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INFLUENCE OF PRE-HARVEST FOLIAR SPRAY OF CHEMICALS ON FRUIT QUALITY ATTRIBUTES AND STORAGE BEHAVIOR OF BER CV. APPLE KUL

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ABSTRACT

The current research entitled "Influence of pre-harvest foliar spray of chemicals on fruit quality attributes and storage behaviour of Ber cv. Apple Kul" was undertaken on 2-year-old ber plant cv. Apple Kul at Farmer's field, Gayeshpur during 2018-19. Nine treatments along with three replications were used in the Randomized Block Design experiment viz T_1 (Calcium Chloride@ 0.3%), T_2 (Calcium Chloride@ 0.5%), T_3 (Calcium Nitrate@ 0.5%), T_4 (Calcium Nitrate@ 1.0%), T_5 (Boric Acid@ 0.1%), T_6 (Boric Acid@ 0.2%), T_7 (Salicylic Acid@ 50 μ mol l^{-1}), T_8 (Salicylic Acid@ 100 μ mol l^{-1}), T_9 (Control-Water Spray). In general, each chemical had an impact on the fruit's quality and shelf life. Fruit yield, fruit weight, length as well as breadth were higher in calcium chloride at 0.5% followed by calcium nitrate 1.0% than control. Maximum TSS (12.7°Brix), total sugar (9.09%), reducing sugar (5.52%) and non-reducing sugar (3.29%) were observed with calcium nitrate@ 1.0% but significantly higher ascorbic acid (56.73 mg/100g) was noted with boric acid 0.2%. Calcium chloride@ 0.5% showed promising results in terms of minimum physiological loss in weight (%), lessening spoilage and higher percentage of marketable fruits; calcium nitrate@ 1.0% during storage improved the overall quality of fruits and extending the shelf life. Thus, keeping in view the significant impact of chemicals on quality and shelf life of ber, the use of $Ca(NO_3)_2$@ 1.0 % and $CaCl_2$@ 0.5 % proved most effective.
***Keywords* :** Apple Kul, Foliar spray, Fruit yield, Shelf life, Physiological loss in weight

Introduction

One of India's oldest and most popular native fruits is the poor man's apple, or ber (*Zizyphus mauritiana* Lamk.), a member of Rhamnaceae family. It may be grown effectively even in the most marginal subtropical and tropical habitats (Pareek, 2001 and Meghwal *et al.*, 2021). Ber's wide range of adaptability, inexpensive cultivation costs and capacity to endure drought all contribute to its popularity (Pal *et al.*, 2020). It is cross pollinated crop and often propagated through seeds resulting variability in quantitative and qualitative characteristics of fruits (Hoque, 2002 and Caccavello *et al.*, 2019). Ber is cultivated globally because of its nutritive value having good amount of vitamins C, A and B complex (Jain *et al.*, 2024). But the post-harvest life of this valuable fruit is brief. According to Jiang *et al.* (2004), it has distinctive characteristics by fungal infections, browning of the flesh, senescence-induced softness and a decrease in the amount of soluble solids (Cao *et al.*, 2013 and Singh *et al.*, 2021). As a result, attempts have been made to use specific agrochemicals to reduce the ripening process, reduce losses, and preserve the quality of the fruit by slowing down the rate of metabolic activity during harvest or in storage (Shafiee *et al.*, 2010). Sprays of calcium chloride applied before harvest appear to be a useful tool for maintaining fruit quality as well as extending its shelf and market life (Gerasopoulos and Drogoudi, 2005). The application of calcium compounds to Indian jujube also enhanced the calcium content in fruit's texture and decreased the brown spots (Shamili and Hajiani, 2012 and Maurya *et al*., 2020). Hayat (2010) claims that plants treated with exogenous salicylic acid acquire systemic acquired resistance (SAR), which provides a strong defense against a variety of abiotic stressors and pathogen invasion. Furthermore, it has been found that the exogenous application of SA improves the effectiveness of the biocontrol yeast *Cryptococcus laurentii* in pears (Yu *et al.,* 2007; Zhang *et al.,* 2008 and Koo *et al*., 2020), cherries (Qin *et al.,* 2003) and in apples (Yu and Zheng, 2006). Applying boron foliarly functions as a signal that can interact with transcription factors within cells to regulate a range of physiological processes that are impacted by boron deficiency (Gonz'alez-Fontes *et al.,* 2008 and Raipuriya *et al*., 2024). Research indicates that boron can affect a growing plant's structure, including root elongation, shoot growth, metabolism and the interface between the cell wall and plasma membrane (Marschner, 2012 and Kumar *et al*., 2022). With the aforementioned information, the current experiment was conducted at a Farmer's field in Gayeshpur to investigate the impact of pre-harvest foliar spraying multiple chemicals on the quality as well as shelf life of ber.

Materials and Methods

Experimental site and treatment specifications

The present research entitled "Influence of pre-harvest foliar spray of chemicals on fruit quality attributes and storage behaviour of Ber cv. Apple Kul" was carried out in Farmer's field at Gayeshpur, Nadia, West Bengal, during 2018-19. With three replications and nine treatments, the study was carried out on a two-year-old ber cv. Apple Kul using a Randomized Block Design viz T_1 (Calcium Chloride@ 0.3%), T_2 (Calcium Chloride@ 0.5%), T_3 (Calcium Nitrate@ 0.5%), T_4 (Calcium Nitrate@ 1.0%), T_5 (Boric Acid@ 0.1%), T_6 (Boric Acid@ 0.2%), T_7 (Salicylic Acid@ 50 μ mol l^{-1}), T_8 (Salicylic Acid@ 100 μ mol l^{-1}), T_9 (Control-Water Spray).

Preparation of Chemical Solution

For preparation of 0.3% and 0.5% Calcium Chloride solution, 3 g and 5 g of Calcium Chloride were dissolved into 1 ltr of water respectively. Similarly for the preparation of 0.5% and 1.0% Calcium Nitrate solution, 5 g and 10 g of salt dissolved into 1 lit of water respectively. For the preparation of boric acid 0.1% and 0.2%, the required amount of Boric acid was taken and dissolved in luke warm water and then desired volume was made with water. The concentration of salicylic acid (50 μ mol l^{-1}) by dissolving 7 mg and salicylic acid (100 μ mol l^{-1}) by dissolving 14 mg in 1 lit of water were prepared.

Time and Method of application

Using a hand sprayer, the plants were sprayed with varying concentrations of calcium chloride, calcium nitrate, boric acid and salicylic acid until the leaves and fruits were moist and solution droplets began to trickle down. The spray was done three weeks before the date of harvesting.

Measurement of physical attributes of fruits

Fruit length and breadth were measured by digital vernier caliper, fruit weight was measured on electronic balance.

Estimation of chemical attributes of fruits

ERMA digital hand refractometers were used to measure the TSS content in fruits (0 to 32°Brix). Anthrone method was used to estimate total sugar as per Dubois *et al.* (1951). In accordance with Sadasivam and Manickam (1996), titratable acidity was calculated. By using 2.6-dichlorophenolindophenol sodium salt solution for titration, ascorbic acid content of the fruits was determined (AOAC, 2000).

Determination of physiological loss in weight & spoilage loss:

$$\text{PLW}(\%) = \frac{\text{Initial weight} \;\; \text{Final weight}}{\text{Initial weight}} \times 100$$

$$\text{Spoilage}(\%) = \frac{\text{No. of spoiled Fruits}}{\text{Total number of fruits at the beginning of the storage}} \times 100$$

Statistical analysis

According to Gomez and Gomez (1984), statistical evaluation for Randomized Block Design (RBD) was carried out using analysis of variance (ANOVA). At a probability threshold of 0.05, Fisher Snedecor's "F" test was used to determine the significance of the difference in the source of variance using error mean square.

Results and Discussion

Impact of chemicals on physical attributes of ber fruit

The data regarding the impact of foliar spray of several chemicals on physical characters as well as yield of fruits are displayed in Table 1. The highest fruit length (34.97 mm) was observed with 0.5% calcium chloride treatment while lowest (32.38 mm) was obtained in Control. The maximum fruit breadth (31.24 mm) was noted in T_2 while minimum (28.14 mm) was recorded in T_9 (Control). Appreciable improvement in fruit length by calcium chloride application might be due to its impacts in influencing the formation and changes of carbohydrates as well as carbohydrate enzyme. The fruit's increased nutritional and photosynthetic capacity as a result of the treatment may account for its increased length. These results are consistent with the observations of Singh *et al.* (2013) who observed that boric acid (1.0%) drastically decreased the fruit length (3.24 cm) but $CaCl_2$ (0.4%) affected the fruit size in a positive manner. Perusal of the data on fruit weight (Table 1) showed that fruits treated with $CaCl_2$@ 0.5% gained maximum fruit weight (19.54 g) while the minimum (16.03 g) was recorded in T_9. Maximum yield (33.83 kg/plant) was obtained from the plant treated with $CaCl_2$@ 0.5% and minimum from Control (25.02 kg/plant).

Table 1: Effect of chemicals on physical and yield characteristics of ber

Treatment	Fruit length (mm)	Fruit breadth (mm)	Fruit weight (g)	Fruit yield (kg plant^{-1})
T1	34.08	30.15	18.42	31.32
T2	34.97	31.24	19.54	33.83
T3	34.17	30.31	18.87	32.65
T4	34.25	31.10	19.07	33.05
T5	33.38	29.94	17.93	30.08
T6	34.01	30.06	18.07	30.75
T7	33.17	29.34	17.55	27.93
T8	33.58	29.92	17.83	28.63
T9	32.38	28.14	16.03	25.02
SEm±	0.630	0.492	0.809	0.401
CD at 5%	NS	NS	NS	1.213

Impact of chemicals on bio-chemical attributes of ber fruit

TSS was significantly impacted by chemical pre-harvest foliar spraying (Table 2). T_4 exhibited the greatest TSS concentration (12.7°Brix) which was statistically at par with T_3 (12.4°Brix) while the minimum (10.2°Brix) was noted in T_9. Yadav *et al.* (2009) in ber and Kirmani *et al.* (2013) in plum both held a similar opinion. The minimum acidity (0.29%) was found in T_4 while the maximum was recorded in T_9 and T_7 (0.38%). These results substantiated the observations of Bhat *et al.* (2009) in pear, Kaur *et al.* (2009) and Nath *et al.* (2012) in litchi. The maximum total sugar (9.09%) was noticed in T_4 while the minimum (6.67%) was recorded in T_9. Similar outcomes were also stated by Bhalerao *et al.* (2010) in sapota, Lal *et al.* (2011) in apricot & Karemera and Habimana (2014) in mango. Highest reducing sugar (3.29%) content was noted in T_4 while the minimum (2.33%) was recorded in T_9. The maximum ascorbic acid (56.73 mg) was obtained from the fruit treated with boric acid @ 0.2% which was statistically at par with T_5 (55.17 mg), while the minimum (44.35 mg) was noted in T_9. These outcomes are in conformity with the observations of Sankar *et al.* (2013).

Table 2: Effect of chemicals on bio-chemical characteristics of ber

Treatment	TSS (°Brix)	Acidity (%)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Ascorbic acid (mg/100 g)
T1	11.8	0.33	7.41	3.03	4.16	51.44
T2	12.1	0.32	7.69	3.08	4.38	52.87
T3	12.4	0.30	8.69	3.17	5.24	52.23
T4	12.7	0.29	9.09	3.29	5.52	54.87
T5	11.0	0.36	8.33	2.74	5.31	55.17
T6	11.2	0.35	8.33	2.82	5.23	56.73
T7	10.5	0.38	7.14	2.63	4.29	47.89
T8	10.9	0.37	7.14	2.70	4.22	48.33
T9	10.2	0.38	6.67	2.33	4.12	44.35
SEm±	0.156	0.005	0.103	0.038	0.062	0.672
CD at 5%	0.472	0.015	0.312	0.115	0.188	2.031

Impact of chemicals on storage behaviour at ambient condition of ber

Perusal of data indicated that every treatment had a notable impact on the physiological weight loss (%). Lowest loss was observed with T_2 (7.15%) while maximum was recorded with T_9 (11.92%). Lowest loss in weight (4.17%) was noted on 4th day of the storage, highest (20.09%) was observed in 12th day of storage. It was discovered that the relationship between treatments and storage times had a statistically significant impact. Lowest loss in weight (2.02%) was noted in T_2 on 4th day of storage, highest (26.23%) was noticed in T_9 on 12th day of storage. Investigations throughout the duration of the study revealed that, independent of treatments, The physiological loss of weight (PLW) increased as storage times increased. When compared to the Control, each chemical's corresponding concentration greatly decreased PLW (%) of fruits. Fruit PLW (%) was shown to be most effectively decreased during storage by $CaCl_2$ and $Ca(NO_3)_2$. This could most likely be the result of pre-harvest calcium sprays increasing the calcium concentration of fruit peels and pulp and ultimately maintained fruit firmness. The results obtained are in accordance with Alila and Achumi (2012) who observed that calcium nitrate (0.6%) resulted in minimum physiological loss in weight during storage period.

Table 3: Effect of chemicals on physiological loss in weight of ber

Treatment	Physiological loss of weight (%) Storage Period (Days)				Mean
	0	4	8	12	
T1	-	4.19	12.23	19.03	8.86
T2	-	2.02	9.27	17.32	7.15
T3	-	4.14	11.87	18.67	8.67
T4	-	3.69	11.23	18.21	8.28
T5	-	4.63	14.31	20.37	9.83
T6	-	4.37	13.77	19.91	9.51
T7	-	4.43	12.92	19.32	9.17
T8	-	4.87	14.88	21.78	10.38
T9	-	5.21	16.23	26.23	11.92
Mean	-	4.17	12.97	20.09	
Factors	**CD at 5%**		**SEm±**		
Storage Interval (S)	0.190		0.067		
Treatment (T)	0.328		0.115		
Interaction (S × T)	0.569		0.200		

The minimum fruit spoilage was recorded with T_2 (19.21%) while the maximum (41.75%) was noted with Control (Table 4). The minimum spoilage (6.87%) was noted on 4th day of storage while the maximum (69.77%) was observed on 12th day of storage. Treatment and storage time interactions significantly impacted spoiling (%) of fruits on 4th, 8th and 12th days of storage. The minimum spoilage (5.01%) was observed in T_6 on 4th day of storage while highest (88.51%) was recorded in Control on 12th day of storage. These recent findings are consistent with Kirmani *et al.* (2013), where plum cv. Santa Rosa treated with $CaCl_2$@ 0.5% was more effective in minimizing the spoilage loss. These results are consistent with the observations of Jawandha *et al.* (2009) and Yadav *et al.* (2009) in ber.

Table 4: Effect of chemicals on spoilage at ambient storage condition of ber

Treatment	Spoilage (%) Storage Period (Days)				Mean
	0	4	8	12	
T1	-	-	28.39	63.46	22.96
T2	-	-	21.71	55.11	19.21
T3	-	-	26.72	60.12	21.71
T4	-	-	25.05	58.45	20.88
T5	-	8.35	41.75	73.48	30.90
T6	-	5.01	36.74	70.14	27.97
T7	-	15.03	50.1	80.16	36.32

T8	-	13.36	46.76	78.49	34.65
T9	-	20.04	58.45	88.51	41.75
Mean	-	6.87	37.30	69.77	
Factors	**CD at 5%**			**SEm±**	
Storage Interval (S)	0.651			0.229	
Treatment (T)	1.128			0.396	
Interaction (S × T)	1.953			0.686	

The maximum marketable fruit (80.80%) were observed in T_2 while the minimum (58.25%) was noted in T_9 (Table 5). The maximum marketable fruits (93.13%) were recorded on 4th day of storage while the minimum (30.23%) were noted on 12th day of storage. Effect of interaction between treatments and storage periods had significant impact on marketable fruits percentage. The maximum marketable fruits (100%) were observed on 4th day of storage in T_1, T_2, T_3 and T_4 while the minimum (11.49%) were observed on 12th day storage in T_9. Fruits attend full marketability (100%) on 4th day of storage except T_5, T_6, T_7, T_8 and T_9. The marketability of fruits increased with Ca application. It could be because calcium slows down the respiration process, which prevents fruit from deteriorating. However, calcium has many other functions, including making fruit firmer, which prolongs its shelf life and delays ripening (Karemera and Habimana, 2014).

Table 5: Effect of chemicals on marketable fruit (%) of ber

Treatment	**Marketable fruit (%)**				**Mean**
	Storage Period (Days)				
	0	**4**	**8**	**12**	
T1	-	100	71.61	36.54	77.04
T2	-	100	78.29	44.89	80.80
T3	-	100	73.28	39.88	78.29
T4	-	100	74.95	41.55	79.13
T5	-	91.65	58.25	26.52	69.11
T6	-	94.99	63.26	29.86	72.03
T7	-	84.97	49.90	19.84	63.68
T8	-	86.64	53.24	21.51	65.35
T9	-	79.96	41.55	11.49	58.25
Mean	-	93.13	62.70	30.23	
Factors	**CD at 5%**			**SEm±**	
Storage Interval (S)	0.862			0.303	
Treatment (T)	1.494			0.525	
Interaction (S × T)	2.587			0.909	

Highest TSS was recorded in T_4 (13.1°Brix) while minimum was observed under T_9 (10.5°Brix). The maximum TSS (12.6°Brix) was noted on 8th day of storage and minimum (11.2°Brix) was noted on 12th day of storage. The maximum TSS was noticed in T_4 (13.9°Brix) on 8th day of storage while minimum was reported in T_9 (10.0°Brix) on 12th day of storage. Initially the TSS content of the fruit enhanced and then decreased with the advancement of the storage periods. However, better results were achieved from the fruits of the trees that were treated with calcium nitrate (0.5% and 1.0%). The increase in TSS might be due to breakdown of starch and polysaccharides into simple sugars and the dehydration of fruits. Wahdan *et al.* (2011) have documented an overall rise in TSS in fruits. Increased senescence and a high respiration rate may be the cause of the TSS's slow decline (Kaur *et al.*, 2009 and Bal *et al.*, 2010). Similar rise and fall in total soluble solids was also noticed by Yadav *et al.* (2009) in ber and Kirmani *et al.* (2013) in plum.

Table 6: Effect of chemicals on TSS at ambient storage condition of ber

Treatment	**Total Soluble Solid (TSS)**				**Mean**
	Storage Period (Days)				
	0	**4**	**8**	**12**	
T1	11.8	12.5	13.1	11.6	12,3
T2	12.1	12.8	13.3	11.9	12.5
T3	12.4	12.9	13.6	12.3	12.8

T4	12.7	13.4	13.9	12.5	13.1
T5	11.0	11.7	12.2	10.8	11.4
T6	11.2	11.9	12.6	10.9	11.6
T7	10.5	10.9	11.7	10.2	10.8
T8	10.9	11.4	11.9	10.5	11.2
T9	10.2	10.6	11.1	10.0	10.5
Mean	11.4	12.0	12.6	11.2	
Factors	**CD at 5%**		**SEm±**		
Storage Interval (S)	0.148		0.052		
Treatment (T)	0.222		0.079		
Interaction (S × T)	NS		0.157		

The minimum titratable acidity was recorded with T_4 (0.25%) while maximum was noted with T_9 (0.37%). The minimum titratable acidity (0.28%) was observed on 12th day of storage while the maximum (0.34%) was noted on 0 day of storage. There was a statistically significant effect on titratable acidity from the interaction between treatments and storage periods. Lowest titratble acidity (0.21%) was found on 12th day of storage with T_4 while maximum (0.38%) was recorded in T_7 and T_9 on 0 day of storage. These observations are in conformity with the observations of Sayyari *et al.* (2009) who proposed that applying salicylic acid to pomegranate at a concentration of 4.1 mM enhanced TA. Tembo *et al.* (2008) studied that TA in ber fruits decreased by 14, 60 and 48 per cent in fruits stored at low, intermediate and ambient storage temperatures during 9 weeks of storage. The findings are consistent with those reported in ber by Bons and Sharma (2023), Yadav *et al.* (2005), Bal (2007) and Jawandha *et al.* (2007). Shokrollahfam *et al.* (2012) claim that calcium compounds enlarged strong bands in the cell walls, which decreased titratable acidity.

Table 7: Effect of chemicals on Titratable acidity at ambient storage condition of ber

Treatment	**Titratable acidity (%)**				**Mean**
	Storage Period (Days)				
	0	**4**	**8**	**12**	
T1	0.33	0.32	0.30	0.28	0.31
T2	0.32	0.30	0.28	0.26	0.29
T3	0.30	0.29	0.26	0.22	0.27
T4	0.29	0.26	0.24	0.21	0.25
T5	0.36	0.36	0.32	0.28	0.33
T6	0.35	0.35	0.32	0.27	0.32
T7	0.38	0.36	0.35	0.35	0.36
T8	0.37	0.35	0.34	0.33	0.35
T9	0.38	0.38	0.37	0.35	0.37
Mean	0.34	0.33	0.31	0.28	
Factors	**CD at 5%**		**SEm±**		
Storage Interval (S)	0.004		0.002		
Treatment (T)	0.006		0.002		
Interaction (S × T)	0.013		0.005		

The maximum total sugar (%) was noted in T_4 (9.43%) while minimum was recorded with T_9 (6.74%). The maximum total sugar (8.45%) was noted on 8th day of storage while the minimum (7.71%) was noted on 12th day of storage. Treatments and storage times interacted to provide a statistically significant impact on total sugar. Highest total sugar (10.01%) was noted on 8th day of storage in T_4 while minimum (6.25%) was noted on 12th day of storage in T_9. Total sugar (%) content of ber fruits showed an increasing trend with all the treatments up to 8 days of storage and thereafter declined up to 12 days. These findings coincide with Jawandha *et al.* (2008) who also noticed a similar pattern of rising total sugars for the first 20 days after storage, then falling subsequently. Additionally, Zhao *et al.* (2009) observed that during the first stage of storage, soluble sugar levels in jujube increased before declining.

Table 8: Effect of chemicals on Total sugar at ambient storage condition of ber

Treatment	Total sugar (%)				Mean
	Storage Period (Days)				
	0	4	8	12	
T1	7.41	7.69	8.33	7.41	7.71
T2	7.69	8.00	8.33	7.69	7.93
T3	8.69	9.09	9.09	8.14	8.75
T4	9.09	9.52	10.01	9.09	9.43
T5	8.33	8.33	8.69	8.14	8.37
T6	8.33	8.69	9.09	8.14	8.56
T7	7.14	7.41	7.69	7.41	7.41
T8	7.14	7.14	7.69	7.14	7.28
T9	6.67	6.89	7.14	6.25	6.74
Mean	7.83	8.09	8.45	7.71	
Factors	**CD at 5%**		**SEm±**		
Storage Interval (S)	0.096		0.034		
Treatment (T)	0.144		0.051		
Interaction (S × T)	0.288		0.102		

The maximum ascorbic acid (51.73 mg) was noted in T_6 while the minimum (37.55 mg) was observed in T_9 (Table 9). The maximum ascorbic acid (51.54 mg) was noted on 0 day of storage and minimum (38.02 mg) was noted on 12th day of storage. There was a statistically significant effect on ascorbic acid content from the interaction between treatments and storage periods. The maximum ascorbic acid (56.73 mg) was noticed in T_6 on 0 day of storage while the minimum (28.13 mg) was noted in T_9 on 12th day of storage. Identical results were also given by Pawar and Hashmi (2010) in custard apple during storage. Ascorbic acid is produced from sugar, a higher amount of ascorbic acid obtained from boron treatment was a result of a higher sugar content. These findings support the observations of Jawandha *et al.* (2007) in ber and Lal *et al.* (2011) in apricot.

Table 9: Effect of chemicals on Ascorbic acid at ambient storage condition of ber

Treatment	Ascorbic acid (mg/100 g)				Mean
	Storage Period (Days)				
	0	4	8	12	
T1	51.44	49.93	45.23	38.78	46.35
T2	52.87	51.07	47.11	41.13	48.05
T3	52.23	50.33	46.04	40.22	47.21
T4	54.87	52.25	47.93	41.86	49.23
T5	55.17	53.76	49.39	43.02	50.34
T6	56.73	54.89	50.93	44.37	51.73
T7	47.89	45.67	40.57	31.89	41.51
T8	48.33	46.11	41.34	32.77	42.14
T9	44.35	41.45	36.28	28.13	37.55
Mean	51.54	49.50	44.98	38.02	
Factors	**CD at 5%**		**SEm±**		
Storage Interval (S)	0.543		0.192		
Treatment (T)	0.814		0.288		
Interaction (S × T)	1.628		0.576		

Conclusion

This current research entitled "Influence of pre-harvest foliar spray of chemicals on fruit quality attributes and storage behaviour of Ber cv. Apple Kul" was carried out at Farmer's field in Gayeshpur, Nadia, West Bengal, in the year of 2018-19 on 2 year old ber plant of cv. Apple Kul. Based on the above outlined results, it can be stated that pre-harvest treatment of several chemicals affected the ber fruit yield, quality as well as shelf life. Calcium chloride@ 0.5% was effective to increase the yield as well as minimizing the physiological loss in weight (%), spoilage (%) and increasing the fruit marketability (%). For obtaining good quality fruit and higher shelf life, plants should be treated with calcium nitrate@ 1.0% 30-45 days before the date of harvesting.

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Author's contribution

Conceptualisation and designing of the research work (SM and BG); Execution of field or lab experiments and data collection (SD, SM and SD); Analysis of data and interpretation (SM, SS and AM); Preparation of manuscript (SD, SB and SD).

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