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Effect of hand trimming and bunch feeding on quality parameters of banana cv. Grand Naine

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Abstract
A field experiment was conducted during the year 2018-19 and 2019-20 at Instructional Farm, ACHF, and Soil and Water Management Research Unit Navsari Agricultural University, Navsari (Gujarat) to assess the effect of hand trimming and bunch feeding on quality parameters of banana cv. Grand Naine. The investigation comprised of ten treatments and each treatment was repeated thrice in CRD. The treatments *viz*. Control (T_1), KNO_3 1% without trimming (T_2), KNO_3 2% without trimming (T_3), SOP 1.5% without trimming (T_4), SOP 2.0% without trimming (T_5), KNO_3 1% with trimming of one apical hand (T_6), KNO_3 2.0% with trimming of one apical hand (T_7), SOP 1.5% with trimming of one apical hand (T8), SOP 2.0% with trimming of one apical hand (T_9) and 300g cowdung slurry + 10g SOP +20g ammonium sulphate (T_{10}) were imposed on banana plants of cultivar 'Grand Naine'. Banana bunch feeding with 300g cow dung slurry + 10g SOP + 20g ammonium sulphate recorded the maximum pulp: peel ratio, TSS, reducing sugars, total sugars, ascorbic acid and shelf life in pooled study. Further, maximum non reducing sugars and minimum acidity content was recorded in SOP 1.5% without trimming and KNO_3 2.0% without trimming, respectively in pooled analysis.

Keywords: Banana, hand trimming, bunch feeding, fruit yield, bunch weight

Introduction
Banana (Musa spp.) often considered as the "Queen of Tropical Fruits" is cultivated by humans since prehistoric times. Banana which belongs to the family Musaceae in the order Scitamineae is now one of the most important fruit crop in the world. It grows well in humid tropical low lands and is predominantly distributed between 300 N and 300 S of equator. Banana is at the forefront in the fight against malnutrition because of its year round availability and affordability to all sections of the society. It contains about 71.3 g moisture, 26.56 g carbohydrate, 1.08 g protein, 0.11 g fibres, 5 mg calcium, 0.49 mg iron, 18 mg phosphorous, 494 mg potassium, 5.1 mg ascorbic acid, 0.044 mg thiamin, 0.045 mg riboflavin and 88 IU vitamin A per 100 g edible portion (Milik *et al.*, 2018) [1]. It is also used as dessert fruit by millions of people and can be used as staple food due to its rich and easily digestible carbohydrates. Owing to its multifaceted uses from underground stem up to the male flower, it is referred as Kalpatharu.

In India, Andhra Pradesh, Gujarat, Maharashtra, Tamil Nadu and Karnataka are the leading banana producing states. In India, it is cultivated over an estimated area of 0.883 million hectares with 30.80 million tonnes of production and a productivity of 34.9 MT/ha. Total export of banana is 101.31 thousand MT valued at Rs. 34877.39 lakh (Anon., 2018) [2]. Gujarat is the second leading producer of banana next to Andhra Pradesh in the country contributing 14.51 percent of total banana production. The state accounts for about 4627.52 thousand MT of the total production from an area of 69.54 thousand hectares with a productivity of 66.54 MT/ha in the country (Anon., 2020) [3].

Nutrient play a significant role in boosting production and promoting quality of fruits. Banana takes up major nutrients in great quantities during peak growth phase and after shooting the rate of nutrient uptake slows down. Nutrients at the shooting stage affects bunch size and quality of banana. Among the several factors affecting fruit quality, adequate nutrients specially nitrogen and potassium application is considered to be of major importance in banana cultivation (Tandon and Sekhon, 1988) [4].

Manipulation of fruit size in banana bunches to meet market demand is vital for realizing maximum profitability which is done by hand trimming and bunch feeding with nutrients. Hand trimming is the removal of the distal one or two hands on banana bunches soon after fruit setting for the purpose of increasing the length of fingers on the remaining hands and to

obtain better prices of the fruit. Bunch feeding with urea and sulphate of potash with cow dung had positive effects on bunch parameters. Addition of sulphate of potash to the blend increased potash content and thereby enhanced fruit yield as well as associated parameters. Tying urea at the rachis promoted bunch yield and hand weight because it increased the availability of urea in aqueous form at later stages for a prolonged period (Kotur *et al.*, 2014) [5].

Therefore, it was felt necessary to investigate the potential impact of Cow dung, KNO3, SOP and ammonium sulphate placement at the cut stalk end on growth and yield attributes in banana cv. Grand Naine.

Materials and Methods

About the Location

The present investigation was carried out at Instructional Farm (2018-19), ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari and Soil and Water Management Research Unit (2019-2020), NAU, Navsari. It is situated on the coast of Arabian Sea at 20º57′ N latitude and 72º54′ E longitude at an altitude of about 11.83m above the mean sea level.

Treatment details

The experiment was laid out in Completely Randomized Design with 10 treatments and 3 repetitions. The treatments comprised Control (T_1), KNO_3 1% without trimming (T_2), KNO_3 2% without trimming (T_3), SOP 1.5% without trimming (T_4), SOP 2.0% without trimming (T_5), KNO_3 1% with trimming of one apical hand (T_6), KNO_3 2.0% with trimming of one apical hand (T_7), SOP 1.5% with trimming of one apical hand (T_8), SOP 2.0% with trimming of one apical hand (T_9) and 300g cowdung slurry + 10g SOP +20g ammonium sulphate (T_{10}).

Methodology of bunch feeding

The methodology involved de-navelling the stalk of the distal/lower hand of the banana bunch after bunch formation by cutting the stalk with a sharp knife keeping about 15 cm long stalk. Plastic bag of 200 guage thickness and 15 cm × 25 cm size was used for bunch feeding. The plastic bag was tied to the stalk with a strong thread in such a way that 8 to 10 cm of the denavelled end remained immersed in the solution.

Result and Discussion

The changes in chemical parameters like TSS (ºBrix), reducing sugars (%), total sugars (%), non-reducing sugars (%), pulp: peel ratio, titrable acidity (%), ascorbic acid (mg/100 g) and shelf life (days) of fruits due to the imposition of treatments were estimated at ripening of fruits and are presented in this section. Bunch feeding treatments and hand trimming has a significant influence on all the above mentioned parameters except acidity. For the sake of brevity, only pooled data is presented and discussed in this paper.

Total Soluble Solids (TSS)

The data with respect to TSS of banana cv. Grand Naine as influenced by various treatments of bunch feeding with and without trimming of one apical hand are presented in Table 1. Treatment T_{10} i.e. bunch feeding of 300g cow dung + 10g SOP + 20g ammonium sulphate recorded the highest value of TSS (21.14ºbrix) in pooled results. This treatment was at par with T_8 (20.64ºbrix), T_4 (20.37ºbrix) and T_9 (20.28ºbrix). The minimum total soluble solids (18.25ºbrix) was noted in control during the investigation. Sulphate (SO_4) ions released from sulphate of potash favour, while chloride reduces, the activity of anabolic enzymes, resulting in accumulation of highly polymerized carbohydrates (starch), which would have subsequently disintegrated into sugars on ripening. Shira *et al*. (2012) [6], Vivela *et al*. (2013) [7], Kotur (2015) [8] and Sahu (2019) [9] had also observed higher TSS with bunch feeding. That TSS content increased by trimming of one apical hand finds support from El-Kholy (2017) [10].

Reducing sugars

The mean data of reducing sugars in banana fruits as affected by different treatments of bunch feeding with and without trimming of one apical hand are presented in Table 1. The maximum reducing sugars (7.29 %) were observed on bunch feeding of 300g cow dung + 10g SOP + 20g ammonium sulphate which was statistically at par with T_9 (7.19 %), T_8 (7.19 %), T_7 (7.08 %), T_5 (7.06 %), T_2 (6.81 %) and T_3 (6.78 %) treatments. Control exhibited the minimum reducing sugars (6.19 %). Higher reducing sugars with bunch feeding was earlier reported by Shira *et al*. (2012) [6], Vivela *et al*. (2103) [7], Sreekanth *et al*. (2018) [11] and Sahu (2019) [9].

Total sugars

With regard to total sugars content of banana fruit, treatment T_{10} registered the highest values (18.04 %) in pooled data. It was statistically at par with treatments T_5 (18.00 %), T_8 (18.90 %), T_4 (17.60 %) and T_9 (17.33 %). The lowest value of total sugars content (14.78 %) was observed in control. This can be attributed to the fact that potassium plays a major role in carbohydrate synthesis, breakdown and translocation and synthesis of protein and neutralization of physiologically important organic acids. Further, sulphate (SO_4) ions released from sulphate of potash favours, while chloride reduces, the activity of anabolic enzymes, resulting in accumulation of highly polymerized carbohydrates (starch), which would have subsequently disintegrated into sugars on ripening. Potassium is involved in phloem loading and unloading of sucrose and amino acid, and storage in the form of starch in developing fruits by activating the enzyme starch synthase (Mengel and Kirkby 1987) [12]. In plants supplied with potassium, the osmotic potential of the phloem sap and the volume flow are higher than in bunches with low K supply, and as a result, sucrose concentration in content of fruit is increased. (Marschner 1995) [13]. This is in line with the findings of Shira *et al*. (2012) [6], Vivela *et al*. (2013) [7] and Sreekanth *et al*. (2018) [11].

Non-reducing sugars

As indicated in Table 1, the maximum value of non-reducing sugar (11.00 %) was recorded by treatment T_4. It was statistically on the same bar with T_5 (10.94 %), T_8 (10.41 %), T_{10} (10.75 %) and T_9 (10.14 %). Whereas, minimum non-reducing sugars (8.42 %) was recorded with control. Bunch feeding increased the non-reducing sugars content in banana fruits which is in close agreement with the findings of Vivela *et al*. (2013) [7] and Sreekanth *et al*. (2018) [11].

Pulp: Peel ratio

The data pertaining to the effect of various treatments of bunch feeding with and without trimming of one apical hand on pulp: peel ratio of banana fruits are presented in Table 2. The highest pulp: peel ratio (3.51) was noted with T_{10} (300g cow dung + 10g SOP + 20g ammonium sulphate) treatment.

This treatment was statistically at par with T_8 (3.50) and T_7 (3.34) in pooled analysis. Further, lowest pulp: peel ratio (2.70) was recorded with control during the investigation. Higher pulp: peel ratio with bunch feeding was also reported by Kotur (2015) [8], Sreekanth *et al*. (2018) [11], Soumya *et al*. (2018) [14] and Sahu (2019) [6]. Trimming of one apical hand too resulted in higher pulp: peel ratio which is in consonance with reports by Wanichkal and Boonma (2009) [15] and Sarkar (2015) [16].

Titrable acidity

Treatments imposed on banana cv. Grand Naine failed to elicit a significant response with regard to titrable acidity in pooled data (Table 2). However, bunch feeding with treatment T_3 recorded the lowest value of acidity (0.082 %). Increased level of potassium application results in reduced acid content of fruits. Under low potassium regime, phosphoenol pyruvate (PEP) was apparently shunted into alternate pathways resulting in a shortage of acetyl CO-A[10]. Hence, oxalo acetate appeared to be preferentially formed from PEP in plants with low levels of potassium and this organic acid derivative underwent accumulation. Hasan *et al*. (2007) [17], Sreekanth *et al*. (2018) [11] and Sahu (2019) [6] has also reported lower acidity with bunch feeding in banana.

Ascorbic acid content

The maximum value of ascorbic acid (5.46 mg/100g) in banana cv. Grand Naine was noted with T_{10} (300g cow dung + 10g SOP + 20g ammonium sulphate) in pooled analysis (Table 2). It was statistically at par with treatments T_5 (5.45 mg/100g), T_9 (5.44 mg/100g) and T_4 (5.26 mg/100g). While, the minimum ascorbic acid (4.30 mg/100g) was noted with control. Increased ascorbic acid content in the fruits may be because 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 (Ananthi *et al.*, 2004) [18]. This is in tandem with the reports of Vivela *et al.* (2013) [7] and Sahu (2019) [6].

Shelf life

Shelf life of banana fruits was significantly influenced by various treatments in pooled analysis (Table 2). Treatment T_{10} (bunch feeding of 300g cow dung + 10g SOP + 20g ammonium sulphate) had the highest shelf life i.e. 8.85 days. This treatment was at par with T_9 (8.23 days) and T_2 (8.13 days). Whereas, lowest shelf life (7.07 days) was recorded in T_4 treatment. Extended shelf life of bunches fed with sulphate of potash might be due to the minimum respiration rate which is thought to be due to its antisenescence properties, inhibition of ethylene biosynthesis or reduced rate of metabolism. Higher shelf life with bunch feeding was earlier recorded by Sahu (2019) [6]. In this study trimming of one apical hand also extended the shelf life of banana. Akin results were reported by Bayeri *et al.* (2009) [19].

Table 1: Effect of bunch feeding and hand trimming on TSS and Sugars in banana cv. Grand Naine

Treatments	TSS (ºBrix)	Reducing Sugar (%)	Total Sugar (%)	Non reducing Sugar (%)
T_1: Control	18.25	6.19	14.78	8.42
T_2: KNO_3 1% without trimming	18.78	6.81	16.52	9.71
T_3: KNO_3 2% without trimming	19.72	6.78	16.21	9.30
T_4: SOP 1.5% without trimming	20.37	6.73	17.60	11.00
T_5: SOP 2.0% without trimming	19.30	7.06	18.00	10.94
T_6: KNO_3 1% with trimming of one apical hand	18.73	6.64	16.16	9.53
T_7: KNO_3 2% with trimming of one apical hand	19.72	7.08	15.82	8.82
T_8: SOP 1.5% with trimming of one apical hand	20.64	7.19	17.90	10.41
T_9: SOP 2.0% with trimming of one apical hand	20.28	7.19	17.33	10.14
T_{10}: 300g cowdung+10g SOP+ 20g Ammonium sulphate	21.14	7.29	18.04	10.75
Mean	19.71	6.89	16.83	9.90
S.Em.±	0.45	0.18	0.26	0.33
C.D. at 5 %	1.29	0.51	0.75	0.95
C.V. %	5.57	5.79	3.54	7.36

Table 2: Effect of bunch feeding and hand trimming on pulp: peel ratio, titrable acidity, ascorbic acid and shelf life in banana cv. Grand Naine

Treatments	Pulp:peel ratio	Acidity (%)	Ascorbic acid (mg/100 g)	Shelf Life (days)
T_1: Control	2.70	0.102	4.30	7.92
T_2: KNO_3 1% without trimming	3.30	0.103	4.60	8.13
T_3: KNO_3 2% without trimming	3.21	0.082	4.33	7.37
T_4: SOP 1.5% without trimming	3.28	0.108	5.26	7.07
T_5: SOP 2.0% without trimming	2.74	0.100	5.45	8.06
T_6: KNO_3 1% with trimming of one apical hand	3.25	0.114	4.35	7.97
T_7: KNO_3 2% with trimming of one apical hand	3.34	0.083	4.35	7.40
T_8: SOP 1.5% with trimming of one apical hand	3.50	0.097	5.17	7.93
T_9: SOP 2.0% with trimming of one apical hand	2.78	0.099	5.44	8.23
T_{10}: 300g cowdung+10g SOP+ 20g Ammonium sulphate	3.51	0.088	5.46	8.85
Mean	3.16	0.097	4.87	7.89
S.Em.±	0.08	0.046	0.07	0.27
C.D. at 5 %	0.19	NS	0.20	0.78
C.V. %	5.57	24.15	3.93	8.44

Conclusion

The present investigation indicates that on complete opening of Grand Naine bunch in banana, feeding with cow dung slurry (300g) + SOP (10g) + ammonium sulphate (20g)

results in the best quality fruits with regard to TSS, reducing sugars, total sugars, pulp:peel ratio, TSS, ascorbic acid and shelf life.

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