Original Research Article

Impact of Organic Manures and Foliar Spray of Moringa Leaf Extract (*Moringa oleifera* L.) on Growth and Yield of Rice Bean [*Vigna umbellata* (Thunb.) Ohwi and Ohashi].

ABSTRACT

A field experiment on rice bean was conducted during *Kharif*, 2021 at SMOF (SHIATS Model Organic Farm), Department of Agronomy, SHUATS, Prayagraj (U.P), India. The soil of the experiment plot was sandy loam in texture, nearly neutral in soil reaction (p^H 7.2), low in organic carbon (0.51%), available nitrogen (230 kg/ha), available phosphorus (17.80 kg/ha) and available potassium (245.10 kg/ha). The foliar spray of *Moringa oleifera* L. extract was applied twice at different concentrations (5.0, 10.0 and 20.0% v/v) with different organic manures (pig manure, goat manure and neem cake) applied at 5 t/ha and control plot with water spray. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. As compared to other treatments, the results disclosed that application of neem cake 5t/ha + 20% moringa leaf extract recorded highest plant height (105.78 cm), nodules per plant at 60 DAS (35.64), branches per plant (20.61), plant dry weight (35.01 g/plant), pods per plant (25.85), seeds per pod (7.45), test weight (50.52 g), seed yield (1.66 t/ha), stover yield (3.72 t/ha), harvest index (30.86 %). Therefore, application of neem cake and foliar application of *Moringa oleifera* L. might be a promising option for yield enhancement of rice bean.

Key words: Pig manure, goat manure, neem cake, moringa leaf extract; growth and yield.

INTRODUCTION

Rice bean [*Vigna umbellata* (Thunb.) Ohwi and Ohashi], also known as climbing bean, mountain bean, oriental bean, haricot bean, red bean, and Jerusalem pea, is a highly branched annual with erector semi-erect stem tending to be viny (Jena *et al*, 2018), grown as pulse, green fodder and green manure. The presumed centre of domestication is Indo-China and is distributed from Southern China through the north of Vietnam, Laos and Thailand into Burma and India (Lawn, 1995). In India, it is known by different vernacular names such as moth, rajmoog and satrangi mash. Rice bean is a multipurpose legume, considered as neglected and underutilized (Joshi *et al.*, 2008). In India, its distribution is mainly confined to the hilly areas of north-eastern hills and the western and eastern ghats. The nutritional quality of rice bean has been reported to be the best among all traditional pulses (Arora *et al.*, 1980).

Rice bean normally grows well in hot and humid climate. It is raised usually as a kharif crop under rainfed conditions and grows well in well-drained light, sandy loam to medium heavy soils. Preferrable annual rainfall ranges from 1000 to 1500 mm and also tolerates drought conditions. Suitable average temperature ranges from 18 to 30°C, tolerates 10-40°C but does not withstand the frost (Rajerison, 2006). If adopted on a large scale, rice bean offers a good scope for increasing future pulse production and reducing protein malnutrition of the vegetarian masses. But attention has not been given much for the development of this crop so far. In this sense, cultivation of rice bean is considered important in contributing food and national security and to utilize uncultivated marginal land and conserving biodiversity (Gautam *et al*., 2007).

Organic manures are plant and animal wastes that are used as sources of plant nutrients in complex organic forms. Nutrients are released by them after decomposition. Organic manures provide a good substrate for the growth of micro-organisms and maintain a favourable nutrient supply environment and improve soil physical-chemical properties (Amruta *et al*., 2015). Swine manure application helps in increase of soil N, P, K, Ca, Mg and Na. Pig manure is reported to be effective in increasing the yields of cereals, legumes, oilseeds, vegetables and pastures, and in increasing plant nutrient concentration, especially N, P and K. (Choudhary *et al*, 1996). Goat manure is rich in nitrogen levels, which makes it an excellent soil conditioner. Goat manure improves soil texture which in turn provides a rich environment for roots to grow as well as allow for excellent water retention.Haridha *et al*, 2020 claimed that combination of goat manure and vermicompost enhanced the yield of

black gram. Neem cake supplies the available nitrogen for a long time in the soil (Katyayan, 2012). Azadirachtin, the primary antifeedant component of neem seed, is highly resistant to attack by numerous species of insects and nematodes (Jacobson, 1986). *Moringa oleifera* extract is rich source of potassium, calcium, iron, ascorbate, amino acids and growth-promoting hormones like zeatin (Fuglie, 1999). Apart from acting as a growth enhancer, moringa leaf extract is environment friendly, cheap, and easily accessible so it can cause a significant increase in crop production (Price, 2007). Therefore, the present investigation is being undertaken to know the impact of organic manures and foliar spray of moringa leaf extract (*Moringa oleifera* L.) on growth and yield of rice bean [*Vigna umbellata (*Thunb.) Ohwi and Ohashi].

MATERIALS AND METHODS

The experiment was carried out during *Kharif* season of 2021 at the SMOF (SHIATS Model Organic Farm), Department of Agronomy, SHUATS, Prayagraj (U.P), India and is situated at 25º24'41.27" N latitude, 81°50'56" E longitude and 98 m altitude above the mean sea level (MSL). The experiment laid out in Randomized Block Design which consisting of ten treatments replicated thrice with different organic manures (pig manure, goat manure and neem cake) applied 5 t/ha and three levels of moringa leaf extract i.e., 5, 10 and 20 percentages with control treatment-water spray (20-40-20 kg/ha).

The experimental site was uniform in topography and sandy loam in texture, nearly neutral in soil reaction (P^H 7.6), low in organic carbon (0.51%), medium available nitrogen (230 kg/ ha), higher available phosphorus (17.80 kg/ ha) and medium available potassium (245.10 kg/ ha). Blanket application of organic manures were applied before sowing in respective prepared plots as per the treatment details before a week of sowing. A control plot with no manure application was also prepared. The seed of rice bean "KBR – I" were sown in the furrow on July, 25th 2021 with constant spacing of 30 cm x 10 cm, each plot of 3m x3m. and 35 kg/ ha seed rate. Moringa leaf extract of 5%, 10% and 20% concentration were sprayed according to the treatment details at 25 and 40 DAS. In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded. The N-P-K content of pig manure, goat manure, neem cake 0.60-0.50-0.40, 3.0-1.0-2.0, 5.2-5.6-1.1-1.5% respectively (Source: Chandrasekaran *et al*, 2010). The growth parameters are plant height (cm), nodules per plant, number of branches per plant and plant dry weight (g) were recorded by taking five plants from border rows aside. The yield parameters like pods per plant, seeds per pod, test weight

(g), seed yield (kg/ha), stover yield (kg/ha) and harvest index were recorded. All the agronomic practices were done as per package of practices of rice bean.

Chemical Analysis of Soil:

To determine the initial soil parameters, composite soil samples are obtained prior to the experiment arrangement. Soil samples were collected from 0-15 cm depth, dried in the shade, powered with a wood pestle and mortar, sieved through a capable 2 mm sieve, and evaluated for organic carbon using quick volumetric analytical method (Nelson and Sommers, 1826). Subbiah and Asija (1956) approximated available nitrogen that use the alkaline permanganate method, available phosphorus that use Olsen's method as outlined by Jackson (1967), available potassium using the flame photometer normal ammonia acetate solution and estimating using the flame photometer (ELICO Model) as outlined by Jackson (1973), and available $ZnSO_4$ using atomic absorption photometer methodology as outlined by Jackson (1973), Lindsay and Norvell (1978).

Statistical Analysis:

The data were statistically analyzed using Fisher's approach of analysis of variance (ANOVA), as reported by Gomez and Gomez (1984). When the significant difference (CD) values were determined, the 'F' test was found to be statistically significant at the 5 % level.

Moringa leaf extract preparation: (Source: Muhammad, 2014).

Moringa leaf extract was prepared by collecting young and disease-free leaves from moringa tree from the university campus, SHUATS, Prayagraj, India. These leaves were washed and then frozen for two days in refrigerator at 4° C. Leaves were grinded in a manual juicer to extract the leaf juice, The juice was collected and filtered by passing through a muslin cloth to remove all the green matter. Aqueous *Moringa oleifera* leaf extract (100%) was diluted with distilled water to prepare solution of different concentrations like 5%, 10% and 20% (v/v) as experiment treatments. The leaf extract of moringa was stored at room temperature for future use.

Table 1. *Moringa oleifera* nutritional value of leaves (fresh vs. powder) analysis in the following per 100 grams of edible portion.

Mineral contents	Fresh leaves	Leaf powder
Moisture (%)	75.0	7.5
Calories (kcal)	92	2.5

Protein (g)	6.7	27.1
Fat (g)	1.7	2.3
Carbohydrate (g)	13.4	38.2
Fiber (g)	0.9	19.2
Minerals (g)	2.3	-
Ca (mg)	440	2003
Mg (mg)	24	368
P (mg)	70	204
K (mg)	259	1324
Cu (mg)	1.1	0.6
Fe (mg)	0.7	28.2
S (mg)	137	870
Oxalic acid (mg)	101	1.60%
Vitamin A- β carotene (mg)	6.8	16.3
Vitamin B- choline (mg)	423	-
Vitamin B_1 – thiamine (mg)	0.21	2.64
Vitamin B_2 – riboflavin (mg)	0.05	20.5
Vitamin B_3- nicotinic acid (mg)	0.8	8.2
Vitamin C – ascorbic acid (mg)	220	17.3
Arginine (g/ 16 g N)	6.0	1.33%
Histidine (g/ 16 g N)	2.1	0.61%

Lysine (G/ 16g N)	4.3	1.32%
Tryptophan (g/ 16g N)	1.9	0.43%
Phenylalanine (G/ 16g N)	6.4	1.39%
Methionine (g/ 16g N)	2.0	0.35%
Threonine (g/ 16g N)	4.9	1.19%
Leucine (g/ 16g N)	9.3	1.95%
Isoleucine (g/ 16g N)	6.3	0.83%
Valine (g/ 16g N)	7.1	1.06%

Source: *Moringa oleifera*: Natural nutrition for the tropics by Fuglie (1999).

RESULTS AND DISCUSSION

The plant height recorded at 20, 40, 60, 80 DAS and at harvest stage are presented in table 2. At harvest, highest plant height (105.78) was recorded with application of neem cake 5 t/ha + 20 % moringa leaf extract was significantly superior over all the other treatments. However, the treatments with application of goat manure 5t/ha + 20% moringa leaf extract (104.79 cm) and neem cake 5t/ha + 10% moringa leaf extract (105.50 cm) were found to be statistically at par with treatment neem cake 5t/ha + 20% moringa leaf extract. The application of neem cake increased the plant height because neem cake act as a nitrogen inhibitor means reduce the nitrification. It supplies the available nitrogen for a long time in the soil which made more available nitrogen to the plants and leads to increase in plant height. The findings were found in accordance with Khangarot *et al*. (2020). Nagar et al. (2006) stated that zeatin (naturally occurring cytokinin), a plant growth hormone, was abundantly found in moringa leaves has substantially increased the growth of plants especially plant height.

Up to the crop age of 60 DAS, there was increase in number of nodules/ plant and kept declining till harvest. The number of nodules per plant recorded at 20, 40, 60, 80 DAS and at harvest are shown in table 3. Application of neem cake 5t/ha + 20% moringa leaf extract recorded highest nodules per plant at 60 DAS (35.64) and was significantly superior over all the treatments. However, the treatments with goat manure 5t/ha + 20% moringa leaf

extract (35.07) and neem cake 5t/ha + 10% moringa leaf extract (35.31) were found to be statistically at par with neem cake 5t/ha + 20% moringa leaf extract. Neem seed cake acts as natural fertilizer with pesticide properties and neem seed cake exhibits insecticidal properties, nitrification retardation and inhibitor of pesticide degradation and it also contains NPK which helped in root proliferation and nodules formation. The findings were found to be similar with Kamal *et al* (2021)**.** Moringa has fast- growing and persistent nature, and produces abundant biomass. Various nutritional benefits can be attained from fresh leaves as they are rich sources of antioxidants, plant metabolites and osmo-protectants that make it a natural tonic for plant growth and a greater number of nodules per plants. Findings were similar with Rady *et al* (2015).

The number of branches per plant recorded at 20, 40, 60, 80 DAS and at harvest stage are demonstrated in table 4. Significantly maximum number of branches per plant (20.61) was recorded at harvest with the treatment neem cake 5t/ha + 20% moringa leaf extract over the other treatments. However, treatments with goat manure 5t/ha + 20% moringa leaf extract (20.31) and neem cake 5t/ha + 10% moringa leaf extract (20.46) were statistically at par with neem cake 5t/ha + 20% moringa leaf extract. Neem cake fertilizer provides adequate supply of nutrients and enhance the vegetative growth of plants like cell elongation, cell division and photosynthesis of plant cells and therefore lead to growth of a greater number of branches. Similar findings by Khangarot *et al*. (2020). Phiri and Mbewe (2010) stated that improvements in crop growth and branches from the influence of zeatin which is a plant growth hormone from the cytokinin group which is found in moringa leaf extract.

Treatment with neem cake 5t/ha + 20% moringa leaf extract recorded significantly maximum dry weight at harvest (35.01 g/plant) over all the treatments (Table 5.). However, the treatments goat manure 5t/ha + 20% moringa leaf extract (34.48 g/plant) and neem cake 5t/ha + 10% moringa leaf extract (34.71 g/plant) which were found to be statistically at par with neem cake 5t/ha + 20% moringa leaf extract. The Neem cake contains NPK (nitrogen-phosphorus-potassium) plus other micro nutrients so plants are fed continually. It helps in prolong supply of plant nutrients to fulfil their nutrient requirements and better vegetative growth which leads to higher biomass accumulation and higher plant dry weight. The results were found to be similar with Toppo and Pal (2018)**.** Foidl *et al* (2001) explained that plants were strengthened, increase of vegetative growth and gain in weight of root and shoot and therefore lead to the increase of dry weight.

The yield attributes and yield of rice bean at harvest as influenced with organic manures and foliar spray of moringa leaf extract (Table 6) represent significantly highest

number of pods/plant (25. 85), maximum number of seeds/ pod (7.45), maximum test weight (50.52 g), maximum seed yield (1.66 t/ha), maximum stover yield (3.72 t/ha), and maximum harvest index (30.86 %) was obtained with the application of neem cake 5t/ha + 20% moringa leaf extract. Neem seed cake performs the dual function of both fertilizer and pesticide, acts as a soil enricher, reduces the growth of soil pest and bacteria, provides macro nutrients essential for all plant growth, helps to increase the yield of plants in the long run, bio degradable, eco-friendly and excellent soil conditioner. This adequate nutrient supply helped plants to attain higher yield. The findings were similar to De et al (2011), Jain and Hasan (1986) and Joshi *et al* (2020). Results of different studies showed that the presence of cytokinin in moringa leaf extract results in larger and greater number of fruits. These results were similar with findings of Foidl et al. (2001).

CONCLUSION

Based on my research trial, the treatment combination of neem cake 5t/ha with 20% moringa leaf extract performed exceptionally in obtaining maximum seed yield of Rice bean. Hence, neem cake 5 t/ha with 20 % moringa leaf extract is useful under eastern Uttar Pradesh conditions.

DISCLAIMER

The products used for this research are commonly and predominantly used products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist**.**

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Table 2. Effect of organic manures and foliar spray of moringa leaf extract on plant height (cm) of rice bean.

Treatments	Plant height(cm)				
	20 DAS	**40 DAS**	**60 DAS**	**80 DAS**	**At Harvest**
1. Pig manure 5t/ha + 5% Moringa Leaf Extract	10.69	33.64	58.31	92.91	101.40
2. Pig manure 5t/ha + 10% Moringa Leaf Extract	10.85	33.91	58.69	92.88	101.73
3. Pig manure 5t/ha + 20% Moringa Leaf Extract	11.42	34.79	60.08	93.93	103.08
4. Goat manure 5t/ha + 5% Moringa Leaf Extract	11.29	34.13	59.13	93.22	102.48
5. Goat manure 5t/ha + 10% Moringa Leaf Extract	12.01	36.48	60.87	95.32	103.71
6. Goat manure 5t/ha + 20% Moringa Leaf Extract	12.10	36.92	61.61	95.82	104.79
7. Neem cake 5t/ha + 5% Moringa Leaf Extract	11.67	35.79	60.22	94.27	103.16
8. Neem cake 5t/ha + 10% Moringa Leaf Extract	12.87	37.43	62.14	96.78	105.50
9. Neem cake 5t/ha + 20% Moringa Leaf Extract	13.23	37.89	62.81	97.85	105.78
10. Control- water spray (20-40-20 kg/ha)	10.13	32.65	57.40	91.07	100.66
F test	NS	S	S	S	S
S. Em. (±)	1.09	0.36	0.41	0.42	0.38
CD (P = 0.05)	-	1.06	1.22	1.26	1.11

Table 3. Effect of organic manures and foliar spray of moringa leaf extract on nodules per plant of rice bean.

Treatments	Nodules/plant				
	20 DAS	**40 DAS**	**60 DAS**	**80 DAS**	**At Harvest**
1. Pig manure 5t/ha + 5% Moringa Leaf Extract	9.53	23.84	33.87	12.92	4.40
2. Pig manure 5t/ha + 10% Moringa Leaf Extract	9.70	24.03	34.06	13.12	4.51
3. Pig manure 5t/ha + 20% Moringa Leaf Extract	10.12	24.58	34.32	13.37	4.75
4. Goat manure 5t/ha + 5% Moringa Leaf Extract	9.87	24.38	34.14	13.24	4.65
5. Goat manure 5t/ha + 10% Moringa Leaf Extract	10.31	25.28	34.93	13.78	5.01
6. Goat manure 5t/ha + 20% Moringa Leaf Extract	10.40	25.66	35.07	14.07	5.07
7. Neem cake 5t/ha + 5% Moringa Leaf Extract	10.19	24.88	34.70	13.65	4.89
8. Neem cake 5t/ha + 10% Moringa Leaf Extract	10.58	25.87	35.31	14.10	5.15
9. Neem cake 5t/ha + 20% Moringa Leaf Extract	10.64	26.13	35.64	14.27	5.35
10. Control- water spray (20-40-20 kg/ ha)	9.07	23.48	33.66	12.77	4.14
F test	NS	S	S	S	S
S. Em (±)	0.22	0.11	0.21	0.08	0.12
CD (P = 0.05)	-	0.33	0.62	0.23	0.35

Table 4. Effect of organic manures and foliar spray of moringa leaf extract on branches per plant of rice bean.

Treatments	Branches/plant				
	20 DAS	**40 DAS**	**60 DAS**	**80 DAS**	**At Harvest**
1. Pig manure 5t/ha + 5% Moringa Leaf Extract	1.99	5.15	12.01	16.46	19.66
2. Pig manure 5t/ha + 10% Moringa Leaf Extract	2.10	5.25	12.09	16.62	19.71
3. Pig manure 5t/ha + 20% Moringa Leaf Extract	2.30	5.53	12.51	16.95	19.94
4. Goat manure 5t/ha + 5% Moringa Leaf Extract	2.28	5.38	12.36	16.69	19.77
5. Goat manure 5t/ha + 10% Moringa Leaf Extract	2.52	5.74	12.71	17.35	20.15
6. Goat manure 5t/ha + 20% Moringa Leaf Extract	2.64	5.93	12.79	17.41	20.31
7. Neem cake 5t/ha + 5% Moringa Leaf Extract	2.40	5.64	12.63	17.14	20.13
8. Neem cake 5t/ha + 10% Moringa Leaf Extract	2.73	5.96	12.94	17.59	20.46
9. Neem cake 5t/ha + 20% Moringa Leaf Extract	2.76	6.14	13.08	17.63	20.61
10. Control- water spray (20-40-20 kg/ ha)	1.81	5.02	11.80	16.01	19.41
F test	NS	S	S	S	S
S. Em (±)	0.21	0.11	0.14	0.08	0.10
CD (P = 0.05)	-	0.33	0.40	0.24	0.30

Table 5. Effect of organic manures and foliar spray of moringa leaf extract on plant dry weight (g/plant) of rice bean.

Treatments	Plant dry weight (g/plant)				
	20 DAS	**40 DAS**	**60 DAS**	**80 DAS**	**At Harvest**
1. Pig manure 5t/ha + 5% Moringa Leaf Extract	1.92	5.72	12.31	23.77	32.64
2. Pig manure 5t/ha + 10% Moringa Leaf Extract	2.04	5.89	12.68	24.03	32.88
3. Pig manure 5t/ha + 20% Moringa Leaf Extract	2.17	6.06	13.23	24.80	33.37
4. Goat manure 5t/ha + 5% Moringa Leaf Extract	2.13	5.93	12.92	24.36	33.14
5. Goat manure 5t/ha + 10% Moringa Leaf Extract	2.33	6.39	13.71	25.42	34.23
6. Goat manure 5t/ha + 20% Moringa Leaf Extract	2.46	6.48	13.96	25.81	34.48
7. Neem cake 5t/ha + 5% Moringa Leaf Extract	2.29	6.15	13.50	25.14	33.90
8. Neem cake 5t/ha + 10% Moringa Leaf Extract	2.49	6.57	14.16	26.04	34.71
9. Neem cake 5t/ha + 20% Moringa Leaf Extract	2.58	6.70	14.28	26.30	35.01
10. Control- water spray (20-40-20 kg/ ha)	1.84	5.45	11.85	22.91	31.83
F test	NS	S	S	S	S
S. Em (±)	0.31	0.07	0.11	0.18	0.18
CD (P = 0.05)	-	0.22	0.32	0.52	0.53

Table 6. Effect of organic manures and foliar spray of moringa leaf extract on yield attributes and yield of rice bean.

Treatments	No. of pods/ plant	Seeds/pod (No.)	Test Weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest Index (%)
1.Pig manure 5t/ha + 5% Moringa Leaf Extract	23.78	6.57	48.44	0.94	3.01	23.79
2. Pig manure 5t/ha + 10% Moringa Leaf Extract	23.90	6.67	49.15	1.02	3.13	24.59
3. Pig manure 5t/ha + 20% Moringa Leaf Extract	24.44	6.94	49.58	1.15	3.27	26.02
4. Goat manure 5t/ha + 5% Moringa Leaf Extract	24.16	6.78	49.37	1.07	3.15	25.35
5. Goat manure 5t/ha + 10% Moringa Leaf Extract	25.24	7.14	50.01	1.38	3.42	28.75
6. Goat manure 5t/ha + 20% Moringa Leaf Extract	25.40	7.19	50.19	1.54	3.55	30.25
7. Neem cake 5t/ha + 5% Moringa Leaf Extract	24.84	7.02	49.81	1.28	3.36	27.64
8. Neem cake 5t/ha + 10% Moringa Leaf Extract	25.58	7.31	50.26	1.58	3.63	30.33
9. Neem cake 5t/ha + 20% Moringa Leaf Extract	25.85	7.45	50.52	1.66	3.72	30.86
10. Control -water Spray (20-40-20 kg/ha)	22.94	6.41	48.09	0.72	2.95	19.62
F test	S	S	S	S	S	S
S. Em (±)	0.17	0.07	0.14	0.04	0.05	0.87
CD (P = 0.05)	0.51	0.02	0.42	0.12	0.15	2.58