

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(8): 833-8396
www.biochemjournal.com
Received: 11-06-2026
Accepted: 15-07-2026

Asha
Ph.D. Scholar, Department of
Fruit Science, College of
Agriculture, Raipur,
Chhattisgarh, India

Deepthi Patel
Associate Professor,
Department of Fruit Science,
College of Agriculture, Raipur,
Chhattisgarh, India

Prabhakar Singh
Professor, Department of Fruit
Science, College of Agriculture,
Raipur, Chhattisgarh, India

GL Sharma
Professor, Department of Fruit
Science, College of Agriculture,
Raipur, Chhattisgarh, India

HK Panigrahi
Associate Professor,
Department of Fruit Science,
College of Agriculture, Raipur,
Chhattisgarh, India

SK Tamrakar
Assistant Professor,
Department of Floriculture
and Landscape Architecture,
College of Agriculture, Raipur
Indira Gandhi Agricultural
University, Raipur,
Chhattisgarh, India

Nupur Mandloi
Ph.D. Scholar, Department of
Fruit Science, College of
Agriculture, Raipur,
Chhattisgarh, India

Corresponding Author:
Asha
Ph.D. Scholar, Department of
Fruit Science, College of
Agriculture, Raipur,
Chhattisgarh, India

Effect of pre-harvest organic spray and bunch cover on biochemical attributes of banana (*Musa paradisiaca* L.) cv. grand naine

Asha, Deepthi Patel, Prabhakar Singh, GL Sharma, HK Panigrahi, SK Tamrakar and Nupur Mandloi

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i8Sj.9537>

Abstract

An experiment entitled “Effect of pre-harvest organic spray and bunch cover on biochemical attributes of banana (*Musa paradisiaca* L.) cv. Grand Naine” was conducted during 2024-25 and 2025-26 at the Research Field of the Commercial Tissue Culture Laboratory, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The results revealed that T₁₂ (Panchagavya 3% + BPE) recorded the maximum biochemical attributes viz., TSS (5.82, 6.01 and 5.92 °Brix), ascorbic acid (4.70, 4.66 and 4.68 mg/100 g), reducing sugar (5.55, 5.46 and 5.51%), non-reducing sugar (1.49, 1.60 and 1.55%), total sugar (7.04, 6.99 and 7.01%) and sugar : acid ratio (28.15, 29.13 and 28.64), with the minimum titratable acidity (0.25, 0.24 and 0.25%) followed by T₁₃ (Panchagavya 3% + WPE) and T₁₄ (Jeevamrutham 3% + BPE) during both the years and pooled mean respectively. The control (T₀) recorded comparatively lower biochemical quality attributes and higher titratable acidity.

Keywords: Cow urine, Vermiwash, Panchagavya, Jeevamrutham, organic spray and bunch cover

Introduction

Banana (*Musa paradisiaca* L.) is one of the most important fruit crops cultivated and consumed in tropical and subtropical regions. India is among the leading producers of banana and the crop is valued for its high productivity, year-round availability, nutritional importance and contribution to farmers' livelihoods. Among the commercial cultivars, ‘Grand Naine’ is widely cultivated due to its high yield potential, desirable bunch characteristics and good fruit quality.

Banana are a rich source of natural sugars, dietary fibre, potassium, vitamins and other essential nutrients. A 100 g edible portion provides approximately 89 kcal of energy, 21.8 g carbohydrates, 2 g dietary fibre, 385 mg potassium and 11.7 mg ascorbic acid, along with other essential nutrients (Rahman *et al.*, 2020) [9]. The biochemical composition of banana changes during fruit development and maturation, influencing fruit quality and subsequent ripening behaviour.

Banana exports are limited by several constraints, with both external and internal quality factors playing a key role in market acceptance. These quality attributes are largely influenced by pre-harvest practices. External characteristics such as colour, shape, size and freedom from defects are important for visual appeal, whereas internal qualities like taste, texture, sweetness, aroma, acidity, flavour, nutritional value and shelf life are crucial in determining export potential (Hewett, 2006; Shewfelt, 2009) [2, 14].

Pre-harvest practices greatly influence fruit development and biochemical composition. Organic formulations such as Cow urine, Vermi wash, Panchagavya and Jeevamrutham may improve physiological processes and fruit development through their nutrient and biologically active components. Similarly, bunch covering protects developing fruits from adverse environmental conditions and modifies the microclimate around the bunch, thereby influencing fruit growth and quality.

Although organic sprays and bunch covering are individually known to influence banana growth and fruit development, their combined application may provide complementary benefits by improving plant physiological processes and creating a favourable

microenvironment around the developing bunch. This may positively influence fruit development, biochemical composition and subsequent ripening behaviour. Therefore, the present study was undertaken to evaluate the effect of pre-harvest organic sprays and bunch covering on the biochemical attributes of banana (*Musa paradisiaca* L.) cv. Grand Naine.

Materials and Methods

The experiment was conducted during 2024-2025 and 2025-2026 at the Research Field of the Commercial Tissue Culture Laboratory, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). Biochemical analysis of banana fruit samples was carried out in the

Department of Fruit Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment was laid out in a Randomized Block Design (RBD) with 16 treatments and three replications. Five plants were maintained in each treatment, comprising a total of 240 plants at a spacing of 1.8 × 1.8 m using banana cv. Grand Naine. Uniform bunches were selected for the study. Denavelling was carried out one week after the emergence of the last hand. Thereafter, the respective pre-harvest organic sprays were applied to the bunches, followed by bunch covering with either blue or white polyethylene bags as per the treatments. The bunch covers were retained until harvest.

Treatment details

S. No.	Treatments	Notations
1.	Control (no spray + no bunch cover)	T ₀
2.	Water spray	T ₁
3.	Cow urine 10%	T ₂
4.	Vermi wash 10%	T ₃
5.	Panchagavya 3%	T ₄
6.	Jeevamrutham 3%	T ₅
7.	Water spray + BPE	T ₆
8.	Water spray + WPE	T ₇
9.	Cow urine 10% + BPE	T ₈
10.	Cow urine 10% + WPE	T ₉
11.	Vermi wash 10% + BPE	T ₁₀
12.	Vermi wash 10% + WPE	T ₁₁
13.	Panchagavya 3% + BPE	T ₁₂
14.	Panchagavya 3% + WPE	T ₁₃
15.	Jeevamrutham 3% + BPE	T ₁₄
16.	Jeevamrutham 3% + WPE	T ₁₅

Note: BPE - Blue polyethylene, WPE- White polyethylene

Total soluble solids (°Brix)

The pulp was extracted separately by passing it through a muslin cloth. The Total Soluble Solids (TSS) content was determined using an ERMA hand refractometer (0-32 °Brix) at room temperature and the values were expressed as °Brix.

Ascorbic acid (mg/100 ml)

Ascorbic acid content of banana pulp was determined

$$\text{Ascorbic acid} \left(\frac{\text{mg}}{100\text{g}} \right) = \frac{\text{Titre value} \times \text{Dye factor} \times \text{Volume made up}}{\text{Aliquot of extraction taken} \times \text{Volume of sample taken}} \times 100$$

Titrateable acidity (%)

Titrateable acidity of banana pulp was determined according to the method described by Ranganna (1986) [10]. The prepared sample was titrated against 0.1 N NaOH using

according to the method described by Ranganna (1986) [10] using 2,6-dichlorophenol-indophenol dye. The pulp extract was prepared in 3% metaphosphoric acid and titrated with the standard dye solution until a light pink end point was obtained. The ascorbic acid content was expressed as mg per 100 g pulp and calculated using the following formula:

phenolphthalein as an indicator until a persistent faint pink end point was obtained. The acidity was expressed as percentage (%) and calculated using the following formula:

$$\text{Acidity (\%)} = \frac{\text{Titrate} \times \text{Normality of alkali} \times \text{volume made up} \times \text{Equivalent weight of acid} \times 100}{\text{Vol. of sample taken for estimation} \times \text{Weight or volume of sample taken} \times 1000}$$

Reducing sugar

A 25 ml aliquot of filtered juice was transferred into a volumetric flask and diluted with 100 ml of distilled water. The solution was neutralized with an alkali solution, followed by the addition of 2 ml of lead acetate solution.

After thorough mixing and allowing the contents to stand for some time, 2 ml of potassium oxalate solution was added to obtain a clarified solution. Five millilitres each of Fehling's solution A and Fehling's solution B were taken in a conical flask. The burette was filled with the clarified

sample solution. The Fehling’s solution was heated over an open flame, and 2-5 ml of the sugar solution was added, followed by 1-2 drops of methylene blue indicator. The solution was heated intermittently while adding the sugar

solution until a brick-red end point was obtained. Reducing sugar was expressed as percentage (%) and calculated using the following formula:

Reducing sugar (%) =
$$\frac{\text{Mg of invert sugar} \times \text{Dilution} \times 100}{\text{Titrate value} \times \text{wt or volume of the sample} \times 1000}$$

Non-reducing sugar (%)

Non-reducing sugar was determined by subtracting the reducing sugar content from the total sugar content. The non-reducing sugar content was expressed as percentage (%).

Non – reducing sugar (%)
= Total sugar (%)
– Reducing sugar (%)

Total sugar (%)

Total sugar content was estimated according to the method described by Lane and Eynon (1923) [6]. Fruit juice (50 mL) was transferred to a 100 mL volumetric flask, mixed with 5 mL of concentrated HCl and kept at room temperature for 24 hours. The solution was then neutralized with NaOH using phenolphthalein as an indicator and the volume was made up to 100 ml. The prepared solution was titrated against a standard mixture of Fehling’s solutions A and B (1:1) using methylene blue as an indicator. The appearance of a brick-red colour was considered the endpoint.

Total sugar (%) =
$$\frac{\text{Fehling’s factor} \times \text{Vol. made up} \times 100}{\text{Titre value} \times \text{wt. of the sample taken}}$$

Sugar: Acid ratio

The sugar ratio was calculated by dividing the total sugar content by the titratable acidity according to the method described by Ranganna (1986) [10] and expressed as a ratio.

Results and Discussion

The results of the present investigation revealed that pre-harvest organic sprays and bunch cover significantly influenced the biochemical attributes of banana cv. Grand Naine. The data pertaining to the biochemical attributes recorded during 2024-25 and 2025-26 are presented in Tables 1 to 4.

Total soluble solids (°Brix)

Pre-harvest organic sprays and bunch cover significantly influenced the Total Soluble Solids (TSS) content of mature unripe banana fruits (Table 1). The highest TSS was recorded under T₁₂: Panchagavya 3% + BPE (5.82, 6.01 and 5.92 °Brix), which was statistically *at par* with T₁₃ (5.72, 5.86 and 5.79 °Brix) and T₁₄ (5.65, 5.74 and 5.70 °Brix). The lowest TSS was recorded under T₀: Control- no spray and no bunch cover (4.30, 4.41 and 4.35 °Brix) during 2024-25, 2025-26 and pooled mean, respectively. The higher TSS content under T₁₂ may be attributed to the combined effect of Panchagavya and blue polyethylene bunch cover, which possibly enhanced photosynthetic efficiency, assimilate production and their translocation towards the developing fruits. The improved accumulation of soluble carbohydrates and other soluble constituents during fruit development may have contributed to the increased TSS content. Similar findings were reported by Kumar *et al.* (2016) [5], Silpa *et al.* (2024) [15], Sahana (2020) [12], Ashutosh *et al.* (2024) [1] and Maksudan *et al.* (2024) [7].

Ascorbic acid (mg/100)

A significant variation in ascorbic acid content of mature unripe banana fruits was observed among the treatments due to the application of pre-harvest organic sprays and bunch cover (Table 1). Treatment T₁₂ (Panchagavya 3% + BPE) exhibited the highest ascorbic acid content with values of 4.70, 4.66 and 4.68 mg/100 g during 2024-25, 2025-26 and pooled mean, respectively, which was statistically comparable with T₁₄ (4.64, 4.59 and 4.62 mg/100 g) and T₁₃ (4.61, 4.52 and 4.56 mg/100 g). While, the minimum ascorbic acid content was recorded in T₀ (control: no spray and no bunch cover) with values of 3.23, 3.28 and 3.26 mg/100 g, respectively. The higher ascorbic acid content may be associated with enhanced metabolic activity and improved biosynthesis and retention of vitamin C during fruit development. Similar results were reported by Kumar *et al.* (2016) [5], Silpa *et al.* (2024) [15], Maksudan *et al.* (2024) [7] and Ashutosh *et al.* (2024) [1].

Table 1: Effect of pre-harvest organic spray and bunch cover on biochemical attributes of banana (*Musa paradisiaca* L.) cv. grand naine

Treatments	Total Soluble Solid (°Brix)			Ascorbic Acid (mg/100g)			Titratable Acidity (%)		
	2024-25	2025-26	Pooled	2024-25	2025-26	Pooled	2024-25	2025-26	Pooled
T ₀	4.30 ^b	4.41 ^d	4.35 ^d	3.23 ^d	3.28 ^b	3.26 ^d	0.37 ^a	0.39 ^a	0.38 ^a
T ₁	4.35 ^b	4.51 ^d	4.43 ^d	3.40 ^{cd}	3.36 ^b	3.38 ^d	0.38 ^a	0.37 ^a	0.38 ^a
T ₂	4.79 ^{ab}	4.93 ^{abcd}	4.86 ^{bcd}	3.87 ^{abcd}	3.94 ^{ab}	3.9 ^{abcd}	0.34 ^a	0.33 ^{ab}	0.34 ^{ab}
T ₃	4.82 ^{ab}	4.69 ^{cd}	4.75 ^{cd}	3.86 ^{abcd}	3.81 ^{ab}	3.84 ^{bcd}	0.35 ^a	0.34 ^a	0.35 ^a
T ₄	4.92 ^{ab}	4.99 ^{abcd}	4.96 ^{bcd}	4.08 ^{abcd}	4.00 ^{ab}	4.04 ^{abcd}	0.33 ^a	0.33 ^{ab}	0.33 ^b
T ₅	4.88 ^{ab}	4.78 ^{bcd}	4.83 ^{bcd}	3.81 ^{bcd}	3.85 ^{ab}	3.83 ^{cd}	0.34 ^a	0.35 ^a	0.34 ^{ab}
T ₆	5.12 ^{ab}	5.31 ^{abcd}	5.21 ^{abcd}	4.26 ^{ab}	4.20 ^{ab}	4.23 ^{abc}	0.31 ^{ab}	0.32 ^{ab}	0.31 ^{bc}
T ₇	5.10 ^{ab}	5.19 ^{abcd}	5.15 ^{abcd}	4.15 ^{abc}	4.17 ^{ab}	4.16 ^{abc}	0.32 ^a	0.36 ^a	0.34 ^{ab}
T ₈	5.58 ^a	5.38 ^{abcd}	5.48 ^{abc}	4.49 ^{ab}	4.43 ^a	4.46 ^{abc}	0.29 ^{ab}	0.29 ^b	0.29 ^{cd}
T ₉	5.34 ^{ab}	5.44 ^{abcd}	5.39 ^{abc}	4.42 ^{ab}	4.32 ^a	4.37 ^{abc}	0.30 ^{ab}	0.31 ^{ab}	0.30 ^{cd}
T ₁₀	5.28 ^{ab}	5.36 ^{abcd}	5.32 ^{abcd}	4.37 ^{ab}	4.39 ^a	4.38 ^{abc}	0.30 ^{ab}	0.30 ^{ab}	0.30 ^{cd}
T ₁₁	5.22 ^{ab}	5.27 ^{abcd}	5.24 ^{abcd}	4.31 ^{ab}	4.35 ^a	4.33 ^{abc}	0.31 ^{ab}	0.30 ^{ab}	0.31 ^{bc}
T ₁₂	5.82 ^a	6.01 ^a	5.92 ^a	4.70 ^a	4.66 ^a	4.68 ^a	0.25 ^b	0.24 ^b	0.25 ^g

T ₁₃	5.72 ^a	5.86 ^{ab}	5.79 ^{ab}	4.61 ^{ab}	4.52 ^a	4.56 ^{abc}	0.27 ^b	0.25 ^b	0.26 ^{fg}
T ₁₄	5.65 ^a	5.74 ^{abc}	5.70 ^{abc}	4.64 ^{ab}	4.59 ^a	4.62 ^{ab}	0.26 ^b	0.27 ^b	0.27 ^{ef}
T ₁₅	5.45 ^a	5.51 ^{abcd}	5.48 ^{abc}	4.57 ^{ab}	4.51 ^a	4.54 ^{abc}	0.28 ^{ab}	0.28 ^b	0.28 ^{de}
S.E(m)±	0.31	0.33	0.24	0.19	0.23	0.16	0.02	0.02	0.02
C.D. at 5%	0.91	0.94	0.70	0.54	0.65	0.47	0.07	0.06	0.04

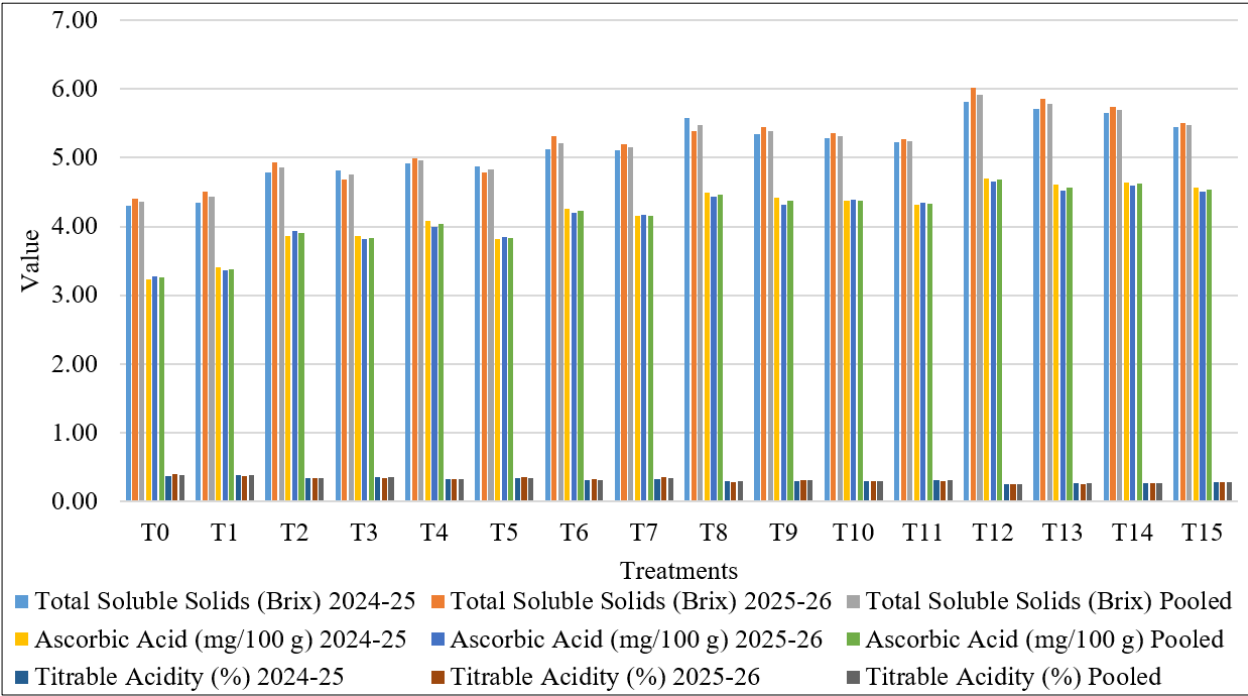


Fig 1: Effect of pre-harvest organic spray and bunch cover on biochemical attributes of banana (*Musa paradisiaca* L.) cv. grand naine

Titration acidity (%)

The titration acidity of mature unripe banana fruits was significantly influenced by pre-harvest organic sprays and bunch cover treatments (Table 2). The highest titration acidity was recorded under T₀ (control: no spray and no bunch cover) (0.37, 0.39 and 0.38%), which remained statistically *at par* with T₁: Water spray (0.38, 0.37 and 0.38%) and T₃ (0.35, 0.34 and 0.35%) during 2024-25, 2025-26 and pooled mean, respectively. The lowest titration acidity was recorded under T₁₂: Panchagavya 3% + BPE (0.25, 0.24 and 0.25%), respectively. The reduction in titration acidity may be attributed to the utilization of organic acids as respiratory substrates during fruit maturation. Similar findings were reported by Maksudan *et al.* (2024) [7] and Ashutosh *et al.* (2024) [1] in banana under blue polyethylene bunch cover.

Reducing sugar (%)

The reducing sugar content of mature unripe banana fruits showed significant variation among the treatments due to the application of pre-harvest organic sprays and bunch cover (Table 2). Treatment T₁₂ (Panchagavya 3% + BPE) recorded the highest reducing sugar content (5.55, 5.46 and 5.51%) during 2024-25, 2025-26 and pooled mean, respectively, which was found statistically *at par* with treatments T₁₄ (5.48, 5.47 and 5.48%) and T₁₃ (5.35, 5.36 and 5.36%). Nevertheless, the minimum reducing sugar content was observed under T₀ (control: no spray and no bunch cover) with values of 4.20, 4.15 and 4.17%, respectively. The increased reducing sugar content may be associated with enhanced carbohydrate metabolism and the conversion of complex carbohydrates into simpler sugars during fruit development. Similar findings were reported by

Islam *et al.* (2019) [3], Jangid *et al.* (2021) [4], Silpa *et al.* (2024) [15], Sahana (2020) [12], Ashutosh *et al.* (2024) [1] and Maksudan *et al.* (2024) [7].

Non-reducing sugar (%)

The non-reducing sugar content of mature unripe banana fruits was significantly affected by pre-harvest organic sprays and bunch cover treatments (Table 3). The highest non-reducing sugar content was recorded under T₁₂ (Panchagavya 3% + BPE) (1.49, 1.60 and 1.55%) during 2024-25, 2025-26 and pooled mean, respectively, which was statistically equivalent with treatments T₁₃ (1.57, 1.53 and 1.55%) and T₁₅ (1.20, 1.30 and 1.25%). The lowest non-reducing sugar content was observed under T₀ (control: no spray and no bunch cover) with values of 0.89, 0.87 and 0.88%, respectively. The increased non-reducing sugar content may be attributed to improved carbohydrate metabolism and enhanced accumulation of soluble sugars during fruit development. Similar findings were reported by Meena *et al.* (2016) [8], Sahana (2020) [12], Ashutosh *et al.* (2024) [1] and Maksudan *et al.* (2024) [7].

Total sugar (%)

The total sugar content of mature unripe banana fruits varied significantly among the treatments under the influence of pre-harvest organic sprays and bunch cover treatments (Table 3). Treatment T₁₂ (Panchagavya 3% + BPE) recorded the highest total sugar content with values of 7.04, 6.99 and 7.01% during 2024-25, 2025-26 and pooled mean, respectively, which was statistically *at par* with T₁₃ (6.92, 6.96 and 6.94%) and T₁₄ (6.68, 6.70 and 6.69%). Conversely, the lowest total sugar content was observed under T₀ (control: no spray and no bunch cover) with values

of 5.09, 5.02 and 5.06%, respectively. The increased total sugar content may be attributed to enhanced carbohydrate metabolism and greater conversion of starch into soluble sugars during fruit development. Similar findings were

reported by Silpa *et al.* (2024) ^[15], Samantaray (2015) ^[13], Rubel *et al.* (2019) ^[11], Sahana (2020) ^[12], Ashutosh *et al.* (2024) ^[1] and Maksudan *et al.* (2024) ^[7] in banana under bunch cover.

Table 2: Effect of pre-harvest organic spray and bunch cover on biochemical attributes of banana (*Musa paradisiaca* L.) cv. grand naine

Treatments	Reducing sugar (%)			Non-reducing sugar			Total sugar		
	2024-25	2025-26	Pooled	2024-25	2025-26	Pooled	2024-25	2025-26	Pooled
T ₀	4.20 ^e	4.15 ^f	4.17 ^d	0.89 ^c	0.87 ^c	0.88 ^c	5.09 ^e	5.02 ^d	5.06 ^g
T ₁	4.23 ^{de}	4.24 ^{ef}	4.24 ^d	0.94 ^{bc}	0.87 ^c	0.91 ^c	5.17 ^e	5.11 ^d	5.14 ^g
T ₂	4.34 ^{cde}	4.32 ^{cdef}	4.33 ^{cd}	0.98 ^{bc}	1.09 ^{abc}	1.04 ^c	5.32 ^{de}	5.41 ^{cd}	5.37 ^{fg}
T ₃	4.36 ^{cde}	4.27 ^{def}	4.32 ^{cd}	1.01 ^{bc}	1.03 ^{abc}	1.02 ^c	5.37 ^{cde}	5.3 ^{cd}	5.34 ^{fg}
T ₄	4.45 ^{bcde}	4.55 ^{abcdef}	4.50 ^{bcd}	1.03 ^{abc}	0.88 ^c	0.95 ^c	5.47 ^{cde}	5.43 ^{cd}	5.45 ^{efg}
T ₅	4.38 ^{cde}	4.39 ^{bcdef}	4.39 ^{cd}	1.02 ^{abc}	0.97 ^{bc}	1.00 ^c	5.4 ^{cde}	5.36 ^{cd}	5.38 ^{fg}
T ₆	4.61 ^{abcde}	4.59 ^{abcdef}	4.60 ^{bcd}	1.09 ^{abc}	1.07 ^{abc}	1.08 ^{a c}	5.70 ^{bcde}	5.66 ^{bcd}	5.68 ^{defg}
T ₇	4.56 ^{abcde}	4.43 ^{abcdef}	4.50 ^{bcd}	1.05 ^{abc}	1.17 ^{abc}	1.11 ^{abc}	5.61 ^{bcde}	5.6 ^{bcd}	5.60 ^{efg}
T ₈	5.27 ^{abcd}	5.29 ^{abcde}	5.28 ^{ab}	1.30 ^{abc}	1.14 ^{abc}	1.22 ^{abc}	6.57 ^{ab}	6.43 ^{ab}	6.50 ^{abc}
T ₉	5.04 ^{abcde}	5.26 ^{abcde}	5.15 ^{abc}	1.28 ^{abc}	1.23 ^{abc}	1.26 ^{abc}	6.32 ^{abc}	6.49 ^{ab}	6.41 ^{abcd}
T ₁₀	5.16 ^{abcde}	5.17 ^{abcdef}	5.17 ^{abc}	1.00 ^{bc}	1.08 ^{abc}	1.04 ^c	6.16 ^{abcd}	6.25 ^{abc}	6.20 ^{bcde}
T ₁₁	4.99 ^{abcde}	5.08 ^{abcdef}	5.04 ^{abcd}	1.10 ^{abc}	1.06 ^{abc}	1.08 ^{a c}	6.09 ^{abcde}	6.14 ^{abc}	6.11 ^{cdef}
T ₁₂	5.55 ^a	5.46 ^{ab}	5.51 ^a	1.49 ^{ab}	1.60 ^a	1.55 ^a	7.04 ^a	6.99 ^a	7.01 ^a
T ₁₃	5.35 ^{abc}	5.36 ^{abc}	5.36 ^{ab}	1.57 ^a	1.53 ^{ab}	1.55 ^{ab}	6.92 ^a	6.96 ^a	6.94 ^{ab}
T ₁₄	5.48 ^{ab}	5.47 ^a	5.48 ^a	1.20 ^{abc}	1.23 ^{abc}	1.21 ^{abc}	6.68 ^a	6.70 ^a	6.69 ^{abc}
T ₁₅	5.23 ^{abcde}	5.33 ^{abcd}	5.28 ^{ab}	1.20 ^{abc}	1.30 ^{abc}	1.25 ^{abc}	6.46 ^{ab}	6.63 ^a	6.54 ^{abc}
S.E(m)±	0.29	0.30	0.20	0.08	0.09	0.06	0.26	0.25	0.18
C.D. at 5%	0.83	0.85	0.57	0.23	0.25	0.18	0.76	0.72	0.53

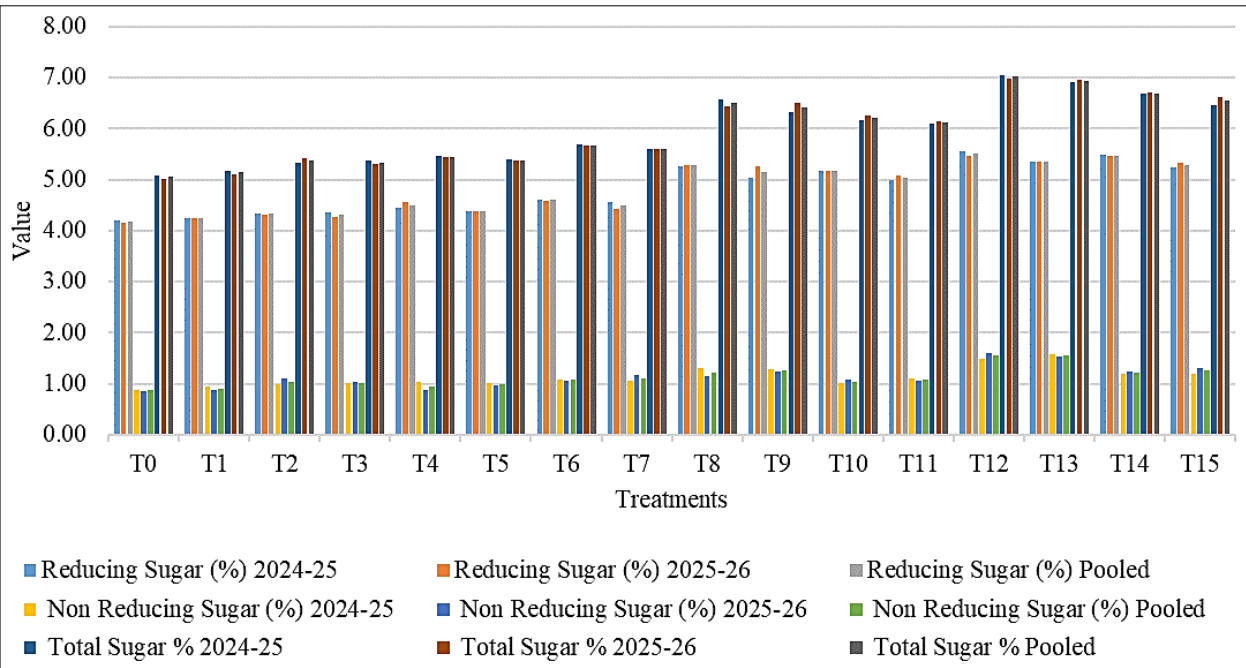


Fig 2: Effect of pre-harvest organic spray and bunch cover on biochemical attributes of banana (*Musa paradisiaca* L.) cv. grand naine

Sugar: Acid ratio

The sugar: acid ratio of mature unripe banana fruits showed significant differences among the treatments receiving different organic sprays and bunch cover treatments (Table 4). The highest sugar: acid ratio was recorded under T₁₂ (Panchagavya 3% + BPE) with values of 28.15, 29.13 and 28.64 during 2024-25, 2025-26 and pooled mean, respectively, which was statistically similar to the treatment

T₁₄ (25.69, 24.81 and 25.25) and T₁₃ (25.63, 27.84 and 26.73). However, the minimum sugar: acid ratio was observed under T₀ (12.87 and 13.25) during 2025-26 and pooled mean, respectively. The higher sugar: acid ratio may be attributed to increased sugar accumulation coupled with reduced titratable acidity during fruit development. Similar results were reported by Maksudan *et al.* (2024) ^[7] in banana under bunch covering condition.

Table 3: Effect of pre-harvest organic spray and bunch cover on sugar: acid ratio of banana (*Musa paradisiaca* L.) cv. Grand Naine

Treatments	Sugar: Acid ratio		
	2024-25	2025-26	Pooled
T ₀	13.63 ^j	12.87 ^j	13.25 ⁱ
T ₁	13.61 ^j	13.81 ^{ij}	13.71 ⁱ
T ₂	15.66 ⁱ	16.39 ^{ef}	16.03 ^h
T ₃	15.35 ^{ij}	15.59 ^{fg}	15.47 ^h
T ₄	16.58 ^{hi}	16.45 ^{ef}	16.52 ^{gh}
T ₅	15.88 ^{hi}	15.31 ^{fghi}	15.59 ^h
T ₆	18.39 ^{fg}	17.69 ^e	18.04 ^g
T ₇	17.53 ^{gh}	15.56 ^{fgh}	16.55 ^{gh}
T ₈	22.66 ^{cd}	22.17 ^{cd}	22.42 ^{de}
T ₉	21.07 ^{de}	20.94 ^d	21.01 ^{ef}
T ₁₀	20.53 ^e	20.83 ^d	20.68 ^f
T ₁₁	19.65 ^{ef}	20.47 ^d	20.06 ^f
T ₁₂	28.15 ^a	29.13 ^a	28.64 ^a
T ₁₃	25.63 ^b	27.84 ^a	26.73 ^b
T ₁₄	25.69 ^b	24.81 ^b	25.25 ^c
T ₁₅	23.07 ^c	23.68 ^{bc}	23.37 ^d
S.E(m)±	0.95	0.98	0.73
C.D. at 5%	2.74	2.82	2.10

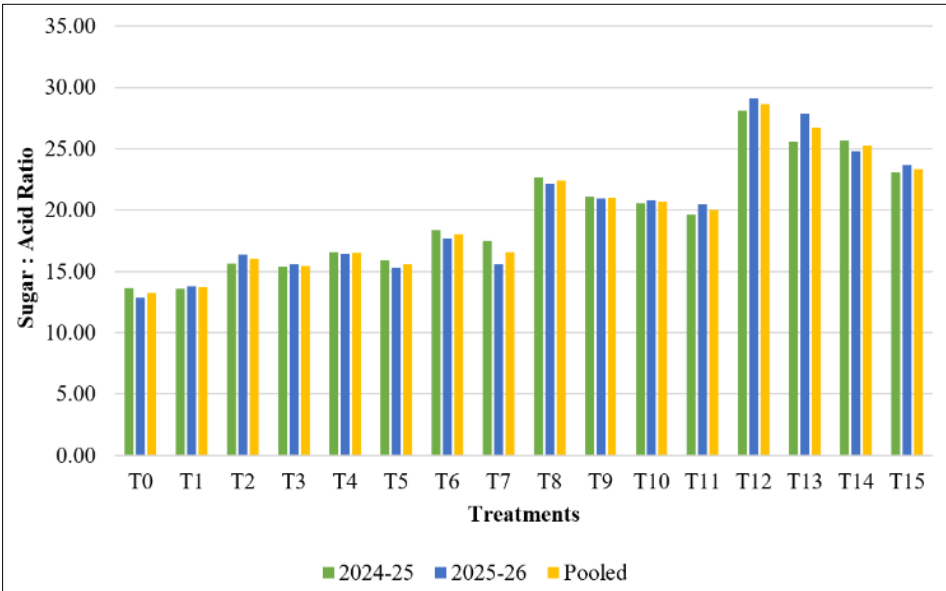


Fig 3: Effect of pre-harvest organic spray and bunch cover on sugar: acid ratio of banana (*Musa paradisiaca* L.) cv. grand naine

Conclusion

The study revealed that pre-harvest organic sprays and bunch covering significantly influenced the biochemical attributes of banana cv. Grand Naine. Among the treatments, T₁₂ (Panchagavya 3% + Blue polyethylene bunch cover) showed superior performance by improving fruit quality attributes and reducing acidity. The favourable effect of Panchagavya combined with blue bunch cover enhanced fruit quality by promoting better biochemical changes during fruit development. Therefore, T₁₂ (Panchagavya 3% + BPE) can be considered an effective organic management approach for improving the biochemical quality of banana fruits.

References

1. Ashutosh, Sahu GD, Singh P, Maksudan. Effect of different bunch covering materials for improving fruit yield and quality of banana (*Musa paradisiaca* L.). Int J Adv Biochem Res. 2024;8(5):93-96.

2. Hewett EW. An overview of pre-harvest factors influencing post-harvest quality of horticultural products. Int J Postharvest Technol Innov. 2006;1:4-15.

3. Islam TM, Shamsuzzoha M, Rahman MS, Bari MA, Akter M, Khatun A, et al. Effect of bagging time on fruit quality and shelf life of mango (*Mangifera indica* L.) cv. Langra in Bangladesh. Int J Agric Environ Res. 2019;4(4):2456-2463.

4. Jangid T, Rathore RS, Naqvi AR, Yadav PK. Study the effect of different fruit bunch covering materials on bird's damage, yield and quality of date palm cv. Halawy in Western Rajasthan. Sugar Tech. 2021;23(4):933-940.

5. Kumar M. Improvement of flowering, yield and quality attributes in acid lime (*Citrus aurantifolia* Swingle) by exogenous application of plant nutrition. Am J Exp Agric. 2016;14(1):1-5.

6. Lane JH, Eynon L. Determination of reducing sugar by Fehling's solution with methylene blue as internal indicator. J Soc Chem Ind. 1923;40(32):32-42.
7. Maksudan, Patel D, Sahu GD, Gauraha A. Response of covering materials and bunch feeding on quality attributes of banana (*Musa paradisiaca* L.) cv. Grand Naine. Plant Arch. 2024;24(2):1608-1614.
8. Meena KR, Maji S, Kumar S, Parihar D, Meena DC. Effect of bagging on fruit quality of guava (*Psidium guajava* L.). Int J Bio-resour Stress Manag. 2016;7(2):330-333.
9. Rahman M, Hossain TB, Hossain MS, Sattar S, Das PC. Effect of banana peel extract on storage stability of banana cv. Sagar. Food Res. 2020;4(2):488-494.
10. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. New Delhi: Tata McGraw-Hill Publishing Company; 1986.
11. Rubel MHK, Hossain MM, Hafiz MMH, Rahman MM, Khatun MR. Effect of banana bunch covering technology for quality banana production in Bangladesh. Prog Agric. 2019;30(3):238-252.
12. Sahana BJ, Madaiah D, Shivakumar BS, Sridhara S, Pradeep S. Influence of organic manures on growth, yield and quality of strawberry (*Fragaria* × *ananassa* Duch.) under naturally ventilated polyhouse. J Pharmacogn Phytochem. 2020;9(5):3284-3287.
13. Samantaray A. Effect of bunch sleeves on bunch characteristics and fruit quality of banana. Bhubaneswar (India): Orissa University of Agriculture and Technology; 2015. p. 75.
14. Shewfelt RL. Measuring quality and maturity. In: Florkowski WJ, Shewfelt RL, Brueckner B, Prussia SE, editors. Postharvest handling: A systems approach. London: Academic Press; 2009. p. 461-481.
15. Silpa R, Pandey AK, Parmar VK, Gurjar T, Raj D, Dubey PK. Effect of post-shooting spray of organics and bunch cover on yield of banana. Prog Hortic. 2024;56(1):46-47.