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RESPONSE OF COVERING MATERIALS AND BUNCH FEEDING ON QUALITY ATTRIBUTES OF BANANA (*MUSA PARADISIACA* L.) CV. GRAND NAINE

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ABSTRACT

The present study was conducted during 2022–2023 and 2023–2024 at the College of Agriculture, IGKV, Raipur, with the objective to know the response of covering materials and bunch feeding on the quality attributes of banana (*Musa paradisiacal* L.) cv. Grand Naine. The bunch feeding was done after the completion of the female phase. The distal stalk of the banana bunch was fed with different nutrient sources like urea, sulphate of potash, banana special, and organic manure forms like cow dung and cow urine with banana bunch covering materials and compared with the control (without bunch feeding and bunch covering materials). The results revealed that the treatment T_{19} *i.e.*9 g Urea + 9 g SOP + 500 g Cow dung +0.2% Banana Special + BPE recorded significantly maximum quality parameters *viz.*, total soluble solids (23.22, 22.38 and 22.80 °Brix), ascorbic acid (6.60, 6.36 and 6.48 mg / 100 g), titratable acidity (0.25, 0.23 and 0.24 %), reducing sugar (17.70, 17.06 and 17.38 %), non-reducing sugar (3.20, 3.08 and 3.14 %), total sugar (20.90, 20.14 and 20.52 %) and sugar : acid ratio (87.55, 83.45 and 85.50) followed by T_{20} *i.e* 9 g Urea + 9 g SOP + 500 g Cow dung +0.2 % Banana Special + WPE during both the years as well as in pooled data respectively.

Keywords; Cowurine, Urea, Sulphate of potash, Banana bunch feeding and covering materials.

Introduction

Banana (*Musa paradisiaca* L.) is a familiar fruit of India. From its native south-western Pacific home, the banana plant spreads to India by about 600 B.C. and later on, it spreads all over the tropical world. It is probably the world's oldest cultivated crop, as its domestication and cultivation date back to the dawn of human civilization. Banana is one of the major fruit crops in the tropics and subtropics and makes a vital contribution to the economies of a number of countries. It is very important for the nutrition of the local population as well as for tradable commodities with a large market throughout the developed world.

In India, banana ranks first position in production among all fruits. Banana is grown in all over India and is available round the year. However, Tamil Nadu, Andhra Pradesh, Maharashtra, Gujarat, Karanataka, Madhya Pradesh and Bihar have ideal condition for its growth and production.

With around 25.7% of the worldwide banana production, India is the world's top banana grower harvest of 113.28 million tonnes bananas. Banana is grown on5.49 million ha around the world, with global yield of 113.28 million tonnes and a yield of 20.62 MT/ha (Anon., 2018). India is the world's leading banana producer, accounting for 25.7 % of global production and ranking first in both region and production. Bananas occupy 883.8 thousand ha of India's total fruit cropland, producing 25.51 million tonnes with a total productivity of 34.9 t/ha.Chhattisgarh is one of the States, where bananas are grown on an area of 26.57 thousand hectares, with an annual production of 745.78 million tonnes and an estimated productivity of 28.07 MT/ha (Anon., 2018). Bananas, on the other hand, have a high export opportunity. Banana exports are now being directed to markets such as the Russian Federation, China and Eastern Europe. India exports bananas to countries in the Middle East.

The rate of nutrient uptake in bananas reduces after shooting and increases throughout the fruit's peak growth phases. To produce high yields, the banana plant is fed nutrients through the soil, foliage, de-navelling (removal of the male inflorescence for nutrient diversion), and post-shoot feeding through the distal stalk-end of the rachis. The quantity and quality of the developing bunch of fruits are influenced by the plant's nutrient status and the unhindered movement of nutrients to it. The fertilizers injected to the soil may be significantly lost due to soil characteristics and environmental variables, resulting in a lack of nutrients available after shooting to satisfy the growing bunch's nutrient needs. Consequently, bunch feeding of nutrients offers a significant opportunity not just for the effective utilization of nutrients but also to safeguard the economy of the farmer by improving the yield potential and quality of the produce. The procedure is said to be crucial for raising the fruit's yield and marketability. During harvest and transportation, bunch covers shield the fruit's surface from predatory birds, wind, cold, thrips, leaf and petiole scarring beetles, dust, light hail, sunburn and handling damage. Additionally, fruit from sleeved bunches has been demonstrated to have a considerably lower incidence of postharvest anthracnose disease. Better fruit quality and an increase in marketable output are the overall effects of using bunch covers; in India, it is also customary practise to cover bunches with dried leaves.

Materials and Methods

The experiment was conducted in the PFDC at the Department of Fruit Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya Raipur, during the years 2022-2023 and 2023-2024. The experiment was conducted on bananas of *cv*. Grand Naine with 25 treatments and three replications in a randomized block design (RBD). The land was ploughed twice, harrowed to bring the soil to a fine tilt, and leveled. The uniform pits of 60 cm^3 were dug out according to the plan of layout and recommended spacing (1.8m × 1.8m). All the cultural practices, like weeding, de-suckering, irrigation and plant protection, were taken up in timely intervals. For bunch stalk feeding, uniform bunches from each treatment were selected. Rachis at the distal end of the bunch were excised along with male buds, giving a slant cut. (De-navelling by excision of the rachis 10 cm after the last hand) Immediately after all the pistillate (female) flowers had set fruit, *i.e*., after four bracts were shed (about 15 days after flower emergence). The prepared 7.5g of urea, 7.5 g of sulphate of potash and 0.2 g banana special were dissolved in 100 ml water prepared in100 ml solution containing 500 g of fresh cowdung was poured in a thick polythene bag and tied securely by dipping the excised rachis and bunch cover blue polyethylene (BPE), white polyethylene (WPE) and maintained till harvest.

Total soluble solids (°Brix):-

The pulp was extracted separately through muslin cloth and total soluble solids (TSS) was determined by using Erma Hand Refractometer (0-32 degree Brix) at 20°C and the mean values were expressed in degree Brix. The refractometer was lightly folded over and looked through the parts with a light-facing projection inlet. It was noted that the line of shades interacts with the un-shaded area of the scale. The sample chamber was cleaned with smooth muslin cloth after every use. The reading was taken at room temperature.

Ascorbic acid (mg/100 g)

In a pestle mortar, a known weight of finely chopped flesh was properly combined with 15 ml 3% meta-phosphoric acid. The contents were put into a 100 ml volumetric flask after macerating, and the volume was made up to the mark with 3% metaphosphoric acid. A known volume of 2, 6-Dichlorophenolindophenol dye solution was heated to a pink end point that lasted 15 seconds (Ranganna, 1997).

The following formula was used to calculate ascorbic acid in fruit pulp:

$$\frac{\text{Titre} \times \text{Dye} \times \text{Volume made up} \times 100}{\text{Aliquot of extract taken for estimation} \times \text{Weight or volume of sample for estimation}}$$

Titratable acidity

The acidity of fruit pulp was determined by the procedure given by Ranganna (1997). Total acid content was estimated by titrating 10 g of fruit pulp against 0.1 N NaOH using phenolphthalein as an indicator. The end point appeared as light pink colour.

The following formula was used to calculate titratable acidity in fruit pulp:

$$\text{Acidity} = \frac{\text{Titre} \times \text{Normality of alkali} \times \text{Volume made up} \times \text{Equivalent wt. of acid} \times 100}{\text{Volume of sample taken for estimation} \times \text{Weight of volume of sample} \times 1000}$$

Total sugar (%)

Estimation Fifty ml clarified sugar solution was added to 5 g of citric acid with fifty ml distilled water. It was boiled slowly for 10 minutes, cooled and transferred into a 250 ml volumetric flask and neutralized with 0.1 N NaOH with phenolphthalein indicator and made up to the volume. Titre was expressed as per cent reducing sugars.

Treatment combination

S.	Treatments	Notations
1.	Control	T_0
2.	7.5 g Urea + 7.5 g SOP + 500 g Cow dung + BPE	T_1
3.	7.5 g Urea + 7.5 g SOP + 500 g Cow dung + WPE	T_2
4.	8 g Urea + 8 g SOP + 500 g Cow dung + BPE	T_3
5.	8 g Urea + 8 g SOP + 500 g Cow dung + WPE	T_4
6.	8.5 g Urea + 8.5 g SOP + 500 g Cow dung + BPE	T_5
7.	8.5 g Urea + 8.5 g SOP + 500 g Cow dung + WPE	T_6
8.	9 g Urea + 9 g SOP + 500 g Cow dung + BPE	T_7
9.	9 g Urea + 9 g SOP + 500 g Cow dung + WPE	T_8
10.	5% Cow urine + 500 g Cow dung + BPE	T_9
11.	5% Cow urine + 500 g Cow dung + WPE	T_{10}
12.	10% Cow urine + 500 g Cow dung + BPE	T_{11}
13.	10% Cow urine + 500 g Cow dung + WPE	T_{12}
14.	7.5 g Urea + 7.5 g SOP + 500 g Cow dung + Banana Special (0.2%) + BPE	T_{13}
15.	7.5 g Urea + 7.5 g SOP + 500 g Cow dung + Banana Special (0.2%) + WPE	T_{14}
16.	8 g Urea + 8 g SOP + 500 g Cow dung + Banana Special (0.2%) + BPE	T_{15}
17.	8 g Urea + 8 g SOP + 500 g Cow dung + Banana Special (0.2%) + WPE	T_{16}
18.	8.5 g Urea + 8.5 g SOP + 500 g Cow dung + Banana Special (0.2 %) + BPE	T_{17}
19	8.5 g Urea + 8.5 g SOP + 500 g Cow dung + Banana Special (0.2 %) + WPE	T_{18}
20.	9 g Urea + 9 g SOP + 500 g Cow dung + Banana Special (0.2%) + BPE	T_{19}
21.	9 g Urea + 9 g SOP + 500 g Cow dung + Banana Special (0.2%) + WPE	T_{20}
22.	5% Cow urine + 500 g Cow dung + Banana Special (0.2%)+ BPE	T_{21}
23	5% Cow urine + 500 g Cow dung + Banana Special (0.2%) + WPE	T_{22}
24.	10% Cow urine + 500 g Cow dung + Banana Special (0.2%) + BPE	T_{23}
25.	10% Cow urine + 500 g Cow dung + Banana Special (0.2%) + WPE	T_{24}

Total sugar (%) = Reducing sugar (in which the titre was obtained after inversion) + % sucrose

Reducing sugar (%)

Estimation A predetermined amount of filtered juice was transferred to a volumetric flask, along with the same amount of distilled water and an alkali solution to neutralise it. A predetermined amount of lead acetate solution was added to this solution, shaken and allowed to stand for a while before adding thenecessary amount of potassium oxalate solution. This procedure was required in order to obtain a clarified solution.

Five ml Fehling's solution "A" and Fehling's solution "B" each was taken in a conical flask. Burette was filled with the sugar solution. Conical flask was heated in an open flame. Two to four ml of sugar solution was poured and 1-2 drop of methylene blue indicator was added. Now, this solution was kept for heating and sugar solution was added to it. The end point appeared with brick red colour. The reducing sugar was expressed in per cent and calculated by following formula:

$$\text{Reducing sugar (\%)} = \frac{\text{Mg of Invert Sugar} \times \text{Dilution} \times 100}{\text{Titre} \times \text{Wt. or volume of the sample taken} \times 100}$$

Non- reducing sugar (%)

Non-reducing sugar was determined by subtracting the value of reducing sugar from total sugar and final value was calculated.

$$\text{Non-reducing sugar (\%)} = \text{Total sugar (\%)} - \text{Reducing sugar (\%)}$$

Sugar: Acid ratio

The sugar : acid ratio was computed by dividing the sugar by the acidity of the fruit and the mean value was reported as a ratio.

Results and Discussion

The fruit quality traits during both years 2022-23 and 2023-24 of different treatments are mentioned in Table 1 and 2, which revealed a significant variation in fruit quality attributestotal soluble solids (°Brix), ascorbic acid (mg / 100 g), titratable acidity (%), reducing sugar (%), non-reducing sugar (%), total sugar (%) and sugar : acid ratio among treatments.

Total soluble solids (°Brix)

Total soluble solids (TSS) is a prime factor which determines the quality of fruits could be attributed to the hydrolysis of insoluble starch into soluble sugars. In the present investigation total soluble solids of the banana fruits recorded significantly differs among the different treatments. The total soluble solids varied from 18.30°B to 22.80°B in different treatments. The TSS content was significantly higher in T_{19} - 9 g Urea + 9 g SOP + 500 g Cow dung +0.2% Banana Special + BPE (23.22, 22.38 and 22.80°B) which was found statistically non-significant

Table 1: Response of covering materials and Bunch Feeding on Quality Attributes of Banana (*Musa paradisiaca* L.) cv. Grand Naine.

Treat-ments	Total soluble solids (°Brix)			Ascorbic acid (mg / 100 g)			Titratable acidity (%)			Reducing sugar (%)		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	22-23	23-24	Pooled	22-23	23-24	Pooled
T_{0}	18.64^{h}	17.96^{g}	18.3^{g}	4.18^{g}	4.02^{g}	4.1^{j}	0.36^{a}	0.34^{a}	0.35^{a}	14.57^{e}	14.03^{e}	14.3^{d}
T_{1}	21.89^{abcde}	22.71^{ab}	22.3^{abcd}	5.15^{bcde}	5.35^{bc}	5.25^{bcdefg}	0.28^{bcd}	0.3^{abcde}	0.29^{abcde}	16.44^{abcd}	17.06^{abc}	16.75^{abc}
T_{2}	21.84^{abcdef}	22.66^{ab}	22.25^{abcd}	5.13^{bcde}	5.33^{bcd}	5.23^{bcdefg}	0.29^{bcd}	0.31^{abcd}	0.3^{abcde}	16.43^{abcd}	17.05^{abc}	16.74^{abc}
T_{3}	22.61^{abcde}	21.79^{abcdef}	22.2^{abcde}	5.3^{bcde}	5.1^{bcdef}	5.2^{bcdefgh}	0.31^{abcd}	0.29^{abcdef}	0.3^{abcde}	17.01^{abc}	16.39^{abcd}	16.7^{abc}
T_{4}	22.31^{abcde}	21.49^{abcdef}	21.9^{abcdef}	5.19^{bcde}	5.01^{cdef}	5.1^{bcdefghi}	0.32^{abc}	0.3^{abcde}	0.31^{abcd}	16.99^{abc}	16.37^{abcd}	16.68^{abc}
T_{5}	21.35^{cdefg}	22.15^{abcde}	21.75^{abcdef}	4.91^{def}	5.09^{bcdef}	5^{bcdefghi}	0.3^{abcd}	0.32^{abc}	0.31^{abcd}	16.34^{bcd}	16.96^{abcd}	16.65^{abc}
T_{6}	22.1^{abcde}	21.3^{bcdef}	21.7^{abcdef}	5.07^{cdef}	4.89^{def}	4.98^{cdefghi}	0.32^{abc}	0.3^{abcde}	0.31^{abcd}	16.81^{abcd}	16.19^{bcd}	16.5^{abc}
T_{7}	22.03^{abcde}	22.87^{ab}	22.45^{abc}	5.2^{bcde}	5.4^{bc}	5.3^{bcdef}	0.28^{bcd}	0.3^{abcde}	0.29^{abcde}	16.54^{abcd}	17.16^{ab}	16.85^{abc}
T_{8}	22.82^{abcd}	21.98^{abcdef}	22.4^{abcd}	5.37^{bcd}	5.17^{bcde}	5.27^{bcdef}	0.3^{abcd}	0.28^{abcdef}	0.29^{abcde}	17.11^{abc}	16.49^{abcd}	16.8^{abc}
T_{9}	21.14^{defg}	20.36^{f}	20.75^{cdef}	4.89^{ef}	4.71^{f}	4.8^{ghi}	0.33^{ab}	0.31^{abcd}	0.32^{abc}	16.28^{cd}	15.68^{d}	15.98^{bc}
T_{10}	21.09^{defg}	20.31^{f}	20.7^{def}	4.84^{ef}	4.66^{f}	4.75^{hi}	0.33^{ab}	0.31^{abcd}	0.32^{abc}	16.25^{cd}	15.65^{d}	15.95^{c}
T_{11}	20.12^{fgh}	20.88^{cdef}	20.5^{ef}	4.63^{fg}	4.81^{ef}	4.72^{i}	0.31^{abcd}	0.33^{ab}	0.32^{abc}	15.6^{de}	16.2^{bcd}	15.9^{c}
T_{12}	19.92^{gh}	20.68^{def}	20.3^{f}	4.61^{fg}	4.79^{ef}	4.7^{i}	0.33^{ab}	0.33^{ab}	0.33^{ab}	15.56^{de}	16.14^{bcd}	15.85^{c}
T_{13}	23.12^{abc}	22.28^{abcde}	22.7^{ab}	5.55^{b}	5.35^{bc}	5.45^{b}	0.27^{bcd}	0.25^{def}	0.26^{cde}	17.7^{a}	17.06^{abc}	17.38^{a}
T_{14}	23.1^{abc}	22.26^{abcde}	22.68^{ab}	5.52^{bc}	5.32^{bcd}	5.42^{bc}	0.28^{bcd}	0.26^{cdef}	0.27^{bcde}	17.62^{ab}	16.98^{abcd}	17.3^{ab}
T_{15}	22.23^{abcde}	23.07^{a}	22.65^{ab}	5.3^{bcde}	5.5^{b}	5.4^{bcd}	0.26^{cd}	0.28^{abcdef}	0.27^{bcde}	16.98^{abc}	17.62^{a}	17.3^{ab}
T_{16}	23.02^{abc}	22.18^{abcde}	22.6^{ab}	5.48^{bc}	5.28^{bcd}	5.38^{bcd}	0.29^{bcd}	0.27^{bcdef}	0.28^{bcde}	17.27^{abc}	16.63^{abcd}	16.95^{abc}
T_{17}	22.13^{abcde}	22.97^{ab}	22.55^{ab}	5.25^{bcde}	5.45^{bc}	5.35^{bcde}	0.27^{bcd}	0.29^{abcdef}	0.28^{bcde}	16.59^{abcd}	17.21^{ab}	16.9^{abc}
T_{18}	22.08^{abcde}	22.92^{ab}	22.5^{ab}	5.22^{bcde}	5.42^{bc}	5.32^{bcde}	0.27^{bcd}	0.29^{abcdef}	0.28^{bcde}	16.57^{abcd}	17.19^{ab}	16.88^{abc}
T_{19}	23.22^{a}	22.38^{abc}	22.8^{a}	6.6^{a}	6.36^{a}	6.48^{a}	0.25^{d}	0.23^{f}	0.24^{e}	17.7^{a}	17.06^{abc}	17.38^{a}
T_{20}	23.17^{ab}	22.33^{abcd}	22.75^{ab}	6.52^{a}	6.28^{a}	6.4^{a}	0.26^{cd}	0.24^{ef}	0.25^{de}	17.69^{a}	17.05^{abc}	17.37^{a}
T_{21}	21.1^{defg}	21.9^{abcdef}	21.5^{abcdef}	4.86^{ef}	5.04^{cdef}	4.95^{defghi}	0.3^{abcd}	0.32^{abc}	0.31^{abcd}	16.09^{cd}	16.71^{abcd}	16.4^{abc}
T_{22}	20.9^{efg}	21.7^{abcdef}	21.3^{abcdef}	4.83^{ef}	5.01^{cdef}	4.92^{efghi}	0.3^{abcd}	0.32^{abc}	0.31^{abcd}	16^{cd}	16.6^{abcd}	16.3^{abc}
T_{23}	21.65^{abcdefg}	20.85^{cdef}	21.25^{abcdef}	4.99^{def}	4.81^{ef}	4.9^{efghi}	0.33^{ab}	0.31^{abcd}	0.32^{abc}	16.4^{bcd}	15.8^{cd}	16.1^{abc}
T_{24}	21.39^{bcdefg}	20.61^{ef}	21^{bcdef}	4.94^{def}	4.76^{ef}	4.85^{fghi}	0.33^{ab}	0.31^{abcd}	0.32^{abc}	16.3^{cd}	15.7^{d}	16^{bc}
SE(m)±	**0.52**	**0.49**	**0.50**	**0.13**	**0.13**	**0.13**	**0.01**	**0.01**	**0.01**	**0.37**	**0.39**	**0.38**
C.D. at 5%	**1.49**	**1.41**	**1.44**	**0.39**	**0.37**	**0.38**	**0.02**	**0.02**	**0.02**	**1.07**	**1.11**	**1.09**

at par with T_{20}- 9 g Urea + 9 g SOP + 500 g Cow dung +0.2% Banana Special + WPE (23.17, 22.33 and 22.75°B) and also with all the other treatments except T_{24}. The lowest TSS of 18.64, 17.96 and 18.30°B was recorded in T_{0}–Control during both the year and pooled data, respectively. Increase in TSS due to potash when supplied exogenously increased the flow of plant assimilates into the developing fruits especially when assimilate flow from other parts of plant becomes limited in bananareported that Kumar and Kumar (2002), Kumar *et al*., (2011), Pathak *et al*., (2011), Shira *et al*., (2013), Khalashi *et al*., (2021) and Sathish *et al*., (2021),

Ascorbic acid (mg/100 g)

The results pertaining to the effect of bunch covering materials and bunch feeding nutrients on the ascorbic acid content of fruit differed among the treatments. The treatment T_{19} - 9 g Urea + 9 g SOP + 500 g Cow dung +0.2 % Banana Special + BPE has recorded the significantly highest ascorbic acid content (6.60, 6.36 and 6.48 mg/100 g) which was found statistically non-significant at par T_{20}- 9 g Urea + 9 g SOP + 500 g Cow dung +0.2% Banana Special + WPE (6.52, 6.28 and 6.40 mg/100g), whereas T_{1} (Control) recorded the lowest ascorbic acid content (4.18, 4.02 and 4.10 mg/100 g) during both the year and pooled data, respectively. Increased ascorbic acid content in the fruits might be due to potassium and sulphur could have helped to slow down the enzyme system that encouraged the oxidation of ascorbic acid, thus helping the plants to accumulate more ascorbic acid content in the fruits. The high energy status in crops well supplied with potassium also promotes synthesis of secondary metabolites, like vitamin C. The results of the investigation are in close conformity with the finding of Mengel (1997), Ananthi *et al*., (2004) and Shira *et al*., (2013).

Titratable acidity(%)

With regard to titratable acidity of banana treatment T_{19} (9 g Urea + 9 g SOP + 500 g Cow dung +0.2%

Table 2: Response of covering materials and Bunch Feeding on Quality Attributes of Banana (*Musa paradisiaca* L.) cv. Grand Naine.

Treat-ments	Non-reducing sugar (%)			Total Sugar (%)			Sugar : Acid ratio		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
T_{0}	2.07^{l}	1.99^{l}	2.03^{g}	16.63^{f}	16.03^{g}	16.33^{d}	47.77^{j}	45.53^{k}	46.65^{j}
T_{1}	2.6^{defgh}	2.7^{def}	2.65^{bc}	19.04^{bcde}	19.76^{abcdef}	19.4^{abc}	65.29^{fg}	68.49^{ef}	66.89^{fg}
T_{2}	2.56^{defghi}	2.66^{defg}	2.61^{bcd}	18.99^{bcde}	19.71^{abcdef}	19.35^{abc}	62.96^{gh}	66.04^{fg}	64.5^{gh}
T_{3}	2.48^{efghi}	2.38^{hij}	2.43^{de}	19.49^{abcde}	18.77^{bcdef}	19.13^{abc}	65.29^{fg}	62.23^{ghi}	63.76^{gh}
T_{4}	2.26^{jkl}	2.18^{kl}	2.22^{fg}	19.25^{bcde}	18.55^{cdef}	18.9^{bc}	62.42^{gh}	59.5^{hij}	60.96^{hi}
T_{5}	2.19^{kl}	2.27^{jk}	2.23^{fg}	18.53^{cde}	19.23^{abcdef}	18.88^{bc}	59.44^{hi}	62.36^{gh}	60.9^{hi}
T_{6}	$2.39^{g ijk}$	2.31^{ijk}	2.35^{ef}	19.2^{bcde}	18.5^{def}	18.85^{bc}	62.25^{gh}	59.35^{hij}	60.8^{hi}
T_{7}	2.6^{defg}	2.7^{def}	2.65^{bc}	19.14^{bcde}	19.86^{abcde}	19.5^{abc}	65.63^{fg}	68.85^{ef}	67.24^{fg}
T_{8}	2.7^{d}	2.6^{efg}	2.65^{bc}	19.81^{abc}	19.09^{abcdef}	19.45^{abc}	68.66^{ef}	65.46^{fg}	67.06^{fg}
T_{9}	2.72^{d}	2.62^{efg}	2.67^{bc}	19^{bcde}	18.3^{f}	18.65^{c}	59.67^{hi}	56.89^{j}	58.28^{i}
T_{10}	2.7^{d}	2.6^{efg}	2.65^{bc}	18.95^{bcde}	18.25^{f}	18.6^{c}	59.51^{hi}	56.73^{j}	58.12^{i}
T_{11}	2.67^{de}	2.77^{cde}	2.72^{b}	18.27^{de}	18.97^{abcdef}	18.62^{c}	56.79^{i}	59.57^{hij}	58.18^{i}
T_{12}	2.7^{d}	2.8^{cde}	2.75^{b}	18.25^{e}	18.95^{abcdef}	18.6^{c}	55.01^{i}	57.71^{hij}	56.36^{i}
T_{13}	3.13^{ab}	3.01^{ab}	3.07^{a}	20.83^{a}	20.07^{abc}	20.45^{a}	80.53^{bc}	76.77^{bc}	78.65^{bc}
T_{14}	3.06^{ab}	2.94^{abc}	3^{a}	20.68^{a}	19.92^{abcd}	20.3^{ab}	76.98^{cd}	73.38^{cde}	75.18^{cd}
T_{15}	2.75^{cd}	2.85^{bcd}	2.8^{b}	19.73^{abcd}	20.47^{a}	20.1^{abc}	72.66^{de}	76.22^{bcd}	74.44^{cde}
T_{16}	3.06^{ab}	2.94^{abc}	3^{a}	20.32^{ab}	19.58^{abcdef}	19.95^{abc}	72.95^{de}	69.55^{ef}	71.25^{def}
T_{17}	2.94^{bc}	3.06^{a}	3^{a}	19.53^{abcde}	20.27^{ab}	19.9^{abc}	69.37^{ef}	72.77^{cde}	71.07^{def}
T_{18}	2.62^{def}	2.72^{def}	2.67^{bc}	19.19^{bcde}	19.91^{abcd}	19.55^{abc}	68.15^{ef}	71.49^{de}	69.82^{ef}
T_{19}	3.2^{a}	3.08^{a}	3.14^{a}	20.9^{a}	20.14^{ab}	20.52^{a}	87.55^{a}	83.45^{a}	85.5^{a}
T_{20}	3.17^{a}	3.05^{a}	3.11^{a}	20.86^{a}	20.1^{abc}	20.48^{a}	83.88^{ab}	79.96^{ab}	81.92^{ab}
T_{21}	2.38^{ijk}	2.48^{ghi}	2.43^{de}	18.48^{cde}	19.18^{abcdef}	18.83^{bc}	59.29^{hi}	62.19^{ghi}	60.74^{hi}
T_{22}	2.45^{fghij}	2.55^{fgh}	2.5^{cde}	18.45^{cde}	19.15^{abcdef}	18.8^{bc}	59.19^{hi}	62.09^{ghi}	60.64^{hi}
T_{23}	2.7^{d}	2.6^{efg}	2.65^{bc}	19.1^{bcde}	18.4^{def}	18.75^{c}	59.99^{hi}	57.19^{ij}	58.59^{i}
T_{24}	2.75^{cd}	2.65^{defg}	2.7^{bc}	19.05^{bcde}	18.35^{ef}	18.7^{c}	59.83^{hi}	57.03^{j}	58.43^{i}
SE(m)±	**0.06**	**0.06**	**0.06**	**0.42**	**0.45**	**0.44**	**1.62**	**1.55**	**1.58**
C.D. at 5%	**0.18**	**0.17**	**0.17**	**1.22**	**1.29**	**1.25**	**4.62**	**4.42**	**4.52**

Banana Special recorded minimum acidity (0.25, 0.23 and 0.24%) while the maximum acid percentage (0.36,0.34 and 0.35 %) was recorded in T_0 (control) during both the year and pooled data, respectively. High potassium levels in fruits were found to reduce acidity by diverting phosphoenolpyruvate (PEP) into alternate pathways, leading to a shortage of acetyl co-A. This process resulted intheaccumulation of oxaloacetate, a less acidic derivative. Additionally, theneutralizationof organic acids due to high potassium levels and increased metabolism from acid-to-sugars conversion contributed to the overall reduction in fruit acidity. The results were in close conformity with those reported by Hasan *et al*., (2007), Patel *et al*., (2010), Millik *et al*., (2017), Sreekanth *et al*., (2018) and Sahu (2019).

Reducing sugar (%)

The maximum reducing sugars (17.70, 17.06 and 17.38 %) were observed on bunch feeding of banana treatment T_{19} (9 g Urea + 9 g SOP + 500 g Cow dung +0.2%Banana Special + BPE which was statistically non-significant at par with T_{20}- 9 g Urea + 9 g SOP + 500 g Cow dung +0.2% Banana Special + WPE (17.69, 17.05 and 17.37 %). Control exhibited the minimum reducing sugars (14.57, 14.03 and 14.30 %) during both the year and pooled data, respectively. Increase in reducing sugar content might be due to the removal of male bud, application of cow dung and potassium to the distal stalk end of bunches which significantly improved the reducing sugar content of the fruits. The results of the present investigation are in close conformity with the finding of Ancy and Kurien (2000), Kurien *et al*., (2000), Singh (2001), Shira *et al*., (2012), Vivela *et al*., (2013), Sreekanth *et al*., (2018) and Sahu (2019).

Non-reducing sugar (%)

As indicated in Table 2, the maximum value of non-reducing sugar (3.20, 3.08 and 3.14 %) was recorded by treatment T_{19} (9 g Urea + 9 g SOP + 500 g Cow dung +0.2% Banana Special + BPE. It was statistically non-significant at par with T_{20}- 9 g Urea + 9 g SOP + 500 g Cow dung +0.2% Banana Special + WPE (3.17, 3.05

and 3.11%). Whereas, minimum non-reducing sugars (2.07, 1.99 and 2.03%) was recorded with control during both the year and pooled data, respectively. Bunch feeding increased the non-reducing sugars content in banana fruits which is in close agreement with the findings of Vivela *et al*., (2013) and Sreekanth *et al*., (2018).

Total sugar (%)

The data presented in Table 2 indicated that there is significant variation among the treatments. The maximum total sugar (20.90, 20.14 and 20.52%) was recorded in T_{19} (9 g Urea + 9 g SOP + 500 g Cow dung +0.2% Banana Special +BPE which was statistically non-significant at par with T_{20}- 9 g Urea + 9 g SOP + 500 g Cow dung +0.2% Banana Special + WPE (20.86, 20.10 and 20.48%). Whereas, minimum total sugars (16.63, 16.03 and 16.33%) was recorded with control during both the year and pooled data, respectively. Potassium is involved in phloem loading and unloading of sucrose and amino acids which stores in the developing fruits in the form of starch. Application of K_2SO_4 was found to be good in increasing sugar percent as potassium plays a major role in synthesis of carbohydrate and protein, breakdown and translocation of organic acids. The potassium when supplied in the form of K_2SO_4 favors conversion of starch into simple sugars during ripening of fruits by activating the sucrose synthetase enzyme, thus resulting in higher sugar percentage. Enhanced quality of fruits particularly the sugar content might be due to the role of sulphate (SO_4) ions released from sulphate of potash as sulphate favoured, while chloride reduced, the activity of anabolic enzymes and resulted in accumulation of highly polymerized carbohydrates (starch), which would have subsequently disintegrated into sugars on ripening. The similar finding were also reported by Kumar and Kumar (2002), Alagarsamy and Neelakandan (2008), Kumar *et al*., (2008) and Nandankumar *et al*., (2011).

Sugar: Acid ratio

From the above context, it could be recalled that the control treatment which recorded the highest acid percentage (0.35 %) also showed the lowest total sugar percentage (16.33 %). Meanwhile, the maximum sugar to acid ratio (87.55, 83.45 and 85.50) was obtained in treatment T_{19} - (9 g Urea + 9 g SOP + 500 g Cow dung +0.2% Banana Special + BPE while the minimum sugar to acid ratio (47.77, 45.53 and 46.65) was recorded in T_0 (control) during both the year and pooled data, respectively. Potassium determines fruit quality by affecting the reducing sugars, non-reducing sugars and total sugars. As potassium supply increases, the sugars to acid ratio increases because of increase in sugars as well as decrease in acidity. The results were in close agreement with the finding of Vadivelu and Shanmugavelu (1978), Hasan *et al*., (2007), Shira *et al*., (2013), Millik *et al*., (2017) and Sathish *et al*., (2021).

Conclusion

On the basis of two year study, it is concluded that the application of 9 g Urea + 9 g SOP + 500 g Cow dung + Banana Special (0.2%) + BPE per bunch was found significantly superior over remaining treatment combinations in terms of quality attributes (TSS, Ascorbic acid, titratable acidity, reducing sugars, non-reducing sugars, total sugar and sugar to acid ratio).

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