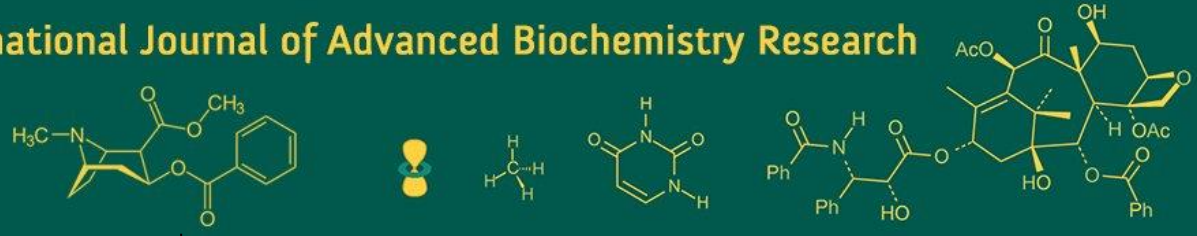
International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(7): 382-386
www.biochemjournal.com
Received: 13-05-2024
Accepted: 16-06-2024

Ridhdhi D Patel
M.Sc. Student, Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Dr. KM Karetha
Associate Professor, Department of P. H. T., College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Divya M Ganvit
M.Sc. Student, Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Lunagariya Radhika J
Ph.D., Research Scholar, Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Corresponding Author:
Ridhdhi D Patel
M.Sc. Student, Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh, Gujarat, India

Effect of bio-stimulants on yield and quality of custard apple (*Annona squamosa* L.) CV. Sindhan

Ridhdhi D Patel, Dr. KM Karetha, Divya M Ganvit and Lunagariya Radhika J

DOI: https://doi.org/10.33545/26174693.2024.v8.i7Se.1550

Abstract
The present investigation entitled "Effect of bio-stimulants on yield and quality of custard apple (*Annona squamosa* L.) cv. Sindhan" was carried out at Madhadibaug, Fruit Research Station, Department of Fruit Science, College of Horticulture, Junagadh Agricultural University, Junagadh during the year 2023-24. The experiment was laid out in Randomized Block Design (RBD) with 11 treatments of bio-stimulants *i.e.* Seaweed extract @ 1% (T_1), Seaweed extract @ 2% (T_2), Humic acid @ 1.5% (T_3), Humic acid @ 2.5% (T_4), *Panchagavya* @ 3% (T_5), *Panchagavya* @ 5% (T_6), *Azotobacter* + PSB + KSB @ 3 ml/plant each as soil application (T_7), *Azotobacter* + PSB + KSB @ 5 ml/plant each as soil application (T_8), Fulvic acid 4 ml/L (T_9), Fulvic acid 5 ml/L (T_{10}), Control (T_{11}) with three replications. Among the bio-stimulants, seaweed extract @ 2% (T_2) was found significantly maximum fruit weight (208.57 g), fruit length (7.39 cm), fruit girth (7.48 cm), pulp weight (102.19 g), rag weight (82.24 g), number of fruits per tree (108.65), fruit yield (22.64 kg/tree), fruit yield (6.27 t/ha), TSS (26.70 ˚Brix), total sugar (23.60%), reducing sugar (19.96%), non reducing sugar (3.27%) and minimum seed: pulp ratio (0.21), titratable acidity (0.20%).

Keywords: Custard apple, bio-stimulants, yield, quality

Introduction
Custard apple (*Annona squamosa* L.) is a delicious and important minor fruit crop cultivated in tropical and subtropical climate. It comes under family "Annonaceae". The origin of different species of annona is reported at different regions. Custard apple is originated in Central America from there; it was distributed to Mexico and Tropical America (Popenoe, 1974) [18].

In India, it is cultivated especially in Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Tamil Nadu, Gujarat and Odisha. In India, it is cultivated on an estimated area of 45 thousand hectares with 387 thousand MT production with productivity 8.45 MT/ha (Anon., 2022) [6]. In Gujarat, it is cultivated on an estimated area of 7760 hectares with 77.84 thousand MT of production with productivity 10.03 MT/ha (Anon., 2023) [5].

Custard apple is mostly cultivated in Gujarat state in Ahmedabad, Aravalli, Bhavnagar, Dahod, Junagadh, Mahisagar, Panchmahal and Vadodara from which Bhavnagar district contributes highest 1026 hectares area and 13.67 thousand MT production with productivity 13.32 MT/ha (Anon., 2023) [5]. Custard apple is an arid fruit crop and hardy in nature. It requires dry climate with mild winter. It can grow from sea level up to 1000 m above the mean sea level elevation. Custard apple flowers during May to August. High temperature, low atmospheric humidity, lack of irrigation water and natural stress during this period results into a smaller number of flowers, poor fruit set and low yield and poor quality fruits.

The custard apple commonly known as "Sitaphal" or "Sugar apple" is minor fruit of commercial value. The custard apple is important due to its nutritive values. The ripened fruits are consumed mainly in fresh form. There has been great demand for custard apple in preparation of ice cream and pudding. Custard apple contains protein (5.20 g), fat (0.50-0.60 g), carbohydrates (59.00 g), crude fibre (0.90-6.60 g), calcium (60.00 mg), phosphorus (80.00 mg), iron (105.00 mg), thiamine (0.08-0.12 mg), riboflavin (0.09-0.18 mg), ascorbic acid (15.00-44.40 mg) and nicotinic acid (0.50 mg) per 100 g of edible portion of custard apple (Nair and Agrawal, 2017) [15].

In recent years, attention has been mainly directed to the use of bio-stimulants in modification growth, flowering, fruiting, fruit quality and yield of different fruits. Conventional (chemicals based) farming is non-sustainable because of many problems such as loss of soil health and productivity from excessive erosion and associated plant nutrient losses, surface and ground water pollution from fertilizers and sediments, impending of non-renewable resources and low farm income from high production costs. The basic concept of plant growth regulators is the adjustment of plant nutrient supply to an optimum level for sustaining the desired crop productivity.

The foliar application of bio-stimulants play a vital role in improving the quality and comparatively more effective for rapid recovery of plants. The foliar feeding of fruit tree has gained much importance in recent years, as micronutrients applied through soil are needed in higher quantity because some amount leaches down and some become unavailable to the plant due to complex soil reactions. The yield parameter like average fruit weight, number of fruits per tree and yield per tree are increased by the spray of bio-stimulants.

Bio-stimulants are substances which affect the plants in numerous ways ultimately affecting yield and quality. They enhance nutrient supply to the crop and increase the crop productivity. Also, they contribute towards sustainable and high output with low input crop production. Now a days, awareness has been mainly focused on the use of nutrients and bio-stimulants in modification of development, fruiting, flowering, quality as well as yield of custard apple.

Materials and Methods

The present investigation was carried out at Madhadibaug, Fruit Research Station, College of Horticulture, Junagadh Agricultural University, Junagadh the 2023-24. The experiment was laid out in Randomized Block Design (RBD) with 11 treatments of bio-stimulants *i.e.* Seaweed extract @ 1% (T_1), Seaweed extract @ 2% (T_2), Humic acid @ 1.5% (T_3), Humic acid @ 2.5% (T_4), *Panchagavya* @ 3% (T_5), *Panchagavya* @ 5% (T_6), *Azotobacter* + PSB + KSB @ 3 ml/plant each as soil application (T_7), *Azotobacter* + PSB + KSB @ 5 ml/plant each as soil application (T_8), Fulvic acid 4 ml/L (T_9), Fulvic acid 5 ml/L (T_{10}), Control (T_{11}) with three replications to study the effect of bio-stimulants on yield and quality parameter *viz.* Fruit weight (g), Fruit length (cm), Fruit girth (cm), Pulp weight (g), Seed weight (g), Rag weight (g), Seed: pulp ratio, Number of fruits/tree, yield (kg/tree), yield (t/ha), TSS (˚Brix), titratable acidity (%), Total sugar (%), Reducing sugar (%) and Non reducing sugar (%). Collected data was statistically analyzed as per method given by Panse and Sukhatme (1985) [16]. All characters were studied for significance by "F" test. Standard error of mean (S. Em.±) and critical difference (CD) were worked out at 5 percent level of significance.

Result and discussion

The data presented in Table 1 and 2 observed that, bio-stimulants were produce significant effect on yield and quality parameters in custard apple studied in this experiment.

Yield and yield attributing parameters

The data from investigation revealed that application of bio-stimulants to be influence on yield and yield attributing parameters *viz.* fruit weight (g), fruit length (cm), fruit girth (cm), pulp weight (g), seed weight (g), rag weight (g), seed: pulp ratio, number of fruits/ trees, yield (kg/tree), yield (t/ha).

The maximum fruit weight (208.57 g) was recorded with the application of with seaweed extract @ 2% (T_2). It was at par with application with seaweed extract @ 1% (T_1). The maximum fruit length (7.39 cm) was recorded with the application of seaweed extract @ 2% (T_2). It was at par with application of humic acid @ 2.5% (T_4), humic acid @ 1.5% (T_3) and seaweed extract @ 1% (T_1). The maximum fruit girth (7.48 cm) was recorded with the application of seaweed extract @ 2% (T_2). It was at par with application of seaweed extract @ 1% (T_1), humic acid @ 1.5% (T_3), humic acid @ 2.5% (T_4) and *panchagavya* @ 5% (T_6). The maximum pulp weight (102.19 g) was recorded with the application of seaweed extract @ 2% (T_2). It was at par with application of seaweed extract @ 1% (T_1). The maximum rag weight (82.24 g) was recorded with the application of seaweed extract @ 2% (T_2). It was at par with application of seaweed extract @ 1% (T_1). The maximum number of fruits per plant (108.65) was recorded with the application of seaweed extract @ 2% (T_2). It was at par with the application of seaweed extract @ 1% (T_1). The maximum yield (22.64 kg/tree and 6.27 t/ha) wear recorded with the application of seaweed extract @ 2% (T_2). It was at par with the application of seaweed extract @ 1% (T_1). Likewise, the minimum seed: pulp ratio (0.21) was recorded with the application of seaweed extract @ 2% (T_2). It was at par with application of seaweed extract @ 1% (T_1) and humic acid @ 2.5% (T_4). However, there was no significant effect observed on seed weight. It might be due to the reason that seaweed extract regulates the plant bio-physiological activities like increasing chlorophyll content in the leaf, nutrient uptake, photosynthetic activity and synthesis of plant growth regulators during growth and development of fruit which might have ultimately increased yield per tree. The growth regulators present in the extracts, especially cytokinin (Featonby Smith and Van Staden, 1984) [8] is associated with nutrient partitioning. Photosynthate distribution could be shifted from vegetative parts to the developing fruits during fruit development by cytokinin. Fruits treated with seaweed extract had higher concentration of cytokinin than the untreated fruits. The results are in close conformity with the findings of Percival (2010) [17] in apple, Sau *et al.* (2016) [22] in guava, El-Shamma *et al.* (2017) [7] in avocado, Al-shatri *et al.* (2020) [4] in strawberry, Harhash *et al.* (2021) [9] in grape, Ahir *et al.* (2022) [2] in mango and Mosa *et al.* (2023) [14] in apple.

Quality parameters

The data from investigation revealed that application of bio-stimulants to be influence on quality parameters *viz.* TSS (˚Brix), titratable acidity (%), Total sugar (%), Reducing sugar (%) and Non reducing sugar (%).

The maximum TSS (26.70 ˚Brix) was recorded with the application of seaweed extract @ 2% (T_2). It was at par with application of humic acid @ 2.5% (T_4), humic acid @ 1.5% (T_3) and seaweed extract @ 1% (T_1). It might be due to the reason that application of seaweed extract may be attributed to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from the leaves to the developing fruits. The results are in conformity with those reported by Inomata *et al.* (1992) [11]

in pear, Hassan *et al*. (2009) [10] in banana, Roshdy (2014) [20] in banana, El-Shamma *et al*. (2017) [7] in avocado, Zankat *et al*. (2022) [24] in muskmelon and Mosa *et al*. (2023) [14] in apple.

The minimum titratable acidity (0.20%) was recorded with the application of seaweed extract @ 2% (T_2). It was at par with application of humic acid @ 1.5% (T_3), humic acid @ 2.5% (T_4) and seaweed extract @ 1% (T_1). The application of seaweed extract at different growth stage significantly decreased the titratable of fruit juice. Lower acidity in fruits might be due to the more accumulation of sugars, better transportation of sugars into fruit tissues and conversion of organic acids into sugars (Kliewer, 1971) [13]. It was also suggested that rapid acid utilization of organic acid in respiration may be another possible reason for minimizing the titratable acidity. Abd EI- Ghany *et al.* (2001) [1] and Ismail *et al*. (2003) [12] also reported decrease in the level of titratable acidity in grape after seaweed extract application. The results are in conformity with those reported by Roshdy (2014) [20] in banana, Salama (2015) [21] in orange, Al-Musawi (2018) [3] in orange and Mosa *et al.* (2023) [14] in apple.

The maximum reducing sugar (19.96%) was noted in application with the seaweed extract @ 2% (T_2). It was at par with application of seaweed extract @ 1% (T_1), humic acid @ 1.5% (T_3), humic acid @ 2.5% (T_4), *Panchagavya* @ 3% (T_5), *Panchagavya* @ 5% (T_6) and *Azotobacter* + PSB + KSB @ 5ml /plant each as soil application (T_8). The maximum non reducing sugar (3.27%) was observed in application with the seaweed extract @ 2% (T_2) and it was at par with application of humic acid @ 1.5% (T_3), seaweed extract @ 1% (T_1) and humic acid @ 2.5% (T_4). The maximum total sugar (23.60%) was recorded in application with the seaweed extract @ 2% (T_2) and it was at par with application of seaweed @ 1% (T_1). It might be due to the reason that the application of seaweed extract increases the activity of the enzymes such as amylases, which hydrolyse the complex polysaccharides into simple sugars. The results are in conformity with those reported by Singh and Brahamchari (1999) [23] in guava, Ram *et al*. (2007) [19] in guava, Hassan *et al*. (2009) [10] in banana, Roshdy (2014) [20] in banana and Mosa *et al*. (2023) [14] in apple.

Table 1: Effect of bio-stimulants on yield and yield attributing parameters of custard apple cv. Sindhan

Sr. No.	Treatments	Fruit weight (g)	Fruit length (cm)	Fruit grith (cm)	Pulp weight (g)	Rag weight (g)	Seed weight (g)	Seed: pulp ratio	Number of fruits per tree	Yield (kg/tree)	Yield (t/ha)
T_1	Seaweed extract @ 1%	204.68	6.87	7.03	100.51	77.87	22.05	0.22	100.47	20.69	5.73
T_2	Seaweed extract @ 2%	208.57	7.39	7.48	102.19	82.24	21.02	0.21	108.65	22.64	6.27
T_3	Humic acid @ 1.5%	181.56	6.64	6.82	85.38	70.53	23.70	0.28	94.57	17.27	4.79
T_4	Humic acid @ 2.5%	193.23	6.86	6.89	94.01	70.67	22.70	0.24	97.18	18.71	5.18
T_5	*Panchagavya* @ 3%	176.47	6.50	6.59	79.25	68.79	23.60	0.30	86.13	15.35	4.25
T_6	*Panchagavya* @ 5%	179.75	6.60	6.73	80.69	70.33	22.77	0.28	89.91	16.16	4.48
T_7	*Azotobacter* + PSB + KSB @ 3ml/plant each as soil application	170.75	6.33	6.41	75.07	65.33	25.38	0.34	80.57	13.71	3.80
T_8	*Azotobacter* + PSB + KSB @ 5ml/plant each as soil application	174.01	6.37	6.48	77.58	66.58	24.02	0.31	84.96	14.63	4.05
T_9	Fulvic acid 4ml/L	163.68	5.73	6.59	70.26	59.30	26.13	0.37	76.61	12.62	3.50
T_{10}	Fulvic acid 5ml/L	168.09	5.90	5.88	72.90	63.16	25.36	0.35	78.57	13.58	3.76
T_{11}	Control	157.24	5.57	5.51	66.83	55.25	29.50	0.44	75.25	11.67	3.23
S. Em.±		4.503	0.265	0.273	2.218	1.943	1.532	0.020	3.316	1.036	0.287
C. D. at 5%		13.21	0.78	0.80	6.51	5.70	NS	0.06	9.73	3.04	0.84
C. V.%		4.34	7.14	7.20	4.67	4.94	6.49	11.22	6.49	11.16	11.16

Table 2: Effect of bio-stimulants on quality parameter of custard apple cv. Sindhan

Sr. No.	Treatments	TSS (˚Brix)	Titratable Acidity (%)	Total sugar (%)	Reducing Sugar (%)	Non reducing Sugar (%)
T_1	Seaweed extract @ 1%	25.45	0.21	22.01	18.75	3.26
T_2	Seaweed extract @ 2%	26.70	0.20	23.60	19.96	3.27
T_3	Humic acid @ 1.5%	24.85	0.23	21.17	18.24	3.05
T_4	Humic acid @ 2.5%	25.00	0.22	21.69	18.44	3.22
T_5	*Panchagavya* @ 3%	23.38	0.25	20.80	18.08	2.72
T_6	*Panchagavya* @ 5%	23.40	0.24	20.93	18.14	2.79
T_7	*Azotobacter* + PSB + KSB @ 3ml/plant each as soil application	23.19	0.27	20.26	17.69	2.56
T_8	*Azotobacter* + PSB + KSB @ 5ml/plant each as soil application	23.22	0.26	20.59	18.02	2.58
T_9	Fulvic acid 4ml/L	22.14	0.29	19.62	17.15	2.47
T_{10}	Fulvic acid 5ml/L	22.17	0.28	19.94	17.40	2.54
T_{11}	Control	20.07	0.30	18.01	15.87	2.14
S. Em.±		0.787	0.009	0.544	0.665	0.104
C. D. at 5%		2.31	0.03	1.60	1.95	0.30
C. V.%		5.78	6.20	4.53	6.40	6.46

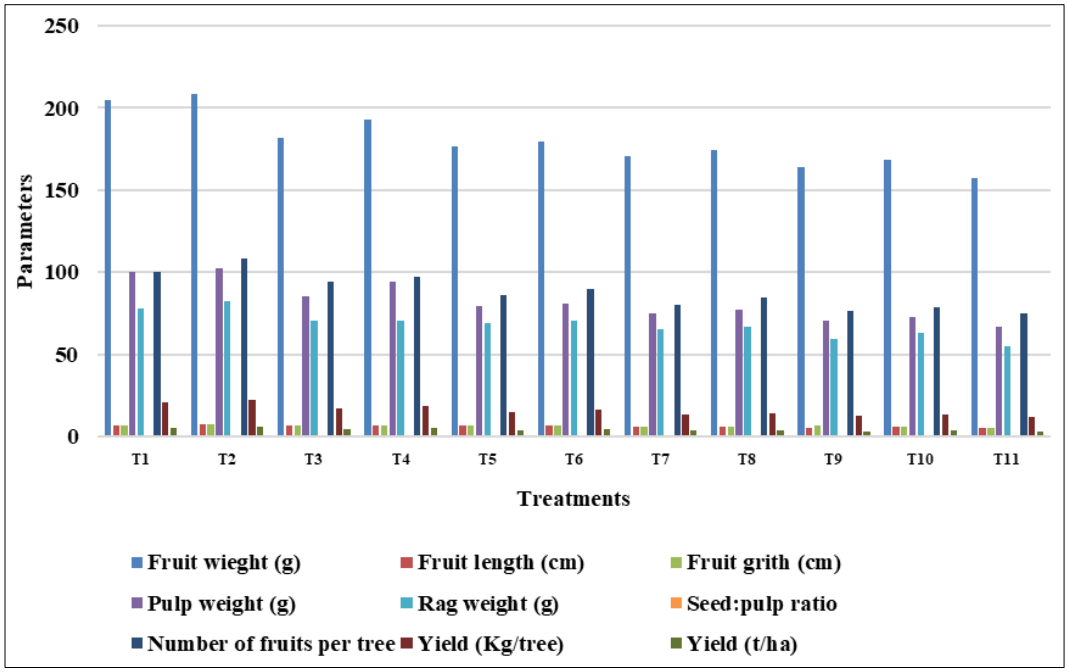


Fig 1: Effect of bio-stimulants on yield and yield attributing parameters of custard apple cv. Sindhan

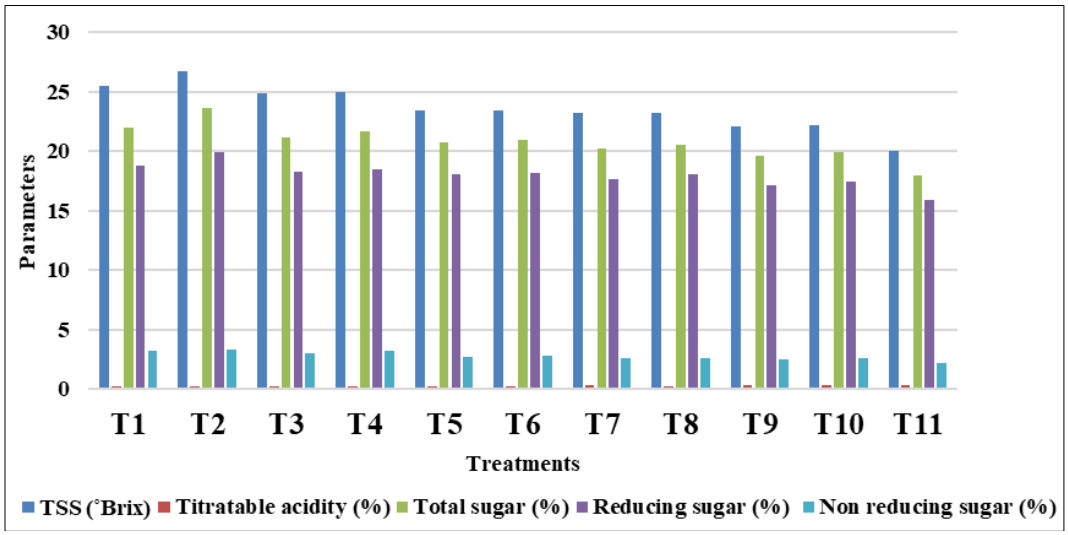


Fig 2: Effect of bio-stimulants on quality parameter of custard apple cv. Sindhan

Conclusion

Based on the results obtained in the present study reported that the foliar spray of seaweed extract @ 2% for two times, once at before flowering and second at 15 days after flowering resulted in enhanced yield and yield attributing parameters and quality parameter cv. Sindhan under South Saurashtra Agro climatic condition.

References

1. Abd El-Ghany AA, Marwad IA, El-samir A, El-said BA. The effect of two yeast strains or their extraction on vines growth and cluster quality of 'Thompson seedless' grapevine. Assiut Journal of Agricultural Sciences. 2001;32:214-224.
2. Ahir UJ, Patil SJ, Patel NB, Tandel BM, Ahir PJ. Response of foliar spray of seaweed extract at different pH levels on fruiting and yield of mango (*Mangifera indica* L.) cv. Kesar. The Pharma Innovation Journal. 2022;11(11):1767-1769.
3. Al-Musawi AHM. Effect of foliar application with algal extract on fruit quality of sour orange (*Citrus aurantium* L.). Journal of Environmental Science and Pollution Research. 2018;4:250-252.
4. Al-shatri AHN, Pakyurek M, Yavic A. Effect of seaweed application on the vegetative growth of strawberry cv. Albion grown under Iraq ecological conditions. Applied Ecology and Environmental Research. 2020;18(1):1211-1225.
5. Anonymous. Directorate of Horticulture. Agriculture, farmer's welfare and cooperation department, Government of Gujarat; c2023. Available from: https://doh.Gujarat.gov.in/horticulturecensus.htm [accessed on 3 May 2024].
6. Anonymous. National Horticulture Board. Ministry of Horticulture, New Delhi; c2022. Available from: https://www.nhb.gov.in [accessed on 3 May 2024].
7. El-Shamma MS, Helal MEM, Maksoud MA, Khalil FH, Mansour AEM. Effects of some bio-stimulants on nutritional status, yield and fruit quality of avocado. Middle East Journal of Agriculture Research. 2017;6:692-699.

8. Featonby Smith BC, Van Staden J. The effect of seaweed concentrate and fertilizer on growth and the endogenous cytokinin content of *Phaseolus vulgaris*. South African Journal of Botany. 1984;3:375-379.
9. Harhash MM, Abd EL-Megeed NA, Abaidalah AS, Mosa WFA. Effect of the foliar spraying of fulvic acid, folic acid and seaweed extract on vegetative growth, yield and fruit quality of grape cv. Flame Seedless. Plant Archives. 2021;21(1):482-492.
10. Hassan HSA, Mostafa EAM, Selah MMS. Effect of foliar spray with biozyme and sitofex on yield and fruit characteristics of banana cv. Grand Naine. Green Farming. 2009;2(10):661-663.
11. Inomata YS, Oikawa S, Shinokawa T, Suzuki E. The effect of gibberellins treatment on flowers of Japanese pear after late frost damage. Bulletin of the Fruit Tree Research Station. 1992;23:123-136.
12. Ismail M, Wanden MT, El-Sheikh M. Response of 'Thompson seedless' and 'Roomy Red' grape cultivar to foliar sprays with yeast extract and GA. Journal of Agricultural Sciences. 2003;28:6321-6334.
13. Kliewer M. The effect of day temperature and light intensity on concentrations of malic and tartaric acid in *Vitis vinifera* L. grape. Journal of the American Society for Horticultural Science. 1971;91:372-377.
14. Mosa WFA, Sas-Paszt L, Głuszek S, Gornik K, Anjum MA. Effect of some bio-stimulants on the vegetative growth, yield, fruit quality attributes and nutritional status of apple. Horticulturae. 2023;9(32):1-14.
15. Nair R, Agrawal V. A review on the nutritional quality and medicinal value of custard apple. International Journal of Current Microbiology and Applied Science. 2017;6(9):1126-1132.
16. Panse VG, Sukhatme PV. Statistical Method for Agricultural Workers. ICAR publication. New Delhi: c1985. p. 361.
17. Percival GC. Effect of systemic inducing resistance and bio-stimulant materials on apple scab using a detached leaf bioassay. Arboriculture and Urban Forestry. 2010;36(1):41-6.
18. Popenoe GJ. Status of *Annona* culture in South Florida. Proceedings of the Florida State Horticulture Society. 1974;87:342-344.
19. Ram Rao DM, Kodandaramaiah J, Reddy MP, Katiyar RS, Rahmathulla VK. Effect of VAM fungi and bacterial biofertilizers on mulberry leaf quality and silkworm cocoon characters under semiarid conditions. Caspian Journal of Environmental Sciences. 2007;5(2):111-117.
20. Roshdy KA. Effect of spraying silicon and seaweed extract on growth and fruiting of Grand Naine banana. Egyptian Journal of Agriculture Research. 2014;92:979-991.
21. Salama ASM. Effect of algae extract and zinc sulfate foliar spray on production and fruit quality of orange tree cv. Valencia. Journal of Agriculture and Veterinary Science. 2015;8:51-62.
22. Sau S, Mandal P, Sarkar T, Das K, Datta P. Influence of bio-fertilizer and liquid organic manures on growth, fruit quality and leaf mineral content of mango cv. Himsagar. Journal of Crop and Weed. 2017;13(1):132-136.
23. Singh UP, Brahmachari VS. Effect of potassium, zinc, boron and molybdenum on the physico-chemical composition of guava (*Psidium guajava* L.) cv. Allahabad Safeda. The Orissa Journal of Horticulture. 1999;27:62-65.
24. Zankat SB, Leua HN, Hathi HS. Effect of time of spray and plant growth regulators on yield, quality and economics of muskmelon (*Cucumis melo* L.). The Pharma Innovation. 2022;11(9):3026-3030.