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Growth, development and pest incidence of okra (*Abelmoschus esculenta*) affected by different Multiplex yield enhancers

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Abstract
The study was conducted at the College of Horticulture, Bengaluru on okra to determine the effect of different Multiplex yield enhancers on its growth and development. The study reported that treatment T10 recorded increased plant height (25 cm, 51.22 cm, and 82.47 cm) and number of leaves per plant (1.33, 3.33, and 4.33) at 30, 60, and 90 DAP, respectively. The same treatment also reported a higher number of branches, but the highest was reported in T6 (1.33, 3.33, and 4.33, respectively). The increased number of pods per plant (42.29) and pod yield was recorded in treatment T16 (190.28 g per plant and 23.78 t/ha, respectively). Similarly, the treatments including Multiplex Biojodi recorded the lowest pest and disease incidence. The combination of both organic and inorganic fertilizers of Multiplex yield enhancers proved to have better results in okra crop than the recommended dose of fertilizer alone.

Keywords: Multiplex yield enhancer, number of branches, yield, pest and disease

Introduction
Okra (*Abelmoschus esculenta* L. Moench) belongs to the Malvaceae family and is believed to have originated in tropical Africa (Lamont, W.J., 1999) [10]. It is commonly known as "lady's finger" in tropical and sub-tropical countries around the world. In India, it is widely grown, distributed, and consumed either fresh or in dried form as a popular vegetable crop throughout the year (Fatokun and Chedda, 1983) [5]. Okra is available in India throughout the year, and the country is the largest producer of okra in the world. In India, various dishes are made from okra pods. Okra is mainly grown in states like Gujarat, West Bengal, and Bihar (APEDA 2022).

Okra is a versatile vegetable that is rich in carbohydrates, amino acids, and vitamins. It can be consumed fresh or cooked, used as animal fodder, and has medicinal and industrial applications (Kumar *et al*., 2017) [9]. In the Indian subcontinent, okra is highly valued for its vitamin and mineral content. It has an average nutritive value of 3.21, which is higher than that of tomatoes, pumpkins, and ash gourd.

The edible part of the pod contains approximately 88% water, 2.1% protein, 0.2% fat, 8.0% carbohydrates, 1.7% fiber, and 0.2% ash per 100 grams. The seeds contain 18-20% oil and 20-23% crude protein. Ripe seeds are sometimes roasted and used as a coffee substitute. The roots and stems are used for clarifying sugarcane juice before it is processed into jaggery and brown sugar. Additionally, the crop is utilized in the paper industry, and fiber is extracted from its stem. Okra is often considered a super-vegetable due to its numerous nutritional and medicinal benefits. It is rich in nutrients, soluble fiber, vitamin B6, and folic acid. Soluble fiber helps to reduce serum cholesterol, thus lowering the risk of heart disease. Additionally, fiber aids in stabilizing blood sugar levels. The mucilage in okra not only binds cholesterol but also the bile acid carrying toxins dumped into it by the liver. The fiber in okra absorbs water and helps prevent constipation. Despite its slippery texture, which some people dislike, it facilitates the elimination of excess cholesterol and toxins from the body (Varmudy V., 2011) [16].

To maintain the nutritional quality of okra, it is recommended to use organic manures such as vermicompost, cow dung, biofertilizers, poultry manure, and liquid seaweed application, rather than inorganic fertilizers (Zodape *et al*., 2008) [17]. Okra is better suited than other vegetables to meet nutritional requirements. Due to its numerous nutritional benefits, it is hoped that okra can help address nutritional and food security challenges in developing countries (Kumar *et al*., 2017) [9].

The use of various chemicals such as nutrients, pesticides for controlling pests, fungicides for controlling diseases, and weedicides for controlling weeds can lead to the accumulation of these chemicals in agricultural produce, potentially resulting in harmful effects. Norman Borlaug once stated that it is up to humans to choose between consuming food with slow-acting poison or suffering from hunger without food.

Despite the poor physical and chemical conditions of soil, there has been an increase in the cultivation of okra in India, leading to poor yields. The high cost and unavailability of inorganic fertilizers have made them inaccessible to many farmers, necessitating the search for alternatives. An experiment was conducted to determine the effects of different multiplex yield enhancers on okra's vegetative and yield parameters is discussed in this paper.

Materials and Methods

The experiment took place in an open field at the College of Horticulture, UHS, Bengaluru. It followed a randomized complete block design (RCBD) with a total of 16 treatments (as listed in Table 1) and was replicated three times. Observations were recorded on days 30, 60, and 90 Days After Planting (DAP) for growth parameters such as plant height, number of leaves per plant, and number of branches per plant. Additionally, yield parameters such as total number of fruits per plant, fruit yield per plant, and fruit yield were also recorded.

$$\text{Fruit yield} = (\text{Fruit yield per plant}/\ \text{Net plot area}\ )\ \text{X}\ 10{,}000$$

Disease and Pest incidence was checked at every 15-day interval.

For fungal disease-the percent disease index (PDI) was calculated using the formula

$$\text{PDI} = \frac{\text{Sum of the indvidual disease rating}}{\text{a number of fruits per leaves observed}} \text{x} \frac{100}{\text{Maximum disease grade}}$$

For bacterial disease, the percentage incidence was calculated using the formula.

$$\text{Percent incidence} = \frac{\text{Number of plants infected}}{\text{Total number of plants}} \text{x}\ 100$$

The incidence of insects was recorded at 15-day intervals.

All the parameters were analyzed using the statistical tool SPSS. ANOVA was done for all the experiments using CD at 5% using LSD.

Table 1: Treatment details

Sl. No	Treatment	Method of application
T_1	RDF (N :P: K) +(FYM)	Basal dose
T_2	RDF+Annapurna@150 kg/ac	Basal dose
T_3	RDF+ Annapurna@240 kg/ac	Basal dose
T_4	RDF+Annapurna @450 kg/ac	Basal dose
T_5	RDF+ Organic magic@ 10 kg/ac	Basal dose
T_6	RDF+Samruddhi @50 kg/ac	50% each as basal+ Earthing up
T_7	RDF+ Zinc high @ 10 kg/ac	50% each as Basal + Earthing up
T_8	RDF+ Navjeevan G@ 10 kg/ac	50% each as Basal + Earthing up
T_9	RDF+ Jivras @3 ml/L	After planting and before flowering during vegetative phase
T_{10}	RDF+ Annapurna (240 kg/ac)+ Samruddhi (50 kg/ac)+Zinc high (10 kg/ac)+ Navjeevan G (10kg/ac)	Basal dose + Earthing up
T_{11}	RDF+ Mahapal @3ml/L + Bio jodi @5 g/L	3 Foliar sprays during the vegetative phase, flowering to fruit setting and fruit development stage. (Except Kranti-2 sprays)
T_{12}	RDF+ Sambrama @5g/15l+ Bio jodi @5 g/L	
T_{13}	RDF+Samras @3ml/L+ Bio jodi @ 5 g/L	
T_{14}	RDF+Kranti @2ml/L+ Bio jodi @5 g/L	
T_{15}	RDF+ Foliar spray (Mahapal + samras+ sambrama +Bio jodi)	
T_{16}	RDF + (Annapurna (120kg/ac)+ Samruddhi (25kg/ac)+ organic magic (5kg/ac)+ Zinc high (5kg/ac)+ Navajeevan G (5kg/ac)	Basal dose + Earthing up

Note: RDF-Recommended Dose of Fertilizer, DAP-Days after planting, FYM – Farmyard manure, NS-non-significant, Annapurna-Decomposed organic matter fortified with vermicompost, Neem Cake, Castor Cake, Coir pith & enriched with millions of beneficial Microorganism, Organic magic: Phosphate solubilizing fungal Bio-Fertilizer along with PGPR bacterial consortium, Samruddhi: Contains secondary nutrients such as Calcium, Magnesium and Sulphur, Zinc high: Contains high percentage of Zinc, Magnesium apart from other secondary and micronutrients like calcium, manganese, molybdenum, boron and sulphur in easily available form, Navajeevan G: Contains Sea-weed, humic acid and a mixture of amino acid and triacontanol, Jivras: Contains Humic acid 12.0% w/w, Mahapal: A combination product of bio-organics and traces of micronutrients in balanced quantity in chelated form, Sambrama: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form, Biojodi: *Bacillus* spp. & *Pseudomonas* spp., Samras: Contains a mixture of 18 natural amino acids, extracted from plant source, Kranti: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form.

Results

Growth Parameters

Plant height (cm)

Summary of data collected and analyzed at the 30th, 60th, and 90th Days After Planting (DAP) showed a significant difference in plant height at 60 and 90DAP (Table 2).

Treatment T_{10} [RDF + Annapurna (240 kg) + Samruddhi (50 kg) + Zinc High (10 kg) + Navajeevan-G (10 kg)] resulted in higher plant heights of 25 cm, 51.22 cm, and 82.47 cm at the 30, 60, and 90 DAP, respectively. Meanwhile, T_4 and T_{11} measured 76.03 cm and 75.59 cm, respectively. T_6 and T_{15} also reached heights of 74.25 cm and 75.81 cm at the 90th day after planting. Comparatively lower plant height was recorded in T_1, with measurements of 14.67 cm, 29.67 cm, and 60.92 cm on 30th, 60th, and 90th DAP, respectively, with the application of RDF only. There was an increase in plant height of okra in every treatment compared to T_1 (RDF) at all intervals recorded.

Table 2: Impact of multiplex yield enhancers on plant height in okra

Treatments		Mean plant height (cm) per plant		
		30 DAP	60 DAP	90 DAP
T_1	RDF (N:P:K) (125:75:63 kg/ha) (FYM-25t/ha)	14.67	29.67	60.92
T_2	RDF + Annapurna @150 kg/ac	18.00	36.89	68.14
T_3	RDF + Annapurna @240 kg/ac	19.67	40.11	71.36
T_4	RDF + Annapurna @450 kg/ac	21.67	44.78	76.03
T_5	RDF + Organic magic @ 10 kg/ac	19.33	39.22	70.48
T_6	RDF + Samruddhi @ 50 kg/ac	21.00	43.00	74.25
T_7	RDF + Zinc High @ 10 kg/ac	16.33	33.78	65.03
T_8	RDF + Navajeevan G @ 10 kg/ac	20.67	42.11	73.36
T_9	RDF + Jivrus @ 3 ml/l	18.00	36.89	68.14
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc High (10 kg/ac) + Navajeevan G (10 kg/ac)	25.00	51.22	82.47
T_{11}	RDF + Mahaphal @ 3 ml/l + Bio Jodi @ 5 g/l	21.67	44.33	75.59
T_{12}	RDF + Sambrama @ 5 g/ 15l + Bio Jodi @ 5g/I	16.67	34.44	65.70
T_{13}	RDF + Samras @ 3 ml/I + Bio Jodi @ 5 g/I	18.67	38.33	69.59
T_{14}	RDF + Kranti @ 2 ml/I + Bio Jodi @ 5 g/l	19.33	39.89	71.14
T_{15}	RDF + Foliar spray (Mahaphal + Samras + Sambrama + Bio Jodi)	21.33	44.55	75.81
T_{16}	RDF + [Annapurna (120 kg/ac) + Samruddhi (25 kg/ac) + Organic Magic (5 kg/ac) + Zinc High (5 kg/ac) + Navajeevan G (5 kg/ac)]	20.67	42.33	73.59
S.Em.+-		2.13	4.35	5.43
C.D @ 5%		NS	12.95	15.65
C.V @ 5%		18.89	18.79	10.56

Note: RDF-Recommended Dose of Fertilizer, DAP-Days after planting, FYM – Farmyard manure, NS-non-significant, Annapurna-Decomposed organic matter fortified with vermicompost, Neem Cake, Castor Cake, Coir pith & enriched with millions of beneficial Microorganism, Organic magic: Phosphate solubilizing fungal Bio-Fertilizer along with PGPR bacterial consortium, Samruddhi: Contains secondary nutrients such as Calcium, Magnesium and Sulphur, Zinc high : Contains high percentage of Zinc, Magnesium apart from other secondary and micronutrients like calcium, manganese, molybdenum, boron and sulphur in easily available form, Navajeevan G: Contains Sea-weed, humic acid and a mixture of amino acid and triacontanol, Jivras: Contains Humic acid 12.0% w/w, Mahapal: A combination product of bio-organics and traces of micronutrients in balanced quantity in chelated form, Sambrama: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form, Biojodi: *Bacillus* spp. & *Pseudomonas* spp., Samras: Contains a mixture of 18 natural amino acids, extracted from plant source, Kranti: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form.

Number of branches

The total number of branches at 30th, 60th, and 90th DAP were recorded and are presented in Table 3. Based on the data in Table, there was a significant difference in the number of branches for different treatments at 60th and 90th DAP. T6 (RDF+ Samruddhi@50kg/ac) had the most branches with 1.33, 3.33, and 4.33 on the 30th, 60th, and 90th DAP respectively. On the 90th DAS, T_{16} had 3.67 branches, while T_4 [RDF + Annapurna @ 450 kg/ac] and T_{10} [RDF + Annapurna (240 kg/ac) + Zinc High (10kg/ac) + Navajeewan-G (10 kg/ac)] each had 4 branches. In contrast, treatment T1 recorded the lowest numbers of 0.33, 1.33, and 2.33 branches on the 30th, 60th, and 90th DAP respectively. All the treatments registered more branches than T_1 (RDF) at all the recorded intervals.

Note: RDF-Recommended Dose of Fertilizer, DAP-Days after planting, FYM – Farmyard manure, NS-non-significant, Annapurna-Decomposed organic matter fortified with vermicompost, Neem Cake, Castor Cake, Coir pith & enriched with millions of beneficial Microorganism, Organic magic: Phosphate solubilizing fungal Bio-Fertilizer along with PGPR bacterial consortium, Samruddhi: Contains secondary nutrients such as Calcium, Magnesium and Sulphur, Zinc high: Contains high percentage of Zinc, Magnesium apart from other secondary and micronutrients like calcium, manganese, molybdenum, boron and sulphur in easily available form, Navajeevan G: Contains Sea-weed, humic acid and a mixture of amino acid and triacontanol, Jivras: Contains Humic acid 12.0% w/w, Mahapal: A combination product of bio-organics and traces of micronutrients in balanced quantity in chelated form, Sambrama: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form, Biojodi: *Bacillus spp. & Pseudomonas spp.,* Samras: Contains a mixture of 18 natural amino acids, extracted from plant source, Kranti: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form.

Table 3: Impact of multiplex yield enhancers on number of branches in okra

Treatments		Mean number of branches per plant		
		30 DAP	60 DAP	90 DAP
T_1	RDF (N:P:K) (125:75:63 kg/ha) (FYM-25t/ha)	0.33	1.33	2.33
T_2	RDF + Annapurna @150 kg/ac	0.67	2.00	3.00
T_3	RDF + Annapurna @240 kg/ac	0.67	2.00	3.00
T_4	RDF + Annapurna @450 kg/ac	1.33	3.00	4.00
T_5	RDF + Organic magic @ 10 kg/ac	1.00	2.33	3.33
T_6	RDF + Samruddhi @ 50 kg/ac	1.33	3.33	4.33
T_7	RDF + Zinc High @ 10 kg/ac	1.00	3.00	4.00
T_8	RDF + Navajeevan G @ 10 kg/ac	0.33	1.67	2.67
T_9	RDF + Jivrus @ 3 ml/l	0.67	2.33	3.33
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc High (10 kg/ac) + Navajeevan G (10 kg/ac)	1.33	3.00	4.00
T_{11}	RDF + Mahaphal @ 3 ml/l + Bio Jodi @ 5 g/l	1.00	2.33	3.33
T_{12}	RDF + Sambrama @ 5g/ 15l + Bio Jodi @ 5g/I	0.33	1.67	2.67
T_{13}	RDF + Samras @ 3 ml/I + Bio Jodi @ 5 g/I	1.00	2.33	3.33
T_{14}	RDF + Kranti @ 2ml/I + Bio Jodi @ 5 g/l	0.67	2.00	3.00
T_{15}	RDF + Foliar spray (Mahaphal + Samras + Sambrama + Bio Jodi)	0.67	2.33	3.33
T_{16}	RDF + [Annapurna (120 kg/ac) + Samruddhi (25 kg/ac) + Organic Magic (5 kg/ac) + Zinc High (5 kg/ac) + Navajeevan G (5 kg/ac)]	1.00	2.67	3.67
S.Em.+-		0.41	0.54	0.67
C.D @ 5%		NS	1.68	2.83

Number of leaves

The total number of leaves on the 30th, 60th, and 90th DAP were recorded and are presented in Table 4. The highest number of leaves was recorded in T_{10} [RDF + Annapurna (240kg) + Samruddhi (50 kg) + Zinc High (10 kg) + Navajeewan-G (10 kg)] with 14.67, 29.33, and 35.33 leaves on the 30th, 60th, and 90th DAP respectively. This was followed by 32 leaves on the 90th DAP in T_4 (RDF + Annapurna @ 450 kg/ac), 26.34 leaves in T_{16}, and 25.56 leaves in T_6 on the 90th DAP. The lowest number of leaves was registered in T_1 with 7, 14, and 20 leaves on the 30th, 60th, and 90th DAP respectively with the application of only RDF. The application of different multiplex enhancers significantly influenced the number of leaves at all the recorded intervals.

Table 4: Impact of multiplex yield enhancers on number of leaves in okra

Treatments		Mean number of leaves per plant		
		30 DAP	60 DAP	90 DAP
T_1	RDF (N:P:K) (125:75:63 kg/ha) (FYM-25t/ha)	7.00	14.00	20.00
T_2	RDF + Annapurna @150 kg/ac	9.67	19.56	22.11
T_3	RDF + Annapurna @240 kg/ac	9.00	18.22	24.22
T_4	RDF + Annapurna @450 kg/ac	13.00	26.00	32.00
T_5	RDF + Organic magic @ 10 kg/ac	8.33	16.44	22.44
T_6	RDF + Samruddhi @ 50 kg/ac	8.00	16.11	25.56
T_7	RDF + Zinc High @ 10 kg/ac	7.00	14.34	20.34
T_8	RDF + Navajeevan G @ 10 kg/ac	8.33	17.00	23.00
T_9	RDF + Jivrus @ 3 ml/l	8.33	17.22	23.22
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc High (10 kg/ac) + Navajeevan G (10 kg/ac)	14.67	29.33	35.33
T_{11}	RDF + Mahaphal @ 3 ml/l + Bio Jodi @ 5 g/l	9.00	18.00	24.00
T_{12}	RDF + Sambrama @ 5g/ 15l + Bio Jodi @ 5g/I	8.00	16.34	22.34
T_{13}	RDF + Samras @ 3 ml/I + Bio Jodi @ 5 g/I	8.33	17.00	23.00
T_{14}	RDF + Kranti @ 2ml/I + Bio Jodi @ 5 g/l	9.33	18.67	24.67
T_{15}	RDF + Foliar spray (Mahaphal + Samras + Sambrama + Bio Jodi)	9.00	18.22	24.22
T_{16}	RDF + [Annapurna (120 kg/ac) + Samruddhi (25 kg/ac) + Organic Magic (5 kg/ac) + Zinc High (5 kg/ac) + Navajeevan G (5 kg/ac)]	10.00	20.34	26.34
S.Em.+-		1.13	2.22	2.22
C.D @ 5%		3.28	6.46	6.46
C.V @ 5%		21.36	20.79	15.70

Note: RDF-Recommended Dose of Fertilizer, DAP-Days after planting, FYM – Farmyard manure, NS-non-significant, Annapurna-Decomposed organic matter fortified with vermicompost, Neem Cake, Castor Cake, Coir pith & enriched with millions of beneficial Microorganism, Organic magic: Phosphate solubilizing fungal Bio-Fertilizer along with PGPR bacterial consortium, Samruddhi: Contains secondary nutrients such as Calcium, Magnesium and Sulphur, Zinc high : Contains high percentage of Zinc, Magnesium apart from other secondary and micronutrients like calcium, manganese, molybdenum, boron and sulphur in easily available form, Navajeevan G: Contains Sea-weed,

humic acid and a mixture of amino acid and triacontanol, Jivras: Contains Humic acid 12.0% w/w, Mahapal: A combination product of bio-organics and traces of micronutrients in balanced quantity in chelated form, Sambrama: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form, Biojodi: *Bacillus spp. & Pseudomonas spp.,* Samras: Contains a mixture of 18 natural amino acids, extracted from plant source, Kranti: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form.

Yield Attributes

Number of fruits

After harvesting, immature pods of varying lengths and weights were measured. The highest number of pods per plant 42.29 was recorded in T_{16} [RDF + [Annapurna (120kg/ac) + Samruddhi (25kg/ac) + Organic Magik (5 kg/ac) + Zinc High (5kg/ac) + Navajeevan-G (5 kg/ac)], 41.66 number in T_4 (RDF + Annapurna @ 450kg/ac) There were 38.07 pods per plant produced by treatment T_{10}, while 34.76 pods are produced by treatment T_6. Also, treatment T_{15} produced 32.53 pods per plant. With only 23.31 pods per plant, T_1(RDF) was the lowest in terms of pod number per plant. Table 5 presents the data on pods counts per plant at harvest**.**

Fruit yield(t/ha)

The data on pod yield of okra influenced by yield enhancers are presented in Table 5 The okra pods were obtained from the entire plot in 6 pickings during the experiment. Treatment T_{16} [RDF + [Annapurna (120kg/ac) + Samruddhi (25kg/ac) + Organic Magik (5kg/ac) + Zinc High (5kg/ac) + Navajeevan-G (5kg/ac)] recorded significantly higher pod yield of 190.28g per plant and 23.78 t/ha respectively. Also, treatment T_4 (RDF + Annapurna @ 450 kg) recorded 187.50g, 23.44 t/ha and T_{10} [RDF + Annapurna (240kg) Samruddhi (50kg) Zinc High (10kg) + Navajeevan-G (10kg)] recorded 171.33g, 21.42 t/ha. In addition to that treatment T_6 (RDF + Samruddhi @ 50 kg/ac) recorded pod yield of 156.44g per plant and 19.56 t/ha. Treatment T_1 with only RDF application recorded the lowest pod yield per plant and yield per hectare of 104.89g and 13.11 t/ha. Application of different yield enhancers have significantly increased tuber yield in all treatments of okra over control(T_1).

Table 5: Impact of multiplex yield enhancers on yield attributes in okra

Treatments		Number of pods/plant	Pad yield/plant (g)	Yield/ha (tons)
T_1	RDF (N:P:K) (125:75:63 kg/ha) (FYM-25t/ha)	23.31	104.89	13.11
T_2	RDF + Annapurna @150 kg/ac	26.79	120.55	15.07
T_3	RDF + Annapurna @240 kg/ac	27.86	125.39	15.67
T_4	RDF + Annapurna @450 kg/ac	41.66	187.50	23.44
T_5	RDF + Organic magic @ 10 kg/ac	30.04	135.17	16.90
T_6	RDF + Samruddhi @ 50 kg/ac	34.76	156.44	19.56
T_7	RDF + Zinc High @ 10 kg/ac	26.85	120.84	15.10
T_8	RDF + Navajeevan G @ 10 kg/ac	28.15	126.67	15.84
T_9	RDF + Jivrus @ 3 ml/l	26.94	121.22	15.15
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc High (10 kg/ac) + Navajeevan G (10 kg/ac)	38.07	171.33	21.42
T_{11}	RDF + Mahaphal @ 3 ml/l + Bio Jodi @ 5 g/l	32.81	147.63	18.45
T_{12}	RDF + Sambrama @ 5g/ 15l + Bio Jodi @ 5g/I	31.84	143.28	17.91
T_{13}	RDF + Samras @ 3 ml/I + Bio Jodi @ 5 g/I	28.15	126.70	15.84
T_{14}	RDF + Kranti @ 2ml/I + Bio Jodi @ 5 g/l	25.80	116.11	14.51
T_{15}	RDF + Foliar spray (Mahaphal + Samras + Sambrama + Bio Jodi)	32.53	146.39	18.30
T_{16}	RDF + [Annapurna (120 kg/ac) + Samruddhi (25 kg/ac) + Organic Magic (5 kg/ac) + Zinc High (5 kg/ac) + Navajeevan G (5 kg/ac)]	42.29	190.28	23.78
S.Em.+-		5.71	25.67	3.21
C.D @ 5%		18.24	76.45	10.52
C.V @ 5%		31.76	31.76	31.75

Note: RDF-Recommended Dose of Fertilizer, DAP-Days after planting, FYM – Farmyard manure, NS-non-significant, Annapurna-Decomposed organic matter fortified with vermicompost, Neem Cake, Castor Cake, Coir pith & enriched with millions of beneficial Microorganism, Organic magic: Phosphate solubilizing fungal Bio-Fertilizer along with PGPR bacterial consortium, Samruddhi: Contains secondary nutrients such as Calcium, Magnesium and Sulphur, Zinc high : Contains high percentage of Zinc, Magnesium apart from other secondary and micronutrients like calcium, manganese, molybdenum, boron and sulphur in easily available form, Navajeevan G: Contains Sea-weed, humic acid and a mixture of amino acid and triacontanol, Jivras: Contains Humic acid 12.0% w/w, Mahapal: A combination product of bio-organics and traces of micronutrients in balanced quantity in chelated form, Sambrama: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form, Biojodi: *Bacillus spp. & Pseudomonas spp.,* Samras: Contains a mixture of 18 natural amino acids, extracted from plant source, Kranti: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form.

Disease incidence

The following diseases were observed during the crop period and regularly monitored: Cercospora leaf spot, Bhendi yellow vein mosaic virus infection, and Fusarium wilt infection. The incidence of various diseases is presented in Table 6. The percent disease index of Cercospora leaf spot was lowest in T_{15} (RDF + Foliar spray (Mahaphal+Samras+Sambrama+ Bio Jodi) at 14.21%, followed by 16.24% in T10, and 16.66% in

T5 (RDF + Organic magik @ 10kg/ac). The results are consistent with the findings of Le, C.N *et al*, 2005, who reported that *Bacillus* and *Pseudomonas* sps suppress stem rot disease, damping-off, black collar rot, leaf spots, and bacterial wilt, and promote plant growth and enhance pod yield in the case of groundnut.

Table 6: Impact of multiplex yield enhancers on disease incidence in okra

Treatments		*Cercospora* Leaf spot (PDI)	Percent incidence of Bhendi Mosaic Virus	Percent wilt
T_1	RDF (N:P:K) (125:75:63 kg/ha) (FYM-25t/ha)	30.49(33.52)	9.33(17.79)	7.67(16.08)
T_2	RDF + Annapurna @150 kg/ac	30.73(33.67)	6.67(14.97)	4.00 (11.54)
T_3	RDF + Annapurna @240 kg/ac	30.70(33.65)	5.33(13.35)	6.67(14.97)
T_4	RDF + Annapurna @450 kg/ac	18.66(25.59)	2.67(9.40)	4.00(11.54)
T_5	RDF + Organic magic @ 10 kg/ac	16.66(24.09)	2.67(9.40)	6.67(14.97)
T_6	RDF + Samruddhi @ 50 kg/ac	20.75(27.10)	5.33(13.35)	5.33(13.35)
T_7	RDF + Zinc High @ 10 kg/ac	26.08(30.71)	4.00(11.54)	6.67(14.97)
T_8	RDF + Navajeevan G @ 10 kg/ac	21.64(27.72)	4.00(11.54)	5.33(13.35)
T_9	RDF + Jivrus @ 3 ml/l	21.33(27.44)	1.33(6.62)	5.33(13.35)
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc High (10 kg/ac) + Navajeevan G (10 kg/ac)	16.24(23.77)	4.00(11.54)	2.67(9.40)
T_{11}	RDF + Mahaphal @ 3 ml/l + Bio Jodi @ 5 g/l	24.71(29.81)	5.33(13.35)	5.33(13.35)
T_{12}	RDF + Sambrama @ 5g/ 15l + Bio Jodi @ 5g/I	23.60(29.06)	5.33(13.35)	4.00(11.54)
T_{13}	RDF + Samras @ 3 ml/I + Bio Jodi @ 5 g/I	26.66(31.09)	5.33(13.35)	6.67(14.97)
T_{14}	RDF + Kranti @ 2ml/I + Bio Jodi @ 5 g/l	22.71(28.46)	4.00(11.54)	6.67(14.97)
T_{15}	RDF + Foliar spray (Mahaphal + Samras + Sambrama + Bio Jodi)	14.21(22.15)	1.33(6.62)	1.33(6.62)
T_{16}	RDF + [Annapurna (120 kg/ac) + Samruddhi (25 kg/ac) + Organic Magic (5 kg/ac) + Zinc High (5 kg/ac) + Navajeevan G (5 kg/ac)]	24.03(29.35)	2.67(9.40)	4.00(11.54)
S.Em.+-		3.54	1.93	1.74
C.D @ 5%		10.28	NS	5.27
C.V @ 5%		26.60	77.15	56.39

Note: RDF-Recommended Dose of Fertilizer, DAP-Days after planting, FYM – Farmyard manure, NS-non-significant, Annapurna-Decomposed organic matter fortified with vermicompost, Neem Cake, Castor Cake, Coir pith & enriched with millions of beneficial Microorganism, Organic magic: Phosphate solubilizing fungal Bio-Fertilizer along with PGPR bacterial consortium, Samruddhi: Contains secondary nutrients such as Calcium, Magnesium and Sulphur, Zinc high: Contains high percentage of Zinc, Magnesium apart from other secondary and micronutrients like calcium, manganese, molybdenum, boron and sulphur in easily available form, Navajeevan G: Contains Sea-weed, humic acid and a mixture of amino acid and triacontanol, Jivras: Contains Humic acid 12.0% w/w, Mahapal: A combination product of bio-organics and traces of micronutrients in balanced quantity in chelated form, Sambrama: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form, Biojodi: *Bacillus spp. & Pseudomonas spp.,* Samras: Contains a mixture of 18 natural amino acids, extracted from plant source, Kranti: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form.

4. Pest infestation

The following pests were identified and controlled during the crop period: leaf miners, aphids, whiteflies, thrips, and fruit borers. The results are presented in table 7. The least percentage of leaf miner infestation (14.58%) on leaves was recorded in T8 (RDF + Navajeewan-G @ 10 kg/ac), 18.03% in T5 (RDF + Magik @ 10 kg/ac), 18.07% in T14 (RDF + Kranti 2ml/l + Bio Jodi @ 5g/l), and 18.93% in T15. The percentage of aphids and whitefly infestation was the least (2.67 and 1.33, respectively) in T10 (RDF + Annapurna (240kg) + Samruddhi (50kg) + Zinc High (10kg) + username_2 (10 kg)). For thrips, T13 and T4 had the lowest infestation of 0.33 each, followed by T10, T6, and T16 each with 0.67. Pods of immature fruits were infested with fruit borers at a lower level of 14.58% in T8, 18.03% in T5, and 18.07% in T14. In comparison to all treatments, T1 had the highest pest infestation: 8.83 aphids, 3.67 whiteflies, 2.33 thrips, 27.43% leaf infestation by leaf miner, and 30.05% pod infestation by fruit borer.

Note: RDF-Recommended Dose of Fertilizer, DAP-Days after planting, FYM – Farmyard manure, NS-non-significant, Annapurna-Decomposed organic matter fortified with vermicompost, Neem Cake, Castor Cake, Coir pith & enriched with millions of beneficial Microorganism, Organic magic: Phosphate solubilizing fungal Bio-Fertilizer along with PGPR bacterial consortium, Samruddhi: Contains secondary nutrients such as Calcium, Magnesium and Sulphur, Zinc high : Contains high percentage of Zinc, Magnesium apart from other secondary and micronutrients like calcium, manganese, molybdenum, boron and sulphur in easily available form, Navajeevan G: Contains Sea-weed, humic acid and a mixture of amino acid and triacontanol, Jivras: Contains Humic acid 12.0% w/w, Mahapal: A combination product of bio-organics and traces of micronutrients in balanced quantity in chelated form, Sambrama: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form, Biojodi: *Bacillus spp. & Pseudomonas spp.,* Samras: Contains a mixture of 18 natural amino acids, extracted from plant source, Kranti: This contains all essential plant nutrients like major nutrients, secondary and micronutrients in chelated form.

Table 7: Impact of multiplex yield enhancers on disease incidence in okra

Treatments		Aphids	Whitefly	Thrips	Percent fruit damage by fruit borer	Percent leaf minor infestation
T_1	RDF (N:P:K) (125:75:63 kg/ha) (FYM-25t/ha)	8.83	3.67	2.33	30.05(33.24)	27.43(31.58)
T_2	RDF + Annapurna @150 kg/ac	7.20	2.33	1.00	15.29(23.02)	23.47(28.98)
T_3	RDF + Annapurna @240 kg/ac	8.50	2.67	1.33	18.24(25.28)	20.60(16.99)
T_4	RDF + Annapurna @450 kg/ac	5.67	2.67	0.33	7.20(15.56)	20.13(16.66)
T_5	RDF + Organic magic @ 10 kg/ac	4.67	1.67	1.33	8.98(17.44)	18.03(15.03)
T_6	RDF + Samruddhi @ 50 kg/ac	5.67	1.67	0.67	9.86(18.30)	23.47(28.98)
T_7	RDF + Zinc High @ 10 kg/ac	6.33	2.33	1.00	8.85(17.31)	22.90(28.59)
T_8	RDF + Navajeevan G @ 10 kg/ac	7.00	2.00	1.00	18.22(25.27)	14.58(22.45)
T_9	RDF + Jivrus @ 3 ml/l	5.00	2.00	1.00	18.56(25.52)	22.69(28.45)
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc High (10 kg/ac) + Navajeevan G (10 kg/ac)	2.67	1.33	0.67	8.57(17.02)	22.56(28.36)
T_{11}	RDF + Mahaphal @ 3 ml/l + Bio Jodi @ 5 g/l	3.67	2.67	1.00	13.86(21.86)	19.54(26.23)
T_{12}	RDF + Sambrama @ 5g/ 15l + Bio Jodi @ 5g/I	4.00	1.67	1.00	14.37(22.28)	19.48(26.19)
T_{13}	RDF + Samras @ 3 ml/I + Bio Jodi @ 5 g/I	5.33	2.33	0.33	11.14(19.50)	21.71(27.77)
T_{14}	RDF + Kranti @ 2ml/I + Bio Jodi @ 5 g/l	5.33	2.00	1.00	11.39(19.72)	18.07(25.16)
T_{15}	RDF + Foliar spray (Mahaphal + Samras + Sambrama + Bio Jodi)	4.67	1.33	1.33	17.21(24.51)	18.93(25.79)
T_{16}	RDF + [Annapurna (120 kg/ac) + Samruddhi (25 kg/ac) + Organic Magic (5 kg/ac) + Zinc High (5 kg/ac) + Navajeevan G (5 kg/ac)]	3.33	2.33	0.67	9.34(17.80)	23.31(28.87)
S.Em.+-		0.93	0.43	0.49	4.19	2.64
C.D @ 5%		2.71	NS	NS	NS	NS
C.V @ 5%		29.43	34.23	84.66	52.48	21.72

Discussion

The vegetative parameters such as plant height and number of leaves were highest in treatment T_{10} at all recorded intervals. This treatment also resulted in a higher number of branches per plant at 90 DAS. T_{10} consists of a combination of organic and inorganic fertilizers, along with the presence of biostimulants. Annapurna, which slowly release nutrients to provide a continuous supply throughout the crop season and also it contains microorganisms which acts as a biofertilizer and biopesticides. Both RDF and Annapurna contain NPK, which are crucial nutrients during the vegetative phase of any crop reported a positive influence of nitrogen and compost on okra, leading to increased vegetative growth of the plant which are in line with our studies.

Samrudhi and high zinc together provide the secondary and micronutrient requirements of the plants. Along with the supply of NPK, this combination would increase the plant height, number of leaves, and branches of the okra plant. Similarly, Arya P, *et al* 2021 [1] also reported increased plant height, leaves, and other vegetative and yield parameters after using a micronutrient mix. Navajeevan G, which is a biostimulant including humic acid, seaweed, and amino acids, influences vegetative growth (EL-Tanahy *et al*., 2019) [4]. Similar results were also obtained by G.P. Shetty *et al.* in 2024 [7] in chili and ridge gourd. The use of biostimulant on okra resulted in improvement in morphological parameters such as the number of branches, leaves, and green fruits. It also influenced the uptake of other essential nutrients like phosphorus, magnesium, zinc, iron, and copper (Avtsyn A P *et al*., 1991) [3].

The treatment T16 resulted in the highest number of fruits and fruit yield because this treatment provided the plant with complete nutrients. When nutrients are available in the right proportion, it enhances the photosynthetic activity of the plants. This improvement leads to better light interception, dry matter production, accumulation, and partitioning (Smith *et al*., 1992) [15].

This positive effect is attributed to the availability of adequate nutrients for plant use, which improves their vegetative growth, synthesis and translocation of photosynthesis from the sources to the sink, and results in a significant increase in the number and weight of fruit yield and yield components.

In comparison, T_1 showed a higher incidence of Cercospora leaf spot at 30.73% PDI. The lowest virus infection was 1.33% in T_9 (RDF+ jivras @3ML/L) and T_{15} treatments, followed by 2.67% in T4 and T5. This is because the Jivras containing humic acid, fulvic acid, and trace elements help the plant establish better roots and, as organic chelates, aid in better nutrient assimilation. The supply of proper nutrients and their assimilation facilitate induced resistance (G.P Shetty *et al*., 2024) [7]. The maximum incidence of virus-affected plants was noticed in T_1, with 9.33%.

In terms of the percentage of bacterial wilt infection, a 1.33% infection rate was observed in T15 with RDF +Foliar spray (Mahaphal +Samras +Sambrama +Bio Jodi). This treatment, which includes bio organics, micronutrients, amino acids, all essential nutrients, and biopesticides, showed a synergistic effect in reducing the infection. These findings are consistent with Aspiras, R.B. and de la Cruz, A.R., 1985, who reported a reduction in bacterial wilt in tomato and potato plants after using Bacillus and Pseudomonas species. In contrast, T1 (RDF) was severely affected, with a 7.67% infection rate of Fusarium wilt compared to all other treatments.

When a plant receives all the essential nutrients, it becomes more capable of developing resistance. A balanced nutrient supply acts as the first line of defense (G.P. Shetty *et al*., 2024) [7]. Additionally, seaweed in the Navajeevan G treatment is helpful in reducing pest attack. It seems that the pest were attracted to the NPK treated plots due to the better vegetative growth of plants, which supported their survival and reproduction. Despite the high pest infestation on NPK treated and manure treated plots, it did not significantly affect yields. This was due to the phenomenon of tolerance. On the other hand, plants suffering from mineral deficiency normally have lower tolerance to plants (Huber *et al*., 2012) [8].

The substances known to influence pest activity include amino acids, sugars, enzymes, phenols, and alkaloids (Palaniapan and Annadurai, 1999) [14]. When nutrients are

made available to crop plant in required quantities, they aid in the formation of these substances that impart resistance/ tolerance to insect pests. This is what happened in this study.

Conclusion

In growth and yield evaluations, different treatments were more effective than others for the Okra variety Monika and at recorded intervals, there were also significant differences between the treatments. In comparison with other treatments and T_1, treatments such as T_4 (RDF + Annapurna @ 450 kg/ac), T_6 (RDF +Samruddhi @ 50 kg/ac), T_{10} [RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc High (10 kg/ac) + Navajeewan-G (10 kg/ac)], T_{16} (RDF + [Annapurna (120kg/ac) + Samruddhi (25 kg/ac) + Organic Magik (5 kg/ac) + Zinc High (5 kg/ac) + Navajeewan-G (5 kg/ac)] and T_{15} produced higher yields and growth.

The percentage of pest infestations in different pests during the crop period was observed lower in treatments T_5 (RDF + Organic magik @ 10 kg/ac), T_6 (RDF + Samruddhi @50 kg/ac), T_{12} (RDF+ Sambrama @ 5g/151+Bio Jodi @ 5g/l), T_{13} (RDF + Samras @ 3 ml/l+ Bio Jodi @ 5 g/l) and T_{15} and lower incidence of disease in treatments T_5 (RDF + Organic magik @ 10 kg/ac), T_9 (RDF + Jivras @ 3ml/l), T_{16} and T_{15} (RDF + Foliar spray (Mahaphal +Samras + Sambrama + BioJodi).

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