

**STUDIES ON MANAGEMENT OF SOIL FERTILITY AND SUSTAINING  
PRODUCTIVITY IN BHENDI [*Abelmoschus esculentus* (L.) Moench]**

## ABSTRACT

A field experiment on COBh Hybrid Bhendi 4 was conducted in the Department of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U.T. of Puducherry, during summer 2022 with the objective of comparing the effects of organics and bioenhancers on soil fertility restoration and sustained vegetable production. The experiment was laid out in a Randomized Block Design with two replications involving two factors (fertilisers and bioenhancers) forming eighteen treatment combination in a factorial way (FRBD). The study material comprised of vermicompost and goat manure (organics) as well as panchagavya and jivamirtham (bioenhancers), besides recommended FYM and N, P, K fertilisers in various combinations. Maximum plant height (118.62 cm), number of primary branches (5.02) at final harvest, maximum fruit length (15.49 cm) and fruit girth (6.89 cm), fruit weight (21.71 g), number of fruits plant<sup>-1</sup> (51.70), highest yield (891.60 g plant<sup>-1</sup> and 16.47 t ha<sup>-1</sup>) and maximum dry matter production (5.74 t ha<sup>-1</sup>) were recorded in the treatment receiving RDF with 3 per cent panchagavya as foliar spray on 30, 45, 60 and 75 DAS.

*Keywords: Vermicompost, Goat manure, Panchagavya, Jivamirtham*

## 1. INTRODUCTION

Vegetables are designated as “protective foods” in human diet due to their varying health benefits, attributable to their richness in vitamins, minerals, essential fatty acids, amino acids, dietary fiber and other important bioactive compounds [1]. India ranks second in vegetable production and the production is estimated at 191.77 m MT from an area of 10.35 m ha [2].

Bhendi [*Abelmoschus esculentus* (L.) Moench] also known as Ladies finger valued for its tender pods is one of the widely cultivated vegetables throughout the tropical and subtropical regions of the world. Globally, India ranks first in bhendi production, with an area of 5.19 m ha, producing 6.37 m MT annually with a productivity of 12 tonnes ha<sup>-1</sup> [2].

Bhendi is of immense importance with large pharmacological, nutritional and industrial applications, with its curative property attributable to the presence of many bioactive compounds and their associated bioactivities [3].

Considering the commercial importance, many bhendi hybrids with high yield and tolerance to biotic and abiotic stresses are in wide cultivation. However, these hybrids are input intensive, resulting in various soil and environmental hazards. Among the major nutrients, nitrogen being highly responsive

for environmental hazards, besides its soaring cost, the search for alternate approaches, including Integrated Nitrogen Management practices in any given environment becomes inevitable.

Integrated Nutrient Management (INM) is a flexible approach to minimize the use of chemical fertilisers and maximize its use efficiency, thus remains the best alternative choice of growers for maintaining soil health and sustainable production [2].

Organic manures, when efficiently and effectively used could ensure sustainable crop productivity by immobilizing nutrients that are susceptible for leaching as the nutrients contained in manures are released more slowly and get stored for a longer time in the soil, ensuring longer residual effects, improved root development and hence, higher crop yields [5]. The present study was hence contemplated to determine the effect of organic sources of nutrients and bio enhancers on growth and yield of hybrid bhendi.

## 2. MATERIALS AND METHODS

A field experiment on 'Effect of organics and bioenhancers on growth and yield of hybrid Bhendi [*Abelmoschus esculentus* (L.) Moench]' was performed in the Department of Horticulture, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U.T. of Puducherry, India during summer 2022. The 'bhendi hybrid CO 4' (COBh H 4) with a crop duration of 110 days was raised. The treatment materials for the study comprised of vermicompost, goat manure, panchagavya and jivamirtham, besides recommended Farm Yard Manure (FYM) and N, P, K fertilisers.

Panchagavya, a term used in Ayurveda represents a fermented product made out of five ingredients of cow, such as milk, urine, dung, curd and clarified butter. It is a popular foliar nutrition prepared by organic growers of Tamil Nadu as an indigenous material and used widely for agricultural and horticultural crops [6]. Jivamirtham refers to an eco-friendly organic preparation made from product of cow. The products of cow have the ability to bring the flow of cosmic energy which in turn can revitalizes the plant growth process [7].

In the present experiment, panchagavya was applied as foliar spray at 3 per cent concentration on 30, 45, 60 and 75 days after sowing. Freshly prepared jivamirtham was applied in the soil at sowing, 20 and 40 days after sowing along with irrigation water.

The experiment was laid out in a Randomized Block Design with two replications involving eighteen treatments (Table 1) in a factorial way (FRBD) and the study comprised of 2 factors viz., Fertiliser (Factor 1) and Bioenhancers (Factor 2). Factor 1 represent different fertiliser combinations

while factor 2 represent the bioenhancers used. There were six levels for Factor 1 and three levels for Factor 2, forming 18 treatment combinations.

## 2.1. Level of factors

### 2.1.1. Factor 1 – Fertilisers

F<sub>0</sub> - Absolute control

F<sub>1</sub> - RDF (Recommended Dose of Fertilisers)

F<sub>2</sub> - 75 % N + RDP + RDK + RDFYM + 25 % N through Vermicompost

F<sub>3</sub> - 75 % N + RDP + RDK + RDFYM + 25 % N through Goat manure

F<sub>4</sub> - 50 % N + RDP + RDK + RDFYM + 50 % N through Vermicompost

F<sub>5</sub> - 50 % N + RDP + RDK + RDFYM + 50 % N through Goat manure

### 2.1.2. Factor 2 – Bioenhancers

B<sub>0</sub> - Absolute control

B<sub>1</sub> - 3 % Panchagavya foliar spray on 30, 45, 60 and 75 DAS

B<sub>2</sub> - Jivamirtham 500 L ha<sup>-1</sup> as soil application thrice with irrigation *viz.*, at sowing, 20 and 45 DAS

## 3. RESULTS AND DISCUSSION

### 3.1. Effect of organics and bioenhancers on growth parameters in bhendi

The influence of various treatments of the study on growth attributes of hybrid bhendi is presented in Table 2. The application of RDF and foliar spraying of 3 per cent panchagavya on 30, 45, 60 and 75 DAS (F<sub>1</sub>B<sub>1</sub>) has recorded the earliest flowering (38.52 days). The earliness in flowering observed with the application of RDF and panchagavya might be due to the accelerated photosynthesis and rapid translocation of photosynthates towards initiating flower buds as reported by Ramesh et al. [8] from their study in tomato. The earliness could also be ascribed to the role played by the timely supply of adequate nutrients to the plants through the use of recommended dose fertilisers (200:100:100 kg ha<sup>-1</sup>) as supply of phosphorus, to plants at right time in optimal quantity play a pivotal role in initiation of flower primordia as reported earlier by Singh et al. [9] and Singh et al. [10].

Flowering at the lowermost node is a preferred trait in bhendi and it was observed under RDF and foliar spraying of 3 per cent panchagavya on 30, 45, 60 and 75 DAS (F<sub>1</sub>B<sub>1</sub> – 4.90) as well as RDF and soil application of jivamirtham 500 L ha<sup>-1</sup> thrice with irrigation *viz.*, at sowing, 20 and 45 DAS

Table 1. Treatment particulars

Sl. No.	Treatment	Treatment details
1	T <sub>1</sub> - F <sub>0</sub> B <sub>0</sub>	Absolute control
2	T <sub>2</sub> - F <sub>0</sub> B <sub>1</sub>	3 % Panchagavya foliar spray on 30, 45, 60 and 75 DAS
3	T <sub>3</sub> - F <sub>0</sub> B <sub>2</sub>	Jivamirtham 500 L ha <sup>-1</sup> as soil application thrice with irrigation viz., at sowing, 20 and 45 DAS
4	T <sub>4</sub> - F <sub>1</sub> B <sub>0</sub>	RDF
5	T <sub>5</sub> - F <sub>1</sub> B <sub>1</sub>	RDF + 3 % Panchagavya foliar spray on 30, 45, 60 and 75 DAS
6	T <sub>6</sub> - F <sub>1</sub> B <sub>2</sub>	RDF + Jivamirtham 500 L ha <sup>-1</sup> as soil application thrice with irrigation viz., at sowing, 20 and 45 DAS
7	T <sub>7</sub> - F <sub>2</sub> B <sub>0</sub>	75 % N + RDP + RDK + RDFYM + 25 % N through Vermicompost
8	T <sub>8</sub> - F <sub>2</sub> B <sub>1</sub>	75 % N + RDP + RDK + RDFYM + 25 % N through Vermicompost + 3% Panchagavya foliar spray on 30, 45, 60 and 75 DAS
9	T <sub>9</sub> - F <sub>2</sub> B <sub>2</sub>	75 % N + RDP + RDK + RDFYM + 25 % N through Vermicompost + Jivamirtham 500 L ha <sup>-1</sup> as soil application thrice with irrigation viz., at sowing, 20 and 45 DAS
10	T <sub>10</sub> - F <sub>3</sub> B <sub>0</sub>	75 % N + RDP + RDK + RDFYM + 25 % N through Goat manure
11	T <sub>11</sub> - F <sub>3</sub> B <sub>1</sub>	75 % N + RDP + RDK + RDFYM + 25 % N through Goat manure + 3 % Panchagavya foliar spray on 30, 45, 60 and 75 DAS
12	T <sub>12</sub> - F <sub>3</sub> B <sub>2</sub>	75 % N + RDP + RDK + RDFYM + 25 % N through Goat manure + Jivamirtham 500 L ha <sup>-1</sup> as soil application thrice with irrigation viz., at sowing, 20 and 45 DAS
13	T <sub>13</sub> - F <sub>4</sub> B <sub>0</sub>	50 % N + RDP + RDK + RDFYM + 50 % N through Vermicompost
14	T <sub>14</sub> - F <sub>4</sub> B <sub>1</sub>	50 % N + RDP + RDK + RDFYM + 50 % N through Vermicompost + 3% Panchagavya foliar spray on 30, 45, 60 and 75 DAS
15	T <sub>15</sub> - F <sub>4</sub> B <sub>2</sub>	50% N + RDP + RDK + RDFYM + 50% N through Vermicompost + Jivamirtham 500 L ha <sup>-1</sup> as soil application thrice with irrigation viz., at sowing, 20 and 45 DAS
16	T <sub>16</sub> - F <sub>5</sub> B <sub>0</sub>	50 % N + RDP + RDK + RDFYM + 50 % N through Goat manure
17	T <sub>17</sub> - F <sub>5</sub> B <sub>1</sub>	50 % N + RDP + RDK + RDFYM + 50 % N through Goat manure + 3% Panchagavya foliar spray on 30, 45, 60 and 75 DAS
18	T <sub>18</sub> - F <sub>5</sub> B <sub>2</sub>	50 % N + RDP + RDK + RDFYM + 50 % N through Goat manure + Jivamirtham 500 L ha <sup>-1</sup> as soil application thrice with irrigation viz., at sowing, 20 and 45 DAS

(F<sub>1</sub>B<sub>2</sub> – 4.90). The influence on node of first flower anthesis in bhendi with the application of RDF might be due to timely availability and uptake of major plant nutrients. The increased uptake of NPK nutrients by plants, could have resulted from increased plant metabolites in soil solution which are helpful in building the plant tissues of bhendi as the nutrient acquisition power of a plant greatly depends on the concentration of the ions in soil solution resulting in better growth and development as reported by Prabhu et al. [11] and Verma et al. [12].

The tallest plants at final harvest (118.62 cm) observed in plots treated with RDF and foliar spraying of 3 per cent panchagavya on 30, 45, 60 and 75 DAS as reported earlier by Muthuvel [13] could be the result of the growth enzymes present in panchagavya, favouring rapid cell division and multiplication as reported by Verma et al. [12]. Panchagavya is also reported to contain macronutrients such as N, P, K, micronutrients, vitamins, amino acids and growth regulators such as auxins and gibberellins, which are essentially required for proper growth and development of plants resulting in increased plant height as reported by Hathi et al. [14]. Nitrogen is the main constituent of protoplasm, cell nucleus, amino acids, proteins, chlorophyll and many other plant metabolic products, while phosphorus is an essential constituent of the energy molecule adenosine tri-phosphate (ATP), thus play in a key role in photosynthesis. Potassium plays a vital role in controlling water economy in the plants giving improved drought tolerance. The gradual increase in plant height with increasing dose of NPK and FYM, could thus, prove beneficial for root and shoot growth of plants as suggested by Amran et al. [15] and Tyagi et al. [16] in bhendi.

The application of RDF and foliar spraying of 3 per cent panchagavya on 30, 45, 60 and 75 DAS (F<sub>1</sub>B<sub>1</sub>) has recorded maximum branches plant<sup>-1</sup> at first flowering and final harvest (4.35 and 5.02). The combined use of organic and inorganic fertilisers could increase cell permeability and supply plant nutrients in a sustained manner (Kuppusamy et al.) [17] resulting in increased number of branches plant<sup>-1</sup> as reported by Majanbu et al. [18].

The effect of bioenhancers on internodal length of bhendi in the present study was insignificant and such a report has been reported earlier by Jadhav et al. [19], while Oroka and Oke [20] reported significant influence of fertilisers on internodal length of bhendi.

The application of RDF and foliar spraying of 3 per cent panchagavya on 30, 45, 60 and 75 DAS (F<sub>1</sub>B<sub>1</sub>) has recorded maximum dry matter production (5.74). The dry matter production of the crop is an index of the plant growth and the dry matter yield determines partly or fully the yield of the

crop. This is attributable to the increased availability of nitrogen with the combined use of organic and inorganic sources of nutrients. This was in accordance with the findings of Anburani and Manivannan [21] in brinjal. The increased dry matter production is further attributable to the well established root system in addition to increased plant height, number of branches and leaves as reported by Tripathy et al. [22] with the combined application of chemical fertilisers and stimulants.

### **3.2. Effect of organics and bioenhancers on yield parameters in bhendi**

The effect of treatment on yield parameters of hybrid bhendi is given in Table 3. The longest fruits observed in RDF with foliar spraying of 3 per cent panchagavya on 30, 45, 60 and 75 DAS ( $F_1B_1$  - 15.49 cm) could have resulted from the supplementation of micronutrients by organic sources applied with inorganic sources of nitrogen, phosphorus and potassium as expressed by Singh et al. [23] in bhendi. The application of nitrogen also favours the metabolic and auxin activities in plant (Yadav et al.) [24] and on decomposition releases nutrient in a sustained manner throughout the plant life cycle leading to higher fruit length (Akhter et al.) [25].

The improved fruit girth (6.89 cm) recorded in  $F_1B_1$  could be attributed to the increased availability of NPK at critical stages of the crop growth resulting in early establishment, vigorous growth and development of plants thus leading to longer and wider fruits as observed by Naidu et al. [26]. Further, the integrated use of chemical fertiliser and vermicompost resulting in balanced fertilization could have enhanced the photosynthetic activity through increased leaf area and resulted in buildup of adequate food reserve for formation and elongation of cells. The synthesized photosynthates might have got translocated to the growing fruits which are in greater demand of assimilates consequently leading to greater thickness of fruit (Kumar et al.) [27].

The maximum fruit weight of bhendi was observed in RDF and foliar spraying of 3 per cent panchagavya on 30, 45, 60 and 75 DAS ( $F_1B_1$  – 21.71 g). The increased photosynthetic area and better translocation of photosynthates resulting out of the supply of adequate nutrients in the treatment could have been responsible for large sized fruits with more number of seeds fruits<sup>-1</sup> resulting in increased fruit weight as reported earlier by Mal et al. [28]. The increased concentration of chlorophyll content of panchagavya treated plants resulting in enhanced photosynthetic efficiency might have also contributed to the fruit weight (Swarnam et al.) [29], as fermented Panchagavya is reported to be rich in N, P, K, S and micronutrients.

The application of inorganic and organic sources of nutrients in right proportion in the treatment receiving RDF and foliar spraying of 3 per cent panchagavya on 30, 45, 60 and 75 DAS has lead to the production of more number of fruits plant<sup>-1</sup> (F<sub>1</sub>B<sub>1</sub> - 51.70) which could be attributable to the maximum number of flowers produced with improved nutrient availability (Kuppusamy et al.) [17]. Accumulation of cytokinin and auxin in the auxillary buds as reported by Swain et al. [30] in panchagavya treated plants could have also resulted in more number of fruits plant<sup>-1</sup>.

The maximum yield (891.60 g plant<sup>-1</sup> / 16.47 t ha<sup>-1</sup>) was observed in treatments receiving RDF and foliar spraying of 3 per cent panchagavya on 30, 45, 60 and 75 DAS (F<sub>1</sub>B<sub>1</sub>). This could have resulted from the improved metabolic and auxin related activities in plants under optimal nutritional level as reported by Singh et al. [10]. Foliar spray of panchagavya at 3 per cent could have resulted in enhanced yield as panchagavya is reported to contain beneficial microbes namely lactic acid bacteria (*Lactobacillus*), yeast (*Saccharomyces*), actinomyces (*Streptomyces*), photosynthetic bacteria (*Rhodopseudomonas*) and certain fungi (*Aspergillus*), as reported by Verma et al. [12].

#### **4. CONCLUSION**

The results of the experiment clearly revealed the significance of applying 100 per cent RDF along with foliar spray of 3 per cent panchagavya at 30, 45, 60 & 75 DAS in terms of growth and yield parameters in bhendi.

Table 2. Effect of organics and bioenhancers on growth attributes of bhendi

Treatment	Days to flowering	Node of first flower anthesis	Plant height at flowering (cm)	Plant height at final harvest (cm)	Primary branches plant <sup>-1</sup> at flowering	Primary branches plant <sup>-1</sup> at final harvest	Internodal length (cm)	Dry matter production (t ha <sup>-1</sup> )								
T <sub>1</sub> - F <sub>0</sub> B <sub>0</sub>	44.25	5.50	19.78	44.84	2.35	3.10	2.30	0.33								
T <sub>2</sub> - F <sub>0</sub> B <sub>1</sub>	49.00	5.40	17.06	51.72	2.60	3.20	2.49	0.85								
T <sub>3</sub> - F <sub>0</sub> B <sub>2</sub>	51.80	5.40	17.22	49.93	2.57	3.13	2.49	0.57								
T <sub>4</sub> - F <sub>1</sub> B <sub>0</sub>	40.40	5.00	24.51	104.99	4.20	4.70	3.34	3.81								
T <sub>5</sub> - F <sub>1</sub> B <sub>1</sub>	38.52	4.90	23.27	118.62	4.35	5.02	3.48	5.74								
T <sub>6</sub> - F <sub>1</sub> B <sub>2</sub>	39.50	4.90	23.72	118.24	4.32	4.80	3.39	4.17								
T <sub>7</sub> - F <sub>2</sub> B <sub>0</sub>	41.71	5.20	25.43	87.54	3.40	4.10	2.93	3.02								
T <sub>8</sub> - F <sub>2</sub> B <sub>1</sub>	41.10	5.00	24.59	103.49	4.02	4.60	3.28	3.76								
T <sub>9</sub> - F <sub>2</sub> B <sub>2</sub>	41.12	5.10	24.90	97.41	4.00	4.52	3.23	3.76								
T <sub>10</sub> - F <sub>3</sub> B <sub>0</sub>	42.20	5.20	25.66	87.26	3.37	4.10	2.93	2.89								
T <sub>11</sub> - F <sub>3</sub> B <sub>1</sub>	41.37	5.10	25.08	96.12	3.80	4.40	3.26	3.62								
T <sub>12</sub> - F <sub>3</sub> B <sub>2</sub>	41.60	5.20	25.22	92.96	3.50	4.40	3.08	3.61								
T <sub>13</sub> - F <sub>4</sub> B <sub>0</sub>	46.37	5.30	30.90	69.87	2.85	3.60	2.73	1.47								
T <sub>14</sub> - F <sub>4</sub> B <sub>1</sub>	42.50	5.20	25.92	83.13	3.37	4.10	2.90	2.76								
T <sub>15</sub> - F <sub>4</sub> B <sub>2</sub>	44.80	5.30	28.20	75.34	3.15	3.75	2.93	2.58								
T <sub>16</sub> - F <sub>5</sub> B <sub>0</sub>	46.62	5.40	30.96	55.66	2.70	3.33	2.71	1.40								
T <sub>17</sub> - F <sub>5</sub> B <sub>1</sub>	42.50	5.30	27.79	79.32	3.30	4.00	2.85	2.75								
T <sub>18</sub> - F <sub>5</sub> B <sub>2</sub>	45.97	5.30	29.82	73.85	2.92	3.70	2.84	1.56								
Factor	SEd	CD (p=0.05)	SEd	CD (p=0.05)	SEd	CD (p=0.05)	SEd	CD (p=0.05)	SEd	CD (p=0.05)	SEd	CD (p=0.05)	SEd	CD (p=0.05)	SEd	CD (p=0.05)
<b>Fertilisers</b>	1.246	2.63	0.136	0.29	1.349	2.84	5.620	11.86	0.271	0.57	0.236	0.50	0.223	0.47	0.853	1.80
<b>Bioenhancers</b>	0.881	NS	0.096	NS	0.954	NS	3.974	8.39	0.191	NS	0.167	NS	0.158	NS	0.603	NS
<b>Fertilisers x Bioenhancers</b>	2.159	NS	0.236	NS	2.338	NS	9.740	NS	0.470	NS	0.410	NS	0.387	NS	1.478	NS

Table 3. Effect of organics and bioenhancers on yield attributes of bhendi

Treatment	Fruit length (cm)		Fruit girth (cm)		Individual fruit weight (g)		Number of fruits plant <sup>-1</sup>		Yield plant <sup>-1</sup> (g)		Yield hectare <sup>-1</sup> (tonnes)	
T <sub>1</sub> - F <sub>0</sub> B <sub>0</sub>	11.60		5.49		12.26		12.75		126.40		2.90	
T <sub>2</sub> - F <sub>0</sub> B <sub>1</sub>	12.40		6.23		14.17		15.66		170.65		3.88	
T <sub>3</sub> - F <sub>0</sub> B <sub>2</sub>	11.83		5.85		12.65		12.90		140.35		3.76	
T <sub>4</sub> - F <sub>1</sub> B <sub>0</sub>	15.05		6.86		19.65		39.22		676.40		16.22	
T <sub>5</sub> - F <sub>1</sub> B <sub>1</sub>	15.49		6.89		21.71		51.70		891.60		16.47	
T <sub>6</sub> - F <sub>1</sub> B <sub>2</sub>	15.07		6.89		20.56		49.45		880.80		16.35	
T <sub>7</sub> - F <sub>2</sub> B <sub>0</sub>	14.01		6.66		17.91		36.00		588.05		13.97	
T <sub>8</sub> - F <sub>2</sub> B <sub>1</sub>	14.74		6.85		19.54		38.30		646.15		15.42	
T <sub>9</sub> - F <sub>2</sub> B <sub>2</sub>	14.70		6.84		19.20		37.50		622.45		15.02	
T <sub>10</sub> - F <sub>3</sub> B <sub>0</sub>	13.88		6.60		17.70		35.80		579.00		11.67	
T <sub>11</sub> - F <sub>3</sub> B <sub>1</sub>	14.31		6.77		18.42		36.90		594.90		14.15	
T <sub>12</sub> - F <sub>3</sub> B <sub>2</sub>	14.23		6.72		18.17		36.30		592.30		14.05	
T <sub>13</sub> - F <sub>4</sub> B <sub>0</sub>	12.99		6.37		15.36		22.50		326.35		5.70	
T <sub>14</sub> - F <sub>4</sub> B <sub>1</sub>	13.67		6.54		16.95		35.20		548.60		7.03	
T <sub>15</sub> - F <sub>4</sub> B <sub>2</sub>	13.26		6.47		16.46		31.90		493.10		6.80	
T <sub>16</sub> - F <sub>5</sub> B <sub>0</sub>	12.56		6.29		14.35		16.32		181.75		5.27	
T <sub>17</sub> - F <sub>5</sub> B <sub>1</sub>	13.53		6.53		16.60		35.02		503.65		6.90	
T <sub>18</sub> - F <sub>5</sub> B <sub>2</sub>	13.23		6.42		16.16		23.60		334.15		6.61	
Factor	SEd	CD (p=0.05)	SEd	CD (p=0.05)	SEd	CD (p=0.05)	SEd	CD (p=0.05)	SEd	CD (p=0.05)	SEd	CD (p=0.05)
<b>Fertilisers</b>	0.635	1.34	0.200	0.42	0.854	1.80	2.461	5.19	38.551	81.34	2.946	6.22
<b>Bioenhancers</b>	0.449	NS	0.142	NS	0.604	1.27	1.740	3.67	27.259	57.51	2.083	NS
<b>Fertilisers x Bioenhancers</b>	1.101	NS	0.348	NS	1.480	NS	4.265	NS	66.804	NS	5.105	NS

## REFERENCES

1. Natesh HN, Abbey L, Asiedu SK. An overview of nutritional and antinutritional factors in green leafy vegetables. Hort Int J. 2017; 1(2): 58-65.
2. Horticultural Statistics. Department of Agricultural co-operation and Farmers Welfare. 2<sup>nd</sup> Advance estimate. Ministry of Agri. Government of India. 2019-20.
3. Elkhalfifa AEO, Alshammari E, Adnan M, Alcantara JC, Awadelkareem AM, Eltoum NE, Mehmood K, Panda BP, Ashraf SA. Okra (*Abelmoschus esculentus*) as a potential dietary medicine with nutraceutical importance for sustainable health applications. Molecules. 2021; 26(3): 696.
4. Anand B, Kadam AS. Okra crop growth and yield responses to different organic sources of nitrogen. Int J Agri Sci. 2016; 8(48): 2042-2044.
5. Akande MO, Oluwatoyinbo FI, Makinde EA, Adepoju AS, Adepoju IS. Response of okra to organic and inorganic fertilization. Nature & Sci. 2010; 8(11): 261-266.
6. Amalraj ELD, Praveen KG, Ahmed SKMH, Abdul R, Kishore N. Microbiological analysis of panchagavya, vermicompost, and FYM and their effect on plant growth promotion of pigeon pea (*Cajanus cajan* L.) in Indian. Organic Agriculture. 2013; 3: 23-29.
7. Natarajan K. Panchagavya - A Manual. Mother India Press. Mapusa. Goa. India. 2002; p.33.
8. Ramesh G, Ajithkumar K, Savitha AS, Patil SG. Integrated influence of organic manures in addition to inorganic fertilizers on growth, yield parameters and early blight disease of tomato (*Lycopersicon esculentum* L.). Int J Biol & Pharmaceutical Res. 2015; 6(6): 478-483.
9. Singh RP, Rajput CBS, Chaurasia SNS. Effect of different levels and methods of potassium application on growth and green pod yield of okra cv. Parbhani Kranti. Haryana J Horti Sci. 1998; 27(4): 288-292.
10. Singh KV, Anuj K, Kumar M, Soni S, Kumar A, Singh MK. Response of different organic and inorganic fertilizers on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench). Annals of Horti. 2015; 8(1): 107-109.
11. Prabhu T, Narwadkar PR, Sajindranath AK, Bhore MR. Effect of integrated nutrient management on yield and quality of okra (*Abelmoschus esculentus* (L.) Moench) cv. Parbhani Kranti. J Applied Hort. 2002; 2(2): 28-33.

12. Verma KS, Singh SS, Mishra SP, Sirothia P, Jaidiya M. Growth and yield of okra (*Abelmoschus esculentus* L.) as influenced by different organic, bioenhancers and inorganic techniques. *Inter J Curr Microbiol & Appl Sci.* 2019; 8(8): 2343-2350.
13. Muthuvel. Effect of organics on growth and yield of bhendi var. Varsha Uphar. Proc. Nation. Conf. on glory of gomatha: panchagavya as potentiator of plant cells: effects on crop plants and the physiology that validates the effects. Dec, 1-3. 2007, S V Vet Univ. Tirupati, 2002; p. 143-148.
14. Hathi HS, Patel MV, Zankat SB. Effect of liquid organic substances, spray frequency and levels of fertilizer on growth and flowering of okra (*Abelmoschus esculentus* (L.) Moench). *The Pharma Innovation J.* 2022; 11(7): 828-832.
15. Amran HA, Prasad VM, Saravanan S. Effect of FYM on growth, yield and fruits quality of okra (*Abelmoschus esculentus* L. Moench). *J Agri & Vet Sci.* 2014; 7(3): 07-12.
16. Tyagi SK, Shukla A, Mittoliya VK, Sharma ML, Khire AR, Jain YK. Effect of integrated nutrient management on growth, yield and economics of okra (*Abelmoschus esculentus* (L.) Moench) under Nimar Valley conditions of Madhya Pradesh. *Int J Tropical Agri.* 2016; 34(2): 415-419.
17. Kuppusamy M, Sankar R, Sundaram V. Effect of organic sources of nitrogen on growth and yield of bhendi [*Abelmoschus esculentus* (L.) Moench], *Asian J Horti.* 2013; 8(1): 154-157.
18. Majanbu IS, Ogunlela VB, Ahmed MK, Olarewaju JD. Response of two okra (*Abelmoschus esculentus* L. Moench) varieties to fertilisers: Yield and yield components as influenced by nitrogen and phosphorus application. *Fertilizer Res.* 1985; 6: 257-267.
19. Jadhav SD, Shinde SJ, Deshmukh KD. Influence of biofertilizer, liquid organic manures along with RDF on growth and flowering of okra (*Abelmoschus esculentus* L. Moench). *J Pharmacogn & Phytochem.* 2021; 10(1): 303-306.
20. Oroka F, Oke. Morphological and yield attributes of okra (*Abelmoschus esculentus* L. Moench) as influenced by vermicompost + NPK nutrient Sources. *Advances in Life Sci & Tech.* 2016; 40: 46-50.
21. Anburani A, Manivannan K. Effect of integrated nutrient management on growth of brinjal. *I J Horti.* 2002; 59: 377-386.
22. Tripathy, Bhattacharyya PB, Maity TK. Response of okra [*Abelmoschus esculentus* (L.) Moench] to integrated nutrient management system. *Orissa J Hort.* 2004; 32(2): 14-18.

23. Singh J, Sreekrishna B, Sundaram MR. Performance of scotch bonnet chilli in Karnataka and its response to vermicompost. *Indian Cocoa, Arecanut & Spices J.* 1997; 21: 9-10.
24. Yadav GL, Singh SP, Jitarwal OP, Yadav VK, Choudhary R. Effect of nitrogen and bio-organics on growth and yield of okra [*Abelmoschus esculentus* (L.) Moench]. *Chemical Science Review and Letters.* 2017; 6(23): 1515-1519.
25. Akhter S, Amin AKMR, Masud AAC. Organic and mineral fertilization – induced yield and seed quality of okra (*Abelmoschus esculentus* (L.) Moench). *J Plant Sci.* 2022; 17: 102-111.
26. Naidu AK, Kushwah SS, Mehta AK, Jain PK. Study of organic, inorganic and biofertilisers in relation to growth and yield of tomato, *JNKVV Res J.* 2002; 35(1/2): 36-37.
27. Kumar V, Saikia J, Barik N. Influence of organic, inorganic and biofertilizers on growth, yield, quality and economics of okra [*Abelmoschus esculentus* (L.) Moench] under Assam condition. *Int J Curr Microbiol & Appl Sci.* 2017; 6(12): 2565-2569.
28. Mal B, Mahapatra P, Mohanty S, Mishra HN. Growth and yield parameters of okra (*Abelmoschus esculentus*) influenced by diazotrophs and chemical fertilizers. *J Crop and weed.* 2013; 9(2): 109-112.
29. Swarnam T, Velmurugan A, Roy N. Effect of foliar application of panchagavya on yield and quality characteristics of eggplant (*Solanum melongena* L). *Advances in Life Sci.* 2016; 5(7): 2636-2639.
30. Swain SS, Sahu GS, Mishra N. Effect of panchagavya on growth and yield of chilli (*Capsicum annum* L. cv. Kuchinda Local). *Green Farming.* 2015; 6(2): 338-340.