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Effect of bunch feeding and trimming on quality attributes and shelf life of banana

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Abstract
In order study the response of bunch feeding and trimming on quality attributes and shelf life in banana cv. Grand Naine, present investigation was conducted during 2022-2023. The experiment was laid out in Factorial Randomized Block Design (FRBD) with nine treatments, twenty treatments combination and three replications *viz*., two factors were different levels of hand trimming and formulations of bunch feeding, retention of 9 hands with feeding of 7.5 g KNO_3 recorded higher Total Soluble Solids (^{0}Brix), Pulp: Peel ratio, Total sugars (%) and Sugar: Acid ratio. In respect to shelf life the same treatment recorded extended Shelf life (days) and attained lowest Acidity.

Keywords: TSS, pulp, peel ratio, acidity, sugar, acid ratio, total sugars and shelf life

Introduction
The basal hands of a banana bunch are often larger than the terminal hands, and these larger basal hands are usually discarded or sold as substandard fruits in the market at marginal returns. Consequently, at least five or six hands in a bunch may not meet the finger quality standards necessary for specialized markets, resulting in a reduction in income for the producers.

The rationale behind hand trimming is the expectation that by removing the terminal hands to redistribute dry matter among the remaining hands. This redistribution is anticipated to contribute an increase size of the remaining hands (Rodriguez *et al*., 1988) [9]. Bananas, being heavy nutrient consumers, require a continuous and substantial supply of nutrients and water for optimal growth and development, significantly impacting its quality. During the grand growth phase, banana uptakes major nutrients in large quantities, but the rate of nutrient uptake decreases at initiation of shooting. To address this, a practice known as bunch trimming and feeding was carried out for retention of hands at different levels with simultaneous supplemental application of Potassium Nitrate to denavelled stalk end after fully opening of bunch. This targeted approach aims to fulfill the specific nutrient needs of bananas during critical growth stages, enhancing exportable quality.

The investigation conducted in the present study takes into account these considerations, aiming to study the effects of bunch feeding and hand trimming in banana cv. Grand Naine.

Materials and Methods
Location
The present investigation was carried out at Experimental farm of Agricultural Research Station, Achalpur, Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India during 2022-2023 situated at an average elevation of 369 meters above mean sea level at 21^{0}15’26’’N latitude and 77^{0}30’31’’E longitude and having marginal Sub-tropical climate.

Treatment details
The experiment was laid out in Factorial Randomized Design with 9 treatments and 3 replications. The levels of bunch trimming were T1- retention of 7 hands, T2- retention of 8 hands, T3- retention of 9 hands and T4- control (no bunch trimming) and formulations of bunch feeding were F0- control (no bunch feeding), F1- application of 5 g KNO_3 per bunch, F2- application of 7.5 g KNO_3 per bunch, F3- application of 10 g KNO_3 per bunch and F4- application of 12.5 g of KNO_3 per bunch.

Methodology

The methodology involved de-navelling of bunch, followed by removal of terminal undersized hands once the bunch is fully opened. This removal was carried out by making a slant cut at a 45^0 angle, about 15-20 cm below the last retained hand, using a sharp knife. The aim is to restrict the movement of photosynthates into undesired area and encourage fruit development. Bunch feeding was implemented using a 50-micron polyethylene bag sized 15 cm × 25 cm. This bag was secured to the stalk with a jute string, ensuring that 8 to 10 cm of the denavelled end remained submerged in KNO_3 solution.

Results and Discussion

Total Soluble Solids

The data pertaining to banana as influenced by a bunch trimming and bunch feeding in presented in table. 1 shown highest TSS (21.67 ^{0}B) in treatment T3F2 (retention of 9 hands with application of 7.5 g KNO_3 per bunch) which was found at par (20.67 ^{0}B) with T2F2 (retention of 9 hands with application of 7.5 g KNO_3 per bunch). It was in tune with the findings of Hasan *et al*. (2007) [4] who found that gradual and steady increase in TSS with removal of hands. Similar result was reported by Biswas and Nair (2012) [2]. Kumar *et al*. (2011) [6] reported that 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 banana. The findings were in close conformity Shira *et al*. (2013) [14], Khalashi *et al*. (2021) [5] and Sathish *et al*. (2021) [12].

Pulp: Peel ratio

Significant results were recorded in the study regarding the influence of hand trimming and bunch feeding on pulp:peel ratio. Treatment involved retaining 9 hands with application of 7.5 g KNO_3 per bunch, resulted in the maximum pulp weight (77.78%) with highest pulp/peel ratio (3.50) respectively. Trimming of one apical hand too resulted in higher pulp: peel ratio which is in consonance with reports by Wanichkul and Boonma (2009) [19] and Sarkar (2015) [11]. The reason behind such result might be due to more pulp and less skin weight. This indicates the beneficial banana role of potassium to obtain good pulp recovery. This was earlier reported by Shira *et al*. (2012) [13], Khalashi *et al*. (2021) [5] and Sathish *et al*. (2021) [12].

Table 1: Effect of hand trimming and stalk feeding on quality attributes and shelf life of

Treatment	TSS (^{0}B)	Pulp: Peel ratio	Total Sugars (%)	Titratable Acidity (%)	Sugar: Acid ratio	Shelf life (days)
Bunch Trimming						
T1	19.27	3.14	14.85	0.34	45.18	6.80
T2	18.93	3.18	14.92	0.30	49.74	7.27
T3	19.47	3.19	15.17	0.29	52.70	7.20
T4	17.67	3.05	14.36	0.29	50.64	6.33
'F' test	Sig	Sig	Sig	Sig	NS	Sig
SE (m) ±	0.16	0.02	0.07	0.07	2.11	0.17
CD at 5%	0.47	0.06	0.21	0.21	-	0.48
Bunch Feeding						
F0	16.58	2.74	13.49	0.36	37.58	4.25
F1	19.17	3.09	14.54	0.32	47.19	8.00
F2	20.67	3.40	17.19	0.27	64.35	8.58
F3	19.75	3.24	14.83	0.28	53.92	7.00
F4	18.00	3.22	14.07	0.32	44.79	6.67
'F' test	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.18	0.02	0.08	0.08	2.36	0.19
CD at 5%	0.52	0.06	0.24	0.24	6.75	0.54
Interaction effect						
T1F0	17.33	2.78	13.97	0.37	38.20	4.33
T1F1	20.67	3.28	14.37	0.37	39.34	8.00
T1F2	21.00	3.18	17.79	0.33	59.73	8.67
T1F3	19.33	3.25	14.47	0.34	45.47	7.33
T1F4	18.00	3.20	13.63	0.32	43.18	5.67
T2F0	17.00	2.75	13.20	0.36	36.74	4.33
T2F1	18.67	3.16	13.93	0.31	43.85	8.00
T2F2	20.67	3.47	17.89	0.26	65.08	8.67
T2F3	20.33	3.29	15.56	0.25	61.60	7.67
T2F4	18.00	3.25	14.00	0.34	41.42	7.67
T3F0	16.67	2.71	13.37	0.35	37.82	4.33
T3F1	19.33	3.14	15.51	0.33	48.03	9.00
T3F2	21.67	3.50	17.95	0.22	81.48	9.33
T3F3	21.00	3.30	14.80	0.24	55.49	6.33
T3F4	18.67	3.28	14.24	0.31	45.94	7.00
T4F0	15.33	2.74	13.44	0.36	37.54	4.00
T4F1	18.00	2.78	14.34	0.27	52.43	7.00
T4F2	19.33	3.43	15.14	0.25	61.47	7.67
T4F3	18.33	3.13	14.49	0.28	53.13	6.67
T4F4	17.33	3.15	14.41	0.30	48.64	6.33
'F' test	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.37	0.04	0.17	0.17	4.72	0.38
CD at 5%	0.47	0.13	0.47	0.47	13.51	1.07

Total Sugars (%)

Increase in Total Sugars might be due to the bunch trimming and feeding reported in bunch retained with 9 hands with application of 7.5 g KNO_3.Potassium in feeding formulation is responsible for conversion of starch into simple sugars during ripening by activating sucrose synthase enzyme, resulting in higher sugars content in fruits (Marschner, 1995) [7]. This is in line with the findings of Shira *et al*. (2012) [13], Vivela *et al*. (2013) [18], Millik *et al*. (2017) [8] and Sreekanth *et al*. (2018) [16].

Titratable Acidity (%)

With regard to Titratable Acidity of ripened banana treatment T3F2 (retention of 9 hands with application of 7.5 g KNO3 per bunch) recorded minimum acidity (0.22%). High potassium levels in fruits were found to reduce acidity by diverting phosphoenol pyruvate (PEP) into alternate pathways, leading to a shortage of acetyl co-A. This process resulted in the accumulation of oxaloacetate, a less acidic derivative. Additionally, the neutralization of organic acids due to high potassium levels and increased metabolism from acid-to-sugars conversion contributed to the overall reduction in fruit acidity (Millik *et al*., 2017) [8]. Hasan *et al*. (2007) [4], Sreekanth *et al*. (2018) [16] and Sahu (2019) [10] has also reported lower acidity with bunch feeding in banana.

Sugar: Acid ratio

As indicated in table. 1, maximum Sugar: Acid ratio (71.12) was reported in treatment T3F2 (retention of 9 hands with application of 7.5 g KNO_3 per bunch). 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. (Vadivelu and Shanmugavelu, 1978) [17]. Result of this investigation is in close confirmation with findings of Hasan *et al*. (2007) [4], Shira *et al*. (2013) [14], Millik *et al*. (2017) [8] and Sathish *et al*. (2021) [12].

Shelf life (days)

The data depicted in table 1. with respect to Shelf life was registered highest (9.33 days) in treatment T3F2 (retention of hands with application of 7.5 g KNO_3 per bunch) extended by 5 days as compared with control. Potassium supplementation enhances storage and shipping quality of bananas, extending their shelf life. Adequate potassium not only boosts yield but also improves fruit quality, promoting longer shelf life and better processing for the industry. Low potassium results in fragile bunches with a shorter shelf life, possibly due to increased peel thickness and firmness. Potassium bunch feeding reduces respiration and ethylene production, delaying senescence and extending green life (Singh and Chuhan, 1986; Bose *et al*., 1998) [15, 3]. Higher shelf life with bunch feeding was earlier recorded by Sahu (2019) [10]. In this study trimming of one apical hand also extended the shelf life of banana. Akin results were reported by Bayeri *et al*. (2009) [1].

Conclusion

On the basis of one year study, it is concluded that the retention of 9 hands with application of 7.5 g KNO_3 per bunch was found significantly superior over remaining treatment combinations in terms of quality attributes and shelf life.

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