

Descriptors for Noni

(*Morinda citrifolia* L.)



Dr. Anurudh K. Singh

Former Head, Division of Germplasm Conservation,
NBPGR (ICAR), New Delhi
Senior Scientist Germplasm / Cytogenetics - ICRISAT)



World Noni Research Foundation

12, Rajiv Gandhi Road, Perungudi, Chennai – 600 096, India
Phone : 91-44-2454 5401 – 04 Fax : 91-44-2454 5406
E mail : mail@worldnoni.net Visit : www.worldnoni.net

Published by :

Prof. P. I. Peter
Chairman
Noni BioTech, Chennai, India

Edited by :

Dr. P. Rethinam
Dr. T. Marimuthu
Dr. K.V. Peter

Copyright : World Noni Research Foundation

Citation :

WNRF. 2010. Descriptors for Noni, *Morinda citrifolia* L., WNRF Technical Bullet - 01.
World Noni Research Foundation, Chennai, India, p-43

Printed at :

Reliance Printers
9, Sardar Patel Road, Adyar, Chennai - 600 020

Contents

No.	Particulars	Page No.
	<i>Foreword</i>	<i>i</i>
	<i>Preface</i>	<i>ii</i>
	<i>Contributors</i>	<i>v</i>
Chapter 1	- Definitions	1
Chapter 2	- The Descriptor States	2
Chapter 3	- Passport	4
	1. Accession data	4
	2. Collection data	6
Chapter 4	- Characterisation	10
	1. Site data	10
	2. Plant data	11
Chapter 5	- Preliminary Evaluation	24
	1. Site data	24
	2. Agronomy data	25
Chapter 6	- Further Evaluation	27
	1. Site data	27
	2. Biotic stress susceptibility data	28
	3. Abiotic stress susceptibility data	30
	4. Nutritional composition and pharmacological data	31
	5. Biochemical and molecular profile	33
Chapter 7	- Management	34
	1. Plant management data	34
	2. Seed management data	35
	3. Multiplication and regeneration data	36
	References	38
	Appendices	39
	Appendix I - Taxonomy Key	39
	Appendix II - List of Representative Noni growing countries of Asia Pacific and their ISO Codes	41
	Appendix III - Descriptor states for the biological status of germplasm collected / assembled	42
	Appendix IV - Descriptor States for the source wherefrom germplasm was collected / assembled	43

Foreword

The World Noni Research Foundation (WNRF) established in 2006 as an autonomous non-profit Trust, devotes itself to research and development of products from different parts of Noni, *Morinda citrifolia* L. The Foundation has research programmes in five major areas, namely, Crop Improvement and management, Plant Protection, Clinical Science, Pharmacology and Food Science with the objectives of promoting research in these areas. To harness maximum potential of Noni, Crop Improvement and Management through genetic improvement of Noni and appropriate adaptable technologies are essential. To achieve this, WNRF provides financial support to Institutions like Indian Council of Agricultural Research, State Agricultural Universities and Private Organizations. WNRF has also collaborative research programme with department of AYUSH.

Collecting and conserving the genetic variability of Noni available in India is an important step to realize the maximum potential. In order to facilitate Noni Researchers to collect and catalogue variations available among *Morinda* (Noni) in India and other countries WNRF decided to bring out a descriptors for Noni for the first time in India. Descriptors will help scientists to follow a standard description of variations occurring among Noni at National and International levels. Realizing this WNRF funded a project to Dr. Anurudh K Singh to prepare a descriptors.

Dr. Singh has taken all pain to bring out this excellent document which will be useful to all Noni researchers. I Congratulate Dr. Anurudh K. Singh for his efforts. My appreciations are also to all the contributors who made this 'Descriptors' possible.

The assistance rendered by Mr. M.S. Pandian, Mr. T. Thanigai Kumar, Mr. P. Sasi Kumar and Mr. A. Arunachalam in computer setting and printing is appreciated.

Chennai
September, 2010



(Kirti Singh)
Chairperson

Preface

Noni, *Morinda citrifolia* L., known as Hai ba ji and Wu ning (Singapore), Luo ling (Singapore and Taiwan) in Chinese; Canary wood (Australia), Indian mulberry, Large-leaved morinda and Noni (Hawaii), Noni fruit, Noni plant, Nonu (Samoa) and Pain killer tree (Caribbean islands) in English; Nono (Tahiti) in French; Mora de la India, Noni (Puerto Rico) in Spanish; Bengkudu, Bengkudu daun besar, Bengkudu laki-laki, Mengkudu and Pacel (Indonesia) in Malay; Munja pavattay (Tamil Nadu, India) in Tamil; and TaIndia, Molagha and Maddi chettu (Andhra Pradesh, India) in Telugu is an important plant. It has been used as a famine food, food supplement and traditional medicine in India and Indo-Pacific Island countries. It grows widely throughout the Pacific and in Andaman and Nicobar Islands and coastal regions of India.

Noni is a small evergreen shrub or tree, native to South, Southeast Asia (Andaman Nicobar islands and coastal regions of India, Indonesia) to Australia, and has a pantropical distribution. It has chromosome number, $2n = 44$ in somatic cells and $n = 22$ in gametic cells. It can grow in wide range of non-fertile, acidic and alkaline soils of very dry to very wet areas. Though, it is a shy plant, yet it persists well even under adverse conditions. It is well suited for intercropping within traditional agro-forestry subsistence farming systems or as a mono-crop. All parts of the plant have traditional and/or modern uses. Roots and bark are used for dyes and medicine; trunks for firewood and tools; and leaves and fruits for food and medicine. It is one of the most significant sources of traditional medicines among Polynesian societies

Recognising its importance, the demand of Noni and Noni products has been growing day by day. It has been realised that demand can be met through improving genetic potential of existing genotypes besides collection, characterisation and conservation of natural variability for further exploitation.

The success of genetic improvement of any organism depends on how well the genetic diversity of that species is characterised and evaluated for potential use in breeding programme. For systematic characterisation and evaluation, one needs to identify the descriptors to meet the requirements of various aspects, an internationally accepted language in the form of descriptor states, which can quantify the genetic variability to facilitate understanding of the desired genetic variability. This helps in identifying the potentially valuable accessions with better productivity and in-built genetic potential to

overcome various stresses, for use in genetic improvement, to develop high yielding cultivars/clones or direct commercial exploitation.

The present descriptors for Noni, *M. citrifolia* is an improvement and extension of the basic descriptors developed by Waki *et al.* (2007) to describe plant morphology to study the levels of genetic diversity of local *M. citrifolia* in Papua New Guinea and the descriptors proposed by Singh (2009). These descriptors would provide a holistic perspective for characterisation of genetic variability not only for morphological features, but also for evaluation of agronomic potential, reaction against various biotic and abiotic stresses, nutritional and pharmacological traits, identifying potential value of each accession from breeding point of view to facilitate its use in genetic improvement programme. It also, includes the descriptors to document the passport and management information about accession or accessions, which become very important in the present scenario of intellectual property rights.

As WNRF encourages collection and characterisation of germplasm, the initial categories of data deals with accession and collection data followed by characterisation and preliminary data. It is advised that the minimal data should be generated for each accession. The other descriptors falling in the categories of further evaluation and management are optional, but preferred to provide additional information on the potential value of an accession. These descriptors and descriptor states need to be developed as per the need of the crop improvement programme or for the curator as guidelines for use and management of accessions in various forms, or storage as well as for multiplication and regeneration.

The descriptor states and the few tables containing their definitions are developed to cover the total spectrum of variability with codes for each variable. These may not be definite, but have been designed to meet the international requirement of global diversity in each trait and thereby produces a universally accepted 'language' for generation of all plant genetic resources data. The adoption of these descriptors shall facilitate easy conversion or transformation of information to other schemes on one hand and will facilitate rapid, easy and efficient exchange, storage, retrieval of information on the other. This will thus assist in effective utilization of germplasm globally. It is advised that information on each accession is generated following the descriptors, as closely as possible with regard to the order, numbering and using the recommended specified descriptors and the descriptors states.

The descriptors listed in the present publication cover most of the traits of consequence and significance, representing both essential and optional traits for characterisation and knowing the potential value of an accession. However, **the user may select a minimum set of descriptors, particularly related with the descriptors listed under further evaluation, based on usefulness from breeding point of view and availability of internationally accepted screening technique for generation of information.** However, there may be scope for further improvement, based on the technological advancement and would be welcome.


I would like to thank the World Noni Research Foundation for providing the financial assistance to undertake the project on development of descriptors for characterisation and evaluation of genetic diversity in Noni and the encouragement and support provided to complete the project successfully. I am very much grateful to Dr. Kirti Singh, Chairperson, WNRF for motivating me in taking up this very important assignment and constant encouragement given during the preparation of the document.

Thanks are also due to all the specialists of various disciplines for sharing the necessary information and help extended in its successful compilation.

I wish to place on record my sincere thanks to the Noni research workers around the world and in India, who have directly or indirectly helped in the development of the descriptors with access to useful information.

The assistance extended by the staff of World Noni Research Foundation, Chennai in providing logistic support for carrying out the survey of morphological diversity in Andaman and Nicobar Islands and conducting consultation meeting with specialists of various disciplines at WNRF, Chennai, is also gratefully acknowledged.

Chennai
September, 2010


(Anurudh K. Singh)

Contributors

Dr. Anurudh K. Singh
Former National Genebank Curator &
Head, Division of Germplasm Conservation, NBPGR (ICAR),
Project Coordinator (Pigeonpea) ICAR &
Senior Scientist (Germplasm/Cytogenetics), ICRISAT
H.No. 2924, Sector-23, Gurgaon-122 017, Haryana, India
Phone: 91-0124-4110355; Cell: 91-0-9540127222
Email: anurudhksingh@gmail.com

Dr. Kirti Singh
Chairperson,
World Noni Research Foundation
Former, Chairman, Agricultural Scientist Recruitment Board
12, Rajiv Gandhi Road, Srinivasa Nagar, Perungudi,
Chennai – 600 096, India Email: kirtisingh1934@hotmail.com

Prof. P.I. Peter
Chairman,
Noni Bio-tech India
85, First Main Road, Gandhi Nagar
Adyar, Chennai – 600 020, India
Email: peter@indian-noni.net

Dr. K.L. Chadha
Former Dy. Director General ICAR (Horticulture)
H.No. 7281, B-10, Vasant Kunj
New Delhi – 110 070, India
Email: klchadha@yahoo.com; klchadha@gmail.com

Dr. K.V. Peter
Director,
World Noni Research Foundation
12, Rajiv Gandhi Road,
Srinivasa Nagar, Perungudi, Chennai – 600 096, India
Email: kvptr@yahoo.com

Dr. T. Marimuthu
Joint Director,
World Noni Research Foundation
12, Rajiv Gandhi Road, Srinivasa Nagar, Perungudi,
Chennai – 600 096, India Email: jdwnrf2010@gmail.com

Dr. Brahma Singh
Advisor,
World Noni Research Foundation
E – 713, Mayur Vihar, Phase II, New Delhi – 110 091, India
Email: brahma88@hotmail.com

Dr. P. Rethinam
Advisor,
World Noni Research Foundation
18, Lakshmi Nagar, S.N. Palayam
Coimbtore – 641 007, Tamil Nadu, India
Email: palms002@yahoo.com; palms02@hotmail.com

Dr. S. Sithanantham
Advisor,
World Noni Research Foundation
House No.3 (Old No.6),
First Floor, 4th Cross Street
Besant Nagar, Chennai- 600 090, Tamil Nadu, India
Email: sithanantham@gmail.com /sithanantham@yahoo.com

Dr. S John Britto SJ
Director,
The Rapinat Herbarium and
Centre for Molecular Systematics
St. Joseph's College (Autonomous)
Tiruchirappalli 620 002, Tamil Nadu, India
Email: sjbrittorht@yahoo.com

Dr. J. Kannaiyan
Sun Agro Biotech Research Centre
3/340, Main Road, Madanandapuram, Porur
Chennai – 600 116. Tamil Nadu, India Email: sabrcchennai@yahoo.co.in

Dr. G. Surendiran
Biocontrol and Microbial Metabolites Lab
Centre for Advanced Studies in Botany
University of Madras, Guindy Campus, Chennai – 600 025
Tamil Nadu, India Email: surend19@gmail.com

Dr. S. K. Jain
Principal Scientist,
Division of Seed Science and Technology
Indian Agricultural Research Institute
Pusa Campus, New Delhi – 110 012, India
Email: skjainsst@gmail.com

Dr. D.R. Singh
Head, Division of Horticulture and Forestry
Central Agricultural Research Institute
PB No. 181, Port Blair – 744 101, India
Email: drsingh1966@yahoo.com

Chapter 1

Definitions

Following definitions are generally used for documentation of information on genetic resources :

- 1. Passport information** : It consists of information on accession identifiers, both for an accession assembled from other source and accession collected by collectors. It will include information, such as origin, location of collection, habitat, natural reaction to prevailing biotic and abiotic stresses, parentage, if any etc.
- 2. Characterisation** : It consists of recording of those morphological/botanical characters, which are highly heritable, can be seen by the eye and expressed in all environments. They would help assigning taxonomic affinity, as *M. citrifolia* has three varieties and two biotypes.
- 3. Preliminary evaluation** : It will include recording of those traits that will give an idea about agronomic potential or thought desirable by the users of crop.
- 4. Further evaluation** : It will include recording of a number of additional descriptors thought to be useful in crop improvement, such as reaction against biotic and abiotic stresses, biochemical, nutritional, pharmacological and molecular characteristics that may help in establishing distinctiveness and superiority of an accession.
- 5. Management** : Recording of information useful in management of an accession in field genebank or medium and long-term stores, as well as for regeneration/multiplication of an accession.

Generally, characterisation and preliminary evaluation is the responsibility of germplasm botanist or the curator, while the further evaluation is generally carried out by a multidisciplinary team of specialists. The data on further evaluation should be provided to the curator for maintenance in the database to facilitate use of accessions in crop improvement programme.

Chapter 2

The Descriptor States

The descriptors used for characterisation and evaluation may belong to either of the two following classes :

- a. **Distinctive, discontinuous variation**, i.e., qualitative, and can be described as present or absent or different distinctive types within. Examples, growth habit, plant canopy, leaf or fruit shape, colour, seed coat colour etc.
- b. **Continuous variation**, i.e., quantitative variation. Examples, plant height, leaf size, fruit size, fruit weight, days to flowering, fruiting, yield, pharmacological detail, anthraquinone glycoside quantity in roots etc.

Accordingly, descriptor states need to be developed, which may either be alphabetical, numerical, binomial or actual as per suitability. The following internationally accepted norms for scoring, coding, and recording of descriptor states be followed:

- a. The SI system of measurement is used. The units applied are given in the brackets following descriptors.
- b. Many quantitative traits, which are in continuum of variability should be recorded on a scale under which distinct classes can be easily identified, based on actual data, for example 1-5 scale, namely,
 1. Very low
 2. Low
 3. Intermediate
 4. High
 5. Very high

Some time the continued variability can be described with selected set of states, such as, 1, 3, 5, 7, 9 or on actual 1-9, describing the variability in selected distinct set of states, spread over 1 to 9 scale. If a character is not expressed, '0' should be recorded.

- c. For accessions which are not uniform for a descriptor (mixed collection or a segregating population), the mean and standard deviation should be recorded, for example in case of quantitative traits.
- d. Absence/ presence of character is recorded as
 - 0 Absent
 - + Present
- e. Blanks are used when information is not yet available
- f. Internationally accepted standard colour chart, such as Royal Horticultural Society Colour chart are preferred for precise description of colour. However, standard shade cards can also be used with proper reference.
- g. Dates should be expressed numerically in the form of DD-MM-YYYY, where
 - DD = Day
 - MM = Month
 - YYYY = year

Chapter 3

Passport

3.1 Accession Data

3.1.1. Accession Number/Identity

This number is a unique identifier for an accession and is given when entered in collection. Once assigned this number is never reassigned to any other accession, even if the accession is lost. Letter/ Alphabet should be used before the numerical number to reflect the name of genebank or the national system [e.g. American PI (Plant Introduction) or Indian IC (Indigenous Collection) followed by a numerical number]

3.1.2. Donor Name

This would refer to the institution/organisation/individual/farmer, which provided the material (e.g., Institutes/individual's name & address).

3.1.3. Donor Identity

The identity, used by the donating institution or individual for its maintenance and use, during supply of the material.

3.1.4. Any Other Number(s) Associated with Accession

If an accession has travelled to other genebank or system, before it is acquired by the immediate donor then their previous identities, if known can be recorded as alternate identity.

3.1.5. Taxonomy Affinity/Scientific Name

Describing the taxonomic affinity, if known (i.e., Botanical species/variety/biotypes) within genus *Morinda* and more *specifically*, *M. citrifolia* (refer to key for classification of *Morinda* species and *M. citrifolia*, Appendix I. As per the appearance Appendix II with taxonomy key should be Appendix I. Hence, if should

be brought forward before Appendix of ISO country code, which would now be Appendix II) in the following key aspects.

1. Species
2. Botanical variety
3. Type

3.1.6. Pedigree

It is the parentage of the collection/ accession, if known, including the parental line from which it is selected.

3.1.7. Cultivar Name

It can be either a vernacular or common name

3.1.8. Biological Status

It refers to the developmental status of the material, when it was assembled (for definition see table 1)

1. Wild
2. Landrace
3. Traditional/Farmers' variety
4. Breeding line/Clone
5. Improved cultivar
6. Released cultivar
7. Genetic stock
8. Others (specify)

3.1.9. Date of Acquisition

The date on which the accession entered into collections (in the format DD-MM-YYYY)

3.1.10. Accession Size

Approximate number of seed or plants in the genebank

3.1.11. Type of Maintenance

1. Vegetative
2. Seed
3. Both, vegetative and seed
4. Tissue culture

3.1.12. Notes

Any other information

3.2. Collection Data

3.2.1. Collector's Identity

It will be a unique identity given to a collection by the collector.

3.2.2. Collecting Institute

Institutional affinity of collector/ Address of the collector

3.2.3. Collection Date

Dates in the form of DD-MM-YYYY

3.2.4. Country of Collection

This would refer to country, where from material originated or collected (FAO, ISO code for countries to be used; see Appendix II for ISO code of Noni growing countries).

3.2.5. Administrative Location of Collection Site

It refers to the physical or administrative place, where from material was collected or acquired, i.e., i) village, ii) district/county iii) province, etc.

3.2.6. Coordinates of Collection Site

- 3.2.6.1. Latitude: Degree and minutes followed by N (North) or S (South)
(e.g., 01030S)
- 3.2.6.2. Longitude: Degree and minutes followed by E (East) or W (West)
(e.g., 07625W)
- 3.2.6.3. Altitude: Elevation of the site above the sea level (mt).

3.2.7. Climate of Collection Site

- 3.2.7.1. Rainfall (range in mm)
- 3.2.7.2. Temperature (range in °C)
- 3.2.7.3. Sunshine hours
- 3.2.7.4. Soil (Type)

3.2.8. Collection Source

It refers to the organisation/institution or the place wherefrom the material was obtained (see table 2)

1. Wild
2. Natural/Weedy
3. Farmer's field
4. Farmer's store
5. Farmer's backyard
6. Individual
7. Market
8. Institute
9. Other

3.2.9. Biological Status

It refers to the developmental status of the material, when it was collected (for definition see table 1)

1. Wild
2. Landrace
3. Traditional/Farmers' variety
4. Breeding line/Clone
5. Improved cultivar
6. Released cultivar
7. Genetic stock
8. Others (specify)

3.2.10. Taxonomy Affinity/Scientific Name

Describing the taxonomic affinity, if known (i.e., Botanical species/variety/biotypes) within genus *Morinda* and more specifically, *M. citrifolia*. (refer to key for classification of *Morinda* and *M. citrifolia*, Appendix I As per the appearance Appendix II with taxonomy key should be Appendix I. Hence, if should be brought forward before Appendix of ISO country code, which would now be Appendix II), on the following key aspects.

1. Species
2. Botanical variety
3. Type

3.2.11. Common Name

It may be a vernacular or common name or number used by local people.

3.2.12. Ethnic Group

Name of the tribe associated with cultivation and use.

3.2.13. Number of Plants Sampled

3.2.14. Number of Fruits/Seeds Collected

3.2.15. Topography

It would refer to the topography of site from where collection was sampled.

1. Swamp
2. Plain
3. Hilly
4. Undulating

3.2.16. Use of the Accession (Local use)

1. Food
2. Medicine
3. Other

3.2.17. Herbarium

Whether herbarium was made at the time of collection ?

- 0 = No
+ = Yes (Provide details)

3.2.18. Photograph

Whether a photograph was taken of the accession or habitat at the time of collection?

- 0 = No
+ = Yes (provide details)

3.2.19. Notes

Any other specific information

Chapter 4

Characterisation

4.1. Site Data

4.1.1. Name of the farm or Institute with address

4.1.2. Site Location

4.1.2.1. Latitude: Degree and minutes followed by N (North) or S (South)
(e.g., 01030S)

4.1.2.2. Longitude: Degree and minutes followed by E (East) or W (West)
(e.g. 07625W)

4.1.2.3. Altitude: Elevation of the site above the sea level (mt)

4.1.3. Planting Date

(Dates of seed sowing/ grafting/ cutting planting, in the form of DD-MM-YYYY)

4.1.4. Characterisation Environment

1. Field (open or shade)
2. Greenhouse
3. Other

4.1.5. Spacing

4.1.5.1. Distance between rows (mt)

4.1.6. Soil Type

4.1.6.1. Classification (This may be taken from local soil survey map)

4.1.6.2. pH

4.1.7. Nature of Cultivation

1. Rainfed
2. Irrigated

4.1.8. Climate

- 4.1.8.1 Rainfall (range in mm)
- 4.1.8.2 Temperature (range in °C)
- 4.1.8.3 Relative humidity (range in %)
- 4.1.8.4 Sunshine (hours)

4.1.9. Notes

Any other specific information

4.2. Plant Data

4.2.1. Gross Morphology

4.2.1.1. Plant habit

(Record after three years of planting at 3-5 m spacing)

1. Shrub
2. Small tree
3. Medium tree
4. Tall tree
5. Climber

4.2.1.2. Plant architecture

(Asses after three years of planting see Figure 1)

1. Conical
2. Spherical
3. Bushy
4. Umbrella
5. Irregular
6. Others (specify)

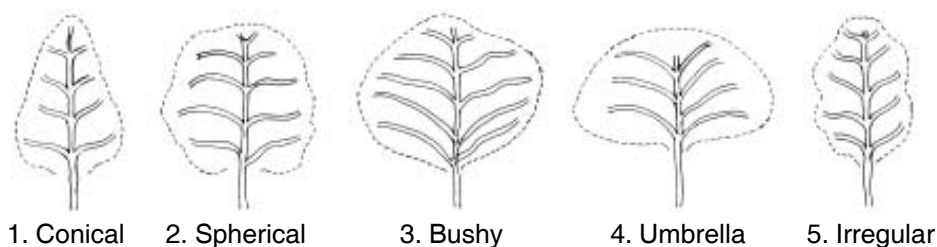


Figure 1. Plant Shape / Canopy

4.2.1.3. Trunk diameter [cm]

[Measure at 20 cm from ground level (age)]

4.2.1.4. Bark surface

1. Smooth
2. Rough (fissured)

4.2.1.5 Bark colour

1. Pale
2. Yellow

4.2.1.6. Internodes length (cm)

(Measure five lower and five top internodes on young branches and provide average)

4.2.1.7. Growing shoot pigmentation

(Observe up to level of 10-15 nodes acropetally from base)

1. Green
2. Red
3. Pink

4.2.1.8. Interpetiolar stipule (leafy)

1. Distinct
2. Adnate to petioles forming a sheath

4.2.1.9. Stipule shape

1. Broadly triangular
2. Obovate
3. Entire
4. Lobed

4.2.2. Leaf

4.2.2.1. Leaf shape

[Assess on fully expanded leaf on third node from the apical bud (see Figure 2)]

1. Elliptic
2. Lanceolate
3. Ovate
4. Oval
5. Others (Specify)

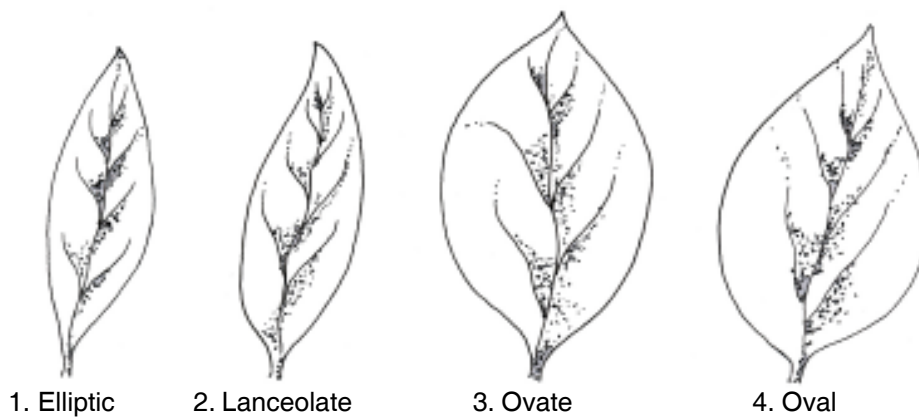


Figure 2. Leaf Shape

4.2.2.2. Leaf apex

(see Figure 3 for assessment)

1. Obtuse
2. Acuminate
3. Acute
4. Cuspidate
5. Others (specify)

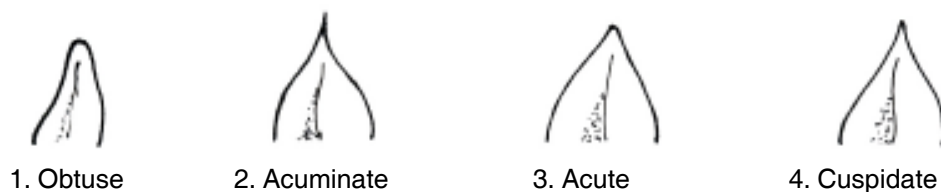


Figure 3. Leaf Apex

4.2.2.3. Leaf margin

1. Entire
2. Wavy
3. Others (specify)

4.2.2.4. Leaf laminar size (length x width in cm) on lowest node of young branches

(Measure from petiole insertion to leaf apex and record the average of five randomly selected mature leaves from lowest node of the lateral shoot.)

4.2.2.5. Leaf laminar size (length x width in cm) on uppermost node of young branches

Measure from petiole insertion to leaf apex and record the average of five randomly selected mature leaves from clear upper node of the lateral shoot.)

4.2.2.6. Leaf lamina colour

1. Light green

2. Green
3. Dark green
4. White-green variegation
5. Others (specify)

4.2.2.7. Leaf glossiness

(Record for both abaxial and adaxial surface in case of difference)

0. Absent
1. Semi-glossy
2. Glossy

4.2.3. Flower

4.2.3.1. Type of flower

1. Pentamerous
2. Hexamerous
3. Mix of all

4.2.3.2. Sexuality of flower

(Record presence/dominance of pistillate florets)

1. Unisexual
2. Bisexual

4.2.3.3. Heterostyly

(If present, indicate whether stigma positioned, above anthers or below anthers; see Figure 4 for assessment)

0. Absent
1. Present

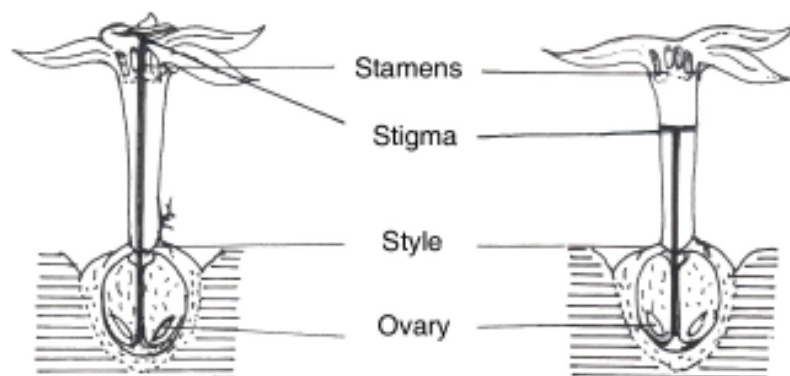


Figure 4. Heterostyly

4.2.3.4. Anther position

1. Included
2. Half-exserted
3. Exserted

4.2.3.5. Corolla tube length [mm]

(Measure from base to sinus)

4.2.3.6. Number of opened florets

(At one time)

1. One
2. Two
3. Three
4. More than three

4.2.3.7. Occurrence of floral bracts

(see Figure 5 for assessment)

1. Single floret
2. Two to three florets
3. More than three florets
4. Rudimentary
5. Others (specify)

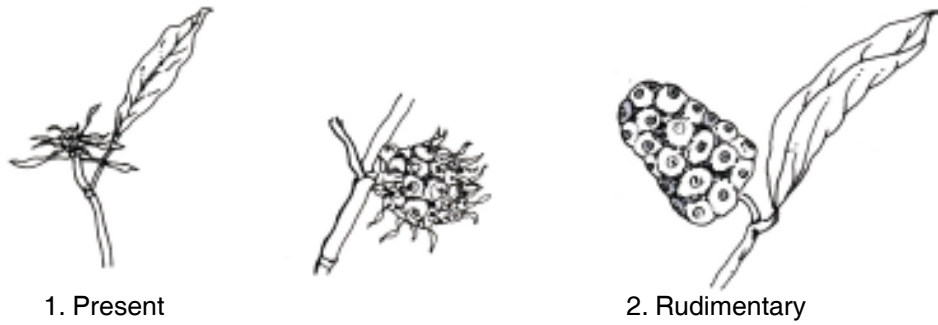


Figure 5. Syncarp / Fruit with Bracts

4.2.4. Fruit and Seed

Fruit is a syncarp, cluster of several fruits aggregated together.

4.2.4.1 Arrangement of syncarp opposed to a leaf

(If there is a mix, indicate the percentage of the two; see Figure 6 for assessment)

1. Solitary
2. Pair
3. Umbellate
4. Other (specify)

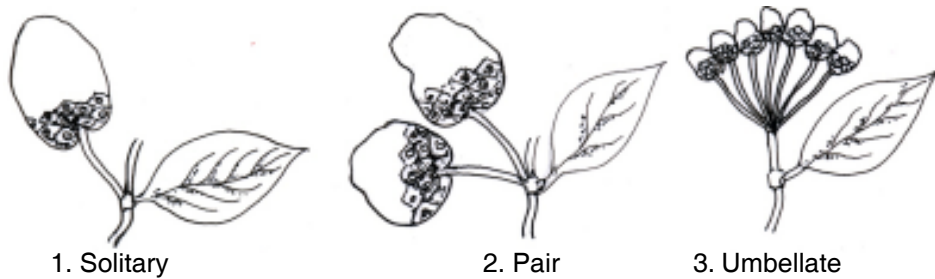


Figure 6. Arrangement of Syncarp

4.2.4.2. Fruit colour

1. Yellowish green
2. Whitish green
3. Green
4. Others (specify)

4.2.4.3. Fruit skin texture

1. Smooth (no or shallow cracks on fruit eyes)
2. Rough (cracks on almost all fruit eyes)
3. Very rough (deep cracks on fruit flesh and eyes)

4.2.4.4. Fruit shape

(see Figure 7 for assessment)

1. Oval
2. Oval elongated cone type
3. Round
4. Irregular
5. Others (specify)

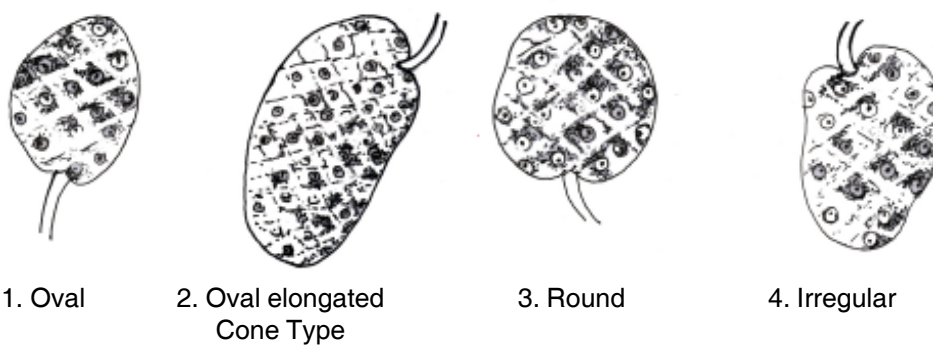


Figure 7. Fruit Shape

4.2.4.5. Presence of parthenocarpic fruits

- 0. Absent
- 1. Present

4.2.4.6. Fruit length [cm]**4.2.4.7. Fruit width [cm]****4.2.4.8. Fruit weight [g]****4.2.4.9. Peduncle length and positioning at fruiting**

(see Figure 8 for assessment)

- 1. Conspicuous long erect
- 2. Conspicuous erect
- 3. Drooping
- 4. Sessile

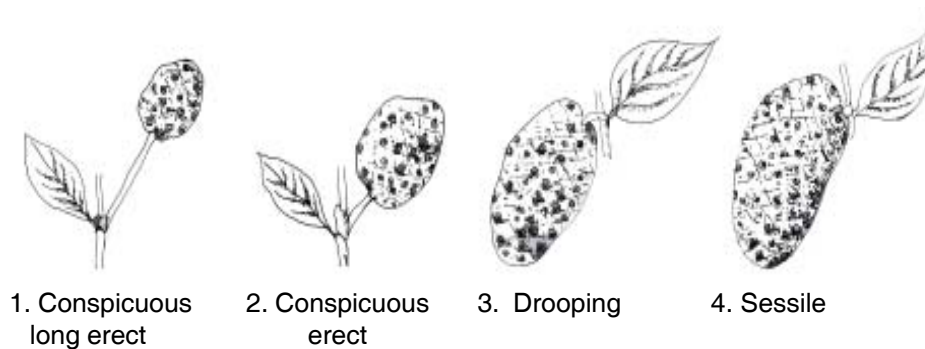


Figure 8. Peduncle Length and Positioning

4.2.4.10. Fruit bunching

(If present, indicate the percentage of fruit; see Figure 9)

- 0. Absent
- 1. Present

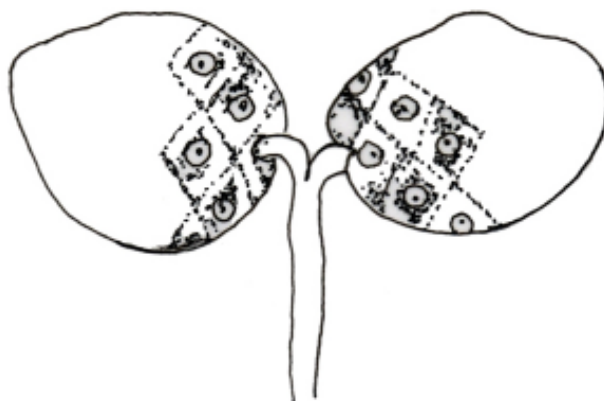


Figure 9. Fruit Bunching

4.2.4.11. Fruit branching

(If present, indicate the percentage of fruit; see Figure 10)

0. Absent

1. Present



Figure 10. Fruit Branching

4.2.4.12. Fruit base shape on mature fruit

(see Figure 11)

1. Broadly acute (cordate)
2. Depressed (Tapering)
3. Strongly depressed (or clasping)
4. Others (specify)

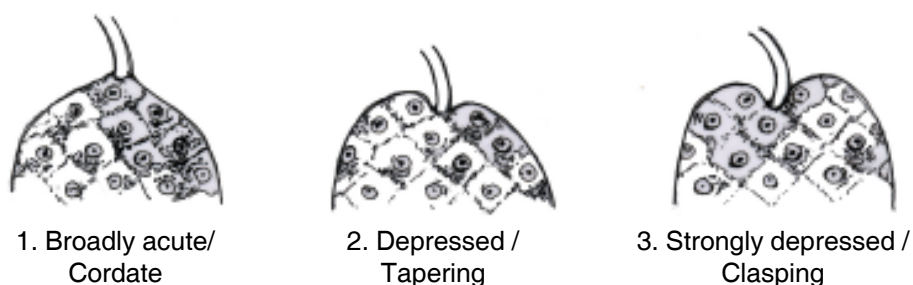


Figure 11. Fruit Base Shape

4.2. 4.13. Floral eye position relative to bract or rudimentary bract
(see Figure 12)

1. Humped with rudimentary bracts
2. Level with rudimentary bracts
3. Above the rudimentary bracts
4. Variable
5. Others (specify)

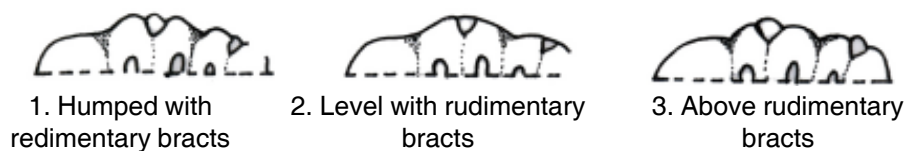


Figure 12. Floral Eye Position

4.2.4.14. Intensity of fruit odour on ripening

1. Strong
2. Medium
3. Less

4.2.4.15. Fruits pyrenes nature

1. Cartilaginous
2. Bony

4.2.4.16. Fruits pyrenes shape

1. Broadly elliptic
2. Compressed
3. Flattened
4. Ovoid

4.2.4.17. Average number of seeds per fruit

4.2.4.18. Seed length [cm]

4.2.4.19. Seed width [cm]

(At widest part)

4.2.4.20. Seed thickness [mm]

(Record on same seed set)

4.2.4.21. Seed wing

0. Absent
1. Present

4.2.4.22. Seed colour

(At maturity)

1. Black
2. Brown
3. Dark brown
4. Silver brown
5. Other

4.2.4.23. Presence of pulp plates on seed coat

(see Figure 13)

1. Absent
2. Only on air sac
3. Only on embryo sac
4. Between spine and air sac
5. On both air sac and embryo sac
6. On air sac, embryo sac and between spine and air sac

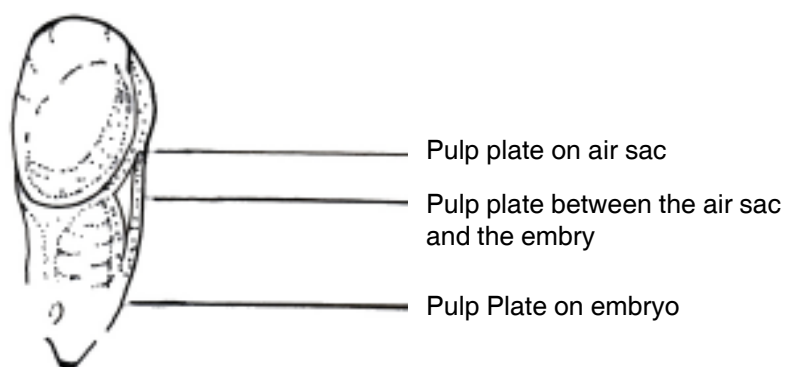


Figure 13. Pulp Plates on Seed Coat

Chapter 5

Preliminary Evaluataion

5.1. Site Data

5.1.1. Site Location (Institute/Farm etc.)

5.1.1.1. Latitude: Degree and minutes followed by N (North) or S (South)
(e.g., 01030S)

5.1.1.2. Longitude: Degree and minutes followed by E (East) or W (West)
(e.g., 07625W)

5.1.1.3. Altitude: Elevation of the site above the sea level (mt).

5.1.2. Planting Date

(Dates of seed sowing/ grafting/ cutting planting, in the form of DD-MM-YYYY)

5.1.3. Evaluation Environment

1. Field (open or shade)
2. Greenhouse
3. Other

5.1.4. Spacing

Distance between rows (mt)

5.1.5 Soil Type

1. pH
2. Classification

5.1.6. Nature of Cultivation

1. Rainfed
2. Irrigated

5.1.7. Climate of Evaluation Site

- 5.1.7.1 Rainfall (range in mm)
- 5.1.7.2 Temperature (range in °C)
- 5.1.7.3 Relative humidity (range in %)
- 5.1.7.4 Sunshine (hours)

5.1.8. Notes

Any other information of value

5.2. Agronomy Data

Asses' traits related with yield and yield components. These traits would be recorded for three years from the date of first flush of flowering and fruiting to calculate cumulative average peak period of flowering, fruiting and yield per plant or per unit area basis. It may include evaluation under different agronomy and at multi-locations.

5.2.1. Date of Initiation of Flowering Flush

To be recorded as the date in annual calendar from which flush of flowers starts, in the form of DD-MM-YYYY

5.2.2. Last Date of Flowering Flush

To be recorded as the date in annual calendar, when the numbers of flowers appreciably goes down, in the form of DD-MM-YYYY

5.2.3. Duration of Peak Flowering

Calculate the extent of flowering peak period, counting number of days from the date of first flush of flowering to the date of appreciable decrease in number of flowers.

5.2.4. Date of Initiation of Fruiting Flush

To be recorded as the date in annual calendar from which flush of marketable fruits starts, in the form of DD-MM-YYYY

5.2.5. Last Date of Fruiting Flush

To be recorded as the date in annual calendar, when the numbers of marketable fruits appreciably goes down, in the form of DD-MM-YYYY

5.2.6. Duration of Peak Fruiting

Calculate the extent of fruiting peak period, counting number of days from the date of first flush of fruiting to the date of appreciable decrease in number of fruits.

5.2.7. Duration for Change of Colour from Green to Yellow

Record the number of day, fruit remain green and then turn yellow into mature fruit.

5.2.8. Number of Fruits per Plant

An average number of fruits from same randomly selected 5 plants, from centre of row of plantation (quantitative).

5.2.9. Fruit Weight

Average weight from cumulative weight of all picked fruits from same randomly selected 5 plants, from centre of row divided by total fruit (quantitative).

5.2.10. Fruit Yield (Kg)

Cumulative yield of all picked fruits from same randomly selected 5 plants, from centre of row or plot (quantitative).

5.2.11. 1000-seed Weight

To be recorded on 1000 dry seeds (quantitative).

5.2.12. Seed/ Pulp ratio

Chapter 6

Further Evaluation

6.1. Site Data

6.1.1. Site Location (Institute/Farm etc.)

6.1.1.1. Latitude: Degree and minutes followed by N (North) or S (South)
(e.g., 01030S)

6.1.1.2. Longitude: Degree and minutes followed by E (East) or W (West)
(e.g., 07625W)

6.1.1.3 Altitude: Elevation of the site above the sea level (mt).

6.1.2. Planting Date

(Dates of seed sowing/ grafting/ cutting planting, in the form of DD-MM-YYYY)

6.1.3. Evaluation Environment

1. Field (open or shade)
2. Greenhouse
3. Other

6.1.4. Spacing

Distance between rows in (mt)

6.1.5 Soil Type

1. Classification
2. pH

6.1.6 Nature of Cultivation

1. Rainfed
2. Irrigated

6.1.7 Climate

- 6.1.7.1 Rainfall (range in mm)
- 6.1.7.2 Temperature (range in °C)
- 6.1.7.3 Relative humidity (range in %)
- 6.1.7.4 Sunshine (hours)

6.1.8 Notes

Any other information

6.2. Biotic Stress Susceptibility Data

It is important to mention the type of infestation under which material is evaluated i.e., natural or artificial, in field (open or shade), greenhouse or laboratory, and should be clearly specified. The reaction is to be recorded on a scale from 1 to 5 reflecting the resistance/susceptibility of the genotypes.

For soil born diseases, nematode, and fruit diseases, which kills the whole plant and fruit, record incidence i.e., percent plant observed with diseases infestation in an experimental plant population

1. No incidence or sign of visible infection = Immune
2. 1 to 10% plants showing incidence = Resistant
3. 11 to 25% plants showing incidence = Moderately resistant
4. 26 to 50% plants showing incidence = Susceptible
5. > 50% plants showing incidence = High susceptible

For foliar diseases and pests (sucking, defoliating, stem feeding and fruit damaging), which damage area or an organ i.e., leaf, record leaf area damage or diseased in terminals of ten branches on selected set plants in an experimental plant population

1. No damage/defoliation or sign of visible infection = Immune
2. 1 to 10% area damaged/defoliated = Resistant

3. 11 to 25% area damaged/defoliated = Moderately resistant
4. 26 to 50% area damaged/defoliated = Susceptible
5. > 50% area damaged /defoliated = High susceptible

6.2.1. Fungal Foliar Diseases

Casual organism	Common name
6.2.1.1 <i>Lasidiplodia theobromae</i>	Leaf spot
6.2.1.2 <i>Alternaria</i> sp	Target spot
6.2.1.3 <i>Colletotrichum gloeosporioides</i>	Shot hole
6.2.1.4 <i>Alternaria alternata</i>	Leaf blight
6.2.1.5 Any other	

6.2.2. Fungal Stem and Root Diseases

6.2.2.1 <i>Phytophthora botryose</i>	Noni black flag
6.2.2.2 <i>Cephleuros minimus</i>	Algal parasite
6.2.2.3 Any other	

6.2.3. Nematodes

6.2.3.1 <i>Meloidogyne</i> spp	Root-knot nematodes
6.2.3.2 Any other	

6.2.4. Foliar Sucking Pests

6.2.4.1 <i>Aphis gossypii</i>	Melon aphid
6.2.4.2 <i>Toxoptera citricida</i>	Aphids
6.2.4.3 <i>Heliethrips haemorrhoidalis</i>	Greenhouse thrips
6.2.4.4 <i>Polyphagotarsonemus latus</i>	Mites
6.2.4.5 <i>Coccus viridis</i>	Green scale
6.2.4.6 <i>Dulinius conchatus</i> Distant	Lace wing bug
6.2.4.7 <i>Poophilus costalis</i>	Spittle bug
6.2.4.8 <i>Maconelliococcus hirsutus</i>	Pink hibiscus mealy bug

6.2.4.9 <i>Planococcus minor</i>	Passion mealy bug
6.2.4.10 <i>Telingana</i> sp.	Tree hopper
6.2.4.11 <i>Flata ocellata</i> Fb.	Green hopper
6.2.4.12 <i>Lamprosema chagosalis</i>	Noni stem borer
6.2.4.13 Any other	

6.2.5 Defoliator Pests

6.2.5.1 <i>Macroglossum gyrans</i>	Horned caterpillar
6.2.5.2 <i>Psara basalis</i>	Leaf folding caterpillar
6.2.5.3 <i>Achaea janata</i>	Croton caterpillar
6.2.5.4 <i>Cyrtacanthacris tatarica</i> (Linn.)	Grasshopper
6.2.5.5 <i>Orthacris maindroni</i> Bolivar	Grasshopper
6.2.5.6 <i>Neorthacris acuticeps</i> Bolivar	Grasshopper
6.2.5.7 Any other	

Note: Only diseases and pest reported in literature are included

6.3. Abiotic Stress Susceptibility Data

The conditions i.e., artificial and/or natural conditions under which the genotypes are evaluated should be clearly specified. The reaction is coded on a scale from 1 to 5 reflecting the reaction/susceptibility of the genotypes.

1. Very low or no visible sign of susceptibility (Immune)
2. Low susceptibility (highly tolerant)
3. Intermediate susceptibility (tolerant)
4. High susceptibility
5. Very high susceptibility

6.3.1. Reaction to Drought

6.3.2. Reaction to Waterlogging/Flooding

6.3.3. Reaction to Salinity

6.3.4. Reaction to Mineral Deficiency

- 6.3.4.1 Iron
- 6.3.4.2 Phosphorus
- 6.3.4.3 Potassium
- 6.3.4.4 Magnesium
- 6.3.4.5 Calcium
- 6.3.4.6 Zinc
- 6.3.4.7 Nitrogen
- 6.3.4.8 Sulphur
- 6.3.4.9 Any other

6.4. Nutritional Composition and Pharmacological data

6.4.1. Plant

About 160 phyto-chemical compounds have been identified in the Noni plant. The major metabolites are phenolic compounds, organic acids and alkaloids. For assessing the nutritional value, evaluate actual quantity on dry matter basis of following biochemical's in all plant parts.

6.4.1.1. Phenolic compounds (record relative presence)

1. Anthraquinones (*e.g.* damnacanthal, morindone, morindin)
2. Aucubin
3. Asperuloside
4. Scopoletin

6.4.1.2. Organic acids

1. Caproic and
2. Caprylic acids

6.4.1.3. Alkaloids

1. Xeronine

6.4.2. Fruit

The fruit contains 90 per cent of water and the main components of the dry matter appear to be soluble solids, dietary fibres and proteins. The protein content is surprisingly high (11.3%) of the fruit juice dry matter. The main amino acids are aspartic acid, glutamic acid and isoleucine. Evaluate actual quantity on dry matter basis, using internationally accepted standard protocols.

6.4.2.1. Nutritional composition (Indicate the range of contents)

1. Protein content
2. Lipid
3. Carbohydrate/sugars
4. Iron
5. Potassium
6. Sodium
7. Magnesium
8. Calcium
9. Manganese
10. Phosphorus
11. Vitamin (ascorbic acid, provitamin A and Vitamin C)
12. Any other

6.4.2.2 Pharmacological constituent responsible for various biological activities

Evaluate the actual quantity/value on dry matter basis primarily in fruit or any other relevant plant parts and produce the data in range, observed in samples studied.

Compound	Activity
1 Neolignan	Antioxidant
2 Americanin A	Antioxidant
3 2-methoxy-1,3,6-trohydroxyanthraquinone	Antioxidant (fruit, root)
4 Acubin	Antibacterial
5 L-Asperuloside	Antibacterial
6 Alizarin	Antibacterial (root)
7 Anthraquinone	Anti-wrinkle
8 Insulin, nystose	Sugars (antidepressant)
9 Succinic acid	Antidepressant
10 Xeronine	Immunity enhancer
11 1-methoxy-2-formyl-3-hydroxyanthraquinone	Antiviral
12 Polysaccharide-rich noni-ppt	Anti tumour
13 Damnacanthal	Anti cancerous
14 Scopoletin	Anti cancerous

Note: Many more compounds have been isolated, which can be evaluated as per priority, provided the biological activity is known?

6.5. Biochemical and Molecular Profile

These may be useful in identification of duplicates and conservation of unique accessions.

6.5.1. Cytology

Chromosome number, meiotic behaviour etc.

6.5.2. Allozyme Composition

6.5.3. DNA Profile

Chapter 7

Management

7.1. Plant Management Data

7.1.1. Accession Number

7.1.2. Population Identification

Passport data : Collector's/Donors number, pedigree, cultivar name etc. depending on type and importance.

7.1.3. Planting Date

(Dates of seed sowing/ grafting/ cutting planting, in the form of DD-MM-YYYY)

7.1.4. Location

(field, greenhouse, location plot/bay number, etc.)

7.1.5. Establishment Through

7.1.5.1. Seed

7.1.5.2. Cutting

7.1.6. Establishment Data

7.1.6.1 Germination percent

7.1.6.2 Seedling status (healthy or poor %)

7.1.6.3 Percent plant stand

7.1.7. Number of Plants

7.1.8. Agronomic Data

7.1.8.1. Soil (type and pH)

7.1.8.2. Spacing between rows and plants (mt)

7.1.8.3. Fertilizer application (yes or no)

7.1.8.4. Watering schedule (on weekly basis)

7.1.9. Agronomic Evaluation Data, If any

(Yield or yield related traits recorded)

7.1.10. Collaborators, if any

7.1.11. Duplication at other Location (address)

7.2. Seed Management Data

7.2.1. Accession Number

7.2.2. Population Identification

Passport data: Collector's/Donors number, pedigree, cultivar name etc. depending on type and importance.

7.2.3. Storage Date

(in the format DD-MM-YYYY)

7.2.4. Storage Address

7.2.5. Germination Test at the Start of Seed Storage (%)

7.2.6. Date of Last Germination

(in the format DD-MM-YYYY)

7.2.7. Germination of Last Test (%) (for medium term at five year interval and for long-term at 10 year interval)

7.2.8. Moisture Content at the Start of Seed Storage (%)

7.2.9. Amount of Seed in Store (gram or number)

7.2.10. Next Date of Monitoring of Germination etc.

(in the format DD-MM-YYYY)

7.2.11. Duplication at other Locations (address)

7.3. Multiplication and Regeneration data

7.3.1. Accession Number

7.3.2. Population Identification

Passport data: Collector's/Donors number, pedigree, cultivar name etc. depending on type and importance.

7.3.3. Planting Date

(in the format DD-MM-YYYY)

7.3.4. Field Plot Number

7.3.5. Location

(Address of the place of multiplication site)

7.3.6. Planting Material

7.3.6.1. Seed

7.3.6.2. Cutting

7.3.7. Agronomy

7.3.7.1. Soil (type, pH, etc.)

7.3.7.2. Planting density (spacing between rows and plants)

7.3.7.3. Fertilizer application (yes or no)

7.3.7.4. Mode of irrigation (flow, drip, basin)

7.3.7.5. Quantity (weekly, fortnightly)

7.3.7.6. Number of plants established

7.3.8. Agronomic Evaluation

(Selected yield or yield related traits)

7.3.9. Previous Multiplication or Regeneration, if any

7.3.9.1. Location

7.3.9.2. Planting date

7.3.9.3. Plot number

7.3.10. Collaborators, if any

7.3.11. Duplication at other Location (address)

References

- Singh Anurudh K 2009. A Perspective Proposal of Descriptors for Characterisation and Evaluation of Noni Germplasm. Proceedings of IV National Seminar on "Noni for Empowerment and Prosperity", 24-25 October, 2009. World Noni Research foundation, Chennai
- Waki J, Okpul T and Komolong MK 2007. A descriptor list for morphological characterisation of Noni (*Morinda citrifolia* L). *The South Pacific Journal of Natural Science*, 10: 61-66

Appendix I**Taxonomy Key**
Morinda
Shrubs or trees**Stipule often 2-lobed**

1. ***Morinda citrifolia***: Leaves 20-45 cm long, 7-20 cm wide; flowers 75-90 per head; corolla white; syncarp 4-12 cm long, yellowish white, soft at maturity.

Large fruits

1.1. ***M. citrifolia* var. *citrifolia***,

1.1.1. Type a) ***M. citrifolia* var. *citrifolia*** Large fruited with short peduncle and broad obovate to ovate leaves (cultivated).

Small fruit

1.1.2. Type b) ***M. citrifolia* var. *citrifolia*** Small-fruited with long erect peduncle and lanceolate to elliptic leaves (wild).

1.2. ***M. citrifolia* var. *bracteata*** Small fruited with long erect peduncle, lanceolate to elliptic leaves and conspicuous bracts subtending the fruits to different levels.

1.3. ***M. citrifolia* var. 'Potteri'**, Small-fruited with long erect peduncle and elliptic to lanceolate variegated green and white leaves.

Stipule un-lobed**Leaf margin undulate****Very small fruits**

2. ***M. angustifolia***: Stipule unlobed, leaf margin undulate, syncarp 2 cm dia., turbinate, black.

Leaf margin entire

3. ***M. pubescens***: Stipule unlobed, leaf margin entire; stigma 2-lobed; syncarp 1.5 – 2.5 cm diameter.

Climbers**Leaf apex acute**

4. *M. umbellata* : A climbing or straggling shrub; leaves coriaceous, obovate-elliptic 6 - 18 cm long, 3 - 5 cm wide; flowers in terminal umbellate head; syncarp 1.5 cm dia., occasionally separate.

Leaf apex acumen**Corolla tube hairy within**

5. *M. reticulata*: A climbing shrub, stem terete, slender; Leaves with elongate acumen at apex, corolla tube hairy within; fruit globose, 1 – 1.8 cm dia., pyrenes pyriform

Corolla tube glabrous within

6. *M. villosa*: A climbing shrub, corolla tube glabrous within; syncarp 1.5 cm dia. deep orange.

Appendix II

**List of Representative Noni growing Countries of
Asia Pacific and their ISO Codes**

Country name	ISO Country code
Australia	AUS
American Samoa	ASM
Bangladesh	BGD
Brunei	BRN
Cambodia	KHM
China Mainland	CHN
China, Taiwan	TWN
Fiji Islands	FJI
French Polynesia	PYF
Guam	GUM
India	IND
Indonesia	IDN
Japan	JPN
Korea, Dem. People's Rep. of	PRK
Korea, Rep. of	KOR
Laos	LAO
Malaysia	MYS
Maldives	MDV
Myanmar	MYA
Micronesia, Fed. States of	FSM
New Zealand	NZL
Philippines	PHL
Papua New Guinea	PNG
Samoa	WSM
Singapore	SGP
Solomon Islands	SLB
Sri Lanka	LKA
Thailand	THA
Tonga	TON
United States of America	USA
Viet Nam	VNM
Vanuatu	VUT
Wallis and Futuna Islands	WLF

Appendix III

**Descriptor states for the biological
status of germplasm collected/ assembled**

Descriptor	Definition	State/ Code
Wild	Wild species related with Noni or collection from wild habitat	WL
Landrace	Cultigens (generally heterogeneous) under cultivation in farmers field	LR
Traditional/ farmer's variety	Cultigens cultivated by farmers with specific vernacular name	TV
Breeding line/clone	Semi-finished products or segregating material generated out of hybridisation programme	BL
Improved cultivars	Improved cultigens of common knowledge, but not released by any system	IC
Released cultivars	Varieties released by a national or international organization	RC
Genetic stock	Trait and gene specific germplasm, experimentally developed or identified (e.g. sources of resistance/ mutant, cytogenetic stock etc.)	GS
Others	Doubtful or material with unknown biological status	OT

*Appendix IV***Descriptor states for the source, wherefrom
germplasm was collected/assembled**

Descriptor	Definition	State/code
Wild	Collected from wild habitat including forest	WL
Natural/Weedy	Collected from natural habitat including growing as weed in farm or road side etc.	NW
Farmer's field	Collected from crop growing in farmer's field	FF
Farmer's store	Collected from farmer's store, maintained for next cultivation	FS
Farmer's backyard	From plants grown in farmer's backyard/ kitchen garden for his personal use	FB
Individual	Material donated/ developed by individual farmer	FV
Market	Any market selling seed	MR
Institute	Any institute storing seed material for research, crop improvement and distribution	IN
Others	From any other source that does not fit in any above definition	OT