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Effect of bio-stimulants on growth, yield and quality of okra (*Abelmoschus esculentus* L. Moench)

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Abstract

The experiment comprised of two factors varieties (GJO 3 and GO 6) and eight bio-stimulants treatment combination with total sixteen treatment combinations were laid out in Factorial Randomized Block Design (FRBD) with three replications. The results revealed that variety GO 6 (V₂) found better in marketable fruit yield and bio-stimulants foliar application of Novel @ 1% and Panchagavya @ 3% just after initiation of flowering at 15 days interval and soil application of Jivamrut @ 500 l/ha (B₈) at sowing onwards 30 days interval has been found effective with regard to growth parameters viz., plant height, number of primary branches, days to 50% flowering, number of flowering nodes and leaf area index; yield parameters viz., fruit length, number of fruits per plant, number of pickings, weight of fruit and marketable yield. Also, the net return and benefit cost ratio obtained higher in variety GO 6 and bio-stimulants Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha.

Keywords: Okra, bio-stimulants, panchagavya, jivamrut, novel, seaweed extract

Introduction

Okra (*Abelmoschus esculentus* L. Moench) is frequently known as Lady's Finger or Bhendi, which belongs to family Malvaceae having chromosome number $2n=130$ (Gadwal *et al.*, 1968) [7]. The primary centre of its origin is believed to be the tropical or subtropical Africa. Besides being vegetable, it has also medicinal and industrial importance. It's root and stem has been used for cleaning the cane juice in the manufacture of jaggery and sugar. Matured fruits and stem contain crude fiber are used in paper industry. Also, useful against genito-urinary disorders, spermatorrhoea and chronic dysentery.

Novel prepared by fiber extraction of harvested banana pseudostem has good source of plant nutrients such as major and micronutrients along with growth promoting hormones like Cytokinin and Gibberellic Acid. Seaweed Extract contains major and micronutrients, amino acid, vitamins, cytokinin, auxin and abscisic acid like growth promoting substances. Panchagavya means the blend of five products obtained from cow namely dung, urine, milk, curd and ghee. Bio-chemical properties of panchagavya revealed that it possesses almost all the major nutrients like nitrogen, phosphorous, potash and micro nutrients essential for plant and growth hormones like IAA and GA required for crop growth (Selvaraj *et al.*, 2007) [18]. Jivamrut contains small amount of major and micro nutrients but enormous amount of microbial load which multiply and enhance nitrogen fixation and nutrient mobilization and increase soil fertility. All bio-stimulants seems to have great potential to stimulate growth, improve yield and quality traits of crops. However very little information is available regarding these matters; therefor current study was conducted to investigate "Effect of bio-stimulants on growth, yield and quality of okra (*Abelmoschus esculentus* L. Moench)".

Materials and Methods

The present investigation was conducted at Educational Farm, Polytechnic in Horticulture, Junagadh Agricultural University, Junagadh during Kharif-2019. Total 16 treatment combinations comprised of two varieties viz., GJO 3 (V₁), GO 6 (V₂), four bio-stimulants alone viz., Novel @ 1% (B₁), Seaweed extract @ 2.5% (B₂), Panchagavya @ 3% (B₃), Jivamrut @ 500 l/ha (B₄) and in combinations viz., Novel @ 1% + Panchagavya @ 3% (B₅), Seaweed extract @ 2.5% + Panchagavya @ 3% (B₆), Panchagavya @ 3% + Jivamrut @ 500

l/ha (B7), Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha (B8) were laid out in Randomized Block Design (RBD) with factorial concept in three replications. Hence, total 16 treatment combinations were tested in this experiment. Novel was borrowed from Navsari Agricultural University, Seaweed Extract was obtained from Fisheries Research station, J. A. U., Okha. Panchagavya was prepared by the method as described by TNAU (Tamil Nadu Agriculture University). Jivamrut was prepared by method as described by National Centre of Organic Farming, Ghaziabad. The recommended dose of FYM 20 t/ha and RDF 100: 50: 50 kg NPK per ha were applied uniformly in all the treatments. Seed sowing was carried out on 22th June, 2019 using 8-10 kg/ha seed rate with spacing of 60 X 30 cm on finely cultivated land. Foliar application of bio-stimulants namely Novel @ 1%, Seaweed Extract @ 2.5% and Panchagavya @ 3% were sprayed at 15 days interval just after initiation of flowering while Jivamrut was applied in soil @ 500 l/ha at 30 days interval onwards sowing. All the necessary agronomic cultural practices were done as and when required.

Results and Discussion

Growth parameters

Effect of varieties: The data revealed that effect of different varieties had produced non-significant effect on growth parameters viz., plant height, number of primary branches, days to 50% flowering and number of flowering nodes (Table 1). However, leaf area index was found to be significant on varieties taken under investigation. Significantly, higher leaf area index was observed in variety GO 6 (V₂) (2.25) of okra. This might be due to genetical differences in varieties.

Effect of bio-stimulants

In case of bio-stimulants, the effect was found significant on growth parameters viz., plant height, number of primary

branches, days to 50% flowering, number of flowering nodes and leaf area index (Table 1). Significantly higher, plant height (193.80 cm), number of primary branches (3.47), days to 50% flowering (44.83), number of flowering nodes (5.77) and leaf area index (2.32) were noted with an application of Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha (B8). The conspicuous impact of liquid organics on growth attributes of okra might be due to their rapidly available form of nutrients, bio-chemicals and microbes present within it, which are easily absorbed, leading to faster growth and development of okra components. Novel contains macronutrients (N, K, P, Ca, Mg, S), micronutrients (Mn, Cu, Zn), some bio-chemicals such as NAA, gibberellic acid, cytokinin and beneficial microbes (PSB, rhizobium, azotobacter and fungus). Effective Micro Organisms (EMO), mostly lactic acid bacteria (*Lactobacillus*), yeast (*Saccharomyces*), actinomyces (*Streptomyces*), photosynthetic bacteria (*Rhodospseudomonas*) and certain fungi (*Aspergillus*) (Xu and Xu, 2001) [27]. Jivamrut may have attributed to the faster enhancement of vegetative growth and storing sufficient reserved food materials for enhanced growth. It might also be due to huge number of beneficial microbes present in jivamrut which may have helped in decomposition of organic matter and releasing of available nutrients for easy uptake and utilization by plants from the soil. Similar results were found by Patel *et al.* (2018) [16] in groundnut; Gore and Sreenivasa (2011) [9] in tomato; Yogananda *et al.* (2015) [28] in cow pea and Gangadhar *et al.* (2020) [8] in chilli.

Interaction effect of varieties and bio-stimulants

The interaction effect between varieties and bio-stimulants had produced non-significant effect in all considered growth parameters in present experiment (Table 1).

Table 1: Effect of varieties and bio-stimulants on growth parameters

Treatment	Plant height (cm)	No. of primary branches	Days to 50% Flowering (days)	Number of flowering nodes	Leaf area index
Factor V: Varieties					
V ₁	179.58	2.55	48.96	4.03	2.20
V ₂	179.73	2.70	48.63	4.28	2.25
S. Em ±	2.09	0.05	0.30	0.07	0.01
C. D. at 5%	NS	NS	NS	NS	0.02
Factor B: Bio-stimulants					
B ₁	172.97	2.33	49.17	3.53	2.17
B ₂	170.70	2.23	50.83	3.17	2.14
B ₃	171.90	2.43	49.33	3.33	2.15
B ₄	176.10	2.23	48.33	3.73	2.21
B ₅	184.90	2.53	50.33	4.13	2.21
B ₆	186.70	2.60	50.67	4.10	2.28
B ₇	180.13	3.17	46.83	5.33	2.31
B ₈	193.80	3.47	44.83	5.77	2.32
S. Em ±	4.19	0.10	0.61	0.14	0.01
C. D. at 5%	11.94	0.31	1.74	0.42	0.04
Interaction (V X B)					
S. Em ±	5.93	0.15	0.86	0.20	0.02
C. D. at 5%	NS	NS	NS	NS	NS
C. V. %	5.72	10.19	3.07	8.71	1.70

Yield parameters

Effect of varieties: The data indicated that effect of different varieties had produced non-significant effect on yield parameters viz., fruit diameter, number of fruits per plant, weight of fruit and total number of pickings (Table 2). However, the effect of varieties found to be significant on fruit length and marketable fruit yield. Significantly, maximum fruit length (11.23 cm) and higher marketable fruit

yield (3.40 kg/net plot and 11.79 t/ha) observed in variety GO 6 (V₂). This might due to increase chlorophyll content helped to enhance photosynthetic activity of variety GO 6 (V₂) which ultimately enhanced utilization of photosynthates and increased allocation of photosynthates which leads to better yield over variety GJO 3 (V₁). The reports are in conformity with Kocira *et al.* (2018) [12] in French bean, Madhukumar *et al.* (2018) [13] in chilli.

Table 2: Effect of varieties and bio-stimulants on yield parameters

Treatment	Fruit length (cm)	Fruit diameter (mm)	Number of fruits per plant	Number of pickings	Weight of Fruit (g)	Marketable yield (kg/net plot)	Marketable yield (t/ha)
Factor V: Varieties							
V ₁	10.58	17.02	15.14	12.29	13.60	3.16	10.97
V ₂	11.23	17.42	15.26	12.18	14.04	3.40	11.79
S. Em ±	0.13	0.16	0.18	0.07	0.17	0.06	0.21
C. D. at 5%	0.37	NS	NS	NS	NS	0.18	0.62
Factor B: Bio-stimulants							
B ₁	10.51	17.11	14.23	10.96	11.91	2.95	10.23
B ₂	10.35	17.41	13.93	11.32	11.43	2.74	9.51
B ₃	10.69	16.64	14.20	11.00	12.51	2.99	10.37
B ₄	10.60	17.36	14.30	11.52	12.99	3.08	10.70
B ₅	11.09	17.11	15.50	12.50	13.79	3.25	11.29
B ₆	11.26	17.10	15.80	13.36	14.92	3.44	11.95
B ₇	11.22	17.26	16.57	13.39	15.65	3.76	13.07
B ₈	11.53	17.77	17.07	14.03	17.34	4.01	13.94
S. Em ±	0.26	0.31	0.37	0.25	0.34	0.12	0.43
C. D. at 5%	0.75	NS	1.08	0.71	0.97	0.36	1.24
Interaction (V X B)							
S. Em ±	0.37	0.45	0.53	0.22	0.48	0.17	0.61
C. D. at 5%	1.05	NS	NS	NS	NS	NS	NS
C. V. %	5.88	4.70	6.09	3.12	6.05	9.37	9.37

Effect of bio-stimulants

The effect of bio-stimulants was found significant on various yield parameters *viz.*, fruit length, number of fruits per plant, weight of fruit, total number of pickings and marketable fruit yield (Table 2). Significantly higher, fruit length (11.53 cm), number of fruits per plant (17.07), weight of fruit (17.34 g), total number of pickings (14.03) and marketable fruit yield (4.01 kg/net plot and 13.94 t/ha) were observed with an application of Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha (B8). The probable reasons for increase in yield might be due to greater availability of nutrients, easy assimilation of nutrients and balance in NPK ratio, increased uptake of nutrients and water, resulting in more photosynthesis and enhanced food accumulation in edible parts of fruits which affects the crop productivity. Salunkhe (2013) [17] also reported that higher level of fertilizers helped in formation of food reservoir due to higher photosynthetic activity, cellular activity in the roots and leaves both resulting in increased the yield. Similar results were found by Deore *et al.* (2010) [3] in chilli, Singhal *et al.* (2015) [19] in cowpea, Singhal *et al.* (2016) [20] in okra. Smaller quantities of IAA and GA present in panchagavya when foliar sprayed could have created stimulative effect in the plant system which in turn increased the production of growth regulator in cell system and the action of growth regulators in plant system stimulated the necessary growth and development, leading to better yield (Patel *et al.*, 2018) [16]. Increase in yield attributes due to jivamrut application might be attributed to solubilization and absorption of nutrients and moisture due to higher microbial load and growth hormones which might have enhanced the soil biomass thereby sustaining the availability and uptake of applied as well as native soil nutrients which ultimately resulted in better growth and yield of okra. The beneficial effects of Jivamrut reported by Palekar (2006) [29], Boraiah *et al.* (2017) [1] in capsicum, Patel *et al.* (2018) [16] groundnut. The effect of bio-stimulants on fruit diameter was found to be non-significant.

Interaction effect of varieties and bio-stimulants

The interaction effect between varieties and bio-stimulants had produced non- significant effect on yield parameters *viz.*, fruit diameter, number of fruits per plant, weight of fruit and

total number of pickings (Table 3). However, it had significant effect on fruit length of okra. Significantly, higher fruit length was found in variety GO 6 with application of Seaweed Extract @ 2.5% + Panchagavya @ 3% (V2B6) (12.07 cm). This might be due to synergistic effect of variety GO 6 with auxin and cytokinin present in Seaweed extract has helped cell division and cell elongation, Rhizobacteria with Panchagavya spray has helped translocation of carbohydrates to developing fruits which ultimately enhance fruit length.

Table 3: Interaction effect of varieties and bio-stimulants on fruit length

Interaction (V X B)								
	B ₁	B ₂	B ₃	B ₄	B ₅	B ₆	B ₇	B ₈
V ₁	10.28	9.77	10.63	10.38	10.15	10.45	11.56	11.66
V ₂	10.73	10.94	10.75	10.81	12.03	12.07	10.87	11.40
S. Em ±	0.37							
C. D. at 5%	1.05							
C. V. %	5.88							

Quality parameters

Effect of varieties

All the quality parameters were found significant in present experiment (Table 4). Significantly, higher chlorophyll content was found in variety GO 6 of okra (28.97 SPAD), higher ascorbic acid was noted with variety GJO 3 (16.72 mg/100g) and lower crude fiber (32.64%) was observed in variety GO 6 of okra. The increase in ascorbic acid and chlorophyll content were also reported by Kalariya *et al.* (2018) [10] in okra, Vennila and Jayanthi (2008) [25] in Okra. Similar finding was observed by Chotaliya *et al.* (2020) [2] in okra.

Effect of bio-stimulants

Bio-stimulants had produced significant effect on quality parameters *viz.*, chlorophyll content, ascorbic acid and crude fiber content (Table 4). Significantly, higher chlorophyll content (36.03 SPAD) and ascorbic acid (21.70 mg/100 g) were found with an application of Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha (B8). The lower crude fiber (30.27%) was observed with an application of Jivamrut @ 500 l/ha (B4) which was found to be at par with

an application of Seaweed Extract @ 2.5% + Panchagavya @ 3% (B6) (30.74%) and Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha (B8) (30.98%). Chlorophyll synthesis requires many elements i.e., nitrogen (N), phosphorous (P) also needs through a series of enzymatic reactions (Fredeen *et al.*, 1990) [6]. Here, nutrients N and P are predominantly present directly or indirectly in all the liquid manures used under this investigation which facilitates to higher chlorophyll content. So, the combination of Novel, Panchagavya and Jivamrut may facilitates more accumulation of N and P as

compared to Seaweed extract. These results are in supporting with Kocira *et al.* (2018) [12] in French bean and Suchitra *et al.* (2017) [21] in okra. The augmentation of ascorbic acid content might due to either increased ascorbic acid biosynthesis or to protection of synthesized ascorbic acid from oxidation through ascorbic acid oxidase. (Kalariya *et al.*, 2018) [10]. Also, better availability and uptake of plant required nutrients and also favourable conditions resulted by the applied jivamrut resulted in increased ascorbic acid content.

Table 4: Effect of varieties and bio-stimulants on quality parameters

Treatment	Chlorophyll content (SPAD)	Ascorbic acid (mg/100 g)	Crude fiber (%)
Factor V: Varieties			
V ₁	26.53	16.72	34.11
V ₂	28.97	16.05	32.64
S. Em ±	0.24	0.15	0.30
C. D. at 5%	0.71	0.43	0.87
Factor B: Bio-stimulants			
B ₁	26.76	12.30	35.01
B ₂	23.49	11.70	35.04
B ₃	24.97	12.58	33.69
B ₄	24.65	15.62	30.27
B ₅	24.04	18.20	37.94
B ₆	29.59	18.72	30.74
B ₇	32.47	20.25	33.33
B ₈	36.03	21.70	30.98
S. Em ±	0.49	0.30	0.61
C. D. at 5%	1.42	0.86	1.74
Interaction (V X B)			
S. Em ±	0.70	0.42	0.86
C. D. at 5%	2.01	1.21	2.46
C. V. %	4.40	4.49	4.49

Interaction effect of varieties and bio-stimulants

The interaction effect between varieties and bio-stimulants was found to be significant in all the considered quality parameters (Table 5, 6 and 7). Significantly, higher chlorophyll content (37.63 SPAD) was observed in variety GO6 with application of Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha (V₂B₈), higher ascorbic acid (21.94 mg/100g) was found in variety GJO3 with application of Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha (V₁B₈), lower crude fiber content (28.79%) was reported in GO6 with application of Jivamrut @ 500 l/ha (V₂B₄). In ascorbic acid, variety GO 6 with application of Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha (V₂B₈) (21.45

mg/100 g) and variety GJO 3 with application of Panchagavya @ 3% + Jivamrut @ 500 l/ha (V₁B₇) (20.75 mg/100 g) were found at par with variety GJO3 with application of Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha (V₁B₈). In crude fiber, variety GO 6 with application of Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha (V₂B₈) (29.23%) and GJO 3 with application of Seaweed Extract @ 2.5% + Panchagavya @ 3% (V₁B₆) (30.17%). This might be due to synergistic effect of varieties and bio-stimulants which play important role to improve quality traits. The results are in supporting with Chotaliya *et al.* (2020) [2] in okra var GAO 5, Suchitra *et al.* (2017) [21] in okra, Swain *et al.* (2015) [22] in chilli var Kuchinda Local.

Table 5: Interaction effect of varieties and bio-stimulants on chlorophyll content

	B ₁	B ₂	B ₃	B ₄	B ₅	B ₆	B ₇	B ₈
V ₁	27.87	23.20	25.57	24.83	22.13	24.13	30.07	34.43
V ₂	25.64	23.77	24.37	24.47	25.95	35.04	34.86	37.63
S. Em ±	0.70							
C. D. at 5%	2.01							
C. V. %	4.40							

Table 6: Interaction effect of varieties and bio-stimulants on ascorbic acid

	B ₁	B ₂	B ₃	B ₄	B ₅	B ₆	B ₇	B ₈
V ₁	13.27	11.64	12.15	16.06	19.06	18.87	20.75	21.94
V ₂	11.33	11.76	13.01	15.18	17.33	18.57	19.75	21.45
S. Em ±	0.42							
C. D. at 5%	1.21							
C. V. %	4.49							

Table 7: Interaction effect of varieties and bio-stimulants on crude fiber content

	B ₁	B ₂	B ₃	B ₄	B ₅	B ₆	B ₇	B ₈
V ₁	33.67	34.52	35.66	31.75	39.77	30.17	34.60	32.73
V ₂	36.35	35.56	31.72	28.79	36.11	31.30	32.06	29.23
S. Em ±	0.86							
C. D. at 5%	2.46							
C.V.%	4.49							

Economics

Higher net return (Rs. 100297.32 per ha) and benefit cost ratio (1.31) was achieved in variety GO 6 (V₂). In bio-stimulants application of Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha (B₈) leads to highernet realization (Rs. 131868.52 per ha) and BCR (1.71). Similar finding was observed by Chotaliya *et al.* (2020) ^[2] in okra.

Conclusion

On the basis of results obtained, it can be concluded that among the different varieties, variety GO 6 found better in marketable fruit yield and bio-stimulants foliar application of Novel @ 1% and Panchagavya @ 3% just after initiation of flowering at 15 days interval and soil application of Jivamrut @ 500 l/ha at sowing onwards 30 days interval has been found effective with regard to growth parameters *viz.*, plant height, number of primary branches, days to 50% flowering, number of flowering nodes and leaf area index; yield parameters *viz.*, fruit length, number of fruits per plant, number of pickings, weight of fruit and marketable yield. Also, the net return and benefit cost ratio obtained higher in variety GO 6 and bio-stimulants Novel @ 1% + Panchagavya @ 3% + Jivamrut @ 500 l/ha.

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