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Effect of bio-enhancers and bio-fertilizers on physiological losses in weight, spoilage and shelf-life of Mango (*Mangifera indica*) cv. Amrapali

ANKIT SINGH BHADAURIA[1] and VIVEK KUMAR TRIPATHI[2*]

Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh 208 002, India

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ABSTRACT

The present experiment was conducted during 2020–21 and 2021–22 at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh to determine the effect of bio-enhancers and bio-fertilizers on physiological losses in weight, spoilage and shelf-life of Mango (*Mangifera indica* L.) cv. Amrapali during storage (25°C±1; 60–65% RH) for 3, 5, 7, 9, 11, 13, and 15 days. The experiment was laid out in randomized block design (RBD) having seven treatments [T_1, FYM (25 kg/tree/year) + Organic mulch (Paddy straw); T_2, FYM (25 kg/tree/year) + Organic mulch + *Amritpani* (20%) + *Azotobacter* (100 g/tree); T_3, FYM (25 kg/tree/year) + Organic mulch + *Panchagavya* (3%) + *Azotobacter* (100 g/tree); T_4, FYM (25 kg/tree/year) + Organic mulch + *Jivamrit* (20%) + *Azotobacter* (100 g/tree); T_5, FYM (25 kg/tree/year) + Organic mulch + *Amritpani* (20%) + PSB culture (100 g/tree); T_6, FYM (25 kg/tree/year) + Organic mulch + *Panchagavya* (3%) + PSB culture (100 g/tree); T_7, FYM (25 kg/tree/year) + Organic mulch + *Jivamrit* (20%) + PSB culture (100 g/tree), respectively] in three replications. The experimental results revealed that T_3 group was recorded significantly higher in TSS (°Brix) and total sugar content (%) followed by T_6 and T_4 groups. Meanwhile, PLW (%), titratable acidity content (%) and spoilage (%) were found minimum in T_3 group followed by T_6 and T_4 groups. Thus, on the basis of the above results, it may be suggested that bio-enhancers and bio-fertilizers could be applied in mango cultivation under the sub-tropical plains of Central Uttar Pradesh, India.

Keywords: Bio-enhancer, Bio-fertilizer, *Jivamrit*, Mango, *Panchagavya,* Shelf life

Mango (*Mangifera indica* L.), a subtropical and tropical fruit in the Anacardiaceae family, is known as the king of tropical fruits (Boghrma *et al.* 2000). Over 40 countries worldwide grow this unique plant commercially, with India, Mexico, Brazil, Pakistan, Haiti, the Philippines, and Bangladesh among the top producers (Alam *et al.* 2017). In India, mango is being cultivated on 2258.13 thousand hectares of land with the production of 21822.32 MT having 9.66 MT/ha productivity (Anonymous 2018). India is the leading mango producing country in the world with 45% share in world mango production and 15% share in world mango export market. Although, it has higher production potential, but the export of fresh fruit is limited to Alphonso and Dashehari varieties. A major consideration for the use of biofortified nutrients from biological organisms is the increased use of inorganic chemicals, which are costly to farmers and have a negative impact on soil and plant health (Hossain *et al.* 2022).

[1]Krishi Vigyan Kendra, Mohanpura, Kasganj, Uttar Pradesh; [2]Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh. *Corresponding author email: drvktripathicsa@gmail.com

In the specific context of India, there has been a remarkable upsurge in the adoption of organic farming in recent times (Roy *et al.* 2024). Bio-enhancers are usually used for all crop activities such as seed/seeding treatment, which enhances the quick decomposition of biomass, improves the nutritive value of compost, and thereby results in higher soil fertility, crop quality, and crop productivity (Kumar *et al.* 2022).

Panchagavya is a natural culture made from five different natural ingredients, including milk, cow dung, curd, urine, and ghee (Ram 2023). The *Panchagavya* contains a wide variety of microorganisms that promote growth and produce more, including aerobic heterotrophic bacteria, lactic acid bacteria, yeast, fungi and anaerobic bacteria (Sagar *et al.* 2023). *Amritpani* is an important bio-enhancer, which can easily be prepared by farmers using cow dung, cow ghee, honey and water (Biswas and Das 2022). The available micro-organism in *Amritpani* are *Actinomycetes*, *Pseudomonas*, Phosphorous solubilising bacteria, *Azotobacter* and *Azospirilum* (Ram *et al.* 2018). *Jivamrit*, is also prepared the same as *Amritpani* except the addition of some other ingredients such as jaggery and pulse flour and banyan tree soil. The micro-organism in

Jivamrit is also more or less the same as *Amritpani* (Pathak and Ram 2013).

Bio-fertilizers are living or dormant cells of various nitrogen-fixing and phosphorus-solubilizing micro-organisms that have the ability to convert soil nutrients from unavailable form to available form through various biological processes in the soil and they mobilize different micronutrients in the soil to varying extents, thereby promoting crop growth (Nayyer *et al.* 2014). *Azotobacter* bio-fertilizers is reported to enhance plant growth and ultimately improving the yield. Phosphate solubilizing bacteria (PSB) are used as inoculation, which increases phosphorus absorption by the plant, resulting in increased crop yield (Tripathi *et al.* 2017). Bacteria or fungi that produce organic acids can convert the insoluble form of phosphate into the soluble form (Reynaldo and Hilda 2000). There are many challenges during the production of mango such as unavailability of extension support systems, improper agronomic techniques, inappropriate technologies for managing pests and diseases, and a dearth of suitable credit support facilities due to improper handling, insufficient storage, or a lack of technical post-harvest understanding (Hassan 2010).

Accordingly, there is a need to develop post-harvest technologies related to quality preservation and post-harvest shelf life enhancement to enhance the export market of mango fruits (Moreno-Hernandez *et al.* 2024). Various post-harvest methods are employed globally to reduce losses and increase shelf life. Thus, bearing the aforementioned truth in mind, an experiment was conducted to assess the effect of bio-enhancers and bio-fertilizers on physiological losses in weight, spoilage and shelf life of Mango cv. Amrapali.

MATERIALS AND METHODS

The present experiment was conducted during 2020–21 and 2021–22 at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (26.4912°N Latitude, 80.3071°E Longitude at an altitude of 125.90 m amsl), Uttar Pradesh. Experimental sites are generally characterised by sub-tropical climates with hot, dry summers and cold winters. At the experimental site, the average yearly rainfall is 800–880 mm of which June through September receives 70–75% of the total rainfall, with the remaining 25–30% falling in sporadic showers throughout the winter. In the experimental area, the soil had a sandy loam texture, mild alkaline reaction, low organic carbon (3.9 g/kg), low nitrogen availability (168.89 kg/ha), medium phosphorus availability (21.63 kg/ha) and potassium availability (263.13 kg/ha), and a safe electrical conductivity. The field experiment comprised of seven treatments [T_1, FYM (25 kg/tree/year) + Organic mulch (Paddy straw); T_2, FYM (25 kg/tree/year) + Organic mulch + *Amritpani* (20%) + *Azotobacter* (100 g/tree); T_3, FYM (25 kg/tree/year) + Organic mulch + *Panchagavya* (3%) + *Azotobacter* (100 g/tree); T_4, FYM (25 kg/tree/year) + Organic mulch + *Jivamrit* (20%) + *Azotobacter* (100 g/tree); T_5, FYM (25 kg/tree/year) + Organic mulch + *Amritpani* (20%) + PSB culture (100 g/tree); T_6, FYM (25 kg/tree/year) + Organic mulch + *Panchagavya* (3%) + PSB culture (100 g/tree); T_7, FYM (25 kg/tree/year) + Organic mulch + *Jivamrit* (20%) + PSB culture (100 g/tree), respectively], laid out in randomized block design (RBD) having three replications.

In mango cultivar Amrapali, enhancers and bio-fertilizers were applied as per the requirement of the treatments. The foliar sprays of bio-enhancers and bio-fertilizers were done before and after flowering. For the foliar application of spray on mango plant such as to adequately drench the entire foliage, 10 L of solution was used for the spraying which is done by using pneumatic foot sprayer fitted with nozzle in the afternoon from 4.00–6.00 pm. For spraying on top of plant, high legged stool was used to fully ensured that all side of the plant was drenched completely. To avoid the spread of surplus spray under the plants, the polythene sheets were spread on the soil so that spray drops may not reach to the soil. The experiment was conducted on 25-year-old Amrapali mango trees planted at a spacing of 2.5 m × 2.5 m under high-density planting system. Further, the crop was managed as per regional recommendations of the crop. Fruits were kept at room temperature in order to obtain data regarding their shelf life. Fruit shelf life is measured in days, starting from the moment of harvest and ending when the fruit is ready to consume. It is assessed by the following parameters:

Fruits were weighed using a digital weighing scale to evaluate their physiological weight loss (PWL) after 3,5,7,9,11,13, and 15 days, respectively. The loss in weight was calculated in percentage as per Nadeem *et al.* (2022).

$$\text{PLW (\%)} \frac{\text{Initial weight} - \text{Final weight (ripe stage)}}{\text{Original weight}} \times 100$$

Extent of spoilage was determined by weighing the rotten fruit after specified days of storage and percentage was calculated on the basis of total weight of fruit stored in each treatment.

$$\text{Spoilage (\%)} \frac{\text{Weight of rotten fruit}}{\text{Total fruit weight}} \times 100$$

Calibration of the refractometer (0–32°) was done with distilled water each time it was used. In the case of temperature above or below 20°C, temperature correction was performed.

For total sugar content, 20 g of mango pulp was thoroughly homogenized in warring blender with the use of distilled water. The volume of that pulp was made to 250 ml. To that solution, then to precipitate the excess lead acetate, 5 mL of 10% sodium oxalate was added, and the mixture was then filtered. After adding strong hydrochloric acid (HCl) to 50 ml of the filtrate, it was left to stand for the entire night. Saturated NaOH solutions were used to offset the excess HCl. Using methyl blue as indicator, the hydrolyzed aliquot was placed in a burette and titrated with 5 ml of boiling solution containing Fehling 'A' and Fehling 'B' (AOAC 1980). The emergence of brick red colour served as a marker for the finish point, and the total sugar content (or glucose equivalent) was calculated in grams (g) of fresh mango pulp weight.

Titration of fruit pulp extracts with 0.1 N NaOH and phenolphthalein as an indicator was used to determine the acidity of the fruit, as described by AOAC (1980). The citric acid content in the pulp of fruit was used as a measure of the titratable acidity. The sample was prepared by taking 10 g of fruit pulp and grinding it properly. For titration, only 10 ml of the final solution was taken for the purpose of filtering into volumetric flasks and making up a final volume of 100 ml.

$$\text{Acidity} = \frac{\text{Titrated value} \times \text{Normality of NaOH} \times \text{Volume of madeup} \times 100}{\text{Aliquot} \times \text{Volume of sample} \times 100}$$

Statistical analysis of physical attributes and yield and yield was performed to examine the effect of different treatments. Analysis of variance was carried out using OP-STAT developed by CCSHAU, Hisar for all the observations recorded during the years. Fisher's test of significance was used to compare the difference between means at 5% probability level. Standard errors were calculated with significant differences at 5% significance to distinguish treatment effects from chance effects.

RESULTS AND DISCUSSION

In Table 1, the pooled data related to physiological weight loss indicate that physiological weight loss increased gradually over both years of experimentation. There was a minimum physiological loss of weight in T_3 (25.08%), which was statistically similar to the T_6 (25.92%) and T_4 (27.04%). The maximum physiological loss in weight was recorded in T_1 (34.06%). This is a result of the fact that efficient microbes can enhance soil quality, plant development, and crop output by producing phytohormones like auxins and other growth regulators that may have mimicked plant growth (Tripathi *et al.* 2017). *Panchagavya* treatment increased the presence of naturally occurring helpful and efficient microorganisms, mainly lactic acid bacteria, yeasts, actinomycetes, photosynthetic bacteria and some fungi. The enhanced nitrogen availability to the plant and its movement from the root to the blossom may be the cause of the improved fruit quality. Panda *et al.* (2020) also observed higher quality parameter, viz. chlorophyll carotenoids, TSS, ascorbic acid and lycopene under 3% *panchagavya* treatment. Similar observation were reported by Kumar and Dhawan (1995) and Kumar (1998) in mango.

The pooled data depicted in the Table 2 related to spoilage percentage revealed that during the both years of experimentation there is a gradual increase in spoilage percentage, the minimum spoilage percentage was recorded in T_3 (26.62%) which was statistically at par with the application of T_6 (27.55%) and T_7 (30.51%). The maximum spoilage percentage was recorded in T_1 (36.41%) which serve as control. Among the treatment presented, T_3 which contain FYM, organic mulch, *Panchagavya* and *Azotobacter*

Table 1 Effect of bio-enhancers and bio-fertilizers on the physiological loss in weight in mango during 2020–21 and 2021–22

Treatments	Physiological loss in weight (%)																				
	After 3 days			After 5 days			After 7 days			After 9 days			After 11 days			After 13 days			After 15 days		
	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled
T_1	4.42	4.61	4.51	8.36	8.46	8.41	13.13	14.33	13.73	17.91	18.24	18.07	22.69	23.67	23.18	28.06	28.10	28.08	34.03	34.09	34.06
T_2	3.14	4.05	3.59	7.87	8.10	7.99	12.59	13.32	12.96	16.79	16.06	16.43	20.47	20.91	20.69	24.66	24.84	24.75	29.36	30.42	29.89
T_3	2.44	3.42	2.93	6.69	6.83	6.76	10.71	11.23	10.97	14.28	13.38	13.83	17.41	17.06	17.24	20.98	20.74	20.86	24.56	25.59	25.08
T_4	2.87	3.83	3.35	7.17	7.21	7.19	11.48	11.84	11.66	15.30	14.45	14.88	18.65	18.75	18.70	22.95	21.90	22.43	26.98	27.09	27.04
T_5	3.75	4.11	3.93	8.05	8.23	8.14	12.88	13.53	13.20	17.18	16.47	16.82	20.94	21.53	21.23	25.77	25.61	25.69	30.62	31.13	30.88
T_6	2.78	3.56	3.17	6.96	7.04	7.00	11.14	11.57	11.35	14.80	14.02	14.41	18.09	17.92	18.01	21.81	21.47	21.64	25.52	26.31	25.92
T_7	3.02	3.95	3.49	7.56	7.68	7.62	12.12	12.63	12.44	16.17	15.41	15.79	19.66	19.92	19.79	23.69	23.69	23.69	28.24	29.07	28.66
SEM±	0.16	0.17	0.17	0.23	0.20	0.19	0.30	0.24	0.28	0.46	0.50	0.58	0.50	0.65	0.63	0.72	0.49	0.63	0.86	0.84	0.85
CD (p=0.05)	0.47	0.49	0.49	0.69	0.60	0.57	0.90	0.71	0.84	1.36	1.47	1.72	1.49	1.93	1.86	2.13	1.44	1.85	2.55	2.47	2.51

Treatment details are given under Materials and Methods.

Table 2 Effect of bio-enhancers and bio-fertilizers on the spoilage in mango during 2020–21 and 2021–22

Treatments	Spoilage (%)														
	After 7 days			After 9 days			After 11 days			After 13 days			After 15 days		
	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled
T_1	3.58	4.55	4.07	8.95	9.09	9.02	16.71	16.93	16.82	25.69	26.04	25.87	36.34	36.48	36.41
T_2	2.62	4.05	3.33	7.34	8.10	7.72	14.69	15.05	14.87	22.04	23.18	22.61	31.49	32.43	31.96
T_3	1.78	3.42	2.60	5.80	6.83	6.32	11.44	12.70	12.07	18.31	19.53	18.92	25.90	27.35	26.62
T_4	1.91	3.60	2.75	6.69	7.21	6.95	12.91	13.39	13.15	19.61	20.60	20.10	28.22	28.84	28.53
T_5	3.22	4.13	3.68	8.02	8.23	8.12	15.03	15.29	15.16	23.10	23.53	23.32	32.75	32.95	32.85
T_6	1.85	3.52	2.69	6.03	7.05	6.54	12.06	13.08	12.57	19.02	20.13	19.58	26.92	28.19	27.55
T_7	2.15	3.84	2.99	7.06	7.68	7.37	13.61	14.28	13.94	21.17	21.97	21.57	30.25	30.76	30.51
SEM±	0.101	0.104	0.100	0.344	0.210	0.236	0.543	0.324	0.446	0.611	0.535	0.615	1.048	0.606	0.921
CD (p=0.05)	0.299	0.307	0.297	1.01	0.621	0.698	1.603	0.955	1.317	1.804	1.581	1.815	3.091	1.789	2.719

Treatment details are given under Materials and Methods.

have many beneficial qualities. The results of present findings are confirmed by Kumar and Dhawan (1995), Kumar (1998), Singh and Narayan (1999) and Yadav *et al.* (2011) in mango.

The pooled data depicted in the Table 3 related to TSS revealed that during both years of experimentation there is a gradual increase in TSS, the maximum TSS was recorded in T_3 (20.02) which was statistically at par with the application of T_6 (19.68) and T_7 (18.77). The minimum TSS was recorded in T_1 (17.47) which serve as control. In addition to improving nutrient availability, these bio fertilizers may have improved fruit quality as a result of improving plants' ability to better absorb solute from the rhizosphere (Patel *et al.* 2012). Similar result obtained were 75% organic with 3% *Panchagavya* application resulted in highest TSS content in tomato (Muthukumar *et al.* 2019). Sahini and Khurdia (1989) also recorded similar results in mango.

The pooled data depicted in the Table 4 related to total sugar content revealed that during both years of experimentation there is a gradual increase in total sugar content, the maximum total sugar content was recorded in T_3 (18.21%) which was statistically at par with the application of T_6 (17.70%) and T_4 (17.18%). The lowest total sugar content was recorded in T_1 (15.04%) which served as control. This may be because the use of bio-amendments, bio-fertilizers, organic manure and straw mulch may have contributed to the increase in total sugar content. These soil fertility-improving measures include increased nutrient uptake and supply, higher concentrations of soil enzymes and microorganisms, rapid mineralization and transformation of plant nutrients in the soil, and increased production of growth-promoting substances by micro-organism. Similar findings were found in *Azotobacter* treatment on strawberry where they found a rise in TSS and total sugar levels because of the quick metabolic conversion of starch and pectin into soluble molecules and the speedy translocation of sugars from leaves to growing fruits (Tripathi *et al.* 2016). The findings of El-Moniem and Radwan (2003), Tripathi *et al.* (2015), Kumar *et al.* (2017) and Srinu *et al.* (2017) in guava are clarified by these data.

The pooled data depicted in the Table 5 related to titratable acidity content revealed that during both years of experimentation there is a gradual decrease in titratable acidity content. The minimum titratable acidity content was recorded in mango fruits which were treated with T_3 (0.16%) and was statistically at par with the application of T_6 (0.18%) and T_4 (0.21%). The maximum titratable acidity content (%) was recorded in T_1 (0.32%) which serve as a control. These results were in accordance to fact that the use of bio-enhancers and bio-fertilizers resulted in a decrease in the titratable acidity content of mango fruits. This reduction might be attributed to a favourable influence on the conversion of acids to sugars and their derivatives via processes in various microbes' glycolytic pathways, or it could be employed in respiration (Singh *et al.* 2018). Similar results also reported by Tripathi *et al.* (2016) who found increased quality and quantity of strawberry when

Table 3 Effect of bio-enhancers and bio-fertilizers on the TSS (°Brix) in mango during 2020–21 and 2021–22

Treatments	TSS (°Brix)																				
	After 3 days			After 5 days			After 7 days			After 9 days			After 11 days			After 13 days			After 15 days		
	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled
T_1	17.48	17.21	17.35	17.77	17.43	17.60	18.25	17.67	17.96	18.68	17.87	18.28	18.33	17.69	18.01	18.19	17.54	17.86	17.59	17.35	17.47
T_2	18.41	18.22	18.32	18.77	18.41	18.59	19.24	18.62	18.93	19.75	18.68	19.21	19.48	18.48	18.98	19.23	18.31	18.77	18.64	18.14	18.39
T_3	19.79	19.73	19.76	20.15	19.93	20.04	20.66	20.13	20.40	21.43	20.39	20.91	21.09	19.89	20.49	20.75	19.99	20.37	20.23	19.82	20.02
T_4	19.15	18.82	18.98	19.49	18.99	19.24	20.14	19.21	19.67	20.57	19.48	20.02	20.26	19.11	19.69	20.14	19.06	19.60	19.53	18.86	19.19
T_5	17.93	17.74	17.84	18.22	17.98	18.10	18.57	18.25	18.41	19.17	18.50	18.84	18.75	18.26	18.50	18.44	18.07	18.26	18.06	17.88	17.97
T_6	19.39	19.45	19.42	19.70	19.68	19.69	20.25	19.88	20.07	20.86	20.11	20.48	20.56	19.24	19.90	20.25	19.64	19.95	19.91	19.46	19.68
T_7	18.75	18.61	18.68	19.13	18.84	18.98	19.45	19.06	19.25	20.11	19.32	19.72	19.74	18.85	19.29	19.37	18.87	19.12	18.85	18.68	18.77
SEM±	0.30	0.33	0.36	0.28	0.35	0.34	0.22	0.32	0.34	0.34	0.35	0.33	0.36	0.29	0.31	0.27	0.35	0.31	0.28	0.36	0.33
CD (p=0.05)	0.89	0.96	1.05	0.83	1.03	0.99	0.64	0.94	0.99	0.99	1.02	0.97	1.05	0.87	0.93	0.79	1.04	0.91	0.83	1.06	0.97

Treatment details are given under Materials and Methods.

Table 4 Effect of bio-enhancers and bio-fertilizers on the total sugar content during 2020–21 and 2021–22

Treatments	Total sugar content (%)																				
	After 3 Days			After 5 Days			After 7 Days			After 9 Days			After 11 Days			After 13 Days			After 15 Days		
	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled
T_1	15.15	14.79	14.97	15.33	14.97	15.15	15.55	15.17	15.36	15.91	15.36	15.63	15.61	15.16	15.39	15.37	14.99	15.18	15.24	14.84	15.04
T_2	16.25	16.45	16.35	16.66	16.68	16.67	17.06	16.89	16.98	17.45	17.13	17.29	17.23	16.95	17.09	16.91	16.77	16.84	16.77	16.59	16.68
T_3	18.16	17.78	17.97	18.55	17.97	18.26	18.95	18.18	18.56	19.33	18.40	18.87	19.00	18.20	18.60	18.82	17.99	18.41	18.59	17.83	18.21
T_4	17.25	16.88	17.07	17.56	17.09	17.33	17.93	17.34	17.64	18.15	17.59	17.87	17.91	17.35	17.63	17.58	17.16	17.37	17.39	16.97	17.18
T_5	15.75	15.77	15.76	16.18	15.96	16.07	16.49	16.17	16.33	16.90	16.43	16.67	16.54	16.24	16.39	16.43	16.03	16.23	16.13	15.83	15.98
T_6	17.60	17.61	17.61	17.92	17.85	17.88	18.35	18.03	18.19	18.69	18.23	18.46	18.33	18.03	18.18	18.09	17.82	17.95	17.76	17.63	17.70
T_7	16.75	16.67	16.72	17.05	16.91	16.98	17.45	17.11	17.28	17.66	17.33	17.50	17.46	17.14	17.30	17.33	16.94	17.14	17.19	16.78	16.99
SEM±	0.44	0.34	0.32	0.35	0.31	0.37	0.44	0.34	0.38	0.43	0.32	0.39	0.44	0.31	0.37	0.45	0.31	0.38	0.43	0.34	0.38
CD (p=0.05)	1.29	1.01	0.94	1.03	0.91	1.09	1.30	1.01	1.12	1.26	0.94	1.15	1.28	0.92	1.10	1.33	0.92	1.12	1.26	1.00	1.11

Treatments details are given under Materials and Methods.

Table 5 Effect of bio-enhancers and bio-fertilizers on the titratable acidity content in mango during 2020–21 and 2021–22

Treatments	Titratable acidity content (%)																				
	After 3 Days			After 5 Days			After 7 Days			After 9 Days			After 11 Days			After 13 Days			After 15 Days		
	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled	2020–21	2021–22	Pooled
T_1	0.46	0.45	0.46	0.44	0.43	0.43	0.42	0.41	0.41	0.38	0.39	0.39	0.35	0.37	0.36	0.33	0.35	0.34	0.31	0.33	0.32
T_2	0.42	0.42	0.42	0.39	0.40	0.39	0.36	0.38	0.37	0.33	0.35	0.34	0.30	0.33	0.31	0.27	0.31	0.29	0.24	0.29	0.27
T_3	0.29	0.28	0.28	0.27	0.28	0.27	0.24	0.26	0.25	0.21	0.23	0.22	0.19	0.22	0.20	0.15	0.20	0.17	0.14	0.17	0.16
T_4	0.34	0.33	0.33	0.30	0.31	0.30	0.29	0.29	0.29	0.26	0.26	0.26	0.24	0.25	0.24	0.21	0.23	0.22	0.19	0.24	0.21
T_5	0.44	0.42	0.43	0.41	0.40	0.41	0.39	0.38	0.38	0.35	0.36	0.35	0.30	0.34	0.32	0.29	0.32	0.30	0.26	0.30	0.28
T_6	0.31	0.32	0.31	0.29	0.30	0.29	0.27	0.28	0.28	0.24	0.25	0.25	0.22	0.24	0.23	0.19	0.22	0.20	0.17	0.20	0.18
T_7	0.37	0.36	0.36	0.34	0.32	0.33	0.32	0.31	0.31	0.28	0.29	0.29	0.28	0.27	0.27	0.23	0.26	0.25	0.22	0.27	0.24
SEM±	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0.01	0.02	0.03	0.02	0.02	0.03	0.02	0.02
CD (p=0.05)	0.06	0.06	0.06	0.05	0.04	0.06	0.06	0.05	0.06	0.06	0.04	0.06	0.08	0.04	0.05	0.08	0.06	0.07	0.07	0.08	0.07

Treatments details are given under Materials and Methods.

applied with bio-enhancer and bio fertilizer. The application of bio-enhancer and bio-fertilizer also increased the quality and quantity of mango as reported by Kumar and Dhawan (1995) and Kumar (1998).

According to the findings, T_3 application significantly increased the TSS (°Brix) and total sugar content (%) after 3, 5, 7, 9, 11, 13, and 15 days. It also showed a significantly higher minimum PLW (%), titratable acidity content (%), and spoilage (%) after 7, 9, 11, 13 and 15 days, comparable to T_6 and T_4 application. Thus, it can be concluded that T_3 might be used in the subtropical plains of central Uttar Pradesh, India to extend mango shelf life while reducing physiological weight loss and fruit deterioration.

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