Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2666

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (3):** 111-117 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Breeding Potential of Cooking Banana Genotypes under Coimbatore Condition

Dinesh Nagar[1*], N. Kumar[1], Reshma V.S.[2] and K. Soorianathasundaram[1]

[1]Department of Fruit Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore-641003, India

[2]Department of Floriculture and Landscape Architecture, Horticulture Section, College of Agriculture Nagpur (Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola) 444 104

*Corresponding Author E-mail: nagar.dinesh86@gmail.com

Received: 8.03.2017 | Revised: 19.03.2017 | Accepted: 20.03.2017

ABSTRACT

Cooking banana (ABB) are important group of banana and plantain and are considered as a major economic source for income and grown especially in many part of Tamilnadu and other part of India. Although serious attempt has not been made to study the breeding potential of cooking banana for crop improvement. Hence, in this study assessed the male and female fertility of ten cooking banana genotypes. For evaluation of female fertility crosses were made in female flowers with the certain potential male parents while male fertility was evaluated in the laboratory condition. A total of 816 crosses were made in 26 cross combinations, out of which 3 combination resulted in 55 viable seeds, however 4 seeds alone germinated and two seedlings survived. Among the cooking banana genotypes (ABB) the Alshy, Chakkiya and Gouria were non pathenocarpic (female fertile) while rest of them were found to be pathenocarpic. All the ten cooking banana exhibited the male fertility. Among them male fertile genotype, Bagner exhibited the highest pollen output (17500), pollen stainability (64.60 %) and pollen germination (11.33 %).

Key words: *Crop improvement, fertility, crossing, germination, seedlings, pathenocarpic*

INTRODUCTION

Banana and plantain (*Musa spp*.) are important tropical and subtropical fruits around the world, and also a staple food for more than 400 million people. It ranks as the fourth major crop after rice, wheat and maize and is considered as a poor man's crop in tropical and subtropical countries[6]. It is a staple and cash crop for millions of people, particularly in Eastern and Central Africa (ECA). Plantain as a stable provides considerable energy (301KJ) and protein (1.28g), although the diet needs to be supplemented in West and Central Africa, people derive about one quarter of their energy requirement from plantains. Different types of banana including of plantain (AAB), cooking type (ABB) and dessert (AAA) are cultivated in different regions of India.

Cite this article: Nagar, D., Kumar, N., Reshma, V.S. and Soorianathasundaram, K., Breeding Potential of Cooking Banana Genotypes under Coimbatore Condition, *Int. J. Pure App. Biosci.* **5(3):** 111-117 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2666

Among them cooking which are extensively used in the culinary purpose especially in South India. Cooking banana are important group of banana and plantain and are considered as a major economic source for income and grown especially in many part of Tamilnadu and other part of India. These banana genomically belong to ABB group and are also effected by nematodes and wilt. Yield improvement through breeding is not yet attempted in a systematic manner in this group.

In order to carry the breeding programme it is essential to determine the breeding potential of the parent. To producing new banana cultivars, breeders should understand the genetic differences of the potential crossing parents for introgression hybridization, but extensive genetic information is lacking. Evaluation of female and male fertility is considered as an important factor in the breeding programmes as genetic improvement in *Musa* depends on its male and female fertility[7]. At TNAU, breeding potential of edible groups of banana such as AAA, AAB were assessed in earlier studies[1,2,5], however, no serious attempt has been made with culinary banana cultivars which has the genomic constitution of ABB. The study assessed the male and female fertility of the hybrids produced with a view to the possibility of using them as parents in future breeding programmes to produce commercially acceptable types.

MATERIALS AND METHODS

The present study was carried out in the Department of Fruit Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2013 to 2014 to assessing the breeding potential of cooking banana genotypes (ABB types). The playnological study and female fertility was carried out with the ten cooking banana genotypes and crossed with certain potential male donor.

Parthenocarpy and female fertility

For the female fertility crossing was made between 6:30 to 9:30 AM. with the potential male parents. Unopened anthers of male parents were collected just prior to dehiscence from the inflorescence on the day of crossing which had entered the male phase after completion of female and neutral phases.

Seed extraction, sowing and germination

The fruits from the harvested bunches in which crosses were attempted were allowed to ripen in the room. From the ripened fingers, seeds were extracted manually by crushing them between the fingers. Extracted seeds were immersed in water soon after extraction. Seeds were washed and soaked in water for eight days and sown in seed pans filled with sterilized pot mixture medium of at a Red soil: Sand: FYM in ratio of 2:1:1 ratio respectively[3]. The seed pans were kept in mist chamber and observed for germination for 14 to 60 days. At five-leaf stage, the seedlings were removed and transplanted separately in larger polythene bags (10 x 15 cm) containing sterile pot mixture.

Palynological studies

Pollen output

The haemocytometer method standardized for banana by Sathiamoorthy[4] was followed, which includes collection of five samples of 10 anthers from each plant just prior to dehiscence. As banana anthers do not dehisce properly, they were crushed with a small glass rod in a vial containing 2.5 ml of distilled water and a drop of teepol for obtaining a good suspension of pollen grains in water. The contents were thoroughly shaken and two drops were pipetted out and placed on each of the two "Counting Chambers" of a "Spencer bright line – Haemocytometer". The number of pollen grains in each of the eight corner squares was recorded. This was repeated five times for each sample and was designated as sub-samples. The average number of pollen grains per square multiplied by 2500 would give the quantity of pollen per anther.

Pollen stainability

The acetocarmine staining method standardized for banana by Sathiamoorthy[4]

was followed. The anthers were collected prior to dehiscence, gently crushed and the pollen grains obtained were placed on a glass slide. A drop of 2 per cent acetocarmine stain was placed on the pollen grains. The number of pollen grains that took the stain was counted for 100 total pollen grains and the percentage was calculated.

Pollen germinability (*in vitro*)

Recently opened flowers were collected from the tenth nodal clusters between 8.00 and 9.00 A.M. and the anthers were twisted to make them dehisce and the pollen was taken out using No.2 "W & N Sable – Hairbrush". The solutions of 10% sucrose and 10 ppm boric acid were prepared. The pollen grains were placed on the cavity slides and the above solution was added. These were placed in petri dishes over glass rods containing moist filter paper and water column covering about 2 mm of the dish-bottom. A moist filter paper was also fastened to the under surface of the dish-cover. Then it was kept for 24 hours incubation under room temperature. The germination percentages were worked out after counting the pollen grains that germinated using a microscope at 10 X The germination percentage was calculated as follows:

$$\text{Per cent pollen germination} = \frac{\text{Number of germinated pollen grains}}{\text{Total number of pollen grains in microscopic field}} \times 100$$

RESULTS

Assessment of female fertility

Each genotype was crossed with potential diploid male parent *viz.*, Rose, Hatidat or Ambalakadali and the number of flowers crossed varied from 14 to 64 (Table 1). However, the seed set and seed germination were observed only in three genotypes viz., Chakkiya, Alshy and Gouria, indicating their female fertile status. The seedlings however survived were only from Alshy. All the other seven genotypes proved to be parthenocarpic but not female fertile.

Seed set and germination

A total of 816 crosses were attempted in 26 cross combinations. Out of these, only 3 cross combination resulted in seed set, accounting a total of 79 seeds of which, 55 viable seeds were sown (Table 2). Seed germination ranged from 2.56 to 20 per cent in different cross combinations. The highest germination per cent was noticed in the Alshy x Rose cross combination and he least germination was recorded in the cross combination of Chakkiya x Ambalakadali. Out of 55 viable seeds obtained from the entire cross combinations, only 4 seeds from 3 cross combinations were germinated, which accounted to 5.06 per cent of the total seeds obtained.

Assessment of male fertility

The pollen output among the genotypes ranged from 1000 to 17,500 pollen grains per anther (Table 2). Among them, Bagner recorded the maximum number of pollen grains per anther (17,500), followed by Alshy (12500), whereas the minimum number of pollen grains per anther was recorded with Pidi Monthan (1000). Pollen stainability also differed considerably among the genotypes. The genotype Bagner recorded the maximum pollen stainability (64.60 %) followed by Chakkiya (58.50 %). The minimum stainability (28.09 %) was recorded with Barsain. The pollen germination also did differ among the genotypes (Table2). Bagner recorded the highest per cent of germination (11.33 %), closely followed by Monthan (11.29 %) and the least per cent of pollen germination was recorded in Pidi Monthan (3 %).

Table 1: Seed set and seed germination percentage of cooking banana genotypes

S. No.	Female plant (ABB)	Male plant (AA/AAA)	No. of female flowers crossed	No.of Seed set	No. of Seed germination	Germination (%)	No. of seeds Survived	Survival (%)	Female fertility
1.	Chakkiya	Rose	35	-	-	-	-	-	P
		Hatidat	42	-	-	-	-	-	P
		Ambalakadali	48	39	1.00	2.56	-	-	NP
2.	Bagner	Rose	64	-	-	-	-	-	P
		Hatidat	48	-	-	-	-	-	P
3.	Alshy	Rose	24	10	2.00	20.00	2	20	NP
4.	Gouria	Rose	24	30	1.00	3.33		-	NP
		YKM 5	22	-	-	-	-	-	P
		Hatidat	32	-	-	-	-	-	P
5.	Bankel	Anaikomban	47	-	-	-	-	-	P
		Ambalakadali	16	-	-	-	-	-	P
		Hatidat	16	-	-	-	-	-	P
6.	PacchaMonthan	Rose	24	-	-	-	-	-	P
		Hatidat	28	-	-	-	-	-	P
7.	NallaMonthan	Rose	24	-	-	-	-	-	P
		Hatidat	14	-	-	-	-	-	P
		Ambalakadali	26	-	-	-	-	-	P
8.	PidiMonthan	Rose	24	-	-	-	-	-	P
		Ambalakadali	22	-	-	-	-	-	P
9.	Barsain	Hatidat	32	-	-	-	-	-	P
		Ambalakadali	42	-	-	-	-	-	P
		Rose	24	-	-	-	-	-	P
10.	Monthan	Erachivazhai	62	-	-	-	-	-	P
		Rose	42	-	-	-	-	-	P
		Anaikomban	12	-	-	-	-	-	P
		Hatidat	22	-	-	-	-	-	P
Total			816	79	4.00	5.06	2.00	2.53	-

Table 2: Palynological studies in cooking banana genotypes

S. No.	Genotypes	Ploidy level	Pollen output per anther	Pollen Stainabililty (%)	Pollen Germination (%)
1.	Chakkiya	ABB	7500.0	58.50	8.00
2.	Bagner	ABB	17500.0	64.60	11.33
3.	Alshy	ABB	12500.0	43.00	5.66
4.	Gouria	ABB	6250.0	45.50	8.33
5.	Bankel	ABB	5833.3	38.87	7.11
6.	PachaMonthan	ABB	2000.0	33.82	5.60
7.	NallaBontha	ABB	2750.0	39.11	6.80
8.	PidiMonthan	ABB	1000.0	29.09	3.00
9.	Barsain	ABB	1750.0	28.09	4.20
10.	Monthan	ABB	7083.3	41.73	11.29

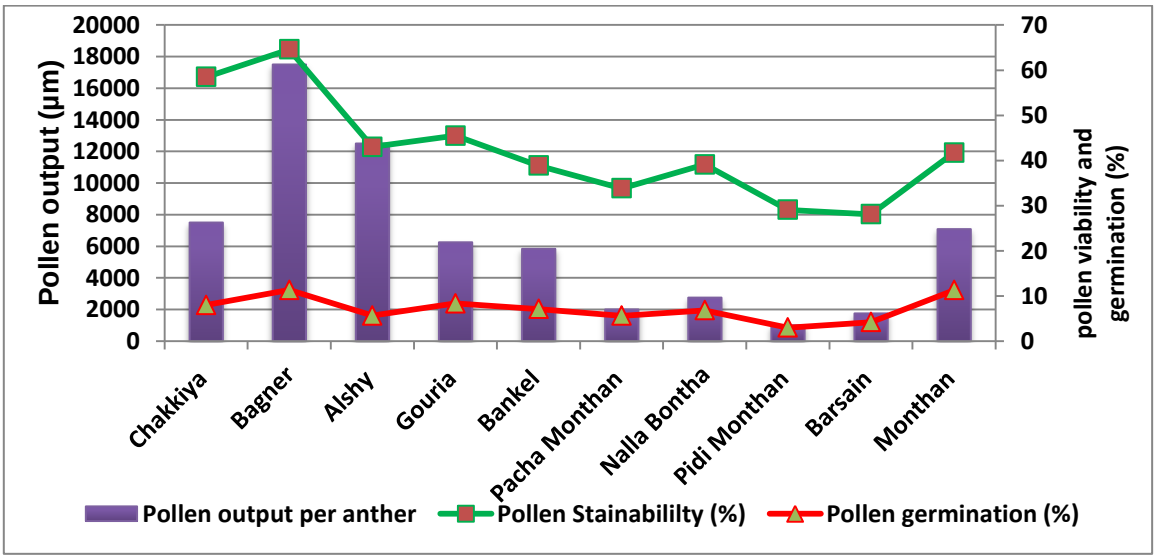

Fig. 1: Male fertility of cooking banana genotype

DISCUSSION

South India particularly Tamil Nadu is known for utilizing many cooking types of banana such as Monthan, Pidi Monthan, Nalla Bontha *etc.* However, no report is available on their breeding potential so far. In the present study, apart from these three popular cooking banana cultivars, seven more were also drawn from the germplasm maintained at Department of Fruit Crops. Thus a total of ten ABB cooking type banana genotypes were utilized in the present study. Evaluation of female and male fertility is considered as an important factor in the breeding programmes as genetic

improvement in *Musa* depends on its male and female fertility[7]. The female fertility was measured by their ability to set seeds when pollinated with pollen using highly fertile male parent. In the present study, out of ten cooking bananas used, three types *viz.*, Chakkiya, Gouria and Alshy are found to be non parthenocarpic producing viable seeds while rest of the seven produced no seeds (parthenocarpic) when crossed with polleniferous diploid cultivars. Generally banana with ABB genome are known to produce viable seeds upon crossing and failure in the present study may be due to seasonal effect, type of male parents used and also the number of crosses attempted per bunch. Sathiamoorthy[5] also faced similar problems when crossing certain diploids and triploids. On the contrary, in an earlier study by Krishnamoorthy[2], crossing with Karpooravalli (ABB) as female parent resulted in more seeds. Further, Karpooravalli (ABB) is known to often produces seeds under natural conditions without any artificial crossing , suggesting that this ABB type is highly female fertile. Hence, in order to rule out all the seven parthenocarpic types as female sterile, there is a need to take up further crossing in future with many diploid parents at different seasons to rule out all the limiting factors. The present study, out of ten cooking bananas used, three types *viz.*, Chakkiya, Gouriab and Alshy are found to be non parthenocarpic producing viable seeds while rest of the seven produced no seeds (parthenocarpic) when crossed with polleniferous diploid cultivars. Generally banana with ABB genome are known to produce viable seeds upon crossing and failure in the present study may be due to seasonal effect, type of male parents used and also the number of crosses attempted per bunch. Sathiamoorthy[5] also faced similar problems when crossing certain diploids and triploids. On the contrary, in an earlier study by Krishnamoorthy[2], crossing with Karpooravalli (ABB) as female parent resulted in more seeds. Further, Karpooravalli (ABB) is known to often produces seeds under natural conditions without any artificial crossing, suggesting that this ABB type is highly female fertile. Hence, in order to rule out all the seven parthenocarpic types as female sterile, there is a need to take up further crossing in future with many diploid parents at different seasons to rule out all the limiting factors.

ABB type genotypes are rarely used as male parents in banana breeding programme. However if used, it is possible that they can possibly produce different types of pollen grains with genomic constitution of A or BB or AB, making it probable for developing new genomic combinations. This calls for assessing the male fertility status of these ABB types. The male fertility assessed in ten genotypes of cooking banana in the present investigation revealed that there is considerable variability in pollen production per anther between the genotypes, with wide variation also in pollen stainability (28 to 64.60 %), however, with narrow range of pollen germination (3 to 11.33 %) among the ten genotypes (Figure 1). This indicates that there is a possibility that these pollen grains could be used as potential male source for banana improvement. The earlier study has indicated acetocarmine staining of pollen grain was not a reliable indication for pollen viability as it stained only the cytoplasm of viable pollen grains and cannot be taken as a full proof for viability and germination. This suggests that these ABB types should be actually used in the breeding programme as male parent to declare them as male fertile or otherwise.

REFERENCES

1. Damodaran, T., Breeding for resistance to *Fusarium* wilt and nematodes in banana (*Musa* spp.). Ph.D. (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore (2003).
2. Krishanmoorthy, V., Breeding for resistance to Sigatoka leaf spot and nematodes in banana (*Musa* spp.). Ph.D. (Hort.)Thesis**,** Tamil Nadu Agricultural University, Coimbatore. (2002).
3. Rowe, P.R. and Richardson, D.L., Breeding bananas for disease resistance, quality and yield. Tech. Bull. No.2. Trop.

Agrl. Res. Ser**.**, La Lima, Honduras. 25 pp. (1975).

4. Sathiamoorthy, S., Preliminary investigations on breeding potential of some banana clones. M.Sc. (Agri.) Thesis, Tamil Nadu Agriculture University, Coimbatore (1973).
5. Sathiamoorthy, S., Studies on male breeding potential and certain aspects of breeding bananas. Ph.D. (Hort.) Thesis, Tamil Nadu Agriculture University, Coimbatore (1987).
6. Swennensharrock, R.S. and Frison, E., Biotechnology in support of small holders cultivating bananas in tropics. In**:** *Proceedings of sustainable agriculture in the New Millennium*. The Impact of Biotechnology on Developing countries, May 28–31, 2000, Belgium, p.155–161 (2000).
7. Vuylsteke, D., Ortiz, R. and Swennen, R., Genetic improvement of plantains and bananas at IITA. *Info Musa*, **2:** 10-12 (1993).