Original Research Article

Assessing the effects of Biostimulanton Tomato Growth, Yields and Quality in open field conditions

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

Key words: biostimulant, tomato, growth, yields, AGMA foliar

INTRODUCTION

Tomato (*Solanum lycopersicum* L. Syn. *Lycopersiconesculentum* 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 sustainabletomato 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.* (2005). The primary objective of foliar nutrition is to ensure that plants receive the appropriate quantity of nutrients. Plantbiostimulants could be quite beneficial to farmers in this situation. In this context, AGMA Foliar (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. The combination of bio-stimulants and nutrients synergistically contributes to protein synthesis, ultimately fostering

enhanced growth and increased yield (Dhanasekaran and Bhuvaneswari, 2005).Abundant use of synthetic chemicals can result in detrimental effects on non-target species and in chemical contamination of soil, water supplies and harvestedproducts.The use of commercial inorganic fertilizers has led to a significant decrease in soil microbial populations, causing pollution throughout the entire rhizosphere (Atieno *et al.,* 2020).Growerscontinue 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 AGMA-Foliar in of Tomato (*Solanum lycopersicum*).

MATERIALS AND METHODS

The field experiments under the present investigation **"**Studies on the efficacy of AGMA-Foliar (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^{o}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 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 the following treatments:

Table 1. Treatments Details

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

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.

Results and discussions

Plant height (cm)

The effect of AGMA Foliar 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 AGMA Foliar (Kazuki Gold) with two application, 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_6 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 $T_{1.}$ The plant which was sprayed with AGMA Foliar Kazuki Energy was also produced the third highest plant height of 112.13 cm.Similar result was reported by Karak *et al*. (2023)who found that the application of biostimulant increased plant growth characters like plant height on potato.

Number of branches per plant (Cm)

Significant influence on number of branches /plants was observed due to different AGMA foliar application at the various stages of the plant growth. The number of branches /plant at 75 DAT showed a good amount of differences of AGMA foliar 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_5). The second highest Number of branches /plant (8.70) was found from T_6 (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 reveled from the table that the minimum number of branches per plant was found lowest of 5.87 from the control plants followed by T_1. AGMA foliar Kazuki Energy also showed third highest number of branches (8.08). From the above observation it was cleared that AGMA foliar application of Kazuki Gold significantly and positively influence the number of branches per plant. AGMA Foliar helps in numerical improvement on number of branches.

Number of flowers per plant

From the perusal of table -2. it was apparent that the application of AGMA FOLIAR (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_5) followed T_7 and $T_{6.}$ 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

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_5) 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 AGMA Foliar has pronounced effect for producing more number of fruits and vital stages for application is during pre – flowering stages of plant growth.

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_5. followed by T_6. 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 AGMA FOLIAR (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.

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 AGMA FOLIAR 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 AGMA foliar produced highestfruit diameter compare to Kazuki Energy and Control. The maximum fruit diameter of 7.33 cm was observed from the T_5 followed by T_6 (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.

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_5. The second highest fruit weight was obtained from the plants which was sprayed three foliarapplications 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_6). From this treatment fruit weight was measured as 113.91gm. I t revealed from the Fig.7 that the lowest fruit weight was observed from control plant (T_8) and (T_1) 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 (Vandana and Verma 2014).

Total Yield (q. ha$^{-1)}$

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 (T5) 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. KazukiEnergy 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 AGMA Foliar 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 AGMA Foliar 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.

EFFECT OF AGMA FOLIAR ON QUALITATIVE CHARACTERS OF TOMATO

Itrevealed 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 AGMA FOLIAR (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 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 pre-flowering stage and fruit development stages . In case of value of titrable 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 AGMA FOLIAR during different stages of plant growth. The highest, TSS of 5,39 ^{0} Brix was obtained from $T_6$and total chlorophyll and total sugar of 1.19% and5.33% of were recorded with T_5.

CONCLUSION:

From the outcome of this experiment, it can be inferred that the growth and yield parameters of tomato significantly influenced by application of AGMA FOLIAR (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 andpromotes plant growth and fruit development. It promoted the plant immune system and higher yield. AGMA FOLIAR (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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TABLE NO. 2.EFFECT OFAGMA-FOLIAR 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 ($q.ha^{-1}$)
T_1	95.64	6.25	71.14	60.57	5.58	4.85	89.13	305.31
T_2	96.76	6.82	76.58	65.42	6.08	5.04	95.28	382.51
T_3	99.21	7.14	74.74	67.86	6.33	5.46	102.68	482.47
T_4	102.54	7.95	79.54	69.80	7.23	5.81	107.63	597.53
T_5	120.56	9.21	87.08	77.27	11.03	7.33	116.90	751.89
T_6	114.18	8.70	85.46	73.77	9.25	6.79	113.91	704.82
T_7	112.13	8.08	85.86	71.70	8.27	6.21	110.55	645.37
T_8	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 NO. 3.EFFECT OFAGMA-FOLIAR ON QUALITYOF TOMATO

Treatments	Total chlorophyll content of leaves (%)	Total Soluble Solids(o Brix):	Total sugar content (%)	Lycopene content (mg/100g)	Beta carotene content (mg/100g	Titrable acidity (%)
T_1	1.17	4.14	4.63	3.73	0.85	**0.47**
T_2	1.07	4.18	4.84	3.81	0.88	**0.45**
T_3	1.05	4.32	4.93	3.94	0.87	**0.45**
T_4	1.21	5.03	5.04	4.26	0.90	**0.48**
T_5	1.12	4.89	5.33	5.08	0.98	**0.55**
T_6	1.19	5.39	5.15	4.92	0.96	**0.52**
T_7	1.17	4.55	5.14	4.35	0.94	**0.48**
T_8	0.89	3.54	4.46	3.07	0.80	**0.41**
SE(m)	0.024	0.111	0.043	0.053	0.006	**0.013**
CD (**%**)	0.07	0.34	0.13	0.16	0.02	**0.04**
C.V.	3.80	4.25	1.52	2.20	1.22	3.12

FIGURE SHOWS EFFECT OF AGMA FOLIAR ON YIELD ATTRIBUTING CHARACTERS

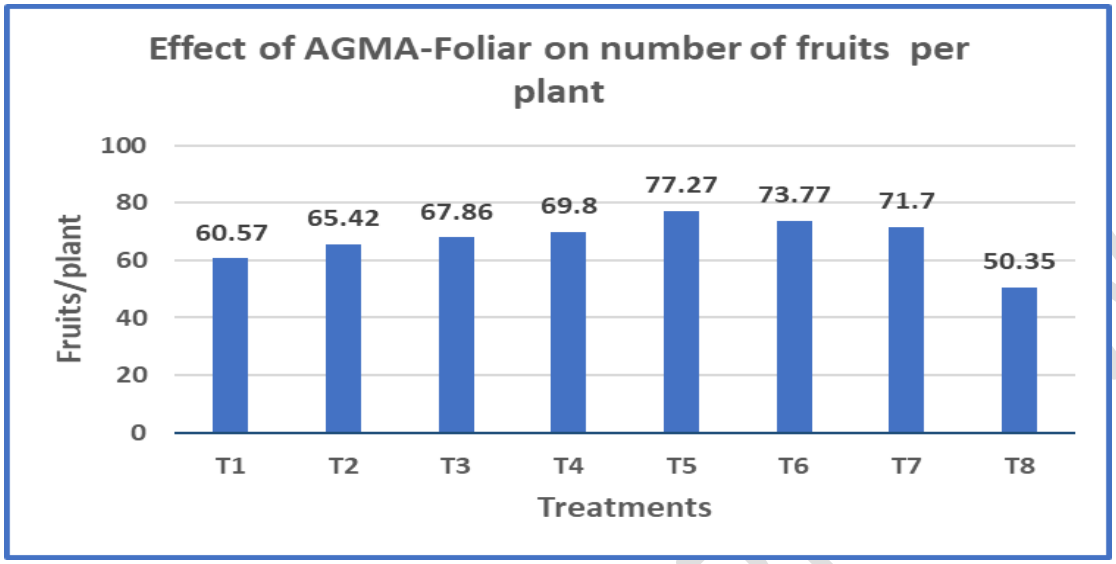

FIG: 1 EFFECT OF AGMA FOLIAR ON NUMBER OF FRUITS/PLANT

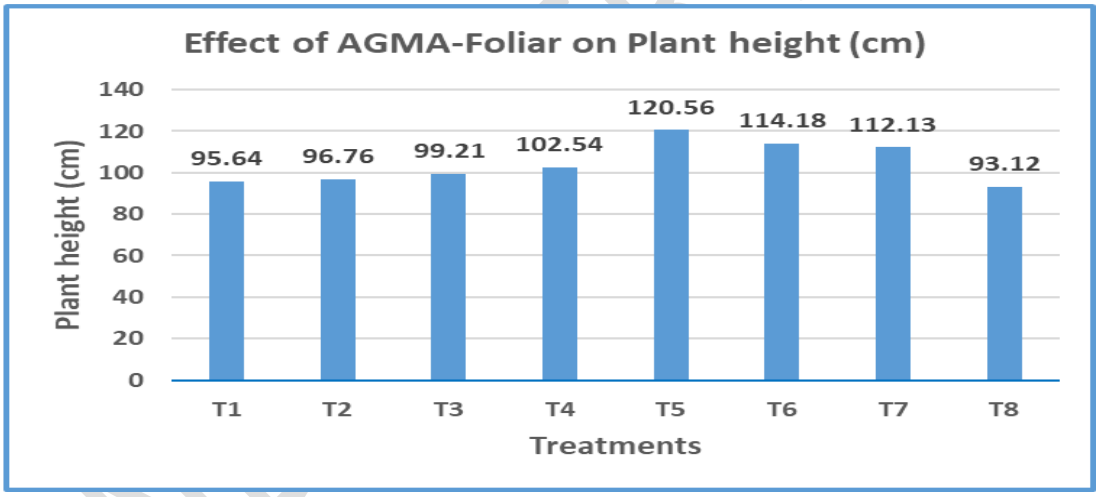

FIG: 2 EFFECT OF AGMA-FOLIAR FOR ON PLANT HEIGHT

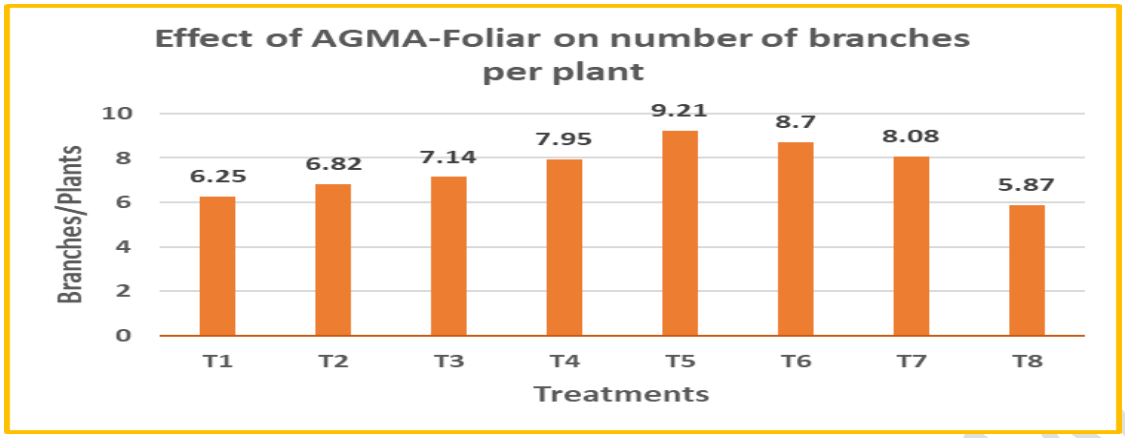

FIG: 3 EFFECT OF AGMA-FOLIAR FOR ON NUMBER OF BRANCHES PER PLANT

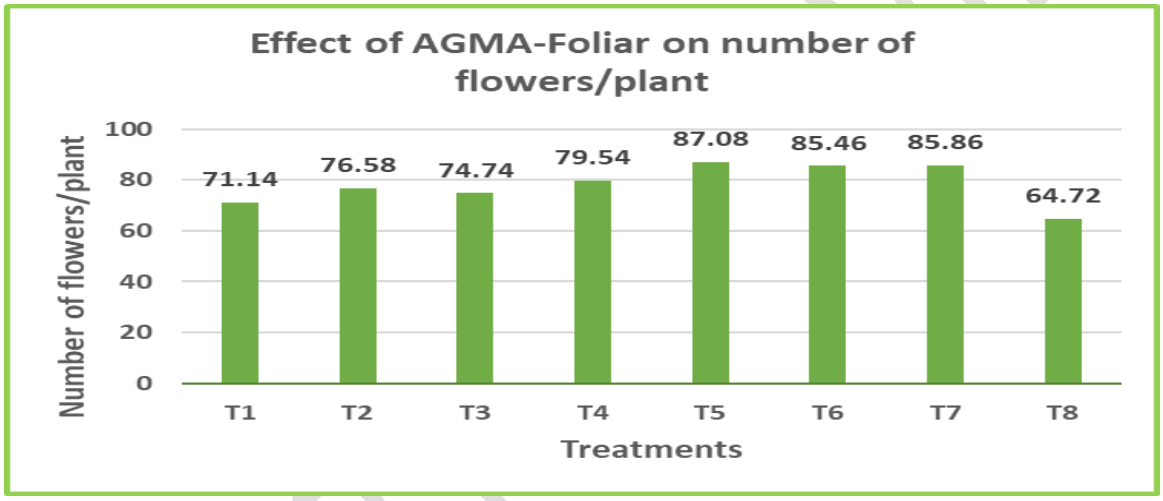

FIG: 4 EFFECT OF AGMA-FOLIAR FOR ON NUMBER OF FLOWERS PER PLANT

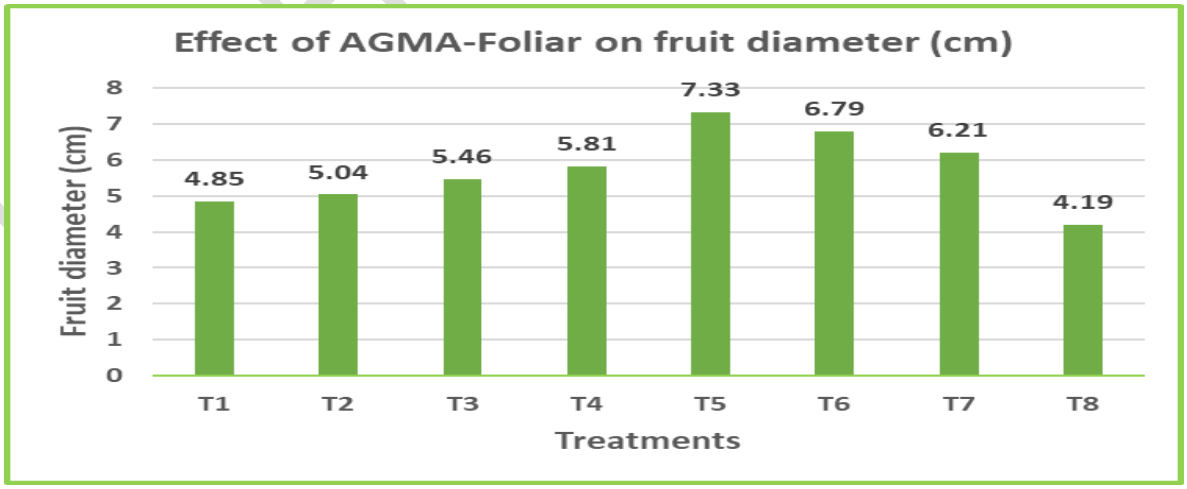

FIG: 5 EFFECT OF AGMA-FOLIAR ON FRUIT DIAMETER

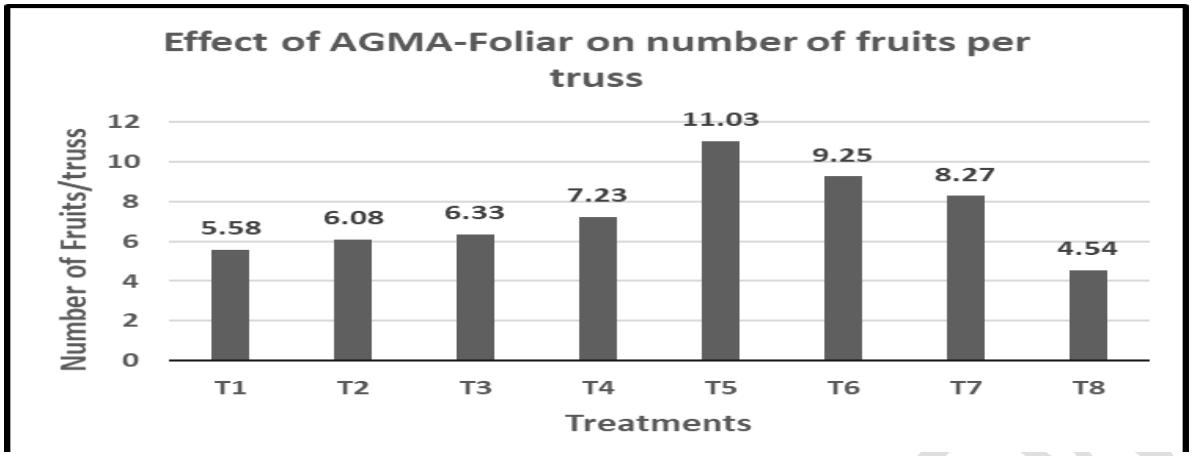

FIG: 6 EFFECT OF AGMA-FOLIAR ON NUMBER OF FRUITS PER TRUSS

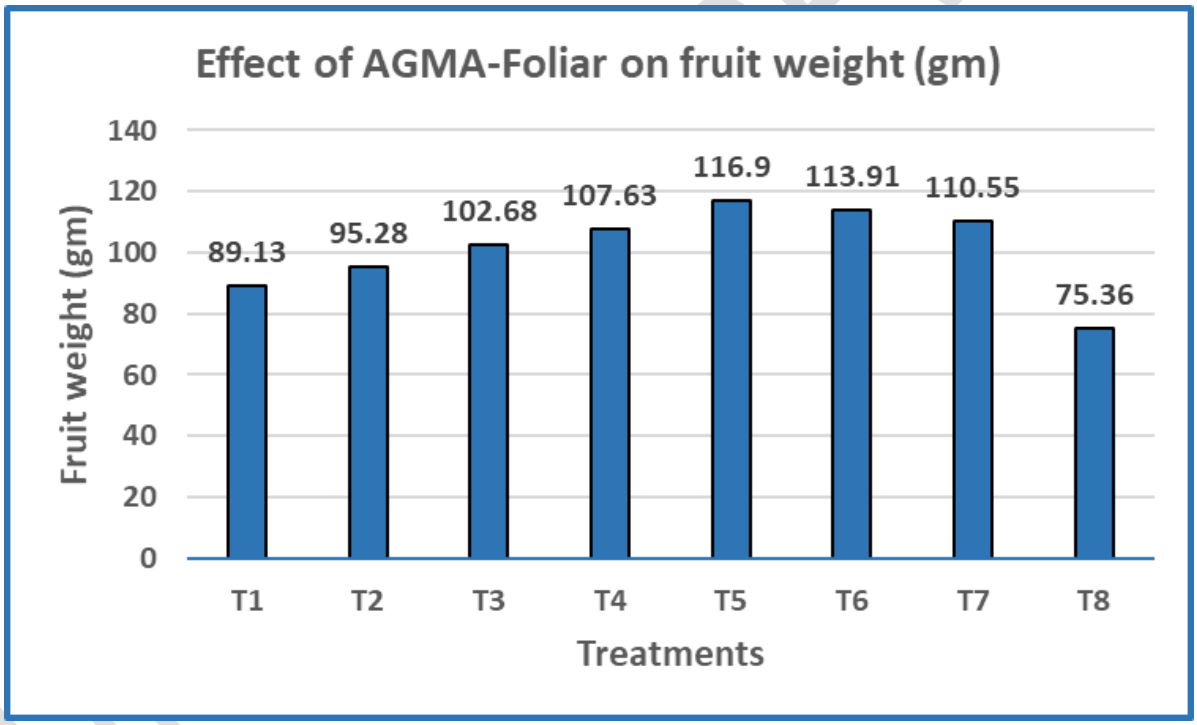

FIG: 7 EFFECT OF AGMA-FOLIAR ON NUMBER OF FRUIT WEIGHT (GM)

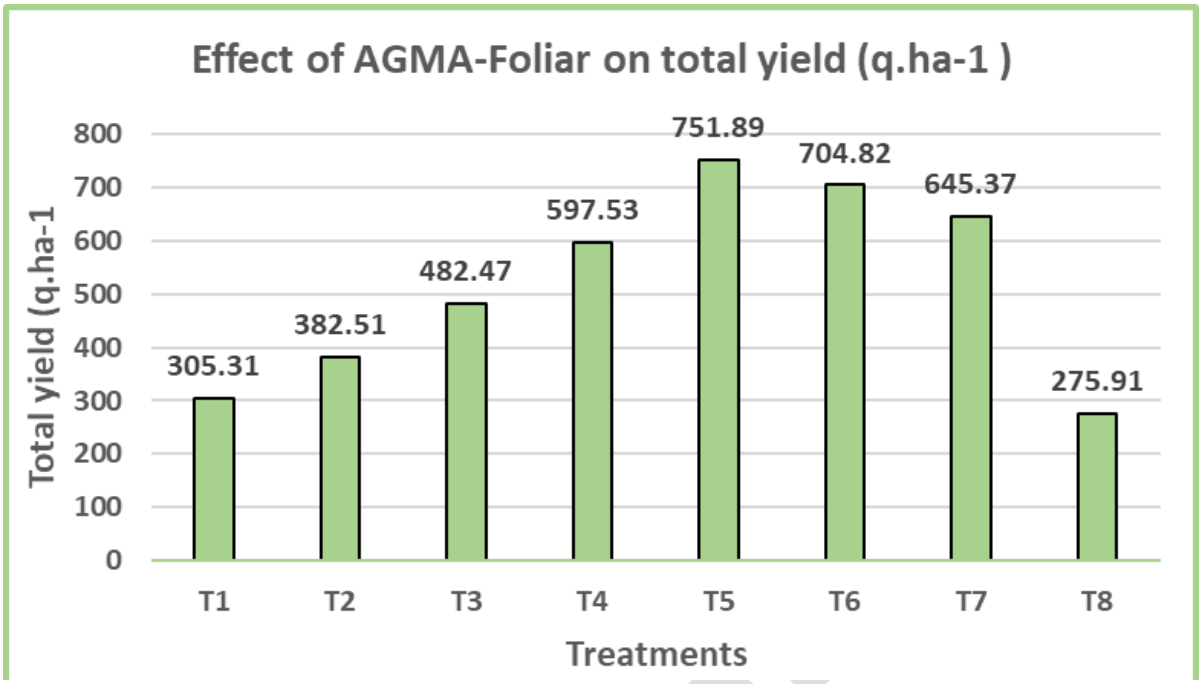

FIG: 8 EFFECT OF AGMA-FOLIAR ON NUMBER OF FRUIT WEIGHT (GM)

FIGURE SHOWS EFFECT OF AGMA-FOLIAR ON QUALITY OF TOMATO

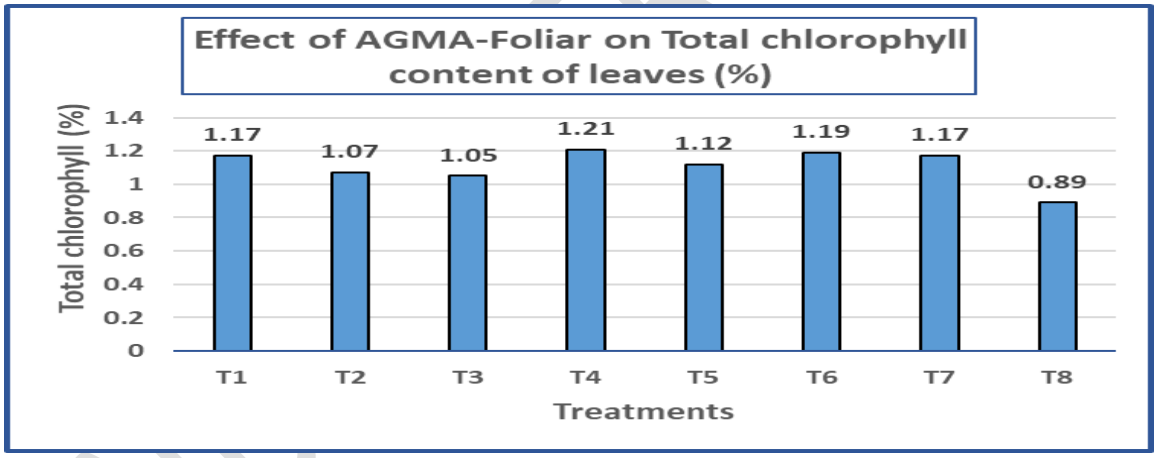

FIG: 9 EFFECT OF AGMA-FOLIAR ON TOTAL CHLOROPHYLL

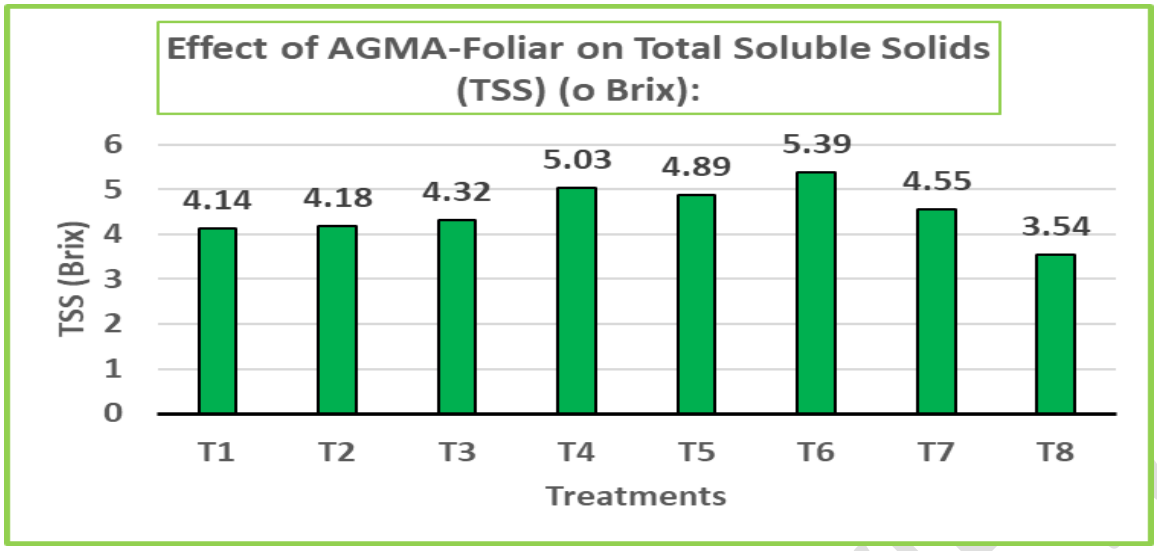

FIG: 10 EFFECT OF AGMA-FOLIAR ON TOTAL SOLUBLE SOLIDS

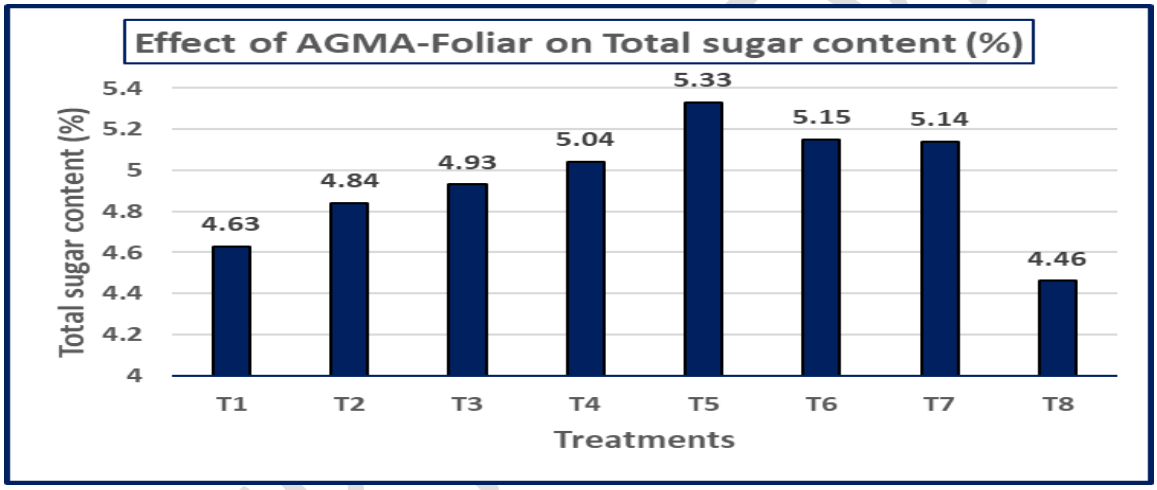

FIG: 11 EFFECT OF AGMA-FOLIAR ON TOTAL SUGAR

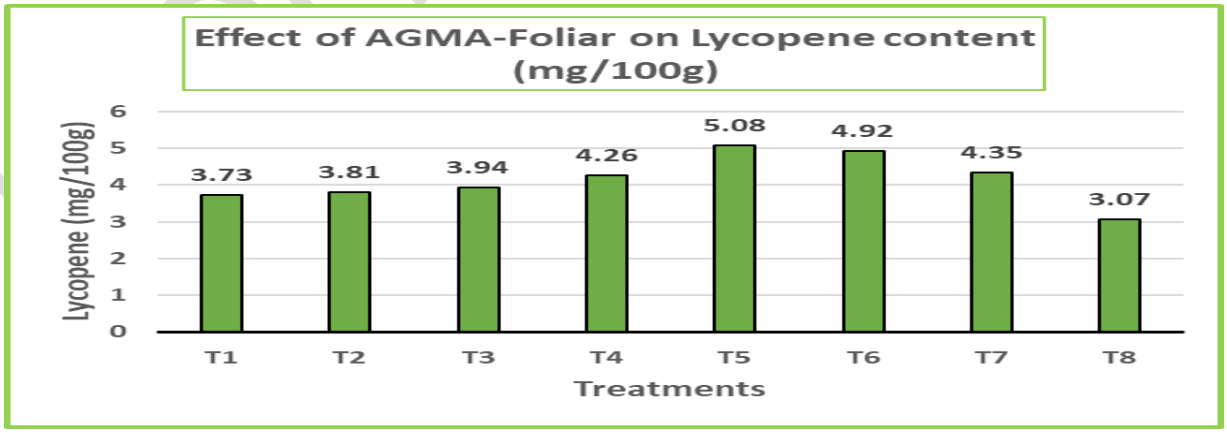

FIG: 12 EFFECT OF AGMA-FOLIAR ON LYCOPENE

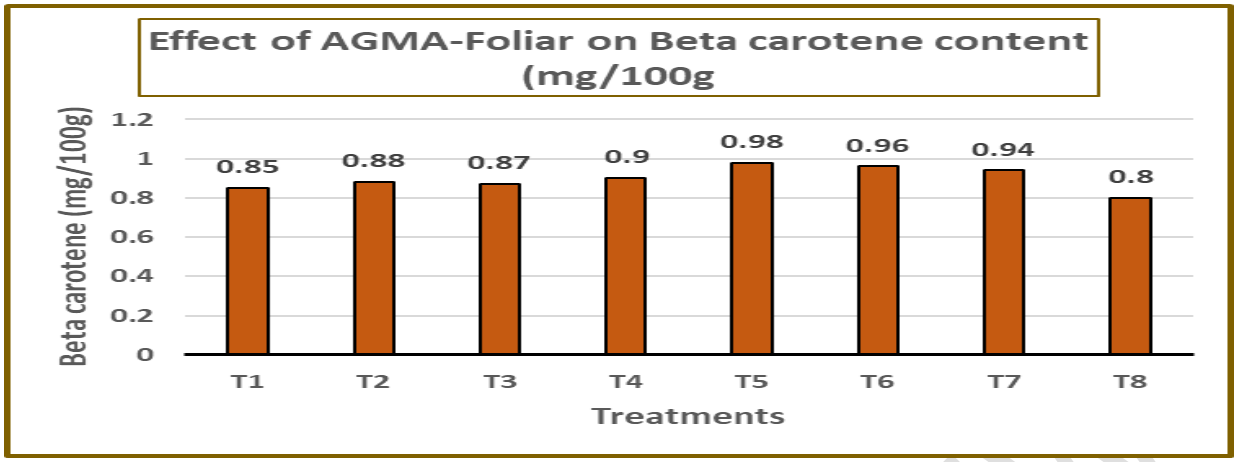

FIG: 13 EFFECT OF AGMA-FOLIAR ON BETA CAROTENE

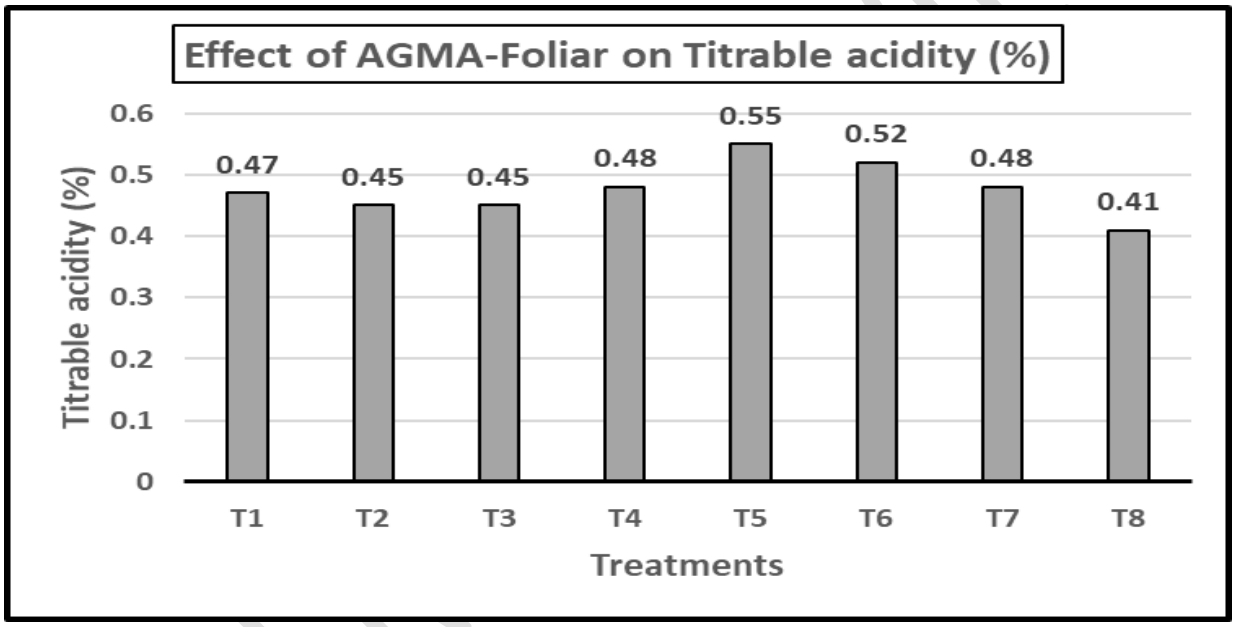

FIG: 14 EFFECT OF AGMA-FOLIAR ON TITRABLE ACIDITY

Pic 1. Tomato fruits with different treatm