Original Research Article

Influence of Nutrient Regulation on Ricebean (*Vigna umbellata*(Thunb.) Ohwi and Ohashi) growth and development.

ABSTRACT

Aims:Within the realm of sustainable agriculture and its attendant issues, there exists a compelling need for a viable approach to cropping systems that integrates pragmatic and economically sound crop management tactics. This is imperative to uphold land productivity and secure a lasting provision of crops for human consumption. Acknowledging the pivotal contribution of organic manure when combined with chemical fertilizers in crop cultivation and the safeguarding of soil well-being, a research inquiry was formulated for a noteworthy cropping sequence.

Study design: Randomized block design

Place and Duration: School of Agricultural Sciences, Nagaland University, Medziphema. Duration: 2019-2021

Methodology: The study took place from 2019 to 2021 at the School of Agricultural Sciences (SAS), Medziphema Campus in Nagaland. The primary aim was to assess the lasting impact of both manure and fertilizers on yield and soil condition in a ricebean system over this two-year duration. In the second week of April in both 2019 and 2020, Dhaincha (Sesbania aculeata), a green manure crop, was sown using seeds. After a 30-day decomposition period, this green manure was incorporated into the soil. Soil samples were collected from the upper 0-15 cm layer of each experimental plot and analyzed.The primary plot factors involved three levels of organic manures: GM (Sesbania) + PM (0.7 t/ha); GM

(Sesbania) + PGM (0.7 t/ha); GM (Sesbania) + FYM (4 t/ha), coupled with varying doses of inorganic fertilizers: 100% RDF, 75% RDF, 50% RDF. The treatment combinations included T_1: GM+ PM (0.7t/ha) + 100% P_2O_5 K_2O; T2: GM+ PM (0.7t/ha) + 75% P_2O_5 K_2O; T_3: GM+ PM (0.7t/ha) + 50% P_2O_5 K_2O; T_4: GM+ PGM (0.7t/ha) + 100% P_2O_5 K_2O; T_5: GM+ PM (0.7t/ha) + 75% P_2O5 K_2O; T_6: GM+ PGM (0.7t/ha) + 50% P_2O_5 K_2O; T_7: GM+ FYM (4t/ha) + 100% P_2O_5 K_2O; T_8: GM+ FYM (4t/ha) + 50% P_2O_5 K_2O; T_9: GM+ PM (4t/ha) + 50% P_2O_5 K_2O, all applied to ricebean (Bidhan-1).

Results: In treatment T1, which involved the application of a blend of green manure and poultry manure at a rate of 0.7 tons per hectare, coupled with a full dose of phosphorus and potassium (P2O5 K2O), exhibited outstanding outcomes in ricebean cultivation. This resulted in elevated seed yields, improved seed quality, sustained soil health, and maximized economic gains for farmers in the foothill conditions of Nagaland.

Conclusion: The substantial enhancement in ricebean growth parameters can be credited to the rich nutrient content and beneficial micronutrients present in poultry manure. Combining Recommended Dose of Fertilizers (RDF) with poultry manure, known for its ability to boost nodule formation in legumes, improved soil fertility, fostered beneficial microbial activity, and promoted legume health, ultimately leading to higher yields. In contrast, farmyard manure (FYM) outperformed pig manure due to its balanced nutrients, microbial activity, organic matter, and positive impact on soil quality, creating an optimal environment for plant growth. Poultry manure's capacity to stimulate nodule formation, enhance soil fertility, and support legume health resulted in increased nitrogen fixation and improved yields in leguminous crops, fostering early root development and robust growth in ricebean crops.

Keywords: Ricebean, poultry manure, growth, development.

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. A uniform 20 kg of nitrogen was applied as a basal dose in all treatments, placed in open furrows. The recommended agronomic practices were adhered to, and post-harvest, the crops were dried, separated, and the harvested seeds were appropriately labeled 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 AND DISCUSSION

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_1 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_6 consistently recorded the minimum plant height, averaging 123.36 cm across both years. T_1 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. The results indicate a significant increase in dry matter (g plant⁻

^{1}) 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_1 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_6 exhibited the minimum in table 3. T_1 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_6 had the lowest. The incorporation of poultry manure along with green manuring and PM at 100% RDF in T_1 significantly yielded the highest seed yield (1161.83 kg ha^{-1}) while T_4 and T_9 were statistically similar but had slightly lower yields, while T_6, with pig manure, recorded the lowest yield.

In terms of stover yield in table 4, T_1 consistently provided the highest significant yield in both 2019 (1893.33 kg ha^{-1}) and 2020 (1904.28 kg ha^{-1}). The harvest index also varied significantly, with T_1 (poultry manure, green manuring, and PM at 100% RDF) having the highest index in both years, while T_6 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_1 exhibited the highest total nitrogen uptake in ricebean plants at 84.45 kg ha^{-1}, with a pooled analysis of 88.60 kg ha^{-1}. Conversely, treatments involving pig manure consistently resulted in the lowest nitrogen uptake for both years. For total phosphorus uptake, T_1 was most effective in 2019 (13.80 kg ha^{-1}) and 2020 (15.94 kg ha^{-1}), while the combined data indicated that the highest phosphorus uptake occurred with green manure (Sesbania) + pig manure (0.7 t ha^{-1}) + 100% RDF (14.87 kg ha^{-1}). T_1 also significantly increased potassium uptake in both 2019 (49.38 kg/ha^{-1}) and 2020 (52.49 kg ha^{-1}), with a pooled average of 50.94 kg ha^{-1} 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_1 consistently showed the highest nitrogen uptake in 2019 (59.16 kg ha^{-1}) and 2020 (64.15 kg ha^{-1}). For phosphorus uptake, T_1 led in 2019 (31.31 kg ha^{-1}), and in 2020, it again had the highest uptake at 35.35 kg ha^{-1}. Regarding potassium uptake, T_1 recorded the highest values in both years (53.57 kg ha^{-1} in 2019 and 58.81 kg ha^{-1} 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 (11,12,13).

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.

CONSENT: All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal

ETHICAL APPROVAL: Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee

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

Reference

1) Katoch, R. (2015).Nutritional potential of ricebean (Vigna umbellata). Journal of Food Science. 78 (1): 8-16.

2) Panda PK, Nandi A, Swain PK, Patnaik SK, Patnaik M. (2012). Soil amendment on growth, nodulation, yield, soil health, and economics of Cowpea. International Journal of Vegetable Science. 18:284–297.

3) Msaakpa, T. S. 2016. Effects of Variety and Poultry Manure on Growth and Yield of Selected Cowpea (Vigna unguiculata (L) Walp) Varieties at Makurdi, Nigeria. International Journal of Scientific and Research Publications. 6(8).

4) Ewulo, B. S. 2005. Effect of poultry and cattle manure on sandy clay loamy soil. Journal of Veterinary and Animal Sciences. 4: 839- 841.

5) Diwale, S.R., Gokhale, N.B., Khobragade, N.H., Wahane, M.R., Joke, A.A. and Dhopavkar, R.V. 2020. Effect of organic manures on yield and nutrient uptake by cowpea and changes in soil nutrient status. The Pharma Innovation Journal. 9(9): 564-567.

6) Jasim, H. and Mhanna, Q. L. 2014. Effect of some organic fertilizer's treatments on dry seed yield of broad bean (Vicia faba L.). Scientific Papers-Series A-Agronomy. 57: 218–222.

7) Anuja, S. and Vijayalakshmi, N. (2014). Effect of organic nutrients on growth and yield of vegetable cowpea. The Asian Journal of Horticulture. 9(1): 136-13

8) Sugihara, S., Funakawa, S., Kilasara, M., and Kosaki, I. 2010. Dynamics of microbial biomass nitrogen in relation to plant nitrogen uptake during the crop growth period in a dry tropical cropland in Tanzania. Soil Science & Plant Nutrition. 56(1): 105-114.

9) Sims, T.J., and D.C. Wolf. 1992. Poultry waste management: Agricultural and environmental issues. Advances in Agronomy. 52:1-84.

10) Hedge, D.M. (1998). Long term sustainability of rice productivity in rice (Oryzae sativa)–wheat (Tricitumaestivum) system in sub-humid ecosystem through integrated nutrient supply. Indian Journal of Agronomy. 43: 189-198

11) Goulding, K., Jarvis, S. and Whitmore, A. (2008). Optimizing nutrient management for farm systems. Philosophical Transactions of the Royal Society B. 363:667-680.

12) Gudadhe, N.N. (2008). Effect of Integrated Nutrient Management system in cotton-chickpea cropping sequence under irrigated conditions. PhD thesis submitted to M.P.K.V., Rahuri (M.S.).

13) Senthivalan, P. and Ravichandran, M. 2019. Residual effect of nutrient management practises on the yield, NPK uptake and profitability of rice fallow black gram . Asian Journal of Science and Technology. 7(1):2305-2310.

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_1	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_2	41.49	43.66	42.57	69.06	76.54	72.80	116.84	130.37	123.60	164.40	168.51	166.45
T_3	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_4	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_5	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_6	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_7	37.87	42.83	40.35	64.71	68.10	66.41	112.34	120.87	116.61	164.25	174.77	169.51
T_8	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_9	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_1	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_2	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_3	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	24.60	22.53	33.93	35.87	34.90
T_4	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_5	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_6	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_7	5.80	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_8	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	33.50
T_9	5.60	6.04	5.82	7.83	8.10	7.97	8.87	8.87	8.87	6.80	7.43	7.12	18.41	21.07	19.74	31.93	33.67	32.80
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^{-1}, seeds pod^{-1} and pod length in ricebean

	No. of pods plant^{-1}			No of seeds pod^{-1}			Pod length (cm)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1	13.00	15.33	14.17	8.87	9.61	9.24	8.90	9.51	9.20
T_2	12.83	14.77	13.80	8.67	9.50	9.08	8.84	9.40	9.12
T_3	12.23	14.67	13.45	8.57	9.57	9.07	8.68	9.33	9.01
T_4	10.17	12.23	11.20	8.07	8.27	8.17	7.90	8.67	8.28
T_5	9.17	12.10	10.63	8.03	8.37	8.20	7.90	8.13	8.02
T_6	8.40	11.40	9.90	6.97	7.13	7.05	7.70	7.93	7.82
T_7	11.25	13.90	12.58	8.33	8.53	8.43	8.75	9.30	9.03
T_8	10.39	13.53	11.96	8.47	8.65	8.56	8.60	8.90	8.75
T_9	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^{-1})			Stover yield (kg ha^{-1})			Harvest index (%)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1	1161.83	1217.77	1189.80	1893.33	1904.28	1898.80	38.70	39.05	38.85

T_2	1102.06	1217.10	1159.58	1860.77	1901.05	1880.91	37.82	39.03	38.43
T_3	1088.70	1199.83	1144.26	1814.23	1895.95	1855.09	37.11	38.97	38.04
T_4	1028.94	1084.41	1056.68	1638.34	1850.42	1744.38	33.65	34.93	34.29
T_5	1012.18	1080.92	1046.55	1621.40	1759.47	1690.43	32.79	34.05	33.42
T_6	1000.44	1079.07	1039.75	1604.32	1704.64	1654.48	31.00	33.12	32.06
T_7	1079.14	1172.77	1125.96	1792.81	1888.14	1840.47	36.95	38.34	37.64
T_8	1057.73	1105.94	1081.84	1731.41	1884.94	1808.18	36.59	37.60	37.09
T_9	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 inricebean

Treatments	Total N uptake (kg ha^{-1}) (Seed + stover)			Total P uptake (kg ha^{-1}) (Seed + stover)			Total K uptake (kg ha^{-1}) (Seed + stover)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	pooled
T_1	84.45	92.75	88.60	13.80	15.94	14.87	49.38	52.49	50.94
T_2	81.18	91.46	86.32	11.91	15.05	13.48	44.62	50.38	47.50
T_3	78.11	90.36	84.23	11.47	13.32	12.39	40.67	49.51	45.09
T_4	68.55	77.59	73.07	11.03	13.61	12.32	41.43	48.88	45.16
T_5	67.42	74.81	71.11	9.33	11.85	10.59	36.85	43.95	40.40
T_6	64.64	72.18	68.41	8.73	9.51	9.12	34.43	43.18	38.80
T_7	76.36	88.31	82.34	11.95	14.21	13.08	44.49	51.01	47.75
T_8	73.28	81.96	77.62	10.84	11.49	11.16	37.78	46.54	42.16
T_9	70.77	79.65	75.21	9.72	9.37	9.55	36.27	45.13	40.70
SEm ±	1.84	2.50	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