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A New Variety of *Musa* sp. Found in Mizoram, North-East India

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ABSTRACT

The present paper deals with the collection of a new variety of *Musa* sp. from Khumtung of Serchhip District, Mizoram in North-East India. A detailed description and photographs are provided for easy identification of the species. Correct identification based on genome score is very important in this region owing to presence of high diverse ethnic groups each naming the variety differently.

Keywords *Musa,* Khumtung, New record, Mizoram.

INTRODUCTION

Banana is perennial herb having a genus name, *Musa.* Among all other herbaceous plants, banana is the largest with its pseudostem reaching a height of 2—8 m in cultivated varieties and upto 10-15 m in some wild species. It is a very fast growing crop and can be harvested all year round. It is the fourth most important food crop in the world. India ranks the highest in the production of banana. It is native to the Indo-Malesian, Asian and Australian tropics and is now found throughout the tropics and sub—tropics. Major banana producing states in India are Tamil Nadu, Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Assam and Madhya Pradesh. Production statistics in 2004 show that banana is an important crop in three major regions : Asia, Latin America and Africa.

The origination of cultivated bananas and plantain is from two wild diploid species, *Musa acuminata* and *M. balbisiana*, with many cultivars being hybrids of the two. *Musa* sp. cultivars vary greatly in plant height, fruit size, plant morphology, fruit quality and disease and insect resistance. In many developing countries, banana contribute to the food security of millions of people and when traded in local markets they provide income and employment to rural populations. Among the varieties, *M. balbisiana* has more diversity in India and majority of the *Musa* species are found in wild conditions, widely distributed throughout the North-East India. Some detailed work on the morphology of the shoot system in banana has been reviewed by Hore et al. (1992), Karamura and

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Karamura (1995), Subbaraya (2006), Sulistyaningsih et al. (2014), Cheeseman (1948—1950), Nelson et al. (2006), Karuna and Rao (2013), Moore (1957).

Bananas also have the largest leaf area, which varies between cultivars and depends upon growing conditions. The areas of individual leaves of dessert banana being 1.27—2.80 m^2 (Borborah et al. 2016, Joe et al. 2014, Silva et al. 2009). But those of plantain are less (0.68—0.92 m^2). The overall leaf area of Cavendish cultivars at flowering may be 16.9—25 m^2. This imposing leaf array provides a close canopy and protects the soil from rain impact and oxidative insolation. In this way the banana crop acts as a good replacement for the cleared tropical forest and this environmental friendliness may be directly attributed to the aerial shoot. It therefore follows that understanding the shoot system will go a long way in enhancing full exploitation of the plant's attributes both as a cash crop, staple food, a source of industrial raw materials and as a conserver of the environment.

Banana production is seriously threatened by *Fusarium* wilt (FW), a disease caused by the soil-borne-fungus *Fusarium oxysporum* f. sp. *cubense* (*Foc*). It is a devastating disease of banana worldwide. Infection occurs through roots and progresses to the pseudostem. Symptoms are internal stem necrosis(reddish or reddish-brown xylem), root and rhizome rot, yellow leaves, plant wilting and plant death. Plants may die during flowering or during periods of moisture stress. The fungus may survive decades in soils. In the mid-twentieth century FW, also known as "Panama disease", wiped out the Gros Michel banana industry in Central America. The devastation caused by *Foc* race 1 was mitigated by a shift to resistant Cavendish cultivars, which are currently the source of 99% of banana exports. However, a new strain of *Foc,* the tropical race 4 (TR4), attacks Cavendish clones and a diverse range of other banana varieties *Foc* TR4 has been restricted to East and parts of South-East Asia for more than 20 years, but since 2010 the disease has spread Westward into five additional countries in South-East and South Asia (Vietnam, Laos, Myanmar, India and Pakistan) and at the transcontinental level into the Middle East (Oman, Jordan, Lebanon and Israel) and Africa (Mozambique). The spread of *Foc* TR4 is of great concern due to the limited knowledge about key aspects of disease epidemiology and the lack of effective management models, including resistant varieties and soil management approaches.

During a field work conducted in the year 2017 for collection, taxonomy, molecular characterization and conservation of *Musa* germplasm from North—Eastern Region (NER) of India, certain varieties of wild as well as cultivated banana cultivars were collected. Among the collected varieties, a particular type of wild inedible banana was found in a village called Khumtung, located in the outskirt of Aizawl city. It differs from other *Musa* sp. in a number of attributes.

MATERIALS AND METHODS

Collection site

Khumtung is the village where the banana species is collected. It is located around 19.9 km away from Aizawl, the nearest district head quarter. It is situated in the Northern part of Mizoram between 23°33.709'N latitude and 92°51.014' E longitude. The mean maximum and minimum temperatures recorded were 36°C and 24°C in September, 2017. The mean maximum and minimum relative humidity was 100 and 58% and the average humidity being 87%. The soil type is clay loam in texture and is acidic.

Data collection

Researchers have used genome score card of Singh and Uma (1996), Singh et al. (2014) and this was used for the genome classification of the collected banana species. 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 carry1mark each on the other hand the BB section characters will carry 5 marks of each are shown in Table1, Fig. 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,

Table 1. Simmonds and Shepherd's (1996) scoring system.

Characters	*Musa acuminate*	*Musa balbisiana*
Pseudostem color	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 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 color	Red, dull purple or yellow outside; pink, dull purple or yellow inside	Distinctive brownish-purple outside; bright crimson inside
Color fading	Inside bract color usually fades to yellow towards the base	Inside bract color usually continuous to base
Bract scars	Prominent	Scarcely prominent
Free tepal of male flower	Variably corrugated below tip	Rarely corrugated
Male flower color	Creamy white	Variably flushed with pink
Stigma color	Orange or rich yellow	Cream, pale yellow or pale pink

35 for AAB, 45 for AB, 55 for ABB and 75 for BB and modified scoring system is also shown in Table 2. We studied all the collected samples for their important characters with Singh and Uma (1996), Kumar and Panday (2010), results are shown in the Table 3. Accordingly, pseudostem height was measured from the base of the plant to the emerging point of the peduncle. The girth of pseudostem was measured around the circumference at 100 cm using meter tape. Leaf habit was also determined through observation. Pseudostem appearance also recorded on the basis of color, shininess (not waxy) or dullness (waxy). Pigmentation of the underlying pseudostem was also recorded. By cutting the external sheath of the pseudostem, the characteristics of the sap color was recorded. The number of suckers was counted and the development of suckers was observed on the tallest sucker. This observation is in relation to the parent plant. Different attributes of the petiole was also carefully observed and recorded. Color of the leaf dorsal and ventral surface along with the midrib was also recorded. Likewise, cigar leaves, inflorescence, peduncle, bunch and rachis characteristics were all recorded at the collection site. The bunch containing the male bud, fruits, rachis and peduncle was taken to the laboratory for further observations.

Table 2. Score card for assigning tentative genomic groups.

Genomes	Simmonds and Shepherd (1982)	Singh and Uma (1996)
AA/AAA	15–23	15–25
AAB	24–46	26–45
AB	49	46–49
ABB	59–63	59–65
ABBB	67	66–69
BB/BBB	–	70–75

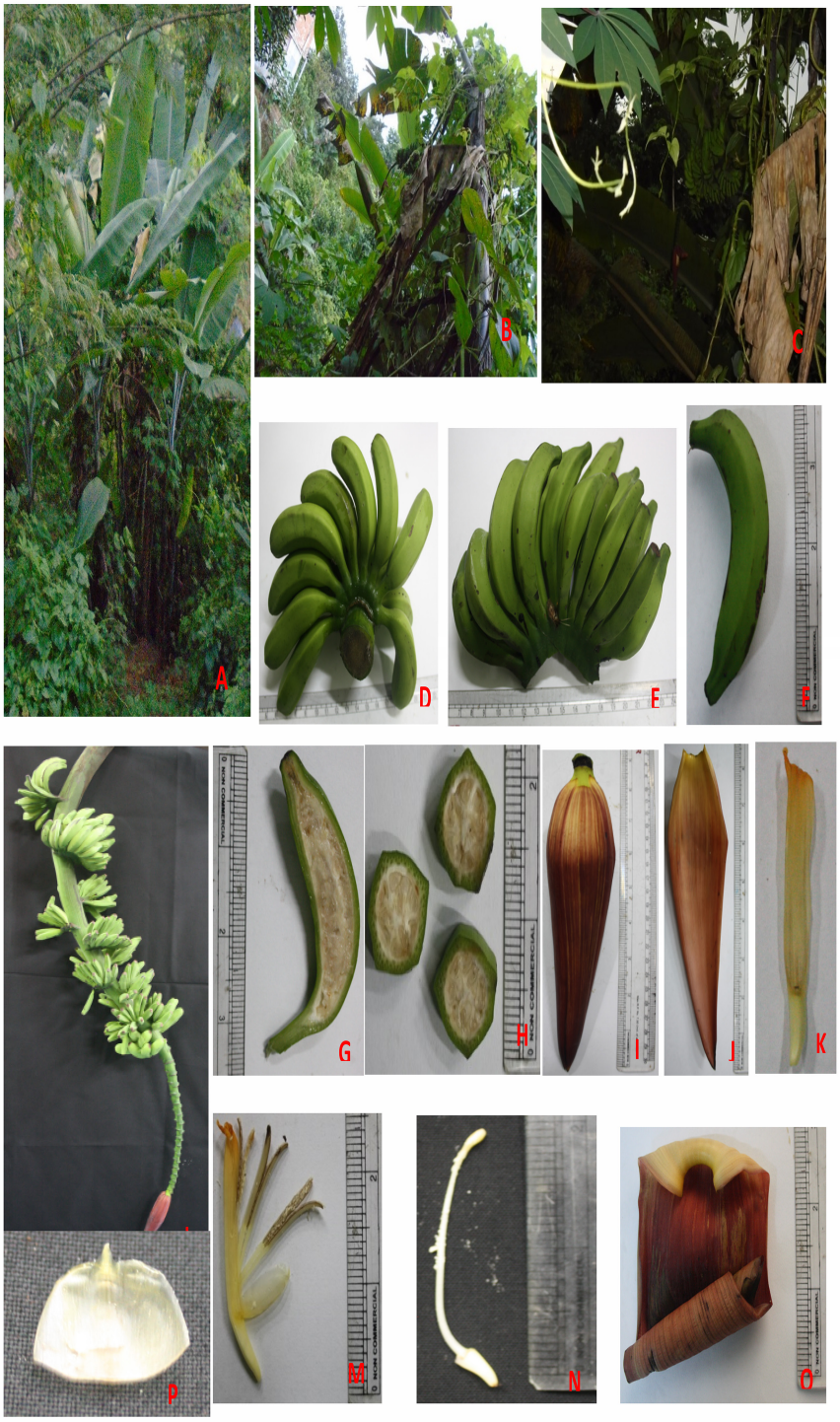

Fig.1. A. Pseudostem, B. Fruit bunch, C. Fruit bunch, D. Fruits, E. Fruits, F. Fruit, G. Longitudinal section of fruit, H. Transverse section of fruit, I. Male bud, J. Bract, K. Compondtepal, L. Bunch, M. Male flower, N. Style, O. Outermost curled bract, P. Free Tepal.

Table 3. Passport data of the collected unknown *Musa* sp. according to the descriptors of banana.

Accession descriptors		
1.2	Donor name	Pu. Lalthakima
1.5.1	Genus	Musa
1.6.3	Year of release/year of registration	25-09-2017
1.9	Type of material received	Bunch, male bud, fruits, leaves and pseudostem
Collecting descriptors		
2.4	Collecting date of original sample (DDMMYYYY)	25-09-2017
2.5	Country of collecting	India
2.6	Province/State	Mizoram
2.8	Location of collecting site	MZU
2.9	Latitude of collecting site	23°33.709'N
2.10	Longitude of collecting site	92°51.014'E
2.11	Elevation of collecting site	996.69 m
2.12	Collecting source	Farm
2.14	Type of sample	Bunch, male bud, fruits, leaves and pseudostem
2.15	Status of sample	Wild
2.17	Ethnic group	Mizo
2.18.2	Cropping system	Food crop
2.18.2.1	Monoculture (pure banana stand)	Mix cropping
2.18.2.2	Mixed cropping	Mostly food crop\
2.19	Associated flora	Tree, herbs, shrubs
2.21	Plant population density	Intermediate
2.23	Other parts of the plant used	Leaves and male bud
2.25	Photograph	1) Yes
Characterization and/ or evaluation site descriptors		
4.1	Country of characterization and/or evaluation	India
4.2	Site (research institute)	MZU Departmental
4.2.1	Latitude	23°33.709'N
4.2.2	Longitude	92°51.014'E
4.2.3	Elevation (m)	996.69 m
4.2.4	Name of farm or institute	Mizoram University
4.8	Field spacing	
4.8.1	Distance between plants in a row (m)	1.5 m
4.8.2	Distance between rows (m)	2 m
4.9	Cropping system	Mixed crop
4.11	Fertilizer	No usage of fertilizers
Collecting and/or characterization/evaluation site environment descriptors		
Site environment		
5.1.1	Topography	6) Hilly
5.1.2	Higher level landform (general physiographic features)	6) Hill
5.1.3	Land element and position	19) Upper slope
5.1.6	Crop agriculture	1) Annual field cropping
5.1.7	Overall vegetation surrounding and at the site	3) Forest
5.1.10	Soil drainage	7) Well drained
5.1.13	Soil matrix color	16) Black
5.1.15	Soil erosion	7) High
5.1.19	Water availability	1) Rain fed

Table 3. Continued.

5.1.20	Soil fertility	5) Moderate
5.1.21.6	Light	7) Sunny
Plant descriptors		
6.1	**Plant general appearance**	
6.1.1	Leaf habit	1) Erect
6.1.2	Dwarfism	1) Normal
6.2	**Pseudostem/Suckers**	
6.2.1	Pseudostem height (m)	2) 2.1 to 2.9 m
6.2.2	Pseudostem aspect	1) Slender
6.2.3	Pseudostem color	3) Green
6.2.4	Pseudostem appearance	1) Dull
6.2.5	Predominant underlying color of the pseudostem	1) Watery green
6.2.6	Pigmentation of the underlying pseudostem	1) Pink-purple
6.2.7	Sap color	1) Watery
6.2.8	Wax on leaf sheaths	4) Very waxy
6.2.9	Number of suckers	eight
6.2.10	Development of suckers	4) Inhibited
6.2.11	Position of sucker	3) Close to parent (vertical growth)
6.3	**Petiole/mid rib/leaf**	
6.3.1	Blotch at the petiole base	2) Small blotches
6.3.2	Blotches color	1) Brown
6.3.3	Petiole canal leaf III	3) Straight with erect margins
6.3.4	Petiole margins	3) Winged and clasping the pseudostem
6.3.5	Wing type	2) Not dry
6.3.6	Petiole margins color	1) Green
6.3.7	Edge of petiole margin	1) Colorless
6.3.8	Petiole margin width (cm)	1) ≤1 cm
6.3.9	Leaf blade length (cm)	3) 221 to 260 (259 cm)
6.3.10	Leaf blade width (cm)	2) 71-80 (69 cm)
6.3.10.1	Leaf ratio	–
6.3.11	Petiole length (cm)	3) 75 cm
6.3.12	Color of leaf upper surface	3) Green
6.3.13	Appearance of leaf upper surface	1) Dull
6.3.14	Color of leaf lower surface	3) Green
6.3.15	Appearance of leaf lower surface	1) Dull
6.3.16	Wax on leaves	3) Moderately waxy
6.3.17	Insertion point of leaf blade on	2) Asymmetric
6.3.18	Petiole	2) One side rounded one pointed
6.3.19	Shape of leaf blade base	2) Few stripes
6.3.20	Leaf corrugation	2) Light green
6.3.21	Color of midrib dorsal surface	2) Light green
6.3.22	Color of midrib ventral surface	1) Green
6.3.23	Color of cigar leaf dorsal surface	2) Little or narrow blotches
	Blotches on leaves of water suckers	
6.4	**Inflorescence/male bud**	
6.4.1	Peduncle length (cm)	2) 31—60 cm (48 cm)
6.4.2	Empty nodes on peduncle	One Node
6.4.3	Peduncle width (cm)	1) ≤ 6 cm (4 cm)
6.4.4	Peduncle color	3) Dark green
6.4.5	Peduncle hairiness	3) Very hairy
6.4.6	Bunch position	2) Slightly angled
6.4.7	Bunch shape	5) Spiral
6.4.8	Bunch appearance	3) Very compact
6.4.9	Flowers that form the fruit	1) Female

Table 3. Continued.

6.4.10	Fruits	2) Biseriate
6.4.11	Rachis type	2) Present and male bud may be degenerated or persistent
6.4.12	Rachis position	2) At an angle
6.4.13	Rachis appearance	1) Bare
6.4.14	Male bud type	1) Normal
6.4.15	Male bud shape	1) Like a top
6.4.16	Male bud size (cm)	2) 21—30 cm
6.5	**Bract**	
6.5.1	Bract base shape	2) Medium
6.5.2	Bract apex shape	2) Slightly pointed
6.5.3	Bract imbrication	1) Old bracts overlap at apex of bud
6.5.4	Color of the bract external face	4) Red-purple
6.5.5	Color of the bract internal face	3) Orange red
6.5.6	Color on the bract apex	1) Tinted with yellow
6.5.7	Color stripes on the bract	2) With discolored lines or stripes on the external
6.5.8	Bract scars on rachis	
6.5.9	Fading of color on bract base	1) Very prominent
6.5.10	Male bract shape	1) Color discoloring towards the base
6.5.11	Male bract lifting	1) <0.28 (0.25) y=15+5 cm x=5 cm
6.5.12	Bract behavior before falling	2) Lifting one at a time
6.5.13	Wax on the bract	1) Revolute
6.5.14	Presence of grooves on the bract	2) Very few wax 1) Few grooves or not grooved
6.6	**Male flower**	
6.6.1	Male flower behavior	1) Falling before the bract
6.6.2	Compound tepal basic color	3) Yellow
6.6.3	Compound tepal pigmentation	1) Very few or no visible sign of pigmentation
6.6.4	Lobe color of compound tepal	3) Orange
6.6.5	Lobe development of compound	3) Very developed
6..6.6	Tepal	3) Tinted with yellow
6.6.7	Free tepal color	2) Oval
6.6.8	Free tepal shape	2) More or less smooth
6.6.9	Free tepal appearance	2) Developed
6.6.10	Free tepal apex development	2) Triangular
6.6.11	Free tepal apex shape	1) Exerted
6.6.12	Anther exertion	2) Cream
6.6.13	Filament color	5) Brown or rusty brown
6.6.14	Anther color	1) White
6.6.15	Pollen sac color	
6.6.16	Pollen vitality (%)	2) Cream
6.6.17	Style basic color	1) Without pigmentation
6.6.18	Pigmentation on style	3) Inserted
6.6.19	Style exertion	1) Straight
6.6.20	Style shape	5) Orange
6.6.21	Stigma color	1) Straight
6.6.22	Ovary shape	2) Cream
6.6.23	Ovary basic color	1) Very few or no visible sign of pigmentation
6.6.24	Ovary pigmentation	3) Yellow
6.6.25	Dominant color of male flower	
6.6.26	Irregular flowers Arrangement of ovules	1) Two rowed
6.7	**Fruit**	
6.7.1	Fruit position	1) Curved towards stalk
6.7.2	Number of fruits	3) ≥ 17 (Twenty one)
6.7.3	Fruit length (cm)	1) ≤15 cm (12.1 cm)

Table 3. Continued.

6.7.4	Fruit shape (longitudinal curvature)	3) Curved
6.7.5	Transverse section of fruit	2) Slightly ridged
6.7.6	Fruit apex	2) Lengthily pointed
6.7.7	Remains of flower relicts at fruit	1) Without any floral relicts
6.7.8	Apex	1) ≤10 mm
6.7.9	Fruit pedicel length (mm)	2) 5 to 10 mm (10 mm)
6.7.10	Fruit pedicel width (mm)	1) Hairless
6.7.11	Pedicel surface	1) Very partially or no visible sign of fusion
6.7.12	Fusion of pedicels	3) Green
6.7.13	Immature fruit peel color	1) Yellow
6.7.14	Mature fruit peel color	1) 2 mm or less
6.7.15	Fruit peel thickness	1) Fruit peels easily
6.7.16	Adherence of the fruit peel	1) Without cracks
6.7.17	Cracks in fruit peel	2) With pulp
6.7.18	Pulp in fruit	1) White
6.7.19	Pulp color before maturity	2) Cream
6.7.20	Pulp color at maturity	1) Persistent
6.7.21	Fruits fall from hands	2) Soft
6.7.22	Flesh texture	2) Tasteless
6.7.23	Predominant taste	3) >20
6.7.24	Presence of seed with source of	1) Smooth
6.7.25	pollen	2) Angular
	Seed surface	
	Seed shape	

Characterization (Singh and Uma 1996)

Characters	Score
(1) Pseudostern color	3
(2) Petiolar canal	3
(3) Peduncle	2
(4) Pedicel	1
(5) Ovules	1
(6) Bract shoulder ratio	2
(7) Bract curling	1
(8) Bract shape	1
(9) Bract apex	2
(10) Bract color	4
(11) Color fading	1
(12) Bract scars	1
(13) Free tepal of male flower	3
(14) Male flower color	3
(15) Stigma color	5

RESULTS AND DISCUSSION

The results of the collected species of banana are presented in the Table 3.

Traditionally, the banana classification is done based on the variation in morphological characteristics; however, sometime it is difficult to correctly classify the banana as the morphological attributes may be affected by local factors such as soil conditions, environment, age and developmental stage of the plant. It is therefore imperative to look for genome score card which would aid in better identification of the species. This is particularly of much use in the region as the region has a very high ethnic diversity where the same banana cultivar may be known by different name (s) in different places, hindering correct identification of the species.

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