Exploration, Collection, Ethnobotany and Morpho-taxonomic Characterization of *Musa* Germplasm from Belgaum, Dharwad and Uttara Kannada Regions of Karnataka

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Parts of Belgaum, Dharwad and Uttara Kannada districts of Karnataka were surveyed for studying *Musa* diversity. A total of 36 accessions were collected and 14 distinct types were identified after characterization using minimum descriptor. Ethnobotanical observations were recorded on some wild *Musa* types in the region. The 14 accessions were planted in field gene bank and characterized for morpho-taxonomic and biometric traits. Results indicated that the 14 accessions belonged to nine distinct groups and subgroups. Their names, synonyms and genomic status have been identified and reported. Biometric data suggested that there is a lot of variability for all the traits studied. Survey for disease occurrence revealed that *banana bunchy top virus* (BBTV), *Banana streak virus* (BSV) and Sigatoka Leaf Spot are the major diseases, while nematodes and pseudostem weevil are important insect-pests occurring on *Musa* accessions collected from the three districts.

Key Words: Characterization, Dharwad, Genetic diversity, *Musa,* Pests, Uttara Kannada

Introduction

India is well-recognized as one of the centers of origin and domestication for the genus *Musa*, comprising banana and plantains (Simmonds 1962; Jacob 1952). Domestication and long periods of cultivation in India have led to the vast diversity in *Musa*. The diversity ranges from delicate edible diploid *acuminata* (AA) types to hardy hybrid triploid (ABB) types. Furthermore, the prevalence of varied agro-climatic conditions has encouraged the development and sustenance of numerous varieties catering to the local needs.

The practice of conferring local names in regional dialects has resulted in a plethora of synonyms, which is the major cause of confusion in the collection and maintenance of large germplasm. Proper characterization helps in unambiguous discrimination among accessions and detecting redundancies. Referring a single cultivar in different names and different names to a single cultivar poses severe problems not only to researchers, but also to the farming community (Uma and Sathiamoorthy, 2002). For example the famous local cultivar of Munavalli region (Belgaum district) – 'Rajapuri' is referred by local farmers in different names such as 'Jawari Bale', 'Wallah', 'Munoli Bale', 'Kullan', 'Gujarathi' etc. (Uma and Sathiamoorthy, 2002).Thus, an exploration programme was executed in Dharwad and Uttara Kannada districts of Karnataka located in the Western Ghats region, which have rich diversity for *Musa*, but not properly documented. The objective was exploration, collection and characterization of *Musa* genetic diversity and to resolve the taxonomic status of the locally named cultivars.

Materials and Methods

In the present study, two different regions of Karnataka were surveyed for *Musa* genetic diversity – North-western region, which is comparatively dry plains, and Uttar Kannada district with moist evergreen forests. Munavalli of Belgaum district which is 60 km (towards north) from Dharwad, is the main banana growing belt of North-western region of Karnataka. This region enjoys rains during June-July and has extremely high temperature during summer. The predominant soil type is black clay while some part has red soil too. The other banana growing belt of North-western Karnataka is Thimmapur region (Dharwad district), where the soil is black clay. This region receives about 1,500 mm rainfall annually.

The second region explored for *Musa* variability (especially for wild banana and *Ensete* spp.) was the moist evergreen hilly area of Uttar Kannada (Karwar district). This region is part of Western Ghats and is a

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high rainfall zone. Among the different places explored, the highest altitude is 1,500 m at Ambikanagar dam site where *Ensete superbum* was found to occur. Areas of exploration are indicated in Fig. 1.

Explorations were conducted during the year 2000 and also in 2009 in the Belgaum, Dharwad and Uttara Kannada districts of Karnataka. The places of exploration lie between 74º–75º East longitude and 14.5º–16º North latitude. A total of 36 accessions were collected. Passport data was collected on-site. Each accession was assigned an accession number.

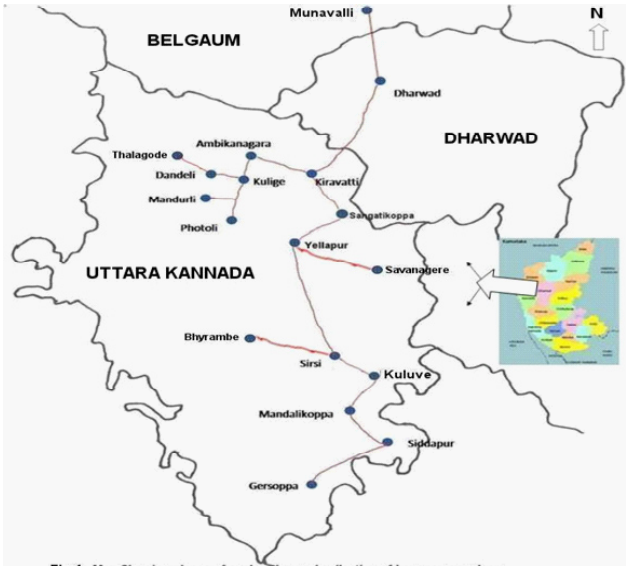

Fig. 1. Map showing places of exploration and collection of banana germplasm

Minimum Crop Descriptor for Banana (http://tag.inibap.org/) was applied to study the nearest grouping of the collected accessions (for the cultivated varieties), while all wild accessions were retained for further studies using molecular characterization. All distinct varieties and wild types (14 nos.) were taken to field gene bank at National Research Centre for Banana (NRCB), Tiruchirapalli, and a duplicate set was supplied to local All India Coordinated Research Project – Tropical Fruits (AICRP - TF) center, Kittur Rani Chennamma College, Arabhavi. Details about accessions collected are given in Table 1. The 15th accession, *Ensete* do not produce suckers and are propagated through fertile seeds. Hence, it could not be taken to field gene bank. During the exploration traditional banana cultivation of the popular cultivar, 'Jawari Bale' was also studied.

The collected accessions were initially planted in the active collection block of NRCB field gene bank and evaluated for morpho-taxonomic and biometric traits. MUSAIDwin software developed by INIBAP/CIRAD (1996) was used to calculate the percent similarity values. Six replicates of each of the 14 accessions were planted in the field gene bank. They were raised under wetland conditions with normal package of practices used for banana cultivation. Morpho-taxonomic characterization of the accessions was carried out using standard banana descriptor (INIBAP/CIRAD 1996). After characterization, they were grouped into standard genomic and sub-genomic categories, along with their probable synonyms grown elsewhere in the country. Data presented is the average of six plants and repeated for two seasons.

Table 1. Accessions collected during the exploration

S.No.	NRCB Accession No.	Name	Location (Latitude/longitude)	Biological status	Genomic group and subgroup
1.	1160	Local Mitli	Kirawatti	domesticated	AB
2.	1156	Shan Bale	Kirawatti	landrace	ABB
3.	1149	Kari Bale	Sangatikoppa	landrace	AAB
4.	1146	Bargi Bale	Sirsi	landrace	AAB
5.	1152	Mitli	Bhyrambe	domesticated	AB
6.	1147	Kaadu Bale-Kuluve	Kuluve	wild	BB
7.	1161	Chandra Bale	Kuluve	domesticated	AAA
8.	1148	Bhoodhi Mitiga	Kuluve	domesticated	ABB
9.	1150	Kaadu Bale-Manjukeri	Manjukeri	wild	BB
10.	1151	Kaadu Bale-Gundha	Gundha	wild	BB
11.	1153	Sakkare Bale	Mandolikoppa	domesticated	ABB
12.	1157	Boodhi Bale	Siddhapura	domesticated	ABB
13.	1158	Rajapuri	Munavali	domesticated	AAB
14.	1159	Mysore Mitli	Haliyal	domesticated	AAB

Results and Discussion

Traditional Way of Banana Cultivation in Munavalli Region of Karnataka

In Munavalli region, the sole banana cultivar under commercial cultivation is 'Rajapuri' (AAB-Pome group), also known as 'Jawari Bale'. 'Rajapuri' is cultivated as a perennial crop; annual replanting of suckers is not practiced in this region. Usually the side suckers are not removed which has resulted in increased incidence of Sigatoka leaf spot and nematode problems. The increased incidence of leaf spot is due to closer spacing between the mats under perennial system of cultivation. Hence, the farming community is now shifting towards Robusta (AAA). Initially, the severely infected clumps of 'Rajapuri' banana is replaced by Robusta suckers which will be maintained for another two years (one main crop plus one ratoon crop) and again fresh planting of 'Rajapuri' banana is being taken up. Though Robusta has been recently introduced, farmers prefer 'Rajapuri' as it fetches premium price in the market and the locals favour 'Rajapuri' for its sweet-acid taste. One of the current startling problem is wide spread occurrence of banana bunchy top disease. The incidence is about 20-25%, which is expected to rise due to ignorance and perennial system of cultivation.

'Rajapuri' banana is maintained under constant perennial system for about 8-12 years. During the first year intercropping is practiced with tomato, chilly and coriander. 'Rajapuri' banana is a hardy cultivar and hence it does perform better under North Karnataka districts. It bears a bunch of 15-18 kg with 6-8 hands. This local cultivar is cultivated organically in this region. About 25-50 kg of well decomposed FYM and sheep manure is dumped around the base of each clump without any organic fertilizers. The local preharvest traders visit the orchard at bunching stage to fix the price of the bunch. The traders prefer organic bananas since they fetch better price because organically grown bananas are said to have extended shelf life after harvest. Non-removal of side suckers and continual system of cultivation results in weekly harvest and marketing of bunches in weekly 'Shandys'. This system fulfils the concept of Subsistence Farming. The other variety, which was noticed in the Munoli/ Munavalli market, is 'Suganthi' (AAB-Mysore), which is not grown commonly in this area but arrives at the local market from other parts of Belgaum district.

Status and Cultivation of Wild Bananas

Rain forest ranges of Western Ghats harbours both wild *Musa* and *Ensete*. Wild banana *Musa balbisiana* was observed under semi-wild conditions which were raised for its leaf and hence it is known as 'Ele Bale' ('Ele' means leaf and 'Bale' means banana, in Kannada) or 'Kaadu Bale'. *Ensete superbum*, the close member of the genus *Musa* was observed in rocky cracks and crevices. It is locally known as 'Kallu Bale'('Kallu' means stony in Kannada, probably denoting its habitat or stony seeds).

Fig. 2. *Musa balbisiana* ('Kaadu Bale')

Musa balbisiana, 'Kaadu Bale' is a seeded, diploid, wild type grown in all rural households of Western Ghats of Karnataka. Banana, both wild and cultivated, is an integral part of backyard gardens. They are also cultivated in *Areca* plantations under multi-storied cropping systems. During the initial years banana serves as shade plant for *Areca*. In due course of time *Areca* becomes the main

crop and banana is maintained to enhance microclimate in the plantations. *Musa balbisiana* with natural tolerance to diseases and pests is preferred by the farmers as it requires minimum care. They also form a perennial source of dining plates due to high phyllochron rate.

Conservation and Perpetuation

Many families have family graves in a corner of their backyard and considered sacred. Suckers of wild types of *Musa*, like 'Kaadu Bale' are usually planted in such vicinities where surroundings are kept clean. Some 10-20 clumps of 'Kaadu Bale' are maintained in each household by the elderly women, taking care of fertilizing, crop production (if necessary) and irrigation etc. Few suckers are carried along while visiting relatives, as a gift along with banana fruits, flowers, betel leaves and sweets (Uma, 2006).

Ensete superbum 'Kallu Bale'

Ensete is the only other important genus in Musaceae. Though there are about 26 species identified by different authors, only nine main species in *Ensete* have been recognized based on their commercial importance and morphological features. They are *E. ventricosum* (Welw.) Cheesman, *E. livingstoniana, E. proboscidea, E. gilletti* (De Wild) Cheesman, *E. buchanani, E. homblei* (Bequaert) Cheesman, *E. perrieri* (Claverie) Cheesman which are prevalent in Africa (Nelson *et al.,* 2006). Current studies have shown that they are not different species, but they are the synonyms for the main 6 species of *Ensete.* India has only two species, *E. superbum* and *E. glaucum*. Unlike *Musa, Ensete* do not produce suckers and are propagated through fertile seeds.

Morpho-taxonomic Characterization of Collected Accessions

A total of 36 accessions were collected. Using minimum descriptors, a total of 15 distinct accessions were identified and 14 of them were taken for characterization and field evaluation. The morpho-taxonomic data for collected 14 accessions (131 traits) revealed distinct nine groups based on genomic (AAA, AB, AAB and ABB) and sub-genomic groups (Ney Poovan, Monthan, Pome etc.) and ploidy levels (2x and 3x). Details are given in Table 2. 'Mitli' and 'Local Mitli' were found synonyms (100%) so also were the three 'Kaadu Bale' (accessions collected from different areas, Kuluve, Gundha and Manjukeri). All were *M. balbisiana* with 99% similarities. 'Bhoodi Bale', 'Kari Bale' and 'Shan Bale' belonged to same group with more than 95% similarities. The 5% of differences probably attributed to ashy fruit nature of 'Boodhi Bale' while 'Kari Bale' and 'Shan Bale' were green 'Monthan' types. 'Chandra Bale' is equivalent of Red Banana. 'Sakkare Bale' and 'Boodhi Mitiga' were similar belonging to Pisang Awak group with ABB genome. 'Bargi Bale' and 'Jawari Bale' grouped together as they belong to Pome subgroup of AAB genome. 'Bargi Bale' is similar to 'Ladan' and 'Pachaladan' of Pome bananas of Tamilnadu. 'Jawari Bale' is an unique landrace with dwarf stature and persistent male bracts and flowers. Most of the growth and other characteristics in comparison with other accessions in respective group is also discussed in previous literature (Uma *et al.*, 2005; Uma and Sathiamoorthy, 2002).

Banana diversity recorded with respect to morphological and biometric traits revealed presence of good diversity among bananas of Western Ghats in Karnataka (Table 3). Data on *Ensete superbum* was not recorded in the present work as it takes more than three years to flower and fruit. Variability with respect to height was found to be varying from 185 cm to 625 cm with lowest being recorded in cultivar 'Rajapuri' (185 cm) and highest being in 'Kadu Bale' (625 cm). Variability with respect to duration indicated a wide range from 326 days ('Bargi Bale') to 585 days ('Kadubale') indicating the suitability of short duration cultivars into the annual cropping system in that area. 'Chandra Bale' followed by 'Rajapuri' and 'Bargi Bale' were found to be poor yielding with lower bunch weight compared to 'Mysore Mitli' and 'Sakkare Bale'. 'Sakkare Bale', 'Boodhi Bale' and 'Boodhi Mitiga' recorded high total soluble sugar (TSS) with good sugar-acid blend compared to other cultivars.

Status of Pests and Diseases on Local Cultivars

Banana attracts a number of pests and diseases, which is aggravated due to perennial cultivation in some traditional banana growing areas (Singh, 2009). Backyard cultivation and polyclonal system is in vogue in the areas surveyed. Backyard cultivation with perennial system has led to spread of several diseases prevalent in the region. None of the commercial cultivars were found to be free of Sigatoka leaf spot disease. Fusarium wilt and *Banana bunchy top virus* (BBTV) infection were noticed in Red banana and 'Karpooravalli' (Table 4). In 'Suganthi' (Mysore-AAB), infestation of pseudostem borer was noticed, while in 'Rajapuri' cultivar in Munavali region, heavy incidence of BBTV was observed.

Table 2. Evaluation and identification of accessions collected and assignment of genomic group and subgroup status

S.No.	Varieties	Genome group	Assignment of subgroup status	National synonyms	International synonyms (Uma and Sathiamoorthy, 2002)
1.	Mitli	AB	Ney Poovan	Elakki Bale, Elarasi	Ney Poovan, Sukali Dizi
2.	Local Mitli	AB	Ney Poovan	Mittuga	–
3.	Boodhi Bale	ABB	Monthan	Ash Monthan, Emmae Bale, Embale, Kachkol	Ash Monthan
4.	Sakkare Bale	ABB	Pisang Awak	Bhoodhi Bale	Pisang Awak, Namwa Khom
5.	Bhoodhi Mitiga	ABB	Pisang Awak	Karpura, Bhoodi Bale, Karpuravalli	Pisang Awak, Namwa Khom
6.	Rajapuri	AAB	Pome	Jawari Bale, Wazha, Munoli Bale, Gujarathi, Kullan	Nil
7.	Mysore Mitli	AAB	Mysore	Poovan, Suganthi, Mysore Poovan, Mittuga	Mysore, Pisang Ceylan
8.	Bargi Bale	AAB	Pome	–	–
9.	Kari Bale	ABB	Bluggoe	–	Bluggoe
10.	Kaadu Bale- Manjukeri	BB	*M. balbisiana*	Ele Bale, Elavazhai	Nil
11.	Kaadu Bale- Gundha	BB	*M. balbisiana*	Ele Bale, Elavazhai	Nil
12.	Kaadu Bale- Kuluve	BB	*M. balbisiana*	Ele Bale, Elavazhai	Nil
13.	Chandra Bale	AAA	Red Banana	Aanbale, Sevvazhai, Agniswar, Agnisagar	Red Dacca
14.	Shan Bale	ABB	Bluggoe	–	Bluggoe

Table 3. Evaluation data on growth, yield and selected fruit parameters

Varieties	Genome group	Plant height (cm)	Pseudo-stem girth	Days to flower	Days to harvest	Bunch weight (kg)	No. of hands	Total no. of fruits	Sugar content (% Brix)	Flesh weight* (g)	Peel weight (g)	Flesh texture	Edible portion (%)
Mitli	AB	340	70	300	410	11	11	160	26	42	68	firm	38
Local Mitli	AB	360	69	295	410	15	12	195	27	56	59	firm	49
Boodhi Bale	ABB	420	76	308	418	16	10	154	30	76	34	firm	69
Sakkare Bale	ABB	384	82	269	388	17	12	172	31	77	42	firm	65
Bhoodhi Mitiga	ABB	399	82	315	430	14	10	146	30	65	50	Medium	57
Rajapuri	AAB	185	80	215	345	9	7	98	22	33	98	Soft	25
Mysore Mitli	AAB	275	74	235	345	18	13	198	25	55	55	firm	50
Bargi Bale	AAB	320	80	194	326	9	8	106	23	46	86	Soft	35
Kari Bale	ABB	390	72	224	344	10	7	108	22	48	72	Firm	40
Kaadu Bale-Manjukeri	BB	620	115	475	520	22	13	160	29	87*	58	Mucilaginous	10
Kaadu Bale-Gundha	BB	625	116	478	520	22	13	160	28	102*	41	Mucilaginous	12
Kaadu Bale-Kuluve	BB	590	120	462	585	24	15	164	28	114*	48	Mucilaginous	10
Chandra Bale	AB	240	56	275	400	8	8	116	26	31	94	Medium	65
Shan Bale	ABB	340	63	200	330	12	5	86	24	52	85	Medium	45

* Mucilaginous flesh with seed weight
Data has been rounded off to next highest value without decimals

Table 4. Major pests recorded in the regions surveyed

S.No.	Area	Varieties	Diseases	Pests
1.	Kirawatti	Ney Poovan, Ash Monthan, Mysore, Shan Bale	BBTV, Sigatoka Leaf Spot	–
2.	Sangatikoppa	Kari Bale	BBTV*	Nematodes
3.	Yallapura	Mundagod Bale (Kari Bale)	BBTV	–
4.	Savanagere	*Musa balbisiana*	BBTV	Nematodes
5.	Sirsi	Ney Poovan, Red banana, Bhoodhi Bale (Pisang Awak), Bargi Bale, Kari Bale, Monthan *Ensete superbum*	BBTV Fusarium wilt, BBTV	Pseudostem borer
6.	Bhyrambe	Bhoodhi Bale (Pisang Awak), Bargi Bale, Mitli (Ney Poovan), Poovan	BBTV, Sigatoka Leaf Spot	Severe incidence of pseudostem borer
7.	Kuluve	Red Banana, Green red, Mysore, Ney Poovan, Bargi Bale, Kari Bale, Bhoodhi mitiga, *Ensete superbum*	BBTV (Severe), Fusarium wilt, BBMV	Pseudostem borer
8.	Mandalikoppa	Karpooravalli, Mitli, (Ney Poovan,), *Musa balbisiana*	BBTV, Fusarium wilt –	
9.	Siddhapura	*Musa balbisiana,* Mysore, Ney Poovan, ed banana, Pachakappa, Bhoodhi Bale (Pisang Awak), Bargi Bale, Kari Bale	BBTV, –	Sigatoka Leaf Spot
10.	Thalagode	*Musa balbisiana*	BBTV	–
11.	Haliyal	Mitli, Mysore Mitli	BBTV, BSV*	–
12.	Kulige	Kari Bale, Ney Poovan, Mysore	Sigatoka Leaf Spot	–
13.	Dandeli	Ney Poovan, Monthan, Mysore	BBTV, Sigatoka Leaf Spot	Nematodes
14.	Ambikanagar Sykes point	Ney Poovan, *Ensete superbum, Musa balbisiana*	–	Nematodes
15.	Gundha	*Musa balbisiana,* Mysore, Ney Poovan	BSV	–

*BBTV – Banana Bunchy Top Virus, *BSV – Banana Streak Virus

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References

IPGRI-INIBAP/CIRAD(1996) Decriptors of Banana (*Musa* spp.). International Plant Genetic Resources Institute, 55p.

Jacob KC (1952) Madras Bananas : A Monograph. Supdt. Govt. Press, Madras, 228p.

Nelson SC, Ploetz RC and Kepler AK (2006) *Species Profiles for Pacific Island Agroforestry*. www.traditionaltree.org, 33p.

Simmonds, NW (1962) *The Evolution of Bananas*. London U.K. Longman, 170p.

Singh HP (2009) Harnessing the potential of banana and plantain in Asia and the pacific for inclusive growth. Keynote address presented in ISHS/Pro Musa Symposium, 'Global Perspective on Asian Challenges' at Phoenix City Hotel, Guangzhou, China, September 14-19, 2009.

Uma S and Sathiamoorthy S (2002) *Names and Synonyms of Bananas and Plantains in India,* National Research Centre for Banana (ICAR), Trichy, 60p.

Uma S (2006) *Farmers' Knowledge of Wild Musa in India.* Food and Agriculture Organization of the United Nations, Rome, 46p.

Uma S. Sathiamoorthy S and Durai P (2005) *Banana–Indian Genetic Resources and Catalogue*. National Research Centre for Banana, Trichy, 268p.