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Analysis of banana genome groups of wild and cultivated cultivars of Manipur, India using sScore card method

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ABSTRACT

Banana is the one of the most important fruit plants of Manipur which is related with the culture. There are many indigenous banana varieties in Manipur as wild and cultivated forms, some banana Pseudo stem and male buds are used as medicinal plants for women, some groups are very costly because of their rarity of cultivation and used only in holistic purpose. Some wild species of bananas like Ensete glaucum, Musa cheesmanii, M. magnesium, M. balbisiana, Musa laterita, etc. have been recorded from the state. Many domesticated banana have proved to be triploid, (2n= 3x = 33) with genome constitution of AAA, AAB or ABB. There are also seedless cultivated AA and AB diploid, and tetraploids (2n= 4x = 44) with genome constitution of AAAA, AAAB, AABB and ABBB. Researchers have used modified genome score card (Singh & Uma, 1996) and 15 important characters of banana plants were used for genome classification of the banana. There are mainly two types of banana genome i.e. AA genome (Musa acuminata) and BB genome (Musa balbisiana) and in the genome score cards are developed with two sections. In the AA genome section's characters were carried 1 mark each on the other hand the BB section characters were carried 5 marks of each character. Most of the cultivars are triploid in nature, tetraploid and vary rare type of diploid is also found and some of the samples were the same genome score but different in their morphological and floral characters, some are same genome type but different in genome scores and some of the cultivars have overlapping scores between the genome types so these need to be characterised using molecular markers.

Key words: *Ensete glaucum, Genome, Tetrapliod, Musa acuminate, Musa balbisiana, Genotype,* Ovules, Pseudostem and Lanceolate.

INTRODUCTION

Manipur is also very rich state in terms of biodiversity as well as culture. Banana is the one of the most important fruit plants of Manipur which is related with the culture. In the auspicious occasion, different types of bananas are used for different purposes. Banana is used in three categories i. e., Banana fruit is used as religious fruit, leave is used as plate, Pseudo stem and male buds are used as vegetables for making curry. There are many indigenous banana varieties in Manipur as wild and cultivated forms, some banana Pseudo stem and male buds are used as medicinal plants only for the Women, some groups are very costly because of their rarity of cultivation and used only in holistic purpose, others are only for their leave, pseudostem, male bud.

The main purposes of banana plantation in Manipur are for their fruits to eat or for their leaves for the preparation of disc. The banana is a perennial giant herb of the genus *Musa* and for the fruit they produce. The centre of origin of the group is in South-East Asia, where they occur from India to Polynesia [Simmonds, 1962]. Almost all modern edible bananas come from the two wild species *Musa acuminata* and *Musa balbisiana*. The scientific names of bananas are *Musa acuminata*, *Musa balbisiana* or hybrids *Musa acuminata* × *balbisiana*, depending on their

genomic constitution [Simmonds, et. al. 1995, taxonomy and origin of the cultivated banana J. *Linn.* Soc. Bot. 55: 302-12].

There are some wild species of banana like *Ensete glaucum, Musa cheesmanii; M. magnesium, M. balbisiana, Musa laterita,* etc. have been recorded from the state. Wild bananas originated in Asia and were domesticated over a thousand years ago. Cultivation spread westward through the Middle East and sub-Saharan Africa, where the plants were 'discovered' by European explorers who then introduced bananas to the New World in the 16th century.

Researchers Norman Simmonds and Ken Shepherd proposed the genome-based nomenclature system in 1955. This system eliminated almost all the difficulties and inconsistencies of the nomenclature system of bananas based on *Musa sapientum* and *Musa paradisiaca*. Despite this, *Musa paradisiaca* is still recognized by some authorities today, leading to confusion.

In 1955, Simmonds and Shepherd [both of whom coincidentally died in 2002] devised a new nomenclature system for the edible fruit bearing bananas based on their genotype. Simmonds and Shepherd listed various features that were characteristic of *Musa acuminata* and *M. balbisiana* and gave them arbitrary numerical values. They then scored plants based on a visual assessment of these characters and together with knowledge of the chromosome number of the plants; they were able to assign them to various genome groups. *Musa acuminata* was designated as genotype AA and *Musa balbisiana* as BB; both are diploid species. Some edible bananas were found to have an AA or AB genotype but the vast majority is triploid. The bananas we are most familiar with in western supermarkets have an AAA genotype; they are derived completely from *Musa acuminata*. These AAA genotype bananas dominate world trade but globally they are not the most important bananas. AAB and ABB genotypes are far more important in Africa and Asia where they are grown by hundreds of thousands of small farmers and are staple foods for millions.

The placing of edible bananas into genome groups based on visual scoring requires a high degree of skill but has been done to the satisfaction of most for all banana cultivars. Modern genetic techniques have largely supported genome assessments made by Simmonds and Shepherd's system but significant changes have sometimes been made.

Bananas and plantains belong to the family *Musaceae*. The edible *Musa* spp. has their origin in two wild species, *Musa accuminata* Colla with the AA genotype and *Musa balbisiana* with the BB genotype, and their hybrids and polyploids [Simmonds, 1966]. The dessert bananas belong to the AA, AB, AAA, and AAB genomic groups whereas plantain belongs to the ABB genomic group. The *Musa* genus is of great importance in the world due to the commercial and nutritional values of bananas and plantains.

Many domesticated banana have proved to be triploid, (2n= 3x = 33) with genome constitution of AAA, AAB or ABB. There are also seedless cultivated AA and AB diploid, and tetraploids (2n= 4x = 44) with genome constitution of AAAA, AAAB, AABB and ABBB [Daniells et al., 2001].

Bananas are best stored at room temperature. They ripen faster in a warm environment. Placing them in the refrigerator will stop them from ripening and will turn their peel dark. The bananas are still edible if they are placed ripened in the refrigerator, it is just that the skin turns from yellow to dark brown. Bananas best taste when the skin is yellow and speckled with brown sugary spots.

MATERIALS AND METHODS

2.1 Plant materials

All the 15 important plant part's samples were collected from 16 Banana cultivars from different district of Manipur State including hilly areas within these important plant parts female flower, male flowers, bracts, etc. are very much important plant parts and studied very deeply. These included all the indigenous varieties as well as commercial cultivars grown and consumed in the Manipur State.

2.2 Modified genome score card system

Researchers have used modified genome score card (Singh & Uma, 1996) and 15 important characters of banana plants were used for genome classification of the banana. There are mainly two types of banana genome i.e. AA genome (*Musa acuminata*) and BB genome (*Musa balbisiana*) and in the genome score cards are developed with two sections. In the AA genome section's characters will carry 1 mark each on the other hand the BB section characters will carry 5 marks of each are shown in Table no. 1.

The system is based on 15 characters that were chosen because they are different in *Musa acuminata* and *Musa balbisiana*. The possible total scores range from a minimum of 15 to a maximum of 75. The expected scores are 15 for AA and AAA, 35 for AAB, 45 for AB, 55 for ABB and 75 for BB according to Simmonds and Shepherd but modified scoring system is slightly different from Simmonds et al. and modified scoring system is also shown in Table 2.

We studied all the collected samples for their important characters with Simmonds & Shepherd (1982) and Singh & Uma (1996), results are shown in the table 3.

RESULTS AND DISCUSSION

In Manipur, most of the types of bananas have triploid genome types and they are also seedless cultivated cultivars, some are tetraploid and diploid type is very rare with presence of seeded fruits. We found same genome score in sample no. 1 and sample no. 7 but they have different characters again in the sample no. 3 and sample no. 13 also have different characters that sample no. 3 is seeded fruit plant but sample no. 13 is seedless fruit plant but they have the same genome. The sample no. 6, 10 and 16 are also having the same genome score and same genome group but they are different from each other in their morphological as well as floral structure. The sample no. 2, 5, 9, 12, 14 and 15 are also having the same genome group of AAB but different in genome score. The genome score of the Sample no. 4 is 55 but there is no specific genome type of the sample no. 4 but in the Simmonds et al it may have ABB type so we put it in the ABB genome type and the genome score of the sample no. 8 is 51 and it is also did not have specific genome type in the genome score card so we put it again in the ABB genome type, these two samples are indigenous cultivars of the Manipur. In our study we found many overlapping scores between the genome types also found same genome types but having different scores so these need to be characterised by using molecular markers.

Table 1. Simmonds and Shepherd's scoring system

Character	*Musa acuminata*	*Musa balbisiana*
Pseudostem colour	More or less heavily marked with brown or black blotches	Blotches very slight or absent
Petiole canal	Margin erect or spreading, with scarious wings below, not clasping pseudostem	Margin inclosed, not winged but clasping pseudostem
Peduncle	Usually downy or hairy	Glabrous
Pedicels	Short	Long
Ovules	Two regular rows in each loculus	Four irregular rows in each loculus
Bract shoulder	Usually high (ratio<0.28)	Usually low (ratio>0.30)
Bract curling	Bracts reflex and roll back after opening	Bracts do not reflex
Bract shape	Lanceolate or narrowly ovate, tapering sharply from the shoulder	Broadly ovate, not tapering sharply
Bract apex	Acute	Obtuse
Bract colour	Red, dull purple or yellow outside; pink, dull purple or yellow inside	Distinctive brownish-purple outside; bright crimson inside
Colour fading	Inside bract colour usually fades to yellow towards the base	Inside bract colour usually continuous to base
Bract scars	Prominent	Scarcely prominent
Free tepal of male flower	Variably corrugated below tip	Rarely corrugated
Male flower colour	Creamy white	Variably flushed with pink
Stigma colour	Orange or rich yellow	Cream, pale yellow or pale pink

Table 2. Modified score card for assigning tentative genomic groups

Genomes	Score card of		
	Simmonds & Shepherd (1982)	Silayoi & Chomchalow (1987)	Singh & Uma (1996)
AA/ AAA	15- 23	15-25	15-25
AAB	24-46	26-46	26-45
AB	49	-	46-49
ABB	59-63	59-63	59-65
ABBB	67	-	66-69
BB/ BBB	-	70-75	70-75

Table 3. Genome scores of the 16 banana cultivars of Manipur

Sl. No.	Cultivars	Scores	Genome types
1.	Heijao-III (Sample 1)	47	AB/AABB
2.	Champa cola (Sample 2)	35	AAB
3.	Changbi langou (Sample 3)	71	BB/BBB
4.	Gera hei (Sample 4)	55	ABB
5.	Hangou hei (Sample 5)	46	AAB
6.	Hei colla (Sample 6)	63	ABB
7.	Heijao Tamhei-1 (Sample 7)	47	AB/AABB
8.	Heikok (Sample 8)	51	ABB
9.	Hei Laa (Sample 9)	42	AAB
10.	Heiren (Sample 10)	63	ABB
11.	Korobot (Sample 11)	23	AA/AAA
12.	Laphu thambal (Sample 12)	39	AAB
13.	Mapal Heijao (Sample 13)	71	BBB
14.	Maring Hei (Sample 14)	31	AAB
15.	Mayang Hei (Sample 15)	43	AAB
16.	Heijao Tamhei-2 (Sample 16)	63	ABB

CONCLUSION

We found that most of the cultivars are triploid in nature, tetraploid and vary rare type of diploid is also found. Some of the samples are the same genome score but different in their morphological and floral characters, some are same genome type but different in genome scores and some of the cultivars have overlapping scores between the genome types so these need to be characterised using molecular markers.

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