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Bio-efficiency Studies of Plant biotiX product "BP-100" on Okra (*Abelmoschus esculentus* (L.) Moench) cultivation

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ABSTRACT

Present investigation was done to evaluate the results of applying industrial product "BP-100" on growth, yield and quality of okra in comparison with domestic popular product as standard check "IFFCO Sea Secret". Both the products were mixture of humic acid and seaweed extract. Experiment was conducted on the agriculture field, LPU, Phagwara in summer, 2023. Okra variety Arka Anamika was obtained from IIHR, Bengaluru. Experiment was based on RBD with five treatments and five replications. Interestingly, most of the parameters like germination percentages, plant height, number of leaves, branches, flowers and fruit, fruit yield, net returns and cost benefits were found maximum under T5 (standard check) while some other traits like seedling length, seedling fresh weight and seedling vigour index I T4 gave higher results. T5 gave also maximum TSS content, ascorbic acid and mucilage content in okra while least fibre content and physiological loss of weight after harvesting was also observed in T5. Based on those observations, the conclusion made out of this experiment is, highest results in almost all parameters are coming from T5 because of more number of applications (as per recommended) on okra and less price of the product compared to test product "BP-100" used in T2, T3 and T4.

Key words: *BP-100, IFFCO Sea Secret, Humic acid, seaweed extract, Okra, Yield.*

Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) is one of the most important vegetable crops in the world which is from Malvaceae family. Due to its rough growing nature and tender green fruits, it is grown almost in all parts of the world. Okra commonly known as "Lady's finger" and "Bhindi" originated from tropical and sub-tropical Africa. Okra pods are consumed in various ways such as fresh or raw, dried, cooked, frozen, fried and pickled.

Okra is a significant vegetable crop that contributes key nutrients to our diet. It is a widely used and well-liked vegetable in Indian kitchens, and it can be grown all over India during the summer and rainy seasons. Okra is a good source of vitamins A, B, and C as well as being high in protein, carbohydrates, lipids, minerals, Iron, and Iodine (Aykroyed, 1963). Around 25% protein is there in okra seeds which is having similar amino acid profile to soyabean (Martin *et al.*, 1979).

Application of chemical fertilizers in cultivation of okra commercially play important role for high yielding and prime source of plant nutrients. The usage of chemical fertiliser indiscriminately will lead to build up of toxic concentration of salt in soil which would eventually create chemical imbalance in soil and soil environment.

Different kind of organic inputs which can be considered as substitute of chemical fertilizers are complete plant food because they provide both micro and macro nutrient elements along with different growth promoting enzymes. The liquid extracts which are obtained from seaweed called seaweed extract, which involve different kinds of multi-cellular, macroscopic marine algae that generally lives at the coastal region of world's ocean where suitable environment exists. It consists of different major and minor nutrients, amino acids, vitamins and growth regulators like auxin, cytokinin and abscisic acid (García-Casal *et al*., 2007). Humic acids are made and derived from decomposition of plant and animal residue in presence of different microorganisms. They are brown-black colour and insoluble in water under acidic condition at pH less than 2. They are cheap source of organic input which can improve the plant growth, balance the enzymatic and hormonal activities and eventually increase the yield and quality of produce (Fahramand *et al*., 2014).

As day by day increase in population cause higher demand for vegetables and as the focus of consumer is shifting toward the quality of produce, more and more studies should be done in area of organic inputs. By keeping this in mind, this study was conducted to evaluate the results by application of industrial product "BP-100" on okra crop.

Materials and Methods

The field experiment was conducted at agriculture field, Lovely Professional University, Punjab during summer, 2023. The experimental product "BP-100" manufactured by ZytexPlantbiotix was obtained from department of agriculture, Lovely Professional University. Standard check product "IFFCO Sea Secret" was purchased from local market based on demand among farming community. Okra variety "Arka Anamika" was used for experiment.

Field preparation: Field was prepared using Randomized block design. 5 treatments with 5 replications total 25 plots having 6m^2 area. Total area used for experiment was 220 m^2. Well decomposed FYM @ 10 t/ha was applied at field preparation. N:P:K @ 120:80:60 kg/ha was applied in which half dose of nitrogen and full dose of phosphorus and potassium was applied at basal dose remaining nitrogen applied at split dose. Seeds were sown on ridge beds. Total 25 plants per plot was maintained.

Test product: "BP-100" a key component of "BP-100" is natural bio polymer – poly gamma glutamic acid. A mixture of seaweed extract and humic acid. Product was dark black in colour and in liquid form, also having foul smell.

Standard check product: IFFCO named "SEA SECRET" was purchased from local market based on popularity among the farming community nearby Phagwara. Product contained 28% of seaweed extract of red and brown algae, humic acid and fulvic acid. Product was in liquid form with dark black colour along with foul smell.

Soil analysis for estimation of its properties, soil testing was done before sowing of seed. The result is mentioned in Table 1.

Treatment details

Data collection

Germination studies include germination (%), seedling length (cm), seedling fresh and dry weight (g) and seedling vigour index I and II was included. Different growth and yield parameters as plant height, number of leaves, branches, flower number, number of fruits, average fruit weight (g), fruit yield (t/ha) considered in this study. Benefit : cost ratio was also calculated based on expenditures and income came out from each treatment. For quality estimation of okra fruit TSS (°Brix) by using refractometer, ascorbic acid (mg/100 g) by Ranganna (1986), mucilage (%) by Ahiakpa *et al*. (2014), crude fibre (%) by A.O.A.C. (1960) and physiological loss of weight (%) was estimated.

Table 1. Soil physiochemical properties.

1	pH	6.4	Using pH meter (Jackson, 1973)
2	Electric conductivity (EC) (dS/m at 25 degree Celsius)	0.72	Using solubridge (Jackson, 1973)
3	Organic carbon (%)	0.53	Walkley and Black (1973)
4	Available Nitrogen (kg/ha)	142.50	Kjeldahl method (Bradstreet, 1954)
5	Available Phosphorus (kg/ha)	35.20	Olsen's method (1954)
6	Available Potassium (kg/ha)	162.90	Flame photometer (Metson, 1956)

The approach applied to the Randomised Block Design as outlined by Panse and Sukhatme (1989) was used to statistically analyse the experimental data and perform a significance test. For treatment comparison, the critical difference was calculated where the "F" test was significant at a 5% level of significance.

Results and Discussion

Germination and seedling traits

The data showed in Table 3 represent the significant effect of product "BP-100" and standard check product "IFFCO Sea Secret" on okra. Highest germination percentage (82.9%), seedling dry weight (0.93 g) and seedling vigour index II (77.15) was observed in T5. While maximum seedling length (20.60 cm), seedling fresh weight (2.2 g) and seedling vigour index II (77.15) was observed in T4. T1 whichis control gave least result in all those parameters.

As those both product is mixture of bio stimulants (seaweed extract and humic acid), they reportedly have effect on these parameters. Seaweed extracts usually improve and speedup the cell division, elongation, differentiation and synthesis of protein (El-Sheekh *et al*., 2016) while humic acid reportedly enhance the uptake of mineral nutrients by plant and improving permeability of root cell membranes (Valdrighi *et al*., 1996) which lead to better performance of seeds. Makhaye *et al*. (2021) and Paksoy *et al*. (2010) also found similar results on okra crop.

Observation on growth, yield and cost economics

As shown in Table 4, different growth, yield and cost economics is influenced by application of products. For all parameter which is plant height at 30 DAS (18.5 cm), 45 DAS (23.1 cm), 60 DAS (53.6 cm), number of leaves at 30 DAS (8.11 cm), 60 DAS (28.72), number of branches per plant 30 DAS (2.09), 60 DAS (3.59), number of flower per plant (18.5), Number of fruit per plant (17.35), average fruit weight (15.82 g) and fruit yield (9 t/ha), T5 gave superior results compared to other treatments. While least was found in T1 which is control.

Similar findings were also concluded by Gad *et al*. (2015) and Swaenam *et al*. (2020) in okra. Abetz (1980) also reported that application of seaweed extract causes more proliferation and establishment of plant roots which enable to mine more in deep layers of soil and make nutrients more available for

Table 2. Treatments

Tr. No	Treatment Detail	Crop Stage and Application	Dosage
T_1	Control (RDF)	-	-
T_2	BP-100 + RDF	1st application – sowing	2.5 L/ Acre
		2nd application – pod formation stage	2.5 L/ Acre
T_3	BP-100 + RDF	1st application – sowing	5 L/Acre
		2nd application – pod formation stage	5 L/Acre
T_4	BP-100 + RDF	1st application – sowing	10 L/Acre
		2nd application – pod formation stage	10 L/ Acre
T_5	Standard check (IFFCO Sea Secret)	As recommended. (Every two week till final harvesting)	As recommended (2.5 ml/L)

Table 3. Effect of products on germination percentage, seedling length, seedling dry and fresh weight, seedling vigour index I & II

	GP (%)	SL (cm)	SFW (g)	SDW (g)	SVI-I	SVI-II
T1	63.5	13.30	1.42	0.29	845.22	18.43
T2	72.9	11.90	1.84	0.66	867.92	48.15
T3	79.6	16.30	1.58	0.4	1298.16	31.86
T4	76	20.60	2.2	0.91	1566.61	69.20
T5	82.9	16.50	2.03	0.93	1368.90	77.15
C.D (0.05%)	3.057	0.64	0.075	0.029	97.87	4.34
S.E(m) ±	1.011	0.212	0.025	0.01	32.37	1.43

(GP -Germination percentage, SL - Seedling length, SFW - Seedling fresh weight, SDW - Seedling dry weight, SVI - Seedling vigour index) plants to be used. As per the reports of Mackowiak *et al*. (2001) and Pilanal and Kaplan (2000), application of humic acid improves the water retention, improve shoot and root growth, plant height and number of fruits.

Maximum net return 2,09,222.93 per ha and B:C (2.99) ratio was found out in T5 which is due to higher yield was obtained under this treatment. Similar results were also suggested by Meena *et al*. (2017) in cucumber and Colla *et al*. (2017) in tomato.

Observation on fruit quality

Different quality parameters were influenced by application of these products as per shown in table 5. Maximum TSS (2.13 °Brix), ascorbic acid (18.73 mg/100 g) and mucilage (13.92%) was observed in T5. This may be resulted due to increment in root biomass and physiological activity of plant stimulated by seaweed extract and humic acid which ultimately led to increasing in photosynthetic activities (Singh and Chandel, 2005). Higher mucilage content may be due to higher accumulation of metabolites like D-galactose, L-rhamnose and D-galacturonic acid in okra pods which is due to better absorption of nutrients by plants (Mani and Ramanathan, 1981) which is enhanced by application of seaweed extract and humic acid. Similar results were found by Swarnam *et al*. (2020) in okra. Least fibre containing okra fruits were more preferred for kitchen purpose as per the general observations. T5 gave least fibre content compared to other treatments which was 7%. This may be due to easy availability of nitrogen which lead to balanced C:N ratio, improving the growth of plant and photosynthetic activities (Wagh *et al*., 2014) by applying seaweed extract and humic acid. Similar results were also found out by Gayathri and Krishnaveni, (2015). Least post-harvest physiological loss in weight was also measured in treatment 5 (9.53%) after 7 days of storage. This may result due to enhancement of nutrient uptake of plant by application of seaweed extract and humic acid (Khaled *et al*., 2011 and Zhang *et al*., 2003).

Conclusion

In absence of any product application (T1 – control), there were lowestobservation in all the parameters.

Table 4. Effect of the products on growth, development, yield and cost economics of okra crop.

	PH			NLP		NBP		NFlP	NFrP	AFW (g)	FY (t/ha)	NR (₹/ha)	B:C ratio
	30 DAS	45 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS						
T1	16.3	21.25	42.85	6.8	22.25	1.2	2.25	16.4	15.05	9.16	4.67	92,893.75	1.79
T2	14.95	17.9	49.98	7.01	19.9	1.6	2.7	17.5	16.5	11.09	6.33	1,35,556.26	2.23
T3	15.12	19.87	50.76	7.66	24.72	1.72	2.92	17.24	16.65	14.71	8.33	1,88,558.31	2.70
T4	16.66	21.9	53.05	7.8	27.3	2.07	3.16	18.3	16.9	14.95	8.67	1,80,891.64	2.06
T5	18.5	23.1	53.6	8.11	28.72	2.09	3.59	18.5	17.35	15.82	9.00	2,09,222.93	2.99
C.D (0.05%)	0.657	0.836	2.046	0.305	0.991	0.073	0.119	0.716	0.672	0.539	0.31	*	*
S.E(m) ±	0.217	0.276	0.677	0.101	0.328	0.024	0.039	0.237	0.222	0.178	0.10	*	*

(PH – Plant height, NLP – Number of leaves per plant, NBP – Number of branches per plant, NFlP – Number of flowers per plant, NFrP – Number of fruits per plant, AFW – Average fruit weight, FY – Fruit Yield, NR – Net Return, B:C ratio – Benefit: cost ratio)

Table 5. Effect of products on different quality parameters of okra fruit.

	TSS (°Brix)	Ascorbic acid (mg/100 gm)	Mucilage (%)	Fibre (%)	PLW (%)
T1	1.52	14.71	6.84	10.9	11.29
T2	1.29	15.5	9.92	11.75	10.8
T3	2.04	16.67	9.72	9.8	11.15
T4	1.91	18.45	10.08	8.3	9.7
T5	2.13	18.73	13.92	7	9.53
C.D (0.05%)	0.071	0.683	0.419	0.403	0.429
S.E(m) ±	0.024	0.226	0.138	0.133	0.142

(TSS – total soluble solids, PLW – physiological loss of weight)

When BP-100 (in T2, T3 and T4) was applied there wasincreased growth in almost all parameters. As higher dose was applied, cost of cultivation was also increased. That's why despite of having higher yield in T4, is less economically sound than T3. T5 "IFFCO Sea Secret" as standard check, was found best in all of criteria for farmer to use because of more number of application in crop, less dose required and also less costly compared to test product "BP-100".

Future aspects for the test product for evaluations

1. Standardize the proper dose and interval for application on crop.
2. Increase the concentration of bio stimulants (ingredients) in product.
3. Check the product on other crop categories like oilseed crops, tree crops, flower crops, etc. for more standard evaluation.

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