Current Horticulture **14**(1): 80–84, January–March 2026
DOI: 10.5958/2455-7560.2026.00013.1
Received: 10 December 2025; Revised: 07 March 2026; Accepted: 15 March 2026

Assessment of liquid bio-botanicals on growth and yield of okra (*Abelmoschus esculentus*) under south- eastern region of Rajasthan

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Abstract

A field experiment was conducted during *kharif* seasons of 2022 and 2023, at Agricultural Research Station, Ummedganj, Kota, Rajasthan, to evaluate the effects of various liquid bio-botanicals on growth and yield of okra (*Abelmoschus esculentus* L.) under the agroclimatic conditions of south- eastern Rajasthan. The randomized block design with three replications and ten treatments: control (T_0), vermiwash spray (10%) at 30, 45, and 60 days after sowing (DAS) (T_1), jeevamrut (500 L/ha) at sowing and at 30, 45, and 60 DAS (T_2), cow urine spray (10%) (T_3), panchagavya spray (5%) (T_4), amritpaani (500 L/ha) (T_5), and combinations was used. The integrated application of jeevamrut and amritpaani (500 l/ha each at sowing), along with foliar sprays of panchagavya (5%) and vermiwash (10%) at 30, 45, and 60 DAS, significantly enhanced plant height, number of leaves, and number of branches compared to the control. This treatment also reduced days to first picking and improved fruit length, fruit weight and number of pickings. Further, it recorded higher gross returns, net returns, and benefit-cost ratio over other treatments. Thus, the integrated use of liquid bio-botanicals is a promising strategy for improving okra productivity and farm profitability under organic production systems in southeastern Rajasthan.

Key words: Bio-botanicals, Jeevamrut, Panchagavya, Vermiwash, Amritpaani, Organic farming

Okra (*Abelmoschus esculentus* L.), belonging to the family Malvaceae, is an important vegetable crop widely cultivated in tropical and subtropical regions. The crop possesses a chromosome number of 2n = 130 and is believed to have originated in Ethiopia. In India, okra is one of the most economically significant vegetable crops due to its wide adaptability, high nutritional value, and continuous market demand. Organic farming systems generally depend on bulky organic manures. The liquid organic formulations have recently gained considerable attention in organic farming. They promote growth and yield, and contribute to improving soil quality and microbial activity, thereby strengthening the sustainability of organic production systems (Mahanta and Dhar, 2021).The FYM plays a crucial role in maintaining soil fertility, improving soil physical properties, and enhancing microbial activity in alternative agricultural systems (Jarvan *et al.*, 2017). Panchagavya, has positive influence on crop growth, yield, and overall plant health (Tharmaraj *et al.*, 2011; Vallimayil and Sekar, 2012).

Similarly, jeevamrut enhances soil microbial activity and improves nutrient availability to crops, thereby supporting plant growth and productivity. Vermiwash acts as a bio-stimulant that promotes crop growth, enhances plant vigour, and improves resistance to environmental stresses (Shivasubarmanian and Ganeshkumar, 2004). Likewise, amritpani has been reported to exhibit synergistic effects with beneficial microorganisms such as mycorrhiza and organic formulations like panchagavya, improving crop performance and overall productivity (Sakubai *et al.,* 2014).Therefore, an experiment was conducted to evaluate the effect of different liquid bio-botanicals on yield of okra under organic production conditions.

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MATERIALS AND METHODS

The field experiment was conducted during the *kharif* seasons of 2022 and 2023 at the Agricultural Research Station, Ummedganj, Kota, Rajasthan, India. The experimental site is located at 25°11′ N latitude and 75°50′ E longitude and falls under Agro-Climatic Zone V (Humid South-Eastern Plain) of Rajasthan and Zone VIII (Central Plateau and Hills) of India. The okra variety 'Pusa Bhindi-5' was used as the test crop in both years. The soil of the experimental field was medium clay loam, deep, well-drained, and slightly alkaline in reaction with a pH of 7.70. Farmyard manure (FYM) containing approximately 0.5% N, 0.2% P, and 1.0% K was applied and incorporated into the soil 15 days before sowing of okra seeds. Jeevamrut was applied at a rate of 500 L/ha at the time of sowing along with the first irrigation. Liquid organic formulations were applied to the crop at 30, 45, and 60 days after sowing (DAS) as per the treatment schedule.

The experiment was conducted in a randomized block design (RBD) consisting of ten treatments with three replications, with each experimental plot comprising

five rows. The data recorded for different growth and yield parameters were subjected to statistical analysis to determine the significance of treatment effects.

Panchagavya solution (5%) was prepared by diluting 500 ml of well-fermented and filtered Panchagavya in 10 L of water. The prepared solution was applied as a foliar spray at 30, 45, and 60 days after sowing (DAS) according to the respective treatments. The spray solution was applied uniformly using a knapsack sprayer at a rate equivalent to 500 L/ha. Jeevamrut was applied to the soil at the time of sowing at a rate of 500 L/ha. The application was carried out when the soil was adequately moist to facilitate better microbial activity and nutrient availability. Jeevamrut was also applied along with irrigation water in the okra crop as per the treatment schedule. Amritpani was applied as a soil drench at 30, 45, and 60 DAS along with irrigation water to ensure proper infiltration and distribution in the root zone. Vermiwash solution (10%) was prepared by diluting 1000 ml of filtered vermiwash in 10 L of water. The solution was applied as a foliar spray at 30, 45, and 60 DAS using a knapsack sprayer, according to the treatment combinations in the okra crop. All foliar applications were carried out during the morning hours to ensure maximum absorption and to minimize evaporation losses.

To determine the initial fertility status of the experimental soil, composite soil samples were collected prior to sowing from random locations across the field (at least five spots) at a depth of 0–15 cm using a screw-type soil auger. The collected samples were analyzed to determine the physico-chemical properties of the soil. The data were recorded on plant height (cm), number of leaves per plant, and number of branches per plant at 20, 40, and 60 DAS, as well as at the final harvest. Yield attributes such as fruit length (cm), fruit weight (g), days to first picking, and number of pickings were also recorded.

The pooled data were analyzed using the standard analysis of variance (ANOVA) procedure applicable to a randomized block design. The significance of variation among treatments was tested using the F-test at the appropriate probability level. Wherever the treatment effects were found to be significant, the critical difference (CD) was calculated to compare the treatment means. The statistical analysis was performed following the methods described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

A analysis of data on plant height and the number of leaves per plant, influenced by various liquid organic manures, revealed significant enhancements in these parameters at different growth stages (20, 40, and 60 days after sowing) (Table 1). This improvement was particularly notable with the application of T_9 (jeevamrut @500 litres/ha at sowing + amritpaani @500 litres/ha at sowing + foliar spray of panchagavya 5% + foliar spray of vermiwash 10% at 30, 45, and 60 DAS). However, at the last harvest stage, there was no significant difference among all treatment groups, although there was a marked increase compared to the control. In case of the number of branches per plant, significant changes in among the treatments and as well as from control treatment was recorded at 20, 40, and 60 DAS and at the final harvest.

A critical analysis of the data on fruit length, fruit weight (g), days taken to picking and number of pickings as influenced by various liquid organic manures, revealed significant enhancements in these parameters in 2022, 2023 and pooled analysis (Fig. 1). This improvement was particularly notable with the application of T_9 (jeevamrut @500 litres/ha at sowing + amritpaani @500 litres/ha at sowing + foliar spray of panchagavya 5% + foliar spray of vermiwash 10% at 30, 45, and 60 DAS).

The influence of liquid organic manures on economic parameters was found to be significant across both years of study (2022 and 2023) as well as in the pooled analysis. The highest pooled values for gross return, net return,

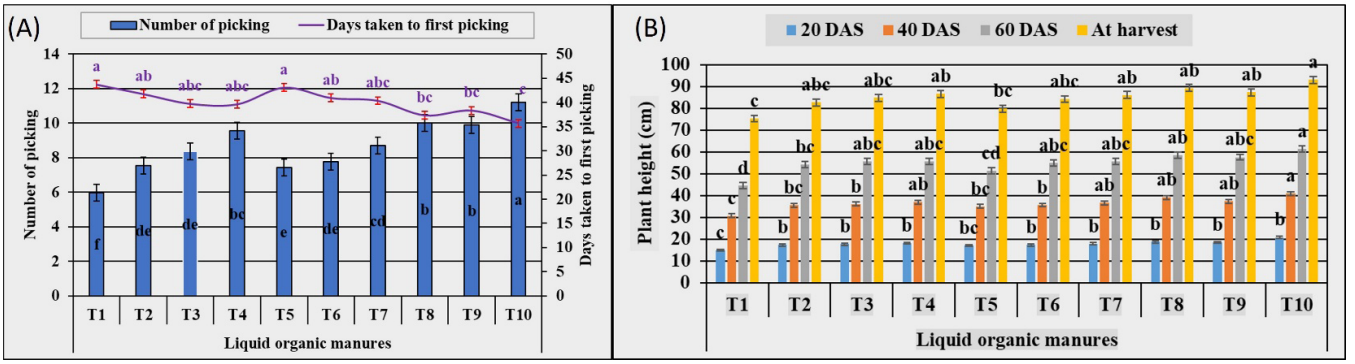

Fig. 1: Effect of different liquid organic manure treatments on (A) days taken to first picking and number of pickings in okra, and (B) height of okra at different stages

Tabel 1. Effect of liquid organic manures on the economics of various treatment combinations used in okra

Treatment	Cost of cultivation (₹/ha) (A)			Estimated yield (q/ha) (B)			Gross return (₹/ha) C= (B×price*)			Net return (₹/ha) D= (C-A)			Net return due to treatment combinations (₹/ha) (E)			B:C ratio F= (D/A)		
	2022	2023	Average	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_0	60715	64315	62515	77.41	79.53	78.47	154813	174972	164892	94098	110657	102377	0	0	0	1.55	1.72	1.64
T_1	63415	67315	65365	82.20	87.12	84.66	164406	191667	178036	100991	124352	112671	6892	13695	10294	1.59	1.85	1.72
T_2	61865	65565	63715	90.88	94.10	92.49	181769	207014	194391	119904	141449	130676	25805	30792	28299	1.94	2.16	2.05
T_3	64165	68065	66115	98.46	101.98	100.22	196924	224353	210638	132759	156288	144523	38661	45631	42146	2.07	2.30	2.18
T_4	62815	66715	64765	80.92	83.35	82.13	161832	183367	172599	99017	116652	107834	4918	5996	5457	1.58	1.75	1.66
T_5	67915	71815	69865	89.10	90.71	89.90	178195	199557	188876	110280	127742	119011	16181	17085	16633	1.62	1.78	1.70
T_6	64315	68215	66265	93.78	98.91	96.35	187553	217610	202582	123238	149395	136317	29139	38739	33939	1.92	2.19	2.05
T_7	64565	68565	66565	104.66	110.08	107.37	209319	242177	225748	144754	173612	159183	50655	62955	56805	2.24	2.53	2.39
T_8	63965	67965	65965	101.81	104.26	103.03	203613	229364	216488	139648	161399	150523	45550	50742	48146	2.18	2.37	2.28
T_9	73765	77965	75865	119.59	128.33	123.96	239175	282331	260753	165410	204366	184888	71312	93709	82511	2.24	2.62	2.43

*Selling price of okra, ₹20/kg in 2022 and ₹22/kg in 2023.

and benefit-cost (B:C) ratio were recorded under treatment T_9, which included the application of jeevamrut (500 L/ha) and amritpaani (500 L/ha) at sowing, along with foliar sprays of panchagavya (5%) and vermiwash (10%) at 30, 45, and 60 days after sowing (DAS). In contrast, the lowest values for all economic parameters were observed in the control (T_0). The superior economic performance of T_9 may be attributed to higher okra yields, especially in 2023, which also saw better market prices. Moreover, application of liquid organic manures appeared to reduce disease incidence, thereby protecting crop yield despite higher input costs. These higher returns ultimately compensated for increased expenditure. The findings align with previous research by Akhtar *et al.* (2018), Patel *et al.* (2018), Parewa *et al.* (2021), Radwan *et al.* (2021), and Kumawat *et al.* (2022), which reported improved economic outcomes due to increased productivity and the cost-effective nature of organic inputs.

The Influence of liquid organic manures on plant height, number of leaves and number of branches was recorded as significant during both the years of investigation, over the control. The increase in plant height was due to improved soil chemical and physical characteristics under manure application. Plants responded to the improved conditions under manure. The significant increase in total yields in manured plots might also be attributed to the increasing branching.

The maximum pooled value of fruit length, fruit weight and number of pickings while, shortened days taken to pickings were observed under T_9 treatment (*i.e.* jeevamrut @500 litres/ha at sowing + amritpaani @500 litres/ ha at sowing + foliar spray of panchagavya 5% + foliar spray of vermiwash 10% at 30, 45 and 50 das). in, okra more branching accounts for increasing number of pickings as pod developed in the axil of every branch once flowering has begun. similarly, the significant changes in fruit length, fruit weight is due to difference in soil structure and fertility. another possible reason for this might be due to that cow dung in jeevamrut acts as a media for the growth of beneficial microorganisms and cow urine provides nitrogen which is essential for crop growth upon fermentation with other ingredients in jeevamrut. These results are in consonance with findings of Siddappa (2015) in field bean, Basavaraj Kumbar (2016).

The analysis of data revealed that application of different liquid organic manures significantly influenced plant growth parameters of okra during both the years of study and in the pooled analysis (Table 1). Growth attributes such as plant height, number of leaves per plant, and number of branches per plant were significantly affected by the treatments at different growth stages (20, 40, and 60 days after sowing).

Among various treatments, combined application of T_9 (jeevamrut @ 500 L/ha at sowing + amritpaani @ 500 L/ha at sowing + foliar spray of panchagavya 5% + foliar spray of vermiwash 10% at 30, 45, and 60 DAS) recorded the highest values for plant height and number of leaves per plant at all observed growth stages. However, at the final harvest stage, the differences among the treatments were statistically non-significant, although all treated plots showed comparatively higher values than the control. This suggests that the application of liquid

organic manures had a more pronounced effect during the early and mid-growth stages of the crop.

Similarly, number of branches per plant was significantly influenced by the different treatments at 20, 40, and 60 DAS as well as at the final harvest stage. The maximum number of branches per plant was recorded under treatment T_9, whereas the lowest values were observed in the control treatment (T_0). Increased branching in okra is particularly important because it contributes to the development of more flowering sites, which ultimately enhances yield potential.

The improvement in growth parameters under liquid organic manure treatments may be attributed to enhanced nutrient availability, improved soil microbial activity, and better soil physical conditions. Organic formulations such as jeevamrut and panchagavya are known to contain beneficial microorganisms, enzymes, and plant growth-promoting substances, which stimulate plant metabolism and vegetative growth. Additionally, the foliar application of liquid formulations such as panchagavya and vermiwash may have facilitated rapid nutrient absorption through leaves, thereby improving physiological efficiency and vegetative growth of the crop.

The data indicate that different liquid organic manure treatments significantly influenced yield attributes of okra, including fruit length, fruit weight, days to first picking, and number of pickings during both years (2022 and 2023) as well as in the pooled analysis (Fig.1).The treatment T9 (jeevamrut @ 500 L/ha at sowing + amritpaani @ 500 L/ha at sowing + foliar spray of panchagavya 5% + foliar spray of vermiwash 10% at 30, 45, and 60 DAS) consistently recorded the highest fruit length, fruit weight, and number of pickings, along with comparatively fewer days required for first picking. In contrast, lowest values for these yield parameters were observed under the control treatment (T_0).

The higher fruit length and fruit weight under treatment T_9 may be attributed to improved nutrient availability and enhanced plant vigour resulting from the combined application of soil-applied and foliar organic formulations. Jeevamrut, which contains fermented cow dung, cow urine, pulse flour, and jaggery, serves as a rich source of beneficial microorganisms and nutrients that enhance soil biological activity and nutrient mineralization. Cow dung present in jeevamrut acts as a medium for microbial proliferation, while cow urine provides nitrogen and other essential nutrients that support plant growth. These processes may have contributed to improved nutrient uptake and better development of reproductive structures.

Furthermore, increase in number of pickings under treatment T_9 could be associated with the higher number of branches observed in the same treatment. In okra, fruits develop in the axils of leaves and branches once flowering begins; therefore, increased branching directly contributes to higher fruit production and extended harvesting duration. Improved soil fertility and soil structure under organic manure treatments may also have supported better root development and nutrient uptake, thereby enhancing fruit development and overall productivity.

The results are consistent with the findings reported by Siddappa (2015) in field bean and Basavaraj Kumbar (2016), who also observed improved growth and yield attributes with the application of organic liquid formulations.

The application of liquid organic manures significantly influenced the economic returns from okra cultivation during both the experimental years and in the pooled analysis. Among the treatments, T_9 recorded the highest gross return, net return, and benefit–cost (B:C) ratio, while the control treatment (T_0) recorded the lowest economic returns. The superior economic performance of treatment T9 can be attributed primarily to the higher fruit yield obtained under this treatment. The improved growth and yield attributes resulting from the combined application of jeevamrut, amritpaani, panchagavya, and vermiwash ultimately translated into greater marketable yield and higher returns to the growers.

Although the application of multiple organic inputs slightly increased the cost of cultivation, the additional yield obtained under this treatment compensated for higher input costs and resulted in improved profitability. Another possible factor contributing to the higher economic returns under organic treatments could be the improved plant health and reduced disease incidence often observed in crops receiving organic amendments. Enhanced microbial activity and improved soil health under organic management practices may have strengthened plant resilience against environmental stresses, thereby protecting yield potential.These results are consistent with earlier findings reported by Akhtar *et al.* (2018), Patel *et al.* (2018), Parewa *et al.* (2021), Radwan *et al.* (2021), and Kumawat *et al.* (2022), who also observed improved economic returns in vegetable crops with the use of organic inputs due to enhanced productivity and relatively lower input costs compared to conventional practices.

CONCLUSION

The application of liquid organic manures significantly improved the growth, yield attributes, and economic returns of okra. Among the treatments, the combined application of jeevamrut (500 L/ha) and

amritpani (500 L/ha) at sowing along with foliar sprays of panchagavya (5%) and vermiwash (10%) at 30, 45, and 60 DAS (T_9) produced the best results in terms of plant growth, fruit and yield parameters.

Conflict of Interest Statement

The authors declare no conflict of interest

ACKNOWLEDGEMENTS

The authors are grateful to the JDR and Agriculture University Kota, Kota, Rajasthan, for providing the necessary facilities and support to conduct the present research work.

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