

ORIGINAL ARTICLE

Influence of Organic Manures and Bio-stimulants on Growth, Yield and Economics of Onion CV. Nasik Red

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ABSTRACT

Background: Onion (*Allium cepa* L.) is a vital vegetable crop in India, significantly contributing to domestic consumption and exports. Sustainable agricultural practices, incorporating organic manures and bio-stimulants can enhance crop productivity, soil and environmental health and economic returns.

Aim: The aim of the investigation was to evaluate the impact of different types of organic manures and bio-stimulants on onion growth, yield, quality and soil health under organic cultivation.

Objectives:

1. To study the effect of different nutrient sources on growth, yield and quality of onion.
2. To find out the soil qualities under different organic nutrient sources.
3. To work out the comparative economics of organic onion cultivation.

Material: The experiment was laid out in split-plot design with three replications during the winter season of 2021–2022 at UBKV, West Bengal. Three levels of organic manures (farmyard manure, vermicompost, poultry manure) and five bio-stimulants (seaweed extract, humic acid, vermiwash, jeevamrutha, and liquid mustard cake) were evaluated for different growth parameters, yield attributes, soil properties and economic return.

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Result: The results showed that enriched farmyard manure (20 t/ha) significantly improved plant growth, bulb yield (21.71 t/ha) as well as quality attributes such as dry matter, TSS and ascorbic acid content. Among bio stimulants, foliar application of seaweed extract (0.3%) resulted in the highest yield (21.53 t/ha) and enhanced soil properties. The combination of enriched farmyard manure and seaweed extract recorded the highest bulb yield (24.36 t/ha) and economic return (B:C ratio of 2.72).

Conclusion: The integration of enriched farmyard manure (20 t/ha), combined with bio-stimulants like seaweed extract (0.3%), significantly enhanced onion growth, yield, quality and economic returns, making organic onion cultivation a viable and sustainable alternative to conventional farming. Organic amendments contribute to better nutrient availability, improved plant vigour, and reduced dependency on synthetic fertilizers.

KEYWORDS

• Organic manure • Bio-stimulant • Organic cultivation • Onion yield and quality

INTRODUCTION

Onion (*Allium cepa* L.) is an essential daily used bulbous vegetable crops of India. The bulb is a source of macro and micronutrients, vitamin and minerals. A unique trait of onion is its characteristic sulphurous aroma, which contributes significantly to its culinary applications (Thakur *et al.*, 2018). The volatile compound allyl propyl disulphide is responsible for the pungency in onion. It is estimated that 100 g of onion bulb contains around 501 µg vitamin A, 0.03 mg of thiamine, 0.04 mg of riboflavin, 0.02 mg of niacin and 9 mg of ascorbic acid as well as the carbohydrates which contribute to dry matter content of the bulb (Ismil and Ali Besar, 2025). Globally India is the leader of onion production followed by China, USA, Turkey, Pakistan. India contributes around 25 % of global onion production. In India, onion cultivation is predominantly concentrated in the states of Maharashtra, Gujarat, Karnataka, Tamil Nadu, and Andhra Pradesh. Onion cultivation in West Bengal is gaining popular due to favourable soil and climatic condition for onion cultivation as well as higher market price of harvested produce. The demand for organically grown onion is steadily rising in both domestic and international markets. Owing to high dry matter content, free from any type of residual toxicity, encourage the buyers to select organic onion. In organic cultivation supply of nutrients is only permissible through organic sources. Traditional organic manures are poor in nutrient content and mineralization rate is very slow therefore,

desirable yield cannot be achieved (Priya *et al.*, 2024). To make the organic cultivation popular, alternate organic nutrient sources should be explored. Therefore, combined use of enriched organic manures and liquid organic inputs are promising practices for enhancing crop growth and yield as well as improving soil health (Yürürdurmaz, 2022). Sustainable nutrient sources are like enriched manure, compost, green manure and animal manure are used to provide essential nutrients to crops in a natural and sustainable way. Enrichment of organic manures with biofertilizers results in increased microbial population as well as available nitrogen, phosphorous, potassium content and enzyme activity of the manures (Sindhu *et al.*, 2020). The mineralization rate of most of organic manures are very slow which releases nutrients throughout growth period. As onion is long duration crop as bulb matures in about 120-150 days hence slow nutrient releasing organic manures will be more effective for organic cultivation. The demand for chemical free onion bulb is increasing in India and abroad. Hence, the present experiment was conducted to study the influence of different enriched organic manures and bio-stimulants on organic onion cultivation.

MATERIALS AND METHODS

The present study was carried out in the winter season of 2021–2022 at Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India, located at 26°19' N latitude, 89°23' E longitude, and an elevation of 43 meters above mean sea level (MSL). The research plot

soil belongs to the Teesta alluvial plain group and has a sandy loam texture with a low water retention capacity and a medium fertility status. The pH level was naturally acidic. The experiment was laid out in Split plot design with three replications and cv. Nasik Red was used in experiment. Factor A (Main plot factor) was 3 levels of enriched organic manure viz., A1-FYM (Farmyard manure-20t/ha)+Azophos Biofertilizer, A2-Vermicompost (5 t/ha) + Azophos Biofertilizer, A3-Poultry manure (5t/ha)+ Azophos Biofertilizer applied as basal and Factor B (sub-plot factor) was 5 levels of Bio-stimulant applied as foliar spray At 15,30, 45, and 60 Days after transplanting, it includes B1-Seaweed extract (0.3 percent) B2-Humic acid (0.3 percent), B3-Vermiwash (3 percent), B4-Jeevamrutha (3 percent), B5-Liquid mustard cake (3 Percent). The details of the treatments were given as fifteen treatments combinations comprising of some enriched organic manures and bio-enhancers viz., T1: Farm yard manure + Azophos Biofertilizer + Seaweed extract T2: Farm yard manure + Azophos Biofertilizer + Humic acid, T3: Farm yard manure + Azophos Biofertilizer + Vermiwash, T4: Farm yard manure + Azophos Biofertilizer + jeevamrutha, T5: Farm yard manure + Azophos Biofertilizer + Mustard cake extract, T6: Farm yard manure + Azophos Biofertilizer + Seaweed extract, T7: Vermi compost + Azophos Biofertilizer + Humic acid, T8: Vermicompost + Azophos Biofertilizer + Vermiwash, T9: Vermicompost + Azophos Biofertilizer + Jeevamrutha T10: Vermicompost + Azophos Biofertilizer + Liquid mustard cake, T11: Vermicompost + Azophos Biofertilizer + Seaweed extract, T12: Vermicompost + Azophos Biofertilizer + Humic acid, T13: Poultry manure + Azophos Biofertilizer + vermiwash, T14: Poultry manure + Azophos Biofertilizer + Jeevamrutha, T15: Poultry manure +

Azophos Biofertilizer + Liquid mustard cake. The different observations were recorded according to standard practices (table 1-7) and the data were statistically analysed (Panse and Sukhatme, 1978).

RESULT AND DISCUSSION

Growth and Yield Parameters of Onion as influenced by Organic Manures and Bio stimulants

The growth and yield attributes of onion at harvest were markedly influenced by the application of organic manures, as presented in Tables 1 to 7. Among different organic manures, enriched farmyard manure (20 t/ha) recorded the highest plant height (70.95 cm), number of leaves (9.23), leaf length (58.56 cm), leaf width (2.27 cm), leaf girth (6.14 cm), polar diameter (4.75 cm), equatorial diameter (5.98 cm), neck thickness (1.45 cm), harvesting index (73.71), average bulb weight (86.16 g) and yield (21.71 t/ha) whereas the minimum days to maturity (125.29) were observed with enriched poultry manure (5 t/ha). In terms of quality, enriched farmyard manure (20 t/ha) resulted in the highest dry matter (15.11 g/100 g), TSS (13.26°B), ascorbic acid content (13.34 mg/100 g) and total sugar content (9.56%). The superior growth and yield observed with enriched farmyard manure (20 t/ha) may be attributed to its slow and sustained nutrient release, enhanced microbial activity and improved soil structure. The higher organic matter content likely contributed to better water retention, aeration and nutrient availability, leading to enhanced root development and overall plant vigour. Additionally, farmyard manure provides a balanced supply of macro- and micronutrients, promoting efficient photosynthesis and assimilate partitioning (Choudhary *et al.*, 2022).

Table 1: Influence of enriched organic manure and bio-stimulants on plant height and number leaves of onion

Particulars	Plant height (cm)	Number of leaves	Particulars	Plant height (cm)	Number of leaves
	Organic manure (A)				
FYM (A ₁)	70.95	9.23	A ₁ B ₂	68.72	7.80
Vermicompost (A ₂)	68.33	8.06	A ₁ B ₃	73.02	9.94
Poultry Manure (A ₃)	65.78	7.74	A ₁ B ₄	67.83	9.97
SEm±	0.65	0.16	A ₁ B ₅	66.96	7.17
CD (P=0.05)	1.91	0.46	A ₂ B ₁	71.96	8.83
			A ₂ B ₂	67.07	7.70

table cont....

Particulars	Plant height (cm)	Number of leaves	Particulars	Plant height (cm)	Number of leaves
Bio-stimulant (B)			A ₂ B ₃	70.99	8.03
Seaweed extract (B ₁)	72.71	9.45	A ₂ B ₄	65.06	7.57
Humic acid(B ₂)	67.41	7.86	A ₂ B ₅	66.57	7.40
Vermiwash(B ₃)	70.20	8.70	A ₃ B ₁	67.95	8.77
Jeevamrutha (B ₄)	65.94	8.36	A ₃ B ₂	66.44	8.07
Liquid Mustard Cake (B ₅)	65.50	7.36	A ₃ B ₃	66.60	7.37
SEm±	0.67	0.25	A ₃ B ₄	64.94	7.53
CD (P=0.05)	1.97	0.72	A ₃ B ₅	62.96	6.97
Interaction (A×B)			SEm±	1.45	0.36
A ₁ B ₁	78.21	10.75	CD (P=0.05) of A	4.29	1.05

Table 2: Influence of enriched organic manure and bio-stimulants on leaf length, width and girth of onion

Particulars	Leaf length	Leaf width	Leaf girth
Organic manure(A)			
FYM (A ₁)	58.56	2.27	6.14
Vermicompost (A ₂)	57.00	2.19	5.89
Poultry Manure (A ₃)	55.92	2.16	5.72
SEm±	0.37	0.03	0.07
CD (P=0.05)	1.11	NS	0.26
Bio-stimulants (B)			
Seaweed extract (B ₁)	59.49	2.34	6.15
Humic acid(B ₂)	56.89	2.16	5.77
Vermiwash(B ₃)	58.10	2.25	6.07
Jeevamrutha (B ₄)	56.05	2.19	5.91
Liquid Mustard Cake (B ₅)	55.3	2.09	5.68
SEm±	0.58	0.03	0.10
CD (P=0.05)	1.70	0.09	0.29
Interaction (A×B)			
A ₁ B ₁	63.50	2.53	6.61
A ₁ B ₂	57.14	2.10	5.85
A ₁ B ₃	59.70	2.35	6.32
A ₁ B ₄	55.75	2.18	5.83
A ₁ B ₅	56.73	2.22	6.07
A ₂ B ₁	58.67	2.19	5.88
A ₂ B ₂	56.69	2.10	5.62
A ₂ B ₃	57.18	2.22	6.13
A ₂ B ₄	56.80	2.07	6.02
A ₂ B ₅	55.65	2.36	5.82
A ₃ B ₁	56.28	2.28	5.96
A ₃ B ₂	56.84	2.06	5.84
A ₃ B ₃	57.40	2.18	5.76
A ₃ B ₄	55.58	2.26	5.89
A ₃ B ₅	53.51	1.99	5.15
SEm± of A	0.38	0.06	0.17
CD (P=0.05) of A	1.14	0.18	0.53

Table 3: Influence of enriched organic manure and bio-stimulants on polar, equatorial diameter and Neck thickness of onion

Particulars	Polar diameter	Equatorial diameter	Neck thickness
Organic manure (A)			
FYM (A ₁)	4.75	5.98	1.45
Vermicompost (A ₂)	4.57	5.89	1.44
Poultry Manure (A ₃)	4.52	5.70	1.43
SEm±	0.04	0.06	0.03
CD (P=0.05)	0.15	0.15	NS
Bio-stimulants (B)			
Seaweed extract (B ₁)	4.70	6.09	1.55
Humic acid (B ₂)	4.64	5.86	1.42
Vermiwash (B ₃)	4.65	5.89	1.49
Jeevamrutha (B ₄)	4.68	5.81	1.37
Liquid Mustard Cake (B ₅)	4.41	5.63	1.36
SEm±	0.06	0.10	0.03
CD (P=0.05)	0.16	0.30	0.09
Interaction(A×B)			
A ₁ B ₁	5.06	6.50	1.60
A ₁ B ₂	4.74	5.80	1.30
A ₁ B ₃	4.92	6.18	1.48
A ₁ B ₄	4.67	5.77	1.36
A ₁ B ₅	4.37	5.67	1.52
A ₂ B ₁	4.47	5.81	1.49
A ₂ B ₂	4.51	5.90	1.35
A ₂ B ₃	4.49	6.11	1.45
A ₂ B ₄	4.51	5.71	1.38
A ₂ B ₅	4.63	5.93	1.49
A ₃ B ₁	4.41	5.34	1.56
A ₃ B ₂	4.82	5.89	1.47
A ₃ B ₃	4.53	6.00	1.54
A ₃ B ₄	4.87	5.96	1.36
A ₃ B ₅	4.24	5.29	1.24
SEm± of A	0.09	0.09	0.06
CD (P=0.05) of A	0.27	0.25	0.17

Table 4: Influence of enriched organic manure and bio-stimulants on harvesting index, days to bulb maturity

Particulars	Days to bulb maturity	Harvesting index	Particulars	Days to bulb maturity	Harvesting index
Organic manure(A)			A ₁ B ₂	136.13	71.25
FYM (A ₁)	138.10	73.71	A ₁ B ₃	138.64	75.20
Vermicompost (A ₂)	131.02	71.90	A ₁ B ₄	134.33	73.81
Poultry Manure (A ₃)	125.29	68.31	A ₁ B ₅	137.62	70.21
SEm±	1.72	1.18	A ₂ B ₁	133.71	74.71
CD (P=0.05)	5.08	3.53	A ₂ B ₂	129.10	70.49
Bio-stimulant(B)			A ₂ B ₃	131.50	73.52
Seaweed extract (B ₁)	133.78	75.15	A ₂ B ₄	131.63	70.92
Humic acid(B ₂)	130.41	69.85	A ₂ B ₅	129.17	69.89
Vermiwash(B ₃)	131.61	72.98	A ₃ B ₁	123.87	72.65
Jeevamrutha (B ₄)	130.38	71.45	A ₃ B ₂	126.00	67.82
Liquid Mustard Cake (B ₅)	131.16	67.11	A ₃ B ₃	124.70	70.23
SEm±	1.47	0.59	A ₃ B ₄	125.20	69.62
CD (P=0.05)	4.36	1.72	A ₃ B ₅	126.70	61.22
Interaction(A×B)			SEm±	1.70	1.02
A ₁ B ₁	143.77	78.09	CD (P=0.05) of A	4.50	2.98

Table 5: Influence of enriched organic manure and bio-stimulants on average yield, yield per plot and yield per hectare

Particulars	Average bulb weight (gm)	Yield per hectare (t/ha)
Organic manure (A)		
FYM (A ₁)	86.16	21.71
Vermicompost (A ₂)	82.52	20.79
Poultry Manure (A ₃)	77.24	19.47
SEm±	1.56	0.40
CD (P=0.05)	4.59	1.15
Bio-stimulants (B)		
Seaweed extract (B ₁)	85.46	21.53
Humic acid(B ₂)	82.20	20.72
Vermiwash(B ₃)	82.56	20.81
Jeevamrutha (B ₄)	83.42	21.02
Liquid Mustard Cake (B ₅)	76.21	19.20
SEm±	1.67	0.42
CD (P=0.05)	4.91	1.24
Interaction (A×B)		
A ₁ B ₁	96.67	24.36
A ₁ B ₂	84.03	21.18
A ₁ B ₃	88.76	22.37
A ₁ B ₄	83.10	20.94
A ₁ B ₅	78.25	19.72
A ₂ B ₁	79.35	19.99

table cont....

Particulars	Average bulb weight (gm)	Yield per hectare (t/ha)
A ₂ B ₂	86.70	21.85
A ₂ B ₃	81.58	20.56
A ₂ B ₄	88.31	22.25
A ₂ B ₅	76.65	19.31
A ₃ B ₁	80.35	20.25
A ₃ B ₂	75.89	19.12
A ₃ B ₃	77.41	19.51
A ₃ B ₄	78.85	19.87
A ₃ B ₅	73.73	18.58
SEm± of A	2.54	0.64
CD (P=0.05) of A	9.03	2.27

Table 6: Influence of enriched organic manure and bio-stimulants on dry matter and TSS

Particulars	Dry matter (g/100g)	TSS 0 Brix	Particulars	Dry matter (g/100g)	TSS 0 Brix
Organic manure(A)			A ₁ B ₂	13.34	12.83
FYM (A ₁)	15.11	13.26	A ₁ B ₃	15.40	13.15
Vermicompost (A ₂)	14.17	13.14	A ₁ B ₄	15.46	13.40
Poultry Manure (A ₃)	13.09	12.59	A ₁ B ₅	15.22	12.83
SEm±	0.09	0.31	A ₂ B ₁	15.82	13.06
CD (P=0.05)	0.26	0.91	A ₂ B ₂	13.23	12.60
Bio-stimulant(B)			A ₂ B ₃	13.85	13.43
Seaweed extract (B ₁)	15.13	13.39	A ₂ B ₄	13.22	13.33
Humic acid(B ₂)	13.17	12.94	A ₂ B ₅	14.70	13.27
Vermiwash(B ₃)	14.24	12.96	A ₃ B ₁	13.38	13.03
Jeevamrutha(B ₄)	14.04	13.04	A ₃ B ₂	12.95	13.37
Liquid Mustard Cake (B ₅)	14.02	12.65	A ₃ B ₃	13.47	12.30
SEm±	0.28	0.14	A ₃ B ₄	13.49	12.40
CD (P=0.05)	0.83	0.42	A ₃ B ₅	12.15	11.86
Interaction(A×B)			SEm±	0.51	0.17
A ₁ B ₁	16.19	14.07	CD (P=0.05) of A	1.47	0.75

Table 7: Influence of enriched organic manure and bio-stimulants on Ascorbic acid and total sugar of onion

Particulars	Ascorbic acid (mg/100g)	Total sugar (%)	Particulars	Ascorbic acid (mg/100g)	Total sugar (%)
Organic manure(A)			A ₁ B ₂	13.85	10.00
FYM (A ₁)	13.34	9.56	A ₁ B ₃	14.60	9.95
Vermicompost (A ₂)	11.94	9.32	A ₁ B ₄	13.63	8.05
Poultry Manure (A ₃)	11.25	8.99	A ₁ B ₅	11.24	9.14
SEm±	0.10	0.07	A ₂ B ₁	12.45	10.13
CD (P=0.05)	0.31	0.29	A ₂ B ₂	11.56	9.55
Bio-stimulant(B)			A ₂ B ₃	12.25	9.37
Seaweed extract (B ₁)	13.45	10.05	A ₂ B ₄	12.43	8.52
Humic acid(B ₂)	11.37	8.57	A ₂ B ₅	11.00	8.82
Vermiwash(B ₃)	12.72	9.31	A ₃ B ₁	12.54	9.69
Jeevamrutha (B ₄)	12.48	9.22	A ₃ B ₂	10.68	8.11
Liquid Mustard Cake (B ₅)	10.86	9.29	A ₃ B ₃	11.31	8.62

table cont....

Particulars	Ascorbic acid (mg/100g)	Total sugar (%)	Particulars	Ascorbic acid (mg/100g)	Total sugar (%)
SEm±	0.21	0.08	A ₃ B ₄	11.37	8.6
CD (P=0.05)	0.62	0.22	A ₃ B ₅	10.34	9.91
Interaction(A×B)			SEm±	0.1	0.16
A ₁ B ₁	15.36	10.35	CD (P=0.05) of A	0.29	0.43

Among bio stimulants, foliar application of seaweed extract (0.3%) at 15, 30, 45, and 60 DAT recorded the highest plant height (72.71 cm), number of leaves (9.45), leaf length (59.49 cm), leaf width (2.34 cm), leaf girth (6.15 cm), bulb polar diameter (4.70 cm), equatorial diameter (6.09 cm), neck thickness (1.55 cm), harvesting index (75.15), average bulb weight (85.46 g), and yield (21.53 t/ha). The shortest maturity period (130.38 days) was observed with the foliar application of jeevamrutha (3%). Seaweed extract (0.3%) also recorded the highest dry matter (15.13 g/100 g), TSS (13.39°B), ascorbic acid (13.45 mg/100 g) and total sugar (10.05 %). The enhanced growth and yield with seaweed extract (0.3%) may be attributed to its rich composition of bioactive compounds, including plant growth hormones (auxins, cytokinins, gibberellins), amino acids, and micronutrients. These compounds stimulate root growth, nutrient uptake, and chlorophyll synthesis, leading to improved photosynthesis and biomass accumulation. Additionally, seaweed extract enhances stress tolerance, enzymatic activity, and cellular metabolism, promoting overall plant vigour and productivity (Mughunth *et al.*, 2024).

The interaction of enriched organic manures and bio stimulants showed that the combination of enriched farmyard manure (20 t/ha) and seaweed extract (0.3%) (A1B1) resulted in the highest plant height (78.21 cm), number of leaves (10.75), leaf length (63.50 cm), leaf width (2.53 cm), leaf girth (6.61 cm), polar diameter (5.06 cm), equatorial diameter (6.50 cm), neck thickness (1.60 cm), harvesting index (78.09), bulb weight (96.67 g), and yield (24.36 t/ha) whereas the minimum days to maturity (123.87) were observed with Poultry Manure and Seaweed extract (B1). Similar findings have been reported in other vegetable crops, such as tomato (Sharma and Sharma, 2004) and garden pea (Pandey *et al.*, 2006). The notable improvement in bulb yield observed in this study can be ascribed to the enhancement of yield-contributing traits, such

as greater bulb diameter and increased bulb weight in the respective treatments compared to others. These results align with the findings of Chaurasia *et al.* (2003), who reported similar trends in their research. The highest dry matter (16.19 g/100 g), TSS (14.07°B), ascorbic acid content (15.36 mg/100 g), and total sugar content (10.35%) were also recorded with this treatment.

Farmyard manure enhances photosynthesis and facilitates photosynthate translocation, increasing bulb diameter and weight (Singh *et al.*, 1995; Mallangouda *et al.*, 1995). The shortest maturity period (124.70 days) was observed with enriched poultry manure (5 t/ha) and vermiwash (A3B5). Seaweed extract enhances shoot proliferation by improving root nutrient absorption (Crouch *et al.*, 1990), leading to better water and nutrient utilization, thereby improving plant growth and vigour. Its extracts at low concentrations have been reported to influence root development, plant height, and leaf number in *Arabidopsis* (Rayorath *et al.*, 2008). Similarly, Rana *et al.*, (2007) observed increased plant height, biomass, and yield in peas following seaweed extract application.

Effect of Organic Manure, bio stimulants and their interaction on soil properties

The soil properties were significantly influenced by organic manure applications, with enriched farmyard manure (20 t/ha) recording the highest soil pH (5.60) and organic carbon (0.87%), while enriched poultry manure (5 t/ha) resulted in the lowest values (5.57 and 0.80%, respectively), likely due to humic material adsorption and organic matter accumulation (Yilmaz & Alagöz, 2010; Diri & Kedonejo, 2024). Enriched vermicompost (5 t/ha) recorded the highest soil available nitrogen (124.14 kg/ha), phosphorus (23.85 kg/ha), and residual potassium (153.01 kg/ha), attributed to efficient nitrogen mineralization and microbial activity (Kale *et al.*, 1992), whereas enriched farmyard manure (20 t/ha) had the lowest nitrogen (115.08 kg/ha), phosphorus

(21.68 kg/ha), and potassium (145.46 kg/ha), indicating variations in nutrient release patterns among organic amendments.

Among the bio stimulants, the highest postharvest soil pH (5.66) and organic carbon (0.85%) were recorded with foliar application of seaweed extract (0.3%), whereas the lowest values (5.55 and 0.82%, respectively) were observed with humic acid (0.3%) and liquid mustard extract (3%). Vermiwash (3%) foliar spray resulted in the highest soil available nitrogen (124.41 kg/ha), phosphorus (24.33 kg/ha), and residual potassium (153.82 kg/ha), followed by liquid mustard cake (3%), while seaweed extract (0.3%) recorded the lowest values for nitrogen (119.26 kg/ha), phosphorus (21.97 kg/ha), and potassium (147.08 kg/ha), highlighting the differential nutrient contributions of bio stimulants. The study indicates that seaweed extract (0.3%) enhanced postharvest soil pH and organic carbon, whereas vermiwash (3%) significantly improved soil nitrogen, phosphorus, and potassium availability. Liquid mustard cake (3%) also contributed to higher nutrient retention, while seaweed extract recorded the lowest values for nitrogen, phosphorus, and potassium (Sarkar *et al.*, 2024).

The interaction of enriched organic manures and bio stimulants had a non-significant effect on postharvest soil properties. The highest soil pH (5.69) and organic carbon (0.89%) were recorded with enriched farmyard manure (20 t/ha) and seaweed extract (0.3%) (A1B1), while the lowest values (5.36 and 0.77%, respectively) were observed with enriched vermicompost (5 t/ha) and humic acid (A2B2) or liquid mustard extract (3%) (A3B5).

Application of enriched vermicompost (5 t/ha) along with vermiwash (3%) (A2B3) resulted in the highest soil available nitrogen (125.88 kg/ha), phosphorus (25.78 kg/ha), and residual potassium (157.62 kg/ha), whereas the lowest nitrogen (115.96 kg/ha), phosphorus (20.45 kg/ha), and potassium (140.22 kg/ha) were recorded with enriched farmyard manure (20 t/ha) and seaweed extract (A1B1). The increased soil potassium with vermicompost application may be attributed to enhanced microbial activity and earthworm-mediated nutrient release (Chatterjee 2015; Chatterjee *et al.*, 2020).

Economics of Production

The economic study (Table 8) indicated that both gross and net returns from onion cultivation were greatly affected by the use of organic manures and bio-stimulants. The highest benefit-cost (B:C) ratio (2.72) was recorded with the combination of Azophos biofertilizer-enriched farmyard manure (20 t/ha) as a basal application and seaweed extract (0.3%) as a foliar spray at 15, 30, 45, and 60 DAT (A1B1). This was followed by enriched vermicompost (5 t/ha) along with foliar application of jeevamrutha (3%) (A2B4), which recorded a B:C ratio of 2.62. The lowest B:C ratio (1.79) was observed in the treatment involving enriched poultry manure (5 t/ha) with foliar application of vermiwash (3%) at the same intervals. The highest gross income (Rs. 633,374.20) was obtained with the A1B1 treatment, whereas the lowest gross income (Rs. 483,100.80) was recorded with enriched poultry manure (5 t/ha) as a basal application and liquid mustard cake (3%) as a foliar spray (A3B5).

Table 8: Influence of enriched organic manure and bio-stimulants on economics of onion cultivation

Treatments	Bulb yield (t/ha)	*Gross income (₹/ha)	Variable cost (₹)	Fixed cost (₹)	Total cost of cultivation (₹/ha)	Net income (₹/ha)	B:C ratio
A ₁ B ₁	24.36	633374.20	66400	104000	170400	462974.20	2.72
A ₁ B ₂	21.18	550579.30	62800	104000	166800	383779.30	2.30
A ₁ B ₃	22.37	581587.19	76000	104000	180000	401587.19	2.23
A ₁ B ₄	20.94	544489.76	64000	104000	168000	376489.76	2.24
A ₁ B ₅	19.72	512703.83	53400	104000	157400	355303.83	2.26
A ₂ B ₁	20.00	519894.25	58400	104000	162400	357494.26	2.20
A ₂ B ₂	21.85	568059.49	54800	104000	158800	409259.49	2.58
A ₂ B ₃	20.56	534509.98	68000	104000	172000	362509.98	2.11
A ₂ B ₄	22.25	578620.22	56000	104000	160000	418620.22	2.62
A ₂ B ₅	19.31	502182.52	45400	104000	149400	352782.52	2.36

table cont....

A ₃ B ₁	20.25	526459.75	68400	104000	172400	354059.75	2.05
A ₃ B ₂	19.12	497150.47	64800	104000	168800	328350.47	1.95
A ₃ B ₃	19.51	507205.61	78000	104000	182000	325205.61	1.79
A ₃ B ₄	19.87	516631.42	66000	104000	170000	346631.42	2.04
A ₃ B ₅	18.58	483100.80	55400	104000	159400	323700.80	2.03

*Sell price of onion bulbs = ₹ 26.00 per kg of onion bulb.

CONCLUSION

The study confirms that enriched organic manure, particularly farmyard manure (20 t/ha), combined with bio-stimulants like seaweed extract (0.3%), significantly improves onion growth, yield, and quality while enhancing soil fertility. The highest economic returns were achieved with this combination, making it a viable option for sustainable onion cultivation. Organic amendments contribute to better nutrient availability, improved plant vigour, and reduced dependency on synthetic fertilizers. The findings highlight the potential of organic practices to enhance productivity while maintaining soil health, supporting the growing demand for organic onions in both domestic and international markets.

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