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RESPONSE OF MICRONUTRIENTS AND GA_3 FOLIAR FEEDING AND STORABILITY TREATMENTS ON POSTHARVEST QUALITY OF BER FRUITS CV. BANARASI KARAKA

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Abstract

The present investigation was carried out on 29-year-old ber plants grown in sodic soil condition at Main Experimental Station, Department of Fruit Science, Acharya Narendra Deva University of Agriculture & Technology Kumarganj Ayodhya (U.P) during the years 2022-23 and 2023-24. The purpose of the study was to determine the effect of micronutrients and GA_3 foliar feeding and storability treatments on postharvest quality of ber fruits . The Factorial Randomised block design was used to record and to analyse the data. Ber fruits were examined as part of the experiment for the parameters of Acidity, Vitamin C, Organoleptic quality. T_5P_6 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)) treatment was found to be best to maintain the quality (Acidity, Vitamin C, Organoleptic quality) of fruits upto 9 days of storage during both the years.

Keywords: *Ziziphus mauritiana* Lamk., Foliar feeding, Post-harvest treatments, Banarasi Karaka

INTRODUCTION

Ber (*Ziziphus mauritiana* Lamk.), belonging to the Rhamnaceae family, is an old and widespread fruit of India and China, cultivated for more than 4000 years (Mehra, 1967). It is also referred to as Chinese date, Indian plum, Indian jujube, or Chinese fig. The ber tree is a hardy fruit crop ideal for cultivation primarily in arid and semi-arid regions where most of the trees fail to thrive due to insufficient irrigation. Commercial cultivation typically extends up to 1000 meters above sea level. It is renowned for its capacity to endure hostile conditions

such as salinity, drought, and waterlogging. It was perceived to be originated in Central Asia, encompassing North-West India, Afghanistan, Tajikistan, Uzbekistan, and China. India has first rank among the ber-growing countries of the world, with an area of 53,000 hectares and an annual production of 580,000 metric tons (Anon, 2021). The major ber-growing states in India include Madhya Pradesh, Bihar, Uttar Pradesh, Punjab, Haryana, Rajasthan, Maharashtra, Assam, Gujarat, West Bengal, Andhra Pradesh, and Tamil Nadu.

Ber fruit is more nutritious than apples, especially in terms of protein, phosphorus, calcium, carotene, and vitamin C. It is often referred to as the poor man's apple due to its high nutritional quality, including higher protein (0.8g), β-carotene (70 IU), and vitamin C (50-100 mg) contents, as well as its medicinal value (Rai and Gupta, 1994).

It is a fast-growing and early-bearing fruit, producing a heavy crop annually. Additionally, the tree can endure hot and dry weather in May and June as it enters a dormant state, reducing its water need during the spell of lack, especially in Rajasthan.

The storage life of ber fruit is very short, lasting only 2-4 days under ambient conditions, which poses a significant challenge for its successful transportation and marketing. Limited studies have been conducted on extending the shelf life of ber through the exogenous application of micronutrients and plant growth regulators (Meena *et al.,* 2013). However, the post-harvest ripening process can be delayed with the application of fruit ripening-inhibiting hormones. Jawandha *et al.* (2012) reported that the application of growth regulators like gibberellic acid (GA3) affects the physicochemical properties and is known to enhance the shelf life of ber fruits. Micronutrients (B, Fe, and Zn) also positively affect ber fruit set, yield, quality, and storage life (Samant *et al*., 2008). The plant hormones and micronutrients affect the yield, physio-chemical character, storability of fruits. Calcium is an essential element that significantly influences the quality and post-harvest life of many fruits. It aids in reducing weight loss and maintaining firmness, acidity, and vitamin A content during storage (Gupta *et al.,* 2011). Salicylic acid, a safe chemical, is utilized to manage post-harvest quality and minimize quantity losses of perishable crops (Razavi *et al.,* 2014). Acetic acid has also been effective in controlling post-harvest decay in fruits (Sholberg and Gaunce, 1995). It is generally recognized as a safe (GRAS) compound (Sholberg, 2009).

Therefore, the study was conducted to investigate the the effect of micronutrients and GA_3 foliar feeding and storability treatments on postharvest quality of ber fruits.

MATERIAL AND METHODS

The present investigation was conducted at Main Experimental Station, Horticulture, Department of Fruit Science; Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) during 2022-23 and 2023-24 on 29 year old Ber plants. Foliar feeding (FF) of $ZnSO_4$, Borax and GA_3 in desired cncentrations was done twice in the month of September and November. Fruits were harvested at the time of maturity and subjected to post-harvest treatments (PHT) at PG Lab, Department of Fruit Science. Aqueous solution of $CaSO_4$, Acetic Acid (AA), Salicylic Acid (SA) used in post-harvest treatment in desired concentrations was prepared by dissolving into required quantity of water. Ethanol was used as a solvent to dissolve SA. The harvested foliar feeded fruits were dipped in aqueous solution of post-harvest treatments. Factorial Randomized Block Design with four replication was used in experimental trial. The treatment combinations, which were used, are following:

T_1P_1 : Control (FF) + Control (PHT)

T_2P_1 : $ZnSO_4$ 0.5% (FF) + Control (PHT)

T_3P_1 : Borax 0.5% (FF) + Control (PHT)

T_4P_1 : GA_3 10 ppm (FF) + Control (PHT)

T_5P_1 : $ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + Control (PHT)

T_1P_2 : Control (FF) + $CaSO_4$ 1% (PHT)

T_2P_2 : $ZnSO_4$ 0.5% (FF) + $CaSO_4$ 1% (PHT)

T_3P_2 : Borax 0.5% (FF) + $CaSO_4$ 1% (PHT)

T_4P_2 : GA_3 10 ppm (FF) + $CaSO_4$ 1% (PHT)

T_5P_2 : $ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% (PHT)

T_1P_3 : Control (FF) + SA 100 ppm (PHT)

T_2P_3 : $ZnSO_4$ 0.5% (FF) + SA 100 ppm (PHT)

T_3P_3 : Borax 0.5% (FF) + SA 100 ppm (PHT)

T_4P_3 : GA_3 10 ppm (FF) + SA 100 ppm (PHT)

T_5P_3 : $ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + SA 100 ppm (PHT)

T_1P_4 : Control (FF) + AA 50 ppm (PHT)

T_2P_4 : $ZnSO_4$ 0.5% (FF) + AA 50 ppm (PHT)

T_3P_4 : Borax 0.5% (FF) + AA 50 ppm (PHT)

T_4P_4 : GA_3 10 ppm (FF) + AA 50 ppm (PHT)

T_5P_4 : $ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + AA 50 ppm (PHT)

T_1P_5 : Control (FF) + $CaSO_4$ 1% + SA 100 ppm (PHT)

T_2P_5 : $ZnSO_4$ 0.5% (FF) + $CaSO_4$ 1% + SA 100 ppm (PHT)

T_3P_5 : Borax 0.5% (FF) + $CaSO_4$ 1% + SA 100 ppm (PHT)

T_4P_5 : GA_3 10 ppm (FF) + $CaSO_4$ 1% + SA 100 ppm (PHT)

T_5P_5 : $ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + SA 100 ppm (PHT)

T_1P_6 : Control (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)

T_2P_6 : $ZnSO_4$ 0.5% (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)

T_3P_6 : Borax 0.5% (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)

T_4P_6 : GA_3 10 ppm (FF) + $CaSO_4$ 1% + Acetic Acid 50 ppm (PHT)

T_5P_6 : $ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)

In order to evaluate the postharvest quality of fruit at ambient temperature, 1kg full mature fresh fruit of each treatment combinations was put in fibre plates and stored at ambient temperature (16.30-29.45^{0}C) for recording the observations on (%), Vitamin C (mg/100g), Organoleptic quality at every three days interval uptill 12 days.

Acidity, Vitamin C were determined with the help of procedure as suggested by Ranganna, 2000. Organoleptic test conducted by the panel of five semi trained judges who tested the fruits to evaluate the colour, sweetness and overall acceptance of fruits. The scoring was recorded by the judges on the 9-point Hedonic scale (Amerine *et al*., 1965).

RESULTS AND DISCUSSION

Acidity

The data furnished in Table 4 shows significant effect of storability treatments on acidity of fruits during storage at ambient temperature during both the years (2022-23 and 2023-24) of investigation.

Effect of Foliar Feeding (FF): All the treatment significantly decreased acidity of ber fruits as compared to control in two years of experimentation. The minimum of 0.148 and 0.135% acidity was noted with application of T_5 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm) in two years, respectively. It was followed by T_3 (Borax 0.5%), T_2 ($ZnSO_4$ 0.5%) and T_4 (GA_3 10 ppm) treatments with 0.159 and 0.146, 0.172 and 0.158, 0.184 and 0.171% acidity, respectively. The maximum of 0.204 and 0.191% acidity was recorded in T_1 (control) in either of two years, respectively. As far as the main effect of days of storage is concerned, it was found that acidity significantly decreased with successive increase in number of storage days irrespective of treatments. It was observed that the minimum of 0.144 and 0.130%

acidity was discerned on the 12th day of storage with T_5 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm) in two years, respectively. While, it was found to be maximum acidity (0.211 and 0.199%) under T_1 (control) on the 3rd days of storage.

Effect of Post-Harvest Treatment (PHT): All the treatment significantly decreased acidity of ber fruits as compared to control in two years of experimentation. The minimum of 0.168 and 0.154% acidity was noted with application of P6 ($CaSO_4$ 1% + AA 50 ppm) in two years, respectively. It was followed by P_5 ($CaSO_4$ 1% + SA 100 ppm), P_4 (AA 50 ppm), P_3 (SA 100 ppm) and P_2 ($CaSO_4$ 1%) treatments with 0.170 and 0.157, 0.172 and 0.159, 0.175 and 0.162, 0.178 and 0.164% acidity, respectively. However, the maximum (0.180 and 0.167%) acidity was recorded under P_1 (control) in both the years, respectively. As far as the main effect of days of storage is concerned, it was found that acidity significantly decreased with successive increase in number of storage days irrespective of treatments. It was observed that the minimum of 0.163 and 0.149% acidity was discerned on the 12th day of storage with P_6 ($CaSO_4$ 1% + AA 50 ppm) in two years respectively. While, it was found to be maximum acidity (0.185 and 0.173 %) under P_1 (control) on the 3rd day of storage.

Table 4: Effect of storability treatments on Acidity of Ber fruits cv. Banarasi Karaka during storage

Treatments	Acidity (%)									
	2022-2023					2023-2024				
	3rd day	6th day	9th day	12th day	Mean	3rd day	6th day	9th day	12th day	Mean
T_1	0.211	0.204	0.202	0.200	0.204	0.199	0.191	0.188	0.186	0.191
T_2	0.176	0.172	0.171	0.167	0.172	0.164	0.159	0.157	0.153	0.158
T_3	0.163	0.161	0.158	0.155	0.159	0.151	0.148	0.144	0.141	0.146
T_4	0.190	0.184	0.182	0.180	0.184	0.178	0.171	0.168	0.166	0.171
T_5	0.152	0.150	0.146	0.144	0.148	0.140	0.137	0.132	0.130	0.135
Mean	0.178	0.174	0.172	0.169		0.166	0.161	0.158	0.155	
SEm±	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	
CD at 5%	0.001	0.001	0.001	0.001		0.001	0.001	0.001	0.001	
P_1	0.185	0.181	0.178	0.175	0.180	0.173	0.168	0.164	0.161	0.167
P_2	0.183	0.178	0.176	0.173	0.178	0.171	0.165	0.162	0.159	0.164
P_3	0.180	0.176	0.173	0.170	0.175	0.168	0.163	0.159	0.156	0.162

P_4	0.177	0.173	0.170	0.168	0.172	0.165	0.160	0.156	0.154	0.159
P_5	0.175	0.171	0.168	0.165	0.170	0.163	0.158	0.154	0.151	0.157
P_6	0.172	0.169	0.166	0.163	0.168	0.160	0.156	0.152	0.149	0.154
Mean	0.179	0.175	0.172	0.169		0.167	0.162	0.158	0.155	
SEm±	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	
CD at 5%	0.001	0.001	0.001	0.001		0.001	0.001	0.001	0.001	
T_1P_1	0.222	0.216	0.213	0.211	0.216	0.210	0.203	0.199	0.197	0.202
T_1P_2	0.218	0.211	0.209	0.208	0.212	0.206	0.198	0.195	0.194	0.198
T_1P_3	0.213	0.207	0.204	0.202	0.207	0.201	0.194	0.190	0.188	0.193
T_1P_4	0.209	0.201	0.200	0.199	0.202	0.197	0.188	0.186	0.185	0.189
T_1P_5	0.204	0.197	0.194	0.192	0.197	0.192	0.184	0.180	0.178	0.184
T_1P_6	0.200	0.194	0.192	0.189	0.194	0.188	0.181	0.178	0.175	0.181
T_2P_1	0.182	0.178	0.176	0.173	0.177	0.170	0.165	0.162	0.159	0.164
T_2P_2	0.180	0.175	0.174	0.170	0.175	0.168	0.162	0.160	0.156	0.162
T_2P_3	0.177	0.174	0.172	0.167	0.173	0.165	0.161	0.158	0.153	0.159
T_2P_4	0.175	0.171	0.169	0.166	0.170	0.163	0.158	0.155	0.152	0.157
T_2P_5	0.173	0.169	0.168	0.164	0.169	0.161	0.156	0.154	0.150	0.155
T_2P_6	0.170	0.167	0.165	0.161	0.166	0.158	0.154	0.151	0.147	0.153
T_3P_1	0.168	0.165	0.164	0.158	0.164	0.156	0.152	0.150	0.144	0.151
T_3P_2	0.165	0.163	0.161	0.157	0.162	0.153	0.150	0.147	0.143	0.148
T_3P_3	0.164	0.161	0.159	0.156	0.160	0.152	0.148	0.145	0.142	0.147
T_3P_4	0.162	0.160	0.156	0.154	0.158	0.150	0.147	0.142	0.140	0.145
T_3P_5	0.161	0.158	0.155	0.152	0.157	0.149	0.145	0.141	0.138	0.143
T_3P_6	0.159	0.157	0.153	0.151	0.155	0.147	0.144	0.139	0.137	0.142
T_4P_1	0.195	0.189	0.187	0.184	0.189	0.183	0.176	0.173	0.170	0.176
T_4P_2	0.194	0.187	0.184	0.182	0.187	0.182	0.174	0.170	0.168	0.174
T_4P_3	0.191	0.185	0.183	0.180	0.185	0.179	0.172	0.169	0.166	0.172
T_4P_4	0.189	0.184	0.181	0.179	0.183	0.177	0.171	0.167	0.165	0.170
T_4P_5	0.186	0.182	0.180	0.177	0.181	0.174	0.169	0.166	0.163	0.168
T_4P_6	0.184	0.179	0.178	0.176	0.179	0.172	0.166	0.164	0.162	0.166
T_5P_1	0.157	0.155	0.151	0.149	0.153	0.145	0.142	0.137	0.135	0.140
T_5P_2	0.156	0.153	0.150	0.147	0.152	0.144	0.140	0.136	0.133	0.138

T_5P_3	0.153	0.151	0.147	0.145	0.149	0.141	0.138	0.133	0.131	0.136
T_5P_4	0.151	0.148	0.145	0.144	0.147	0.139	0.135	0.131	0.130	0.134
T_5P_5	0.149	0.147	0.143	0.141	0.145	0.137	0.134	0.129	0.127	0.132
T_5P_6	0.146	0.145	0.142	0.139	0.143	0.134	0.132	0.128	0.125	0.130
Mean	0.178	0.174	0.172	0.169		0.166	0.161	0.158	0.155	
SEm±	0.001	0.001	0.001	0.001		0.001	0.001	0.001	0.001	
CD at 5%	0.002	0.002	0.002	0.002		0.002	0.002	0.002	0.002	

Effect of Foliar Feeding and Post Harvest Treatment: All the treatment significantly decreased acidity of ber fruits as compared to control in two years of experimentation. The minimum of 0.143 and 0.130% acidity was noted with T_5P_6 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)) in two years, respectively. It was closely followed by T_5P_5 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + SA 100 ppm (PHT)), T_5P_4 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + AA 50 ppm (PHT)) and T_5P_3 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + SA 100 ppm (PHT)) by showing of 0.145 and 0.132, 0.147 and 0.134, 0.149 and 0.136% acidity, respectively. The maximum of 0.216 and 0.202% acidity was recorded in T_1P_1 (Control (FF) + Control (PHT)) in either of two years, respectively. As far as the main effect of days of storage is concerned, it was found that acidity significantly decreased with successive increase in number of storage days irrespective of treatments. It was observed that the minimum of 0.139 and 0.125% acidity was discerned on the 12^{th} day of storage with T_5P_6 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)) in two years, respectively. While, it was found to be maximum (0.222 and 0.210%) acidity under T_1P_1 (Control (FF) + Control (PHT)) on the 3^{rd} days of storage.

The declined in acidity may be attributed to utilization of acids in the process of respiration during ripening in presence of reduced supply of sugar as a substrate of respiration due to lower rate of starch degradation during ripening and which might be due to conversion of acids into salts and sugars by the enzymes particularly invertase. Gradual and progressive decrease in acidity was observed under all the treatments during storage and this progressive decline might be due to utilization of acid in metabolism. The above finding are in line with the finding of Sandbhor and Desai (1991), Jawandha *et al.* (2008), Singh *et al.* (2013), Byas (2014), Haritha and Anmol (2022).

Vitamin C content

The data has been presented in Table 1, which reveals the effect of storability treatments on vitamin C during storage at ambient temperature during both the years (2022-23 and 2023-24) of study.

Effect of Foliar Feeding (FF): Table 1 clearly shows that treatments tended significant effect on vitamin C content of ber fruits over control in two years. The maximum (73.61 and 73.83 mg/100g) ascorbic acid was noted with application of T_5 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm) in two years, respectively and it was followed by T_3 (Borax 0.5%), T_2 ($ZnSO_4$ 0.5%) and T_4 (GA_3 10 ppm) treatments with 72.30 and 72.53, 70.96 and 71.20, 69.57 and 69.81 mg/100g ascorbic acid, respectively. However, the minimum (67.89 and 68.12 mg/100g) ascorbic acid was recorded under T_1 (control) in both the years, respectively. As far as the main effect of days' storage is concerned, it was found that ascorbic acid significantly decreased with successive increase in the days of storage. It was observed that the maximum of 77.71 and 77.93 mg/100g ascorbic acid was recorded with T_5 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm) at 3rd days of storage period, whereas minimum (64.97 and 65.20 mg/100g) ascorbic acid was recorded with T_1 (control) on 12th days of storage during 2022-23 and 2023-24.

Effect of Post-Harvest Treatment (PHT): All the post-harvest treatments showed significant effect over control. The maximum (71.47 and 71.71 mg/100g) ascorbic acid was noted with application of P_6 ($CaSO_4$ 1% + AA 50 ppm) in two years, respectively and it was followed by P_5 ($CaSO_4$ 1% + SA 100 ppm), P_4 (AA 50 ppm), P_3 (SA 100 ppm) and P_2 ($CaSO_4$ 1%) treatments with 71.23 and 71.47, 70.98 and 71.21, 70.74 and 70.98, 70.50 and 70.74 mg/100g ascorbic acid, respectively. However, the minimum (70.26 and 70.49 mg/100g) ascorbic acid was recorded under P_1 (control) in both the years, respectively. With regards to effect of storage, it was found that ascorbic acid significantly decreased with successive increase in the days of storage. It was observed that the maximum of 75.70 and 75.94 mg/100g ascorbic acid was recorded with P_6 ($CaSO_4$ 1% + AA 50 ppm) at 3rd days of storage period, whereas minimum (67.19 and 67.42 mg/100g) ascorbic acid was recorded with P_1 (control) on 12th day of storage during 2022-23 and 2023-24.

Effect of Foliar Feeding and Post-Harvest Treatment: All the treatments showed significant effect over control. The maximum of 74.16 and 74.38 mg/100g ascorbic acid was noted under T_5P_6 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)) in either of the two years, respectively. It was closely followed by T_5P_5 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + SA 100 ppm (PHT)), T_5P_4 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + AA 50 ppm (PHT)) and T_5P_3 ($ZnSO_4$ 0.5% + Borax 0.5% +

GA_3 10 ppm (FF) + SA 100 ppm (PHT)) by showing of 73.99 and 74.22, 73.72 and 73.93, 73.49 and 73.71 mg/100g ascorbic acid, respectively. The minimum (67.10 and 67.32 mg/100g) ascorbic acid was observed with T_1P_1 (Control (FF) + Control (PHT)). With regards to effect of storage, it was found that ascorbic acid significantly decreased with successive increase in the days of storage. It was observed that the maximum of 78.21 and 78.43 mg/100g ascorbic acid was recorded with T_5P_6 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)) at 3rd day of storage period, whereas minimum (64.19 and 64.41 mg/100g) ascorbic acid was recorded with T_1P_1 (Control (FF) + Control (PHT)) on 12th day of storage during 2022-23 and 2023-24.

Ascorbic acid continuously decreased with increase in duration of storage in all the treatments. The decrease may be due to the degradation of ascorbic acid into dehyanoscorbic acid. The rate of decreasing of ascorbic acid was found lesser in treated fruits as compared to controlled fruits. These results are in conformity to those reported by Jawandha *et al.* (2008), Singh *et al.* (2013), Byas (2014) and Meena *et al.* (2021).

Table 1: Effect of storability treatments on Vitamin C content of Ber fruits cv. Banarasi Karaka during storage

Treatments	Vitamin C (mg/100g)									
	2022-2023					2023-2024				
	3rd day	6th day	9th day	12th day	Mean	3rd day	6th day	9th day	12th day	Mean
T_1	72.35	68.08	66.15	64.97	67.89	72.58	68.32	66.39	65.20	68.12
T_2	75.21	71.81	69.20	67.60	70.96	75.46	72.05	69.44	67.85	71.20
T_3	76.44	73.04	70.63	69.07	72.30	76.68	73.28	70.86	69.31	72.53
T_4	73.94	69.99	67.81	66.54	69.57	74.18	70.22	68.04	66.78	69.81
T_5	77.71	73.82	72.02	70.88	73.61	77.93	74.04	72.25	71.10	73.83
Mean	75.13	71.35	69.16	67.81		75.37	71.58	69.40	68.05	
SEm±	0.05	0.04	0.04	0.04		0.05	0.04	0.04	0.04	
CD at 5%	0.13	0.12	0.12	0.11		0.13	0.12	0.12	0.11	
P_1	74.56	70.73	68.54	67.19	70.26	74.80	70.96	68.78	67.42	70.49
P_2	74.79	70.98	68.79	67.42	70.50	75.03	71.23	69.03	67.66	70.74
P_3	75.02	71.22	69.04	67.69	70.74	75.26	71.46	69.28	67.92	70.98
P_4	75.25	71.47	69.27	67.94	70.98	75.48	71.70	69.50	68.17	71.21

P_5	75.45	71.73	69.53	68.21	71.23	75.69	71.97	69.77	68.45	71.47
P_6	75.70	71.95	69.79	68.43	71.47	75.94	72.19	70.03	68.67	71.71
Mean	75.13	71.35	69.16	67.81		75.37	71.59	69.40	68.05	
SEm±	0.05	0.05	0.05	0.04		0.05	0.05	0.05	0.04	
CD at 5%	0.14	0.13	0.13	0.12		0.14	0.13	0.13	0.12	
T_1P_1	71.56	67.28	65.36	64.19	67.10	71.78	67.50	65.60	64.41	67.32
T_1P_2	71.88	67.65	65.70	64.41	67.41	72.13	67.90	65.95	64.66	67.66
T_1P_3	72.26	67.92	66.00	64.82	67.75	72.53	68.19	66.27	65.09	68.02
T_1P_4	72.51	68.24	66.29	65.16	68.05	72.75	68.48	66.53	65.40	68.29
T_1P_5	72.72	68.52	66.62	65.45	68.33	72.94	68.74	66.84	65.67	68.55
T_1P_6	73.14	68.88	66.93	65.77	68.68	73.35	69.11	67.16	66.00	68.91
T_2P_1	74.69	71.04	68.64	67.15	70.38	74.94	71.28	68.88	67.39	70.62
T_2P_2	74.90	71.30	68.85	67.33	70.60	75.17	71.57	69.12	67.60	70.87
T_2P_3	75.15	71.66	69.10	67.55	70.87	75.38	71.89	69.33	67.78	71.10
T_2P_4	75.31	71.96	69.33	67.69	71.07	75.52	72.17	69.54	67.90	71.28
T_2P_5	75.50	72.31	69.46	67.84	71.28	75.75	72.56	69.71	68.09	71.53
T_2P_6	75.73	72.58	69.80	68.05	71.54	76.00	72.85	70.07	68.32	71.81
T_3P_1	75.94	72.89	70.05	68.23	71.78	76.18	73.13	70.29	68.47	72.02
T_3P_2	76.10	72.94	70.31	68.57	71.98	76.35	73.19	70.56	68.82	72.23
T_3P_3	76.35	73.01	70.51	68.86	72.18	76.59	73.25	70.75	69.10	72.42
T_3P_4	76.56	73.07	70.74	69.25	72.41	76.81	73.32	70.99	69.50	72.66
T_3P_5	76.72	73.15	70.95	69.59	72.60	76.96	73.39	71.19	69.83	72.84
T_3P_6	76.97	73.19	71.20	69.94	72.83	77.18	73.40	71.41	70.15	73.04
T_4P_1	73.45	69.20	67.24	66.09	69.00	73.68	69.43	67.47	66.32	69.23
T_4P_2	73.66	69.54	67.47	66.27	69.24	73.87	69.75	67.68	66.48	69.45
T_4P_3	73.76	69.81	67.71	66.44	69.43	73.99	70.04	67.94	66.67	69.66
T_4P_4	74.07	70.12	67.85	66.62	69.67	74.30	70.35	68.08	66.85	69.90
T_4P_5	74.28	70.52	68.17	66.85	69.96	74.53	70.77	68.42	67.10	70.21
T_4P_6	74.45	70.73	68.41	66.97	70.14	74.72	71.00	68.67	67.23	70.41
T_5P_1	77.18	73.25	71.43	70.28	73.04	77.40	73.47	71.65	70.50	73.26
T_5P_2	77.41	73.49	71.61	70.51	73.26	77.65	73.73	71.85	70.75	73.50
T_5P_3	77.59	73.70	71.90	70.76	73.49	77.81	73.92	72.12	70.98	73.71

T_5P_4	77.80	73.95	72.14	70.98	73.72	78.01	74.16	72.35	71.19	73.93
T_5P_5	78.05	74.15	72.45	71.31	73.99	78.28	74.38	72.68	71.54	74.22
T_5P_6	78.21	74.37	72.61	71.44	74.16	78.43	74.59	72.83	71.66	74.38
Mean	75.13	71.35	69.16	67.81		75.37	71.58	69.40	68.05	
SEm±	0.11	0.10	0.10	0.10		0.11	0.10	0.10	0.10	
CD at 5%	0.31	0.29	0.28	0.28		0.31	0.29	0.28	0.28	

Organoleptic quality

A perusal of Table 5 shows significant influence of storability treatments on organoleptic quality during storage at ambient temperature during both the years (2022-23 and 2023-24) of investigation.

Effect of Foliar Feeding (FF): All the treatments showed significant effect over control. The maximum of 7.49 and 7.62 score of organoleptic quality was noted under T_5 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm) in either of the two years, respectively. It was followed by T_3 (Borax 0.5%), T_2 ($ZnSO_4$ 0.5%) and T_4 (GA_3 10 ppm) treatments by showing of 7.12 and 7.27, 6.83 and 6.97, 6.51 and 6.65 score of organoleptic quality, respectively. The minimum (5.81 and 5.94) score of organoleptic quality was observed with control (T_1) in either of two years. With regards to effect of storage, it was found that organoleptic quality significantly decreased with successive increases over a period of 12th days of storage. The treatments and days of storage were found significant. The maximum (8.35 and 8.48) organoleptic score was recorded with T_5 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm) at 3rd day of storage period, whereas minimum (4.78 and 4.92) organoleptic score was recorded with control (T_1) on 12th day of storage during 2022-23 and 2023-24.

Effect of Post-Harvest Treatment (PHT): All the post-harvest treatments showed significant effect over control during both the years. The maximum (6.94 and 7.08) organoleptic score was noted with application of P_6 ($CaSO_4$ 1% + AA 50 ppm) in two years respectively and it was followed by P_5 ($CaSO_4$ 1% + SA 100 ppm), P_4 (AA 50 ppm), P_3 (SA 100 ppm) and P_2 ($CaSO_4$ 1%) treatments with 6.87 and 7.00, 6.79 and 6.92, 6.71 and 6.85, 6.64 and 6.78 organoleptic score, respectively. However, the minimum (6.61 and 6.70) organoleptic score was recorded under control (P_1) in both the years, respectively. With regards to effect of storage, it was found that organoleptic quality significantly decreased with successive increases over a period of 12th days of storage. The treatments and days of storage were found significant. The maximum (7.80 and 7.94) organoleptic score was recorded with

P_6 ($CaSO_4$ 1% + AA 50 ppm) at 3rd day of storage period, whereas minimum (5.64 and 5.78) organoleptic score was recorded with control (P_1) on 12th day of storage during 2022-23 and 2023-24.

Effect of Foliar Feeding and Post-Harvest Treatment: All the treatments showed significant effect over control during the year 2022-23 and 2023-24 of the experimentation. The maximum of 7.63 and 7.75 organoleptic score was noted with T_5P_6 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)) in either of the two years, respectively. It was closely followed by T_5P_5 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + SA 100 ppm (PHT)), T_5P_4 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + AA 50 ppm (PHT)) and T_5P_3 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + SA 100 ppm (PHT)) by showing of 7.58 and 7.69, 7.52 and 7.64, 7.46 and 7.59 organoleptic score, respectively. The minimum of 5.43 and 5.55 organoleptic score was recorded in T_1P_1 (Control (FF) + Control (PHT)) in both the years, respectively. With regards to effect of storage, it was found that organoleptic quality significantly decreased with successive increases over a period of 12th days of storage. The treatments and days of storage were found significant. The maximum (8.50 and 8.63) organoleptic score was recorded with T_5P_6 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)) at 3rd day of storage period, whereas minimum (4.25 and 4.37) organoleptic score was recorded with T_1P_1 (Control (FF) + Control (PHT)) on 12th day of storage during 2022-23 and 2023-24.

Organoleptic characters are very much influenced by the storability treatments of fruits. The overall organoleptic rating like color, texture, appearance and taste of the fruit of all treatments deteriorated on account of faster ripening, reduced TSS and consequent decline in acidity. These findings were in accordance with the findings of Byas (2014), Jain *et al.* (2017), Ravi *et al.* (2018), Moradinezhad *et al.* (2019), Haritha and Anmol (2022).

Table 5: Effect of storability treatments on Organoleptic quality of Ber fruits cv. Banarasi Karaka during storage

Treatments	Organoleptic quality									
	2022-2023					2023-2024				
	3rd day	6th day	9th day	12th day	Mean	3rd day	6th day	9th day	12th day	Mean
T_1	6.55	6.46	5.44	4.78	5.81	6.68	6.59	5.57	4.92	5.94
T_2	7.74	7.30	6.24	6.02	6.83	7.88	7.44	6.39	6.17	6.97
T_3	8.06	7.64	6.57	6.21	7.12	8.20	7.78	6.72	6.36	7.27

T_4	7.30	7.09	5.93	5.73	6.51	7.44	7.23	6.07	5.87	6.65
T_5	8.35	8.10	7.01	6.48	7.49	8.48	8.24	7.14	6.61	7.62
Mean	7.60	7.32	6.24	5.84		7.74	7.46	6.38	5.99	
SEm±	0.01	0.01	0.00	0.00		0.01	0.01	0.00	0.00	
CD at 5%	0.03	0.02	0.01	0.01		0.03	0.02	0.01	0.01	
P_1	7.40	7.32	6.07	5.64	6.61	7.54	7.27	6.21	5.78	6.70
P_2	7.48	7.20	6.15	5.73	6.64	7.62	7.34	6.29	5.87	6.78
P_3	7.57	7.29	6.19	5.80	6.71	7.71	7.43	6.33	5.94	6.85
P_4	7.64	7.35	6.27	5.89	6.79	7.77	7.49	6.40	6.02	6.92
P_5	7.72	7.43	6.34	5.97	6.87	7.85	7.56	6.47	6.10	7.00
P_6	7.80	7.50	6.40	6.05	6.94	7.94	7.64	6.54	6.18	7.08
Mean	7.60	7.35	6.24	5.85		7.74	7.46	6.37	5.98	
SEm±	0.01	0.01	0.01	0.00		0.01	0.01	0.01	0.00	
CD at 5%	0.03	0.02	0.02	0.01		0.03	0.02	0.02	0.01	
T_1P_1	6.15	6.09	5.21	4.25	5.43	6.27	6.21	5.33	4.37	5.55
T_1P_2	6.31	6.22	5.30	4.47	5.58	6.44	6.35	5.45	4.62	5.72
T_1P_3	6.50	6.39	5.37	4.63	5.72	6.65	6.55	5.53	4.79	5.88
T_1P_4	6.63	6.54	5.48	4.90	5.89	6.76	6.68	5.62	5.04	6.03
T_1P_5	6.78	6.70	5.58	5.11	6.04	6.90	6.82	5.70	5.23	6.16
T_1P_6	6.95	6.84	5.67	5.33	6.20	7.07	6.96	5.79	5.45	6.32
T_2P_1	7.58	7.22	6.16	5.96	6.73	7.72	7.36	6.30	6.10	6.87
T_2P_2	7.64	7.25	6.20	5.98	6.77	7.79	7.40	6.35	6.13	6.92
T_2P_3	7.72	7.29	6.22	6.01	6.81	7.88	7.45	6.38	6.17	6.97
T_2P_4	7.76	7.32	6.25	6.03	6.84	7.91	7.47	6.40	6.18	6.99
T_2P_5	7.83	7.34	6.29	6.06	6.88	7.98	7.48	6.43	6.20	7.02
T_2P_6	7.89	7.37	6.32	6.08	6.92	8.03	7.51	6.46	6.22	7.06
T_3P_1	7.95	7.40	6.35	6.10	6.95	8.11	7.56	6.51	6.26	7.11
T_3P_2	7.99	7.49	6.47	6.15	7.03	8.14	7.64	6.62	6.30	7.18
T_3P_3	8.04	7.60	6.52	6.19	7.09	8.18	7.74	6.66	6.33	7.23
T_3P_4	8.07	7.68	6.61	6.24	7.15	8.22	7.83	6.75	6.38	7.30
T_3P_5	8.12	7.78	6.69	6.28	7.22	8.26	7.92	6.83	6.42	7.36
T_3P_6	8.16	7.87	6.78	6.33	7.29	8.31	8.02	6.93	6.48	7.44

T_4P_1	7.11	6.99	5.76	5.55	6.35	7.24	7.12	5.89	5.68	6.48
T_4P_2	7.19	7.03	5.83	5.62	6.42	7.33	7.17	5.97	5.77	6.56
T_4P_3	7.25	7.08	5.89	5.71	6.48	7.38	7.21	6.02	5.84	6.61
T_4P_4	7.34	7.10	5.96	5.75	6.54	7.47	7.23	6.09	5.89	6.67
T_4P_5	7.41	7.15	6.02	5.83	6.60	7.56	7.30	6.17	5.98	6.75
T_4P_6	7.50	7.18	6.09	5.89	6.67	7.66	7.34	6.25	6.05	6.83
T_5P_1	8.20	7.97	6.86	6.37	7.35	8.35	8.12	7.01	6.52	7.50
T_5P_2	8.26	8.02	6.92	6.42	7.41	8.40	8.16	7.06	6.56	7.55
T_5P_3	8.34	8.08	6.95	6.46	7.46	8.47	8.21	7.08	6.59	7.59
T_5P_4	8.38	8.13	7.04	6.51	7.52	8.50	8.25	7.16	6.63	7.64
T_5P_5	8.45	8.19	7.12	6.55	7.58	8.56	8.30	7.23	6.66	7.69
T_5P_6	8.50	8.24	7.16	6.60	7.63	8.63	8.38	7.29	6.71	7.75
Mean	7.60	7.32	6.24	5.85		7.74	7.46	6.38	5.99	
SEm±	0.02	0.02	0.01	0.01		0.02	0.02	0.01	0.01	
CD at 5%	0.06	0.05	0.03	0.03		0.06	0.05	0.03	0.03	

CONCLUSION

Based on the results, It may be educed from the results found in extant investigation that the T_5 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm), P_6 ($CaSO_4$ 1% + AA 50 ppm), T_5P_6 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)) treatment was found to be best. In which, T_5P_6 ($ZnSO_4$ 0.5% + Borax 0.5% + GA_3 10 ppm (FF) + $CaSO_4$ 1% + AA 50 ppm (PHT)) treatment was found to be most effective to maintain the quality (Acidity, Vitamin C, Organoleptic quality) of fruits upto 9 days of storage during both the years.

AUTHORS' CONTRIBUTION

Conceptualization of research work and designing of experiments (ON AND BD); Execution of field/ lab experiments and data collection (ON); Analysis of data and interpretation (ON AND BD); Preparation of manuscript (ON AND BD)

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