



## Research Article

### IMPACT OF NUTRIENT MANAGEMENT ON RICEBEAN (*Vigna umbellata* (Thunb.) Ohwi and Ohashi)

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**Abstract:** The Ricebean has garnered attention as an underutilized crop due to its significant global food contributions and its emerging potential as a valuable legume with a remarkable nutritional profile, boasting over 25% protein content and essential amino acids. A field experiment conducted from 2019 -2021 focused on green manuring with a legume crop, ricebean, on the same field. The study aimed to assess growth, yield, and quality parameters. Treatment T<sub>1</sub>, incorporating a combination of green manure and poultry manure at a rate of 0.7 tons per hectare along with 100 % RDF (Recommended dose of fertilizers), demonstrated superior performance in ricebean resulted in higher seed yields, enhance seed quality, maintain soil health, and optimize financial returns for farmers in the foothill conditions of Nagaland.

**Keywords:** Ricebean, Growth attributes, Yield attributes, Quality attribute

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#### Introduction

In alignment with the guidelines of the World Health Organization (WHO) and the Food and Agriculture Organization (FAO), achieving food security and the right to food involves incorporating legumes, particularly underutilized ones, into diets. These legumes are nutritionally rich, providing high-quality protein, dietary fiber, various micronutrients, and numerous health benefits [1]. Despite India's pulse production being 16.47 million tonnes (2015-16), 3.58 million tonnes below the target of 20.05 million tonnes, the inclusion of legumes like *Vigna umbellata*, or rice bean, is crucial. Rice bean has gained attention for its nutritional profile, including over 25% protein content, 5% fiber, essential amino acids, and valuable vitamins. It exhibits traits such as drought resistance, pest and disease resistance, synchronized pod maturity, resistance to storage pests, and high seed viability. Frequently intercropped or combined with crops like maize, sorghum, or cowpea, rice bean is predominantly cultivated in rainfed conditions in the Northeastern region (NER) of India, particularly in areas practicing shifting cultivation. With its high nutritional quality, robust grain yield, and versatile utility in food, animal feed, cover crops, and green manure, rice bean contributes to sustainable and nutrient-rich agricultural systems. The traditional reliance on chemical additives in modern agriculture has led to issues such as declining soil productivity, nutrient depletion, and groundwater contamination. Addressing these concerns, the combination of chemical fertilizers with organic manures shows potential for higher yields and consistent crop production. Sustainable and profitable crop management is urgently needed, and advancements in agricultural technology, especially in cropping systems and nutrient management, are essential for enhancing productivity in crop cultivation.

#### Materials and methods

Between 2019 and 2021, a research study was carried out at the Medziphema Campus of the School of Agricultural Sciences (SAS) in Nagaland with the primary aim to assess the impact of Integrated Nutrient Management (INM) on the growth, yield, and quality of a ricebean cropping system over this two-year period. The organic manures involved Sesbania green manure (GM) combined with poultry manure (PM) at a rate of 0.7 tons per hectare, Sesbania GM with pig manure

(PGM) at a rate of 0.7 tons per hectare, and Sesbania GM with farmyard manure (FYM) at 4 tons per hectare. These organic sources were paired with different doses of inorganic fertilizers: 100% Recommended Dose of Fertilizers (RDF), 75% RDF, and 50% RDF. The treatment combinations included various formulations, each specifying the type and amount of organic and inorganic inputs.

In terms of inorganic fertilizers, urea, single super phosphate (SSP), and muriate of potash (MOP) were applied at concentrations of 100%, 75%, and 50% the day before crop sowing. The recommended agronomic practices were adhered to, and post-harvest, the crops were dried, separated, and the harvested seeds were appropriately labelled for each plot. During the experiment, Bidhan-1 ricebeans were cultivated using a randomized plot design with the suggested spacing. Three organic manures were combined with varying doses of inorganic fertilizers at the recommended levels. The green manure was sown in the middle of March 2019 and the first week of April 2020, and it was integrated into the soil in May for both crop seasons. Organic manures were applied a month before planting, and they were blended into the soil along with 20 kg of nitrogen in the form of urea.

#### Results

##### Growth attributes

The current study explores the impact of various nutrient combinations on the growth, yield, and quality characteristics of the ricebean, as outlined in [Table-1]. The findings reveal a noteworthy influence of nutrient management on plant height at 30, 60, 90 days after sowing, and at the harvest stage. Plant height is a crucial determinant in fodder crops, reflecting how different nutrient treatments affect plant growth and vitality. Treatment T<sub>1</sub> exhibited the maximum plant height at harvest, measuring 167.93 cm in 2019, 174.70 cm in 2020, and an average of 171.32 cm in pooled data. In contrast, T<sub>6</sub> consistently recorded the minimum plant height, averaging 123.36 cm across both years. T<sub>1</sub> also demonstrated a significant impact on the number of branches and nodules at various growth stages, particularly at 30, 60, 90 days after sowing, and at harvest in [Table-2]. Notably, the addition of poultry manure with recommended dose of fertilizers (RDF) significantly increased the number of nodules compared to other treatments [2], who reported enhanced effectiveness of rhizobium in cowpea with poultry manure.

Table-1 Effect of nutrient management on plant height at different growth stages in ricebean

	30DAS (cm)			60DAS (cm)			90 DAS (cm)			Harvest (cm)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T <sub>1</sub>	41.86	48.79	45.33	75.02	81.30	78.16	118.34	133.68	126.01	167.93	174.70	171.32
T <sub>2</sub>	41.49	43.66	42.57	69.06	76.54	72.80	116.84	130.37	123.6	164.4	168.51	166.45
T <sub>3</sub>	38.81	43.03	40.92	68.25	73.09	70.67	113.33	126.56	119.94	164.11	168.24	166.18
T <sub>4</sub>	34.91	37.19	36.05	58.55	66.49	62.52	105.35	108.72	107.04	135.85	140.71	138.28
T <sub>5</sub>	34.45	36.35	35.40	57.69	66.03	61.86	104.55	107.74	106.15	129.04	130.88	129.96
T <sub>6</sub>	32.74	33.08	32.91	54.05	60.83	57.44	103.23	105.63	104.43	121.89	124.83	123.36
T <sub>7</sub>	37.87	42.83	40.35	64.71	68.1	66.41	112.34	120.87	116.61	164.25	174.77	169.51
T <sub>8</sub>	37.25	41.97	39.61	62.88	66.78	64.83	109.52	113.07	111.29	152.37	166.36	159.37
T <sub>9</sub>	35.82	40.13	37.97	61.92	66.53	64.23	109.38	110.20	109.79	156.92	151.47	154.20
SEm ±	1.66	2.35	1.44	3.30	2.77	2.15	3.06	5.38	3.10	10.00	11.85	7.75
CD (P=0.05)	4.97	7.04	4.14	9.89	8.30	6.20	9.18	16.14	8.92	29.97	35.53	22.33

Table-2 Effect of nutrient management on number of branches and nodules

	30DAS			60DAS			90 DAS			30DAS			60DAS			70 DAS		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T <sub>1</sub>	6.53	6.73	6.63	8.28	8.51	8.39	9.43	9.74	9.59	7.50	7.97	7.73	20.63	26.33	23.48	36.07	38.20	37.13
T <sub>2</sub>	6.00	6.35	6.17	8.23	8.43	8.33	9.30	9.63	9.47	7.24	7.83	7.54	20.47	26.00	23.23	35.13	37.37	36.25
T <sub>3</sub>	6.13	6.01	6.07	8.23	8.40	8.32	9.27	9.47	9.37	7.13	7.82	7.48	20.47	24.6	22.53	33.93	35.87	34.90
T <sub>4</sub>	5.57	6.00	5.78	7.67	7.97	7.82	8.70	8.77	8.73	6.73	7.37	7.05	17.20	21.33	19.27	29.07	31.47	30.27
T <sub>5</sub>	5.47	5.83	5.65	7.39	7.52	7.45	8.47	8.68	8.58	6.50	6.70	6.60	15.87	16.00	15.93	28.40	31.40	29.90
T <sub>6</sub>	4.97	5.79	5.38	7.11	7.26	7.19	8.10	8.44	8.27	6.47	6.57	6.52	15.47	15.87	15.67	27.73	32.00	29.87
T <sub>7</sub>	5.8	6.03	5.92	8.15	8.21	8.18	9.19	9.34	9.27	7.10	7.80	7.45	19.93	25.33	22.63	33.53	34.47	34.00
T <sub>8</sub>	5.67	6.07	5.87	8.07	8.19	8.13	9.13	9.17	9.15	7.07	7.77	7.42	19.30	22.07	20.68	32.47	34.53	33.5
T <sub>9</sub>	5.60	6.04	5.82	7.83	8.10	7.97	8.87	8.87	8.87	6.8	7.43	7.12	18.41	21.07	19.74	31.93	33.67	32.8
SEm ±	0.27	0.13	0.15	0.19	0.25	0.16	0.22	0.23	0.16	0.47	0.55	0.36	0.82	2.47	1.30	1.45	1.53	1.06
CD (P=0.05)	0.81	0.38	0.43	0.58	0.76	0.46	0.67	0.70	0.46	NS	NS	NS	2.45	7.41	3.75	4.36	4.60	3.04

Table-3 Effect of nutrient management on no. of pods plant<sup>-1</sup>, seeds pod<sup>-1</sup> and pod length in ricebean

	No. of pods plant <sup>-1</sup>			No. of seeds pod <sup>-1</sup>			Pod length (cm)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T <sub>1</sub>	13	15.33	14.17	8.87	9.61	9.24	8.90	9.51	9.20
T <sub>2</sub>	12.83	14.77	13.80	8.67	9.5	9.08	8.84	9.40	9.12
T <sub>3</sub>	12.23	14.67	13.45	8.57	9.57	9.07	8.68	9.33	9.01
T <sub>4</sub>	10.17	12.23	11.20	8.07	8.27	8.17	7.90	8.67	8.28
T <sub>5</sub>	9.17	12.10	10.63	8.03	8.37	8.2	7.90	8.13	8.02
T <sub>6</sub>	8.40	11.40	9.90	6.97	7.13	7.05	7.70	7.93	7.82
T <sub>7</sub>	11.25	13.9	12.58	8.33	8.53	8.43	8.75	9.30	9.03
T <sub>8</sub>	10.39	13.53	11.96	8.47	8.65	8.56	8.60	8.90	8.75
T <sub>9</sub>	10.47	13.06	11.77	8.13	8.47	8.30	8.57	8.70	8.63
SEm ±	0.99	0.67	0.60	0.26	0.46	0.27	0.28	0.35	0.22
CD	2.96	2.02	1.72	0.79	1.39	0.77	0.84	1.03	0.64

Table-4 Effect of nutrient management on seed, stover and harvest index in ricebean

	Seed yield (kg ha <sup>-1</sup> )			Stover yield (kg ha <sup>-1</sup> )			Harvest index (%)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T <sub>1</sub>	1161.83	1217.77	1189.8	1893.33	1904.28	1898.80	38.70	39.05	38.85
T <sub>2</sub>	1102.06	1217.10	1159.58	1860.77	1901.05	1880.91	37.82	39.03	38.43
T <sub>3</sub>	1088.70	1199.83	1144.26	1814.23	1895.95	1855.09	37.11	38.97	38.04
T <sub>4</sub>	1028.94	1084.41	1056.68	1638.34	1850.42	1744.38	33.65	34.93	34.29
T <sub>5</sub>	1012.18	1080.92	1046.55	1621.40	1759.47	1690.43	32.79	34.05	33.42
T <sub>6</sub>	1000.44	1079.07	1039.75	1604.32	1704.64	1654.48	31.00	33.12	32.06
T <sub>7</sub>	1079.14	1172.77	1125.96	1792.81	1888.14	1840.47	36.95	38.34	37.64
T <sub>8</sub>	1057.73	1105.94	1081.84	1731.41	1884.94	1808.18	36.59	37.60	37.09
T <sub>9</sub>	1038.65	1101.37	1070.01	1693.87	1872.57	1783.22	34.81	37.01	35.91
SEm ±	28.74	37.27	23.53	65.77	42.75	39.22	1.03	1.23	0.80
CD (P=0.05)	86.15	111.74	67.78	197.17	128.17	112.98	3.10	3.69	2.32

Table-5 Effect of nutrient management on total NPK uptake in ricebean

Treatments	Total N uptake (kg ha <sup>-1</sup> ) (Seed + stover)			Total P uptake (kg ha <sup>-1</sup> ) (Seed + stover)			Total K uptake (kg ha <sup>-1</sup> ) (Seed + stover)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	pooled
T <sub>1</sub>	84.45	92.75	88.60	13.80	15.94	14.87	49.38	52.49	50.94
T <sub>2</sub>	81.18	91.46	86.32	11.91	15.05	13.48	44.62	50.38	47.50
T <sub>3</sub>	78.11	90.36	84.23	11.47	13.32	12.39	40.67	49.51	45.09
T <sub>4</sub>	68.55	77.59	73.07	11.03	13.61	12.32	41.43	48.88	45.16
T <sub>5</sub>	67.42	74.81	71.11	9.33	11.85	10.59	36.85	43.95	40.40
T <sub>6</sub>	64.64	72.18	68.41	8.73	9.51	9.12	34.43	43.18	38.80
T <sub>7</sub>	76.36	88.31	82.34	11.95	14.21	13.08	44.49	51.01	47.75
T <sub>8</sub>	73.28	81.96	77.62	10.84	11.49	11.16	37.78	46.54	42.16
T <sub>9</sub>	70.77	79.65	75.21	9.72	9.37	9.55	36.27	45.13	40.70
SEm ±	1.84	2.5	1.55	0.46	1.01	0.55	1.98	2.03	1.42
CD (P=0.05)	5.51	7.49	4.47	1.38	3.02	1.60	5.93	6.07	4.08

The results indicate a significant increase in dry matter (g plant<sup>-1</sup>) at different growth stages for ricebean [3], suggesting the notable impact of poultry manure on enhancing growth and yield parameters in cowpea plants. This implies that poultry manure efficiently releases essential nutrients crucial for plant vigor and growth, complementing its strong nitrogen-fixing capabilities [4].

The substantial growth observed in the poultry manure-treated group may be attributed to the increased availability of nutrients released during the mineralization process of poultry manure. Additionally, poultry manure tends to contain higher nutrient levels compared to other sources [5].

### Yield attributes

T<sub>1</sub> showed the highest number of pods per plant (13.00 in 2019, 15.33 in 2020, and a pooled average of 14.17), while T<sub>6</sub> exhibited the minimum in [Table-3]. T<sub>1</sub> also resulted in the highest number of seeds per pod (8.87 in 2019, 9.61 in 2020, and a pooled average of 9.24), whereas T<sub>6</sub> had the lowest. The incorporation of poultry manure along with green manuring and PM at 100% RDF in T<sub>1</sub> significantly yielded the highest seed yield (1161.83 kg ha<sup>-1</sup>) while T<sub>4</sub> and T<sub>9</sub> were statistically similar but had slightly lower yields, while T<sub>6</sub>, with pig manure, recorded the lowest yield.

In terms of stover yield in [Table-4], T<sub>1</sub> consistently provided the highest significant yield in both 2019 (1893.33 kg ha<sup>-1</sup>) and 2020 (1904.28 kg ha<sup>-1</sup>). The harvest index also varied significantly, with T<sub>1</sub> (poultry manure, green manuring, and PM at 100% RDF) having the highest index in both years, while T<sub>6</sub> had the lowest. The data analysis revealed significant variations in seed and stover yield due to different nutrient management sources. These findings align with previous research indicating that the accumulation of nitrogen, facilitated by both fertilizers and organic manures, positively influences production and yields. The results align with research [6], where an improved yield in broad beans was observed. The increased yield was attributed to the organic matter's contribution in providing essential nutrients, promoting vegetative growth, and enhancing the photosynthesis process. The additional energy from photosynthesis was utilized in building plant components, reducing intra-plant competition, and minimizing abortion rates. This, in turn, resulted in a higher number of seeds per pod, consistent in common beans [7].

### Quality attribute

In 2019, T<sub>1</sub> exhibited the highest total nitrogen uptake in ricebean plants at 84.45 kg ha<sup>-1</sup>, with a pooled analysis of 88.60 kg ha<sup>-1</sup>. Conversely, treatments involving pig manure consistently resulted in the lowest nitrogen uptake for both years. For total phosphorus uptake, T<sub>1</sub> was most effective in 2019 (13.80 kg ha<sup>-1</sup>) and 2020 (15.94 kg ha<sup>-1</sup>), while the combined data indicated that the highest phosphorus uptake occurred with green manure (Sesbania) + pig manure (0.7 t ha<sup>-1</sup>) + 100% RDF (14.87 kg ha<sup>-1</sup>). T<sub>1</sub> also significantly increased potassium uptake in both 2019 (49.38 kg/ha<sup>-1</sup>) and 2020 (52.49 kg ha<sup>-1</sup>), with a pooled average of 50.94 kg ha<sup>-1</sup> as depicted in [Table-5]. Research highlighted [8] that early application of poultry manure enhances microbial biomass nitrogen, contributing to improved crop growth. Poultry manure, rich in major and micronutrients, increases nutrient availability, supporting crop growth and nutrient content. It was noted that poultry manure surpasses other animal manures in nutritional content and mineralization rate [9]. In total nutrient uptake, T<sub>1</sub> consistently showed the highest nitrogen uptake in 2019 (59.16 kg ha<sup>-1</sup>) and 2020 (64.15 kg ha<sup>-1</sup>). For phosphorus uptake, T<sub>1</sub> led in 2019 (31.31 kg ha<sup>-1</sup>), and in 2020, it again had the highest uptake at 35.35 kg ha<sup>-1</sup>. Regarding potassium uptake, T<sub>1</sub> recorded the highest values in both years (53.57 kg ha<sup>-1</sup> in 2019 and 58.81 kg ha<sup>-1</sup> in 2020). This combined approach of utilizing organic and inorganic nutrient sources has the potential to enhance overall agricultural productivity, aligning with sustainable farming practices supported by previous research. The recent findings are consistent with the concept that the application of organic nutrients to preceding crops can significantly enhance the subsequent crop's performance [10]. The integrated strategy of utilizing both organic and inorganic nutrient sources has the capacity to enhance overall agricultural productivity and promote sustainable farming practices which aligns with research [11-13].

### Conclusion

The notable improvement in various growth parameters in ricebean can be attributed to the abundant nutrient content and beneficial micronutrients found in poultry manure. The combination of Recommended Dose of Fertilizers (RDF) with poultry manure, known for its ability to enhance nodule formation in legumes, contributed to enhanced soil fertility, encouraged beneficial microbial activity, and supported the health and growth of legumes, ultimately resulting in higher yields. In comparison, farmyard manure (FYM) surpassed pig manure due to its balanced nutrients, microbial activity, organic matter, and positive impact on soil quality, creating a more favorable environment for plant growth. Poultry manure's capacity

to stimulate nodule formation, improve soil fertility, and support legume health resulted in increased nitrogen fixation and improved yields in leguminous crops, promoting early root development and robust growth in ricebean crops.

**Application of research:** To comprehend the influence of nutrient management, particularly focusing on green manure, on legume crops and crop quality, emphasis is placed on organic manures and sources

**Research Category:** Agronomy

**Abbreviations:** FYM-Farmyard manure, RDF- Recommended dose of fertilizers

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**Study area / Sample Collection:** School of Agricultural Sciences, Medziphema, 797106

**Cultivar / Variety / Breed name:** Ricebean (*Vigna umbellata* (Thunb.) Ohwi and Ohashi) - Bidhan 1

**Conflict of Interest:** None declared

**Ethical approval:** This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

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