International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(6): 49-57
www.biochemjournal.com
Received: 22-04-2024
Accepted: 26-05-2024

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Impact of multiplex yield enhancer on the growth, yield, disease, and insect incidence of tomato crop

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DOI: https://doi.org/10.33545/26174693.2024.v8.i6a.1261

Abstract
Multiplex yield enhancers were evaluated on tomato growth, yield and pest incidence. The findings suggest that soil application of Treatment T_{10} that is Bio-enriched organic manures along with other macro and micronutrients and bio-stimulants has shown highest plant height (51.60 cm, 95.26 cm and 147.33 cm), number of leaves per plant (111.73, 191 and 291.8) and number of branches per plants (12.86, 33.40 and 44.80) at 30, 60 and 90 Days after planting respectively. The same treatment is known to record enhanced yield attributes like Number of fruits/plant (238.66), fruit yield/ plant (12.39 kg), and yield/ha (13.76 tons). Whereas the foliar application of Bio Jodi which is a Bio bactericide with nutrients showed effective control of pest and diseases. Tomatoes demand balanced nutrients for better growth and development. When these are provided with a combined application of organic manures and fertilizers enhance the overall growth, hinder pest and disease development intern increases the yield.

Keywords: Yield enhancer, organic manure, biostimulant, macro and micro nutrient

Introduction
Tomato is the second most important vegetable crop in India next only to potato. It is universally considered as a "Protective Food" as it possesses special nutritive value traits, particularly antioxidant compounds used in several commercial therapeutic formulations (Jat *et al*., 2012: Binoy *et al*., 2004) [9, 5]. Fruit pulp and juice are digestible, a promoter of gastric secretion, and blood purifier. It supplies vitamin C and adds a variety of colors and flavors to the food. Green and red tomatoes are used for pickles and preserves. It provides small amounts of the vitamin B complex, such as thiamine, and riboflavin. Therefore, the demand for tomatoes is evergreen as it takes integral part in our daily diet. In India, it is grown in a total area of 8.09 lakh ha with an annual production of 1997 lakh tones with 24.34 t/ha productivity. The major states growing tomatoes are Uttar Pradesh, Karnataka, Maharashtra, Haryana, Punjab, and West Bengal (Yadav *et al*., 2022) [17].

Tomato is grown all over India with the use of huge amounts of fertilizers and pesticides targeting a higher yield. For exploiting tomatoes for higher yield, supplementation with secondary and micronutrients is essential (Sainju *et al*., 2003) [14]. Tomato production has a great number of different pressures and environmental impacts due to the excessive use of conventional fertilizers, and climate change, which subjects the crop to extreme environmental conditions. One of the solutions to these problems could be the use of organic manures, bio-fertilizers, and bio-stimulant products that are rich sources of amino acids, which substitute and/or complement conventional fertilizers and help plants adapt to climate changes (Terry-Alfonso, *et al*., 2018) [15]. It has been observed that the use of these products significantly improves the performance of crops, as they have beneficial effects on the physiological processes of plants, such as the absorption of water and nutrients (Mutale-joan *et al*., 2020) [12]. To study the mixed application of organic manure along with nutrients and bio stimulant on the tomato growth and yield attributes, a present study was undertaken.

Materials and Methods
The experiment is carried out in open field conditions in the College of Horticulture, UHS, Campus, GKVK Post, Bengaluru.

The experiment was laid out in a randomized complete block design (RCBD). A total of 16 treatments (Table 1) were randomly allocated among the plots and replicated three times.

Tomato hybrid NS501 from Namdhari Seeds company was used as a test crop. Seeds of tomato were sown in protrays with fermented coco peat as rooting medium and seedlings were raised in a poly house. The main experimental field was thoroughly ploughed and levelled and farm yard manure at 25 tons per hectare was also applied during the last ploughing and seedlings were transplanted with a spacing of 90 cm x 45 cm. Bio enriched organic manure (Multiplex Annapurna) was mixed along with the Farm Yard Manure in the respective beds and the recommended dose of basal NPK at 250:250:250 kg per hectare was applied for the entire field. Fifty percent of N was applied at the time of transplanting and the remaining 50 percent of N was applied at the time of earthing up. For every 16 rows of tomatoes 1 row of marigolds was planted to avoid nematode infestation. Sticky traps are used to manage insects and appropriate plant protection measures were taken to control of different pests and diseases throughout the cropping period. Twenty-five plants were planted for each treatment. Treatment details are given in table 1.

Soil characteristics:

Soil is a major component for any plant's growth as it supplies nutrients required for the healthy life cycle starting from seed germination to seed formation and maturation in a plant. Soil samples were collected from both experimental sites by following the grid method of soil sampling. The true representative soil sample was taken to assess the physical properties and chemical properties before cropping. The soil samples were analyzed for available nitrogen, phosphorus, and potassium before and after cropping for each crop and their respective cultivated soil (Table 2)

Observations recorded: all the observations were recorded on five plants at 30,60 and 90 DAP for growth parameters like Plant height (from the ground level to the tip of the main shoot), Number of leaves per plant, Number of branches per plant: The total number of branches arising from the main stem from each selected plant. Yield parameters like Total number of fruits per plant (The number of fruits harvested from different harvests was added to obtain the total number of fruits per plant), Fruit yielded per plant (kg) (The weight of fruits harvested from each picking was recorded from five labeled plants of each plot and the total yield per plant was worked out by adding the yield of each harvest), Fruit yield (The total yield per hectare was estimated based on the fruit yield per plant from each harvest to the number of plants per hectare).

$$\text{Fruit yield} = \frac{\text{Fruit yield per plot}}{\text{Net plot area } (m^2)} \text{X } 10{,}000$$

Disease incidence

Fungal disease

- The major disease occurring on the crops were recorded at every 15 days interval using the 0-5 scale for various crops and various diseases
- Per cent disease index (PDI) was calculated using the formula.

$$(\text{PDI}) = \frac{\text{Sum of the individual disease ratings}}{\text{Number of fruits/ leaves observe}} \text{ X } \frac{100}{\text{Maximum disease grade}}$$

Bacterial and viral diseases

The percentage incidence was calculated using the formula.

Insect incidence

The incidence of insects on all the crops was recorded at 15-day intervals

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

Analysis and result

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

Resul1ts

Growth Parameters

Plant height (cm)

Plant height is an indicator of the growth performance of the crop influenced by the soil, nutrient status, and management factors. The results were analyzed and presented in Table 3. The growth at 30 DAP did not show any significant difference. A significant difference in plant height was observed at 60 and 90 DAP. The highest plant height was recorded in T_{10} of 51.6 cm, 95.26 cm, and 147.33 cm at 30, 60, and 90 DAP respectively with the application of RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc High (10 kg/ac) + Navajeevan G (10 kg/ac). The treatments T_4 (RDF + Annapurna @ 450 kg/ac) and T_{15} (RDF + Foliar spray (Mahaphal + Samras + Sambrama + Bio Jodi) recorded the second and third highest plant heights of 140.68 cm and 140.66 cm at 90 DAP respectively. Comparatively lower plant height of 39.93 cm, 60.86 cm, and 79.80 cm was recorded in T_1 on the 30, 60, and 90 DAP respectively with the application of RDF only.

1.2 Number of branches

Total number of branches at 30, 60 and 90 DAP were recorded and are presented in Table 4**.** As evident from the data given in Table 4, there was a significant difference in the number of branches concerning different treatments at all the recorded intervals. The highest number of branches of 12.86, 33.40 and 44.80 was recorded in T_{10} on 30, 60 and 90 DAP respectively Also, the application of Annapurna @ 450 kg/ac of T_4 and RDF + Foliar spray (Mahaphal + Samras + Sambrama + Bio Jodi) of T_{15} recorded 42.60 and 45.46 number of branches respectively on 90 DAP. Whereas lowest number of branches of 10.06, 12.80 and 15.20 were recorded in T_1 on 30, 60 and 90DAP respectively which was RDF only. All the treatments registered a greater number of branches over T_1 (RDF) at all the recorded intervals.

Number of leaves

Total number of leaves at 30, 60 and 90 DAP were recorded and are presented in Table 5. The highest number of leaves were recorded in T_{10} of 111.73, 191.00 and 291.80 at 30, 60 and 90 DAP respectively followed by T_4 with 268.40 leaves, T_{15} with 268.86, T_6 (RDF + Samruddhi @ 50 kg) with 258.13 leaves and T_{16} RDF + (Annapurna (120 kg/ac) + Samruddhi (25 kg/ac) + Organic Magik (5 kg/ac) + Zinc

High (5 kg/ac) + Navajeevan G (5 kg/ac)] with 257.66 leaves. The lowest number of leaves of 78.40, 105.93, and 117.20 was registered in T_1 on 30, 60 and 90 DAP respectively with the application of only RDF. The application of different multiplex enhancers did not significantly influence the number of leaves at 30 DAP, it significantly influenced at the later stages on 60 and 90 DAP.

Yield attributes

Number of fruits

The number of fruits per plant at harvest was counted and the data is presented in Table 6. The highest number of fruits per plant was recorded in T_{10} of 238.66 followed by T_{14} (RDF + Kranti @ 2 ml/L + Biojodi @ 5 g/L) with 193.33 fruits and T_3 (RDF + Annapurna @ 240 kg) with 178 fruits respectively. Comparatively lowest number of fruits per plant was recorded in T_1 (RDF) with 56.33.

Fruit yield (t/ha)

The data on the fruit yield of tomatoes influenced by yield enhancers are presented in Table 7. Tomato fruits were harvested in seven pickings from the experimental plot. Treatment T_{10} recorded significantly higher fruit yield per plant as well as per hectare of 12.39 kg and 30.60 t/ha respectively. Also, with application of RDF + Annapurna @ 450 kg of T_4 and RDF + Kranti @ 2 m1/1 + Bio Jodi @ 5 g/I of T_{14} and recorded 9.68 kg, 21.48 t/ha and 9.48 kg, 20.4 t/ha respectively. Again, the fruit yield per plant and yield per hectare was recorded lowest at 2.46 kg and 8.60 t/ha in treatment T_1 with the application of RDF only. Application of different yield enhancers has significantly increased fruit yield in all treatments of tomato over control (T_1).

Disease incidence

Incidence of early blight, late blight and other minor diseases was recorded regularly. The incidence of various diseases is presented in Table 8 The per cent disease index of early blight in T_{13} (RDF + Samras @ 3 ml/L + Biojodi @ 5 g/L) was 12.88, followed by 13.77 in T_{16} (RDF + (Annapurna (120 kg/ac) + Samruddhi (25 kg/ac)). The treatments T_{14} (19.97), T_6 (17.77), T_5 (19.37), T_4 (19.15) and T_2 (16.12) were on par with each other. The late blight incidence of 17.47 was noticed in T_{14}, followed by 24.34 in T_{11} which was on par with T_{12} (29.28), T_{13} (25.39) and T_{16} (28.94). Maximum late blight incidence was noticed in T_1 with 47.17% PDI, flowed by 45.73 in T_2 and 45.49 in T_9. With respect to percentage of leaf curl incidence, 13.91% in T_9 was least affected followed by T_7 and T_3 at 15.81% and 16.80% respectively. The treatment, T_1 (RDF) was severely affected with percentage of leaf curl incidence of 47.04% compared to all other treatment

Pest infestation

Leaf minor, fruit borer, whitefly and pinworm were the major pest infestation observed and managed accordingly during tomato crop period and is presented in Table 9. The least incidence of leaf minor infestation of 9.32 was observed in T_{11} followed by 9.33 in T_9 and 10.19% in T_{15}. The fruit borer infestation was least in T_9 with 7.09 followed by 7.70 % in T_3 and 7.23% in T_{14}. In case of sucking pests, white fly infestation was comparatively less in both T_{10} and T_{15} with 0.33%. Pin worm infestation was noticed least in T_{11} at 11.29% and T_1 was severely infested with all major pests against all other examined treatments.

Discussion

Growth parameters

After the application of multiplex yield enhancer, we could find significant differences among the different treatments used however the highest plant height (51.60 cm, 95.26 cm, and 147.33 cm), number of leaves per plant (111.73, 191 and 291.8) and number of branches per plants (12.86, 33.40 and 44.80) were found in T_{10} at 30, 60 and 90 DAP respectively. That's because the bio-enriched organic manure (Annapurna) has a positive response towards the growth parameters (Ashwini *et al*., 2014) [20] as these will have the de-oiled cakes, vermicompost, biofertilizer, and biopesticides which protect the soil from diseases and pests intern the metabolites of which are known to have positive attributes in growth parameters. Tomato demands balanced nutrition to exhibit its highest quality attribute, as this treatment includes all the essential nutrients along with biofertilizers and bio-stimulant have a positive effect on the growth parameter of the tomato (Raj *et al*., 2012: Alfosea *et al*., 2021: Tiyagi *et al.*, 2015) [13, 2, 16]. The combination of the organic and inorganic fertilizer and bio-stimulants treated plot showed better growth performance (Anwar *et al*., 2017) [3].

Yield parameter

The yield parameters like Number of fruits/plant (238.66), Fruit yield/ plant (12.39 kg), and Yield/ha (13.76 tons) were found to be highest in the treatment T_{10}, which is followed by the T_{14} in a number of fruits /plant (193.33), T_4 in Fruit yield/plant (9.68 kg) and Yield/ha (21.48 tons). Because of the good growth provided by the treatment, the yield attributes also increased accordingly. The chemical fertilizer alone may also reduce the protein and carbohydrates which may hinder quality produce (Laily *et al*., 2021) [10] treatment with combined application of organic and chemical fertilizer would result in a higher quality of the produce (Mojeremane *et al*., 2016) [11]. The humic acid like bio stimulants are known to enhance the fresh fruit weight, number of flowers and fruits contributing to increased yield (Yildirim 2007) [19]. Calcium and Boron are known to give a good fruit quality parameter and shelf life. Therefore, when these all are given with combination definitely it will increase the yield additionally conserving soil fauna. These results are also in line with the findings of Ye, L *et al*., 2020 and Tiyagi, *et al*., 2015) [18, 16]. Hence the combination of the organic and inorganic fertilizer and bio-stimulants treated plot showed better growth performance and yield attributes (Ferdous *et al*., 2016) [7].

Pest and Disease incidence

Nutrients along with the Bio-Jodi (Bio bactericide) treatment has shown the better management of disease and pests than other treatments and control. *Bacillus* and *Pseudomonas* species hinder the pathogens by competing for the food near rhizosphere or production of secondary metabolites to manage various pest and diseases (Adesemoye *et al*., 2008) [1] They also serve as Plant growth promoters and have been previously shown with significant effects on plant growth, root development, biocontrol of soil-borne diseases and inducing plant systemic resistance

(Huang *et al*., 2011) [8] Chen, L.-H. *et al.,* 2012) [6]. When these biopesticides are given with nutrients, the plant is free from pest and disease and with the nutrient supply plant will grow better and yield better.

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
T6	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 (10 kg/ac)	Basal dose + Earthing up
T_{11}	RDF + Mahapal @ 3 ml/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 @ 5 g/15l + Bio jodi @ 5 g/L	
T_{13}	RDF + Samras @ 3 ml/L + Bio jodi @ 5 g/L	
T_{14}	RDF + Kranti @ 2 ml/L + Bio jodi @ 5 g/L	
T_{15}	RDF + Foliar spray (Mahapal + samras + sambrama + Bio jodi)	
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)	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

Table 2: Initial physio-chemical properties of soil tomato field:

Sl. No	Soil properties	Value
1	pH	5.8
2	Electrical conductivity (ds/m)	0.09
3	Organic carbon (%)	0.68%
4	Available N (kg/ha)	380
5	Available P (kg/ha)	4
6	Available K (kg/ha)	62
7	Exchangeable Ca (meg/100 g of soil)	544.5
8	Exchangeable Mg (meg/100 g of soil)	100.7
9	Available S (mg/Kg)	3.47
10	Available Zn (mg/Kg)	0.57
11	Available Fe (mg/Kg)	11.88
12	Available Cu (mg/Kg)	0.95
13	Available Mn (mg/Kg)	42.13
14	Available B (mg/Kg)	0.26

Table 3: Impact of multiplex yield enhancers on plant height in tomato

Sl. No	Treatment	Mean plant height (cm) per plant		
		30 DAP	60 DAP	90 DAP
T_1	RDF (N:P: K) + (FYM)	39.93	60.86	79.80
T_2	RDF + Annapurna @ 150 kg/ac	41.13	75.73	104.46
T_3	RDF + Annapurna @ 240 kg/ac	47.00	90.60	138.27
T_4	RDF + Annapurna @ 450 kg/ac	49.66	93.60	140.68
T_5	RDF + Organic magic @ 10 kg/ac	43.40	68.66	93.93
T6	RDF + Samruddhi @ 50 kg/ac	42.93	73.60	85.26
T_7	RDF + Zinc high @ 10 kg/ac	44.53	80.60	116.66
T_8	RDF + Navjeevan G @ 10 kg/ac	45.60	64.26	79.60
T_9	RDF + Jivras @ 3 ml/L	47.73	80.20	112.66
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc high (10 kg/ac) + Navjeevan G (10 kg/ac)	51.60	95.26	147.33
T_{11}	RDF + Mahapal @ 3 ml/L + Bio jodi @ 5 g/L	43.26	78.13	116.33
T_{12}	RDF + Sambrama @ 5 g/15l + Bio jodi @ 5 g/L	48.06	77.53	107.00
T_{13}	RDF + Samras @ 3 ml/L + Bio jodi @ 5 g/L	41.93	69.00	92.20
T_{14}	RDF + Kranti @ 2 ml/L + Bio jodi @ 5 g/L	45.60	77.60	105.46
T_{15}	RDF + Foliar spray (Mahapal + samras + sambrama + Bio jodi)	45.60	75.73	140.66
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)	43.20	62.60	114.07
S.Em +		3.23	0.73	3.27
C.D @ 5%		NS	2.13	10.78
C.V @ 5%		12.43	16.62	25.97

Note: RDF-Recommended Dose of Fertilizer, DAP- Days after planting, FYM – Farmyard manure, NS- non-significant,

Table 4: Impact of multiplex yield enhancers on number of branches in tomato

Sl. No	Treatment	Mean plant height (cm) per plant		
		30 DAP	60 DAP	9 0DAP
T_1	RDF (N:P: K) + (FYM)	10.06	12.80	15.20
T_2	RDF + Annapurna @ 150 kg/ac	10.80	19.80	26.80
T_3	RDF + Annapurna @ 240 kg/ac	11.00	22.33	27.23
T_4	RDF + Annapurna @ 450 kg/ac	12.40	32.13	42.60
T_5	RDF + Organic magic @ 10 kg/ac	10.93	22.06	32.20
T6	RDF + Samruddhi @ 50 kg/ac	10.86	29.73	37.60
T_7	RDF + Zinc high @ 10 kg/ac	10.53	22.73	33.93
T_8	RDF + Navjeevan G @ 10 kg/ac	12.26	12.80	17.66
T_9	RDF + Jivras @ 3 ml/L	11.60	23.60	34.60
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc high (10 kg/ac) + Navjeevan G (10 kg/ac)	12.86	33.40	44.80
T_{11}	RDF + Mahapal @ 3 ml/L + Bio jodi @ 5 g/L	10.66	20.73	30.40
T_{12}	RDF + Sambrama @ 5 g/15l + Bio jodi @ 5 g/L	10.06	19.53	28.00
T_{13}	RDF + Samras @ 3 ml/L + Bio jodi @ 5 g/L	12.40	27.46	41.53
T_{14}	RDF + Kranti @ 2 ml/L + Bio jodi @ 5 g/L	12.20	21.06	28.93
T_{15}	RDF + Foliar spray (Mahapal + samras + sambrama + Bio jodi)	12.20	29.33	45.46
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)	11.00	31.46	40.93
S.Em +		0.63	1.13	2.26
C.D @ 5%		1.82	3.27	6.53
C.V @ 5%		9.62	8.20	11.04

Note: RDF-Recommended Dose of Fertilizer, DAP- Days after planting, FYM – Farmyard manure, NS- non-significant

Table 5: Impact of multiplex yield enhancers on number of leaves of tomato

Sl. No	Treatment	Mean plant height (cm) per plant		
		30 DAP	60 DAP	90 DAP
T_1	RDF (N:P: K) + (FYM)	78.40	105.93	117.20
T_2	RDF + Annapurna @ 150 kg/ac	93.86	175.40	182.40
T_3	RDF + Annapurna @ 240 kg/ac	99.26	165.00	222.73
T_4	RDF + Annapurna @ 450 kg/ac	103.20	170.26	268.40
T_5	RDF + Organic magic @ 10 kg/ac	102.47	170.46	208.46
T6	RDF + Samruddhi @ 50 kg/ac	80.20	131.00	258.13
T_7	RDF + Zinc high @ 10 kg/ac	103.26	172.33	230.73
T_8	RDF + Navjeevan G @ 10 kg/ac	102.0	115.73	149.26
T_9	RDF + Jivras @ 3 ml/L	99.53	179.00	208.46
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc high (10 kg/ac) + Navjeevan G (10 kg/ac)	111.73	191.00	291.80
T_{11}	RDF + Mahapal @ 3 ml/L + Bio jodi @ 5 g/L	86.80	175.26	253.73
T_{12}	RDF + Sambrama @ 5 g/15l + Bio jodi @ 5 g/L	86.80	161.33	225.86
T_{13}	RDF + Samras @ 3 ml/L + Bio jodi @ 5 g/L	84.66	185.93	250.13
T_{14}	RDF + Kranti @ 2 ml/L + Bio jodi @ 5 g/L	91.93	163.60	225.26
T_{15}	RDF + Foliar spray (Mahapal + samras + sambrama + Bio jodi)	92.60	185.73	268.86
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)	100.46	184.06	257.66
S.Em +		10.91	3.11	12.75
C.D @ 5%		NS	9.02	37.01
C.V @ 5%		19.93	3.27	9.84

Note: RDF-Recommended Dose of Fertilizer, DAP- Days after planting, FYM – Farmyard manure, NS- non-significant

Table 6: Impact of multiplex yield enhancers on yield of tomato

	Treatment	Number of fruits/plants	Fruit yield/plant (kg)	Yield/ha (tons)
T_1	RDF (N:P: K) + (FYM)	56.33	2.46	8.60
T_2	RDF + Annapurna @ 150 kg/ac	103.66	6.73	15.24
T_3	RDF + Annapurna @ 240 kg/ac	178.00	8.70	16.62
T_4	RDF + Annapurna @ 450 kg/ac	158.66	9.68	21.48
T_5	RDF + Organic magic @ 10 kg/ac	162.00	7.67	18.95
T6	RDF + Samruddhi @ 50 kg/ac	147.33	9.04	22.32
T_7	RDF + Zinc high @ 10 kg/ac	159.66	5.57	13.66
T_8	RDF + Navjeevan G @ 10 kg/ac	155.66	7.22	17.83
T_9	RDF + Jivras @ 3 ml/L	120.33	6.17	13.76
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc high (10 kg/ac) + Navjeevan G (10 kg/ac)	238.66	12.39	30.60
T_{11}	RDF + Mahapal @ 3 ml/L + Bio jodi @ 5 g/L	153.00	7.00	17.29
T_{12}	RDF + Sambrama @ 5 g/15l + Bio jodi @ 5 g/L	147.00	8.19	20.22
T_{13}	RDF + Samras @ 3 ml/L + Bio jodi @ 5 g/L	80.66	6.93	11.51
T_{14}	RDF + Kranti @ 2 ml/L + Bio jodi @ 5 g/L	193.33	9.48	20.41
T_{15}	RDF + Foliar spray (Mahapal + samras + sambrama + Bio jodi)	144.00	5.80	14.33
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)	131.00	9.04	23.90
S.Em +		1.00	110.18	1.15
C.D @ 5%		2.9	319.76	3.35
C.V @ 5%		28.33	23.88	29.14

Note: RDF-Recommended Dose of Fertilizer, DAP- Days after planting, FYM – Farmyard manure, NS- non-significant

Table 7: Impact of multiplex yield enhancers on Chlorophyll content in tomato leaves

Treatment		Chlorophyl content (mg/g tissue)		
		Ch.a	Ch. b	Total.Ch
T_1	RDF (N:P: K) + (FYM)	1.36	0.30	1.72
T_2	RDF + Annapurna @ 150 kg/ac	1.82	0.56	2.34
T_3	RDF + Annapurna @ 240 kg/ac	2.25	0.73	2.92
T_4	RDF + Annapurna @ 450 kg/ac	2.93	1.45	4.45
T_5	RDF + Organic magic @ 10 kg/ac	2.06	0.61	2.56
T6	RDF + Samruddhi @ 50 kg/ac	2.59	1.13	3.62
T_7	RDF + Zinc high @ 10 kg/ac	2.78	1.57	4.29
T_8	RDF + Navjeevan G @ 10 kg/ac	2.65	1.12	3.64
T_9	RDF + Jivras @ 3 ml/L	2.86	0.65	2.58
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc high (10 kg/ac) + Navjeevan G (10 kg/ac)	2.42	1.76	4.60
T_{11}	RDF + Mahapal @ 3 ml/L + Bio jodi @ 5 g/L	2.29	0.86	3.18
T_{12}	RDF + Sambrama @ 5 g/15l + Bio jodi @ 5 g/L	2.12	0.73	2.99
T_{13}	RDF + Samras @ 3 ml/L + Bio jodi @ 5 g/L	1.91	0.45	2.13
T_{14}	RDF + Kranti @ 2 ml/L + Bio jodi @ 5 g/L	1.37	0.46	2.18
T_{15}	RDF + Foliar spray (Mahapal + samras + sambrama + Bio jodi)	1.69	0.56	1.96
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)	2.84	1.42	4.08
S.Em +		1.00	110.18	0.29
C.D @ 5%		2.9	319.76	0.86
C.V @ 5%		28.33	23.88	16.80

Note: RDF-Recommended Dose of Fertilizer, DAP- Days after planting, FYM – Farmyard manure, NS- non-significant

Table 8: Impact of multiplex yield enhancers on disease incidence in tomato

Treatments		PDI		Percent fruit infection (LB)	Percent Leaf curl
		Late blight	Early blight		
T_1	RDF (N:P: K) + (FYM)	47.17 (43.38)	45.36 (42.34)	12.20 (20.44)	47.04 (43.30)
T_2	RDF + Annapurna @ 150 kg/ac	45.73 (42.55)	16.12 (23.67)	7.40 (15.79)	32.45 (34.73)
T_3	RDF + Annapurna @ 240 kg/ac	30.93 (33.79)	33.94 (35.63)	7.53 (15.93)	16.80 (24.20)
T_4	RDF + Annapurna @ 450 kg/ac	45.45 (42.39)	19.15 (25.96)	6.26 (14.49)	18.0 (25.10)
T_5	RDF + Organic magic @ 10 kg/ac	37.09 (37.52)	19.37 (26.11)	6.73 (15.04)	15.47 (23.16)
T6	RDF + Samruddhi @ 50 kg/ac	32.71 (34.88)	17.77 (24.93)	7.40 (15.79)	24.02 (29.35)
T_7	RDF + Zinc high @ 10 kg/ac	37.04 (37.49)	22.00 (27.97)	5.60 (13.69)	15.81 (23.13)
T_8	RDF + Navjeevan G @ 10 kg/ac	34.49 (35.96)	43.12 (41.05)	9.53 (17.98)	17.42 (24.67)
T_9	RDF + Jivras @ 3 ml/L	45.49 (42.41)	22.74 (28.48)	5.86 (14.01)	13.91 (21.90)
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc high (10 kg/ac) + Navjeevan G (10 kg/ac)	31.77 (34.31)	21.49 (27.62)	5.60 (13.69)	19.96 (26.54)
T_{11}	RDF + Mahapal @ 3 ml/L + Bio jodi @ 5 g/L	24.34 (29.56)	28.42 (32.22)	4.93 (12.83)	19.90 (26.49)
T_{12}	RDF + Sambrama @ 5 g/15l + Bio jodi @ 5 g/L	29.28 (32.76)	26.04 (30.68)	6.00 (14.18)	20.93 (27.23)
T_{13}	RDF + Samras @ 3 ml/L + Bio jodi @ 5 g/L	25.39 (30.26)	12.88 (21.03)	5.00 (12.92)	27.12 (31.38)
T_{14}	RDF + Kranti @ 2 ml/L + Bio jodi @ 5 g/L	17.47 (24.71)	19.97 (26.54)	4.53 (12.29)	18.02 (25.12)
T_{15}	RDF + Foliar spray (Mahapal + samras + sambrama + Bio jodi)	37.90 (38.00)	14.28 (12.20)	6.20 (14.42)	19.11 (25.92)
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)	28.94 (32.54)	13.77 (21.78)	7.46 (15.82)	19.52 (26.22)
S.Em +		3.03	8.98	1.71	5.74
C.D @ 5%		8.79	N/A	N/A	16.67
C.V @ 5%		21.89	45.17	43.18	46.07

Note: RDF-Recommended Dose of Fertilizer, DAP- Days after planting, FYM – Farmyard manure, NS- non-significant

Table 9: Impact of multiplex yield enhancers on pest. incidence in tomato

Treatment		Percent leaf minor infestation	Percent fruit borer infestation	Number of whitefly per leaf	Pin worm Infestation/total number of leaves
T_1	RDF (N:P: K) + (FYM)	22.12 (28.06)	25.90 (30.59)	1.33	26.40
T_2	RDF + Annapurna @ 150 kg/ac	10.23 (18.65)	14.60 (22.46)	0.66	18.82
T_3	RDF + Annapurna @ 240 kg/ac	11.11 (19.47)	7.70 (16.11)	0.66	13.36
T_4	RDF + Annapurna @ 450 kg/ac	15.34 (23.06)	9.77 (18.21)	1.00	17.53
T_5	RDF + Organic magic @ 10 kg/ac	11.18 (19.53)	9.55 (18.39)	0.66	13.38
T6	RDF + Samruddhi @ 50 kg/ac	10.25 (18.67)	11.75 (20.05)	0.66	12.00
T_7	RDF + Zinc high @ 10 kg/ac	16.23 (23.76)	12.88 (21.03)	0.33	18.40
T_8	RDF + Navjeevan G @ 10 kg/ac	20.63 (27.05)	12.00 (20.27)	1.00	24.88
T_9	RDF + Jivras @ 3 ml/L	9.33 (17.79)	7.09 (15.44)	1.33	11.36
T_{10}	RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc high (10 kg/ac) + Navjeevan G (10 kg/ac)	14.93 (22.73)	12.44 (20.65)	0.33	12.14
T_{11}	RDF + Mahapal @ 3 ml/L + Bio jodi @ 5 g/L	12.66 (20.84)	10.94 (10.31)	0.66	11.29
T_{12}	RDF + Sambrama @ 5 g/15l + Bio jodi @ 5 g/L	17.50 (24.73)	10.40 (18.81)	0.66	17.14
T_{13}	RDF + Samras @ 3 ml/L + Bio jodi @ 5 g/L	12.66 (20.84)	20.35 (26.81)	0.33	14.667
T_{14}	RDF + Kranti @ 2 ml/L + Bio jodi @ 5 g/L	17.50 (24.73)	7.23 (15.60)	0.66	19.74
T_{15}	RDF + Foliar spray (Mahapal + samras + sambrama + Bio jodi)	10.19 (18.62)	10.60 (19.00)	0.33	12.06
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)	14.03 (22.00)	12.63 (20.82)	1.00	15.98
S.Em +		2.81	1.73	0.49	2.86
C.D @ 5%		NS	5.01	NS	8.31
C.V @ 5%		35.28	24.51	117.10	30.64

Note: RDF-Recommended Dose of Fertilizer, DAP- Days after planting, FYM – Farmyard manure, NS- non-significant

Conclusion

The impact of multiplex yield enhancer improved the growth, yield, and related attributes of tomato hybrid NS501 compared to control and was found significant at different intervals during the crop period. Among all the treatment, T_{10} with the application of RDF + Annapurna (240 kg/ac) + Samruddhi (50 kg/ac) + Zinc high (10 kg/ac) + Navjeevan G (10 kg/ac) performed significantly better than other treatments with respects to both growth and other yield attributed further T_4, T_{16} an T_{15} were the other treatment which performed better than the control. However other treatments also showed different levels of disease incidences and pest infestation over control during the tomato crop period. But treatments which included foliar sprays at different intervals performed better than soil application-based treatments concerning disease and insect resistance.

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