

Original Research Article

Evaluation of N-Carb in Rice Soils

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Abstract

Soil-based biostimulants are increasingly being evaluated as sustainable inputs for improving soil health, nutrient-use efficiency, and crop productivity. The present study was conducted to evaluate the effectiveness of N-Carb, an organic carbon- and nitrogen-based product, in improving growth, yield, nutrient uptake, and selected physiological indicators of rice. A field experiment was conducted during the kharif season of 2022 at the ICAR-Indian Institute of Rice Research farm, Hyderabad, using rice variety DRR Dhan 48. The experiment was laid out in a randomized block design with three replications and four treatments consisting of recommended dose of fertilizers (RDF) alone and RDF combined with N-Carb applied at different crop growth stages. N-Carb was applied at a concentration of 6.5 mL L⁻¹ according to the respective treatment schedules. The initial soil was a slightly alkaline deep black clayey Vertisol with low available nitrogen, medium available phosphorus, and high available potassium. Application of N-Carb along with RDF generally improved plant growth, effective tillering, grain yield, and nutrient uptake compared with RDF alone. The highest grain yield (6.28 t ha⁻¹) was recorded with three applications of N-Carb at basal, active tillering, and panicle initiation stages, followed closely by application at basal and active tillering stages (6.26 t ha⁻¹). N-Carb application also increased SPAD meter readings and NDVI values and improved post-harvest soil nitrogen status. The results indicate that N-Carb has potential as a supplementary input for improving rice growth and productivity when integrated with recommended fertilizer practices.

Keywords: N-Carb, rice, biostimulant, nutrient uptake, grain yield, soil health

Introduction

Soil health is a critical component of sustainable agricultural production because it influences nutrient availability, water retention, root development, microbial activity, and crop productivity. Continuous and intensive cultivation, together with imbalanced fertilizer use, can adversely affect soil fertility and nutrient-use efficiency. Therefore, the use of supplementary soil inputs that improve nutrient availability and plant nutrient uptake has gained increasing attention. Soil-based biostimulants are natural or biological products that stimulate plant growth, nutrient-use efficiency, microbial activity, and tolerance to environmental stresses. Unlike conventional fertilizers, their primary function is not necessarily to supply nutrients directly but to enhance nutrient availability, uptake, and utilization by crops.

N-Carb is an organic carbon- and nitrogen-based product developed by ADASCA India for agricultural application. It is intended for basal and subsequent applications to improve nutrient absorption and bioavailability in crops. The product is also reported to support soil microbial activity and improve soil physical and biological properties. The addition of organic carbon may provide a favourable environment for soil microorganisms involved in nutrient cycling and decomposition. The effectiveness of such products may vary with crop, soil type, application rate, and timing of application. Therefore, systematic field evaluation is necessary to determine their suitability under different crop production environments. Rice is an important cereal crop with high nutrient requirements, and efficient nutrient management is essential for maintaining productivity and soil fertility. Hence, the present study was undertaken to evaluate the effect of N-Carb application at different crop growth stages on growth, yield, nutrient uptake, physiological indicators, and post-harvest soil nutrient status of rice.

Materials and Methods

Experimental site and soil characteristics

A field experiment was conducted during the kharif season of 2022 at the ICAR-Indian Institute of Rice Research (ICAR-IIRR) farm, Hyderabad, India. The experimental field was located at approximately 17°19' N latitude, 78°23' E longitude, and 542 m above mean sea level, with a mean annual rainfall of about 750 mm.

The experiment was conducted on a deep black clayey Vertisol classified as Typic Pellustert. The selected experimental plot (A-3) had a soil pH of 8.13 and soil organic matter content of 1.25%, corresponding to approximately 0.71% soil organic carbon. The soil con-

tained low available nitrogen (270 kg ha⁻¹), medium available phosphorus (10.7 kg ha⁻¹), and high available potassium (332 kg ha⁻¹). Available calcium and magnesium were high, whereas available sulphur was low (8 kg ha⁻¹). The soil also had high available zinc and copper and low available iron and manganese.

Experimental design and treatments

The experiment was conducted in a randomized block design with three replications. Rice variety DRR Dhan 48 was used as the test variety. The plot size was 23.8 m² (3.5 m × 6.8 m). Four treatments were evaluated to determine the effect of different N-Carb application schedules in combination with the recommended dose of fertilizers (RDF):

- T₁: Control (RDF alone)
- T₂: RDF + N-Carb at basal application @ 6.5 mL L⁻¹
- T₃: RDF + N-Carb at basal application @ 6.5 mL L⁻¹ + active tillering stage @ 6.5 mL L⁻¹
- T₄: RDF + N-Carb at basal application @ 6.5 mL L⁻¹ + active tillering stage @ 6.5 mL L⁻¹ + panicle initiation stage @ 6.5 mL L⁻¹

The recommended dose of fertilizer was 120:80:60 kg N₂O₅2O ha⁻¹. Nitrogen was applied in split doses, with two-thirds applied initially and the remaining one-third during the subsequent crop stage. N-Carb was applied according to the respective treatment schedules.

Crop management and observations

Rice was sown on 9 July 2022 and transplanted on 10 August 2022. Urea and N-Carb were applied according to the experimental schedule. Weed management was carried out as per the recommended practice, and the crop was harvested on 28 November 2022.

Observations were recorded for plant growth, tiller production, dry matter accumulation, yield attributes, grain yield, straw yield, and nutrient uptake. Growth observations were recorded at different crop growth stages, including active tillering, panicle initiation, and physiological maturity. Yield attributes included panicle number, grains per panicle, and grain weight. SPAD meter readings and normalized difference vegetation index (NDVI) values were also recorded. Post-harvest soil samples were analysed for available N, P, and K using the IIRR soil testing kit and Krishi RASTAA machine.

The experimental data were statistically analysed using AGRES statistical software. The results are presented in Tables 1–4.

Results and Discussion

Table 1. Effect of N-Carb application on growth parameters of rice variety DRR Dhan 48

Treatment	Plant height (cm)	Dry matter (g m^{-2})	Tillers (m^{-2})	Panicles (m^{-2})	Effective tillers (%)
T ₁ – RDF alone (Control)	83	832	304	272	89
T ₂ – RDF + N-Carb at basal	86	887	357	325	91
T ₃ – RDF + N-Carb at basal + active tillering	87	854	325	297	91
T ₄ – RDF + N-Carb at basal + active tillering + panicle initiation	88	852	352	313	89
CD _{0.05}	NS	33.98	NS	NS	4.27
CV (%)	5.08	2.20	7.41	8.49	2.63
Experimental mean	85	849	329	293	89

Table 2. Effect of N-Carb application on grain and straw yield of rice variety DRR Dhan 48

Treatment	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T ₁ – RDF alone (Control)	5.78	6.32
T ₂ – RDF + N-Carb at basal	5.88	6.22
T ₃ – RDF + N-Carb at basal + active tillering	6.26	6.85
T ₄ – RDF + N-Carb at basal + active tillering + panicle initiation	6.28	6.75
CD _{0.05}	0.38	0.50
CV (%)	3.55	4.26
Experimental mean	6.00	6.51

Growth parameters

The application of N-Carb in combination with RDF generally improved the growth and tillering characteristics of DRR Dhan 48 compared with RDF alone (Table 2). Plant height increased from 83 cm under the RDF control (T₁) to 86, 87, and 88 cm under T₂, T₃, and T₄, respectively. Dry matter accumulation was also higher with N-Carb application. The highest dry matter accumulation (887 g m^{-2}) was recorded with basal application of N-Carb (T₂), compared with 832 g m^{-2} under RDF alone. The number of tillers m^{-2} increased from 304 in T₁ to 357 in T₂, 325 in T₃, and 352 in T₄. Similarly, the number of panicles m^{-2} increased from 272 in T₁ to 325, 297, and 313 in T₂, T₃, and T₄, respectively. The percentage of effective tillers was 89% in the control and increased to 91% with T₂ and T₃. These observations indicate that N-Carb application in combination with RDF favourably influenced vegetative growth and tiller development. The improvement may be associated with enhanced nutrient availability and uptake under N-Carb application. These results are reported by Bharamappanavara et al. (2020), Brajendra, et al. (2020), Caon, and Vargas, (2017).

Yield and yield attributes

Grain yield of DRR Dhan 48 was positively influenced by N-Carb application (Table 3). The control treatment (T₁) produced a grain yield of 5.78 t ha^{-1} . Application of N-Carb at the basal stage (T₂) increased grain yield to 5.88 t ha^{-1} , while application at basal + active tillering stages (T₃) resulted in 6.26 t ha^{-1} . The highest grain yield of 6.28 t ha^{-1} was recorded in T₄, in which N-Carb was applied at basal, active tillering, and panicle

initiation stages. Thus, grain yield increased by approximately 8.7% under T₄ compared with the RDF control. Straw yield was also improved with multiple N-Carb applications. The highest straw yield (6.85 t ha^{-1}) was recorded under T₃, followed by T₄ (6.75 t ha^{-1}), compared with 6.32 t ha^{-1} in the control. The higher grain yield under N-Carb treatments was mainly associated with improved effective tillering and panicle production. The results suggest that repeated application of N-Carb during important crop growth stages may support crop growth and yield formation. However, the differences among N-Carb application schedules should be interpreted based on the statistical significance indicated by the analysis. These results are reported by Gopal et al. (2014), Gorlapalli et al. (2022) and Kale et al. (2021).

SPAD meter and NDVI readings

SPAD meter readings and NDVI values were higher in N-Carb-treated plots than in the RDF control (Table 4). The SPAD value increased from 36.5 in T₁ to 39.8, 40.1, and 43.0 in T₂, T₃, and T₄, respectively. The highest SPAD reading was therefore recorded with three applications of N-Carb. NDVI values followed a similar trend, increasing from 0.72 in the control to 0.73 in T₂ and T₃ and 0.74 in T₄. The higher SPAD and NDVI readings suggest improved crop canopy development and leaf greenness under N-Carb application. These physiological indicators may reflect improved crop nutritional status, particularly nitrogen status, although direct relationships should be confirmed through detailed nutrient analysis. These results are reported by Kale et al. (2020), Parmar et al. (2022) and Rathod et al.

Table 3. Effect of N-Carb application on SPAD meter readings and NDVI of rice variety DRR Dhan 48

Treatment	SPAD meter reading	NDVI
T ₁ – RDF alone (Control)	36.5	0.72
T ₂ – RDF + N-Carb at basal	39.8	0.73
T ₃ – RDF + N-Carb at basal + active tillering	40.1	0.73
T ₄ – RDF + N-Carb at basal + active tillering + panicle initiation	43.0	0.74

Table 4. Effect of N-Carb application on post-harvest available nutrient status of soil

Treatment	IIRR Soil Testing Kit			Krishi RASTAA machine		
	N	P	K	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)
T ₁ – RDF alone (Control)	Low	Medium	High	302	16.5	345
T ₂ – RDF + N-Carb at basal	Medium	Medium	High	335	17.8	333
T ₃ – RDF + N-Carb at basal + active tillering	Medium	Medium	High	362	17.6	323
T ₄ – RDF + N-Carb at basal + active tillering + panicle initiation	Medium	Medium	High	375	18.1	312

(2021).

Post-harvest soil nutrient status

Post-harvest soil analysis indicated differences in available nutrient status among the treatments (Table 5). According to the IIRR soil testing kit, available nitrogen was classified as low under the RDF control and medium under all N-Carb treatments. Available phosphorus remained in the medium category and available potassium remained high across the treatments. Measurements obtained using the Krishi RASTAA machine showed available nitrogen values of 302, 335, 362, and 375 kg ha⁻¹ in T₁, T₂, T₃, and T₄, respectively. Available phosphorus values ranged from 16.5 to 18.1 kg ha⁻¹, while available potassium ranged from 312 to 345 kg ha⁻¹. The highest post-harvest available nitrogen was recorded under T₄, suggesting that repeated N-Carb application may have contributed to maintaining a higher soil nitrogen status after crop harvest. However, longer-term experiments are required to establish the effects of N-Carb on soil fertility and nutrient dynamics. These results are reported by Sahoo et al. (2022), Srilatha et al. (2019) and Tuti et al. (2022).

Conclusion

The field experiment conducted with rice variety DRR Dhan 48 demonstrated that N-Carb application in combination with the recommended dose of fertilizers improved several growth and yield parameters compared with RDF alone. Application of N-Carb at basal, active tillering, and panicle initiation stages (T₄) recorded the highest grain yield of 6.28 t ha⁻¹, compared with 5.78 t ha⁻¹ under RDF alone. N-Carb treatments also resulted in higher tiller and panicle production, SPAD meter readings, NDVI values, and post-harvest available nitrogen. Overall, the results indicate that N-Carb has potential as a supplementary input for improv-

ing rice growth, nutrient availability, and productivity when used along with recommended fertilizer practices. Among the treatments evaluated, application at basal + active tillering + panicle initiation stages showed the most consistent overall performance. However, multi-season and multi-location studies are required to confirm the agronomic and soil-health benefits of N-Carb before making broader recommendations.

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