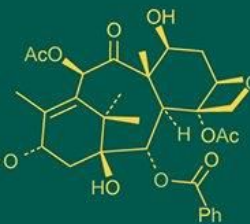


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K Pavani
Department of Fruit Science,
Dr YSR Horticultural
University-College of
Horticulture,
Anantharajupeta,
Andhra Pradesh, India

T Susila
Department of Horticulture,
Dr YSR Horticultural
University-Banana Research
Station, Pulivendula,
Andhra Pradesh, India

M Siva Prasad
Department of Horticulture,
Dr YSR Horticultural
University-College of
Horticulture,
Anantharajupeta,
Andhra Pradesh, India

Y Sharat Kumar
Department of Physiology,
Dr YSR Horticultural
University-Horticultural
Research Station,
Anantharajupeta,
Andhra Pradesh, India

Corresponding Author:
K Pavani
Department of Fruit Science,
Dr YSR Horticultural
University-College of
Horticulture,
Anantharajupeta,
Andhra Pradesh, India

Assessing the effects of dehanding and growth regulators on the quality characteristics of banana cv. Grand Naine

K Pavani, T Susila, M Siva Prasad and Y Sharat Kumar

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Abstract

An experiment was conducted to study the effect of dehanding and bunch spray of GA₃ and CPPU on the quality of banana cv. Grand Naine at the Banana Research Station, Dr YSR Horticultural University, Pulivendula, A.P, India during 2023-24. Banana tissue culture plants were planted by following a Randomized Block Design with the factorial concept. The experiment included dehanding and growth regulator sprays as factors and 12 different treatment combinations. The maximum total soluble solids, TSS: acid ratio, total sugars, reducing sugars and minimum titratable acidity were observed in T₂ (GA₃ 100 ppm + CPPU 4 ppm) and maximum non-reducing sugars in treatment T₁ (GA₃ 50 ppm + CPPU 4 ppm). Among various levels of dehanding, D₁ (8 hands per bunch after dehanding) showed minimum titratable acidity and maximum TSS: acid ratio. The combination of 8 hands per bunch after dehanding and bunch spray of GA₃ 100 ppm + CPPU 4 ppm (D₁T₂) produced the highest TSS: acid ratio (80.84) and total sugars (21.34%). The highest amount of reducing sugars (14.71%) was found in the treatment combination of 9 hands per bunch after dehanding and bunch spray of GA₃ 100 ppm + CPPU 4 ppm (D₂T₂). The highest non-reducing sugars (8.59%) was observed in dehanding to 9 hands per bunch and spraying with GA₃ 50 ppm + CPPU 4 ppm (D₂T₁).

Keywords: Grand Naine, dehanding, GA₃, CPPU, sugars, acidity

1. Introduction

The Banana (*Musa paradisiaca* L.) is a perennial, herbaceous, monocotyledonous and monocarpic plant belonging to the Musaceae family, which is commonly referred to as the "Apple of Paradise" and originated from the tropical regions of South East Asia. Banana has culinary, medicinal, and industrial uses. It is often called Kalpatharu, which means, "the tree of virtues" due to its wide range of benefits. Bananas are one of the most significant tropical fruit harvests in the world and are also believed to be one of the first foods consumed by humans. Compared to other seasonal fruits, bananas are the most widely grown fruit in India because they are nutritious, affordable, and available throughout the year. Around 5.6 million hectares of land is used to grow bananas worldwide, producing about 135 million tons each year. China, Indonesia, and India are the largest banana producers in the world. Latin American countries are the largest exporters in the world. The top ten banana-growing countries are - Costa Rica, Guatemala, Tanzania, India, China, Indonesia, Brazil, Ecuador, Philippines, and Angola. India ranks first in the world for both banana production and productivity, because of its varied climate and suitable soil (Mustaffa and Kumar, 2012) [10]. Bananas are grown around the year in India. Since 2010, banana production has steadily increased. Bananas, now account for 13% of the total fruit-growing area and 33% of the total fruit production in the country.

In 2023-24, around 993 thousand hectares of land were used for banana farming in India, producing an estimated 37.38 million metric tons of bananas (NHB 2023-24). Dehanding is a common practice followed in the production of export-quality bananas, where two or three terminal hands are removed from each bunch. This removal is expected to distribute dry matter more evenly among the remaining hands (Rodriguez *et al.*, 1988) [15]. It is known that when a plant reaches a certain limit, competition for nutrients, or photo assimilates, affects fruit growth (Dennis, 1982) [3]. As the number of fruits per plant increases, the size of each fruit tends to decrease (Krauss *et al.*, 1999) [8].

Rodriguez *et al.* (1988)^[15] found that terminal hands are not used for commercial purposes, as they lead to reduced respiration and redistribution of dry matter with little economic benefit. Removing these hands allows the remaining fruits to grow larger. This study aims to improve the quality of bananas by using better management practices to meet the needs of a specialized market. To improve the physical quality of the fruit and increase bunch production, methods like hand clipping and the application of different hormone combinations are used. Therefore, developing these bunch management techniques will help farmers increase their yield and improve income through the production of better-quality bananas.

2. Materials and Methods

The study was conducted at the Banana Research Station, Pulivendula, Andhra Pradesh, India during 2023-2024 (14°27'57.7"N 78°12'54.8"E). Tissue culture banana plants of the Grand Naine variety were planted with 1.8 m x 1.8 m in Factorial Randomized Block Design involving dehanding at four levels (D₁- 8 hands after dehanding, D₂- 9 hands after dehanding, D₃- 10 hands after dehanding, D₄- no dehanding), growth regulator sprays at three levels (T₁- GA₃ 50 ppm + CPPU 4 ppm, T₂- GA₃ 100 ppm + CPPU 4 ppm, T₃- Water spray) cumulating to the total of 12 treatment combinations. Observations on quality parameters were recorded after the harvest. All the plants received the same fertilizers and care during the experiment. In this experiment growth regulators GA₃ at 50 ppm, 100 ppm, and CPPU at 4 ppm were used. The solutions were prepared according to the treatment plan and sprayed on the banana bunches. The spraying was done immediately after the opening of the last hand and again 15 days after the first spraying. Dehanding or bunch trimming, means cutting off the smaller hands of bananas that have less market value. This helps the remaining fruits to get more nutrients, making them grow better and improving their quality for export. In this study, dehanding was done one week after the last hand was opened, using a knife or a sickle. Data was recorded on TSS, titratable acidity, TSS: acidity ratio, total sugars, reducing sugars and non-reducing sugars. Data was recorded on four plants in each replication. The data from all treatments and replications were averaged and reported.

2.1 Assessment of quality parameters in banana cv. Grand Naine

The biochemical parameters were estimated and analysed. Total soluble solids, expressed in °Brix, were measured using an Atago RX1000 digital refractometer (HRN-18). Titratable acidity was evaluated using a titration method with NaOH as the neutralizer and phenolphthalein as the indicator for endpoint detection as outlined by Ranganna (1997)^[13]. The TSS: Acid ratio was calculated by dividing the percentage of total soluble solids by the percentage of titratable acidity. Total sugars were estimated using the anthrone reagent method explained by Yemm and Willis (1954)^[20]. Reducing sugars percentage was evaluated using DNS (3,5-dinitrosalicylic acid) described by Sadasivam and Manickam (1992)^[16]. Non-reducing sugars were calculated by subtracting reducing sugars from total sugars and expressing the result as a percentage.

2.2 Statistical analysis

The quality data were analysed using the methods described

by Panse and Sukhatme (1978)^[12] for a Factorial Randomized Block Design (FRBD). The analysis of variance was checked using the F value at 5% significance level.

3. Results and Discussion

The results of the study showed that total soluble solids (TSS), titratable acidity and TSS: acid ratio were significantly influenced by growth regulators spray. The highest TSS (22.75 °Brix) was recorded in bunches sprayed with GA₃ 100 ppm + CPPU 4 ppm spray. Pre-harvest bunch spray with growth regulators though improved the TSS of the fruits but was non-significant in the case of all dehanding treatments. Total soluble solids are meant to be an excellent indicator of fruit quality as they primarily reflect sugar levels in fruits. Significant differences were observed among dehanding and growth regulators for titratable acidity. A minimum titratable acidity of 0.34% was recorded in bunches retained with 8 hands per bunch after dehanding (D₁) and a maximum of 0.39% in bunches with no dehanding. The minimum titratable acidity of 0.31% was recorded when bunches were sprayed with GA₃ 100 ppm + CPPU 4 ppm (T₂) and a maximum of 0.44% with water spray (T₃). With respect to the treatment combinations, no significant difference was found. The decrease in acidity content of fruits might be due to an increase in TSS (Total Soluble Solids) and total sugars. The acids, under the influence of chemicals, might have been converted into sugars and their derivatives through reactions involving the reversal of the glycolytic pathway, or they might have been utilised as substrates in respiration, or possibly both (Yadav *et al.*, 2001, Der *et al.*, 2021)^[19, 4]. These results were in agreement with the findings of Kunda and Mitra (1999)^[9] in guava, Kim *et al.* (2006)^[7], and Barkule *et al.* (2017)^[2] in sapota.

The maximum TSS: Acid ratio (64.89) was recorded in the bunches retained with 8 hands after dehanding (D₁) and minimum ratio (55.74) was recorded in bunches with no dehanding (D₄). The maximum TSS: Acidity ratio (74.73) was recorded by the plants treated with GA₃ 100 ppm + CPPU 4 ppm (T₂) and the minimum ratio (44.04) was observed by the water-sprayed bunches (T₃). Analysing the interaction effect, the treatment combination retained with 8 hands per bunch + GA₃ 100 ppm + CPPU 4 ppm (D₁T₂) exhibited maximum TSS: Acid ratio (80.84). Whereas, a minimum of 41.95 in the bunches sprayed with water spray along with no dehanding (D₄T₃). No significant effect was observed due to dehanding on the percentage of the non-reducing sugars in banana fruits among different levels of dehanding. The influence of bunch spray with growth regulators revealed that GA₃ 50 ppm + CPPU 4 ppm (T₁) had the highest non-reducing sugars percentage (7.98%) while, water sprays recorded lowest (6.50%). The interactions between dehanding and growth regulators revealed that the highest non-reducing sugars percentage (8.59%) was registered in bunches retained with 9 hands after dehanding sprayed with GA₃ 50 ppm + CPPU 4 ppm (Table 1). The lowest non-reducing sugars percentage was observed in water-sprayed bunches with no dehanding (5.80%).

Reducing sugars percentage showed a non-significant difference among the dehanding levels, indicating that dehanding had no observable effect. Among the bunch spray treatments, growth regulators spray of GA₃ 100 ppm +

CPPU 4 ppm recorded the highest reducing sugars percentage of 13.57%. The lowest reducing sugars of 11.47% were observed in water-sprayed plants (T₃). There is a significant interaction between dehanding and growth regulators spray for reducing sugars. The bunches retained

with 9 hands after dehanding sprayed with GA₃ 100 ppm + CPPU 4 ppm (D₂T₂) showed a maximum reducing sugars percentage of 14.71% and the minimum reducing sugars percentage of 10.98% was recorded in water-sprayed bunches retained with 9 hands after dehanding (D₂T₃).

Table 1: Effect of dehanding and bunch spray of GA₃ and CPPU on quality of banana cv. Grand Naine

Treatments	TSS (°Brix)	Titrateable acidity (%)	TSS: Acid ratio	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)
Dehanding (D)						
D ₁	21.19	0.34	64.89	19.90	12.56	7.34
D ₂	21.21	0.35	63.62	19.89	12.52	7.37
D ₃	21.20	0.35	62.30	19.88	12.50	7.38
D ₄	21.18	0.39	55.74	19.85	12.50	7.34
SE (m)	0.16	0.008	1.55	0.18	0.20	0.24
CD at 5%	NS	0.02	4.55	NS	NS	NS
Growth regulators (T)						
T ₁	21.64	0.33	66.14	20.51	12.53	7.98
T ₂	22.75	0.31	74.73	21.16	13.57	7.59
T ₃	19.20	0.44	44.04	17.97	11.47	6.50
SE (m)	0.14	0.007	1.34	0.16	0.17	0.21
CD at 5%	0.40	0.02	3.94	0.46	0.51	0.61
Interaction D x T						
D ₁ T ₁	21.67	0.31	69.26	20.25	12.47	7.77
D ₁ T ₂	22.29	0.28	80.84	21.34	13.66	7.68
D ₁ T ₃	19.60	0.44	44.57	18.12	11.55	6.57
D ₂ T ₁	21.48	0.31	68.91	20.46	11.87	8.59
D ₂ T ₂	23.07	0.30	77.09	21.08	14.71	6.36
D ₂ T ₃	19.08	0.43	44.85	18.12	10.98	7.15
D ₃ T ₁	21.52	0.32	67.50	20.53	12.87	7.67
D ₃ T ₂	22.86	0.31	74.62	20.92	12.95	7.97
D ₃ T ₃	19.23	0.43	44.77	18.19	11.68	6.50
D ₄ T ₁	21.87	0.38	58.88	20.80	12.90	7.90
D ₄ T ₂	22.79	0.34	66.38	21.28	12.94	8.33
D ₄ T ₃	18.88	0.45	41.95	17.46	11.66	5.80
SE (m)	0.28	0.014	2.69	0.31	0.35	0.42
CD at 5%	NS	NS	8.11	0.97	1.20	1.44

D₁- 8 hands after dehanding

D₂- 9 hands after dehanding

D₃- 10 hands after dehanding

D₄- no dehanding

T₁- GA₃ 50 ppm + CPPU 4 ppm

T₂- GA₃ 100 ppm + CPPU 4 ppm

T₃- Water spray

No significant differences were observed regarding total sugars among the various levels of dehanding. The percentage of total sugars was significantly affected by the bunch spray of growth regulators. The highest percentage of total sugars, 21.16%, was recorded in the bunches sprayed with GA₃ 100 ppm + CPPU 4 ppm (T₂). The lowest percentage of total sugars (17.97%) was observed in water spray. The interaction between dehanding and growth regulators was found to be significant. The bunches retained with 8 hands after dehanding (D₁) sprayed with GA₃ 100 ppm + CPPU 4 ppm (T₂) resulted in the highest total sugars percentage of 21.34%. The lowest total sugars percentage, 17.46%, was recorded in water-sprayed bunches with no dehanding (D₄T₃). The elevated percentage of total sugars, reducing sugars and non-reducing sugars were observed in GA₃ 100 ppm + CPPU 4 ppm treated banana bunches which can be attributed due to GA₃'s role in regulating the efficient translocation of photosynthates to the fruits. These findings confirm the results reported by Ram *et al.* (2005) [14] in ber, Sharma *et al.* (2015) [17]. The increased levels of reducing sugars and total sugars may be attributed to the higher

number of leaves with increased chlorophyll content, which enhances photosynthesis and the production of metabolites. CPPU foliar spray accelerates the flow of these photosynthetic products, primarily carbohydrates, towards the fruits. As carbohydrates, particularly sugars, are a major component of soluble solids, the source-to-sink relationship explains the higher percentages of reducing sugars and total sugars observed in the treated fruits. These results are in agreement with the findings of Al-Obeed *et al.* (2011) [1], Kassem *et al.* (2011) [5], Khot *et al.* (2015) [6] and Barkule *et al.* (2017) [2] in sapota.

Conclusion

It is concluded that the use of GA₃ and CPPU significantly increased quality attributes in banana. Bunch Spray of GA₃ 100 ppm + CPPU 4 ppm showed maximum TSS, TSS: titrateable acidity ratio, total sugars, reducing sugars and minimum titrateable acidity. Retention of 8 hands per bunch after dehanding combined with bunch spray of GA₃ 100 ppm + CPPU 4 ppm (D₁T₂) enhanced the quality attributes when compared with other treatment combinations.

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