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Research Paper

Influence of organic sources of nutrient on mungbean performance in South-Eastern Rajasthan

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ABSTRACT

A field experiment was conducted during the *Kharif* seasons of 2022 and 2023 at the organic farming block of the Agricultural Research Station, Ummedganj, Agriculture University, Kota (Rajasthan), to study the effects of organic sources of nutrient on mungbean growth and yield in the mungbean-wheat cropping system of south-eastern Rajasthan. The experiment included eight treatments: T_1, Absolute control; T_2, 100% N by farm yard manure (FYM) + cow urine @ 10% spray at 15, 30, and 45 days after sowing (DAS); T_3, 100% N by FYM + panchagavya @ 5% spray at 15, 30, and 45 DAS; T_4, 75% N by FYM + 25% N by vermicompost + vermiwash @ 10% spray at 15, 30, and 45 DAS; T_5, 50% N by FYM + 50% N by vermicompost + vermiwash @ 10% spray at 15, 30, and 45 DAS; T_6, 75% N by FYM + jeevamrut @ 500 liters/ha at sowing + vermiwash @ 5% spray @ 15, 30, and 45 DAS; T_7, 100% N by FYM + NPK consortia of biofertilizers + Zinc solubilising bacteria (ZSB) each @ 62.5 ml/kg seed inoculation + amrita sanjeevani @ 500 liters/ha at sowing, 15 and 30 DAS and 75% N by FYM + NPK consortia of biofertilizers @ 62.5 ml/kg seed inoculation + sasyagavya @ 10% spray at 15, 30, and 45 DAS (T_8). The treatments were arranged in a randomized block design with 3 replications. The 2-years pooled results showed that the treatment T_5 produced significantly higher values for plant height (54.62 cm), number of branches/plant (9.65), total number of effective nodules/plant (31.65), fresh and dry weight of root nodules/plant (119.94 mg and 23.98 mg, respectively), number of pods/plant (26.28), number of seeds/pod (9.39), pod length (8.17 cm), test weight (34.99 g), seed yield (1242 kg/ha), and straw yield (2,204 kg/ha) compared to the absolute control. These results were statistically on par with the T_3 and T_7 treatments, and the seed yield was found at par with T_3 in the pooled analysis. Hence, the application of 50% N by FYM and 50% N by vermicompost, along with vermiwash spray, is highly effective mungbean yield in the South Eastern Rajasthan for enhancing.

Key words: FYM, Growth parameters, Mungbean, Organic sources, Vermicompost

Mungbean (*Vigna radiata* L.) ranks as the third most crucial pulse crop in India, cultivated across 3.19 million hectares, resulting in a total production of 3.0 million tonnes and an average productivity of 940 kg/ha (GOI, 2023–24). The primary mungbean-producing states in India include Rajasthan, Madhya Pradesh, Maharashtra, and Bihar. Rajasthan stands out as a significant contributor, producing 11.75 lakh tonnes from 23.32 lakh hectares, with an average productivity of 503 kg/ha (GOI, 2023–24). Mungbean cultivation predominantly occurs in arid and semi-arid regions of Rajasthan, encompassing districts such as Nagaur, Churu, Pali, Ajmer, Jaipur, and some parts of the Vth zone (S-E part of Kota regionMungbean are a source of vitamin C, with 4.8 milligrams of ascorbic acid per 100 grams. Furthermore, they provide essential B vitamins, including 0.621 milligrams of thiamine, 0.233 milligrams of riboflavin, and 2.251 milligrams of niacin. They also contain 1.910 milligrams of pantothenic acid and 114 IU of vitamin A (Khairnar *et al*., 2019).

The excessive utilization of inorganic fertilizers and pesticides, leading to environmental, soil, and water contamination and pest outbreaks, has emerged as a significant concern in recent years. In today's agricultural landscape, there is a growing trend towards organic farming,

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emphasizing a shift from high-volume to high-value production systems. Key management techniques focus on preserving soil health, implementing nutrient supply systems reliant on organic materials rather than chemicals, and adopting integrated pest management strategies. Consequently, the utilization of botanicals and bio-enhancers derived from cows, when combined with organic manures, has emerged as a beneficial approach in organic farming for ensuring a dependable and cost-effective nutrient supply. Organic sources such as farmyard manure (FYM), vermicompost, biofertilizers, and solid and liquid organic manures serve not only as nutrient and organic matter sources but also contribute to enhancing microbial population size, diversity, and activity in the soil. Vermicompost boasts higher levels of organic matter, organic carbon, total and available NPK (nitrogen, phosphorus, and potassium), micronutrients, as well as increased microbial and enzyme activities (Ranganathan, 2006; Parthasarathi *et al*., 2007; Pandey *et al*., 2017; Verma *et al*., 2017).

Panchagavya, a fermented organic product derived from five specific cow-derived substances including cow dung, cow urine, cow milk, cow ghee, and cow curd, alongside additional ingredients such as banana and coconut water, has demonstrated its efficacy as a foliar fertilizer in numerous crops in India (Selvaraj, 2003). The extracted body fluid of earthworms, known as vermiwash, constitutes a valuable nutrient component facilitating optimal plant growth (Gorakh *et al*., 2009). Jeevamrut, an organic solution derived from cow dung, cow urine, pulses flour, jaggery, and soil collected beneath the banyan tree, serves as a potent enhancer of microbial populations, soil fertility, and overall soil productivity (Sharma *et al*., 2023). Additionally, sasyagavya and amrita sanjeevani play pivotal roles in sustainable agriculture by improving microbial populations in the soil, thereby increasing the bioavailability of nutrient content in the soil. Seed inoculation or soil application of NPK consortia of biofertilizers represent microbial formulations containing strains of bacteria capable of synthesizing/assimilating atmospheric nitrogen, as well as solubilizing phosphate and potash into readily available forms, thereby ensuring balanced nutrition for crops. Furthermore, certain PGPR, such as zinc solubilizing bacteria (ZSB), have been identified for their ability to enhance plant growth and development by colonizing the rhizosphere and solubilizing complex zinc compounds into simpler forms. The combined application of these products not only leads to higher yield but also improves soil health. Moreover, NPK consortia and ZSB biofertilizers play a pivotal role in meeting crop nutrient requirements with greater efficiency and addressing nutrient deficiencies in organic production systems. Supply of

Table 1. Effect of various organic nutrient sources on yield attributes of mungbean

Treatment	Growth attributes of mungbean											
	Plant height (cm) at harvesting			Number of branches/plant at harvesting			Total number of effective nodules/plant			Fresh weight of nodules/plant			Dry weight of nodules/plant		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1	39.94	39.47	39.71	6.75	6.60	6.67	22.20	21.48	21.84	80.29	79.94	80.11	16.05	15.98	16.02
T_2	46.79	47.55	47.17	8.10	8.25	8.18	25.82	26.95	26.39	97.72	98.38	98.05	19.54	19.67	19.61
T_3	51.73	53.35	52.54	9.45	9.62	9.53	29.23	29.32	29.28	110.32	112.66	111.49	22.03	22.54	22.29
T_4	49.57	50.73	50.15	8.70	8.89	8.79	26.80	27.91	27.35	103.99	105.64	104.81	20.79	21.11	20.95
T_5	53.51	55.73	54.62	9.57	9.74	9.65	30.48	32.81	31.65	118.83	121.05	119.94	23.76	24.21	23.98
T_6	45.43	47.12	46.28	7.90	8.09	7.99	25.76	26.28	26.02	96.56	97.54	97.05	19.31	19.51	19.41
T_7	50.80	51.89	51.35	9.04	9.22	9.13	28.41	29.97	29.19	109.30	111.59	110.45	21.85	22.32	22.08
T_8	47.68	48.44	48.06	8.30	8.48	8.39	26.79	27.39	27.09	101.39	102.23	101.81	20.27	20.44	20.36
SEm±	1.77	2.15	1.39	0.38	0.42	0.28	1.20	1.56	0.98	4.86	5.11	3.52	0.97	1.02	0.71
CD (P=0.05)	5.38	6.53	4.04	1.14	1.27	0.81	3.64	4.72	2.85	14.73	15.49	10.21	2.95	3.10	2.04

sufficient nutrient through organic sources inorganic farming is the major issue responsible for low yield in conversion period. Combining more than one organic source for supplying nutrients to wheat has been found tobe very effective instead of meeting the nutrient requirement by single source (Meena *et al*., 2024). The current study was conducted to find out the best organic nutrient sample for the profitable mungbean production in South Eastern Rajasthan.

MATERIALS AND METHODS

A field experiment was conducted during the *kharif* season of 2022 and 2023 at organic farming block (field No. 14) at Agricultural Research Station, Ummedganj, Kota and is situated at 25°11' N latitude and 75°50' E longitude at an altitude of 258 m above the mean sea level to study the effects of organic sources on mungbean growth and yield in the mungbean-wheat cropping system of south-eastern Rajasthan**.** The experiment was laid out in randomized block design laid with allocation of treatments in three replications consisted of 8 treatments, *viz*. (T_1) Absolute control; (T_2) 100 % N by Farm Yard Manure (FYM) + cow urine @ 10% spray at 15, 30, and 45 days after sowing (DAS); (T_3) 100% N by FYM + panchagavya @ 5% spray at 15, 30, and 45 DAS; (T_4) 75% N by FYM + 25% N by vermicompost + vermiwash @ 10% spray at 15, 30, and 45 DAS; (T_5) 50% N by FYM + 50% N by vermicompost + vermiwash @ 10% spray at 15, 30, and 45 DAS; (T_6) 75% N by FYM + jeevamrut @ 500 liters/ha at sowing + vermiwash @ 5% spray @ 15, 30, and 45 DAS; (T_7) 100% N by FYM + NPK consortia of biofertilizers + Zinc solubilising bacteria (ZSB) each @ 62.5 ml/kg seed inoculation + amrita sanjeevani @ 500 liters/ha at sowing, 15 and 30 DAS and 75% N by FYM + NPK consortia of biofertilizers @ 62.5 ml/kg seed inoculation + sasyagavya @ 10% spray at 15, 30, and 45 DAS (T_8). The soil of the experimental field was medium black clay loam in texture with a pH of 7.72 and mean bulk density of 1.39 mg/m^3. The soil was medium in organic carbon (0.55), available nitrogen (352.3 kg/ha), phosphorus (50.78 kg/ha), high in available potassium (432.25 kg/ha) and normal in zinc (0.84 mg/kg soil). A seed rate of 20 kg/ha of variety IPM 410-03 (shikha) was used during both the years. FYM (0.5% N, 0.2% P and 0.5% K) was applied 15 days before sowing in mungbean and vermicompost (1.5% N, 0.8% P and 1.0% K) were incorporate just before sowing in mungbean. Jeevamrut and amrita sanjeevani at sowing was applied with first irrigation in mungbean. Liquid organic manure sprayed on mungbean crop at 15, 30 and 45 DAS as per the treatment. The growth parameters of mungbean were assessed by counting the total number of plants/metre row length at 25 DAS and at harvest, and measuring plant height and number of branches from five randomly selected plants at 25 DAS, 50 DAS, and at harvest. Effective nodules per plant were recorded at 40 DAS by uprooting and washing roots, followed by weighing fresh and dry nodules. Post-harvest observations included counting filled pods per plant, seeds per pod, and measuring pod length from five randomly selected plants, along with determining test weight by weighing 1000 seeds. Seed yield, straw yield, and biological yield were calculated from the total biomass harvested, with seed and straw yields expressed in kg/ha. The observations recorded covered various growth attributes such as plant height, number of branches per plant, total number of effective nodules per plant, fresh and dry weight of root nodules per plant, and yield attributes including number of pods per plant, num-

Table 2. Effect of various organic nutrient sources on yield attributes of mungbean

Treatment	Yield attributes of mungbean											
	Number of pods/plant			Number of seeds/pod			Pod length (cm)			Test weight (g)		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1	13.20	12.73	12.97	5.40	5.27	5.33	6.62	6.57	6.59	32.52	32.49	32.50
T_2	17.93	18.27	18.10	7.12	7.67	7.39	6.89	7.18	7.04	33.41	33.96	33.68
T_3	22.67	24.33	23.50	8.51	9.07	8.79	7.39	7.76	7.58	33.92	34.84	34.38
T_4	21.53	22.87	22.20	7.71	8.27	7.99	7.24	7.41	7.33	33.52	34.24	33.88
T_5	26.03	26.53	26.28	9.04	9.73	9.39	7.96	8.38	8.17	34.87	35.11	34.99
T_6	17.87	18.20	18.03	6.53	7.07	6.80	6.80	7.11	6.96	32.66	33.77	33.22
T_7	21.47	23.47	22.47	8.11	8.73	8.42	7.30	7.55	7.43	33.73	34.66	34.20
T_8	19.27	20.27	19.77	7.31	7.87	7.59	6.95	7.22	7.09	33.46	34.17	33.82
SEm±	1.47	1.09	0.92	0.37	0.45	0.29	0.45	0.48	0.33	1.63	1.63	2.03
CD (P=0.05)	4.46	3.30	2.65	1.12	1.37	0.84	NS	NS	NS	NS	NS	NS

ber of seeds per pod, pod length, test weight, seed yield, and straw yield. In order to test the significance of variation in experimental data obtained for various treatment effects, the data were statistically analysed as described by Panse and Sukhatme (1985). The critical differences were calculated to assess the significance of treatment means, wherever the 'F' test was found significant at 5 per cent level of probability.

RESULTS AND DISCUSSION

Growth Attributes

The data indicated that these organic nutrient sources significantly influenced plant height, number of branches per plant, total number of effective nodules per plant, and the fresh and dry weight of root nodules compared to the absolute control (Table 1). Further pooled data showed significantly higher plant height (53.51, 55.73, and 54.62 cm), number of branches/plant (9.57, 9.74, and 9.65), total number of effective nodules/plant (30.48, 32.81, and 31.65), fresh weight (118.83, 121.05, and 119.94 mg), and dry weight (23.76, 24.21 and 23.98 mg) of root nodules/plant of mungbean with the application of 50% N by FYM + 50% N by VC + VW @ 10% spray at 15, 30, and 45 DAS (T_5). These results were on par with the treatments of 100% N by FYM + PG @ 5% spray at 15, 30, and 45 DAS (T_3) and 100% N by FYM + NPK consortia of biofertilizer + ZSB each @ 62.5 ml/kg SI + AS @ 500 liters/ha at sowing, 15, and 30 DAS (T_7) during 2022, 2023, and in the pooled analysis. The increase in growth attributes due to the application of organic sources such as FYM, VC, along with two sprays of VW, enhances the availability of macro and micronutrients and stimulates the activity of beneficial microorganisms in organic crop cultivation (Chaturvedi *et al*., 2010). This enhancement might be linked to FYM, which potentially increases the availability of cytokinins to the shoot. Cytokinins are pivotal in the cell elongation process, either through cell division or enlargement, thereby facilitating faster growth and taller plant height. Similar results have been reported by Patil and Udmale (2016). Similarly, the application of FYM, VC, along with three sprays of VW, may have led to a significant increase in the number of branches/plant. This could be attributed to an accelerated metabolic rate resulting from a balanced supply of all available nutrients. Such conditions likely promoted cell division and elongation, as extensively discussed by Karhale *et al*. (2021). Additionally, the increase in nodulation resulting from the application of organic manure such as FYM, VC, along with two sprays of VW, may be associated with its effects on the availability of macro and micronutrients in the soil, moisture supply, or the improvement of soil struc-

Table 3. NPK fertilization done in different treatments

Treatment	Farmyard manure			Vermicompost			Panchgavya			Vermiwash			Cow urine			Jeevamrut			Sasyagavya			Amritasanjeevani			Total Applied		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Nutrient content (%)	0.5	0.25	0.5	1.5	0.8	1	0.78	0.2	0.33	0.01	1.7	0.0026	0.97	0.08	1.1	1.97	0.17	0.3	0.43	0.14	0.43	0.87	0.37	0.27			
T_1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_2	20	10	20										0.65	0.12	1.7										20.65	10.12	21.7
T_3	20	10	20				0.58	0.15	0.25																20.58	10.15	20.25
T_4	15	7.5	15	5	2.66	3.33				0.015	2.55	0.0034													20.015	12.71	18.3334
T_5	10	5	10	10	5.33	6.66				0.015	2.55	0.0034													20.015	12.88	16.6634
T_6	15	7.5	15							0.009	1.27	0.0019				9.85	0.85	1.5							24.859	9.62	16.5019
T_7	15	7.5	15																			4.35	1.85	1.35	19.35	9.35	16.35
T_8	20	10	20																0.64	0.21	0.65				20.64	10.21	20.65

ture, thereby creating a more conducive environment for nodulation (Rurangwa *et al*., 2018).

Yield Attributes

The results (Table 2) revealed that the application of various organic nutrient sources significantly influenced the yield attributes of mungbean. Both the yearly data and pooled analysis indicated that the application of 50% N by FYM + 50% N by VC + VW @ 10% spray at 15, 30, and 45 DAS (T_5) resulted in a significantly higher number of pods per plant (26.03, 26.53, and 26.28) and number of seeds per pod (9.04, 9.73 and 9.39) compared to other treatments. This was followed by the treatments 100% N by FYM + PG @ 5% spray at 15, 30, and 45 DAS (T_3) and 100% N by FYM + NPK consortia of biofertilizer + ZSB each @ 62.5 ml/kg SI + AS @ 500 liters/ha at sowing, 15, and 30 DAS (T_7). Pod length (7.96, 8.38, and 8.17 cm) and test weight (34.87, 35.11, and 34.99 g) were also highest in the T_5 treatment during individual years and pooled data, though not at significant levels.

Organic manures enhance the nutrient balance and maintain soil fertility, leading to increased N uptake and photosynthetic activity. This overall growth and development are reflected in yield-contributing characters, which positively correlate with the final crop yield. Yield is the synthesis and outcome of physiological and biochemical processes (Avasthi, 2020). Moreover, liquid organic manure in combination with solid organic manures showed an additive effect on yield attributes, likely due to the stimulatory effect of liquid organic manure on physiological processes such as respiration activities, cell division, and various enzyme activities. It also plays a crucial role in regulating photosynthetic carbon reduction. The higher yield attributing characters in the aforementioned treatments are a consequence of the higher availability of all essential nutrients in balanced proportions, increased rate of photosynthesis, and efficient translocation of photosynthates from the source (leaf and stem) to the sink (pods), leading to a significant improvement in sink size (number of pods). These findings align with those of Rathod *et al.* (2015), Shivran *et al*. (2017), Yadav *et al*. (2017), and Chongre *et al*. (2019). The increase in pods per plant might be due to the availability and optimum supply of nutrients from FYM and foliar spray of vermiwash, which favorably influenced flowering and seed formation, ultimately increasing the number of pods per plant and seeds per pod.

Yield

The results revealed that the application of various organic nutrient sources significantly influenced the grain yield of mungbean (Fig. 1). The treatment involving 50% N from FYM + 50% N from VC + VW @ 10% spray at 15, 30, and 45 DAS (T_5) resulted in significantly higher seed yield (1243 kg/ha), straw yield (2204 kg/ha), and biological yield (3447 kg/ha) on pooled basis as compared to other treatments. These results were statistically comparable to the treatments 100% N by FYM + PG @ 5% spray at 15, 30, and 45 DAS (T_3) for seed and straw yield. The next best treatment, 100% N by FYM + PG @

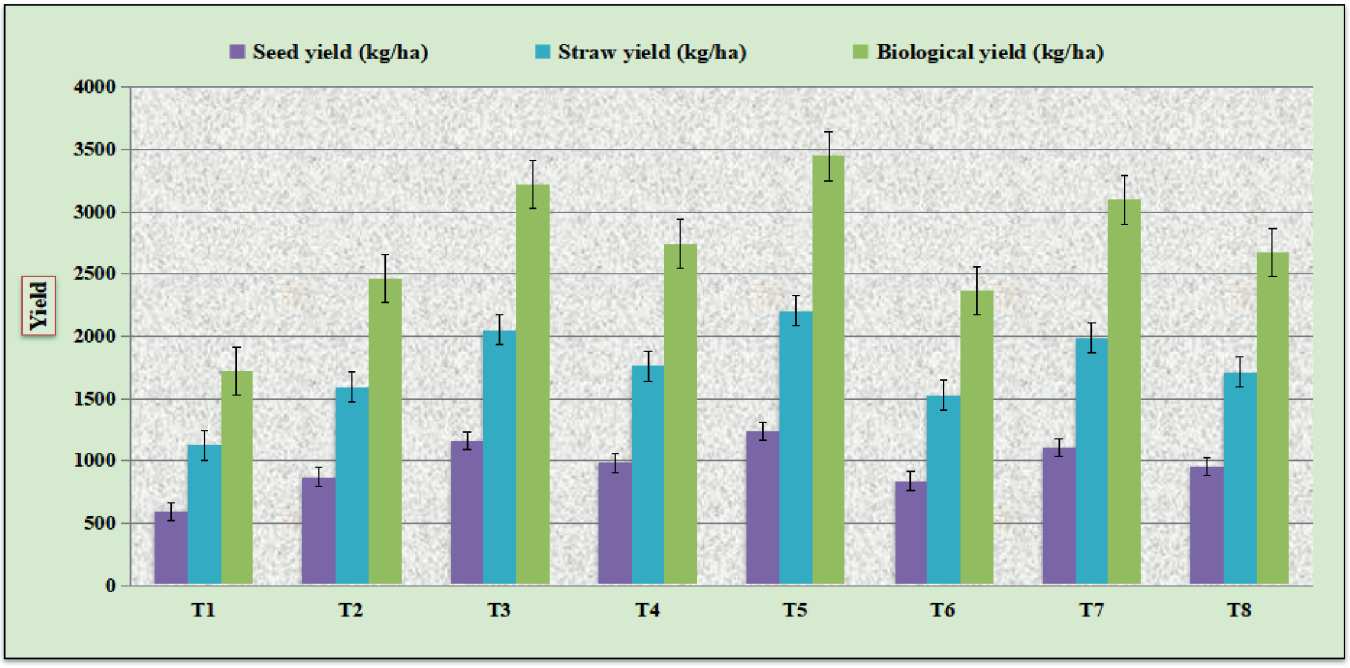

Fig. 1: Yields of mungbean as influenced by various treatment of organic nutrient sources (pooled of 2 years)

5% spray at 15, 30, and 45 DAS (T_5), also recorded significantly higher yields compared to other treatments and was statistically comparable to 100% N by FYM + NPK consortia of biofertilizer + ZSB each @ 62.5 ml/kg SI + AS @ 500 liters/ha at sowing, 15, and 30 DAS (T_7). The higher yield observed in these treatments can be attributed to the increased availability of N and P, as well as micronutrients, through the application of FYM. The slow release of nutrients from decomposed organic matter, improved soil structure due to organic matter application, and significant nitrogen fixation from more root nodules contributed to enhanced plant growth and yield attributes. These findings are in agreement with those reported by Prakasham *et al*. (2019).

Furthermore, the addition of vermicompost provided a balanced supply of nutrients over a longer period and played a crucial role in enhancing the physico-chemical and biological properties of the soil, creating a favorable soil environment that ultimately resulted in higher yields. The beneficial influence of vermiwash on vegetative development (e.g., number of branches per plant) and reproductive growth (e.g., pods, seeds, and test weight) were essential yield parameters with a strong positive association with seed and straw yield. Similar findings were also reported by Joshi *et al* (2023).

The two-year field experiment underscored the significant impact of organic sources on mungbean growth and yield within the mungbean-wheat cropping system of southeastern Rajasthan. The application of 50% N by Farm yard manure + 50% N by vermicompost + vermiwash @ 10% spray intervals at 15, 30, and 45 DAS (T_5) exhibited the most favourable results. These findings highlight the potential of organic amendments for fostering sustainable mungbean cultivation practices in the region.

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