might be due to increased availability of nutrients from different organic and inorganic sources, which facilitated enhanced uptake of

nutrients by plants and soil rhizosphere, resulting in better conversion of acid to sugar and their derivatives by the reverse glycolytic pathways. The results are in accordance with the findings of Verma *et al.* (2019) ^[11] in Dragon fruit.

2.4 Reducing sugar (%)

The data on reducing sugar was significantly influenced by integrated nutrient management during years 2023-24. Results revealed that maximum reducing sugar of dragon fruit was recorded (9.80) in the treatment T₆-NPK (75%) + Azotobacter + PSB which was statistically at par with T₅ (9.36) and T₉ (9.34). while, the minimum reducing sugar of

dragon fruit was recorded in the treatment T₁control (8.84). It was due to the addition of NPK, PSB, and Azotobacter that sufficient nutrients, growth-promoting substances that enhanced metabolic and hormonal activity of the plant and promoted production of more photosynthates stored in fruits in the form of starch and carbohydrates. It is a fact that the transformation of mature fruit into ripe form i.e., during the process of ripening in the fruit, undergoes physical, physiological and biochemical changes. The present results are in close conformity with the findings of Verma *et al.* (2019)^[11] in Dragon fruit, Yadav *et al.* (2011)^[12] in guava, and Soorianathasundaram *et al.* (2001)^[9] in Banana.

2.5 Non-reducing sugar (%)

The data on non-reducing sugar was significantly influenced by integrated nutrient management during the years 2023-24. Results revealed that the maximum non-

reducing sugar of dragon fruit was recorded (1.98) in the treatment T₆-NPK (75%) + Azotobacter + PSB, which was statistically at par with T₅ (1.97) and T₄ (1.92). while, the minimum non-reducing sugar of dragon fruit was recorded in the treatment T₁control (1.72).

It could be attributed to the conversion of reserved starch and other insoluble carbohydrates into soluble sugars with the addition of NPK, PSB, Azotobacter supply good amount of nutrients, moisture and growth promoting substances which might have enhanced metabolic and hormonal activity of the plant and that must have promoted production of more photosynthates which was stored in fruits in the form of starch and carbohydrates. The present results are in close conformity with the findings of Verma *et al.* (2019)^[11] in Dragon fruit, Yadav *et al.* (2011)^[12] in guava and Soorianathasundaram *et al.* (2001)^[9] in Banana.

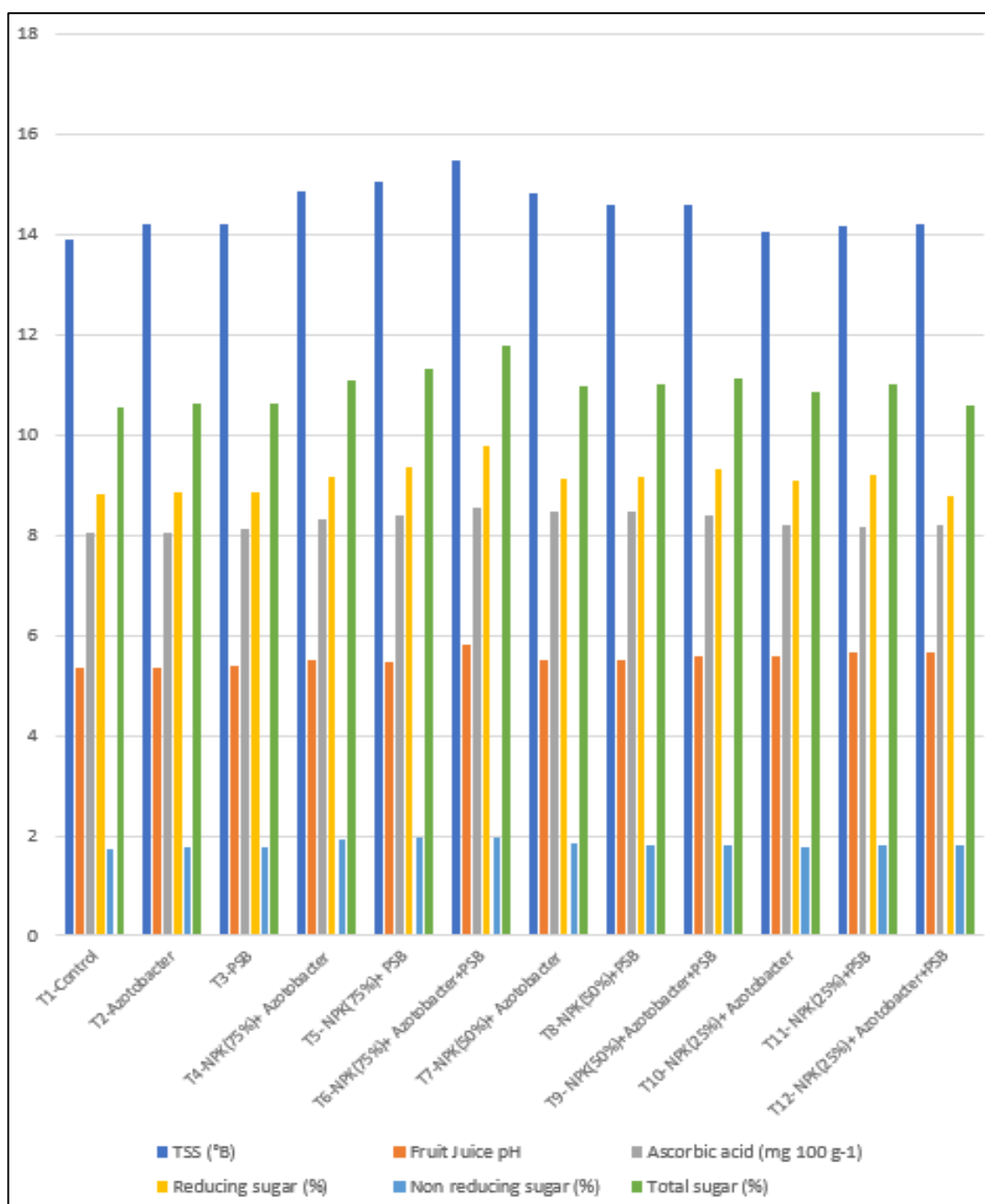


Fig 2: Quality parameter of dragon fruit as influenced by integrated nutrient management

2.6 Total sugars (%)

The data on total sugars was significantly influenced by integrated nutrient management during years 2023-24. During the year 2023-24 results revealed that maximum total sugars of dragon fruit was recorded (11.79) in the treatment T₆-NPK (75%) + Azotobacter + PSB which were statistically at par with T₅ (11.32) and T₉ (11.29). while, the minimum total sugars of dragon fruit were significantly in T₁ control (10.52).

It could be attributed to the conversion of reserved starch and other insoluble carbohydrates into soluble sugars with the addition of integrated nutrient management by supplying the required amount of nutrients and growth promoting substances which might have enhanced metabolic and hormonal activity of the plant and that must have promoted production of more photosynthates which was stored in fruits in the form of starch and carbohydrates. The present results are in close conformity with the findings of Verma *et al.* (2019) ^[11] in Dragon fruit, Yadav *et al.* (2011) ^[12] in guava and Soorianathasundaram *et al.* (2001) ^[9] in Banana.

Conclusion

The findings of the present study clearly indicate that integrated nutrient management plays a vital role in improving the productivity and quality of *Hylocereus polyrhizus* under subtropical conditions. The combined application of 75% recommended NPK along with Azotobacter and PSB (T₆) consistently recorded the highest number of fruits per pole and maximum fruit yield. This treatment also significantly enhanced important quality parameters such as ascorbic acid, reducing sugars, non-reducing sugars, and total sugars. Although yield differences were statistically non-significant, the overall performance trend favored integrated nutrient application over control and individual treatments. Hence, the integration of 75% NPK with bio-fertilizers can be recommended as an effective, economical, and sustainable nutrient management practice for improving yield and fruit quality of dragon fruit.

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