



# Assessing the Effects of Biostimulant on Tomato Growth, Yield and Quality in Open Field Condition

Sourav Kundu <sup>a</sup>, Subhadeep Karak <sup>b</sup>,  
Narendra Nath Hansda <sup>a</sup>, Umesh Thapa <sup>a\*</sup>  
and Abujafar Oliyar Rahaman <sup>a</sup>

<sup>a</sup> Department of Vegetable Science, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, 741252, India.

<sup>b</sup> Indian Space Research Organization, National Remote Sensing Centre, Balanagar, Hyderabad, 500037, India.

## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

**Aim:** This study, conducted at "C" Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, during the period of 2022–23, explores the impact of biostimulants on the growth, yield, and quality of tomatoes (*Lycopersicon esculentum* Mill.). The primary objectives include investigating the significant effects of biostimulants and determining the optimal stage for their application, given the current emphasis on sustainable farming practices.

**Study Design:** The experimental design employed Randomized Block Design (RBD) with three replications and eight treatments. Results indicate that biostimulant application, particularly as a foliar spray, significantly enhances crop growth and stimulates reproductive growth in later stages

\*Corresponding author: E-mail: [drumesh.thapa@gmail.com](mailto:drumesh.thapa@gmail.com);

compared to control plants. Notably, the application of Biostimulant (Kazuki Gold) topically at 500 ml/acre during pre-flowering stage and during fruit development stage (T5) significantly registered the highest yield of 751.89 q/ha.

**Place and Duration of Study:** The farm, situated near the Tropic of Cancer, exhibits coordinates of approximately 22.89°N latitude and 88.45°E longitude, with an altitude of around 9.75 m above sea level.

**Results:** The highest lycopene content of 5.08 mg/100gm, which was significantly superior over all the treatments was obtained with the application of Kazuki gold during the two stages of application (i.e. at pre-flowering stages and during fruit development stage). The study also observed substantial impacts on other quality parameters with the application of seaweed extracts, protein hydrolysates, and N-fixing growth promoters during various stages of plant growth.

**Conclusion:** Based on the findings, it can be concluded that Applying KAZUKI GOLD/YOSHI GOLD through foliar spray at a rate of 500ml per acre during the pre-flowering and fruit development stages has demonstrated profitability and advantages, leading to increased yields of high-quality tomato fruits.

**Keywords:** Biostimulant; tomato; growth; yields;

## 1. INTRODUCTION

Tomato (*Solanum lycopersicum* L. Syn. *Lycopersicon esculentum* Mill.,  $2n=2x=24$ ) is one of the most world's largest grown vegetable crop after potato and sweet potato. It belongs to the family Solanaceae and is native of Andean region that includes parts of Colombia, Ecuador, Peru, Bolivia and Chile. It is mostly considered as 'Protective food' based on its nutritive value and antioxidant properties due to the presence of lycopene and flavonoids. In order to avoid using excessive amounts of external inputs without compromising crop performance, it is essential for a sustainable tomato production system to maximize soil nutrient availability and nutrient usage efficiency. In contemporary agricultural practices, essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K) are commonly administered to vegetable crops via foliar sprays, as highlighted by Chaurasia et al. [1]. Lack of these elements leads to change in intracellular pH, ionic disbalance, protein content, organic acids and carbohydrates [2,3]. The primary objective of foliar nutrition is to ensure that plants receive the appropriate quantity of nutrients. Plant biostimulants could be quite beneficial to farmers in this situation. In this context, Biostimulant (Brand Name: Kazuki Gold/Yoshi Gold, Kazuki Energy) is liquid formulation of protein hydrolysate and amino acid which is a complex mixture of peptide and amino acids that can be produced from various biomass sources. Low concentration of biostimulant enhance growth and metabolic status of plants [4,5]. The combination of bio-stimulants and nutrients synergistically contributes to protein synthesis, ultimately fostering enhanced growth

and increased yield [6]. Abundant use of synthetic chemicals can result in detrimental effects on non-target species and in chemical contamination of soil, water supplies and harvested products. The use of commercial inorganic fertilizers has led to a significant decrease in soil microbial populations, causing pollution throughout the entire rhizosphere [7]. Growers continue to search for sustainable strategies that will improve crop yields without adversely impacting on the environment. Keeping this view in perspectives, the present experiment was conducted to standardize the efficacy of Kazuki Gold/Yoshi Gold, Kazuki Energy for growth and yield of Tomato (*Solanum lycopersicum*) and to find out the stage of application of Biostimulant in of Tomato (*Solanum lycopersicum*).

## 2. MATERIALS AND METHODS

The field experiments under the present investigation "Studies on the efficacy of Biostimulant (Kazuki Gold/Yoshi Gold) for growth and yield of Tomato (*Solanum lycopersicum*)," was carried out during the period of 2022-23. The experiment was conducted at "C" Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, and West Bengal. The farm is located very close to the Tropic of Cancer having approximately 22.89°N latitude and 88.45°E longitude. The altitude of the place is about 9.75 m above the sea level. The mean annual temperature falls below 20°C in the November and continue till the early part of February. The temperature starts rising from second fortnight of February reaches its maximum usually in April-May in the Gangetic Plains of West Bengal. The

**Table 1. Treatments details**

Treatments	Products	Dose/acre	No. of application	Time of Application
T1	Biostimulant (Kazuki Gold/Yoshi Gold)	500 ml	1	30-35 Days after transplanting
T2	Biostimulant (Kazuki Gold/Yoshi Gold)	500ml	1	Pre flowering stage (1% flowering)
T3	Biostimulant (Kazuki Gold/Yoshi Gold)	500 ml	1	Fruit development stage
T4	Biostimulant (Kazuki Gold/Yoshi Gold)	500ml	2	1st application: 30-35 Days after transplanting 2nd application: Pre flowering stage (1% flowering)
T5	Biostimulant (Kazuki Gold/Yoshi Gold)	500ml	2	1st application: Pre flowering stage (1% flowering) 2nd application: Fruit development stage
T6	Biostimulant (Kazuki Gold/Yoshi Gold)	500ml	3	1st application: 30-35 Days after transplanting 2nd application: Pre flowering stage (1% flowering) 3rd application: Fruit development stage
T7	Biostimulant (Kazuki Energy)	500ml	1	Pre flowering stage (1% flowering)
T8	Control (water only)			

soil composition consisted of sandy loam with a slightly acidic pH. The experimental site was equipped with reliable irrigation facilities. The experiment was conducted using randomized block design, consisting of eight treatments that were each replicated three times. The treatment factors included in Table 1.

The study focused on the tomato cultivar Sahoo (TO3251) Hybrid. Nitrogen, phosphorus, and potassium were applied using urea, di-ammonium phosphate, and muriate of potash, respectively. All recommended agronomic practices and plant protection measures were implemented for tomato crop production. Growth-related characteristics and yield parameters were observed in five randomly selected and tagged plants from each plot. These five plants per treatment were monitored until harvest. The seedlings were selected for transplantation into the field 28 days after sowing. Only healthy seedlings, devoid of any diseases, and reaching a height of 10-12 cm with a 3-4 leaf stage were chosen for transplanting. The transplanting process followed a spacing pattern of 75 x 75 cm. The F-test was used to determine the significance of treatment effects on the tomato crop. Standard errors of variance and critical differences for various treatments were calculated at the 5% significance level to

evaluate the reliability of each respective treatment.

### 3. RESULTS AND DISCUSSION

#### 3.1 Plant Height (cm)

The effect of Biostimulant on Plant height of the tomato was observed to be highly significant. It revealed from the Table 2 that the height of the plant varied from 93.12 cm to 120.56cm with different treatments. The plant height was measured among all treated and untreated plants and was recorded highest plant height of 120.56cm cm in plants with the application of Biostimulant (Kazuki Gold) with two applications, first application was done during the pre-flowering stage and the second application was done during the fruit development stage. The second highest plant of 114.18cm was observed from T<sub>6</sub> treatments plants (Kazuki Gold was applied in the three stages i.e. first application was done 30-35DAT, second application during the pre-flowering stage and third application during fruit development stage The lowest plant height of 93.12 cm was obtained in plants with spray of water as control and the second lowest plant height of 95.64cm was recorded from the T<sub>1</sub>. The plant which was sprayed with Biostimulant Kazuki Energy was also produced

the third highest plant height of 112.13 cm. Similar result was reported by Karak et al.[8] who found that the application of biostimulant increased plant growth characters like plant height on potato.

### 3.2 Number of Branches Per Plant (Cm)

Significant influence on number of branches /plants was observed due to different Biostimulant application at the various stages of the plant growth. The number of branches /plant at 75 DAT showed a good amount of differences of Biostimulant application. Number of branches /plants varied from 5.87 to 9.70. The maximum number of branches /plant of 9.70 was obtained from the plants where Kazuki Gold was applied during pre-flowering stage and fruit development stage. (T<sub>5</sub>). The second highest Number of branches /plant (8.70) was found from T<sub>6</sub> (Kazuki Gold was applied during three stages i.e. first application 30-35DAT, second application at pre – flowering stage and third application during fruit development stage). It revealed from the table that the minimum number of branches per plant was found lowest of 5.87 from the control plants followed by T<sub>1</sub>. Biostimulant Kazuki Energy also showed third highest number of branches (8.08). From the above observation it was cleared that Biostimulant application of Kazuki Gold significantly and positively influence the number of branches per plant. Biostimulant helps in numerical improvement on number of branches.

### 3.3 Number of flowers per plant

From the perusal of Table 2. it was apparent that the application of Biostimulant (Kazuki Gold) had significant effect on number of flowers per plant. The maximum number of flowers per plant (87.08) was observed from the plants which received foliar application of Kazuki gold during pre-flowering stage and fruit development stage (T<sub>5</sub>) followed T<sub>7</sub> and T<sub>6</sub>. The minimum number of flowers per plant was obtained from the plant when sprayed with water only. From the above results of the present investigation, it is assumed that the application of Kazuki Gold was found to be superior for producing a greater number of flowers when Kazuki gold was sprayed in two stages

### 3.4 Number of Fruits Per Plant

The data recorded on number of fruits per plant is furnished in Table 2. Among the treatments, foliar application of Kazuki Gold exhibited

significant influence on number of fruits per plant. Application of Kazuki Gold @ 500ml/acre during pre-flowering stage and during fruit development stage (T<sub>5</sub>) significantly registered the highest number of fruits per plant of 77.27. The treatments viz, application of Kazuki Gold during 30-35 days, pre-flowering and fruit development stage which stood next in order of ranking for producing more number of fruits of 73.77. Kazuki Energy when sprayed as foliar during the pre-flowering stage also showed increasing tendency of producing more number of fruits. It indicates from the observation that Biostimulant has pronounced effect for producing more number of fruits and vital stages for application is during pre – flowering stages of plant growth.

### 3.5 Number of Fruits Per Truss

Data recorded on number of fruits per truss showed significant variation among the treatments. Its value ranged from 4.54 –11.03. Maximum number of fruits per truss was observed in T<sub>5</sub>. followed by T<sub>6</sub>. With the application of Kazuki Gold, it was noticed that there was great variation on number of fruits as compare to control plants. 11.03 numbers of fruits were obtained as highest from the plants which was sprayed with Kazuki Gold during the two stages of plant growth. When Kazuki gold was sprayed after 30-35 DAT, the effect on increasing a number of fruits per plant was not satisfactory. Simultaneously it was also observed that the Biostimulant (Kazuki Energy) when applied in the plants at pre -flowering stage, it shows good response to produced more number of fruits compare to Kazuki Gold when sprayed only at 30-35 DAT. It was clear from the investigation time of application also plays a major role to exhibits more number of fruits per truss.

### 3.6 Fruit Diameter (cm)

The different treatments had significant difference on fruit diameter. Fruit diameter varied from 4.19 cm. to 7.33 mm. The details of the results are presented below. The application of Biostimulant showed the positive responses for better fruit diameter. There were significant differences in fruit diameter due to application of Kazuki Golan ad Kazuki Energy. The treatments with application of Biostimulant produced highest fruit diameter compare to Kazuki Energy and Control. The maximum fruit diameter of 7.33 cm was observed from the T<sub>5</sub> followed by T<sub>6</sub> (6.79cm.) The minimum diameter of 4.19 and

4.85 was obtained from control and from the plants which received only once foliar application of Kazuki Gold.

### 3.7 Fruit Weight (g)

Fruit weight differs significantly among the different treatments. It revealed from the data that fruit weight was statistically influenced by different treatments. The maximum fruit weight of 116.90 gm. was obtained from the T<sub>5</sub>. The second highest fruit weight was obtained from the plants which was sprayed three foliar applications of Kazuki Gold during three stages of plant growth i.e. first application was done 30-35 DAT and second was done during pre-flowering stage and third was given during fruit development stages. (T<sub>6</sub>). From this treatment fruit weight was measured as 113.91gm. It revealed from the Fig.7 that the lowest fruit weight was observed from control plant (T<sub>8</sub>) and (T<sub>1</sub>) which was 75.36gm and 89.13 gm, respectively. The nitrogen previously absorbed by vegetative components has been redirected toward reproductive organs, where it transforms into amino acids. Through condensation, these amino acids combine to create proteins, ultimately contributing to the increased weight of the fruits [9].

### 3.8 Total Yield (q. ha<sup>-1</sup>)

Among the treatments, foliar application of Kazuki Gold exhibited significant influence on total yield of tomato. Application of Kazuki Gold @ 500ml/acre during pre-flowering stage and during fruit development stage (T<sub>5</sub>) significantly registered the highest yield of 751.89q/ha. The treatments viz, application of Kazuki Gold during

30-35 days, pre-flowering and fruit development stage which stood next in order of ranking for producing highest yield of 704.82. Kazuki Energy when sprayed as foliar during the pre-flowering stage also showed increasing tendency of producing yield i.e. 645.37q/ha. It indicates from the observation that Biostimulant has positive influenced to boost of the production when applied in the right stages of plant growth. The lowest yield of 275.91 q/ha was obtained from control plants. The better yield obtained from the plant with the application of Biostimulant may be the fact that crop duration is extended more days for which more number of harvesting can be taken compare to the control plants.

### 3.9 Effect of Biostimulant on Qualitative Characters of Tomato

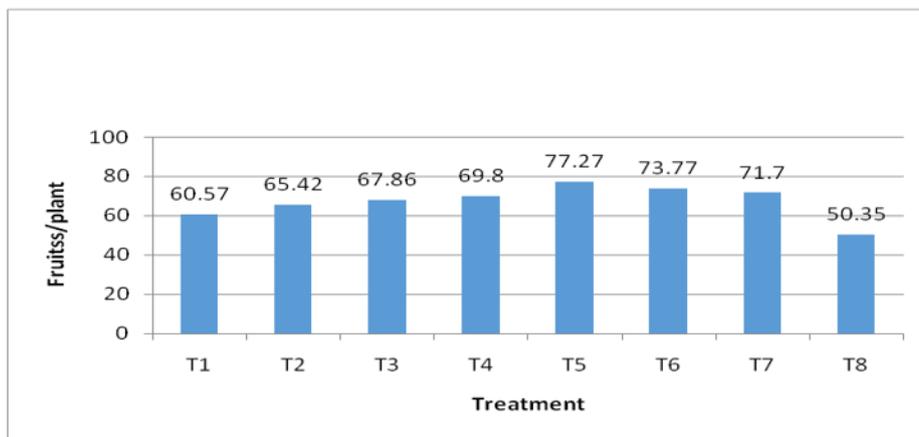
It revealed that different treatments showed distinct variation in respect of qualitative characters. Results given in Table 3 reflected significant differences in the values of lycopene content with the application of Biostimulant (Kazuki Gold/Yoshi Gold and Kazuki Energy). The highest lycopene content of 5.08 mg/100gm, which was significantly superior over all the treatments was obtained with the application of Kazuki gold during the two stage of application (i.e. at pre- flowering stages and during fruit development stage. The similar report was reported by Hansda *et al.*, 2023. The lowest lycopene content of 3.07/100gm and 3.73mg/100gm was obtained from control plant and with one application of Kazuki Gold (i.e. 30-35 DAT) Summarily, the maximum content of titrable acidity (0.55 mg/100gm) was found in the plant which was sprayed with Kazuki Gold during

**Table 2. Effect of biostimulant for growth and yield of tomato**

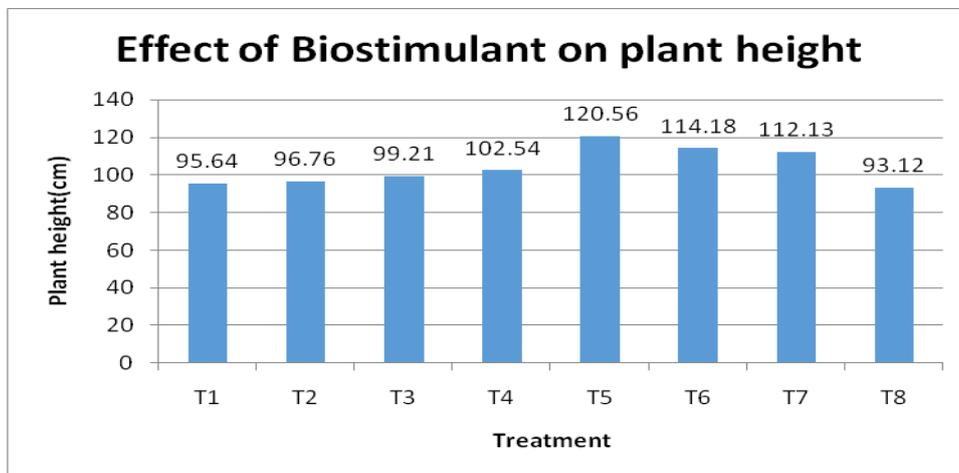
Treatments	Plant height (cm)	No. of branches per plant	Number of flowers/plants	No. of fruits per plant	No. of fruits per truss	Fruit diameter (cm)	Fruit Weight (g)	Total yield (q.ha <sup>-1</sup> )
T <sub>1</sub>	95.64	6.25	71.14	60.57	5.58	4.85	89.13	305.31
T <sub>2</sub>	96.76	6.82	76.58	65.42	6.08	5.04	95.28	382.51
T <sub>3</sub>	99.21	7.14	74.74	67.86	6.33	5.46	102.68	482.47
T <sub>4</sub>	102.54	7.95	79.54	69.80	7.23	5.81	107.63	597.53
T <sub>5</sub>	120.56	9.21	87.08	77.27	11.03	7.33	116.90	751.89
T <sub>6</sub>	114.18	8.70	85.46	73.77	9.25	6.79	113.91	704.82
T <sub>7</sub>	112.13	8.08	85.86	71.70	8.27	6.21	110.55	645.37
T <sub>8</sub>	93.12	5.87	64.72	50.35	4.54	4.19	75.36	275.91
SE(m)	0.608	0.08	0.329	0.439	0.146	0.103	0.411	4.537
CD (%)	1.84	0.27	1.00	1.33	0.44	0.31	1.25	13.76
C.V.	1.01	2.06	0.73	1.13	3.47	3.12	0.70	1.52

**Table 3. Effect of biostimulant on quality of tomato**

Treatments	Total chlorophyll content of leaves (%)	Total Soluble Solids (o Brix):	Total sugar content (%)	Lycopene content (mg/100g)	Beta carotene content (mg/100g)	Titration acidity (%)
T <sub>1</sub>	1.17	4.14	4.63	3.73	0.85	<b>0.47</b>
T <sub>2</sub>	1.07	4.18	4.84	3.81	0.88	<b>0.45</b>
T <sub>3</sub>	1.05	4.32	4.93	3.94	0.87	<b>0.45</b>
T <sub>4</sub>	1.21	5.03	5.04	4.26	0.90	<b>0.48</b>
T <sub>5</sub>	1.12	4.89	5.33	5.08	0.98	<b>0.55</b>
T <sub>6</sub>	1.19	5.39	5.15	4.92	0.96	<b>0.52</b>
T <sub>7</sub>	1.17	4.55	5.14	4.35	0.94	<b>0.48</b>
T <sub>8</sub>	0.89	3.54	4.46	3.07	0.80	<b>0.41</b>
SE(m)	0.024	0.111	0.043	0.053	0.006	<b>0.013</b>
CD (%)	0.07	0.34	0.13	0.16	0.02	<b>0.04</b>
C.V.	3.80	4.25	1.52	2.20	1.22	3.12



**Fig. 1. Effect of Biostimulant on number of fruits/plant**



**Fig. 2. Effect of Biostimulant on plant height (cm)**

pre-flowering stage and fruit development stages. In case of value of titration acidity lowest was observed in control and the from the plant

which was sprayed with Kazuki Gold during 30-35DAT. Beta carotene content was also influenced significantly with the treatments and

found high value of 0.98 mg/100g) from the fruits of the plant which was applied Kazuki Gold twice, first application during pre-flowering stage and second was applied during fruit development stages. Besides this other fruit quality parameters like TSS, total chlorophyll and total sugar content were also influenced significantly with the application of Biostimulant during different stages of plant growth. The highest, TSS of 5,39<sup>0</sup> Brix was obtained from

T<sub>6</sub> and total chlorophyll and total sugar of 1.19% and 5.33% of were recorded with T<sub>5</sub>. However Koleska et al. [10] found that biostimulant application lowered total soluble solids and total acidity that correlated with each other. Additional researchers have verified that the use of biostimulants leads to a reduction in sugar and total acids content in tomato fruits, along with alterations in their ratio [11].

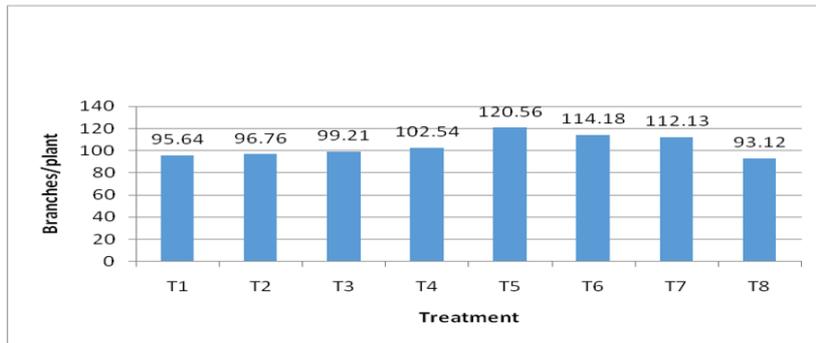


Fig. 3. Effect of Biostimulant for on number of branches per plant

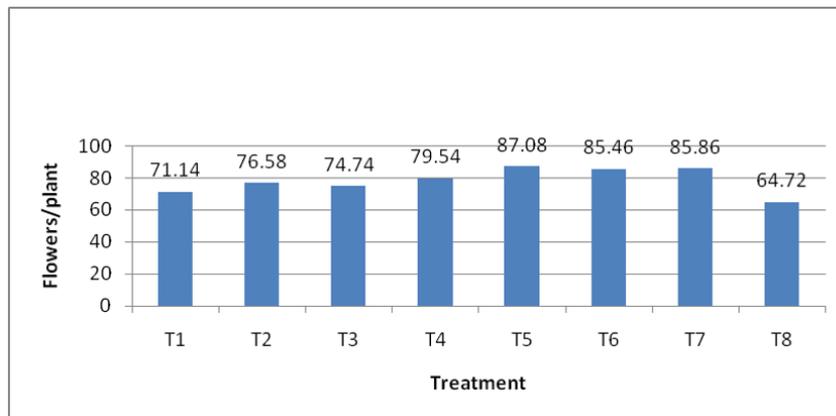


Fig. 4. Effect of Biostimulant for on number of flowers per plant

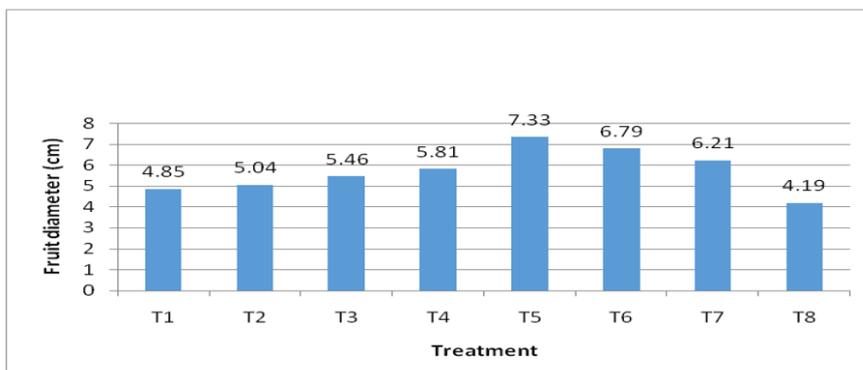


Fig. 5. Effect of Biostimulant on fruit diameter (cm)

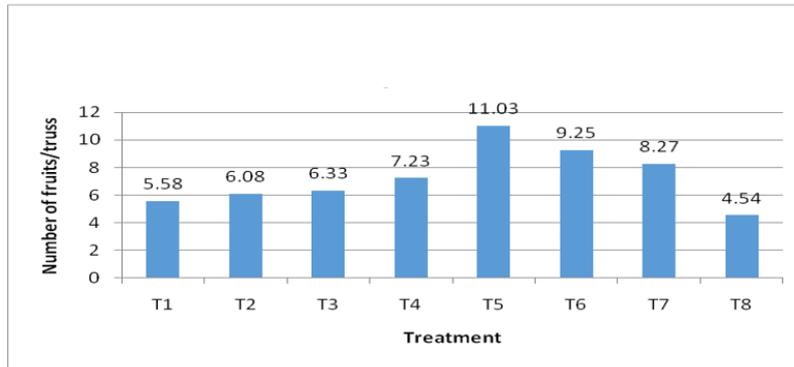


Fig. 6. Effect of Biostimulant on number of fruits per truss

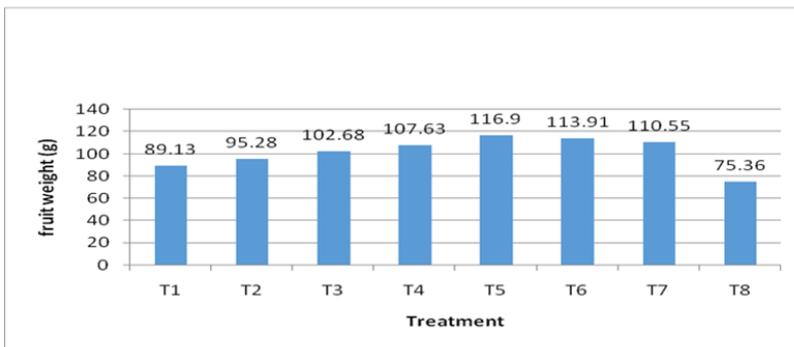


Fig. 7. Effect of biostimulant on fruit weight (g)

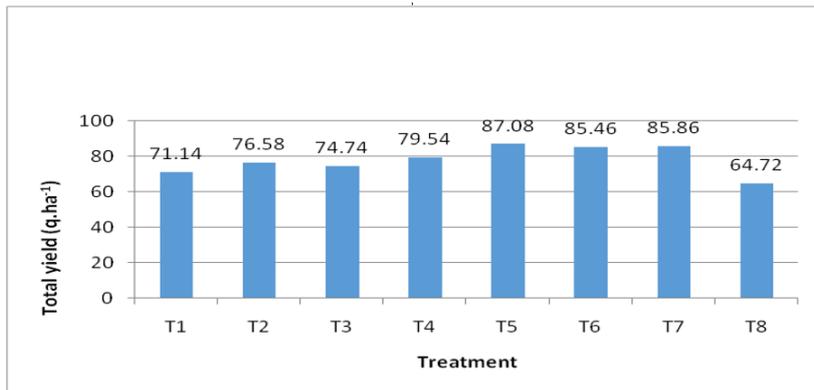


Fig. 8. Effect of biostimulant on total yield (q.ha-1)

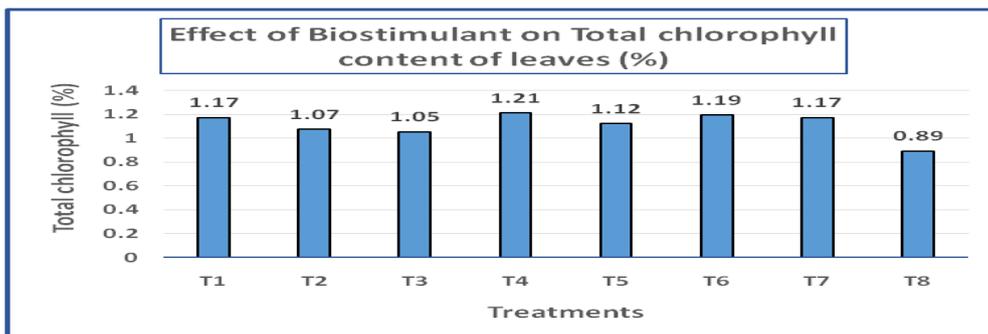


Fig. 9. Effect of biostimulant on total chlorophyll

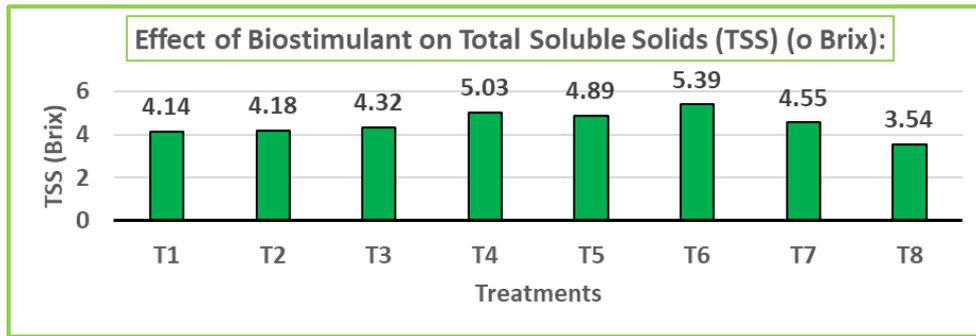


Fig. 10. Effect of biostimulant on total soluble solids

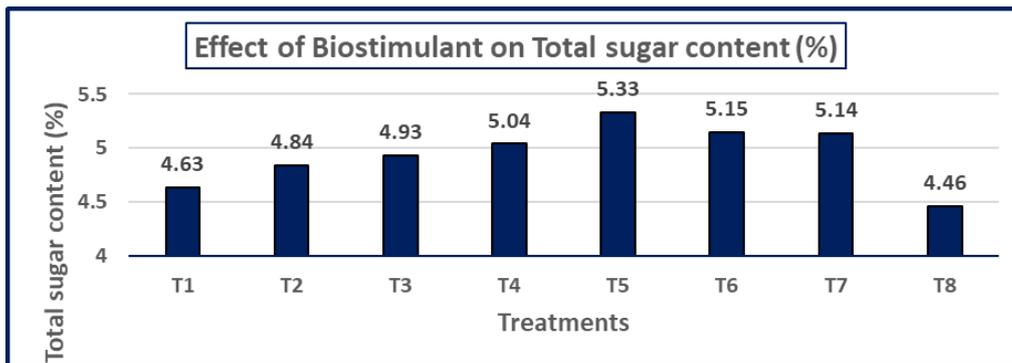


Fig. 11. Effect of biostimulant on total sugar

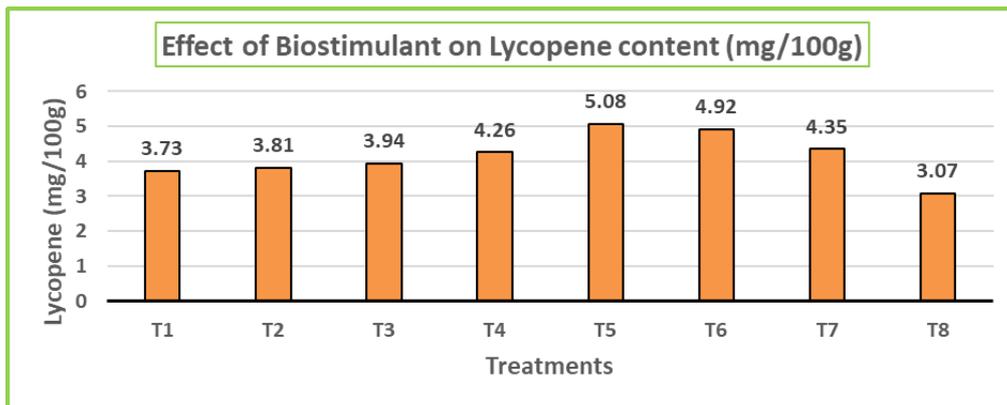


Fig. 12. Effect of biostimulant on lycopene content

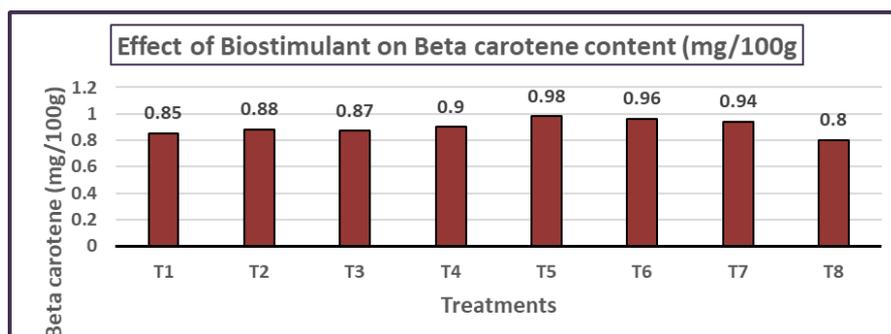


Fig. 13. Effect of biostimulant on beta carotene content

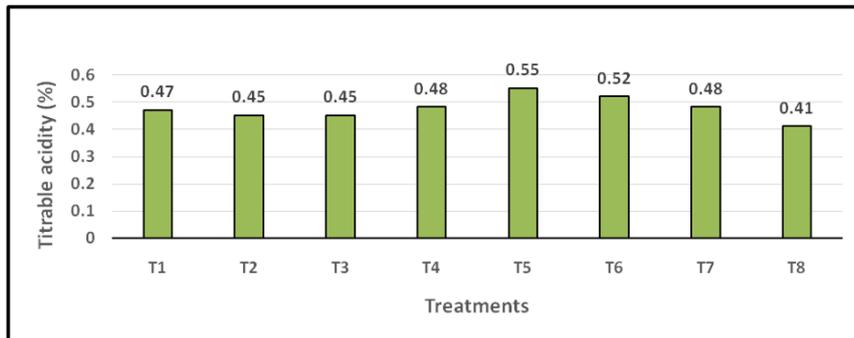


Fig. 14. Effect of biostimulant on titrable acidity (%)



Pic. 1. Tomato fruits with different treatments

#### 4. CONCLUSION

From the outcome of this experiment, it can be inferred that the growth and yield parameters of tomato significantly influenced by application of Biostimulant (Kazuki Gold/Yoshi Gold). Foliar application of Kazuki Gold during pre-flowering and fruit development stages is efficient in reducing the deficiency symptoms in the plants and promotes plant growth and fruit development. It promoted the plant immune system and higher yield. Biostimulant (Kazuki Gold/Yoshi Gold) holds promise as an eco-friendly and economically suitable component in nutrient management system for boosting the yield of tomato. Among the treatments, foliar application of KAZUKI GOLD/YOSHI GOLD @ 500ml/acre spray at during the pre-flowering and fruit development stages proved to be remunerative and advantageous in order to get higher yield of quality tomato fruit.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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