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Evaluation of Bio-efficacy Studies of PlantbiotiX product "Incryl Ultra" on Okra (*Abelmoschus esculentus* (L.) Moench) cultivation

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ABSTRACT

The field experiment was carried out during summer season of 2023 at the Agriculture Research Farm, School of Agriculture, Lovely Professional University, Phagwara (Punjab). The experiment was planned using RBD with five treatments which were T1: control (RDF), T2: Incryl Ultra @ 0.5g/l + RDF, T3: Incryl Ultra @ 1.0g/l + RDF, T4: Incryl Ultra @ 2.0g/l + RDF and T5: Standard check product (IFFCO Sea Secret) and five replications. Results revealed that the treatment T4 gave maximum results in traits like germination percentage (83.50%), seedling dry weight (0.95 g), seedling fresh weight (2.85 g) and seedling vigor index II (79.38) while in T5 seedling vigor index I (1596.76) were highest. Parameters like plant height (55.90 cm), number of leaves per plant (29.90), number of branches per plant (3.40), leaf area (409 cm^2) and leaf chlorophyll content were maximum in T4 (60.21 SPAD meter reading). Traits related to flowering like days to first flowering was least in T2 (45.45) and days to 50% flowering was least in T4 (47.80). The number of flowers per plant was also highest in T4 (19.85). The number of fruits per plant and average fruit weight were also maximum in T4 (18.42) and (16.77g) respectively. Maximum yield, i.e., 10.30 ton/ha was observed in T4. T4 gave also maximum TSS content (2.51 ^oBrix) while T5 gave maximum ascorbic acid (21.10 mg/100 g) and mucilage content (13.85%) in okra. The least crude fiber content (7.04%) was found in T5 and physiological loss in weight (8.68%) after harvesting was also observed in T4. Best net returns (2,28,781.43/ha) were found in T4 and best B:C ratio (2.84) was observed under T4.

Key words: *Incryl ultra, IFFCO Sea secret, Humic acid, Seaweed extract, Okra, Yield.*

Introduction

Okra (*Abelmoschus esculentus* (L.) Monech) is an economically significant vegetable growing in tropical and sub-tropical regions of the world. This crop can be grown both as a garden crop and on industrial farms. India is the top producer of okra in the world, accounting for 3.5 million tons (or 70% of global production) on more than 0.35 million hectares of land. Okra is polyploid in nature and a member of the Malvaceae family with 2n=8x=72 or 144. Okra is a self-pollinated crop, and the crop is frequently cross pollinated due to insect outcrossing, which occurs to an extent of 20 per cent.

Okra seed is well-known for being a good source of high-quality protein, especially when compared

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to other plant protein sources in terms of the proportion of essential amino acids. The fibrous fruits or pods of okra are grown for their spherical, white seeds. Okra's roots and stems are used to purify the cane juice needed to make gur or brown sugar (Chauhan, 1972).

Commercial okra farming depends heavily on the use of chemical fertilizers since they provide a high yield and are a key source of plant nutrients. One of the significant problems preventing their best utilization is the ongoing increase in the price of chemical fertilizers. When chemical fertilizers are used carelessly, dangerous salt concentrations will build up in the soil, eventually leading to chemical imbalances in the soil and its surroundings. A variety of organic inputs that can be used as an alternative to chemical fertilizers are complete plant foods since they contain both micro and macronutrient components as well as a variety of growth-promoting enzymes. Organic inputs provide a well-balanced supply of nutrients since they break down slowly in the soil and feed plants over an extended period of time. In the end, it resulted in less nutrient leakage into the soil and the sustainable growth of plants.

Humic acid is a key ingredient in humic substances, which make up the majority of the organic material in soil. They have a brownish-black color and are insoluble in water when the pH is less than 2. When plant and animal waste decompose in the presence of certain microbes, humic acid is produced. Humic acid is used in agricultural crops as a bio stimulant. They are an inexpensive organic input that can enhance plant development, balance hormonal and enzymatic activity, and ultimately improve production and quality of produce.

Seaweed extract, a liquid obtained from seaweed, is currently used more frequently in a variety of agricultural production, including cereals, oil seeds, vegetables, fruits, floral species, and grasses. Seaweeds are many types of multicellular, microscopic marine algae that typically grow along ocean coasts where the conditions are right. It includes many minerals, vitamins, amino acids, and growth regulators like auxin, cytokinin, and abscisic acid. Ascophyllum nodosum is the seaweed that is the most frequently utilized in agricultural activities and has beneficial effects on plants. Its extract functions as a soil conditioner and is used as a bio stimulant to promote early seed germination, plant development, increased crop performance and higher yields, resistance to biotic and abiotic stress, and an extension of the shelf life of various perishable agricultural produce.

Materials and Methods

The experiment was carried out at LPU vegetable research farm, school of Agriculture, Phagwara (Punjab) during summer season of 2023. The field experiment was laid out in RBD with five treatments which were T1: control (RDF), T2: Incryl Ultra @ 0.5g/l + RDF, T3: Incryl Ultra @ 1.0g/l + RDF, T4: Incryl Ultra @ 2.0g/l + RDF and T5: Standard check product (IFFCO Sea Secret) and five replications. Okra variety Arka Anamika was obtained from IIHR, Bengaluru was used as test crop. The seeds were dibbled at the spacing of 60cm x 30cm. During seed bed preparation, a well-rotten vermicompost @ 10-15 t/ha was applied. The NPK dosage used was 120:80:80 kg/ha of urea (46:00:00), diammonium phosphate (18:46:00), and potash muriate (00:00:60). As a base dosage, a half dose of nitrogen, a full dose of phosphorus, and a full dose of potassium were used. To minimise leaching and volatilization, the remaining half dose of nitrogen was given in split doses at 30 and 60 days after planting. Incryl Ultra was applied in two stages at basal dose and pod formation stage and standard check product (IFFCO Sea Secret) was applied twice a month. The data on 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 (^{o}Brix), ascorbic acid (mg/100 g), mucilage (%), crude fibre (%) and physiological loss of weight (%) were recorded using standardized procedures. The statistical analysis of data was performed using OPSTAT software. The initial chemical properties of soil are presented in the Table 1.

Results and Discussion

Germination and seedling traits

The data showed in Table 2 represent the significant effect of test product "Incryl Ulta" and standard

check product "IFFCO Sea Secret" on okra. Highest germination percentage (83.50%), seedling fresh weight (2.85 g), seedling dry weight (0.95 g) and seedling vigour index II (79.38) was observed in T4. While maximum seedling length (20.11 cm) and seedling vigour index I (1596.76) was observed in T5. T1 which is control gave least result in all those parameters. It may be because of the presence of some growth stimulating compounds such as IAA and IBA, gibberellins, cytokinins, minerals, vitamins and amino acids present in seaweed extract (Challen and Hemingway, 1965). Humic acid provided vital nutrients and water to the seedlings and allowed germination Khalesro *et al*. (2015). Auxins, an important growth hormone present in humic acid and seaweed extract, will stimulate cell division and cell elongation, which is another likely explanation for the increase in seedling length (Gollan and Wright, 2006).

Growth, yield and cost economics

As shown in Table 3, different growth parameters, yield and cost economics is influenced by application of products. For all parameter which is plant height at 30 DAS (19.20 cm), 45 DAS (26.40 cm), 60 DAS (55.90 cm), number of branches per plant 30 DAS (2.92) and 60 DAS (3.40), number of flower per plant (19.85), number of fruit per plant (18.42), average fruit weight (16.77 g) and fruit yield (10.3 t/ha), T4 gave superior results compared to other treatments while the maximum number of leaves at 30 DAS (9.03 cm) found in T5 and number of leaves at 60 DAS (29.9) found maximum in T4. While least was found in T1 which is control.

Zodape *et al.* (2011) also demonstrated that utilizing seaweed extract (5.0%) as a foliar spray resulted in enhanced plant height. Humic acid has been noted to promote the absorption of calcium, which plays a crucial role in the mitotic cell division of apical meristems. Pizzeghello *et al.,* (2001) evaluated the hormone activity of humic compounds, which had comparable effects to auxin and may have led to the growth in the number of branches. According to Dange *et al*. (2002), cytokinin and phosphorus buildup in the axillary bud may have had an impact on the plant's reproductive characteristics. Similar results were found by Kumar *et al.* (2015) demonstrating early flowering in okra with the application of humic acid. By increasing cell division and enlargement, activating hormones like auxin and cytokinin, and maintaining higher soil water potential and nutrient holding capacity, humic acid application aids in increasing yield-attributing characters.

Maximum net return 2,28,781.43 per ha and B:C (2.84) ratio was found out in T4 which is due to higher yield was obtained under this treatment. Similar results were also found by Fathima and

Table 1. Soil physiochemical properties

Sr.No.	Parameters	Results	Method of Analysis
1.	Soil pH	7.39	Using pH meter (Jackson,1973)
2.	Organic carbon (%)	0.53	Walkley and Black (1973)
3.	Electrical conductivity (dS/m)	0.317	Electrical conductivity meter
4.	Available N (kg/ha)	178.144 kg/ha	Kjeldahl method (Bradstreet,1954)
5.	Available P (kg/ha)	14.67 kg/ha	Olson's extraction method(1954)
6.	Available K (kg/ha)	187.7 kg/ha	Flame photometer meter(Metson 1956)

Table 2. 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	60.70	15.72	1.60	0.38	954.82	23.08
T2	72.15	21.03	1.45	0.69	1518.29	49.82
T3	77.90	16.60	1.95	0.54	1293.97	42.09
T4	83.50	18.50	2.85	0.95	1545.75	79.38
T5	79.35	20.11	2.03	0.87	1596.76	69.08
C.D (0.05%)	3.062	0.759	0.082	0.031	115.629	4.578
S.E(m) ±	1.013	0.251	0.027	0.01	38.239	1.514

(GP - Germination percentage, SL - Seedling length, SFW - Seedling fresh weight, SDW - Seedling dry weight, SVI - Seedling vigour index)

Denesh (2013) in chilli and Hafez and Geries (2018) in onion.

Quality parameters

Based on data available in Table 4, the significantly highest TSS was found in T4 which was (2.51^ Brix). The greater transfer of absorbed sugars from leaves to fruits is facilitated by plant's higher potassium content, which may also be a factor in the higher TSS levels. Similar results were found by Sahu *et al*. (2018), Shafeek *et al*. (2016), and Yildrim 2007. The maximum ascorbic acid content (21.10 mg/100g) and mucilage content (13.85%) found in T5. The use of biostimulants enhances the synthesis of phenolic compounds due to the presence of glycine betaine, a substance found in seaweed extract (Karjalainen *et al*., 2002), which has also been shown to have a favorable relationship with the production of ascorbic acid (Abdel-Mawgoud *et al*., 2010). The least fibre content (7.04%) was found in T5 whereas least physiological loss of weight was found in T4 which was (8.68%) after seven days observed at ambident environment conditions. A balanced C:N ratio can be maintained by the presence of easily accessible nitrogen in the environment. According to Wagh *et al*. (2014), this balanced ratio encourages vegetative development and increases photosynthetic activity. Similar findings were found in okra by Sureshkumar *et al*. (2019). When biostimulant compounds are used, metabolites including carbohydrates, proteins, and osmolytes are produced at greater levels, which may result in reduced weight loss following harvest. Kandil *et al*. (2013) discovered similar outcomes when studying onions and bell peppers, respectively.

Conclusion

From the above mentioned treatments, T4 Incryl Ultra (2.0 g/L+ RDF) and T5 standard check product (IFFCO Sea Secret) consistently showed positive effects on various aspects of plant growth and development. These effects include improved seed germination, seedling growth, plant height, branch number, leaf number. This treatment also resulted in early onset of flowering and increased number of flowers per plant. In addition, fruit production was

Table 3. Effect of the products on growth, development, yield and cost economics of okra crop.

	PH			NLP		NBP		NFlP	NFrP	AFW	FY	NR	B:C
	30 DAS	45 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS			(g)	(t/ha)	(/ha)	ratio
T1	13.66	18.29	39.98	7.21	18.55	1.29	1.98	15.10	15.75	10.45	5.49	88,872.53	1.17
T2	12.50	20.91	44.12	7.35	19.62	1.53	2.32	14.75	15.35	12.50	6.40	1,15,052.61	1.50
T3	14.35	22.35	49.80	6.90	24.87	1.88	2.56	16.54	16.90	13.15	7.41	1,44,306.21	1.84
T4	19.20	26.40	55.90	7.76	29.90	2.92	3.40	19.85	18.42	16.77	10.30	2,28,781.43	2.84
T5	16.90	26.02	51.72	9.03	27.21	2.51	3.24	19.22	17.85	15.97	9.51	1,96,927.17	2.23
C.D(0.05%)	0.622	0.931	1.971	0.308	0.983	0.085	0.111	0.692	0.683	0.567	0.644	*	*
S.E(m)±	0.206	0.308	0.652	0.102	0.325	0.028	0.037	0.229	0.226	0.188	0.213	*	*

(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 4. Effect of products on different quality parameters of okra fruit.

	TSS (°Brix)	Ascorbic acid (mg/100 gm)	Mucilage (%)	Fibre (%)	PLW (%)
T1	1.23	15.07	9.12	10.90	11.75
T2	1.05	15.42	9.88	10.76	11.72
T3	1.72	16.85	10.23	8.45	10.45
T4	2.51	17.32	12.58	7.54	8.68
T5	2.03	21.10	13.85	7.04	8.90
C.D(0.05%)	0.072	0.694	0.455	0.374	0.427
S.E(m) ±	0.024	0.229	0.151	0.124	0.141

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

improved, including an increased number of fruits per plant and heavier fresh fruit weight. In addition, quality parameters such as total soluble solids, ascorbic acid and chlorophyll content were also significantly improved by these treatments. Treatment T4 gave the highest yield, most favorable economic yield and gave the highest B:C ratio. In contrast, control treatments generally produced the lowest scores for all parameters assessed. Proper use of biostimulant products will reduce the dependency of chemical fertilizers.

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