Descriptors for Cinnamon (*Cinnamomum verum*)

Team of TURIS 2013 Project
University of Ruhuna Sri Lanka

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PREFACE

Cinnamon, which belongs to the family Lauraceae is one of the earliest known spices used by humankind. It is endemic to Sri Lanka, which is the major cinnamon producer in the world market. Sri Lankan cinnamon is known in trade as true cinnamon or Ceylon cinnamon (Babu *et al*., 2004). The production of true cinnamon from Sri Lanka represents over 75 % of the world production (Jayasinghe *et al.*, 2006). Cinnamon is the most prominent spice crop grown in Sri Lanka. The export volume of cinnamon and earning for 2012 was 14,435 metric tons and 16,654.7 million rupees respectively (Sri Lanka Custom, 2012).

According to Ravindran, *et al*. 2003, the binomial *Cinnamomum verum* was first coined by Berchthold and Presl in 1825. Almost at the same time it was named as *Cinnamomum zeylanicum* by Blume in 1826.

Cinnamon was originally grown wild in central hill country of Sri Lanka, where it seems to have been originated. Genus *Cinnamomum,* consists of a wide secondary gene pool. There are seven wild species namely *Cinnamomum dubium, Cinnamomum ovalifolium, Cinnamomum sinharajaense, Cinnamomum litseaefolium, Cinnamomum capparu-coronde, Cinnamomum rivulorum and Cinnamomum citriodorum* (Sritharan, 1984), which are considered to be at extinction risk according to national red list status (Kumarathilake *et al*., 2010).

Many species of Cinnamon produce volatile oil on distillation. *Cinnamomum verum*, *Cinnamomum cassia* and *Cinnamomum camphora* produce the most important cinnamon oils in world market. The major compounds present in stem-bark, root bark and leaf of *Cinnamomum verum* are cinnamaldehyde, camphor and eugenol respectively (Senanayake *et al.*, 1978). Cinnamon bark oil possesses the aroma of the spice and a sweet and pungent taste. It is employed mainly in the flavorings industry (Joy and Maridass, 2008).

A wide genetic variation of cultivated cinnamon can be expected in Sri Lanka. Cinnamon has an enormous variability within and between species due to its cross pollination behavior. In a study of determining morphological variation among mother plants, progenies and other plants in a more than 50 years old population, none of the progenies were 100% similar to mother plants. New phenotypes for leaf shape and leaf base were found in progenies. This work indicates contribution of cross pollination for allele richness leading to morphological variation in cinnamon germplasm (Azad *et al*., In press). Variation in plant morphology and chemical composition of cinnamon oil would indicate the genetic variation. Understanding the need of germplasm

collection for genetic diversity, Department of Export agriculture has established a germplasm collection of cinnamon at Cinnamon Research Station, Palolpitiya. However, the above germplasm collection did not represent the whole country as it was collected from selective areas in Southern Sri Lanka.

In 1996 these accessions were screened using a scoring system based on some useful morphological characters, peeling ability, resistance to pests and diseases, pungency and yield. After extensive field evaluation, two accessions namely Sri Vijaya and Sri Gemunu, were released as new varieties (Wijesinghe and Pathirana, 2000).

A cinnamon collection of 234 accessions had been evaluated for growth, yield and quality parameters in India as well. The yields of eugenol and leaf oil primarily associated with leaf yield which had been positively correlated with canopy spread and plant height (Joy *et al*., 1998). In India, based on quality analysis, 9 accessions were selected as elite lines and after field evaluation two varieties were released as new varieties (Krishnamoorthy *et al*., 1997). Although cinnamon is a long lived perennial, it reaches its reproductive stage early while vegetative propagation is also possible. Therefore if a plant breeder makes intensive effort, impact on the industry within short period can be expected.

Joseph (1981), Kubitzsky and Kurz (1984) and Mohanakumar *et al*. (1985) have studied the floral biology of *Cinnamomum verum*, and suggested that flower exhibit protogynous dichogamy which leads to the maturing of the female phase first, and the male phase later assuring cross-pollination. Levels of out crossing in cinnamon is not determined yet. Saumayasiri (2007) has identified phylogenetic relationships of *Cinnamomum* species using a molecular approach. Hsu *et al*. (2012) have identified potential molecular markers for cinnamaldehyde biosynthesis. In a study by Abeysinghe *et al*. 2009, a number of variable sites for cpDNA sequences of *trn*L intron, *trn*L-*trn*F IGS, *trn*T-*trn*L IGS, *trn*H-*psb*A IGS and intergenic transcribed spacer (ITS) regions of rDNA were identified. The ITS region of the rDNA was mentioned to be effective to identify species.

Considering the knowledge gap on *Cinnamomum verum* germplasm in Sri Lanka, the team of TURIS 2013 project aimed at investigation of genetic diversity of Sri Lankan *Cinnamomum verum* germplasm. We collected the germplasm of 280 accessions belonging to Matara, Galle, Hambanthota, Rathnapura, Kalutara and Kurunegala Districts throughout the country. The need for a complete set of descriptors was a perquisite for our study which

directed us developing a set of descriptors for cinnamon germplasm characterization.

CONTENTS

INTRODUCTION

Descriptor: A descriptor is defined as an attribute, characteristic or measurable trait that is observed in an accession of a gene bank. It is used to facilitate data classification, storage, retrieval, exchange and use (Bioversity International, 2007).

Bioversity International in collaboration with international partners has developed six types of descriptors:

i. **Crop Descriptors**
   Provide an international format and a universally understood language for plant genetic resources data. They are targeted at farmers, curators, breeders, scientists and users and facilitate the exchange and use of resources. Information includes such details as the plant's height, flowering patterns and ancestral history.

ii. **FAO/Bioversity Multi-crop Passport Descriptors**
   Originally published in 2001, the 'Multi-Crop Passport Descriptors' is widely used as the international standard to facilitate germplasm passport information exchange. Now expanded to include emerging documentation needs, this new version resulted from consultation with more than 300 scientists from 187 institutions in 87 countries.

iii. **Descriptors for Genetic Marker Technologies**
   A tool for researchers to generate and exchange genetic marker data that are standardized and replicable. They represent the minimum set of descriptors needed to describe a marker technology used with a particular plant species.

iv. **Key access and utilization descriptors for crop genetic resources**
   Initial sets of characterization and evaluation descriptors for crop genetic resources. These descriptors will become the basis for the information portal being developed by Bioversity to facilitate access and use of plant samples (accessions) held in genebanks.

v. **Descriptors for farmers' knowledge of plants**
   The first attempt to capture and share information between farmers and scientists, integrating biology with traditional knowledge.

vi. **Core descriptors for *in situ* conservation of crop wild relatives v.1**
   These core Crop Wild Relatives descriptors are designed to facilitate the compilation and exchange of *in situ* conservation data, which are

needed to develop and implement *in situ* conservation activities (Bioversity International, 2016).

IPGRI: The International Plant Genetic Resources Institute (IPGRI) is an independent international scientific organization that seeks to advance the conservation and use of plant genetic diversity for the well-being of present and future generations. It is one of 16 Future Harvest Centres supported by the Consultative Group on International Agricultural Research (CGIAR), an association of public and private members who support efforts to mobilize cutting-edge science to reduce hunger and poverty, improve human nutrition and health, and protect the environment. IPGRI has its headquarters in Maccarese, near Rome, Italy, with offices in more than 20 other countries worldwide. The Institute operates through three programmes: (1) the Plant Genetic Resources Programme, (2) the CGIAR Genetic Resources Support Programme and (3) the International Network for the Improvement of Banana and Plantain (INIBAP) (IPGRI, 1995).

MCPD: Multicrop passport descriptors were developed jointly by IPGRI and FAO to provide international standards to facilitate germplasm passport information exchange. These descriptors aim to be compatible with IPGRI crop descriptor lists and with the descriptors used for the FAO World Information and Early Warning System (WIEWS) on plant genetic resources (PGR). For each multi-crop passport descriptor, a brief explanation of content, coding scheme and suggested fieldname (in parentheses) is provided to assist in the computerized exchange of this type of data. It is recognized that networks or groups of users may want to further expand this MCPD List to meet their specific needs. As long as these additions allow for an easy conversion to the format proposed in the multi-crop passport descriptors, basic passport data can be exchanged worldwide in a consistent manner.

DEFINITIONS AND USE OF THE DESCRIPTORS

IPGRI uses the following definitions in genetic resources documentation (IPGRI, 1995):

Passport descriptors: These provide the basic information used for the general management of the accession (including registration at the gene bank and other identification information) and describe parameters that should be observed when the accession is originally collected.

Management descriptors: These provide the basis for the management of accessions in the genebank and assist with their multiplication and regeneration.

Environment and site descriptors: These describe the environmental and site-specific parameters that are important when characterization and evaluation trials are held. They can be important for the interpretation of the results of those trials. Site descriptors for germplasm collecting are also included here.

Characterization descriptors: These enable an easy and quick discrimination between phenotypes. They are generally highly heritable, can be easily seen by the eye and are equally expressed in all environments. In addition, these may include a limited number of additional traits thought desirable by a consensus of users of the particular crop.

Evaluation descriptors: The expression of many of the descriptors in this category will depend on the environment and, consequently, special environmental designs and techniques are needed to assess them. Their assessment may also require complex biochemical or molecular characterization methods. This type of descriptor includes characters such as yield, agronomic performance, stress susceptibilities and biochemical and cytological traits. They are generally the most interesting traits in crop improvement.

Characterization will normally be the responsibility of genebank curators, while evaluation will typically be carried out elsewhere (possibly by a

multidisciplinary team of scientists). The evaluation data should be fed back to the genebank, which will maintain a data file.

Highly discriminating descriptors are marked with a star (★).

The following internationally accepted norms for the scoring, coding and recording of descriptor states should be followed:

(a) The Système International d'Unités (SI system) is used;

(b) The units to be applied are given in square brackets following the descriptor name;

(c) Standard colour charts, e.g. Royal Horticultural Society Colour Chart, Methuen Handbook of Colour, or Munsell Colour Chart for Plant Tissues, are strongly recommended for all ungraded colour characters (the precise chart used should be specified in the section where it is used);

(d) The three-letter abbreviations from the International Standard (ISO) Codes for the representation of names of countries are used;

(e) Many quantitative characters, which are continuously variable, are recorded on a 1-9 scale, where:

1 Very low	6 Intermediate to high
2 Very low to low	7 High
3 Low	8 High to very high
4 Low to intermediate	9 Very high
5 Intermediate	

is the expression of a character. The authors of this list have sometimes described only a selection of the states, e.g. 3, 5 and 7, for such descriptors. Where this has occurred, the full range of codes is available for use by extension of the codes given or by interpolation between them, e.g. in Section 9 (Biotic stress susceptibility), 1 = very low susceptibility and 9 = very high susceptibility;

(f) When a descriptor is scored using a 1-9 scale, such as in (e), '0' would be scored when (i) the character is not expressed, and (ii) a descriptor is inapplicable. In the following example, '0' will be recorded if an accession does not have a central leaf lobe:

Shape of central leaf lobe

1 Toothed

2 Elliptic

3 Linear

(g) Absence/presence of characters is scored as in the following example:

Terminal leaflet

0 Absent

1 Present

(h) Blanks are used for information not yet available

(i) For accessions which are not generally uniform for a descriptor (e.g. mixed collection, genetic segregation), the mean and standard deviation could be reported where the descriptor is continuous. Where the descriptor is discontinuous, several codes in the such as Rana *et al*. (1991), or van Hintum (1993), that clearly state a method for scoring heterogeneous accessions;

(j) Dates should be expressed numerically in the format YYYYMMDD, where

YYYY - 4 digits to represent the year

MM - 2 digits to represent the month

DD - 2 digits to represent the day.

PASSPORT

1. Accession descriptors

1.1 Institute code [MCPD]

Code of the institute where the accession is maintained. The codes consist of the three-letter ISO 3166 country code of the country where the institute is located plus a number. The current set of Institute Codes is available from the FAO website (http://apps3.fao.org/wiews/).

1.2 Accession number [MCPD]

This number serves as a unique identifier for accessions and is assigned when an accession is entered into the collection. Once assigned this number should never be reassigned to another accession in the collection. Even if an accession is lost, its assigned number is still not available for reuse. Letters should be used before the number to identify the genebank or national system (e.g. IDG indicates an accession that comes from the genebank in Bari, Italy; CGN indicates an accession from the genebank at Wageningen, The Netherlands; PI indicates an accession within the USA system).

1.2.1 Local plant number

This identifies a single plant within a population of plants having the same accession number. It may be any combination of plot identity, row number, or tree position within the row.

1.3 Donor name

Name of institution or individual responsible for donating the germplasm

1.4 Donor institute code [MCPD]

Code for the donor institute. It follows the Institute code standard.

1.5 Donor accession number [MCPD]

Number assigned to an accession by the donor. It follows the Accession number standard.

1.6 Curator's name

Name of the officer responsible for maintaining the genetic resources material held at the institute specified in descriptor 1.1 Institute code

1.7 Other identification (numbers) associated with the accession [MCPD]

Any other identification (numbers) known to exist in other collections for this accession. Use the following system: INSTCODE: ACCENUMB; INSTCODE: ACCENUMB;... INSTCODE and ACCENUMB follow the standard described above and are separated by a colon. Pairs of INSTCODE and ACCENUMB are separated by a semicolon without space. When the institute is not known, the number should be preceded by a colon.

1.8 Genus [MCPD]

Genus name for taxon. Initial uppercase letter required.

1.9 Species [MCPD]

Specific epithet portion of the scientific name in lowercase letters. Following abbreviation is allowed: 'sp.'

1.9.1 Species authority [MCPD]

Provide the authority for the species name.

1.10 Subtaxa [MCPD]

Subtaxa can be used to store any additional taxonomic identifier. Following abbreviations are allowed: 'subsp.' (for subspecies); 'convar.' (for convariety); 'var.' (for variety); 'f.' (for form).

1.10.1 Subtaxa authority [MCPD]

Provide the subtaxa authority at the most detailed taxonomic level.

1.11 Ancestral data [MCPD]

Information about either pedigree or other description of ancestral information (i.e. parent variety in case of mutant or selection). For example a pedigree 'Hanna/7*Atlas//Turk/8*Atlas' or a description 'mutation found in Hanna', 'selection from Irene' or 'cross involving amongst others Hanna and Irene'.

1.12 Cultivar origin

1 Open pollination
2 Artificial pollination
3 Clonal selection
4 Seedling selection

1.13 Accession name [MCPD]

Either a registered or other formal designation given to the accession. First letter uppercase. Multiple names separated with semicolon without space. For example: Rheinische Vorgebirgstrauben;Emma;Avlon NGB30 TAIPALE ME0201;OTRA MIX (Finnish cultivar of Barley, NGB)

1.13.1 Synonyms

Include here any previous identification other than the current name. Collecting number or newly assigned station names are frequently used as Identifiers

1.13.2 Common crop name [MCPD]

Name of the crop in colloquial language, preferably English (i.e. 'Pani-Miris Kurundu', 'Thiththa Kurundu', 'Miris Kurundu' or 'Sevel Kurundu')

1.14 Acquisition date [YYYYMMDD] [MCPD]

Date on which the accession entered the collection where YYYY is the year MM is the month and DD is the day. Missing data (MM or DD) should be indicated with hyphens. Leading zeros are required.

1.15 Accession size

Number or weight of seeds, seedlings, saplings, budsticks, in vitro plants, etc. of an accession in the genebank

1.16 Type of material received

1 Fruit
2 Seed
3 Shoot/budwood/stem cutting
4 In vitro culture (Plantlets)
5 Plant (Seedling, sapling)
99 Other (e.g. more than one type, specify in descriptor 1.17 Remarks)

1.17 Remarks

The remarks field is used to add notes or to elaborate on descriptors with value 99 or 999 (=Other). Prefix remarks with the field name they refer to and a colon (e.g. COLLSRC:roadside). Separate remarks referring to different fields are separated by semicolons without space.

2. Collecting descriptors

2.1 Collecting institute(s)

Name and address of the institute(s) and individual(s) collecting/ sponsoring the collection of the sample(s)

2.2 Collecting institute code [MCPD]

Code of the Institute collecting the sample. If the holding institute has collected the material, the collecting institute code (COLLCODE) should be the same as the holding institute code (INSTCODE). It follows the Institute code standard.

2.3 Site number

Number assigned to the physical site by the collector

2.4 Collecting number [MCPD]

Original number assigned by the collector(s) of the sample, normally composed of the name or initials of the collector(s) followed by a number. This number is essential for identifying duplicates held in different collections. It should be unique and always accompany subsamples wherever they are sent.

2.5 Collecting date of sample [YYYYMMDD] [MCPD]

Collecting date of the sample where YYYY is the year, MM is the month and DD is the day. Missing data (MM or DD) should be indicated with hyphens. Leading zeros are required.

2.6 Country of origin [MCPD]

Code of the country in which the sample was originally collected. Use the three letter ISO 3166-1 extended country codes.

2.7 Province/State

Name of the primary administrative subdivision of the country in which the sample was collected

2.8 Department/County

Name of the secondary administrative subdivision (within a Province/State) of the country in which the sample was collected

2.9 Location of collecting site [MCPD]

Distance in kilometers and direction from the nearest town, village or map grid reference point (e.g. Deiyandara 5N means 5 km north of Deiyandara)

2.10 Latitude of collecting site[1] [MCPD]

Degrees and minutes followed by N (North) or S (South) (eg. 09632N)

2.11 Longitude of collecting site[1] [MCPD]

Degrees and minutes followed by E (East) or W (West) (eg. 06854E)

2.12 Elevation of collecting site [m asl] [MCPD]

Elevation of collecting site expressed in meters above sea level. Negative values are allowed.

2.13 Collecting/acquisition source [MCPD]

The coding scheme proposed can be used at 2 different levels of detail: either by using the general codes (in boldface) such as 10, 20, 30, 40 or by using the more specific codes such as 11, 12, etc.

10 Wild habitat
11 Forest/woodland
12 Shrubland
13 Grassland
14 Desert/tundra
15 Aquatic habitat
20 Farm or cultivated habitat
21 Field
22 Orchard
23 Backyard, kitchen or home garden (urban, peri-urban or rural)
24 Fallow land
25 Pasture
26 Farm store
27 Threshing floor
28 Park

[1]To convert from longitude and latitude in degrees (°) minutes (′), seconds (″) and a hemisphere (North or South and East or West) to decimal degrees, the following formula should be used: d°m's"=h*(d+m/60 + s/3600) where h=1 for Northern and Eastern hemispheres and -1 for the Southern and Western hemispheres, i.e., 30°30'0"S = -30.5 and 30°15'55"N=30.265.

30 Market or shop
40 Institute, experimental station, research organization, genebank
50 Seed company
60 Weedy, disturbed or ruderal habitat
61 Roadside
62 Field margin
99 Other (Specify in descriptor 2.31 Collector's notes)

2.14 Breeding institute code [MCPD]

Institute code of the institute that has bred the material. If the holding institute has bred the material, the breeding institute code (BREDCODE) should be the same as the holding institute code (INSTCODE). It follows the Institute code standard.

2.15 Collecting source environment

Use descriptors 6.1.1. to 6.1.27 in section 6

2.16 Type of sample

Type of sample collected. If different types of material were collected from the same source, each sample type should be designated with a unique collecting number and a corresponding unique accession number

1 Seed
2 Seedling/sapling
3 Budwood
4 Graft
5 In vitro plantlet
6 Fruit
99 Other (specify which part of the plant is used in descriptor 2.31 Collector's notes)

2.17 Biological status of accession [MCPD]

The coding scheme proposed can be used at three different levels of detail: either by using the general codes (in boldface) such as 100, 200, 300, 400 or by using the more specific codes such as 110, 120, etc.

100 Wild
110 Natural
120 Semi-natural/wild
200 Weedy
300 Traditional cultivar/landrace
400 Breeding/research material

410 Breeder's line
411 Synthetic population
412 Hybrid
413 Founder stock/base population
414 Inbred line (parent of hybrid cultivar)
415 Segregating population
420 Mutant/genetic stock
500 Advanced/improved cultivar
999 Other (Specify in descriptor 2.31 Collector's notes)

2.18 Local/vernacular name

Name given by farmer to crop and cultivar/landrace/weed. State language and dialect if the ethnic group is not provided

2.19 Ethnic group

Name of the tribe of the farmer donating the sample or of the people living in the area of collecting

2.20 Population size

Number of plants sampled. If estimated, provide method used (i) row per column count; (ii) area per plant density; for both, allow for missing stands

2.21 Plant population density

1 Low
2 Intermediate
3 High

2.22 Genetic erosion

Estimate of the rate at which genetic erosion of the species is occurring in the region of collecting

1 Slow
2 Intermediate
3 Rapid

2.23 Cultural practices

2.23.1 Sowing date [YYYYMMDD]
2.23.2 Transplanting date [YYYYMMDD]
2.23.3 Harvest date [YYYYMMDD]
2.23.4 Irrigation

Specify amount, frequency, and method of application

2.24 Cultural methods

2.24.1 Cropping system

1 Monoculture (specify spacing)
2 Intercropping (specify spacing and type of intercrop)
3 Agropastoralism (specify type of animals)
4 Natural cropping (i.e. wild types topworked) with cultivar/self sown trees retained in homesteads)
99 Other (Specify in descriptor 2.31 Collector's notes)

2.24.2 Propagation methods

Method used to produce trees

1 Seed propagation
2 Vegetative propagation
3 Air layering
4 Micropropagation
99 Other (Specify in descriptor 2.31 Collector's notes)

2.24.3 Irrigation

1 Rainfed
2 2Irrigated (specify average annual amount of water supplied per hectare)
99 Other (Specify in descriptor 2.31 Collector's notes)

2.25 Associated flora

Other dominant crop/plant species, including other *Cinnamomum* species, found in and around the collecting site

2.26 Parts of the plant used

1 Bark
2 Leaf
3 Seed
99 Other (Specify in descriptor 2.31 Collector's notes)

2.27 Uses of the accession

1 Spice
2 Bark oil
3 Leaf oil
4 Medicinal
5 Food preservative
6 Flavoring agent in beverages
7 Fuel
99Other (Specify in descriptor 2.31 Collector's notes)

2.28 Photograph

Was a photograph(s) taken of the accession or habitat at the time of collection?

If so, provide an identification number(s) in descriptor 2.31 Collector's notes

0 No

1 Yes

2.29 Herbarium specimen

Was a herbarium specimen collected? If so, indicate the plant part used, provide an identification number and indicate in which place (Herbarium) the specimen was deposited, in descriptor 2.31 Collector's notes

0 No

1 Yes

2.30 Prevailing stresses

Information on associated biotic and abiotic stresses and the accession's reaction. Indicate if disease indexing was done at the time of collecting

2.31 Collector's notes

Additional information recorded by the collector or any specific information on any state in any of the above descriptors

MANAGEMENT

3. Seed management descriptors

3.1 Accession number (Passport 1.1)

3.2 Population identification (Passport 2.4)
Collecting number, pedigree, cultivar name, etc. depending on the population type

3.3 Storage address
(Building, room, shelf number/ location in medium- and/or long-term storage)

3.4 Storage date [YYYYMMDD]

3.5 Germination at storage (initial) [%]

3.6 Date of last germination test [YYYYMMDD]

3.7 Germination at the last test [%]

3.8 Date of next test [YYYYMMDD]
Date (estimate) when the accession should next be tested

3.9 Moisture content at harvest [%]

3.10 Moisture content at storage (initial) [%]

3.11 Amount of seed in storage(s) [g or number] (Passport 1.15)

3.12 Location of duplicates of the accession (Within the host's programme)

4 Multiplication/Regeneration descriptors

4.1 Accession number (Passport 1.1)

4.2 Population identification (Passport 2.4)

4.3 Field plot number

4.4 Location

4.5 Collaboration

4.6 Cultural practices

4.6.1 Sowing date [YYYYMMDD]

4.6.2 Grafting date [YYYYMMDD]

4.6.3 Transplanting date [YYYYMMDD]

4.6.4 Harvest date [YYYYMMDD]

4.6.5 Irrigation

Specify amount, frequency and method of application

4.7 Sowing density [%]

4.8 Fertilizer application [g m^{-2}]

4.9 Germination in the nursery [%]

4.10 Germination in the field [%]

4.11 Seedling vigour

Assessed at 18 days after emergence

4.12 Number of plants established by hectare

4.13 Number of plants used as seed source for each regeneration

4.14 Pollination method

1 Self pollinated
2 Often cross-pollinated
3 Cross pollinated

4.15 Pollen viability

3 Low
5 Intermediate
7 High

4.16 Previous multiplication and/or regeneration

4.16.1 Location
4.16.2 Sowing date [YYYYMMDD]
4.16.3 Plot number

4.17 Number of times accession regenerated

Since the date of acquisition

4.18 Notes

Any additional information may be specified here

ENVIRONMENT AND SITE

5. Characterization and/or evaluation site descriptors

5.1 Country of characterization and/or evaluation
(See instructions in descriptor 2.6 Country of collecting)

5.2 Site (research institute)
5.2.1 Latitude
Degrees and minutes followed by N (North) or S (South) (e.g. 1030S). Missing data (minutes) should be indicated with hyphen (e.g. 10-S).

5.2.2 Longitude
Degrees and minutes followed by E (East) or W (West) (e.g. 07625W). Missing data (minutes) should be indicated with hyphen (e.g. 076-W).

5.2.3 Elevation [m asl]

5.2.4 Name and address of farm or institute

5.3 Evaluator's name and address

5.4 Sowing/stem cutting/air layering date [YYYYMMDD]

5.5 Harvest date [YYYYMMDD]

5.6 Evaluation environment
Environment in which characterization/evaluation was carried out
1 Field
2 Screenhouse
3 Glasshouse
4 Laboratory
99 Other (specify in descriptor 5.16 Notes)

5.7 Seed germination [%]
Specify number of days over which germination is measured

5.8 Field establishment [%]

Percentage of plants established. Specify number of days from planting/sowing, after which establishment is measured

5.9 Number of days to planting after air layering

5.10 Number of days to 50% field emergence

Emergence for each accession

5.11 Sowing/planting site in field

Give block, strip and/or row/plot numbers as applicable, plants/plot, replication

5.12 Field spacing

5.12.1 Distance between plants in a row [m]

5.12.2 Distance between rows [m]

5.13 Environmental characteristics of site

Use descriptors 6.1.1 to 6.1.27 in section 6

5.14 Fertilizer

Specify types used, doses, frequency of each and method of application

5.15 Plant protection

Specify pesticides used, doses, frequency of each and method of application

5.16 Notes

Any other site-specific information

6. Collecting and/or characterization/evaluation site environment Descriptors

6.1 Site environment

★ 6.1.1 Topography

(Adapted from FAO, 1990)

This refers to the profiles in elevation of the land surface on a broad scale.

1	Flat	0 - 0.5%
2	Almost flat	0.6 - 2.9%
3	Gently undulating	3 - 5.9%
4	Undulating	6 - 10.9%
5	Rolling	11 - 15.9%
6	Hilly	16 - 30%
7	Steeply dissected	>30%, moderate elevation range
8	Mountainous	>30%, great elevation range (>300 m)
9	Other	(Specify in appropriate section's Notes)

★ 6.1.2 Higher level landform (general physiographic features)

(Adapted from FAO, 1990)

The landform refers to the shape of the land surface in the area in which the site is located.

1 Plain
2 Basin
3 Valley
4 Plateau
5 Upland
6 Hill
7 Mountain

6.1.3 Second level landform

(Adapted from FAO, 1990)

1	Alluvial plain	(A plain formed from the deposition of alluvium usually adjacent to a river that periodically overflows (aggraded valley plain, river plain, wash plain, waste plain))
2	Coastal plain	
3	Lacustrine plain	
4	Glacial plain	
5	Peneplain	(Base-leveled plain) (Any Land surface changed almost to a plain by subaerial erosion)

6 Pediment (A piedmont slope formed from a combination of mainly erosional processes; the surface is chiefly bare rock but may have a covering veneer of alluvium or gravel (conoplain, piedmont interstream flat))
7 Volcano
8 Dunefield
9 Delta
10 Tidal flat (A marshy, sandy, or muddy nearly horizontal coastal flatland which is alternately covered and exposed as the tide rises and falls)
11 Playa (A small, generally sandy land area at the mouth of a stream or along the shore of a bay)
12 Cay (A flat coral island)
13 Other (Specify in appropriate section's Notes)

★ 6.1.4 Land element and position

(Adapted from FAO, 1990)
Description of the geomorphology of the immediate surroundings of the site. (See Fig. 1)

1 Plain level
2 Escarpment
3 Interfluve
4 Valley
5 Valley floor
6 Channel
7 Levee
8 Terrace
9 Floodplain
10 Lagoon
11 Pan
12 Caldera
13 Open depression
14 Closed depression
15 Dune
16 Longitudinal dune
17 Interdunal depression
18 Mangrove
19 Upper slope
20 Midslope
21 Lower slope
22 Ridge
23 Beach
24 Beachridge
25 Rounded summit
26 Summit
27 Coral atoll
28 Drainage line (bottom position in flat or almost-flat terrain)
29 Coral reef
99 Other (specify in appropriate section's Notes)

★ 6.1.5 Slope [°]

Estimated slope of the site

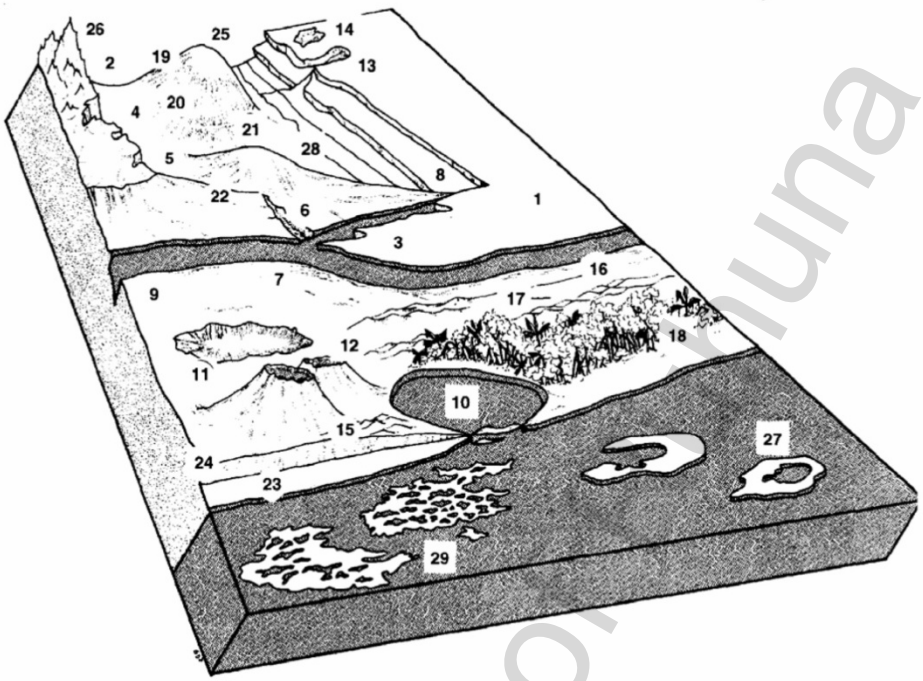

Fig. 1. Land element and position

★ 6.1.6 Slope form

(Adapted from FAO, 1990)

It refers to the general shape of the slope in both the vertical and horizontal directions.

1 Straight
2 Concave
3 Convex
4 Terraced
5 Complex (irregular)

★ 6.1.7 Slope aspect

The direction that the slope on which the accession was collected faces. Describe the direction with symbols N, S, E, W (e.g. a slope that faces a southwestern direction has an aspect of SW).

6.1.8 Crop agriculture

(Adapted from FAO, 1990)

6.1.8.1 Perennial field cropping

1 Non-irrigated cultivation
2 Irrigated cultivation
3 Other (Specify in appropriate section's Notes)

6.1.9 Overall vegetation surrounding and at the site

(Adapted from FAO, 1990)

1	Grassland	(Grasses, subordinate forbs, no woody species)
2	Forbland	(Herbaceous plants predominant)
3	Forest	(Continuous tree layer, crowns overlapping, large number of tree and shrub species in distinct layers)
4	Woodland	(Continuous tree layer, crowns usually not touching, understorey may be present)
5	Shrubland	(Continuous layer of shrubs, crowns touching)
6	Savanna	(Grasses with a discontinuous layer of trees or shrubs)
7	Other	(specify in appropriate section's Notes)

★ 6.1.10 Soil parent material

(Adapted from FAO, 1990)

Two lists of examples of parent material and rock are given below. The reliability of the geological information and the knowledge of the local lithology will determine whether a general or a specific definition of the parent material can be given. Saprolite is used if the *in situ* weathered material is thoroughly decomposed, clay-rich but still showing rock structure. Alluvial deposits and colluvium derived from a single rock type may be further specified by that rock type.

6.1.10.1 Unconsolidated material

1 Aeolian deposits (unspecified)
2 Aeolian sand
3 Littoral deposits
4 Lagoonal deposits
5 Marine deposits
6 Lacustrine deposits
7 Fluvial deposits
8 Alluvial deposits
9 Unconsolidated (unspecified)
10 Volcanic ash
11 Loess
12 Pyroclastic deposits
13 Glacial deposits
14 Organic deposits
15 Colluvial deposits
16 *In situ* weathered
17 Saprolite
99 Other (specify in appropriate section's Notes)

6.1.10.2 Rock type

(Adapted from FAO, 1990)

1 Acid igneous/ metamorphic rock
2 Granite
3 Gneiss
16 Limestone
17 Dolomite
18 Sandstone
19 Quartzitic sandstone

4 Granite/gneiss
5 Quartzite
6 Schist
7 Andesite
8 Diorite
9 Basic igneous/ metamorphic rock
10 Ultra basic rock
11 Gabbro
12 Basalt
13 Dolerite
14 Volcanic rock
15 Sedimentary rock
20 Shale
21 Marl
22 Travertine
23 Conglomerate
24 Siltstone
25 Tuff
26 Pyroclastic rock
27 Evaporite
28 Gypsum rock
29 Other (specify in appropriate section's Notes)
0 Not known

6.1.11 Stoniness/rockiness/hardpan/cementation

1 Tillage unaffected
2 Tillage affected
3 Tillage difficult
4 Tillage impossible
5 Essentially paved

★6.1.12 Soil drainage

(Adapted from FAO, 1990)

3 Poorly drained
5 Moderately drained
7 Well drained

6.1.13 Flooding

(Adapted from FAO, 1990)

Flooding or temporary inundation is described according to its estimated frequency, duration and sampling depth. Information may be obtained from records past flooding or from local enquiry. The frequency and duration classes should give an indication of the average occurrence of inundation

★6.1.14 Soil salinity

1 <160 ppm dissolved salts
2 160 - 240 ppm
3 241 - 480 ppm
4 >480 ppm

6.1.15 Quality of the groundwater

(Adapted from FAO, 1990)

1 Saline
2 Brakish
3 Fresh
4 Polluted
5 Oxygenated
6 Stagnating

★ 6.1.16 Soil depth to groundwater table

(Adapted from FAO, 1990)

The depth to the groundwater table, if present, as well as an estimate of the approximate annual fluctuation, should be given. The maximum rise of the groundwater table can be inferred approximately from changes in profile colour in many, but not all, soils.

1 0 - 25 cm
2 25.1 - 50 cm
3 50.1 - 100 cm
4 100.1 - 150 cm
5 >150 cm

6.1.17 Soil moisture

(Adapted from FAO, 1990)

Moisture conditions prevailing in the soil at the time of collecting should be given together with the depth. Attention should be paid to unusual moisture conditions caused by unseasonal weather, prolonged exposure of the profile, flooding, etc.

3 Dry
5 Slightly moist
7 Moist
9 Wet

★ 6.1.18 Soil pH

Actual value of the soil within the following root depths around the accession

6.1.18.1 pH at 10-15 cm
6.1.18.2 pH at 16-30 cm
6.1.18.3 pH at 31-60 cm
6.1.18.4 pH at 61-90 cm

★ 6.1.19 Soil erosion

3 Low
5 Intermediate
7 High

6.1.20 Soil matrix colour

(Adapted from FAO, 1990)

The colour of the soil matrix material in the root zone around the accession is recorded in the moist condition (or both dry and moist condition, if possible) using the notation for hue, value and chroma as given in the Munsell Soil Color Charts (Munsell, 1975). If there is no dominant soil matrix colour, the horizon is described as mottled and two or more colours are given and should be registered under uniform conditions. Early morning and late evening readings are not accurate. Provide depth of measurement (cm). If colour chart is not available, the following states may be used:

1	White	7	Reddish brown	13	Greyish
2	Red	8	Yellowish brown	14	Blue
3	Reddish	9	Yellow	15	Bluish-black
4	Yellowish red	10	Reddish yellow	16	Black
5	Brown	11	Greenish, green		
6	Brownish	12	Grey		

6.1.21 Soil organic matter content

1 Nil (as on arid zones)
2 Low (as in long-term cultivation in a tropical setting)
3 Medium (as in recently cultivated but not yet much depleted)
4 High (as in never cultivated, and in recently cleared from forest)
5 Peaty

★ 6.1.22 Rock fragments

(Adapted from FAO, 1990)

Large rock and mineral fragments (>2 mm) are described according to abundance

1	0 - 2%	4	15.1 - 40%
2	2.1 - 5%	5	40.1 - 80%
3	5.1 - 15%	6	>80%

6.1.23 Soil texture classes

(Adapted from FAO, 1990)

For convenience in determining the texture classes of the following list, particle size classes are given for each of the fine earth fractions below. (See Fig. 2)

1	Clay	12	Coarse sandy loam
2	Loam	13	Loamy sand
3	Clay loam	14	Loamy very fine sand
4	Silt	15	Loamy fine sand
5	Silty clay	16	Loamy coarse sand
6	Silty clay loam	17	Very fine sand
7	Silt loam	18	Fine sand
8	Sandy clay	19	Medium sand
9	Sandy clay loam	20	Coarse sand
10	Sandy loam	21	Sand, unsorted
11	Fine sandy loam	22	Sand, unspecified

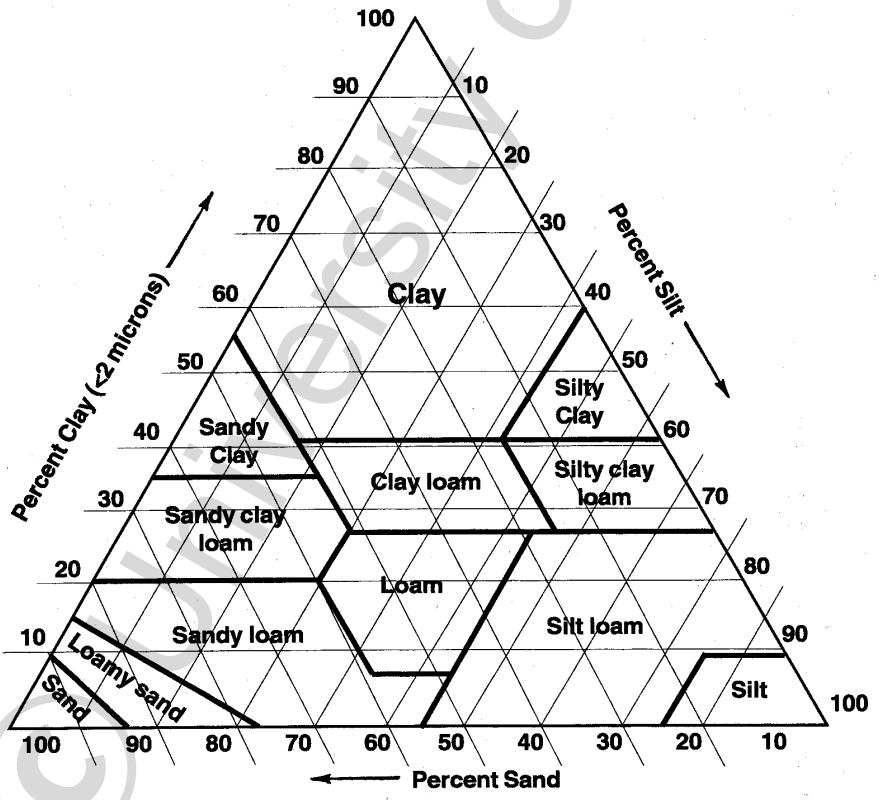

Fig. 2. Soil texture classes

★ 6.1.23.1 Soil particle size classes

(Adapted from FAO, 1990)

1	Clay	< 2 µm
2	Fine silt	2 - 20 µm
3	Coarse silt	21 - 63 µm
4	Very fine sand	64 - 125 µm
5	Fine sand	126 - 200 µm
6	Medium sand	201 - 630 µm
7	Coarse sand	631 - 1250 µm
8	Very coarse sand	1251 - 2000 µm

6.1.24 Soil taxonomic classification

As detailed a classification as possible should be given. This may be taken from a soil survey map. State class (e.g. Alfisols, Spodosols, Vertisols, etc.).

★ 6.1.25 Water availability

1 Rain-fed
2 Irrigated
3 Flooded
4 River banks
5 Sea coast
99 Other (specify in appropriate section's Notes)

6.1.26 Soil fertility

General assessment of the soil fertility based on existing vegetation

3 Low
5 Moderate
7 High

6.1.27 Climate of the site

Should be assessed as close to the site as possible

6.1.27.1 Temperature [°C]

Provide either the monthly (mean, maximum, minimum) or the seasonal (mean, maximum, minimum)

6.1.27.2 Rainfall [mm]

Annual average rainfall of given location.

6.1.27.3 Light intensity

3 Shady
7 Sunny

6.1.27.4 Photoperiod

Specify the duration of light availability during each month

6.1.27.5 Trees intercropping with cinnamon

1 Coconut
2 Rubber
3 Coffee
4 Others (specify in appropriate section's Notes)

6.1.28 Other

(Specify in appropriate section's Notes)

CHARACTERIZATION

7. Plant descriptors

For all colour descriptors, RHS colour codes are given in parentheses beside descriptor states

7.1 Overall tree

For descriptors 7.1.1-7.1.6, specify number of trees characterized per accession

7.1.1 Tree age [y]

7.1.2 Tree type

1 Seedling
2 Vegetative propagation plant
3 Micropropagation
4 Other (specify in descriptor 7.7 Notes)

7.1.3 Tree vigour

3 Weak
5 Intermediate
7 Strong

7.1.4 Tree spread [m]

Measured as the mean diameter using two directions

7.1.5 Tree height [m]

From ground level to the top of the tree. Evaluate only unpruned trees

7.1.6 Tree shape

1 Columnar
2 Pyramidal
3 Obovate
4 Rectangular
5 Circular
6 Semicircular
7 Semielliptic
8 Irregular
9 Other (specify in descriptor 7.7 Notes)

★7.1.7 Trunk surface

3 Smooth
5 Rough
7 Very rough

7.1.8 Trunk circumference [cm]

Recorded at 30 cm above ground level

7.1.9 Branching pattern

1 Extensive (one branch arises below apex of twig with each flush of growth)
2 Intensive (several branches arise below apex of twig with each flush of growth)
3 Both patterns (record prominent one)

7.1.10 Distribution of branches

1 Ascendant
2 Irregular
3 Verticillate
4 Axial
5 Horizontal

7.1.11 Crotch angle of main branches

1 Acute (90°)
2 Obtuse (>90°)
3 Other (specify in descriptor 7.7 Notes)

7.1.12 Extension growth of twigs [cm]

Measured after major growth flush following harvest. Mean of 10 randomly selected twigs

★ 7.1.13 Internode length of twigs [cm]

Measured at the intermediate part of the twigs, after current season's growth has ceased. Mean of 10 randomly selected twigs

★ 7.1.14 Twig diameter [cm]

Of current shoot at an internode of the intermediate part of the twig, measured after current season's growth has ceased. Mean of 10 randomly selected twigs

★ 7.1.15 Surface of young twig

1 Glabrous
2 Pubescent
3 Other (specify in descriptor 7.7 Notes)

7.1.16 Leaf size

Recorded on plants exposed to full sunlight

1 Small (<10 cm in length/<4 cm width)
2 Medium (10-16 cm in length/4-8 cm width)
3 Large (>16 cm in length/>8 cm width)
4 Other (specify in descriptor 7.7 Notes)

★ 7.1.17 Leaf length (cm)

It is measured from the leaf apex to leaf base of the leaf blade. It is done at the different five stages of maturity. Average of 10 leaves

★ 7.1.18 Leaf width (cm)

It is measured at the widest position of the leaf blade. Average of 10 leaves. Same leaves are used for the measurement as in 7.1.17.

★ 7.1.19 Leaf arrangement

(See Fig. 3)

1 Opposite
2 Sub-opposite
3 Opposite or sub-opposite in different branch but in same plant
4 Opposite to sub-opposite in the same branch in same plant
5 Other (specify in descriptor 7.7 Notes)

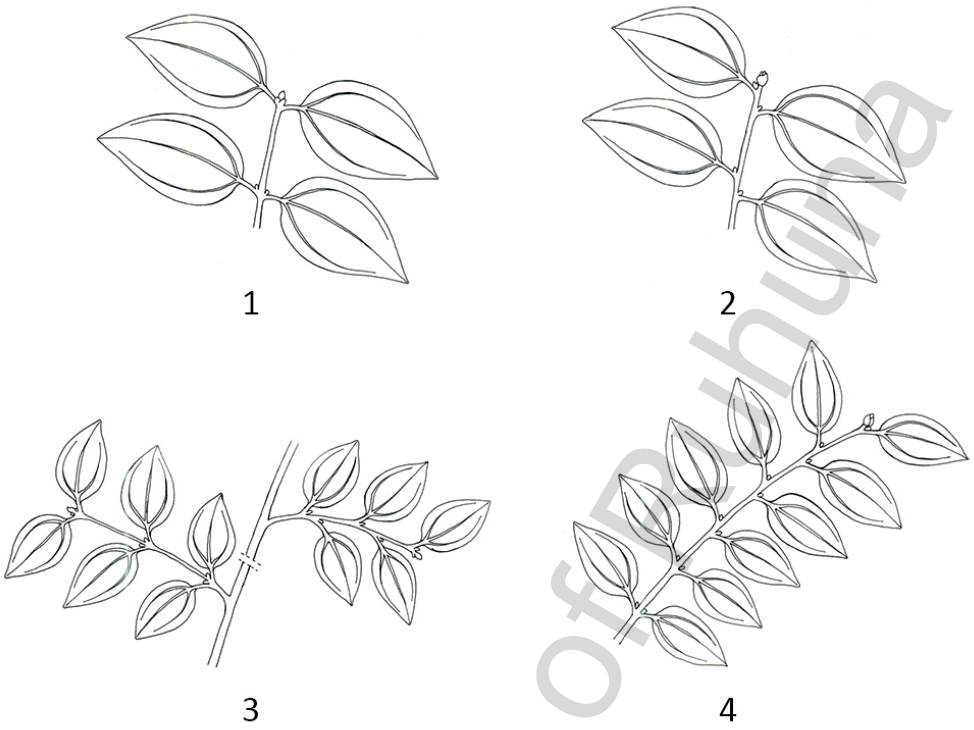

Fig. 3. Diagram showing different types of leaf arrangement of cinnamon

★ 7.1.20 Leaf shape

(See Fig. 4)

1 Elliptic
2 Broadly elliptic
3 Narrowly elliptic
4 Ovate
5 Broadly ovate
6 Oval
7 Lanceolate
8 Ovate-lanceolate
9 Oblong-lanceolate
10 Other (specify in descriptor 7.7 Notes)

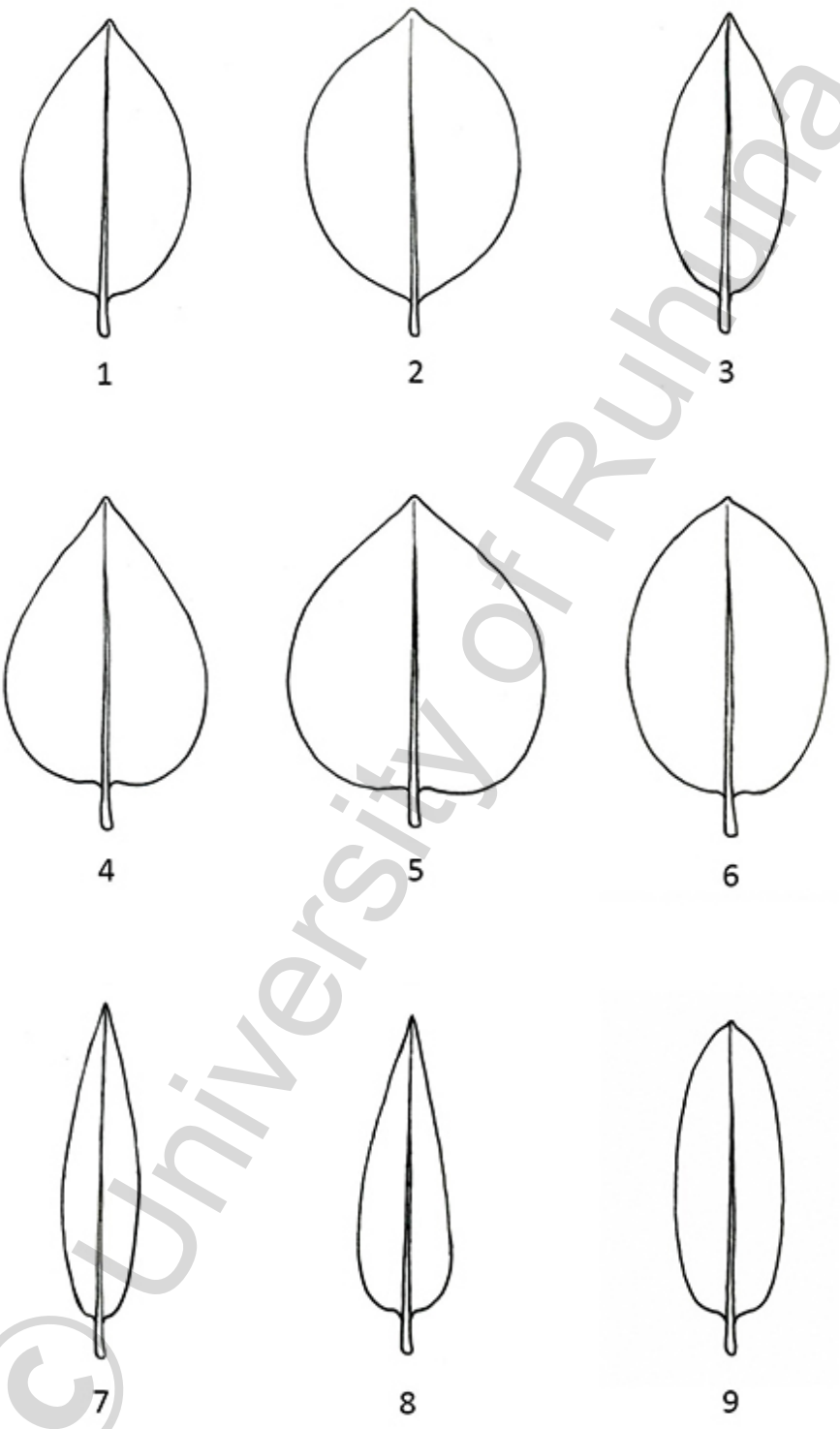

Fig. 4. Diagram showing different types of leaf shape of cinnamon

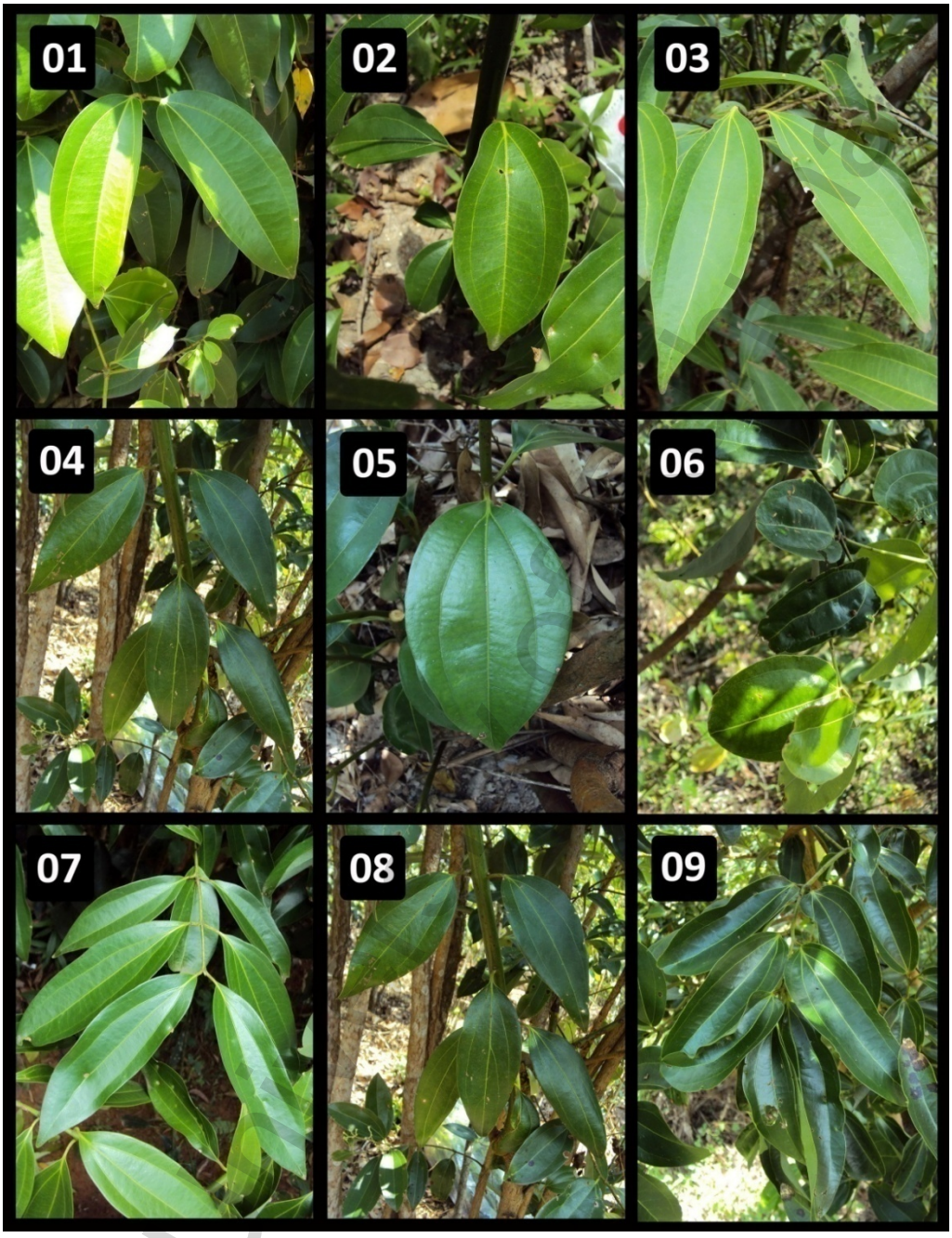

Fig. 5. Different types of leaf shape; 01 Elliptic, 02 Broadly elliptic, 03 Narrowly elliptic, 04 Ovate, 05 Broadly ovate, 06 Oval, 07 Lanceolate, 08 Ovate-lanceolate, 09 Oblong-lanceolate

★ 7.1.21 Leaf apex

(See Fig. 6)

1 Acute
2 Obtuse
3 Acuminate
4 Long acuminate
5 Narrowly acuminate
6 Acuminate with broad acumen
7 Other (specify in descriptor 7.7 Notes)

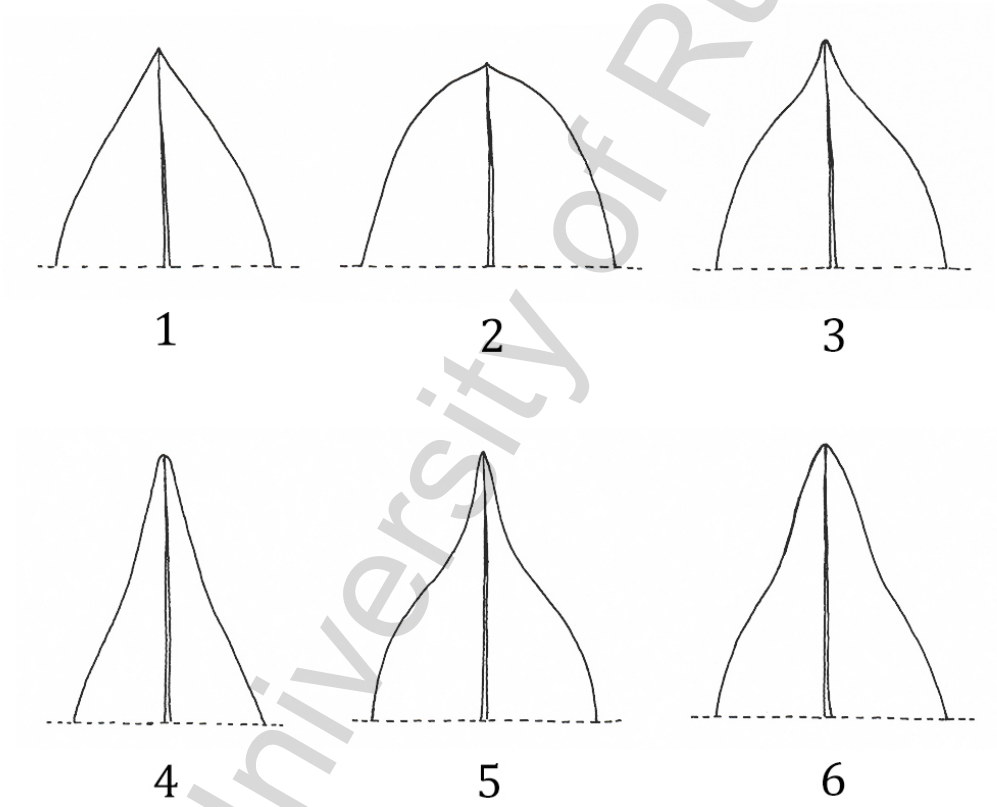

Fig. 6. Diagram showing different types of leaf apex of cinnamon

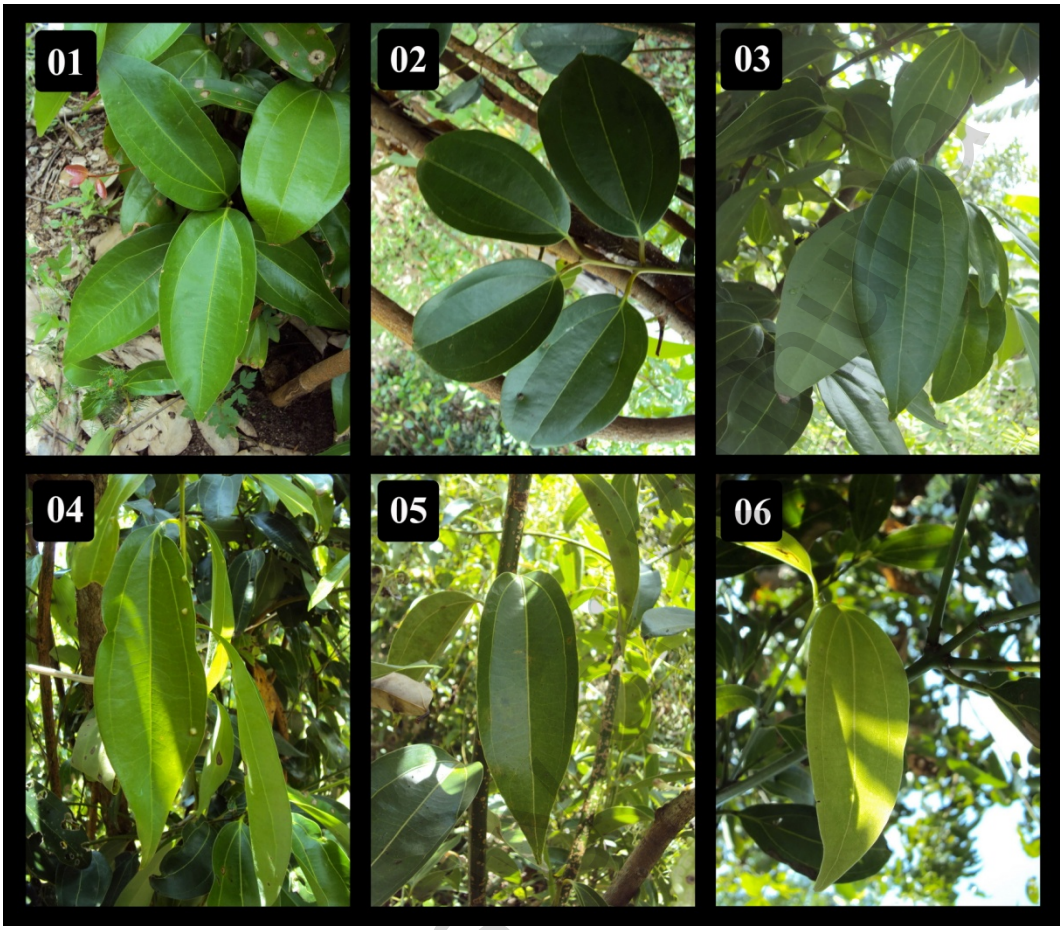

Fig. 7. Different types of leaf apex; 01 Acute, 02 Obtuse, 03 Acuminate, 04 Long acuminate, 05 Narrowly acuminate, 06 Acuminate with broad acumen

★ 7.1.22 Leaf base

(See Fig. 8)

1 Acute
2 Subacute
3 Cuneate
4 Rounded
5 Subcordate
6 Obtuse
7 Obtuse, contracted into petiole, then shortly cuneate
8 Other (specify in descriptor 7.7 Notes)

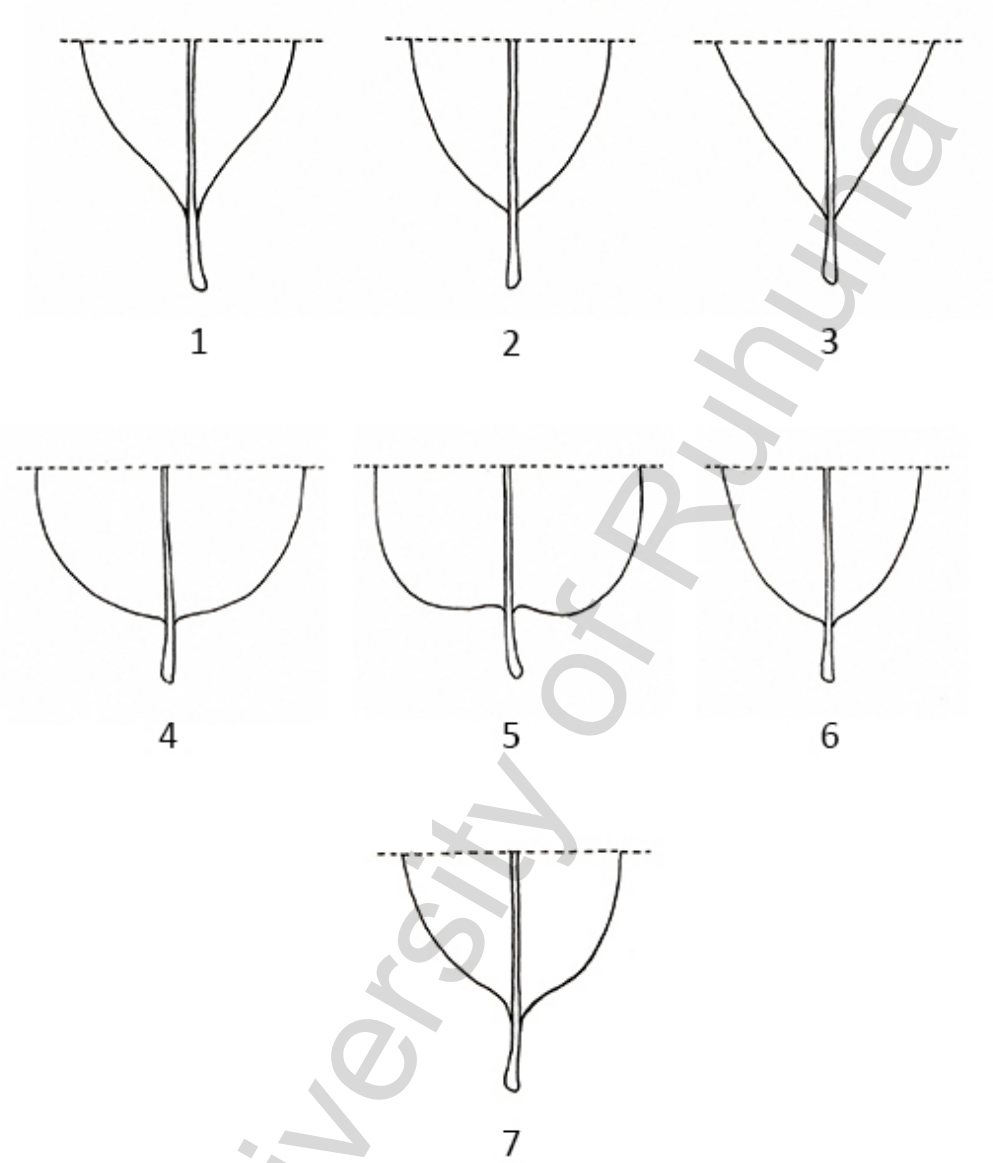

Fig. 8. Diagram showing different types of leaf base of cinnamon

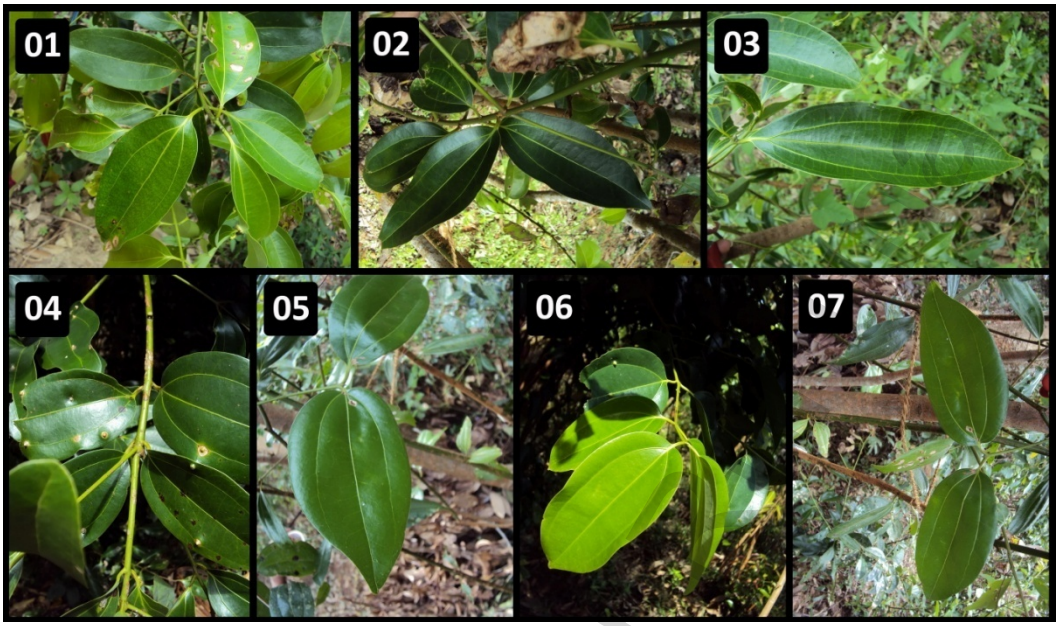

Fig. 9. Different types of leaf base; 01 Acute, 02 Subacute, 03 Cuneate, 04 Rounded, 05 Subcordate, 06 Obtuse, 07 Obtuse, contracted into petiole, then shortly cuneate

★ 7.1.23 Leaf texture

1 Coriacerous
2 Subcoriaceous
3 Rigidly coriaceous
4 Thinly to stiffly coriaceous
5 Chartaceous to rigidly chartaceous
6 Chartaceous
7 Other (specify in descriptor 7.7 Notes)

★ 7.1.24 Upper surface leaf texture

1 Glabrous
2 Glabrous, glossy
3 Glabrous, glossy, smooth
4 Soon glabrous, glossy, smooth
5 Glabrous, minutely pitted to smooth
6 Rugose
7 Other (specify in descriptor 7.7 Notes)

★ 7.1.25 Upper surface leaf color

1 Green (specify the code using Munsell Colour Chart)
2 Other (specify in descriptor 7.7 Notes)

★ 7.1.26 Lower surface leaf texture

1 Smooth, glossy, glabrous
2 Glabrescent
3 Minutely appressed-pubescent, soon glabrous
4 Rugose
5 Smooth, glabrous
6 Other (specify in descriptor 7.7 Notes)

★ 7.1.27 Lower surface leaf color

1 Green (specify the code using Munsell Colour Chart)
2 Other (specify in descriptor 7.7 Notes)

★ 7.1.28 Leaf venation

1 3-veined
2 5-veined
3 3-veined or 5-veined
4 Other (specify in descriptor 7.7 Notes)

★ 7.1.29 Petiole length (cm)

It is measured from the leaf base to node of the stem. It is done at the different five stages of maturity. Average of 10 leaves. Same leaves are used for the measurement as in 7.1.17.

★ 7.1.30 Leaf margin

1 Entire
2 Undulate
3 Other (specify in descriptor 7.7 Notes)

7.2 Flush

7.2.1 Flush color

1 Red (specify distribution of code following Munsell Colour Chart)
2 Green (specify distribution of code following Munsell Colour Chart)
3 Purplish (specify distribution of code following Munsell Colour Chart)
4 Other (specify in descriptor 7.7 Notes)

7.3 Inflorescence and Flower

Data recorded from ten flowers and inflorescences per tree replicated three times. Recorded at full flowering. See Fig. 10 and 11.

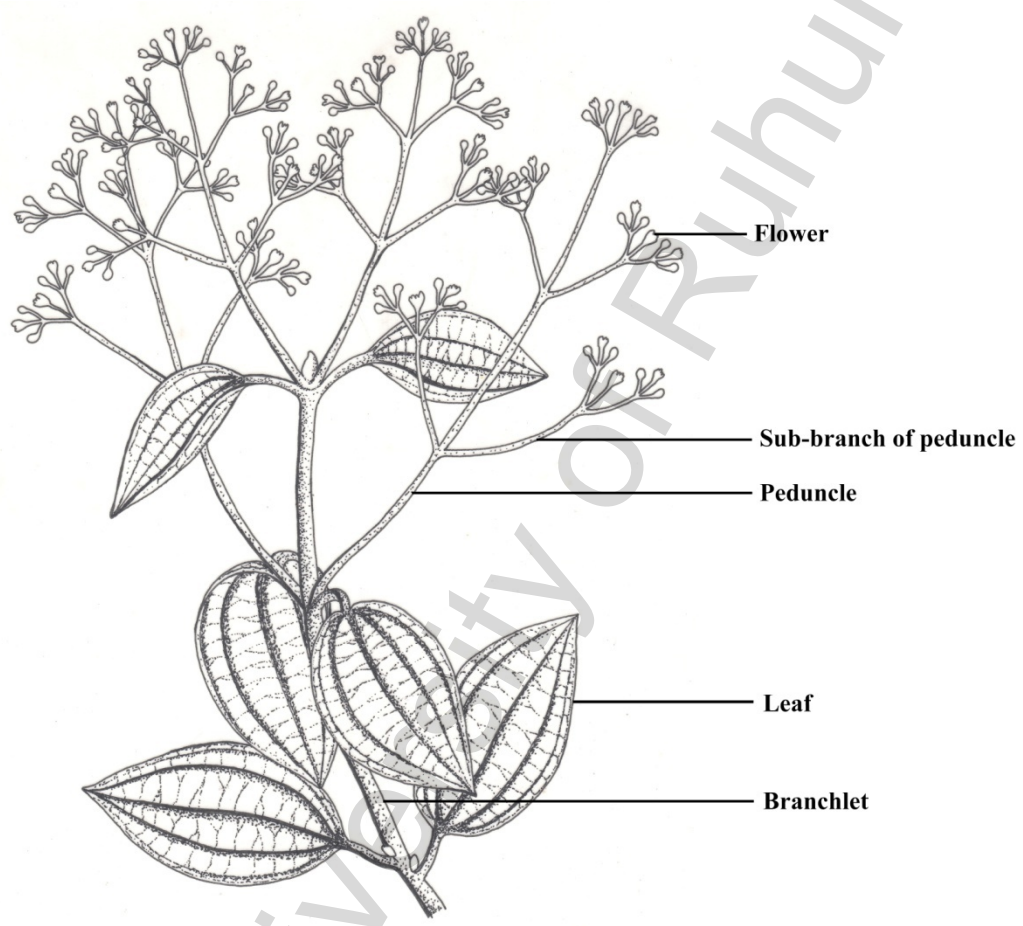

Fig. 10. Diagram showing a flowering branch of cinnamon

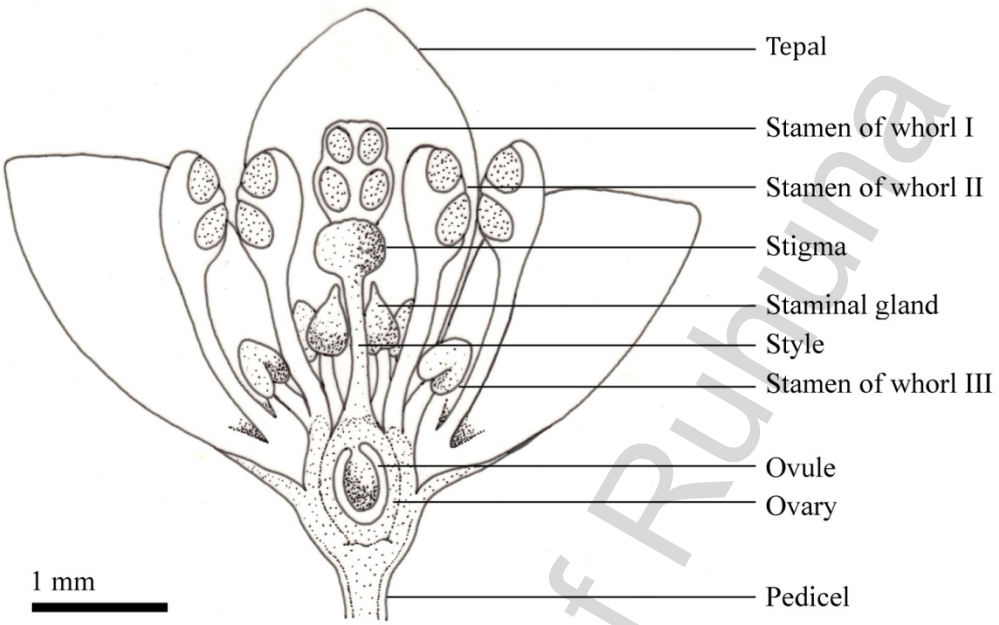

Fig. 11. Diagram showing longitudinal section of a cinnamon flower

7.3.1 Panicle length

From the base to the tip of the panicle at near maturity. Average of 10 panicles.

7.3.2 Panicle type

1 Axillary in upper leaves
2 Axillary near apex of branchlets
3 Axillary with short branchlets
4 Axillary with long branchlets
5 Other (specify in descriptor 7.7 Notes)

7.3.3 Flower color

1 Greenish (specify distribution of code following Munsell Colour Chart)
2 Pale yellowish-green (specify distribution of code following Munsell Colour Chart)
3 Yellowish (specify distribution of code following Munsell Colour Chart)
4 Other (specify in descriptor 7.7 Notes)

(A) **(B)** **(C)**

Fig. 12. Cinnamon panicle types (Scale bar 2cm); A. Axillary in upper leaves, B. Axillary near apex of branchlets and short branchlets, C. Axillary with long branchlets.

7.3.4 Flower length

It is measured from the tepal tip to the beginning of the pedicel. It is done at the mature stage of the flower. Average of 10 flowers.

7.3.5 Flower width

It is measured from the widest part of the flower. It is done at the mature stage of the flower. Average of 10 flowers.

7.3.6 Tepal length

The length of the tepal is measured from the tip of the tepal to the beginning of the pedicel. Average of 10 tepals.

7.3.7 Tepal width

The width of the tepal is measured at the widest position of the tepal. Average of 10 tepals.

7.3.8 Tepal number

3 Six
5 Eight
7 Other (specify in descriptor 7.7 Notes)

7.3.9 Tepal pubescence

Specify if it is observed in the inner or outer parts

3 Sparse
5 Intermediate
7 Dense

7.4 Fruit

7.4.1 Fruit length [mm]

Average of ten fruits

7.4.2 Fruit diameter [mm]

Measured at the broadest part. Average of ten fruits

7.4.3 Fruit shape

Specify mature fruits evaluated.

1 Ellipsoid
2 Ovoid
3 Ovoid and ellipsoid in same plant
4 Other (specify in descriptor 7.7 Notes)

(A) **(B)**

Fig. 13. Cinnamon fruit shape; (A) Ellipsoid (B) Ovoid

7.4.4 Fruit color (Mature fruit)

3 Purple (specify distribution of code following Munsell Colour Chart)
5 Black (specify the code following Munsell Colour Chart)
7 Other (specify in descriptor 7.7 Notes)

7.4.5 Fruit petiole length

It is measured from the fruit base to node of the stem. Average of 10 fruit petiole.

7.5 Bark

7.5.1 Bark fragrant

1 Weak fragrant aroma
2 Intermediate fragrant aroma
3 Good fragrant aroma
4 Strong fragrant aroma

7.5.2 Bark taste

1 Sweet
2 Pungent
3 Sweet pungent
4 Bitter
5 Bitter pungent
6 Astringent

7.5.3 Bark thickness (mm)

It is measured from the upper surface to hard wood of the stem.

7.5.4 Bark peeling quality

1 Good
2 Intermediate
3 Week

7.5.5 Bark surface

1 Slightly rough
2 Rough
3 Very rough
4 Smooth

7.5.6 Bark color

1 Brown
2 Whitish brown
3 Light brown
4 Greenish to brown
5 Brownish to black
6 Black
7 Other (specify in descriptor 7.7 Notes)

7.6 Vegetative propagation

7.6.1 Shoot regeneration percentage from a set of cutting after 4 weeks in propagator

3 Slowly regenerative, < 30%
5 Medium regenerative, 30-60%
7 Highly regenerative, >60%

7.6.2 Shoot production frequency from cutting after 2 weeks of field transfer

1 0 shoot
2 1 shoot
3 2 shoots
4 Other (specify in descriptor 7.7 Notes)

7.7 Notes

Any additional information, especially in the category of 'other' under various descriptors above, may be specified here

EVALUATION

8. Abiotic stress susceptibility

Scored under artificial and/or natural conditions, which should be clearly specified. These are coded on a susceptibility scale from 1 to 9:

1 Very low or no visible sign of susceptibility
3 Low
5 Intermediate
7 High
9 Very high

8.1 Low temperature

According to Department of Export Agriculture when temperature is below 25° (Department of Export Agriculture, 2013).

8.2 High temperature

According to Department of Export Agriculture when temperature is higher than 32° (Department of Export Agriculture, 2013).

8.3 Water salinity

8.4 Drought

According to Department of Export Agriculture rainfall range is 1,750- 3,500 mm (Department of Export Agriculture, 2013). It can be caused by low rainfall.

8.5 Soil acidity

If the pH is lower than 4.3

8.6 Soil salinity

If the pH is higher than 8.0

8.7 Mineral deficiencies

1 Nitrogen
2 Phosphorous
3 Potassium
4 Other (specify in descriptor **8.8 Notes**)

8.8 Notes

Specify here any additional information

9. Biotic stress susceptibility

In each case, it is important to state the origin of the infestation or infection, i.e. natural, field inoculation, laboratory. Record such information in descriptor **9.3 Notes**. These are coded on a susceptibility scale from 1 to 9, viz.:

1 Very low or no visible sign of susceptibility
3 Low
5 Intermediate
7 High
9 Very high

9.1 Diseases

List of diseases recorded on cinnamon (*Cinnamomum verum*)

Disease or common name	**Causal organism**	**Country**	**Reference**
Leaf spot/blight	*Colletotrichum gloesporioides*	Sri Lanka	Anandaraj and Devashayam, 2004; Kumara, 1999a
Grey leaf spots/blight	*Pestalotia cinnamomi,*	Sri Lanka	Anonymous, 1996
	P. palmarum,	India	Karunakaran *et al.,* 1993
	P. furierea	Dominican Republic, Pakistan	Ciferri, 1926; Ciferri and Fragoso, 1927
Black sooty mould	*Stenella* spp.	Sri Lanka	Rajapakse and Kumara, 2007
Algal leaf spots	*Cephaleuros virescens*	Sri Lanka	Rajapakse and Kumara, 2007
Rough bark disease	Unknown	Sri Lanka	Rajapakse and Kumara, 2007; Kumara, 1999b
Stripe canker	*Phytophthora cinnamomi*	West coast of Sumatra, Indonesia	Rands, 1922; Mehrlich, 1934

Pink disease	*Corticium salmonicolor*	Sri Lanka, India and Indonesia	Weiss, 2002
Brown root rot	*Phellinus lamaensis, P. noxius*	Sri Lanka	Rajapakse and Kumara, 2007
Stem disease	*Exobasidium cinnamomi*	Sri Lanka	Weiss, 2002
Stem blight, Nursery disease	*Diplodia* spp.	Sri Lanka	Rajapakse and Kumara, 2007
Root rot	*Rosellinia* spp.	Sri Lanka	Rajapakse and Kumara, 2007
White rot	*Leptoporus lignosus*	Sri Lanka	Rajapakse and Kumara, 2007
Reddish elongated leaf spot	*Phytophthora capsici*	India	Prakasam, 1991
Red leaf spot	*Colletotrichum capsici*	India	Prakasam, 1991
Hypertrophy and witches' broom on young shoots	*Caeoma keralensis*	India	Hosagoudar, 1984
Stripe canker	*Phytophthora cinnamomi*	Sumatra, Java	Rands, 1922
Red root	Fomes pseudoferrus	Indonesia	Van Overeem, 1925
Premature defoliation	*Sphaerella cinnamomicola, Pestalozzia funerea*	Dominican Republic	Ciferri and Fragoso, 1927
	Phyllosticta cinnamomi	Pernambuco, Brazil	Batista and Vital, 1952
	Cytosporella cinnamomi	Pernambuco, Brazil	Batista *et al*., 1953

Foliar disease	*Exosporium cinnamomi*	India	Muthappa, 1965, 1967
	Leptosphaeria almeidae, L. cinnamomi	St. Thomas [Gulf of Guinea]	Da Camera Edes, 1929
	Physalospora cinnamomi, Fusarium allescherianum	Prague, Czech Republic	Cejp, 1930
	Sclerotium cinnamomi	Japan	Sawada, 1933
	(*Corticium*) *Hypnochnus sasaki*	South Africa	Ver Woerd and Sasaki Du Plessis, 1933; Matsumoto and Hirane, 1933
Black mildews	*Armatella cinnamomi*	India	Hansford and Thirumalachar, 1948
	A. balakrishnanii	India	Hosagoudar, 1988
	A. cinnamomicola	India	Hosagoudar and Balakrishnan, 1995
Rust	*Uraecium nothopegiae*	India	Ramakrishnan, 1965
Dieback	*Colletotrichum capsici*	India	Sharma, 1979; Karunakaran and Nair, 1980
Shot hole	*Rosenscheldia orbis*	India	Srivastava, 1979
	Pestalotia cinnamomi	India	Narendra and Rao, 1972
	Zygosporium oscheoides	India	Patil and Thite, 1967; Rangaswamy *et al*., 1970
Withering *in vitro*	*Clavibacter michiganensis* sub sp. *sepedonicus*	-	Trejo and Lopez, 1990

Photos of major cinnamon diseases prevailing in Sri Lanka (Azad *et al*., 2016):

(A) **(B)**

Fig 14. Cinnamon leaves affected by leaf spot disease, (A) A leaf showing small brownish leaf spots and (B) A leaf later stage of disease development where leaf spots coalesce and form large necrotic blotches. Sometimes central portion of the infected area becomes shot-hole appearance.

(A) **(B)**

Fig 15. Rough bark disease in cinnamon, (A) Cinnamon stem affected by rough bark disease (Symptoms appears as black or brown spots which later become large patches and surrounded by dark brown or black border. Infected bark shows rough scab like appearance), (B) Leaf chlorosis due to rough bark disease.

9.2 Pests

List of insects recorded on cinnamon (*Cinnamomum verum*)

Pests (Genus/species)	**Pest or common name**	**Country**	**Reference**
Trioza cinnamomi	Jumping plant louse	Sri Lanka	Rajapakse and Kulasekara, 1982
Eriophyes boisi	Leaf gall	Sri Lanka	(Mani, 1973). Perera *et al.* (1985)
Chilasa clytia	Common Mime Butterfly	Sri Lanka	Rajapakse and Kulasekara, 1982
Graphium sarpedon	Blue bottles	Sri Lanka	Van der Poorten and Van der Poorten, 2004

Graphium doson	Common jay	India	Bell, 1912
Orthaga vitialis	Leaf and shoot webber	India	Singh, *et al.,* 1978
Euproctis fraternal, E. irrotata	Hairy caterpillar	India, Sri Lanka	Singh *et al*., 1978; Rajapakse and Kulasekara, 1982
Dasychira mendosa, D. horsfieldi	Moth	India, Sri Lanka	Butani, 1983; Rajapakse and Kulasekara, 1982
Synanthedon spp.	Clearwing moth	Sri Lanka	Dharmadasa and Jayasinghe, 2000
Alcides morio	Fruit borer	India	Premkumar, 1988
Acrocercops spp.	Leaf miner	India	Singh *et al*., 1978
Thalassodes spp.	Looper caterpillar	Sri Lanka	Rajapakse and Kulasekara, 1982
Olethreutes semiculta	Tortricid moth	Sri Lanka	Hutson, 1921
Attacus atlas, Agroploce aprobola	Moth	Sri Lanka	Rajapakse and Kulasekara, 1982
Ceroplastes rubens	Scale	Sri Lanka	Rajapakse and Kulasekara, 1982
Coptosoma pygmaeum, Leptocentrus obliquus	Sucking bugs	Sri Lanka	Rajapakse and Kulasekara, 1982
Coenobium lateralis, Cryptocephalus snillus, C. virgule, Podagrica badia	Chrysomelid beetles	Sri Lanka	Rajapakse and Kulasekara, 1982
Leucopholis pinguis	White grub	India	Beeson, 1921
Popillia complanata	Chaffer beetle	India	Singh, *et al.,* 1978

Singhala helleri	Leaf beetle	India	Singh, *et al.,* 1978
Oecophylla smaragdina	Weaver ant	India, Sri Lanka	Singh *et al*., 1978; Rajapakse and Kulasekara, 1982
Pauropsylla depressa	Insect gall	India	Ayyar, 1940
Conopomorpha civica	Leaf miner	India	Devasahayam and Koya, 1993
Sorolopha archimedias	Shoot and leaf webber	India, Sri Lanka	Singh *et al*., 1978; Rajapakse and Kulasekara, 1982
Phyllocnistis chrysophthalma,	Leaf miner	India	Meyrick, 1932
P. citrella	Leaf miner	Sri Lanka	Rajapakse and Kulasekara, 1982
Gargara extrema	Treehoppers	India	CPCRI, 1979
Bothrogonia sp.	Leafhopper	India	Kumaresan *et al*., 1988
Bemicia tabaci	Silverleaf whitefly	India	Koya *et al*., 1983
Micromyzus nigrum	Sucking bugs	Sri Lanka	Van der Goot, 1918
Icerya longirostris	Scale	Seychelles	Dupont, 1931
Coccus mangiferae	Scale	Seychelles	Vesey-Fitzgerald, 1938
Eucalymnatus perforates	Scale	Seychelles	Vesey-Fitzgerald, 1938
Neolecanium cinnamomi, N. pseudoleae	Scale	Sri Lanka	Rutherford, 1914
Vinsonia stellifera	Stellate Scale	Seychelles	Hill, 1983

Aulacaspis tubercularis	Scale	Java (Indonesia)	Williams, 1961
Chrysomphalus dictyospermi, C. ficus	Scale	Seychelles	Vesey-Fitzgerald, 1938
Pulvinaria pyriformis	Pyriformis scale	Seychelles	Vesey-Fitzgerald, 1938
Parasaissetia nigra	Nigra scale	India	Suresh and Mohanasundaram, 1996
Helopeltis sp.	Mosquito bugs	Java (Indonesia)	Roepke, 1916
Leptocentrus obliqus	Treehoppers	Sri Lanka	Rajapakse and Kulasekara, 1982
Apogonia proxima	Scarab beetle	India	Veenakumari and Mohanraj, 1993
Evorinea hirtella	Beetle	Sri Lanka	Rajapakse and Kulasekara, 1982
Apoderus scitulus	Leaf-rolling beetle	India	Singh *et al*., 1978
Centrocorynus dohrnii	Beetle	Sri Lanka	Rajapakse and Kulasekara, 1982
Centhorrhynchus corbetti	Bettle	Malaysia	Marshall, 1935
Thamnurgides cinnamomi	Bettle	Sri Lanka	Eggers, 1936
Zeuzera coffeae	Red Coffee Borer	Sri Lanka	Rutherford, 1913
Latoia lepida	Nettle Caterpillar or Blue-striped Nettle Grub	India	Devasahayam, 2000
Homona coffearia	Tea tortrix or camellia tortrix	Malaysia	Hill, 1983
Lopharcha sp.	Moth	India	Devasahayam and

			Koya, 1993
Olethreutes (*Argyroploce*) *aprobola*	Leaf Roller	Sri Lanka, Seychelles	Hutson, 1921; Dupont, 1921
Anartula thurivora	Snout moth	Sri Lanka	Meyrick, 1932
Pingasa ruginaria	Moth	Malaysia	Corbett, 1929
Sauris sp., *Semiothisa* sp.	Moth	India	Singh *et al*., 1978
Thalassodes sp.	Moth	Sri Lanka	Rajapakse and Kulasekara, 1982
Bharetta cinnamomea	Moth	India	Butani, 1983
Cricula trifenestrata	Moth	India, Burma	Ghosh, 1925; CPCRI, 1981
Thevetra nessus	Moth	Malaysia	Corbett, 1929
Argina syringe,	Moth	India	CPCRI, 1979
Diacrisia obliqua	Moth	India	CPCRI, 1981
Selepa celtis	Moth	India	Singh *et al*., 1978
Hyposidra talaca, *Redoa submarginata*	Moth		CPCRI, 1979
Leucoma submarginata	Moth	Malaysia	Corbett, 1929
Anoplolepis longipes	Yellow crazy ant	Seychelles	Haines and Haines, 1978

9.3 Notes

Specify here any additional information

10. Biochemical markers

10.1 Isozyme

For each enzyme, indicate the tissue analyzed and the zymogram type. A particular enzyme can be recorded as 10.1.1; 10.1.2, etc.

10.2 Other biochemical markers

(e.g. Polyphenol profile)

11. Molecular markers

Describe any DNA polymorphism of the accession. Some of the basic methods for DNA polymorphism are listed below;

11.1 Restriction fragment length polymorphism (RFLP)

Report probe/enzyme combination (approach can be used for nuclear, chloroplast or mitochondria genomes)

11.2 Amplified fragment length polymorphism (AFLP)

Report primer pair combinations and accurate molecular size of products (used for nuclear genomes)

11.3 DNA amplification fingerprinting (DAF); random amplified polymorphic DNA (RAPD); AP-PCR

Accurately report experimental conditions and molecular size of products (used for nuclear genomes)

11.4 Sequence-tagged microsatellites (STMS)

Report primer sequences, and accurate product sizes (can be used for nuclear or chloroplast genomes)

11.5 PCR-sequencing

Report PCR primer sequences, and derived nucleotide sequence (can be used for single copy nuclear, chloroplast or mitochondrial genomes)

11.6 Other molecular markers

12. Cytological characters

12.1 Chromosome number

1 2n=24
2 Other (specify in descriptor 14 Notes)

12.2 Ploidy level

Ploidy level can be determined by Microscope observation/Using a flow cytometer genome size for ploidy level can be determined comparing to a standard genome (2x, 3x, 4x, etc.)

12.3 Other cytological characters

Chromosomal aberrations are reported. Mention if find any chromosomal aberration in observed sample.

13. Identified genes

Describe any known specific mutant present in the accession

14. Notes

Any additional information, especially in the category of 'other' under various descriptors above, may be specified here

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