# Descriptors for
# *Dichanthium–Bothriochloa* Complex

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**Indian Grassland and Fodder Research Institute (IGFRI), Jhansi,** a national Institute under the administrative control of Indian Council of Agricultural Research (ICAR), New Delhi is mandated to conduct basic, strategic, applied and adaptive research; training and development in forage production and utilization.

The Institute has highly experienced and internationally trained human resources engaged in need-led, participatory, inter-disciplinary approaches for, forage crops research. With more than 45 years of experience in forage research and development, IGFRI today stands as the premier R&D institution in s outh Asia for sustainable agriculture through quality forage production for improved animal productivity.

Since its establishment in 1962, it has been instrumental in fostering research, training and extension programmes on all aspects of forage production and utilization through inter-disciplinary approach. It has three Regional stations to cater to forage related location specific R&D needs of humid tropics (at Dharwad, Karnataka), semi-arid and arid (at Avikanagar, Rajasthan) and temperate (at Srinagar (J&K)/ Palampur (Himachal Pradesh) ecosystems.

Forage plant genetic resources are one of the core areas of research at IGFRI, Jhansi. IGFRI is maintaining more than 5500 forage germplasm in its medium term conservation (MTS) module and most of them are also kept in National Gene Bank at National Bureau of Plant Genetic Resources (NBPGR), New Delhi.

IGFRI has now become one of the largest forage germplasm holders at the national and international level. The tropical forage perennial grasses occupy a significant place in IGFRI research and we are holding more than 1200 germplasm in various perennial forage grasses such as *Dichanthium* sp., *Bothriochloa* sp., *Sehima* sp., *Heteropogon* sp., *Chrysopogon* sp., *Panicum* sp., *etc.*

IGFRI has so far published a series of evaluation catalogues in different forage crops namely, Cowpea (*Vigna unguiculata*), Maize (*Zea mays*), Stylos (*Stylosanthes* sp.), Siratro (*Macroptelium atropurpureum*), Oat (*Avena sativa*), *Berseem* (*Trifolium alexandrinum*), Teosinte (*Zea diploperennis*), *Cenchrus* species *etc.*

Being the national institute on forage crops, it is imperative for IGFRI to publish descriptors in forage crops especially the tropical perennial/ annual forage crops in which Biodiversity International (formerly IPGRI) has so far not paid desired attention. This descriptor is first in this series, which will be immensely useful to the grassland workers and forage workers throughout the world.

# Contents

# Preface

'Descriptors for *Dichanthium – Bothriochloa* complex' is first descriptors on tropical forage crop. The descriptors was developed based on the rich experience of IGFRI, Jhansi in forage genetic resource collection, evaluation, conservation and documentation. IGFRI, Jhansi is holding more than 5500 forage germplasm and is the leading institution in the world on the forage crop research and development particularly in the tropical forage crops.

The reason behind inclusion of two genera *Dichanthium- Bothriochloa* is their forming an agamic complex and with development of many intermediate forms. Many a times it becomes a problem for taxonomist and forage workers to distinguish between them. Presence of facultative sexuality coupled with apomixis has created a wide array of diverse genotypes in this complex and has also led to its widespread adaptability in different parts of India as well Asia and Africa. In the introduction section we have elaborated on these issues.

*Dichanthium* and *Bothriochloa* are the important constituents of two grass covers (*Dichanthium-Cenchrus-Lasiurus* and *Sehima-Dichanthium*) of 5 major grass covers identified in the country (Dabadghao and Shankarnarayanan, 1973).

Being perennial and apomictic, these crops can be maintained in the field easily by root stocks or alternatively by seeds. IGFRI, Jhansi is holding approximately 500 genotypes of *Dichanthium – Bothriochloa* complex that have been evaluated for morphological traits, nutritive parameters, isozyme banding pattern and molecular markers.

This descriptors is based on IBPGR/IPGRI/ Biodiversity International catalogue on rice, wheat and forage crops, with modifications to suit to these particular grasses.

Four types of descriptors has been considered important – Passport, Management, Environment and site, characterization/ evaluation. The number of descriptors selected may vary based on individual experience and local needs/ capacity.

Descriptor list has been provided in an international format as suggested by Biodiversity International which is the leading organization in providing a universally accepted 'language' for plant genetic resources data. The adoption of this scheme for data encoding, will produce a rapid, reliable, and efficient means for information storage, retrieval and communication, and will assist with the use of germplasm. It is therefore recommended, that information should be produced by closely following the descriptors list with regard to ordering and numbering the descriptors, using the descriptors specified and using the descriptor states recommended.

This descriptors list is intended to be comprehensive for the descriptors that it contains. This approach assists with the standardization of descriptor definitions. However, it is assumed that curators/ scientists will be able to characterize accessions of their collections using all descriptors given. Descriptors should be used when they are useful to curators for the management and maintenance of the collection and/or to the users of plant genetic resources. However, highly discriminating descriptors are highlighted in the text to facilitate the selection of descriptors and are listed in Annex I.

Any suggestions for further improvement on the 'Descriptors for *Dichanthium – Bothriochloa'* will be highly appreciated.

**Authors**

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We are also thankful to our learned and experienced reviewers Dr. Bhag Mal, Dr. J.L. Kariahloo and Dr. S.N. Zadoo in the field of forage crops and plant genetic resources who have contributed significantly in the improvement, editing of this document with their constructive suggestions and views.

We are also thankful to the forage workers in the country and abroad, whose experience and interactions have helped in crystallizing the ideas of developing descriptors.

# Introduction

*Dichanthium* Willemet and *Bothriochloa* O. Kuntze are closely related members of the tribe Andropogoneae, section Amphilophiastre of the family Gramineae (Poaceae). They form an interrelated agamic complex together with genus *Capillipedium* of the same tribe.

Twenty species of the genus *Dichanthium have* been reported from the tropics and sub-tropics. Bor (1960) has reported occurrence of seventeen species of *Bothriochloa* of which seven are endemic and six (*B. caucasia*, *B. glabra*, *B. insculpta*, *B. intermedia*, *B. ischaemum*, and *B. pertusa*) are important from fodder point of view. Out of these, *B. pertusa* and *B. intermedia* are wide spread in different parts of the country and are considered to be of excellent fodder value. *Bothriochloa intermedia* (R. Br.) A. camus is distributed from Pacific Island, Africa, Sri Lanka, China and Malaya. In India, it appears to have a wide range of distribution from the Peninsula to the high hills of northern India up to a height of above 2,300m (Bor, 1960).

India has eight species of *Dichanthium* distributed in various agro-ecological zones (Arora *et al.,* 1975), but only two species, viz. *Dichanthium annulatum* (Forsk.) stapf and *D. caricosum* (*L.*) A. camus, are important for their forage attributes. Out of eight species, four are endemic to India (Bor, 1960). Different ploidy levels and morphologically distinct types are reported in the *Dichanthium annulatum* complex (Mehra, 1961). The species includes four distinct geographic races. The tropical morphotypes are distributed in China, Vietnam, Myanmar (Burma), India, Bangladesh, Nepal, and Pakistan to eastern Africa. The Mediterranean morphotype occurs from Morocco to Algeria, Tunisia, Egypt, Sudan, Somalia, Jordan, Iraq and Afghanistan. A distinct morphotype is apparently restricted to Senegal and a south African morphotype is distributed from south West Africa to Bechunaland, Union of South Africa, Zambia, Malawi, east Africa and Ethiopia (Mehra, 1966).

*Dichanthium* and *Bothriochloa* are important constituents of Indian grasslands. They are represented by several species and races along with various intermediate introgressed derivatives, and are widely distributed throughout tropical and sub-tropical parts of the country.

*Dichanthium* sp. commonly called, as marvel grass is an important perennial range grass, and covers a large area of pasture and rangelands in India (Dabadghao and Shankarnarayan, 1973). It is one of the important constituents of two major grass covers of India, i.e. *Dichanthium-Cenchrus-Lasiurus* and *Sehima-Dichanthium*. Being indigenous to the Indian and African gene centers, it shows maximum genetic diversity in India and south Africa (Mehra and Magoon, 1974). In India, it is distributed throughout the hills and plains from Kashmir to Bengal and throughout southern India. The diploid forms occur in Bengal and Bihar and the tetraploid forms all over the Indo-Gangetic plains and central and southern Indian plateau (Mehra, 1961). Marvel grass has a wide range of adaptation from low rainfall areas in Rajasthan and Gujarat to heavy rainfall areas of western and southern India (Kanodia, 1987).

*Bothriochloa intermedia* in sub-tropical conditions, becomes one of the principal species of the grass cover represented by *Phragmites/ Saccharaum/ Impertata* and *Themeda/ Arundinella* (Dabadghao and Shankarnarayan, 1973). *Bothriochloa pertusa* (L.) A. camus is distributed eastwards from Arabia to south east Asia, and tropical Africa. In India, it is widely distributed practically all over the country even ascending hills up to 2,100 m and rainfall from 500 to 1375 mm (Dabadghao and Shankarnarayan, 1973).

**Cytogeographical variation:** Cytogeographical studies conducted on representative samples of several species of *Dichanthium-Bothriochloa* complex revealed certain interesting patterns. The *Dichanthium annulatum* complex consists of a polyploid series with basic building material of n=10. Diploids, tetraploids and hexaploids are common, triploids and possibly others may occur rarely but there is no indication of aneuploidy (Celarier *et al.,* 1958).

Different ploidy levels and morphologically distinct types are reported in *Dichanthium annulatum* complex (Mehra, 1961). The diploids are of the tropical type and seem to have regular meiotic behavior. The hexaploids are all of the south-African type, and are extremely irregular in meiotic behavior. The tetraploids distributed almost throughout the range of distribution of the complex, show different recognizable type *i.e.,* Tropical, tropical type (showing evidence of introgression from *Bothriochloa*), inter-grading types between the Tropical and Mediterranean type, Mediterranean type (showing introgression from *Bothriochloa*). In India the diploid forms occur in Bengal and Bihar and the tetraploid forms all over the Indo-Gangetic plains and central and southern Indian plateau (Mehra, 1961).

Mehra (1961) has demonstrated the presence of introgression between the *Dichanthium annulatum* complex and certain species of the genus *Bothriochloa*. In the entire Indo-Gangetic plains, active introgression is going on between *Bothriochloa intermedia* and *Dichanthium annulatum* (Harlan *et al.,* 1958), and some forms intermediate between these species have been established, *i.e., Bothriochloa grahamii* (Bor, 1960). Similarly, in the foothills of northern Pakistan and parts of Himachal Pradesh extensive introgression occurs between the Gangetic race of *B. intermedia* and *B. ischaemum* (Harlan, 1963b). In *Bothriochloa ischaemum L.*) Keng, the tetraploids occur in India (Himachal Pradesh, J&K) (Celarier and Harlan, 1958). In the *B. intermedia* complex, the diploids have been reported from Nilgiris and Western Ghats; tetraploid from Indo-gangetic plains (Harlan, 1963a). In *B. pertusa* complex, the diploids and tetraploids are known from India, while tetraploids and hexaploids are reported from Africa (de Wet and Higgins, 1964).

Out of fifty-eight accessions of *Dichanthium annulatum* complex, four accessions were found to be diploid (2n=20), seven were hexaploids (2n=60) and remaining forty-seven were tetraploids (Celarier *et al.,* 1958).

Cytological studies of the few *Dichanthium* hybrids involving the Tropical (2n=20, 40) and Mediterranean (2n=40) types and their F2 and back cross progenies indicated that they are closely related with each other (Mehra, 1960; Borgaonkar and Singh, 1962). *D. papillosum* and *D. fecumdum* are isolated geographically but they are closely related to *D. annulatum* and may be classified as *D. annulatum* var. *papillosum* (2n=60) and *D. annulatum* var. *fecundum* (2n=40) respectively (Singh and Mehra, 1965).

Hybridization studies in *Dichanthium-Bothriochloa* complex exhibited preponderance of apomicts in $F_1$, $F_2$ and later generations suggesting that apomixis is inherited as a dominant character (Gupta, 1995).

In *Dichanthium-Bothriochloa* complex, cytological studies indicated that the diploid (2n=20) reproduces sexually whereas, tetraploids are facultative or obligate apomicts (Gupta *et al.,*

1969). However, exceptions such as some Australian and African species of *Bothriochloa*, that reproduce sexually are hexaploids or higher polyploids as 2n=60, 80,120,180 (Celarier and Harlan, 1957). In *Dichanthium* sexuality and apomixis were associated with ploidy level and depend upon a complex genetic balance for their expression. Chromosome studies in *Dichanthium* summarize apomictic line as auto-tetraploid, 2n=4x=40, though tetraploid sexual lines obtained through polyploidization of diploid lines as well as of natural origin are also reported (Singh, 1962).

The embryological studies in *Dichanthium* complex have revealed that the apomictic *D. annulatum* formed multiple embryo sacs, majority of which belonged to the unreduced, four nucleate, *Oenothera* type. On the other hand, the diploid species *D. aristatum* and *D. caricosum* formed a single eight nucleate, polygonum type of embryo sac, which was characteristic of sexual reproduction observed in the grass species. Ovules with more than one embryo sac and possessing four-nucleate embryo sac were classified as apomicts and those possessing eight nucleate polygonum type of embryo sac were considered as sexual.

Srivastava and Purnima (1990) reported that in *Dichanthium annulatum*, *Bothriochloa intermedia* and their natural hybrids, agamospermy occurred as facultative aposporous apomixis with two types of embryo sacs, sexual and aposporic.

Yu *et al*., 2000 found that apomixis in *Dichanthium-Bothriochloa* complex is of the pseudogamous apospory and adventative embryony type. Higher ratio of embryo sac abortion is also an important factor causing sterility in *D. setosum*.

# Definitions and Use of the Descriptors

**Passport descriptors**

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

**Management descriptors**

These provide the basis for the management of accessions in the gene bank and assist with the multiplication and regeneration.

**Environment and site descriptors**

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

**Characterization / Evaluation descriptors**

These enable an easy and quick discrimination between phenotypes. Some of them are generally highly heritable, can be easily seen by the eye and are equally expressed in all environments. However, the expression of many of the descriptors depends on the environment; consequently, special experimental designs and techniques are needed to assess them. Their assessment may also require complex biochemical or molecular characterization methods. These types of descriptors include characters such as yield, agronomic performance, stress susceptibilities, biochemical and cytological traits. They are generally the most interesting traits in crop improvement. In addition, there might be more additional traits thought desirable by a consensus of users of the particular crop.

## General Guidelines for evaluation

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

(a) The Système International d'Unités (SI) 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 is strongly recommended for all 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) Quantitative characters, i.e. those that are continuously variable, should preferably be measured quantitatively. Alternatively, in cases where it is difficult to measure quantitatively, it is acceptable to score instead on a 1–5 scale, where
1. Very low
2. Low
3. Medium
4. High
5. Very high

(f) Absence/presence of characters can be scored as
0 Absent
1 Present

(g) Stages: this refers to the stage of development when the descriptor is recorded.

(h) Dates should be expressed numerically in the format DD-MM-YYYY where DD 2 digits to represent the day
MM 2 digits to represent the month
YYYY 4 digits to represent the year

(i) Leaf descriptors: unless otherwise specified, all descriptors for leaves and their components (ligule, sheath and blade) are recorded on the third leaf from top (excluding the flag leaf).

## Glossary of morphological terms

**Awn:** A fibrous bristle present in some cultivars, formed as an extension of the midrib of the lemma.

**Caryopsis:** The fruit of grasses, consisting of a single seed with the seed coat fused to a thin dry pericarp.

**Floret:** In grasses, the reproductive unit of a spikelet, consisting of a lemma and a palea around a small single-ovule flower.

**Glume:** In grasses, any of several types of bract in a spikelet, including the lemma and palea.

**Seed:** A mature seed consisting of a caryopsis enclosed within a lemma and palea.

**Lemma:** The larger (lower) of two bracts that contains the flower. The lemma and palea provide a protective covering for the flower as well as for the seed after ripening, and together are known as the hull of the seed.

**Palea:** The smaller (upper) of two bracts that contains the flower and later the seed.

**Pericarp:** The fruit wall. In grasses, the pericarp forms the outer surface of the caryopsis and is fused with the seed coat.

**Spikelet:** The flowering unit of grasses, comprising one or more florets with two bracts (glumes) at the base of the spikelet.

## Passport Descriptors

**1. Accession descriptors**

**1.1 Institute code or Institute name -** Name of the institute and place, country should be given.

**1.1.1 Site where maintained -** Name of the institution in which collection is maintained.

**1.1.2 Curator's name –** Name of person responsible for maintaining the material.

**1.2 Accession number** - The number provided by the National Bureau of Plant Genetic Resources (NBPGR), New Delhi should be given. For indigenous collections, IC number and for exotic material, EC number should be provided.

**1.3 Donor name -** Name of institution or individual responsible for donating the germplasm.

**1.4 Donor accession number -** Number assigned to an accession by the donor.

**1.5 Other identification number(s) associated with the accession -** Any other identification (numbers) known to exist in other collections for this accession.

**1.6 Scientific name**

**1.6.1 Genus -** Genus name for taxon. Initial uppercase letter required.

**1.6.2 Species -** Specific epithet portion of the scientific name in lowercase letters. The abbreviation 'sp.' is used if the species is unknown.

**1.6.2.1 Species authority -** Provide the authority for the species name.

**1.6.3 Subtaxa -** Subtaxa can be used to store any additional taxonomic identifier, if available.

**1.6.3.1 Rank name -** The rank of the subtaxon name. Use the following abbreviations: 'subsp.' (for subspecies); 'convar.' (for convariety); 'var.' (for botanical variety); 'f.' (for form).

**1.6.3.2 Subtaxon name -** The infraspecific epithet of the scientific name

**1.6.3.3 Subtaxon authority -** Provide the subtaxon authority at the most detailed taxonomic level.

**1.6.3.4 Genetic Origin**

**1.6.3.5 Accession name** – registered or any other formal name given to the accession.

**1.7 Common crop name -** Name of the crop in colloquial language.

**1.8 Acquisition date** [DD-MM-YYYY] - Date on which the accession entered the gene bank collection

**1.9 Notes -** Any other information on the particular accession.

## Collection Descriptors

**2. Collecting descriptors**

**2.1 Collecting institute code and name -** Name of the institute and place, country should be given. If the holding institute has collected the material, the collecting institute name should be the same as holding institute.

**2.2 Collecting number** - Original number assigned by the collector(s) of the sample. It will help in identifying duplicates held in different collections.

**2.3 Collecting date of original sample** [DD-MM-YYYY] Collecting date of the sample, where DD is the date, MM is the month and YYYY is the year.

**2.4 Country of origin –** Name of the country in which the sample was collected.

**2.5 State -** Name of the primary administrative subdivision of the country in which the sample was collected.

**2.6 District -** Name of the secondary administrative subdivision (within a province/state) of the country in which the sample was collected.

**2.7 Village / city / place -** Location of collecting site - Location that describes where the accession was collected.

**2.8 Latitude of collecting site -** Degrees, minutes and seconds followed by N or S.

**2.9 Longitude of collecting site -** Degrees, minutes and seconds followed by E or W.

**2.10 Elevation of collecting site** - Altitude of the collecting place in meter above sea level.

**2.11 Collecting source**

1 **Wild habitat** - Forest/woodland, Shrubland, Grassland, Desert/tundra
2 **Farm or cultivated habitat** - Field, Orchard, Garden, Fallow land, Pasture, Store, threshing yard
3 **Market** - Town, Village, Urban area (around city), other exchange system
4 **Institute/research organization, genebank**
99 **Other** (specify in descriptor 2.22 collector's note).

**2.12 Biological status of accession**

1 Wild
2 Weedy
3 Landrace
4 Breeding/research material (advance breeding line, mutant/genetic stock)
5 Advanced/improved cultivar
6 Released varieties
99 Other (specify in descriptor 2.22 collector's note)

**2.13 Breeding institute name and code -** Institute code or name of the institute that has bred the material.

**2.14 Type of sample -** Type of sample collected

1 Seed
2 Vegetative samples (root stocks, tillers, seedlings, tubers etc)
99 Other (specify in descriptor 2.22 collector's note)

**2.15 Use of samples collected**

1 Food
2 Forage
3 Medicinal
4 Religious
99 Other (specify in descriptor 2.22 collector's note)

**2.16 Plant population density** Visual assessment of plants in the area

1 Rare - Few individual plants only
2 Occasional (1-5 % cover)

3 Frequent (5-25% cover)
4 Abundant (25% cover)

**2.17 Spatial distribution**

1 Patchy
2 Uniform

**2.18 Floristic structure**

1 Dominant species
2 Dominant grass species
3 Dominant legume species
4 Indicator species

**2.19 Special characteristics –** if any

**2.20 Prevailing stresses -** Information on main associated stresses at the time of collection.

1 Biotic (pests, diseases, weeds *etc*.)
2 Abiotic (drought, flood, salinity *etc*)

**2.21 Local/vernacular name** – Name given by the farmer to the crop and cultivar/landrace/wild form.

**2.22 Collector's notes -** Additional information recorded by the collector or any specific information on any state in any of the above descriptors.

## Management Descriptors

**3. Management descriptors**

**3.1 Accession number**

**3.2 Population identification -** Collecting number, pedigree, cultivar name *etc*. depending on population type

**3.3 Seed storage location identifier -** (Building, room, shelf number/location in medium and / or long term storage

**3.4 Storage date** (DD-MM-YYYY)

**3.5 Seed germination at storage** - Initial (%)

**3.6 Date of last seed germination test** (DD-MM-YYYY)

**3.7 Seed germination at last test [%]**

**3.8 Date of next seed germination test** (DD-MM-YYYY) – Estimated date when the accession should next be tested.

**3.9 Seed moisture content at harvest [%]**

**3.10 Seed moisture content at storage** – Initial [%]

**3.11 Type of stored plant material**

1 Seed
2 Vegetative
3 Tissue
4 Pollen
99 Other - specify in descriptor 3.16 notes

**3.12 Amount of seed in storage [g or number]**

**3.13 Duplication at other location(s)**

**3.14 *In vitro* conservation**

**3.15 Cryopreservation**

**3.16 Notes** – Any additional information may be specified here.

## Multiplication/Regeneration Descriptors

**4. Multiplication/ regeneration descriptors**

**4.1 Accession number**

**4.2 Population identification**

**4.3 Field plot number**

**4.4 Multiplication/regeneration site locations**

**4.5 Collaborator**

**4.6 Propagation method**

1 Seed
2 Cutting
3 Tissue culture
99 Others (specify in descriptor 4.13 notes)

**4.7 Sowing/planting date (DD-MM-YYYY)**

**4.8 Cultural practices**

**4.8.1 Distance between plants [cm]**

**4.8.2 Distance between rows [cm]**

**4.8.3 Irrigation –** specify amount, frequency and method used.

**4.8.4 Fertilizer application** – Specify type, dose, frequency and method of application

**4.9 Plant/seedling vigour** – Assess 45 days after emergence

1 Low
2 Medium
3 High

**4.10 Number of plants established**

**4.11 Previous multiplication/regeneration**

**4.11.1 Location**

**4.11.2 Sowing /planting date** [DD-MM-YYYY]

**4.11.3 Plot number**

**4.12 Number of times accession regenerated**

**4.13 Notes**– Any additional information may be specified here.

## Environment and Site Descriptors

**5. Characterization and/or evaluation site and site environment descriptors**

**5.1 Country of characterization and/or evaluation**

**5.2 Site** (research institute)

**5.2.1 Latitude**

**5.2.2 Longitude**

**5.2.3 Elevation [m asl]**

**5.2.4 Name and address of farm or institute /station/centre**

**5.3 Sowing date** [DD-MM-YYYY]

**5.4 Evaluator's name and address**

**5.5 Evaluation environment** - Environment in which characterization/evaluation /screening was carried out

1 Field (F)
2 Nursery or greenhouse (N)
3 Laboratory (L)
4 Phytotron (P)
99 Other (specify in descriptor notes)

**5.6 Field spacing**

**5.6.1 Distance between plants in a row [cm]**

**5.6.2 Distance between rows [cm]**

**5.7 Seed germination (%)**

**5.8 Fertilizer –** Specify fertilizer used, doses, frequency and method of application

**5.9 Plant protection –** Specify pesticides used, doses, frequency and method of application.

**5.10 Site environment**

**5.10.1 Topography**

1 Flat
2 Gently Undulating
3 Undulating
4 Hilly
5 Mountainous
99 Other (specify in descriptor 5.11 notes)

**5.10.2 Land element and position**- Description of the geomorphology of the immediate surroundings of the site –

1 Plain level
2 Upper slope
3 Midslope
4 Lower slope
5 Valley
6 Valley floor
7 Ridge
8 Mangrove
9 Terrace
10 Floodplain
11 Rounded summit
12 Summit
99 Other (specify in descriptor 5.11 notes)

**5.10.3 Slope [º]** - Estimated slope of the collecting site

**5.10.4 Ecological zone** – Forest, Transition zone, Alpine, arid, semi-arid, tropical, temperate, desert, semi-desert *etc.*

**5.10.5 Soil drainage** – Poor, Moderate, Good, Excessive *etc.*

**5.10.6 Soil salinity** – Indicate the EC level of the soil.

**5.10.7 Soil pH** - Actual pH value of the soil.

**5.10.8 Root depth** [cm] - Indicate the root depth at which the soil pH is being measured.

**5.10.9 Soil texture classes**

1 Sand
2 Loam
3 Clay
4 Silt
5 Clay loam
6 Sandy loam
7 Sandy clay
8 Silt clay
99 Others (specify in descriptor 5.11 notes)

**5.10.10 Soil taxonomic classification** - Indicate class (*e.g*. Alfisols, Spodosols, Vertisols, *etc.*).

**5.10.11 Climate of the site**- Should be assessed as close to the site as possible.

**5.10.11.1 Temperature** [ºC] - Provide either the monthly or the annual mean.

**5.10.11.2 Rainfall** [mm] - Provide either the monthly or the annual mean.

**5.10.12 Relative humidity**

**5.10.12.1 Indicate diurnal range [%]**

**5.10.12.2 Indicate seasonal range [%]**

**5.11 Notes** - Specify any additional information.

## Characterization and Evaluation Descriptors

**6. Plant descriptors -** for all quantitative descriptors (metric traits), record the average of ten plants measurements per accession. Most of the observations should be made at the maximum growth stage (at 50% flowering), unless otherwise specified.

**6.1 Growth characters**

**6.1.1 Population uniformity** – Homogeneous, Heterogeneous (specify)

**6.1.2 Life cycle** –

1 Annual
2 Biennial
3 Perennial
4 Others (please specify)

**6.1.3 Coleoptile: anthocyanin colouration -** Observed in 20-25 days-old seedlings

0 Absent
1 Very weak
2 Weak
3 Medium
4 Strong

**6.1.4 Growth habit – Record at 50% flowering stage [Fig. 1]**

1 Erect
2 Semi-erect
3 Spreading
4 Procumbent
5 Runner
6 Creeper
99 Other (specify in descriptors note

**6.2 Stem character**

**6.2.1 Plant height [cm] -** Measured from ground level to the base of the panicle on ten representative plants.

**6.2.2 Culm: number -** Recorded as the total number of tillers on ten plants

**6.2.3 Culm: thickness [cm] -** Measured at the third internode form the base of the main stem, record average of five representative plants.

**6.2.4 Culm internode length [cm] –** Measured between third and fourth internode from top.

**6.2.5 Culm: anthocyanin colouration on nodes -** The presence and distribution of purple colour observed on the outer surface of the nodes on the culm.

0 Absent
1 Purple
2 Light purple
3 Purple lines

**6.2.6 Culm: node colour -** The underlying colour of the outer surface of the nodes on the culm, ignoring any anthocyanin colouration.

0 No underlying colour visible due to anthocyanin
1 Light yellow
2 Green
3 Others (specify in descriptor notes)

**6.2.7 Culm: node hairiness** – Intensity of hairs around nodes (Fig. 2]

0 Absent
1 Scanty
2 Medium
3 Dense
4 Very dense

**6.2.8 Culm: node hair size** – Size of hairs around nodes [Fig. 3]

1 Very short
2 Short
3 Medium
4 Long
5 Very long

**6.2.9 Culm: internode colour -** The colour of the outer surface of the internodes on the culm,.

1 Purple
2 Purple lines
3 Green
4 Yellowish green
5 Purplish green
6 Others (specify)

**6.2.10 Culm: no. of nodes -** Count number of nodes on main culm of five plants.

## 6.3 Leaf characters

**6.3.1 Basal leaf sheath colour -** Colour of the outer surface of the leaf sheath.

1 Green
2 Green with purple lines
3 Light purple
4 Purple
99 Other – Specify in descriptor note

**6.3.2 Leaf sheath: anthocyanin colouration** - Presence and intensity of anthocyanin colouration on the outer surface of the sheath on the third leaf from top.

0 Absent
1 Weak
2 Medium
3 Strong

**6.3.3 Leaf blade: anthocyanin colouration**

0 Absent
1 On tips only
2 On margins only
3 In blotches
4 Even (uniform purple)
99 Other – Specify in descriptor note

**6.3.4 Leaf blade colour**

1 Light green
2 Medium green
3 Dark green
99 Other – Specify in descriptor note

**6.3.5 Leaf blade: attitude -** Position of the tip of the blade relative to its base, scored on the third leaf from top. [Fig. 4]

1 Erect
2 Horizontal
3 Drooping

**6.3.6 Leaf blade: pubescence -** Assess both visually and by touch, rubbing fingers over the leaf surface from the tip downwards.

1 Glaborous (smooth)
2 Lax
3 Medium hairy
4 Dense hairy

**6.3.7 Leaf margin: pubescence -** Assess pubescence of leaf margins.

1 Glabrous (no hairs)
2 Hairy or ciliated

**6.3.8 Ligule length [mm]** - Measured from base of collar to the tip of the ligule of the third leaf from top.

**6.3.9 Ligule shape** [Fig. 5]

0 Absent
1 Fringe of hairs
2 Truncate
3 Obtuse or rounded
4 Membranous

**6.3.10 Ligule margin hairiness**

0 Absent
1 Present

**6.3.11 Ligule pubescence -** Visual assessment using hand lens. [Fig. 6]

0 Glaborous
1 Partially hirsute: hairs covering less than 50% of the ligule
2 Mostly hirsute: hairs covering more than 50% of the ligule

**6.3.12 Ligule colour**

0 Absent (liguleless)
1 Whitish
2 Yellowish green
3 Purple
4 Light purple
5 Purple lines

**6.3.13 Longest leaf: length [cm] -** Measure length of the longest leaf, from the ligule to the tip of the blade, on three representative plants.

**6.3.14 Longest leaf: width [cm] -** Measure width at the widest portion of the longest leaf on three representative plants.

**6.3.15 Longest leaf sheath length [cm]** – Measure the length of longest leaf sheath from culm attachment to the ligule of opening of blade.

**6.3.16 Longest leaf sheath width [cm]** – Measure the width of longest leaf sheath from culm attachment to the ligule of opening of blade.

**6.3.17 Flag leaf: length [cm] -** Measure length of the flag leaf, from the ligule to the tip of the blade, on three representative plants.

**6.3.18 Flag leaf: width [cm] -** Measure width at the widest portion of the flag leaf on three representative plants.

**6.3.19 Flag leaf sheath length [cm]** – Measure the length of flag leaf sheath from culm attachment to the ligule of opening of blade.

**6.3.20 Flag leaf sheath width [cm]** – Measure the width of flag leaf sheath from culm attachment to the ligule of opening of blade.

**6.3.21 Flag leaf: attitude** [Fig. 7]

1 Erect
2 Semi-erect
3 Horizontal
4 Descending

**6.4 Inflorescence and seed characters**

**6.4.1 Uniformity of inflorescence emergence** –

1 Synchronous –All the plants in an accession have uniform pattern
2 Non-synchronous – Plants differ in inflorescence emergence in an accession

**6.4.2** **Seasonal inflorescence production** – Record the inflorescence production at each season and regrowth

1 Once in a year
2 Twice a year
3 Many times a year

**6.4.3** **Date of 50% flowering** – Record the date of flowering in 50% of culms.

**6.4.4** **Lemma and palea: colour**

1 White
2 Green-stripped white
3 Brown (tawny)
4 Blackish brown
5 Green
6 Yellowish green
7 Purple
8 Reddish to light purple
99 Others (specify)

**6.4.5** **Awns: distribution** - The presence and distribution of awns along the panicle. [Fig. 8]

0 None (awnless)
1 Tip only
2 Upper half only
3 Whole length

**6.4.6** **Awns: colour** - Stage: after anthesis

0 Absent (awnless)
1 Whitish
2 Straw
3 Brown (tawny)
4 Light green
5 Purple
6 Black
7 Others (specify)

**6.4.7** **Panicle: arrangement of primary branches.** [Fig. 9]

1 Whorled
2 Alternate

**6.4.8** **Panicle: number of basal primary branches** - The number of primary panicle branches attached to the basal whorl of the panicle.

**6.4.9** **Panicle: texture of main axis** - Assess by rubbing fingers from the base towards the tip of the panicle axis. Stage: at full panicle exsertion

1 Scabrous
2 Smooth

**6.4.10** **Panicle: number per plant** - Record the number of panicles per plant

**6.4.11** **Panicle: length [cm]** - Length of main axis of panicle measured from the panicle base to the tip.

**6.4.12 Panicle: secondary branching** - The abundance and distribution of spikelets borne on secondary branches of the panicle. Stage: near maturity. [Fig. 10]

0 Absent
1 Sparse
2 Dense
3 Clustered

**6.4.13 Panicle: colour** - The abundance and distribution of spikelets borne on secondary branches of the panicle. Stage: near maturity.

1 White
2 Green-stripped white
3 Brown (tawny)
4 Blackish brown
5 Green
6 Yellowish green
7 Purple
8 Reddish to light purple
99 Others (specify)

**6.4.14 Lemma and palea pubescence -** Visual assessment of the presence and distribution of hairs on mature seeds using hand lens. [Fig. 11]

1 Glabrous
3 Short hairs
5 Long hairs (velvety)

**6.4.15 Presence of pits –** Presence of pits on florets to be recorded [Fig. 12]

0 Pit absent
1 Single pit present
2 Two pits present

**6.4.16 Caryopsis: length [mm]**

**6.4.17 Caryopsis: width [mm]**

**6.4.18 Caryopsis: shape**

1 Round
2 Semi-round
3 Elliptical
4 Spindle-shaped
5 Others (specify)

**6.4.19 Caryopsis: pericarp colour**

1 White
2 Light brown
3 Brown
4 Variable purple
5 Purple
6 Others (specify)

**6.4.20 100 seed weight (g) -** Record weight of 100 seed including all the appendages after harvest and dried to 15% moisture level.

**6.5 Forage characters**

**6.5.1 First cut green herbage yield** (g/tussock) - Green herbage yield recorded after 30-45 days of crop growth.

**6.5.2** **Second cut green herbage yield** (g/tussock) - Green herbage yield recorded after 30 days of regrowth.

**6.5.3** **Third cut green herbage yield** (g/tussock) - Green herbage yield recorded at 50% flowering

**6.5.4** **First cut dry herbage yield** (g/tussock) – Green herbage yield from first cut dried in oven at 60oC till constant weight.

**6.5.5** **Second cut dry herbage yield** (g/tussock) - Green herbage yield from second cut dried in oven at 60oC till constant weight.

**6.5.6** **Third cut dry herbage yield** (g/tussock) - Green herbage yield from third cut dried in oven at 60oC till constant weight.

**6.5.7** **Green fodder yield/ tussock** (g/tussock) - Sum total of green fodder yield of all cuts

**6.5.8** **Green stem weight** (g/tussock) - Separate leaf portion from the culm and weigh the stem part at 50% flowering.

**6.5.9** **Green leaf weight** (g/tussock) - Weigh the leaf portion from the above point

**6.5.10** **Dry fodder yield** (g/tussock) - Sum total of dry fodder yield of all cuts

**6.5.11** **Stem dry weight** (g/tussock) - Dry the green stem harvest into oven at 60oC till constant weight and record the dry biomass yield

**6.5.12** **Leaf dry weight** (g/tussock) - Dry the green leaf harvest into oven at 60oC till constant weight and record the dry biomass yield

**6.5.13** **Leaf stem ratio:** It can be calculated by dividing dry leaf weight by dry stem weight

**6.5.14** **Agronomic potential:** Visual observation of forage yield potential of tussock.

## Nutritive Parameter Descriptors

**7.1** **Crude protein (%) -** Estimate the Crude protein on dry weight basis using nitrogen estimation method by Kjel dahl or other methods from harvest at 50% flowering stage. Indicate the method and reference followed.

**7.2** **Neutral detergent fibre (%) -** Estimate the extent of neutral detergent fibre from harvested sample at 50% flowering stage.

**7.3** **Acid detergent fibre (%)** - Estimate the extent of acid detergent fibre from harvested sample at 50% flowering stage.

**7.4** ***In vitro*** **Dry Matter Digestibility (IVDMD %) -** Estimate IVDMD from harvested sample at 50% flowering stage.

**7.5** **Lignin (%)** - Estimate the lignin content from harvested sample at 50% flowering stage.

**7.6** **Organic matter (%)** - Estimate the organic matter content from harvested sample at 50% flowering stage.

**7.7** **Hemicellulose (%)** - Estimate the hemicellulose content from harvested sample at 50% flowering stage.

**7.8** **Cellulose (%)** - Estimate the cellulose content from harvested sample at 50% flowering stage.

## Abiotic Stress Evaluation Descriptors

**8. Abiotic stress susceptibility –** scored under artificial and/or natural conditions, which should be clearly specified. These are to be recorded on a susceptibility scale of 1 to 9

1 Very low or almost no visible sign of sensitivity
3 Low
5 Medium
7 High
9 Very high

**8.1 Cold**

**8.2 Drought**

**8.3 Salt stress**

**8.3.1 Salinity**

**8.3.2 Alkalinity**

**8.4 Flood or submergence**

**8.5 Other** - Specify here any additional information.

## Biotic Stress Evaluation Descriptors

**9. Biotic stress sensitivity -** scored under artificial and/or natural conditions, which should be clearly specified. These are to be recorded on a susceptibility scale of 1 to 9

1 Very low or almost no visible sign of sensitivity
3 Low
5 Medium
7 High
9 Very high

**9.1 Diseases caused by fungi** – Mention causal organism and common name of the disease

**9.2 Diseases caused by bacteria** – Mention causal organism and common name of the disease

**9.3 Diseases caused by viruses and mycoplasma-like organisms -** Mention causal organism and common name of the disease

**9.4 Insects - causal agent common name -** Mention causal organism and common name of the disease

**9.5 Notes** - Specify here any additional information.

**10. Biochemical Markers Descriptors** - Specify methods used and cite reference(s).

**11. Molecular Markers Descriptors** - Specify methods used and cite reference(s).

**12. Cytological Characters Descriptors**

**12.1 Chromosome number -** Determined from pollen mother cells taken at booting stage or from the root tip of germinating seedlings.

**12.2 Ploidy level -** Indicate the ploidy level of the accession with reference to the basic chromosome number

**12.3 Other cytological characters-** Please give details

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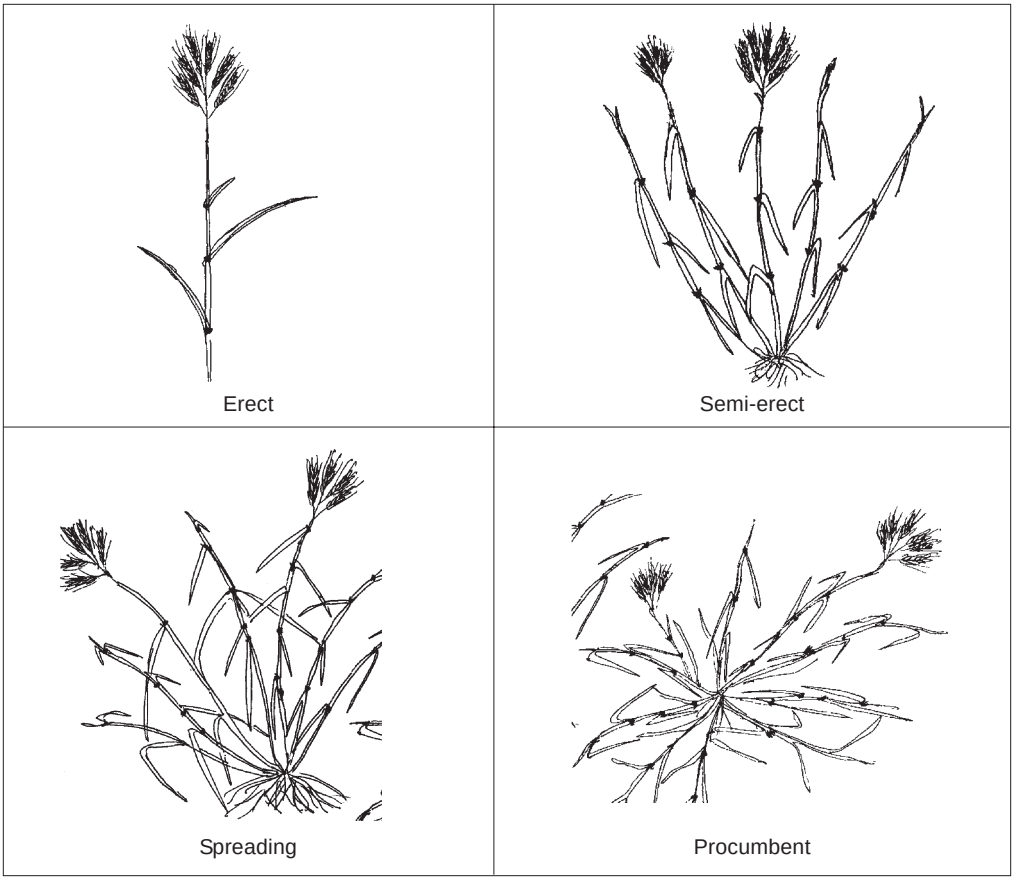


Fig. 1: Growth habit [6.1.4]

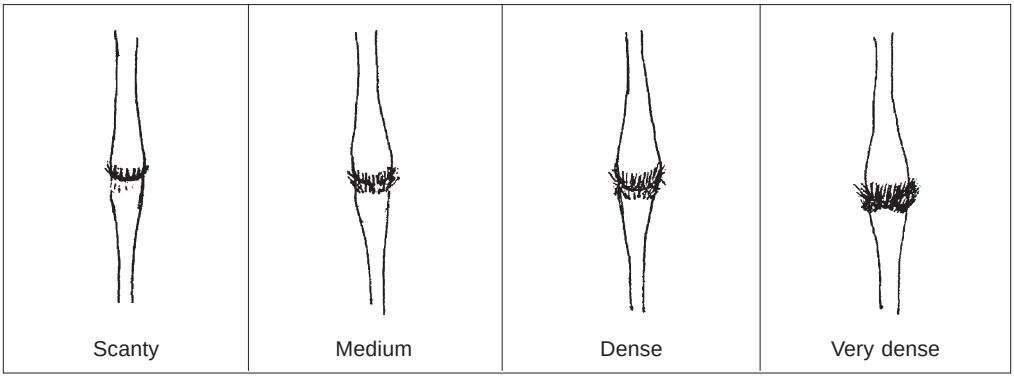


Fig. 2: Culm node hairness [6.2.7]

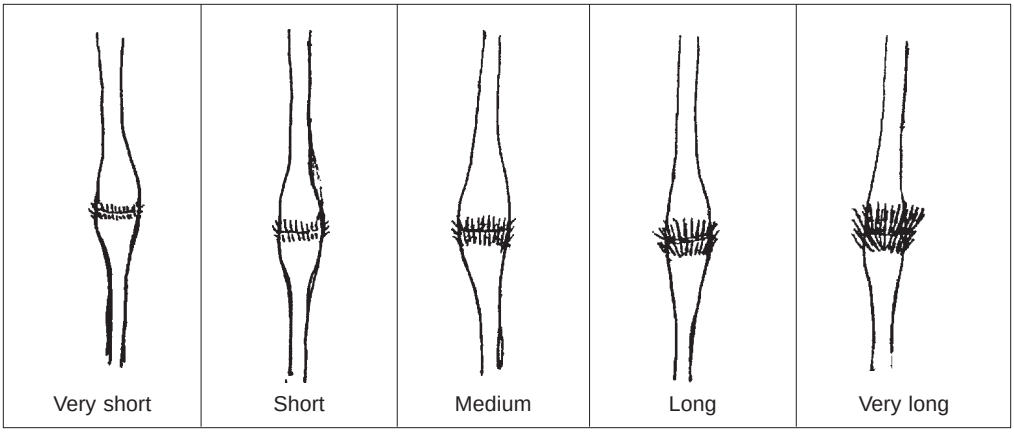


Fig. 3: Culm node hair size [6.2.8]

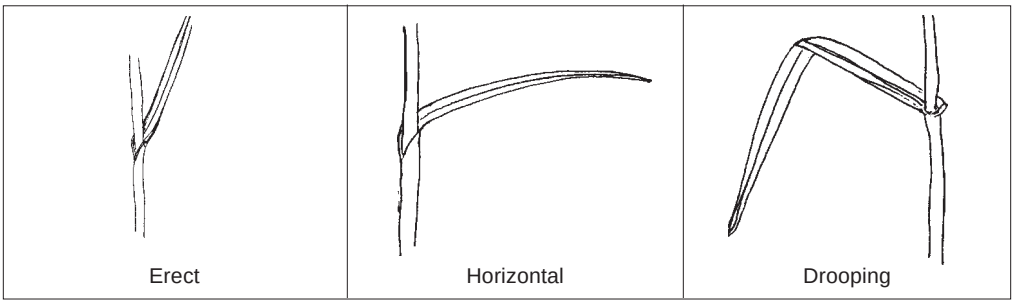


Fig. 4: Leaf blade attitude [6.3.5]

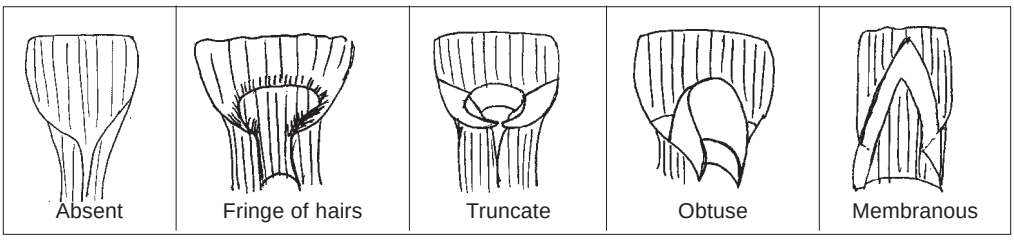


Fig. 5: Ligule shape [6.3.9]

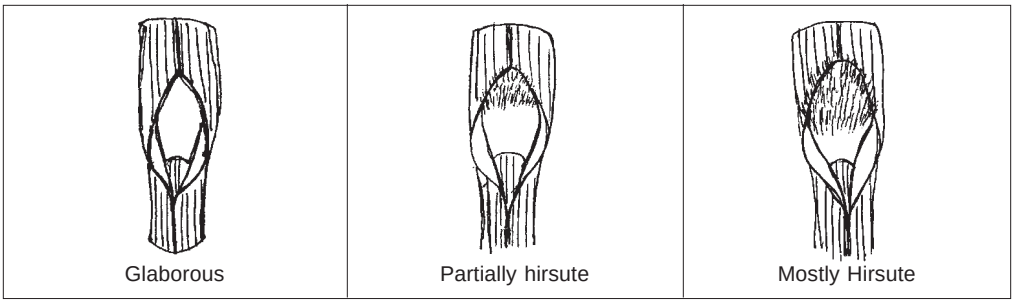


Fig. 6: Ligule pubescence [6.3.11]

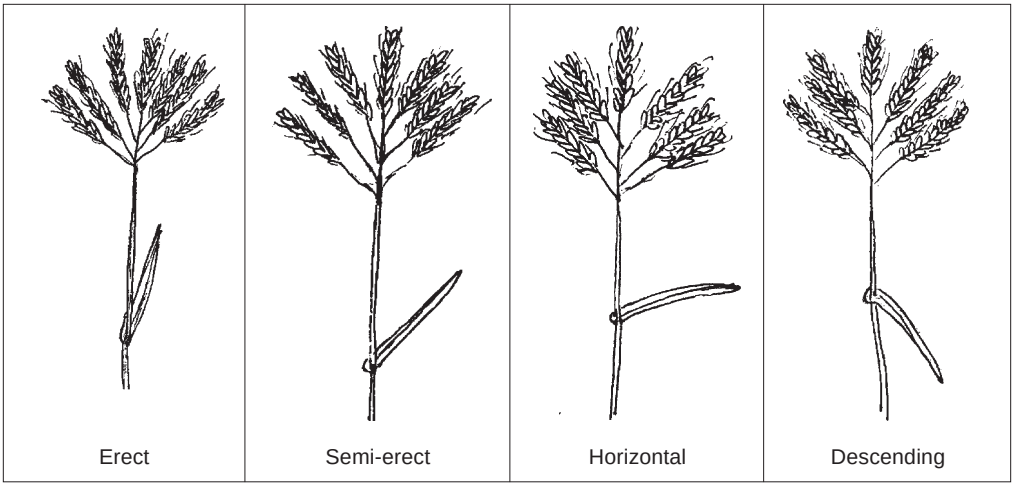


Fig. 7: Flag leaf attitude [6.3.21]

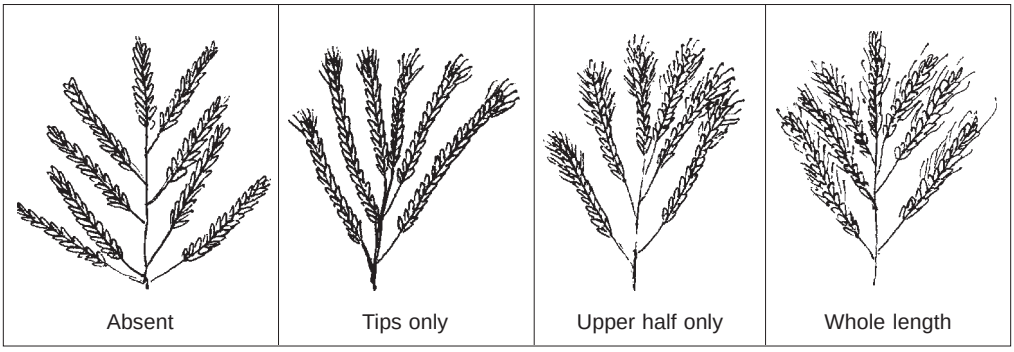


Fig. 8: Awns: Distribution [6.4.5]


Fig. 9: Panicle: Arrangement of primary branches [6.4.7]

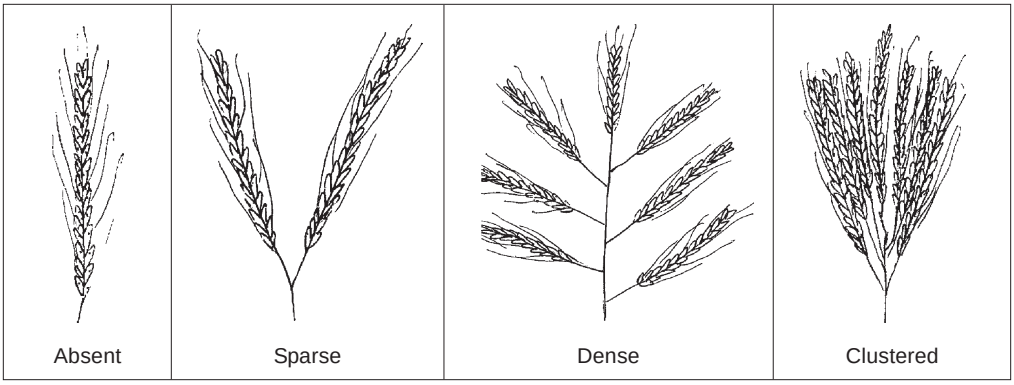


Fig. 10: Panicle: Secondary branches [6.4.12]

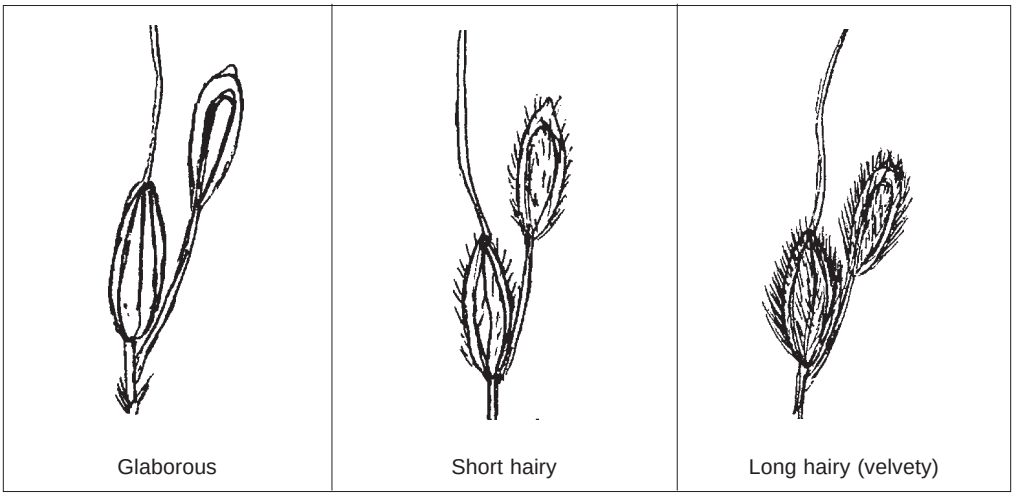


Fig. 11: Lemma and palea pubescence [6.4.14]

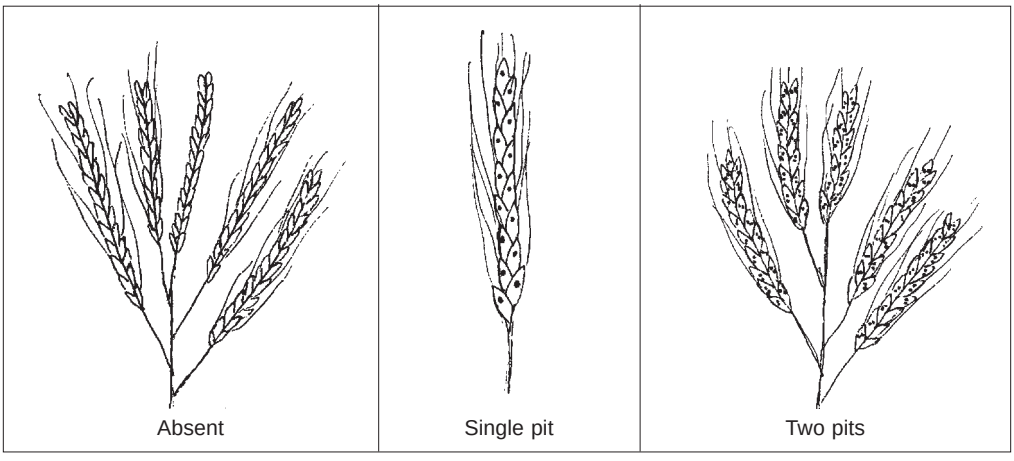


Fig. 12: Presence of pits [6.4.15]