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Effect of Nitrogen Fertilizer and Some Bio-Stimulants Extracts on Flowering Traits and Fruit Yield Quality of Tomato (*Solanum lycoersicom* L.)

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ABSTRCT

Two field trials were conducted during two successive summer seasons of 2023 and 2024 at the Experimental Farm of Faculty of Technology and Development, Zagazig University at Ghazala Region, Sharkia Governorate, Egypt to elucidate the effect of nitrogen fertilizer rates as soil application and foliar spray with two bio-stimulants extracts *viz*, seaweed extracts and dry yeast on growth, and fruit yield of tomato, chemical contents in leaves, flowering traits and fruit quality of tomato cv. Master R.S. treatments included three rates of nitrogen application (0, 50 and 100 kg/feddan) and foliar spray with seaweed extracts (2 g/l) and dry yeast extract (4 g/l). The experiment was laid out in split plot system with three replicates, where the main plot was nitrogen fertilizer rates, and the sub-plot was foliar spray with seaweed and dry yeast extracts. The results indicated that nitrogen at the rate of 100 kg/feddan, seaweed extracts (2 g/l) and their interaction effect between them caused an increase in chemical contents in leaves, flowering traits and fruit quality of tomato cv. Master R.S.

Consequently: it can be concluded that nitrogen at the rate of 100 kg/feddan and foliar spray with seaweed extracts at 2g/l, gave the highest values of chemical contents in leaves, flowering traits and fruit quality of tomato cv. Master R.S.

Key words: Nitrogen fertilizer - Seaweed extracts - Dry yeast extract - chemical contents in leaves, flowering traits - fruit quality - Tomato.

INTRODUCTION

Tomato (*Solanum lycopersicom* L.) is one of the most consumed vegetables in the world (**Guan *et al.*, 2018**). Tomato enjoys a significant position based on nutritional view have in 100g encompasses virtually, 48mg calcium , 27mg ascorbic acid, 20mg phosphorus, 3.6g carbohydrates, 0.9g proteins , 0.8g fiber, 0.4mg iron, and 0.2g fats. As well as, it also comprise *B*-carotene and lycopene pigments. Lycopene is an extremely vital as it is responsible for the respective red colour characteristics of tomatoes.

In addition, tomatoes also keep the blood vessels in healthy condition and prevent scurvy (**Ejaz *et al.*, 2011**). Crop fertilization is one of the most common cultural practice and farmers employ it to maximize yield.

Nitrogen (N) is an essential nutrient for tomato production, when limiting can reduce growth and crop production (**Yong *et al.,* 2018**). Nitrogen is one of the main nutrients required for plant growth and is therefore applied to crops in large amounts to ensure big yields. Many investigators illustrated that nitrogen (N) fertilizer increased growth, chemical contents, flowering characters yield and fruit quality of tomato (**Benard *et al.*, 2009**, **Singh *et al.,* 2010**, **Ragaie and Tavakoly, 2016** and **Qu et *al.,* 2020**).

Bio-stimulants like as seaweed and dry yeast extracts foliar spray caused an increase in growth, chemical contents, yield and quality of tomatoes. Seaweed extract contains appreciable quantities of nutrients, phytohormones, amino acids and vitamins (**Nour *et al.,* 2010**). Foliar spray with seaweed extract significantly increased growth, chemical contents, flowering characters yield and fruit quality of tomato (**Awad *et al.,* 2006**; **Sasikl *et al.,* 2016**; **Di Stasio *et al.,* 2018** and **Yao *et al.*, 2020**). As well as, dry yeast (*Saccharomyces cerevisae*) is one of the bio-stimulant that provides safe plant nutrition and free of any environmental damaging products. It is very rich in amino acids and when yeast is put in water, it hydrolyses cells formed extracted as a result of internal enzymes activity without the addition of external enzymes to a large number of vitamins and mineral salts, amino acids, but what is the most important of them all is the cytokinin hormone, which is considered to activate the roots and increase the vegetative growth rate in the first ages of the plant life (**Neklyudof *et al.,* 1993**). Many investigators concluded that foliar spray with dry yeast extract significantly increased growth, chemical contents, flowering characters, fruit yield and quality of tomato (**Alali *et al.,* 2017**; **Abou El Ghit *et al.,* 2020**; **Hassan *et al.,* 2023** and **Al-Mousaw *et al.,* 2024**). Regarding the interaction between nitrogen fertilizer and yeast, **Salloom *et al.* (2023)** demonstrated that nitrogen and yeast combined effect significantly increased growth characters, chemical contents, flowering tomato and chlorophyll of tomato plants.

Therefore, the aim of the present study is to improve chemical content and fruit quality of tomato plants by nitrogen fertilizer application in the soil and foliar spray with some bio-stimulants, i.e. seaweed and dry yeast extracts.

MATERIALS AND METHODS

The experiments was conducted at the farm of Faculty of Technology and Development, Zagazig University at Ghazala region, Sharkia Governorate, Egypt during growing seasons of 2023 and 2024 to investigate the effect of nitrogen fertilizer soil application and foliar spray with seaweed and dry yeast extracts on the growth and yield of tomato plants cv. Master R.S.

The soil analyses of the field experimental are presented in Table (1).

The experiment included 9 treatments, which were the combination of three nitrogen fertilizer rates (0.0, 50, and 100 kg N/feddan) as soil application and three foliar spray of plant extracts (0.0, seaweed and dry yeast).

Seaweed extract (Algaton 80%) as powder contains of nutrients, phytohormones, amino acids, vitamins and some Algae (*Ascophyllum nodosum*) (Table, 2). It was obtained from El-Salhia Company for intermediate chemicals at New Salhia City, Sharkia Governorate, Egypt (Table, 2).

Dry yeast extract as powder was obtained from Market contains nutrients, hormone, amino acids and some vitamins (Table, 3).

Treatments were arranged in a split plot system with three replicates, where the nitrogen fertilizer rates were assigned in the main plots, while the bio-stimulants extracts (seaweed and dry yeast) were distributed in sub plots. The seeds of tomato cv. Master R.S. were sown in nursery foam trays with soil of peatmoss and mixed with fermicolite and perlite (1:1:1) on 4th and 5th of March in 2023 and 2024 seasons, respectively.

Table (1): The physical and chemical properties of the experimental soil

Content	Value
Sand (%)	95.7
Silt (%)	2.7
Clay (%)	1.6
Soil texture	Sandy soil
Field capacity (FC)	6.7
Water holding capacity	14.3
Organic matter (%)	0.04
Available N (ppm)	6.3
Available P (ppm)	6.1
Available K (ppm)	61
Calcium carbonate (%)	0.23
pH	7.9

Table (2): The chemical analysis of seaweed extract

Components	Value
Moisture (%)	6.3
Organic matter (%)	43.6
Ash (%)	53.0
Micro. elements:	
Total nitrogen (%)	1.5
Available P_2O_5 (%)	2.8
Soluble K_2O (%)	20.5
Magnesium (Mg) (%)	0.3
Calcium (Ca) (%)	0.2
Micro. elements: (ppm) Boron (B)	113.0
Iron (Fe)	130.0
Copper (Cu)	10.20
Zinc (Zn)	53.0
Vitamins (ppm)	
B1	6.2
B2	5.5
B12	5.1
Ascorbic acid (V.C)	280

Table (3): The chemical analysis of used activity dry yeast

Characters	Value
Protein (%)	34.87
Ash (%)	7.55
Glycogen (%)	6.54
Fats (%)	2.09
Cellulose (%)	4.92

The seedlings were transplanted on 7th and 10th of April 2023 and 2024 seasons, respectively. The plot area was 15 m^2 (plants were spaced at 40 cm apart, 3 dripper line 4 m in length, 1.25 m in width with about 30 plants, in every plot. One dripper line was left between each two plots without spraying as a guard cow to avoid the **earmarked** contamination of spraying solution. One dripper line (5 m^2) was for samples and the two other dripper lines (10 m^2) were earmarked for estimating yield and its components.

Seaweed extract (2 g/L) and dry yeast extract (4 g/L, dissolved in tap water and added one small spoon from sucrose sugar to activate the fungi), The plant extracts (bio stimulants) were applied as foliar spray three times ten days intervals, the first one at 30 day after transplanting, and the other two sprays at ten days intervals (30, 40 and 50 days after transplanting. The control treatment was sprayed with tap water.

Nitrogen fertilizer rates were added at two equal portions, at 30 and 45 days from transplanting as soil application.

The normal agriculture practices of tomato plants under drip irrigation system were followed according to the recommendations of Egyptian Agriculture Ministry.

In this study, the treatments were carried out as follows: **A.**

Main plots (Nitrogen fertilizer rats):

1- 0.02- 50 kg/feddan.
3- 100 kg/feddan.

A. Sub plots plant extracts (bio stimulants):

1- 0.0 (Tap water).
2- Seaweed extract (2 g/L).
3- Dry yeast extract (4 g/L).

Data recorded:

1- Leaves chemical constituents:

Dried leaves were finely ground separately and digested with sulfuric acid and perchloric acid (3:1). Nitrogen, phosphorus and potassium were determined according to the method described by **A.O.A.C. (1990).**

2- Flowering traits:

A random sample of ten plants from each plot in both growing seasons were labeled and calculated the days to the first flowering, first fruiting and maturity on the first four trusses.

3- Fruit chemical contents (The nutritive value):

1. **Ascorbic acid (mg/100gFW):** it was determined according to **Ellong *et al.* (2015)**.
2. ***B*-Carotene:** It was determined spectrophotometrically as described by **A.O.A.C. (2012)**.
3. **Total sugars (%):** It was determined by the method described by **Somogyi (1952)** and **Nelson (1974)**.
4. **Total soluble solids (TSS):**

Samples taken especially for chemical contents, the full-ripe fruits were blended and filtrated through muslin cloth and then through filter paper No. 1, consequently the total soluble solids was determined in the filtrate by using Culr Zeis refractometer.

Statistical analysis:

Obtained data were subjected to the analysis of variance according to **Snedecor and Cochran (1980)**. Least significant difference (L.S.D) was used for the comparison among treatments using SAS software program (**SAS, 2004**).

RESULTS AND DISCUSSION

This work study the nitrogen fertilizer as soil application, and some bio stimulants, i.e. seaweed and dry yeast extracts on leaves chemical constituents, flowering traits and fruit quality (the nutritive value) of tomato as follows:

Leaves chemical constituents:

Effect of nitrogen fertilizer rates:

Data presented in Table (4) indicate that the highest rate of nitrogen fertilizer had the superior positive effect on N, P and K contents of tomato leaves compared to the other rates (0.0 and 50kgN\fed.) with increasing nitrogen fertilizer from 50kgN\fed. up to 100kgN\fed. significantly increased the chemical contents of tomato leaves, while the lowest values of chemical content was obtained from the control treatment (0.0kgN\fed). Regarding the important role of nitrogen for plants, **Wajid *et al.* (2010)** pointed out that nitrogen vegetative growth and development of plant, then increased metabolism and bio-processes of plant. These results are in concurrence with those listed by **Ragaie and Tavakoly (2016)** and **Qu *et al.* (2020)**.

Effect of bio-stimulants extracts:

Data in Table (4) revealed that bio-stimulants, i.e. seaweed and dry yeast extracts as foliar spray were significantly augmented on N, P and K contents of tomato leaves. Seaweed extract, being the most effective on chemical contents of tomato leaves, followed by dry yeast extract compared to the control treatment.

Respecting to the vital root of seaweed and dry yeast extracts on chemical contents of tomato plant, **Nour *et al.* (2010)** showed that seaweed extract contains appreciable quantities of nutrients, phytohormones, amino acid and vitamins which encourage the chemical contents of plant organs. These results are agreed with those of **Awad et *al.* (2006)** and **Yao *et al.* (2020)**. In addition, **Neklyudof *et al.* (1993)** demonstrated that dry yeast extract is very rich in amino acids, minerals salts, and hormones, especially cytokinin which is considered to activate the root for absorption the nutrients from the soil and then increased its in plant. The obtained results are agreement with those recorded by **Abou El Ghit *et al.* (2020)**, **Hassan *et al.* (2023)** and **Al-Mousaw *et al.* (2024).**

The interaction effect between nitrogen fertilizer and bio- stimulants:

The illustrated date in Table (5) cleared that the interaction between nitrogen at the rate of 100kgN\fed. and seaweed extract (2g/l) being the most effective on chemical contents of N, P and K in tomato leaves, followed by nitrogen (100kg/fed.) with dry yeast (4g\l). These findings hold true for both growing seasons. These results supported with those recorded by **Salloom *et al.* (2023).**

Table (4): Effect of nitrogen rates and bio-stimulants on nitrogen, phosphorus and potassium percentages content of tomato plants dried leaves during 2023 and 2024 seasons

Treatments	N%		P%		K%	
	2023 season	2024 season	2023 season	2024 season	2023 season	2024 season
N rates:						
0	2.39	2.38	0.24	0.24	3.22	3.23
50	2.53	2.50	0.27	0.27	3.48	3.47
100	2.68	2.67	0.33	0.34	3.87	3.84
L S D (0.05)	0.12	o.11	0.02	0.02	0.13	0.15
Bio-stimulants extracts: 0						
	2.28	2.30	0.19	0.20	3.13	3.14
Seaweed	2.72	2.68	0.34	0.34	3.78	3.46
Dry yeast	2.60	2.57	0.31	0.31	3.66	3.64
L S D (0.05)	0.11	0.08	0.02	0.02	0.11	0.13

Table (5): The interaction effect of nitrogen rates and bio-stimulants on nitrogen, phosphorus and potassium percentages content of tomato plants dried leaves during 2023 and 2024 seasons

		N%		P%		K%	
		2023 season	2024 season	2023 season	2024 season	2023 season	2024 season
0		2.21	2.23	0.17	0.18	3.01	3.03
	weed	2.55	2.51	0.29	0.27	3.36	3.41
	y yeast	2.41	2.39	0.25	0.26	3.29	3.25
50		2.27	2.24	0.20	0.21	3.17	3.14
	weed	2.74	2.71	0.32	0.31	3.75	3.71
	y yeast	2.57	2.55	0.30	0.28	3.53	3.55
100		2.36	2.42	0.21	0.20	3.21	3.24
	weed	2.87	2.83	0.41	0.43	4.24	3.27
	y yeast	2.82	2.77	0.37	0.39	4.15	4.11
D (0.05)		0.05	0.02	0.02	0.02	0.03	0.07

Flowering traits:

Effect of nitrogen fertilizer rates:

Data presented in Table (6) study the effect of nitrogen fertilizer rates on flowering traits of tomato, i.e. days to first flowering, days to first fruiting and days to maturity. The increase of nitrogen fertilizer rates from 0.0, 50 and 100kgN\fed. are gradually increased the flowering traits of tomato plants.

Regarding the important role of nitrogen on plants, **Yong *et al.* (2018)** revealed that nitrogen is an essential nutrient for tomato production which promotes the development of plants to format the flowers in plants. These results are true in both growing seasons. These results supported by those recorded by **Benard *et al.* (2009)** and **Qu *et al.* (2020)**.

Effect of bio stimulants extracts:

Data in Table (6) investigated the effect of seaweed and dry yeast extracts on flowering characters of tomato plant during both growing seasons. Seaweed extract, being the most effective on flowering traits of tomato plant, followed by dry yeast extract in this concern.

Regarding the effect of seaweed and dry yeast extracts on flowering traits of tomato plants, respectively, **Neklyudov *et al.* (1993)** and **Nour *et al.* (2010)** stated that these bio stimulants which contain many minerals, hormones and amino acids that activate the flowering buds for initiation and formation the flowers, then maturity.

The interaction effect between nitrogen fertilizer rates and bio stimulants extracts:

Data in Table (7) explain that nitrogen fertilizer at the highest rate (100kgN\fed.) with seaweed extract, followed by the same rate of nitrogen with dry yeast extract gave the highest values of flowering traits of tomato plants. **Salloom *et al.* (2023)** come to the same results by the interaction effect between nitrogen and dry yeast extract.

Table (6): Effect of nitrogen rates and bio-stimulants on days to first (Flowering, Fruiting and maturity) of tomato plants during 2023 and 2024 seasons

Treatments	Days to First Flowering		Days to First Fruiting		Days to Maturity	
	2023 season	2024 season	2023 season	2024 season	2023 season	2024 season
N rates:						
0	28.79	28.80	42.58	42.60	74.18	74.16
50	28.31	28.32	39.49	39.48	69.51	69.49
100	27.60	27.63	38.29	38.30	68.14	68.19
L S D (0.05)	0.27	0.28	0.91	0.97	0.95	0.97
Bio-stimulants extracts: 0	29.59	29.59	44.24	44.22	76.50	76.53
Seaweed	27.16	27.20	37.24	37.28	66.45	66.44
Dry yeast	27.95	27.97	38.88	38.87	68.88	68.87
L S D (0.05)	0.36	0.41	0.75	0.79	0.92	0.96

Table (7): The interaction effect of nitrogen rates and bio-stimulants on days to first (Flowering, Fruiting and Maturity) of tomato plants during 2023 and 2024 seasons

		Days to First Flowering		Days to First Fruiting		Days to Maturity	
		2023 season	2024 season	2023 season	2024 season	2023 season	2024 season
0	0 Seaweed	29.89	28.11 29.91	45.13	45.17	78.23	78.26
			28.17	40.51	40.55	71.11	71.07
	Dry yeast	28.36	28.33	42.11	42.07	73.19	73.14
50	0 Seaweed	29.56	29.51	44.22	36.11 44.17	75.89	75.91
		27.22	27.25		36.15	64.36	64.31
	Dry yeast	28.15	28.20	38.15	38.11	68.29	68.25
100	0 Seaweed	29.31	29.35	43.37	35.11 43.33	75.37	75.41
		26.15	26.17		35.15	63.87	63.93
	Dry yeast	27.33	27.37	36.39	36.42	65.17	65.22
L S D (0.05)		0.15	0.14	0.75	0.79	0.43	0.48

Fruit quality (chemical constituents and nutritive value):

Effect of nitrogen fertilizer rates:

Data presented in Table (8) found that nitrogen at the highest rate of 100kgN\fed. gave the highest vale in tomato fruit quality, i.e. TSS, ascorbic acid, *B*-carotene and total sugars, compared to the other rate of 50kgN\fed. These results are sum of chemical contents of leaves (Table 4) and flowering traits (Table 6) in this concern. These results sustained those recorded by **Benard *et al.* (2009)**, **Singh *et al.* (2010)** and **Qu *et al.* (2020)**.

Effect of bio stimulants extracts:

Data in Table (8) indicated that bio-stimulants significantly increased the nutritive value of fruit quality of tomato compared to the control treatment. Whereas, seaweed extract, being the most effective treatment in nutritive value of tomato fruit, followed by the treatment of dry yeast extract, respectively.

In this concern, the highest value of nutritive value of fruit quality of tomato when treated plants with both bio- stimulants due to the sun of chemical contents (Table 4) and flowering traits (Table 6) of tomato plants.

Similar trends were also registered by **Sasikala *et al.* (2016)** and **Al-Mousaw et *al.* (2024)** whom treated plants as foliar application with seaweed and dry yeast extracts, respectively.

The interaction effect of nitrogen fertilizer rates and bio stimulants:

Data in Table (9) investigated the effect of interaction between nitrogen fertilizer rates and foliar spray with bio-stimulants extracts on nutritive value of tomato fruits.

The obtained results revealed that nitrogen fertilizer rate at the highest rate (100kgN\fed.) and seaweed extract gave the highest value on nutritive of fruit tomato, followed by the same rate of nitrogen (100kgN\fed.) with dry yeast extract.

Table (8): Effect of nitrogen rates and bio-stimulants on fruit quality (Ascorbic acid, *B*-carotene content, total sugars and TSS %) of tomato plants during 2023 and 2024 seasons

Treatments	Ascorbic acid (mg/kg)		*B*-Carotene (mg/kg)		Total sugar (%)		Total Soluble Solids (TSS %)	
	2023 season	2024 season	2023 season	2024 season	2023 season	2024 season	2023 season	2024 season
N Rates:								
0	8.57	8.40	7.88	7.88	8.32	2.30	3.90	4.00
50	10.07	9.79	8.18	8.18	2.53	2.56	4.17	3.97
100	10.43	10.13	8.65	8.63	2.59	2.57	4.43	4.17
L S D (0.05)	0.32	0.29	0.54	0.51	0.05	0.02	0.18	0.19
Bio-Stimulants extracts:								
0	7.57	7.37	6.88	6.87	8.22	2.25	3.67	3.60
Seaweed	10.90	10.63	9.12	9.09	2.65	2.64	4.50	4.37
Dry yeast	10.60	10.32	8.72	8.74	2.56	2.55	4.33	4.17
L S D (0.05)	0.27	0.26	0.39	0.37	0.07	0.08	0.13	0.11

Table (9): The interaction effect of nitrogen rates and bio-stimulants on fruit quality (Ascorbic acid, B-carotene content, total sugars and TSS %) of tomato plants during 2023 and 2024 seasons

		Ascorbic acid (mg/kg)		*B*-Carotene (mg/kg)		Total sugar (%)		Total Soluble Solids (TSS %)	
		2023 season	2024 season	2023 season	2024 season	2023 season	2024 season	2023 season	2024 season
0	0 Seaweed	7.2	7.0	6.66	6.63	20.17	2.19	3.4	3.6
		9.4	9.2	8.63	8.61	2.43	2.41	4.2	4.3
	Dry yeast	9.1	9.0	8.36	8.41	2.35	2.31	4.1	4.1
50	0 Seaweed	7.6	7.4	6.73	6.76	2.23	2.25	3.7	3.5
		11.4	11.1	9.25	9.22	2.74	2.76	4.5	4.3
	Dry yeast	11.2	10.87	8.57	8.55	2.63	2.66	4.3	4.1
100	0 Seaweed	7.9	7.7	7.25	7.21	2.27	2.31	3.9	3.7
		11.9	11.6	9.47	9.44	2.79	2.74	4.8	4.5
	Dry yeast	11.5	11.1	9.22	9.25	2.71	2.67	4.6	4.3
L S D (0.05)		0.02	0.02	0.19	0.17	0.03	0.02	0.01	0.01

Conclusively: It can be concluded that nitrogen fertilizer at the highest rate of (100kgN\fed.) and seaweed extract, followed by dry yeast extract gave the highest values of chemical contents in leaves, flowering traits and fruit quality of tomato cv. Master R.S.

REFERENCES

1. Abou El Ghit, H. M. (2020). Effect of application of yeast extraction hydroponic tomato plants grown in a soilless culture system. *Plant Archives,* 8220-8226.
2. Alali, F.A.; M. Alabboud and K. Mohi Alden (2017). The effect of foliar spray of yeast extract on the vegetative growth and productivity in tomato. 3rd International conference on sustainable Development, strategies and challenges With a focus on Agriculture, Natural Resources, Environment and Tourism 79 March 2017, Tabriz, Iran.
3. Al-Mousawi, Z.; Y. F. Sallom and Z. M. Abdul-Qader (2024). Evaluation of foliar spray with extract of marine algae and yeast and mowing date on growth, yield and active components of water cress. *Iraqi Journal of Agricultural Sciences,* 55(1): 459-469.
4. A.O.A.C. (2012). Official Method of Analysis 18th Ed., Association of Official Analytical Chemists, Washington DC.
5. Awad, El- M. M.; M. N. S. Youssef and Z. S. El-Shall (2006). Effect of foliar spraying with seaweed extracts and inorganic fertilizer levels on growth, yield and quality of potato crop. *J . Agric. Sci., Mansoura Univ.,* 31(10): 6549-6559.
6. Benard, C.; H.Gautier; F. Bourgaud; D. Grasselly; B. Naves; C. Caris-Veyrat; M. Weiss and M. Genard (2009). Effect of low nitrogen supply on tomato (*Solanum lycopersicum*) fruit yield and quality with special emphasis on sugars, acids, ascorbate, carotenoids, and phenolic compounds. *J. Agric. Food Chem.,* 57: 4112-4123.
7. Di Stasio, E.; Van Oosten M. J.; Silletti S.; Raimondi G.; Dell'Aversana E;, Carillo P. and A. Maggio (2018). Ascophyllum nodosum-based algal extracts act as enhancers of growth, fruit quality, and adaptation to stress in salinized tomato plants. *J. Appl. Phycol.,* 30: 2675–2686.
8. Ejaz, M.; S. U. Rehman; R. Waqas; A. Manan; M. Imran and M. A. Bukhari (2011). Combined efficacy of micronutrients as foliar application on growth and yield of tomato grown by vegetable forcing. *IJAVMS,* 5(3): 327-335.
9. Ellong, E. N.; C. Billard, S. Adenet and V. Rochefort (2015). Polyphenols, carotenoids, vitamin C.

   content in tropical fruits and vegetables and impact of processing methods. *Food and Nutri. Sci.,* 6: 299313.
10. Guan, Z.; T. Biswas and F. Wu (2018). The U.S. Tomato industry: An overview of production and trade. University of Florida.
11. (http://edis.ifas.ufl.edu/pdffiles/fe/fe102700.pdf).
12. Hassan, A.; A. Hamad; Z. Jan, Z. A. Khan; M. Raza and Z. Shah (2023). Effect of humic acid and bread yeast application on the vegetative, yield and qualitative attributes of tomato (*Lycopersicon esculelntum* L.). *Pure Appl. Biol,* 12(1): 677-682.
13. Neklyudov, A. D.; N.V. Fedorova; V. P. Ilyukhina and E. P. Lisitsa (1993). "Enzyme profile of autolyzing yeasts of the genus Saccharomyces." *Applied Biochemistry and Microbiology,* 29(5): 547554.
14. Nelson, N. (1974). A photometric adaptation of Somogyi methods for determination of glucose. *J. Biology Chem.,* 159: 375 – 380.

15. Nour, K. A. M.; N. T. S. Mansour and W. M. Abd El-Hakim (2010). Influence of foliar spray with seaweed extracts on growth, setting and yield of tomato during summer season. *J. Plant Production, Mansoura University,* 1(7): 961-976.

16. Ragaie, M. and A. R. Tavakoly (2016). Effects of municipal waste compost and nitrogen fertilizer on growth and mineral composition of tomato. *Int. J. Recycl Org Waste Agricult*, 5: 339-347.

17. Sallom, Y.; M. Mejbel; M. obaid and Salah H. and J. Hchami (2023). Effect of foliar spray of nano nitrogen and bread yeast on some vegetative growth of pepper plant. Iop Conf. Series: Earth and Environmental Science, 1214.012012. DOI:10.1088/1755-1315/1214/1/012012

18. SAS Institute Inc. (2004). Getting started with the ADX interface for experiments. Cary. Nc.: SAS Institute Inc.

19. Sasikala, M.; E. Indumath; S. Radhika and R. Sasireka (2016). Effect of seaweed extract (*Sargassum tenerrimum*) on seed germination and growth of tomato plant (*Solanum lycopersicom*). *International Journal of Chemtech Research,* 285-293.

20. Snedecor, G. W. and W. G. Cochran (1980). Statistical Methods. 7th ed. The Iowa State Univ., Press, Amer., Iowa, USA.

21. Singh, B. K.; K. A. Pathak; T. Boopath and B. C. Deka (2010). Vermicompost and NPK fertilizer effects on morpho-physiological traits of plants, yield and quality of tomato fruits. *Vegetable Crops Research Bulletin,* 73: 77-86.

22. Somogyi, M. (1952). Determination of reducing sugars by Nelson-Somogyi method. *Journal of Biological Chemistry,* 200-245.

23. Qu, Z.; X. Qi.; R. Shi; Y. Zhao; Z. Hu; Q. Chen and C. Li (2020). Reduced N fertilizer application with optimal blend of controlled – release urea and urea improves tomato yield and quality in greenhouse production system. Journal *of Soil Science and Plant Nutrition,* 20: 1741-1750.

24. Wajid A.; A. Ahmed; Khaliq T.; S. Alams; A. Hussain; K. Hussain, W. Nassem; M. Usman and S. Ahmed (2010). Quantification of growth, yield and radiation use efficiency of promising cotton cultivars at varying nitrogen levels. *Pakistan J. Bot.,* 42 (3): 1703-1711.

25. Yao, Y.; X. Wang; B. Chen; M. Zhang and J. Ma (2020). Seaweed extract improved yield, leaf photosynthesis, ripening time and net returns of tomato (*Solanum lycopersicum* Mill). *Acsomega*, 5: 4242-4249.

26. Yong, T. W.; Ping C.; Qian D.; Qing D.; Feng Y.; Wang X. C.; Liu W. G. and W. Y. Yang (2018). Optimized nitrogen application methods to improve nitrogen use efficiency and nodule nitrogen fixation in a maize-soybean relay intercropping system. *J Integr Agric.,* 17: 664–76.