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Modulating physico-chemical profile and post-harvest quality of mango cv. Kesar through foliar application of novel plant growth regulators under HDP

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Abstract

The investigation entitled “Modulating physico-chemical profile and post-harvest quality of mango cv. kesar through foliar application of novel plant growth regulators under HDP ” was conducted at Fruit Research Station, Sakkarbaug, Junagadh Agricultural University, Junagadh. The experiment was carried out with 10 treatments comprised T₁ (Control), T₂ (Tricontanol 500 ppm), T₃ (Tricontanol 750 ppm), T₄ (Tricontanol 1000 ppm), T₅ (Brassinosteroid 1 ppm), T₆ (Brassinosteroid 2 ppm), T₇ (Brassinosteroid 3 ppm), T₈ (Salicylic acid 1500 ppm), T₉ (Salicylic acid 2000 ppm) and T₁₀ (Salicylic acid 2500 ppm). Among the brassinosteroids levels, brassinosteroid 1 ppm (T₅) showed the best performance, with significant improvements in total soluble solid (24.25, 23.57 and 23.91 °Brix), vitamin A (2693.74, 2548.64 and 2621.19 µg/100 g), fruit firmness (13.82, 13.80 and 13.81 kg/cm²), ascorbic acid (29.47, 28.35 and 28.91 mg/100 g), reducing sugar content (5.40, 5.27 and 5.33%), non-reducing sugar (11.05, 10.58 and 10.82%), total sugar (16.45, 15.85 and 16.15%), shelf life (15.50, 15.33 and 15.42 days) and lowest acidity (0.209, 0.212 and 0.211%) were recorded in brassinosteroid 1 ppm (T₅) during both experimental years as well as in pooled analysis.

Keywords: Vitamin A, firmness, shelflife, kesar and brassinosteroid

1. Introduction

Mango (*Mangifera indica* L.) is one of the most vital fruit crops in Asia deeply rooted in Indian culture and tradition since ancient times (Bose *et al.*, 2001) [6]. It's presence in early sanskrit literature under the name *Amra* highlights its long-standing heritage. From the historical praises of Babur to its status as the national fruit of India mango stands as a timeless symbol of country's heritage. Mango has earned the undisputed title of the king of fruits due to its unparalleled flavor, fragrance and nutritional richness.

Mangifera indica is characterized by an exceptionally dense nutrient matrix. Quantitatively a 100 g portion of mango pulp is primarily an aqueous carbohydrate system containing 81.7% water and 16% carbohydrates complemented by specific concentrations of dietary fiber, lipids and proteins. The fruit's micronutrient density is particularly distinguished by its high Vitamin A content (approximately 4,800 IU) alongside a robust profile of Vitamin C, Vitamin B-complex and essential minerals including iron, phosphorus and magnesium. Furthermore, its biological efficacy is significantly bolstered by a diverse array of secondary metabolites and antioxidants (Joyce *et al.*, 2014) [8].

The physiological benefits of the mango extend to cardiovascular optimization. High concentrations of potassium and magnesium facilitate blood pressure regulation and rhythmic stability, while the presence of the xanthone glycoside, mangiferin offers potential anti-inflammatory protection for cardiac tissues (Abdalla *et al.*, 2007) [1].

Mango (*Mangifera indica*) is distinguished by its exceptional flavour profile and aromatic intensity offering significant utility at every phase of its physiological development. The immature fruit is primarily utilized for the production of chutneys and pickles, whereas the ripe fruit serves as both a premium dessert and a raw material for industrial products like nectar, jam and squashes. Beyond the pulp the mango seed kernel contains high-quality fats, making it a valuable resource for saponification and a functional substitute for cocoa butter in the confectionery industry.

2. Materials and Methods

The research entitled “Modulating physico-chemical profile and post-harvest quality of mango cv. kesar through foliar application of novel plant growth regulators under HDP” conducted at Fruit Research Station, Sakkarbaug, College of Horticulture, JAU, Junagadh during the year 2023-24 and 2024-25. The experimental design selected was Randomized Block Design consisting of ten treatments comprising T₁ (Control), T₂ (Tricentanol 500 ppm), T₃ (Tricentanol 750 ppm), T₄ (Tricentanol 1000 ppm), T₅ (Brassinosteroid 1ppm), T₆ (Brassinosteroid 2 ppm), T₇ (Brassinosteroid 3 ppm), T₈ (Salicylic acid 1500 ppm), T₉ (Salicylic acid 2000 ppm) and T₁₀ (Salicylic acid 2500 ppm) which were replicated three times.

The primary goal of this investigation was to evaluate the influence of contemporary plant growth regulators on the qualitative traits of mango. Key quality indices, including Total Soluble Solids (TSS), Vitamin A, fruit firmness, ascorbic acid content, and titratable acidity, along with sugar fractions (reducing, non-reducing, and total sugars) and shelf life, were rigorously monitored. The experimental data were subjected to statistical validation following the methodology of Panse and Sukhatme (1985) [11]. Treatment effects were scrutinized using the 'F' test, while the Standard Error of Mean (S.E.m.±) and Critical Difference (CD) at a 5% probability level were utilized to determine the significance of variations across different treatments. Following methodology and formulas used to determine the quality parameters.

2.1 TSS (°Brix)

Total Soluble Solids (TSS) was determined using a digital hand refractometer (with an accuracy of ±0.2% Brix). The instrument was initially calibrated with distilled water to ensure precision. A drop of extracted mango pulp was placed on the prism and the resulting values were recorded in degrees Brix (°Brix). For each treatment five independent readings were documented and subsequently averaged to obtain a representative value.

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titrate} \times \text{Dye factor} \times \text{volume made up}}{\text{Aliquot taken for estimation} \times \text{Weight or volume of sample taken for estimation}} \times 100$$

2.4 Acidity (%)

Titratable acidity was determined following the standard A.O.A.C. (1970) procedure. A 5 g aliquot of fruit pulp was macerated with distilled water and filtered through a muslin cloth to obtain a clear extract. This extract was titrated

$$\text{Acidity (\%)} = \frac{\text{Titrate} \times \text{Normality of NaOH} \times \text{Equivalent wt. of citric acid}}{\text{Weight of sample (5 g)} \times 1000} \times 100$$

2.5 Reducing sugars (%)

Reducing sugar content was estimated using the dinitrosalicylic acid (DNSA) method as prescribed by Sadasivam and Manickam (1999) [15]. A 0.1 g sample was thoroughly crushed and extracted with 10 ml of 80% methanol. Subsequently a 0.1 ml aliquot of the supernatant was diluted with 0.9 ml of distilled water to reach a final volume of 1.0 ml. Following this 3.0 ml of DNS reagent was added to each test tube and mixed thoroughly. The reaction mixture was incubated in a boiling water bath for 10-15 minutes until the color developed then cooled to ambient temperature. The absorbance was measured at 565 nm using

2.2 Vitamin A (µg/100 g)

The estimation of Vitamin A (as beta carotene) was carried out following the spectrophotometric method as described by Srivastava and Kumar (2005). A 5 g portion of the fresh sample was extracted with 10-15 ml of acetone and anhydrous sodium sulphate was added to ensure the removal of moisture. After decanting and repeating the process for complete extraction the supernatant was transferred to a separatory funnel. Following the addition of 10-15 ml of petroleum ether and thorough mixing the upper organic layer was collected and diluted to a final volume of 100 ml. The absorbance was measured at 452 nm and the beta carotene content was calculated using the standard formula.

$$\beta\text{-Carotene (\mu g/100 g)} = \frac{\text{O.D.} \times 13.9 \times 10^4 \times 100}{\text{Sample weight (g)} \times 560 \times 100}$$

$$\text{Vitamin A (\mu g/100 g)} = \frac{\beta\text{-Carotene (\mu g/100 g)}}{0.6}$$

2.3 Ascorbic acid (mg/100g)

The ascorbic acid content in the fruit pulp was determined using the 2, 6-dichlorophenol indophenol visual titration method as suggested by Ranganna (1986) [13]. A 10 g representative pulp sample was homogenized and diluted to 100 ml using 3% metaphosphoric acid as a stabilizing medium. The suspension was allowed to stand for 30 minutes before being filtered through Whatman No. 1 filter paper. Prior to the analysis, the dye solution was standardized against a known concentration of synthetic ascorbic acid to establish the dye factor. A 5 ml aliquot of the filtered extract was titrated against the standardized dye until a persistent light pink endpoint was achieved for at least 15 seconds. The final vitamin C concentration was calculated based on the titration volume and expressed as mg per 100 g of pulp. Ascorbic acid content was calculated by using following equation.

against 0.1 N NaOH solution utilizing phenolphthalein as a visual indicator. The persistence of a light pink color was recorded as the equivalence point. Finally, the acidity was calculated and expressed as a percentage of citric acid equivalent using the following formula:

a spectrophotometer and the concentration was determined using the following formula:

$$\text{Reducing sugar (\%)} = \frac{\text{O.D.} \times \text{G.F.} \times 100 \times \text{Total volume}}{\text{Sample weight} \times \text{Aliquot taken}} \times 100$$

2.6 Non reducing sugars (%)

Non-reducing sugar content was derived by calculating the difference between total sugars and reducing sugars for each pulp sample. The resulting values were expressed as a percentage on a fresh weight basis.

Non-reducing Sugar (%) = Total sugar (%) - Reducing sugar (%)

2.7 Total sugars (%)

Take 0.1 g sample of mango pulp and mixed and crushed with 10 ml of 2.5 N 80% methanol. Then 0.1 ml aliquot from crushed sample was taken and added 0.9 ml distilled water to make final volume of 1.0 ml. Then 1.0 ml phenol 5% and 5.0 ml of 96% H₂SO₄ were added one by one in each test tube. Then all samples were put in ice bath for 10-15 minutes. Spectrophotometer reading was taken at 490 nm wavelength (Rangana, 1986) [13]. By use of the following formula total sugar content was calculated:

Total sugar (%) = Sample O.D. × Standard O.D. × Dilution factor × 100

2.8 Fruit firmness (kg/cm²)

Fruit firmness was measured by means of penetrometer. The circular thin size of skin about 1 cm diameter was removed from the fruit surface with the help of a sharp knife and the penetrometer adjusted to zero was pierced into the fruit up to the knob. The pressure required to penetrate flesh penetrometer was recorded in kg/cm² provided on the circular disk of the penetrometer. Firmness was measured on two opposite sides of a fruit and average values were worked out.

2.9 Shelf life (days)

Shelf life was determined by monitoring five representative fruits per treatment under ambient storage conditions. The duration (in days) from the date of harvest to the stage where the fruits reached optimum edibility or showed the

first signs of senescence (decay) was recorded. This period was defined as the total marketable lifespan of the fruit.

3. Results and Discussion

The quality parameters were found to be significantly influenced by different chemicals during both experimental years as well as in pooled result.

The maximum total soluble solid (24.25, 23.57 and 23.91 °Brix), vitamin A (2693.74, 2548.64 and 2621.19 µg/100 g), fruit firmness (13.82, 13.80 and 13.81 kg/cm²), ascorbic acid (29.47, 28.35 and 28.91 mg/100g), reducing sugar content (5.40, 5.27 and 5.33%) and shelf life (15.50, 15.33 and 15.42 days) were recorded in brassinosteroid 1 ppm (T₅) during both experimental years as well as in pooled analysis. The maximum value of non-reducing sugar of fruit (11.05 and 10.58%) was achieved when the plants were treated with brassinosteroid 1 ppm (T₅) during both individual experimental years, respectively. Furthermore, the pooled analysis also confirmed a significantly higher non-reducing sugar content (10.82%) in the same treatment. The maximum total sugar (16.45 and 15.85%) was registered with treatment brassinosteroid 1 ppm (T₅) during individual years, respectively. The pooled analysis further confirmed a significantly higher total sugar (16.15%) in the same treatment. The lowest acidity (0.209, 0.212 and 0.211%) was registered under the foliar application of brassinosteroid 1 ppm (T₅) during both experimental years as well as in pooled data, respectively. However, the control treatment (T₁) recorded lower values for all the above fruit quality attributing characters during the years 2023-24, 2024-25 and in the pooled data analysis.

Table 1: Effect of novel plant growth regulators on TSS and vitamin A of mango cv. Kesar under HDP

Treatments	TSS (°Brix)			Vitamin A (µg/100 g)		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
T ₁ : Control	19.36	18.80	19.08	2144.89	2114.51	2129.70
T ₂ : TRIA 500 ppm	20.14	20.34	20.24	2199.68	2259.25	2229.47
T ₃ : TRIA 750 ppm	20.80	21.21	21.01	2235.06	2210.56	2222.81
T ₄ : TRIA 100 ppm	19.83	19.86	19.84	2153.97	2182.23	2168.10
T ₅ : BRs 1 ppm	24.25	23.57	23.91	2693.74	2548.64	2621.19
T ₆ : BRs 2 ppm	23.57	22.50	23.03	2641.63	2572.65	2607.14
T ₇ : BRs 3 ppm	23.50	21.66	22.58	2522.08	2546.84	2534.46
T ₈ : SA 1500 ppm	22.45	21.89	22.17	2468.96	2339.36	2404.16
T ₉ : SA 2000 ppm	23.02	22.37	22.70	2664.72	2417.16	2540.94
T ₁₀ : SA2500 ppm	21.70	21.34	21.52	2506.13	2334.13	2420.13
S.Em.±	0.648	0.604	0.443	55.259	62.432	41.687
C.D. at 5%	1.93	1.80	1.27	164.18	185.49	119.57
C.V.%	5.14	4.90	5.02	3.95	4.60	4.28
Year						
S.Em. ±	-	-	0.198	-	-	18.643
C.D. at 5%	-	-	NS	-	-	53.47
Y × T						
S.Em. ±	-	-	0.627	-	-	58.955
C.D. at 5%	-	-	NS	-	-	NS

Table 2: Effect of novel plant growth regulators on ascorbic acid and acidity of mango cv. Kesar under HDP

Treatments	Ascorbic acid (mg/100 g)			Acidity (%)		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
T ₁ : Control	25.29	24.96	25.12	0.259	0.260	0.259
T ₂ : TRIA 500 ppm	25.73	25.40	25.57	0.248	0.253	0.251
T ₃ : TRIA 750 ppm	26.70	25.55	26.12	0.242	0.249	0.246
T ₄ : TRIA 100 ppm	25.65	25.43	25.54	0.251	0.256	0.254
T ₅ : BRs 1 ppm	29.47	28.35	28.91	0.209	0.212	0.211
T ₆ : BRs 2 ppm	29.23	27.86	28.55	0.212	0.214	0.213
T ₇ : BRs 3 ppm	28.62	27.06	27.84	0.219	0.220	0.220
T ₈ : SA 1500 ppm	26.53	26.07	26.30	0.233	0.240	0.236
T ₉ : SA 2000 ppm	27.46	25.26	26.36	0.227	0.226	0.227
T ₁₀ : SA2500 ppm	26.53	26.32	26.42	0.240	0.244	0.242
S.Em.±	0.648	0.672	0.467	0.006	0.006	0.004
C.D. at 5%	1.93	2.00	1.34	0.02	0.02	0.01
C.V.%	4.14	4.44	4.29	4.16	4.63	4.40
Year						
S.Em. ±	-	-	0.209	-	-	0.002
C.D. at 5%	-	-	0.60	-	-	NS
Y × T						
S.Em. ±	-	-	0.660	-	-	0.006
C.D. at 5%	-	-	NS	-	-	NS

Table 3: Effect of novel plant growth regulators on ascorbic acid and acidity of mango cv. Kesar under HDP

Treatments	Reducing sugar (%)			Non reducing sugar (%)			Total sugar (%)		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
T ₁ : Control	3.62	3.41	3.51	9.06	9.01	9.03	12.68	12.41	12.55
T ₂ : TRIA 500 ppm	4.41	4.22	4.32	9.36	9.28	9.32	13.77	13.50	13.64
T ₃ : TRIA 750 ppm	4.67	4.63	4.65	9.54	9.49	9.52	14.21	14.12	14.17
T ₄ : TRIA 100 ppm	3.94	4.14	4.04	9.29	9.17	9.23	13.23	13.31	13.27
T ₅ : BRs 1 ppm	5.40	5.27	5.33	11.05	10.58	10.82	16.45	15.85	16.15
T ₆ : BRs 2 ppm	5.17	5.10	5.14	10.30	10.11	10.20	15.47	15.20	15.34
T ₇ : BRs 3 ppm	5.16	5.08	5.12	10.02	9.91	9.97	15.18	14.99	15.09
T ₈ : SA 1500 ppm	4.84	4.77	4.80	9.72	9.84	9.78	14.57	14.61	14.59
T ₉ : SA 2000 ppm	4.93	4.94	4.94	10.00	9.82	9.91	14.93	14.76	14.84
T ₁₀ : SA2500 ppm	4.81	4.65	4.73	9.61	9.60	9.60	14.41	14.25	14.33
S.Em.±	0.098	0.122	0.078	0.231	0.214	0.157	0.334	0.368	0.248
C.D. at 5%	0.29	0.36	0.22	0.69	0.63	0.45	0.99	1.09	0.71
C.V.%	3.61	4.59	4.12	4.09	3.82	3.96	3.99	4.46	4.23
Year									
S.Em. ±	-	-	0.035	-	-	0.070	-	-	0.111
C.D. at 5%	-	-	NS	-	-	NS	-	-	NS
Y × T									
S.Em. ±	-	-	0.111	-	-	0.222	-	-	0.351
C.D. at 5%	-	-	NS	-	-	NS	-	-	NS

Table 4: Effect of novel plant growth regulators on fruit firmness and shelf life of mango cv. Kesar under HDP

Treatments	Fruit firmness (kg/cm ²)			Shelf life (Days)		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
T ₁ : Control	10.55	10.52	10.54	10.53	9.93	10.23
T ₂ : TRIA 500 ppm	11.66	11.38	11.52	11.33	11.67	11.50
T ₃ : TRIA 750 ppm	11.85	11.42	11.64	12.67	12.00	12.33
T ₄ : TRIA 100 ppm	11.21	10.86	11.04	11.33	11.00	11.17
T ₅ : BRs 1 ppm	13.82	13.80	13.81	15.50	15.33	15.42
T ₆ : BRs 2 ppm	13.56	13.24	13.40	14.67	15.00	14.83
T ₇ : BRs 3 ppm	13.21	12.94	13.07	14.43	14.33	14.38
T ₈ : SA 1500 ppm	12.45	12.14	12.30	13.90	13.67	13.78
T ₉ : SA 2000 ppm	12.78	12.44	12.61	14.17	14.17	14.17
T ₁₀ : SA2500 ppm	12.28	11.88	12.08	13.80	13.13	13.47
S.Em.±	0.294	0.278	0.202	0.650	0.578	0.435
C.D. at 5%	0.87	0.83	0.58	1.93	1.72	1.25
C.V.%	4.12	4.00	4.06	8.51	7.68	8.11
Year						
S.Em. ±	-	-	0.090	-	-	0.194
C.D. at 5%	-	-	0.26	-	-	NS
Y × T						
S.Em. ±	-	-	0.286	-	-	0.615
C.D. at 5%	-	-	NS	-	-	NS

The significant increase in TSS (total soluble solids) content following brassinosteroid application is primarily due to the enhanced source to sink mobilization of photo assimilates. brassinosteroid act as powerful signaling molecules that stimulate the activity of sucrose metabolizing enzymes such as invertases and sucrose synthase, which facilitate the unloading of sugars from the phloem into the fruit mesocarp. This result is in close conformity with the findings of Ramani *et al.* (2016) ^[12], Almutairi *et al.* (2023) ^[2], Balachandran *et al.* (2024) ^[4] and Hassan *et al.* (2025) ^[7] in mango.

The increase in vitamin A is due to the brassinosteroid mediated upregulation of the carotenoid biosynthetic pathway, specifically activating the enzyme phytoene synthase (PSY). Brassinosteroid also promote the development of chromoplasts, which serve as storage units for beta carotene in the pulp. This leads to higher nutritional density and deeper pulp color. These findings align with previous studies of Balachandran *et al.* (2024) ^[4] and Sattar *et al.* (2024) ^[16] in mango.

The enhancement in ascorbic acid content is attributed to the brassinosteroid mediated upregulation of the L-galactose pathway, which increases the net biosynthesis of Vitamin C. Brassinosteroid reduce titratable acidity is primarily attributed to the accelerated metabolic utilization of organic acids as respiratory substrates. Brassinosteroid function as signaling molecules that fast track the fruit ripening process, leading to the rapid conversion of organic acids (mainly citric and malic acids) into sugars or their oxidation during respiration. These findings are in close conformity with the physiological observations of Roghabadi and Pakkish (2014) ^[14] in sweet cherry, Zhu *et al.* (2015) ^[18] in mandarin and Aly *et al.* (2021) ^[3] in sugar apple.

The significant increase in sugar content following brassinosteroid application is primarily attributed to the accelerated hydrolysis of starch into simpler sugars. Brassinosteroid enhance the activity of key enzymes involved in carbohydrate metabolism such as alpha-amylase and beta-amylase which break down stored starch into glucose and fructose during fruit ripening. Furthermore, brassinosteroid promote the translocation of hexoses from the leaves to the fruit by increasing the sink strength of the mesocarp. The higher photosynthetic efficiency also ensures a continuous supply of precursors for sugar biosynthesis, ultimately resulting in an improved flavor profile. These results are in close conformity with the findings of Mostafa and Kotb (2018) ^[10] and Aly *et al.* (2021) ^[3] in sugar apple and Balachandran *et al.* (2024) ^[4] in mango.

Brassinosteroid extend shelf life might be due to the delayed senescence and regulation of the respiration rate. Brassinosteroid help in maintaining the structural integrity of the fruit by inhibiting the enzymes responsible for cell wall degradation, such as pectinmethylesterase (PME) and polygalacturonase (PG). Consequently, the treated fruits retain their firmness and freshness for a longer duration, is in close conformity with the result of Ban *et al.* (2024) ^[5] in jujuba, Roghabadi and Pakkish (2014) ^[14] in sweet cherry and Meena *et al.* (2023) ^[9] in mango.

4. Conclusion

Based on the results obtained from the present experiment it can be concluded that the foliar spray of brassinosteroid 1 ppm at flowering, pea and marble stage improve quality parameters in mango cv. Kesar under HDP.

References

1. Abdalla AEM, Darwish SME, Ayad EHE, Hamahmy RM. Egyptian mango by-product 2: Antioxidant and antimicrobial activities of extract and oil from mango seed kernel. *Food Chemistry*. 2007;103(4):1141-1152.
2. Almutairi KF, Krzysztof G, Ahmed A, Hesham SA, Walid FA. Performance of mango trees under the spraying of some biostimulants. *Journal of Agricultural Science*. 2023;15:5543-5548.
3. Aly MA, Thanana EM, Mahmoud GA, Khadeejah HN. Effect of some growth regulators on productivity, fruit quality and storability of sugar apple (*Annona squamosa* L.). *Natural Volatiles and Essential Oils*. 2021;8(5):12298-12316.
4. Balachandran A, Sivakumar V, Kavitha C, Veeranan V, Giridhari A, Rajavel M. Effect of bioactive compounds on enzymatic regulation and shelf life of mango during post-harvest. *Plant Science*. 2024;13(5):120-127.
5. Ban ZC, Li LC, Yizhou GAB, Lingling LU, Jiancai LD, Farouk EC. Exogenous brassinolides and calcium chloride synergically maintain quality attributes of jujube fruit (*Ziziphus jujuba* Mill.). *Postharvest Biology and Technology*. 2024;216:1130-1138.
6. Bose TK, Mitra SK, Sanyal D. *Fruits: Tropical and Subtropical*. 3rd ed. Calcutta: Naya Udyog Publisher; 2001. p. 130-136.
7. Hassan AH, Mansour N, Samaan MSF, Nasser MA. Improving Naomi mango trees capability to withstand salt stress using some plant growth regulators. *Journal of Soil Science and Plant Nutrition*. 2025;25:7152.
8. Joyce OO, Latayo BM, Onyinye AC. Chemical composition and phytochemical properties of mango (*Mangifera indica*) seed kernel. *International Journal of Advanced Chemistry*. 2014;2(2):185-187.
9. Meena NK, Asrey R, Singh S, Singh D, Paul V. Exogenous application of brassinolide affects ripening, phenotypic traits, jelly seed and sensory properties of “Dashehari” mango at ambient storage. *Annals of Plant and Soil Research*. 2023;25(2):205-210.
10. Mostafa LY, Kotb HR. Effect of brassinosteroids and gibberellic acid on parthenocarpic fruit formation and fruit quality of sugar apple (*Annona squamosa* L.). *Middle East Journal*. 2018;7(4):1341-1351.
11. Panse VG, Sukhatme PV. *Statistical methods for agricultural workers*. 3rd rev ed. New Delhi: ICAR; 1985. p. 361.
12. Ramani MM, Patel CR, Sharma KM, Amarcholi JJ, Patel AH. Effect of 28-homobrassinolide and shoot thinning on vegetative growth, flowering and yield of mango cv. Kesar. *Advances in Life Sciences*. 2016;5(17):7097-7099.
13. Rangana S. *Handbook of analysis and quality control for fruit and vegetable products*. 2nd ed. New Delhi: Tata McGraw Hill Publication Co. Ltd.; 1986.
14. Roghabadi MA, Pakkish Z. Role of brassinosteroid on yield, fruit quality and post harvest storage of ‘Tak Danehe Mashhad’ sweet cherry (*Prunus avium* L.). *Agricultural Communications*. 2014;2(4):49-56.
15. Sadasivam S, Manickam A. *Biochemical methods for agricultural sciences*. New Delhi: Wiley Eastern Limited; 1999.
16. Sattar C, Rashid S, Makhasha E, Laila Y, Mostafa RAE, Abdelzaher HZR. Improving mango productivity and crop water productivity by 24-epibrassinosteroids

- and hydrogen peroxide under deficit irrigation. *Agricultural Water Management*. 2024;298(10):1-14.
17. Srivastava RP, Kumar S. Fruit and vegetable preservation principles and practices. Lucknow: International Book Distributing Company; 2005. p. 355-356.
 18. Zhu F, Yun Z, Ma Q. Effects of exogenous 24-epibrassinolide treatment on postharvest quality and resistance of Satsuma mandarin (*Citrus unshiu*). *Postharvest Biology and Technology*. 2015;100:8-15.