Current Journal of Applied Science and Technology

39(14): 119-124, 2020; Article no.CJAST.56886
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Standardization of Optimum Planting Time on Yield and Fruit Quality of Banana var. Grand Naine under Mid Hill Condition of Arunachal Himalaya

Thejangulie Angami[1*], Homeswar Kalita[1], Jitendra Kumar[2], D. Ramajayam[3], Raghuveer Singh[1] and Anup Chandra[4]

[1]ICAR (Research Complex) for NEH Region, Arunachal Pradesh Centre, Basar-791101, India.
[2]ICAR-IISS, Nabibagh, Berasia Road, Bhopal-462038, India.
[3]ICAR- National Research Centre for Banana, Thogamalai Road, Tiruchirapalli-620102, India.
[4]ICAR- Indian Institute of Pulses Research, Kalyanpur, Kanpur-208024, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2020/v39i1430709
Editor(s):
(1) Dr. Rodolfo Dufo Lopez, University of Zaragoza, Spain.
Reviewers:
(1) Luciana Cardoso Nogueira Londe, Empresa de Pesquisa Agropecuária de Minas Gerais, Brazil.
(2) Moataz Eliw Mostafa, Al-Azhar university, Egypt.
Complete Peer review History: http://www.sdiarticle4.com/review-history/56886

Original Research Article

Received 07 March 2020
Accepted 12 May 2020
Published 15 June 2020

ABSTRACT

A field experiment was executed during 2013-16 at ICAR Research Farm, Gori, ICAR (Research Complex) for NEH Region, Arunachal Pradesh Centre, Basar to find out the optimum planting time for yield and quality attributes of Grand Naine banana. The experiment was laid out in RBD having five treatments with four replications. The study divulged that the planting dates had a significant influence on growth, yield and fruit quality of banana. Fruits harvested from mid-may planting recorded the highest in yield based parameters *viz.* number of hands per bunch (13.17), number of fingers per bunch (162.63) and bunch weight (24.67 kg) respectively. However, fruits from mid-june planting exhibited the highest finger weight (148.67 g) which was statistically at par with mid-may planting (147.54 g). It was noted that plants of mid-june planting produced the maximum number of functional leaves at the shooting stage (15.38) which was found at par with mid-may planting (15.13).The fruit quality attributes like sugars, ascorbic acid, acidity were also influenced by planting times whereas it had no significant effect on TSS content of the fruits. Fruits from mid-may plant recorded the highest TSS (21.03°Brix), minimum acidity (0.23%) and highest ascorbic acid content

**Corresponding author: E-mail: thejaangami@yahoo.com;*

(14.99 mg per 100 g) followed by mid-june planting with TSS, acidity and ascorbic acid content of (20.56°Brix), (0.24%) and (14.47 mg per 100 g) respectively. Starch content was found maximum in fruits from mid-august planting (2.08%) whereas, minimum starch content was recorded in fruits from mid-june planting (0.71%) inferring that mid-may is the optimum time for planting for Grand Naine variety of banana under subtropical mid-hill conditions of Arunachal Pradesh justifying future actions in the expansion of planting.

Keywords: Musa paradisiacal; Grand Naine; optimum; planting; yield; quality; mid-hill.

1. INTRODUCTION

Banana (*Musa paradisiaca*) is one of the major commercial fruit crops of many tropical and subtropical regions of the world. It is an important fruit in several regions due to its nutritional value, being relatively cheap and can be consumed far from the places where it is produced making accessible to populations in all regions and social classes. The absence of seeds and availability throughout the year also contributes to its acceptance worldwide [1]. India being the largest producer of banana in the world producing 29.7 million tons from an area of 0.88 million hectares with the productivity of 37 MT/ha, contribute about 29.19% share in the total world production [2]. Apparently it is pertinent to state that the productivity of banana in the North-eastern region of India especially the state of Arunachal Pradesh in particular is quite low as compared to the national average which is due to several reasons. One of the reasons may be due to lack of knowledge in identifying the optimum planting season especially under subtropical mid-hill condition of the state where low temperature induced during winter months limits the planting season unlike tropical region where planting can be done during any months as ideal condition exists for continuous growth and fruit development of bananas. Proper planting time is an important non monetary input in crop production which affects crop growth, yield and quality to an extent. A small change in planting time leads to a significant changes in crop performances. Therefore, considering the importance of banana for the livelihood of the people and with the fact that no such work has been done earlier in finding out the right time of planting in the state. Hence, a study was undertaken with the aim to select the best time of planting suckers that would be responsible for promoting yield quantitatively and qualitatively of Grand Naine banana in the mid-hill of Arunachal Pradesh under rainfed conditions.

2. MATERIALS AND METHODS

The study on the standardization of optimum planting time on yield and fruit quality of banana var. Grand Naine under mid-hill condition of Arunachal Himalaya was executed in the year 2013-2016 at ICAR Research Complex for NEH Region, Arunachal Pradesh Centre, Basar, India situated in the mid hill zone (latitude 27º59' N;

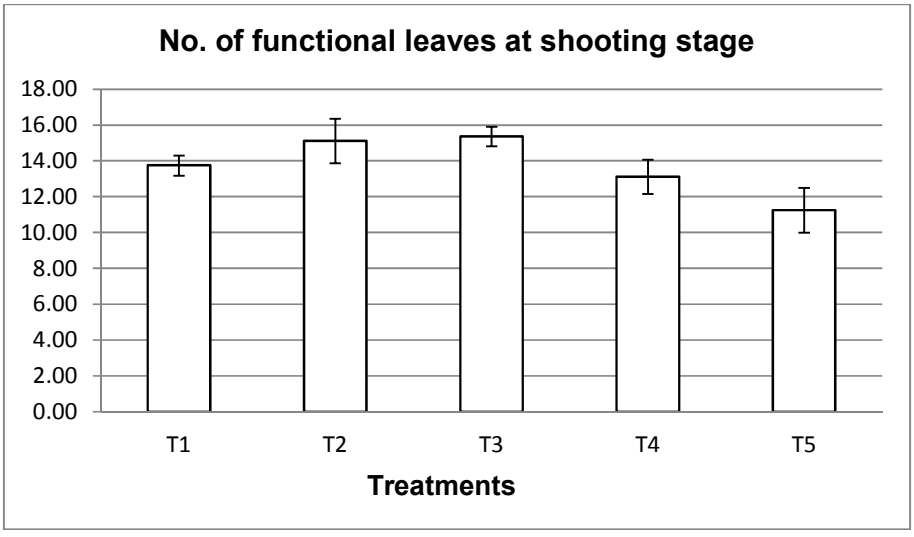

Fig. 1. Graphical representation showing functional leaves at shooting stage

longitude 94°41' E) at an altitude of 650 m above msl. The mean annual precipitation is approximately 2100 mm and the mean annual temperature is 20.2°C, with a maximum monthly mean value of 26.2°C (August) and a minimum monthly mean value of 11.9°C (January). The experiment was laid out in simple randomized block design with four replications. The five treatments were *viz*. T_1: Date of planting (mid - april), T_2: Date of planting (mid-may), T_3: Date of planting (mid-june), T_4: Date of planting (mid-july), T_5: Date of planting (mid-august).The tissue cultured banana suckers were planted during mid of every mentioned months following all proper cultural management. The soil of the experimental site is sandy clay loam, highly acidic with rich in organic carbon, medium N & K and low P. The tissue cultured plants were planted at a spacing of 1.8 x 1.8 m.

Yield based parameters along with actual number of functional fully opened green leaves on the plant were recorded and average was calculated. Nutritional quality *viz*. TSS, titratable acidity, reducing sugar, total carbohydrate, ascorbic acid and starch were estimated using the standard method of chemical analysis.

Total soluble solids (TSS) was determined by one drop of the juice calibrated in digital refractometer.

Titratable acidity of the fruit was determined by titrating the fruit juice against 0.1 N NaOH solution using phenolphthalein as an indicator (light pink end point) and expressed as percentage in terms of citric acid [3].

$$\text{Acidity (\%)} = \frac{\text{Titre reading x Normality of alkali x Equivalent weight of acid x 100}}{\text{Volume of sample taken}}$$

Ascorbic acid content was determined by the method described by Ranganna [4]. 5 g of sample was taken, blended with 3 per cent metaphosphoric acid and made the volume to 50 ml with metaphosphoric acid and filtered. Then titrated 5 ml aliquot with standard dye to a pink colour endpoint which persisted for at least 15 seconds. Ascorbic acid was calculated as:

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titre value x Dye factor x volume made up x 100}}{\text{volume of aliquot taken for estimation x weight of sample}}$$

Reducing sugar was estimated by Nelson-Somogyi method as described by Sadasivam et al. [5]. Here, sugar was extracted by macerating 100 mg of the sample with 5 ml of warm 80 per cent ethanol. The content was centrifuged for 5 minutes. Water was added to dissolve the sugars. An aliquot of 0.2 ml was taken and diluted to 2 ml with distilled water. Further, 1 ml of alkaline copper tartrate reagent was added to each tube. The tube was placed in boiling water for 10 minutes. The tube was allowed to cool down and 1 ml of arsenomolybolic acid reagent was added to each tube, final volume was made up to 10 ml with distilled water. The content was incubated for 10 minutes at room temperature. After 10 minutes the sample was read against the blank solution in a UV visible spectrophotometer at 620 nm.

Total carbohydrate was estimated by Anthrone method as described by Sadasivam et al. [5]. Sample (100 mg) was taken in a boiling tube and hydrolyzed by keeping it in a water bath for three hours with 5 ml of 2.5 N HCl. The sample was cooled to room temperature and was neutralized with sodium carbonate until the effervescence ceased. The volume was made up to 100 ml and the content was centrifuged and supernatant was collected. An aliquot of 1 ml was taken and 4 ml of anthrone reagent was added to it. The content was heated for eight minutes in boiling water bath and was cooled rapidly. Dark green colour of the sample was read against the blank solution at 630 nm using UV visible spectrophotometer.

Starch content was determined by the method of Hedge and Hofreiter [6]. Sample (500 mg) was homogenized in 80% warm ethanol to remove the sugars and the content was centrifuged and the residue was collected. The residue was repeatedly washed with 80% warm ethanol. The residue was dissolved in 5 ml of water and 6.5 ml of 52% perchloric acid was added to it and the content was incubated at 0°C for 20 minutes. The content was centrifuged and the supernatant was collected. Further, 0.2 ml of the supernatant was pipetted out and the volume was made up to 1 ml with distilled water followed by addition of 4 ml of anthrone reagent to it. The content was then heated in a boiling water bath for 8 minutes and cooled rapidly. The intensity of dark green colour was read against the blank solution at 630 nm using UV visible spectrophotometer.

The data recorded were tabulated and subjected to statistical analysis using Statistical Analysis

System 9.3 computer software (SAS Institute Inc., 13). DMRT procedure was used at P = 0.05 level to determine if there were significant differences among the means.

3. RESULTS AND DISCUSSION

The results on the effect of planting time on bunch characteristics enumerated in Table 1 indicated that fruits from mid-june planting exhibited the highest finger weight (148.67 g) followed by mid-may planting (147.54 g) which was statistically at par with each other. However, fruits from mid-may planting recorded the highest in remaining yield based parameters *viz.* number of hands per bunch (13.17), number of fingers per bunch (162.63) and bunch weight (24.67 kg) respectively. Such finding may be due to the subtropical mid-hill condition of the place where suitable temperature and humidity existed that was essential for improving growth with quality fruits [7]. It was noted that mid-june planting produced the maximum number of functional leaves at shooting stage (15.38) which was found at par with mid-may planting (15.13). The present result is in harmony with a researcher who reported that the number of standing leaves at harvest as the most reliable predictor of bunch weight [8]. The present findings on the number of functional leaves is also in line with a team of researchers who reported that characteristics of the banana plant could be influenced by the season and further observed that suckers planted during june gave good vegetative growth [9].

In banana, quality standards have become the most important factor influencing the economic yield. Fruit size and quality is of great importance in banana though consumer acceptance varies from place to place [10]. The fruit quality attributes like sugars, ascorbic acid, acidity etc. were also influenced by planting times. The results on the effect of planting time on nutritional composition of banana fruits enumerated in Table 2 revealed that fruits from mid-may planting recorded the highest TSS (21.03 °Brix), minimum acidity (0.23%) and highest ascorbic acid content (14.99 mg per 100 g) followed by mid-june planting with TSS, acidity and ascorbic acid content of (20.56 °Brix), (0.24 %) and (14.47 mg per 100 g) respectively. However, planting times had no significant effect on TSS content of the fruits.

Fruits from mid-june planting recorded the maximum reducing sugar (6.36%) closely followed by fruits from mid-may planting (6.2 %) which was par with each other. On the other hand, fruits from mid-april planting recorded highest total carbohydrate (11.95%) which was found statistically at par with mid-june planting (11.90%) and mid-may planting (11.67%) respectively. The increase in sugar and carbohydrate content might be due to more number of fully functional leaves at shooting stage with higher synthesis of assimilates which are translocated from leaves to developing fruits. The fruits which possessed the maximum TSS, sugars and ascorbic acid content under different treatments might also be due to the fact that

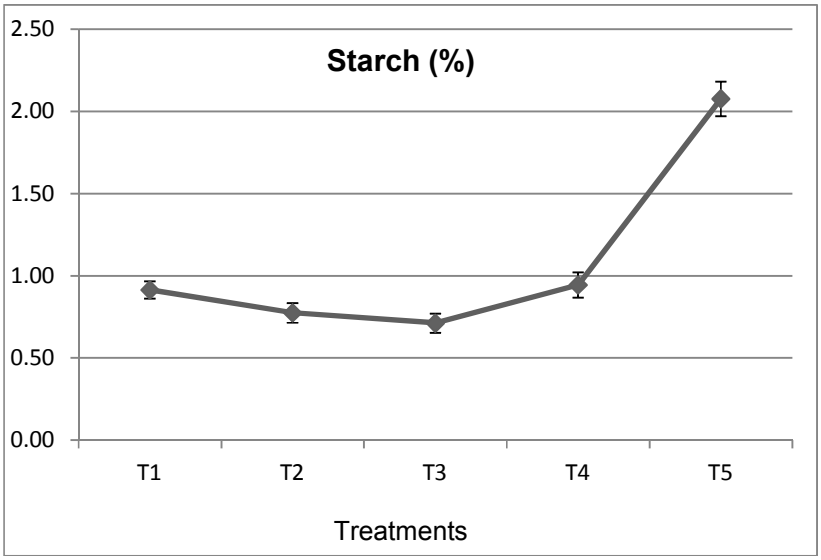

Fig. 2. Graphical representation showing starch concentration against treatments

Table 1. Effect of planting time on bunch characteristics of banana var. Grand Naine

Treatments	Finger weight (g)	Number of hands per bunch	Number of fingers per bunch	Bunch weight (Kg)
T_1: (DOP, April)	145.67^{b}±1.28	11.63^{b}± 0.49	152.75^{c}±1.84	23.00^{b}± 0.76
T_2: (DOP, May)	147.54^{ab}± 0.90	13.17^{a}± 0.60	162.63^{a}± 1.25	24.67^{a}± 0.36
T_3: (DOP, June)	148.67^{a}± 2.19	11.75^{b}± 0.43	158.04^{b}± 1.81	23.71^{ab}± 1.48
T_4: (DOP, July)	140.08^{c}±1.72	11.04^{bc}± 0.38	143.13^{d}±0.62	21.13^{c}± 0.79
T_5: (DOP, August)	139.04^{c}±0.95	10.29^{c}± 0.14	141.83^{d}± 0.84	20.13^{c}± 0.67
LSD (0.05)	2.00	0.84	2.33	1.54

Values within the columns with similar superscripts are statistically identical and values with dissimilar superscripts differ significantly at p<0.05 level of significance

Table 2. Effect of planting time on nutritional composition of banana var. Grand Naine

Treatments	TSS (°Brix)	Titratable acidity (%)	Ascorbic acid (mg/100 g)	Reducing sugar (%)	Total carbohydrates (%)
T_1: (DOP, April)	18.88 ± 1.60	0.27^{ab}± 0.03	12.94^{b}± 1.39	5.94^{b}± 0.17	11.95^{a}± 0.32
T_2: (DOP, May)	21.03 ± 1.90	0.23^{b}± 0.01	14.99^{a}± 0.43	6.25^{ab}± 0.09	11.67^{a}± 0.27
T_3: (DOP, June)	20.56 ± 0.42	0.24^{b}± 0.02	14.47^{a}± 0.24	6.36^{a}± 0.24	11.90^{a}± 0.13
T_4: (DOP, July)	17.83 ± 1.57	0.28^{ab}± 0.03	12.86^{b}± 1.32	5.97^{b}± 0.19	10.66^{b}± 0.24
T_5: (DOP, August)	17.42 ± 1.85	0.31^{a}± 0.03	12.32^{b}±1.28	5.14^{c}± 0.26	10.08^{b}± 0.72
LSD (0.05)	NS	0.05	1.42	0.33	0.76

Values within the columns with similar superscripts are statistically identical and values with dissimilar superscripts differ significantly at p < 0.05 level of significance

since the fruits were exposed to favourable and congenial environment conditions.

Starch content was found maximum in fruits from mid-august planting (2.08%) whereas, minimum starch was recorded in fruits from mid-june planting (0.71%). High starch content in fruits from mid-august planting might be because the fruit development coincided with the winter months which delayed or prevented the maturity of the fruits due to low temperature. Whereas fruits from remaining planting seasons coincided with summer months which were favourable for the growth and maturity of the fruits thus starch is hydrolyzed further converted to sugar during the process and ends up being less than 1.00% when the banana is fully ripe.

4. CONCLUSION

From the two years of experimental data, it can be observed that suckers planted during mid-may exhibited the overall better performance in terms of growth, yield and quality attributes. Therefore, mid-may be considered as the ideal time for planting banana suckers to achieve higher yield with better quality fruit from Grand Naine variety under sub tropical mid-hill conditions of Arunachal Pradesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Lichtemberg LA. Colheita e pós-colheita da banana. Informe Agropecuário, Belo Horizonte. 1999;20(196):73-90.
2. Available:http://agriexchange.apeda.gov.in /news/NewsSearch.aspx?newsid=27388.
3. AOAC. Official methods of analysis of the Association of Official Analytical Chemists. 18th edition. Virginia. USA; 2005.
4. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. 2nd edition, Tata McGraw-Hill Publ. Co. New Delhi, India;1986.
5. Sadasivam S, Manickam A. Biochemical methods, Revised 2nd edition. New Age Int. Publ. New Delhi; 2005.
6. Hedge JE, Hofreiter BT. Estimation of starch by anthrone reagent. In: Whistler RL, Be Miller JN, editors. Methods in

carbohydrate chemistry. Academic Press, New York; 1962.
7. Simmonds NW. Bananas. 2nd edition, Longman Green Ltd., London, UK; 1970.
8. Baiyeri KP. Phenotypic relationships among growth, yield, and black leaf streak disease responses of Musa genotypes. J. Crop Improvement. 2008;21:41-54.
9. Yadav A, Ram RB, Kumar R, Sonkar P, Meena ML. Latha R. Response of planting dates on growth and yield characteristics of banana (*Musa sp*.) cultivars. Ann. Hort. 2011;4:95-100.
10. Bauri FK, De A, Misra DK, Bandyopadhyay B, Debnath S, Sarkar SK. Avani, P. Improving yield and quality of banana cv. Martaman (Musa AAB, Silk) through micronutrient and growth regulator application. J. Crop Weed. 2014;10:316-19.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/56886