The Pharma Innovation Journal 2022; 11(11): 2269-2275

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(11): 2269-2275
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www.thepharmajournal.com
Received: 13-09-2022
Accepted: 21-10-2022

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Response of okra [*Abelmoschus esculentus* (L.) Moench] to foliar application of organic bio-stimulants and micronutrients under Eastern dry zone of Karnataka

Mohammad Nasim Ayobi, Jyothi Kattegoudar, Dhananjaya BN, Devappa V and Sajidullah Safi

Abstract
Crop growth and yield are the results of genotypic expression, which can be modulated by continuous interaction with the environment and other factors. Among them, bio-stimulants and micronutrients are most important factors, which help in efficient use of available soil nutrients and foliar application is considered to be the best method due to quick response and low application rate. This field study was aimed to examine the effect of foliar application of organic bio-stimulants and micronutrients on performance of okra (*Abelmoschus esculentus* (L). Moench.) Cv. Arka Nikitha conducted at College of Horticulture, Bengaluru, Karnataka, India during summer-2021. The experiment was laid out in Randomized Complete Block Design with eight treatments and three replications. The results showed that foliar application of 0.2 percent vegetable special at 20, 40 and 60 days after sowing along with soil application of RDF (125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1}) recorded significantly maximum plant height with more number of branches and leaves per plant at 30 days after sowing (44.94 cm, 3.20 and 13.08, respectively) followed by plants sprayed with 0.2 percent humic acid at 20, 40 and 60 days after sowing and supplied with soil application of RDF while, they were least in plants which received soil application of RDF alone (38.64 cm, 2.20 and 7.80, respectively) and the same trend was continued till 70 days after sowing. The same treatment combination produced significantly maximum stem diameter (19.30 mm), length of petiole (16.02 cm), length of internodes (4.87 cm), number of nodes per plant (28.14), number of pods per plant (23.86), pod length (14.53 cm), pod diameter (1.77 cm), pod yield per plant (484.78 g), pod yield per plot (16.97 kg) and total pod yield per hectare (23.70 t) besides, took significantly minimum days for 50 percent flowering (59.87). The okra plants which received the same treatment combination were quite high in total N (1.77%), P (0.86%) and K (1.20%) contents in the index tissues with efficient utilization of soil nutrients without affecting pH, EC and organic matter status of soil. The highest net monetary returns (Rs. 1,71,720 ha^{-1}) and B : C ratio (2.63) were realized from the same treatment combination.

Keywords: Okra, foliar spray, vegetable special, bio-stimulants, yield, economics

Introduction
Okra (*Ablemoschus esculentus* L.) is one of the most important vegetable crop grown in all agro-ecological zones mainly for its immature fruits, which eaten as cooked vegetable. Apart from its use as a vegetable, its stem and roots are used for cleaning the cane juice from which sugar is prepared and dried seeds are nutritious food. Okra is being grown throughout the world, covering an area of 2.16 mha with production of 8.90 mt and productivity of 4.12 t ha^{-1}. In India, it is grown in an area of 0.50 mha with a production of 6.09 mt and productivity of 11.97 t ha^{-1}. The major okra growing states are West Bengal, Gujarat, Bihar, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh and Karnataka. Karnataka occupies an area of 10 thousand hectares with a production of 98 thousand tons and productivity of 9.06 t ha^{-1} (Anon., 2018) [3]. Crop growth and yield are the results of genotypic expression, which can be modulated by continuous interaction with the environment and other factors. Among them, bio-stimulants and micronutrients are most important factors, which help in the efficient use of available soil nutrients. Micronutrients are vital to the growth of plants, acting as catalyst in promoting various organic reactions taking place within the plant and their deficiencies often limit crop productivity (Sudha *et al.*, 2018) [19]. Foliar application of organic bio-stimulants and micronutrients is considered to be the best method due to quick response, uniform distribution and low application rate (Polara *et al.*, 2017) [16].

Hence, the present study was undertaken to study the effect of foliar application of different organic bio-stimulants and micronutrients on growth, yield, tissue nutrients content, soil chemical properties and economics of okra.

Material and Methods

A field experiment was conducted at Vegetable Research Block, College of Horticulture, Gandhi Krishi Vigyan Kendra Campus, Bengaluru, Karnataka, India during summer season of 2021 to study the effect of foliar application of organic bio-stimulants and micronutrients on growth, yield, tissue nutrients content, soil chemical properties and economics of okra. The experiment was laid out in Randomized Complete Block Design with eight treatments and three replications. The treatments consisted of foliar application of 0.5 per cent seaweed extract, waste decomposer as per the recommendation of National Centre of Organic Farming, Ghaziabad, 0.2 per cent humic acid, 0.5 per cent zinc sulphate, 0.5 per cent zinc sulphate plus 0.2 per cent borax, and 0.2 per cent vegetable special with soil application of recommended doses of fertilizers (125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1}) to all treatments and they were compared with control which received soil application of recommended doses of fertilizers alone. The seaweed extract has been derived from algae which acts as metabolic bio-enhancer and contains micronutrients, vitamins, plant growth hormones *viz.*, auxins, cytokinin and gibberellins. The waste decomposer is a consortium of few beneficial microorganisms isolated from desi cow dung by National Centre of Organic Farming (NCOF), Ghaziabad and works as biofertilizer, biocontrol and soil health reviver (Chandra *et al.*, 2019) [5]. Humic acid is a fraction of humic substances produced by continuous decomposition of plant, animal and microbial residues, encompassing alteration of carbohydrates, proteins, fats, resins, wax and so on. Humic acid is a long chain ploymerized compounds with more aromatic hydrophobic groups compared to carboxylic and alcoholic hydroxyl groups and on an average, it contains 54 to 59 per cent carbon, 3 to 6 per cent hydrogen, 1 to 5 per cent nitrogen, 0.1 to 0.5 per cent sulphur and 33 to 38 per cent oxygen. The vegetable special is a multi-micronutrients combination, consisting of zinc, boron, manganese, iron and copper developed from Indian Institute of Horticultural Research, Bengaluru.

The seeds of okra were soaked in water for overnight and sown on flat bed system in last week of March 2021, maintaining a spacing of 60 cm x 30 cm. The organic bio-stimulants and micronutrients solutions were prepared as per the treatment and sprayed on the foliage of the plants to each treatment and replication at 20 days intervals. All the cultural operations and plant protection measures were followed uniformly for all the treatments during the entire period of the experimentation. The growth parameters *viz*., plant height (cm), number of branches per plant and number of leaves per plant at 30, 50 and 70 days after sowing as well as stem diameter (mm), length of petiole (cm) and length of internodes at harvest were recorded. The flowering behaviour *viz.*, number of nodes per plant, node number at which first flower appeared and days to 50 per cent flowering were recorded. The yield attributes *viz*., number of pods per plant, pod length (cm), pod diameter (cm) and pod yield per plant (g) and pod yield per plot (kg) were recorded besides, pod yield per hectare (t) was computed.

The recently matured whole leaf along with petiole were collected separately from each treatment and were washed, dried and powdered. For determination of total P and K contents, the powdered samples were digested with diacid mixtures (HNO_3: $HClO_4$ in the ratio of 10: 4) while for determination of total N content, they were digested with concentrated sulphuric acid in presence of digestion mixture. The total N content in sulphuric acid digested sample was estimated by Kjeldahl's distillation method (Piper, 1966) [15]. Total P in the diacid digested plant sample was estimated by vanadomolybdate yellow colour using spectrophotometer as explained by Piper (1966) [15]**.** Total K in the diacid digested plant sample was estimated by flame photometric method (Piper, 1966) [15]. Similarly, the surface soil samples (0 to 15 cm) were collected separately from each treatment block at the end of experiment and were processed as per standard procedure outlined by Jackson (1973) [10]. The soil pH was estimated in 1 : 2.5 soil-water suspension using calibrated digital pH-meter, while the electrical conductivity (EC) of this supernatant was measured by using conductivity meter as described by Jackson (1973) [10]. Organic carbon was determined by following the wet-oxidation method as described by Walkley and Black (1934) [20]. Available nitrogen content of soil was determined by following alkaline potassium permanganate method as described by Subbiah and Asija (1956) [18]. Available phosphorus was extracted with Bray's No. 1 extractant and estimated by spectrophotometric method as described by Jackson (1973) [10]. Available potassium was determined flame photometrically using neutral normal ammonium acetate extractant as given by Jackson (1973) [10].

The cost of cultivation of okra crop was calculated by taking into account all of the expenses. The gross returns, net returns and cost benefit ratio were worked out by considering the market price of different inputs used, labour charges and miscellaneous expenditures that were prevailed at the time of experimentation as well as pod yield and the prevailing market price of okra. The data on various parameters recorded and analyzed during the course of investigation were statistically analyzed by applying the technique of analysis of variance as suggested by Panse and Sukhatme (1985) [14]. Wherever, the treatments differences were found significant, critical difference was worked out at five per cent probability level.

Results and Discussion

Growth parameters

The growth parameters of okra *viz*., plant height, number of branches per plant and number of leaves per plant at 30, 50 and 70 days after sowing differed significantly due to foliar application of different organic bio-stimulants and micronutrients (Table 1). The plants sprayed with 0.2 per cent vegetable special and supplied with soil application of RDF (125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1}) produced significantly longest plants with more number of branches and leaves per plant at 30 days after sowing (44.94 cm, 3.20 and 13.08, respectively) followed by plants sprayed with 0.2 per cent humic acid and supplied with soil application of RDF (43.70 cm, 3.13 and 12.03, respectively) while, they were least in plants which received only RDF (38.64 cm, 2.20 and 7.80, respectively). The same trend was continued till 70 days after sowing where, significantly maximum plant height (161.31 cm), more number of branches per plant (5.20) and leaves per plant (32.65) were recorded in the same treatment.

The other growth parameters *viz.*, stem diameter, length of petiole, length of internode and number of nodes per plant recorded at final harvest were also differ significantly due to foliar application of different organic bio-stimulants and micronutrients (Table 2). The plants which received foliar spray of 0.2 per cent vegetable special and soil application of RDF showed significantly maximum stem diameter (19.30 mm), length of petiole (16.02 cm), length of internode (4.87 cm) with more number of nodes per plant (28.14) followed by plants which received foliar spray of 0.2 per cent humic acid and soil application of RDF (17.47 mm, 14.62 cm, 4.83 cm and 26.04, respectively) while, they were least in plants which received only RDF (14.31 mm, 12.04 cm, 3.11 cm and 21.83, respectively). The flowering behaviour such as node number at which first flower appeared and days to 50 per cent flowering differed significantly due to foliar application of different organic bio-stimulants and micronutrients (Table 2). Significantly minimum node number at which first flower appeared (4.47) and minimum days to 50 per cent flowering (59.87) were recorded in the treatment which received foliar spray of 0.2 per cent vegetable special plus soil application of RDF.

The increased growth parameter and earliness of flowering due to foliar spray of vegetable special and soil application of RDF might be attributed to existence of micronutrients *viz.*, zinc, boron, manganese, iron and copper in vegetable special and their active role in plant metabolic processes involving cell wall development, respiration, photosynthesis, chlorophyll formation, enzyme activity and nitrogen fixation. Further, Polara *et al.* (2017) [16] opined that direct spray of micronutrients to crop foliage is found beneficial due to quick response, uniform distribution and low application rate. Similar results were obtained by Divyashree *et al.* (2018) [6] in mungbean who reported that the foliar spray of micronutrients mixture involving Fe, Mn, Zn, Cu, B and Mo had significantly increased the plant growth and yield parameters. The foliar application of 0.2 per cent humic acid recorded significantly on par results with foliar spray of 0.2 per cent vegetable special that might be due to change in the structure and fluidity of the membrane and cell membrane permeability as affected by the surface active properties of humic acid (Kirn *et al.*, 2010) [11]. The humic acid stimulates shoot elongation, increases leaf nutrients accumulation, chlorophyll biosynthesis, enzymatic actions, cell division and active biological processes of plant which leads to increased vegetative growth. Similar results were also reported by Gad *et al.* (2015) [8] and Alhasnawi *et al.* (2020) [2]. The next best treatment with on par results obtained was foliar application of 0.5 per cent zinc sulphate plus 0.2 per cent borax due to their synergetic effects which in turn helped for balanced absorption of available soil nutrients, increased rate of photosynthesis and both nutrients are involved in nitrogen metabolism. Similar findings were reported by Elayaraja and Dhanasekaran (2016) [7].

Yield parameters

The yield parameters of okra *viz.*, number of pods per plant, pod length, pod diameter, pod yield per plant, net plot pod yield and total pod yield per hectare differed significantly due to foliar application of organic bio-stimulants and micronutrients (Table 3). Among the treatments tested, the significantly maximum number of pods per plant (23.86), pod length (14.53 cm), pod diameter (1.77 cm), pod yield per plant (484.78 g), net plot pod yield (16.97 kg) and total pod yield per hectare (23.70 t) were recorded in the treatment T_8 which received soil application of RDF (125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1}) plus foliar spray of 0.2 per cent vegetable special at 20, 40 and 60 days after sowing. The increased yield parameters due to foliar spray of 0.2 per cent vegetable special might be attributed to existence of micronutrients *viz.*, zinc, boron, manganese, iron and copper in vegetable special and their active role in plant metabolic processes involving cell wall development, respiration, photosynthesis, chlorophyll formation, enzyme activity and nitrogen fixation might have increased the plant vegetative growth that resulted in more assimilation of photosynthates to sink since significant correlations exists between various vegetative growth traits and yield parameters. These outcomes are in line with the findings of Polara *et al.* (2017) [16], Mohammadi *et al.* (2016) [12] and Ngoroyemoto *et al.* (2019) [13]. The yield parameters of treatment T_8 were closely followed by the treatments T_4: Soil application of RDF + Foliar spray of 0.2 per cent humic acid at 20, 40 and 60 days after sowing and T_7: Soil application of RDF + Foliar spray of 0.5 per cent zinc sulphate plus 0.2 per cent borax at 20, 40 and 60 days after sowing. The increased vegetative growth of the plants in both the treatments resulted in improved yield parameters. Similar results are also reported by Abbasi *et al.* (2010) [1] and Helaly and Ibrahim (2019) [9].

Plant tissue nutrients

The data on total N, P and K contents (Fig. 1) in the index tissues of okra as influenced by foliar spray of organic bio-stimulants and micronutrients revealed that the plants supplied with soil application of RDF (125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1}) and sprayed with 0.2 per cent vegetable special at 20, 40 and 60 days after sowing recorded significantly maximum concentration of total N (1.77%), P (0.86%) and K (1.20%) contents in the index tissues of okra over rest of the treatments tried. Whereas, significantly minimum concentration of NPK (1.39, 0.65 and 1.03%, respectively) was recorded in the index tissues of okra grown in control plot which received the soil application of RDF alone. The increased concentration of primary nutrients in the index tissues of okra due to foliar spray of vegetable special might be attributed to existence of micronutrients *viz.*, zinc, boron, manganese, iron and copper in vegetable special which upon absorption by the leaf tissues might have enhanced the absorption of other nutrients from the soil. Similar results were reported by Rani *et al.* (2013) [17] and Arya *et al.* (2021) [4] regarding NPK uptake by okra.

Soil chemical properties

The chemical properties *viz.*, pH, EC, organic carbon and available nitrogen content of soil after harvest of the crop did not differ significantly due to foliar spray of organic bio-stimulants and micronutrients (Table 4). However, available P_2O_5 and K_2O contents of soil found to be significantly highest (27.03 and 190.25 kg ha^{-1}, respectively) in the post-harvest soil of control plot which received soil application of RDF alone. While, significantly lowest available P_2O_5 and K_2O contents (24,22, and 184.93 kg ha^{-1}, respectively) were found in the soil which received the treatment T_8: Soil application of RDF (125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1}) + Foliar spray of 0.2 per cent vegetable special at 20, 40 and 60 days after sowing. The highest quantity of

available P_2O_5 and K_2O contents of post-harvest soil in the control plot might be due to lesser absorption of NPK nutrients by plants during vegetative and reproductive growth. On the other hand, foliar application of 0.2 per cent vegetable special stimulated the plants to absorb optimum quantity of nutrients from soil. Thus, the residual nutrients content in the soil have reduced in the treatment T_8. Similar results were recorded by Elayaraja and Dhanasekaran (2016) [7] and Arya *et al.* (2021) [4].

Economics

The economics of okra cultivation in terms of gross returns, net returns and B: C ratio as influenced by the foliar application of different types of organic bio-stimulants and micronutrients included in the present experiment had been worked out and depicted in the Figure 2. Among the different treatments tried, the treatment T_8 which received foliar spray of 0.2 per cent vegetable special at 20, 40 and 60 days after sowing along with soil application of RDF (125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1}) was found superior with highest gross returns (Rs. 2,37,000 ha^{-1}), net returns (Rs. 1,71,720 ha^{-1}) and B : C ratio (2.63) followed by the treatment T_4 which received foliar spray of 0.2 per cent humic acid at 20, 40 and 60 days after sowing plus soil application of RDF. Both the treatments T_8 and T_4 were found to be economically profitable and highly remunerative as they produced more total pod yield of 23.70 t ha^{-1} and 23.03 t ha^{-1}, respectively. While, the lowest gross returns (Rs. 1,94,900 ha^{-1}), net returns (Rs. 1,31,192 ha^{-1}) and B : C ratio (2.06) were obtained from the control treatment which received soil application of RDF alone. The results clearly indicated that the use of organic bio-stimulants and micronutrients as foliar spray along with soil application of RDF (125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1}) had increased the yield of okra, so gave remunerative returns to okra growers. This is in accordance with the finding of Arya *et al.* (2021) [4].

Table 1: Effect of foliar application of organic bio-stimulants and micronutrients on growth parameters of okra at different stages of crop growth

Treatment details	Plant height (cm)			No. of branches per plant			No. of leaves per plant		
	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS
T_1 : Control (RDF: 125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1})	38.64	105.16	134.70	2.20	3.07	4.07	7.80	15.07	21.60
T_2 : RDF + Foliar application of 0.5% seaweed extract	40.40	110.69	153.26	2.60	3.47	4.60	10.33	17.14	25.67
T_3 : RDF + Foliar application of waste decomposer	40.16	110.45	152.14	2.60	3.33	4.27	9.67	16.43	24.56
T_4 : RDF + Foliar application of 0.2% humic acid	43.70	115.11	158.11	3.13	4.00	4.87	12.03	21.77	29.76
T_5 : RDF + Foliar application of 0.5% zinc sulphate	40.42	111.17	153.59	2.67	3.67	4.67	8.97	18.12	22.94
T_6 : RDF + Foliar application of 0.2% borax	42.18	111.18	155.63	2.90	3.73	4.72	10.00	20.10	25.12
T_7 : RDF + Foliar application of 0.5% zinc sulphate + 0.2% borax	42.73	111.34	157.71	2.93	3.80	4.87	11.96	20.51	29.72
T_8 : RDF + Foliar application of 0.2% vegetable special	44.94	124.11	161.31	3.20	4.20	5.20	13.08	22.96	32.65
S.Em ±	1.20	3.25	4.56	0.10	0.18	0.19	0.40	0.97	1.04
CD @ 5%	3.65	9.86	13.83	0.29	0.56	0.57	1.22	2.96	3.16
CV	5.03	5.01	5.15	5.92	8.70	7.04	6.62	8.88	6.81

Table 2: Effect of foliar application of organic bio-stimulants and micronutrients on growth parameters of okra at final harvest and earliness of flowering

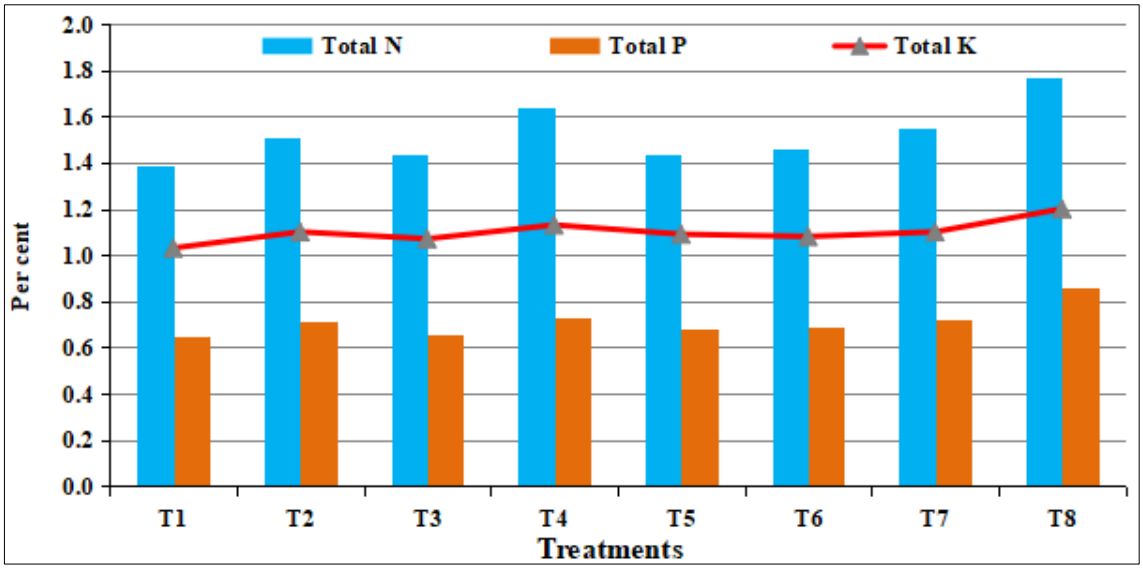
Treatment details	Stem diameter (mm)	Length of petiole (cm)	Length of internodes (cm)	No. of nodes per plant	Node no. at which 1st flower appears	Days to 50 per cent flowering
T_1 : Control (RDF: 125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1})	14.31	12.04	3.11	21.83	5.87	63.53
T_2 : RDF + Foliar application of 0.5% seaweed extract	15.30	12.85	4.12	24.90	4.87	61.13
T_3 : RDF + Foliar application of waste decomposer	15.12	12.62	3.26	23.13	4.87	62.53
T_4 : RDF + Foliar application of 0.2% humic acid	17.47	14.62	4.83	26.04	4.60	61.13
T_5 : RDF + Foliar application of 0.5% zinc sulphate	16.87	13.60	3.87	24.78	5.40	62.67
T_6 : RDF + Foliar application of 0.2% borax	16.81	14.19	4.00	24.57	5.07	61.60
T_7 : RDF + Foliar application of 0.5% zinc sulphate + 0.2% borax	17.30	14.44	4.58	25.46	4.67	61.80
T_8 : RDF + Foliar application of 0.2% vegetable special	19.30	16.02	4.87	28.14	4.47	59.87
S.Em ±	0.76	0.57	0.26	1.12	0.18	0.27
CD @ 5%	2.32	1.72	0.80	3.40	0.55	0.83
CV	7.99	7.10	11.13	7.81	6.29	0.77

Table 3: Effect of foliar application of organic bio-stimulants and micronutrients on yield parameters of okra

Treatments details	No. of pods per plant	Pod length (cm)	Pod diameter (cm)	Yield per plant (g)	Net plot yield (kg)	Yield per hectare (t)
T_1 : Control (RDF: 125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1})	18.12	11.91	1.27	401.35	14.04	19.49
T_2 : RDF + Foliar application of 0.5% seaweed extract	18.99	12.92	1.62	464.17	16.25	22.57
T_3 : RDF + Foliar application of waste decomposer	18.80	12.53	1.60	416.57	14.55	20.46
T_4 : RDF + Foliar application of 0.2% humic acid	20.45	13.81	1.67	475.61	16.60	23.03
T_5 : RDF + Foliar application of 0.5% zinc sulphate	18.74	12.13	1.60	418.74	14.66	20.41
T_6 : RDF + Foliar application of 0.2% borax	18.82	12.63	1.56	457.14	15.99	22.23
T_7 : RDF + Foliar application of 0.5% zinc sulphate + 0.2% borax	19.12	13.44	1.66	468.29	16.40	22.73
T_8 : RDF + Foliar application of 0.2% vegetable special	23.86	14.53	1.77	484.78	16.97	23.70
S.Em ±	0.82	0.50	0.07	18.64	0.56	0.78
CD @ 5%	2.47	1.50	0.22	56.53	1.69	2.35
CV	7.20	6.61	8.02	7.20	6.15	6.16

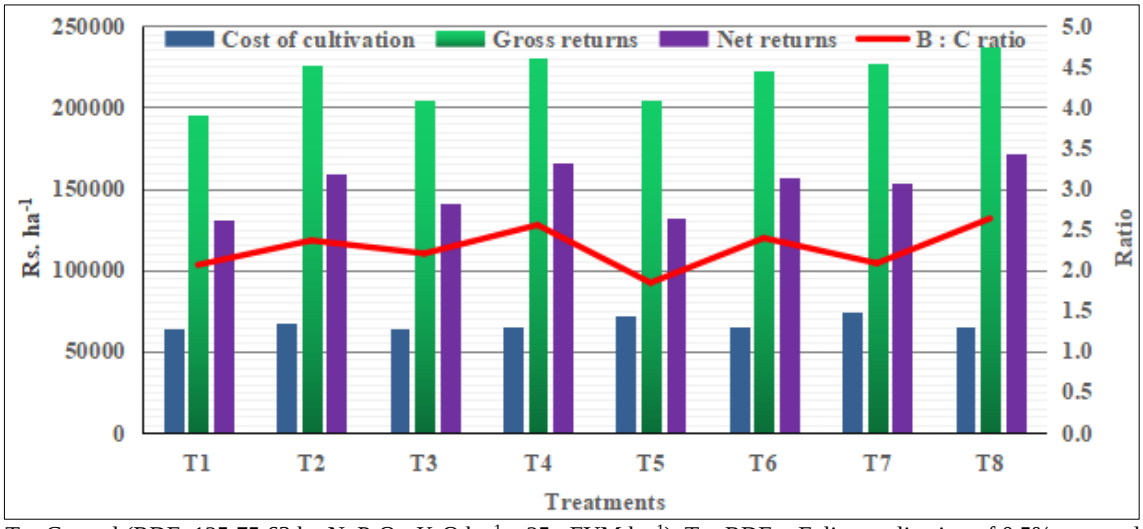
Table 4: Effect of foliar spray of organic bio-stimulants and micronutrients on chemical properties of soil after harvest of the okra

Treatments details	pH	EC (dS m^{-1})	OC (&)	Avail. N (kg ha^{-1})	Avail. P_2O_5 (kg ha^{-1})	Avail. K_2O (kg ha^{-1})
T_1 : Control (RDF: 125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1})	6.92	0.34	0.71	311.40	27.03	190.25
T_2 : RDF + Foliar application of 0.5% seaweed extract	6.91	0.36	0.69	307.39	25.46	178.78
T_3 : RDF + Foliar application of waste decomposer	6.90	0.36	0.71	310.31	26.90	188.55
T_4 : RDF + Foliar application of 0.2% humic acid	6.91	0.36	0.69	304.43	24.44	185.30
T_5 : RDF + Foliar application of 0.5% zinc sulphate	6.91	0.36	0.70	309.06	26.79	187.67
T_6 : RDF + Foliar application of 0.2% borax	6.90	0.35	0.69	308.21	25.83	187.67
T_7 : RDF + Foliar application of 0.5% zinc sulphate + 0.2% borax	6.90	0.36	0.69	306.24	24.67	185.68
T_8 : RDF + Foliar application of 0.2% vegetable special	6.91	0.36	0.70	301.74	24.22	184.93
S.Em ±	0.08	0.01	0.01	3.30	0.30	2.08
CD @ 5%	NS	NS	NS	NS	0.92	6.29
CV	2.09	2.73	1.58	1.86	2.05	1.93



T_1 : Control (RDF: 125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1}), T_2 : RDF + Foliar application of 0.5% seaweed extract, T_3 : RDF + Foliar application of waste decomposer, T_4 : RDF + Foliar application of 0.2% humic acid, T_5 : RDF + Foliar application of 0.5% zinc sulphate, T_6 : RDF + Foliar application of 0.2% borax, T_7 : RDF + Foliar application of 0.5% zinc sulphate + 0.2% borax and T_8 : RDF + Foliar application of 0.2% vegetable special

Fig 1: Effect of foliar application of organic bio-stimulants and micronutrients on primary nutrients content in the index tissues of okra



T_1 : Control (RDF: 125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1}), T_2 : RDF + Foliar application of 0.5% seaweed extract, T_3 : RDF + Foliar application of waste decomposer, T_4 : RDF + Foliar application of 0.2% humic acid, T_5 : RDF + Foliar application of 0.5% zinc sulphate, T_6 : RDF + Foliar application of 0.2% borax, T_7 : RDF + Foliar application of 0.5% zinc sulphate + 0.2% borax and T_8 : RDF + Foliar application of 0.2% vegetable special

Fig 2: Effect of foliar application of organic bio-stimulants and micronutrients on economics of okra

Plate 1: General view of the experimental plot at different growth stages

Plate 2: Physical characteristics of okra pods as influenced by foliar spray of organic bio-stimulants and micronutrients

Conclusion

From the outcome of this experiment, it can be inferred that the growth and yield parameters of okra are significantly influenced by foliar application of organic bio-stimulants and micronutrients. Foliar application is efficient in reducing the deficiency of nutrients in the plants due to quick and direct response of plants to applied fertilizers as compared to soil application. Among the treatments, foliar application of 0.2 per cent vegetable special at 20, 40 and 60 days after sowing along with soil application of RDF (125:75:63 kg N, P_2O_5, K_2O ha^{-1} + 25 t FYM ha^{-1}) proved to be remunerative and advantageous in order to get higher yield with better utilization of available soil nutrients without affecting soil reaction (pH), total soluble salts content (EC) and organic carbon (OC) status of soil in okra [*Abelmoschus esculentus* (L.) Moench] under Eastern dry zone of Karnataka.

Acknowledgement

Senior author is grateful to the Greenery Department of Kabul Municipality, Afghanistan support, Indian Council for Cultural Relations for sponsoring the education programme, University of Horticultural Sciences, Bagalkot, India for providing all the support during study period and Dr. H. B. Lingaiah, Retired Emeritus Professor of Vegetable Science, University of Horticultural Sciences, Bagalkot for his constant guiding during my research.

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