

DESCRIPTORS FOR *BRASSICA* AND *RAPHANUS*

IBPGR



INTERNATIONAL
BOARD FOR
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GENETIC
RESOURCES

DESCRIPTORS FOR *BRASSICA* AND *RAPHANUS*

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PREFACE

This descriptor list has been prepared in an IBPGR standard format.

Brassica and *Raphanus* spp. are highly polymorphic, exhibiting a wide range of intraspecific variation and utilization. Similar morphotypes exist among several species. The descriptors and descriptor states used in this document have been selected from extensive lists of descriptors prepared by crop experts in various countries. Descriptors have been selected to provide the characterization and preliminary evaluation of the range of discrete morphotypes and intergrading morphotypes found in most of the *Brassica* species and *Raphanus*. The system is also sufficiently flexible as to accommodate the characterization of wild and weedy species. The greatest variety of descriptor states exists for the mature vegetative stage of the various morphotypes. Therefore, for some morphotypes certain descriptor states will not be applicable and therefore omitted from use, e.g. descriptors for root characteristics would not be used for heading or large stemmed morphotypes, nor would many of the vegetative descriptors be of value in characterizing or evaluating oilseed forms.

IBPGR encourages the collection of data on the first four categories of this list: 1. Accession; 2. Collection; 3. and 4. Characterization and preliminary evaluation. IBPGR endorses the information in categories 1-4 as the minimum that ideally should be available for any one accession. Other descriptors are given in categories 5 onwards that will enable the simple encoding of further characterization and evaluation data and which can serve as examples for the creation of additional descriptors in the IBPGR form by any user.

Although the suggested coding should not be regarded as the definitive scheme, this format has the full backing of IBPGR and is promoted worldwide. The descriptor list given here provides an international format and thereby produces a universally understood 'language' for all plant genetic resources data. The adoption of this scheme for all data encoding, or at least the production of a transformation method to convert other schemes to the IBPGR format, will produce a rapid, reliable and efficient means for information storage, retrieval and communication. This will greatly assist the utilization of germplasm throughout the international plant genetic resources network. It is recommended, therefore, that information should be produced by closely following the descriptor list with regard to: ordering and numbering descriptors; using the descriptors specified; and using the descriptor states recommended.

Any suggestions for modifications will be welcomed by IBPGR Headquarters, Rome.

DESCRIPTOR LIST FOR *BRASSICA* AND *RAPHANUS*

IBPGR now uses the following definitions in genetic resources documentation:

- (i) *passport* (accession identifiers and information recorded by collectors);
- (ii) *characterization* (consists of recording those characters which are highly heritable, can be easily seen by the eye and are expressed in all environments);
- (iii) *preliminary evaluation* (consists of recording a limited number of additional traits thought desirable by a consensus of users of the particular crop).

Characterization and preliminary evaluation will be the responsibility of the curators, while further characterization and evaluation should be carried out by the plant breeder. The data from further evaluation should be fed back to the curator who will maintain a data file.

Because of the wide diversity of form and utilization both within and among crucifer species, a large number of descriptors have been entered into the list 4; PLANT DATA under the category CHARACTERIZATION AND PRELIMINARY EVALUATION. It is expected that curators would use initially those descriptors that are most appropriate to their particular collections and resources. For various plant characteristics, e.g. plant size, leaf number, etc., descriptors have been developed to provide for both direct measurements and for quantitative estimates. No descriptors have been provided for 6; PLANT DATA under the category FURTHER CHARACTERIZATION AND EVALUATION, however evaluators are encouraged to enter specific descriptors and appropriate descriptor states in this category

The following internationally accepted norms for the scoring or coding of descriptor states should be followed as indicated below:

- (a) measurements are made according to the SI system. The units to be applied are given in square brackets following the descriptor;
- (b) many descriptors which are continuously variable are recorded on a 1-9 scale. 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 8 (Pest and disease susceptibility) 1 = extremely low susceptibility and 8 = high to extremely high susceptibility;
- (c) presence/absence of characters are scored as 0 (absent) and + (present);

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- (d) for descriptors which are not generally uniform throughout the accession (e.g. mixed collection, genetic segregation) mean and standard deviation could be reported where the descriptor is continuous or mean and 'x' where the descriptor is discontinuous;
- (e) when the descriptor is inapplicable, '0' is used as the descriptor value, e.g. if an accession does not form flowers, 0 would be scored for the following descriptor

Flower colour

1	White
2	Yellow
3	Red
4	Purple

- (f) blanks are used for information not yet available;
- (g) standard colour charts, e.g. Royal Horticultural Society Colour Chart, Methuen Handbook of Colour, Munsell Color Charts for Plant Tissues are strongly recommended for all ungraded colour characters (the precise chart used should be specified in the NOTES descriptor, 11);
- (h) dates should be expressed numerically in the format DDMMYYYY, where

DD - 2 digits to represent the day
MM - 2 digits to represent the month
YYYY - 4 digits to represent the year

PASSPORT

1. ACCESSION DATA

1.1 ACCESSION NUMBER

This number serves as a unique identifier for accession and is assigned by the curator when an accession is entered into his 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 re-use. Letters should occur before the number to identify the gene bank or national system (e.g. MG indicates an accession comes from the gene bank at Bari, Italy; PI indicates an accession within the USA system).

1.2 DONOR NAME

Name of institution or individual responsible for donating the germplasm

1.3 DONOR IDENTIFICATION NUMBER

Number assigned to accession by the donor

1.4 OTHER NUMBERS ASSOCIATED WITH THE ACCESSION

Any other identification number known to exist in other collection for this accession, e.g. USDA Plant Inventory number (not collection number, see 2.1). Other numbers can be added as 1.4.3, etc.

1.4.1 Other number 1

1.4.2 Other number 2

1.5 SCIENTIFIC NAME

See Table 1

1.5.1 Genus

1.5.2 Species

1.5.3 Subspecies

1.5.4 Crop

1.5.5 Cultivar group

Table 1. Genomic designations of varietal or subspecific taxa of agriculturally important brassicas and radish

Species (n)	Subspecies or variety	Common name	Descriptor state under 4.2.2
<u>Brassica</u>			
<u>nigra</u> (bb = 16)	--	Black mustard	1
<u>oleracea</u> (cc = 18)	--	Cole crops	1
	<u>acephala</u>	Kales	1
	<u>alboglabra</u>	Chinese kale, Kailan	7
	<u>botrytis</u>	Cauliflower, Heading broccoli	7
	<u>capitata</u>	Cabbage	2
	<u>costata</u>	Portuguese cabbage	2
	<u>gemmifera</u>	Brussels sprouts	5
	<u>gongylodes</u>	Kohlrabi	4
	<u>italica</u>	Broccoli, Calabrese	7,8
	<u>medullosa</u>	Marrow stem kale	4
	<u>palmifolia</u>	Tree cabbage	4
	<u>ramosa</u>	Thousand-head kale	6
	<u>sabauda</u>	Savoy cabbage	2
	<u>sabellica</u>	Collards	4
	<u>selsensia</u>	Borecole	4
<u>rapa</u> (aa = 20)			
(syn. <u>campestris</u>)	<u>chinensis</u>	Pak choi	1
	<u>narinosa</u>		1
	<u>nipposinica</u>		3
	<u>oleifera</u>	Turnip rape, Toria	1
	<u>parachinensis</u>	Choy sum	7
	<u>pekinensis</u>	Chinese cabbage, Petsai	2

Considerable taxonomic confusion exists in the literature for Brassica. The designations above are a convenient provisional classification of the major Brassica and Raphanus morphotypes and include most, but not all, of those reported in the published literature. For the haploid complement of chromosomes (n), a = 10; b = 8; c and r = 9. Considerable discussion is underway among scientists regarding the most appropriate ways of categorizing Brassica morphotypes and cultivars. A number of alternative classifications exist [e.g. 1], and molecular and cytogenetic approaches to

1.6 PEDIGREE/CULTIVAR NAME

Nomenclature and designations assigned to breeder's material

1.6.1 Pedigree number

1.6.2 Cultivar name

Table 1. Continued. Genomic designations of varietal or subspecific taxa of agriculturally important brassicas and radish

Species (n)	Subspecies or variety	Common name	Descriptor state under 4.2.2
	<u>perviridis</u>	Tendergreen, Komatsuna, Mustard spinach	1
	<u>rapifera</u>	Turnip	9
	<u>trilocularis</u>	Sarson	1
	<u>utilis</u>	Broccoli raab	8
<u>carinata</u> (bbcc = 34)		Ethiopian mustard	1
<u>juncea</u> (aabb = 36)			
	<u>capitata</u>	Head mustard	2
	<u>crispifolia</u>	Cut leaf mustard	1
	<u>faciliflora</u>	Broccoli mustard	7
	<u>lapitata</u>	Large petiole mustard	1
	<u>multiceps</u>	Multishoot mustard	8
	<u>oleifera</u>	Indian mustard, Raya	1
	<u>rapifera</u>	Root mustard	9
	<u>rugosa</u>	Leaf mustard	
	<u>spicea</u>	Mustard	1
	<u>tsa-tsai</u>	Big stem mustard	4
<u>napus</u> (aacc = 38) --		Fodder rape	
	<u>oleifera</u>	Oil rape	1
	<u>rapifera</u>	Swede, Rutabaga	9
<u>Raphanus</u> --		Radish	
<u>sativus</u> (rr = 18)	<u>radicola</u>	Radish, Dikon	9
	<u>oleifera</u>	Oil radish	1
	<u>caudatus</u>	Rat tail radish	1

Brassica taxonomy are producing new insights into the categorization of morphotypes. The use of cultivar groups [e.g. 2] may also prove helpful, and this table and the accompanying descriptor states should be regarded as a useful bridge to a new and more widely accepted taxonomy that is likely to emerge in the future.

[1] Crute, I.R., Gray, A.R., Crisp, P. and Buczacki, S.T. 1980. Pl. Breed. Abstr. 50, 91-104.

[2] Toxopeus, H., Oost, E.H., Tamagishi, H. and Prescott-Allen, R. 1988. Crucif.Newsl. 13, 9-11.

1.7 ACQUISITION DATE

The date in which the accession entered the collection

1.8 DATE OF LAST REGENERATION OR MULTIPLICATION

1.9 ACCESSION SIZE

Approximate number of seeds of accession in collection

1.10 NUMBER OF TIMES ACCESSION REGENERATED

Number of regenerations or multiplications since original collection

1.11 NUMBER OF PLANTS IN EACH REGENERATION

2. COLLECTION DATA

2.1 COLLECTOR'S NUMBER

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

2.2 COLLECTING INSTITUTE

Institute or person collecting/sponsoring the original sample

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE

2.4 COUNTRY OF COLLECTION OR COUNTRY WHERE
CULTIVAR/VARIETY BRED

Use the 3 letter abbreviations supported by the Statistical Office of the United Nations. Copies of these abbreviations are available from IBPGR Headquarters and have been published in the FAO/IBPGR Plant Genetic Resources Newsletter number 49

2.5 PROVINCE/STATE

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

2.6 LOCATION OF COLLECTION SITE (INCLUDING ADDRESS)

Number of kilometres and direction from nearest town, village or map grid reference (e.g. TIMBUKTU 7S MEANS 7 KM SOUTH OF Timbuktu)

2.7 LATITUDE OF COLLECTION SITE

Degrees and minutes followed by N (north) or S (south), e.g. 1030S

2.8 LONGITUDE OF COLLECTION SITE

Degrees and minutes followed by E (east) or W (west), e.g. 7625W

2.9 ALTITUDE OF COLLECTION SITE [m]

Elevation above sea level

2.10 COLLECTION SOURCE

- 1 Wild
- 2 Farm land
- 3 Farm store
- 4 Backyard
- 5 Village market
- 6 Commercial breeding company or seed shop
- 7 Institute
- 8 Other (specify in the NOTES descriptor, 11)

2.11 STATUS OF SAMPLE

- 1 Wild
- 2 Weed
- 3 Breeder's line
- 4 Breeder's population
- 5 Primitive cultivar/landrace
- 6 Advanced cultivar (bred)
- 7 Other (specify in the NOTES descriptor, 11)

2.12 TYPE OF SAMPLE

- 1 Vegetative
- 2 Seed
- 3 Pollen

2.13 LOCAL/VERNACULAR NAME

Name given by farmer to cultivar/landrace/weed

2.14 NUMBER OF PLANTS SAMPLED

Approximate number of plants collected in the field to produce this accession

2.15 PHOTOGRAPH

Was a photograph taken of the accession or environment at collection?
If photo has been taken, provide the identification number/system in the NOTES descriptor, 11

0 No
+ Yes

2.16 HERBARIUM SPECIMEN

Was a herbarium specimen collected?

0 No
+ Yes

2.16.1 Herbarium identification and specimen number

2.17 DISTANCE FROM POSSIBLE CROSS POLLINATING CROPS [m]

2.18 NORMAL CROP SOWING SEASON

If sown in more than 2 seasons, give the appropriate choices

1 Spring
2 Summer
3 Autumn
4 Winter
5 All year round

2.19 NORMAL HARVESTING SEASON

As in 2.18 if grown in 2 seasons

1 Spring
2 Summer
3 Autumn
4 Winter
5 All year round

2.20 ORGAN USED AS PRIMARY PRODUCT

- 1 Seed
- 2 Young plant
- 3 Mature plant
 - 3.1 Leaf
 - 3.2 Stem
 - 3.3 Head
 - 3.4 Axillary bud
 - 3.5 Inflorescence
 - 3.6 Fruit
 - 3.7 Root

2.21 ORGAN USED AS A SECONDARY PRODUCT

- 1 Seed
- 2 Young plant
- 3 Mature plant
 - 3.1 Leaf
 - 3.2 Stem
 - 3.3 Head
 - 3.4 Axillary bud
 - 3.5 Inflorescence
 - 3.6 Root

2.22 MAJOR CROP USAGE

- 1 Vegetable
 - 1.1 Unprocessed
 - 1.2 Processed (specify local names for the processed product)
- 2 Oil
 - 2.1 Edible oil
 - 2.2 Industrial oil (chemical synthesis)
 - 2.3 Meal cake
- 3 Condiment
- 4 Forage/fodder/feed/ensiled
- 5 Green manure
- 6 Ornamental
- 7 Other (specify in the NOTES descriptor, 11)

2.23 MINOR CROP USAGE

- 1 Vegetable
 - 1.1 Unprocessed
 - 1.2 Processed (specify local names for the processed product)
- 2 Oil
 - 2.1 Edible oil
 - 2.2 Industrial oil (chemical synthesis)
 - 2.3 Meal cake
- 3 Condiment
- 4 Forage/fodder/feed/ensiled
- 5 Green manure
- 6 Ornamental
- 7 Other (specify in the NOTES descriptor, 11)

2.24 OTHER NOTES FROM COLLECTOR

Collectors will record ecological information. For cultivated crops, cultivation practices such as irrigation, season of sowing, etc. will be recorded. Wild species and primitive cultivars are mainly used as sources of resistance to pests, diseases, and other environmental stresses. If such resistances occur, they are most likely to have developed in areas which are subject to abnormal environmental stresses, or where particular pests or diseases are prevalent. The breeder's chance of finding resistance is therefore greatly increased if he knows which of these factors occur where each seed stock evolved. The breeder is interested in factors which have repeatedly damaged or stressed plants over many seasons in that general area. The collector should refer to the lists of ABIOTIC STRESSES given in Section 7 and PESTS and DISEASES in Section 8 and record the absence (-) or presence (+) of a particular stress in the notes under this section 2.24

CHARACTERIZATION AND PRELIMINARY EVALUATION

3. SITE DATA

- 3.1 COUNTRY OF CHARACTERIZATION AND PRELIMINARY EVALUATION
- 3.2 SITE (RESEARCH INSTITUTE)
- 3.3 NAME OF PERSON(S) IN CHARGE OF CHARACTERIZATION
- 3.4 SOWING DATE
- 3.5 TRANSPLANTING DATE
- 3.6 FIRST HARVEST DATE
- 3.7 LAST HARVEST DATE

4. PLANT DATA

4.1 SEEDLING

4.1.1 Hypocotyl colour

Observe at 5-leaf stage

- 1 White
- 2 Pale green
- 3 Green
- 4 Pink
- 5 Red
- 6 Purple
- 7 Other (specify in the NOTES descriptor, 11)

4.1.2 Seedling leaf colour

- 1 White green
- 2 Yellow green
- 3 Light green
- 4 Green
- 5 Dark green
- 6 Purple green
- 7 Purple
- 8 Other (specify in the NOTES descriptor, 11)

4.1.3 Seedling leaf (marginal incisions)

See Fig. 1

- 0 Entire
- 1 Crenate
- 2 Dentate
- 3 Serrate
- 4 Undulate
- 5 Doubly dentate
- 6 Other (specify in the NOTES descriptor, 11)

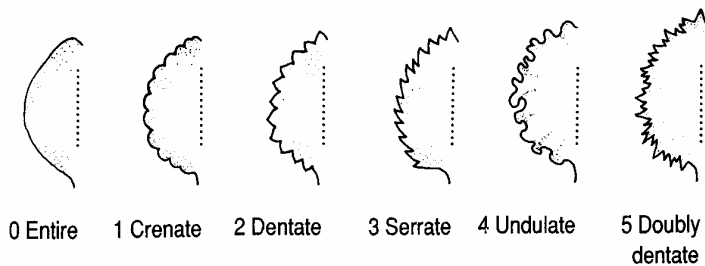


Fig. 1. Leaf division, margin

4.1.4 Seedling pubescence

- 0 Glabrous
- 1 Very sparse (few on leaf margins only)
- 3 Sparse
- 5 Intermediate
- 7 Abundant

4.1.5 Juvenile development

Rate of covering the ground

- 3 Slow
- 5 Intermediate
- 7 Fast

4.1.6 Cotyledon retention

- 3 Early drop
- 7 Nondropping

4.2 VEGETATIVE-PREFLOWERING MATURE

Observe immediately before normal harvest. For many wild and biennial species this will represent the rosette stage prior to floral axis elongation.

4.2.1 Morphotype uniformity

- 1 Uniform
- 2 Continuous variation
- 3 Two or more distinct types

4.2.2 Plant growth habit

See Fig. 2, following page

If crop or plant type is unknown, describe for the predominant type or a specified morphotype in the accession

- 1 Shortened nonbranching stem supporting leafy rosette
- 2 Shortened nonbranching stem terminating in leafy head
- 3 Extremely shortened branching stems forming leafy crown
- 4 Elongate and/or enlarged nonbranching stem (tubers) supporting leaves and/or head
- 5 Elongate nonbranching stem supporting enlarged compact axillary buds
- 6 Elongate branching stems supporting leaves and/or heads
- 7 Elongate nonbranching stem terminating in enlarged floral or prefloral apex (curd)
- 8 Elongate branching stems terminating in enlarged floral or prefloral apices
- 9 Enlarged root
- 10 Other (specify in the NOTES descriptor, 11)

4.2.3 Plant height [cm]

See Fig. 3, p. 15

Measure extremity of plant

4.2.4 Plant diameter [cm]

See Fig. 3, p.15

Measure extremity of plant

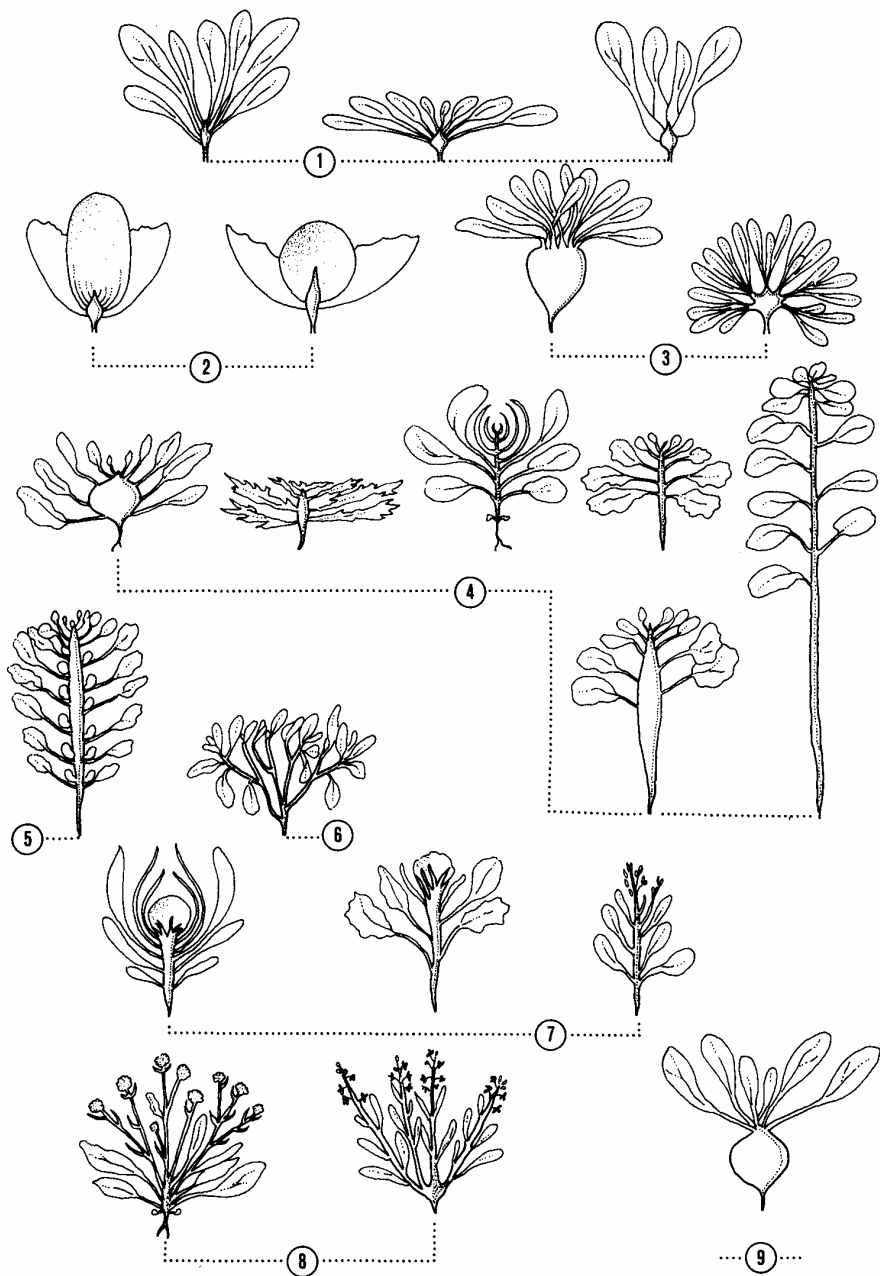


Fig. 2. Plant growth habit

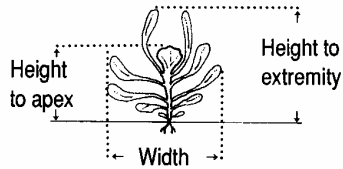


Fig. 3. Plant height, diameter

4.2.5 Plant height/diameter ratio

See Fig. 3

4.2.6 Weight of harvested organ [g]

4.2.7 Weight of total plant excluding fibrous roots [g]

4.2.8 Harvest index

Compute ratio 4.2.6/4.2.7

4.2.9 Lodging

- 3 Low
- 5 Intermediate
- 7 High

4.2.10 Number of leaves and leaf scars, counted

4.2.11 Number of leaves, estimated

- 3 Few
- 5 Intermediate
- 7 Many

The following leaf characteristics are measured on the outermost fully expanded leaf

4.2.12 Leaf length [cm]

See Fig. 4, following page

Measure largest leaf including petiole

4.2.13 Leaf blade width [cm]

See Fig. 4

Measure widest point of largest leaf

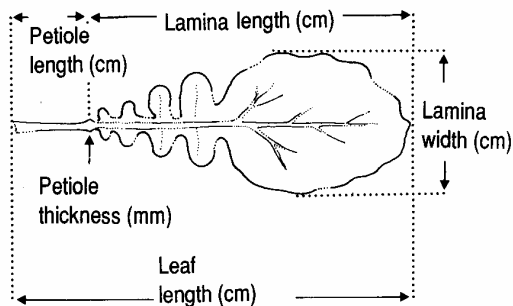


Fig. 4. Leaf blade/leaf length ratio

4.2.14 Leaf blade width/leaf length ratio

Compute ratio 4.2.13/4.2.12

4.2.15 Leaf angle

Angle of petiole with horizontal

- | | | |
|---|---------------|---------|
| 1 | Erect | (>87°) |
| 2 | Open | (~67°) |
| 3 | Semiprostrate | (~45°) |
| 4 | Prostrate | (<30°) |
| 5 | Horizontal | |
| 6 | Oblique | (>-10°) |

4.2.16 Leaf blade shape in outline, including lobes

See Fig. 5, opposite

- 1 Orbicular
- 2 Elliptic
- 3 Obovate
- 4 Spathulate
- 5 Ovate
- 6 Lanceolate
- 7 Oblong
- 8 Other (specify in the NOTES descriptor, 11)

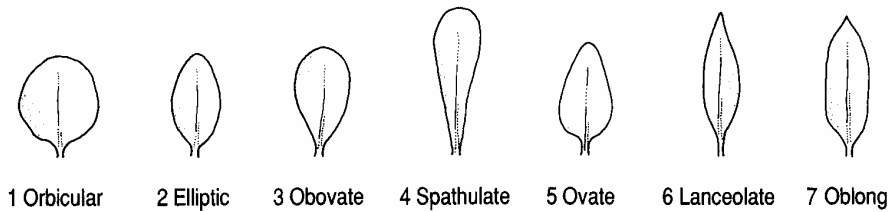


Fig. 5. Leaf blade shape in outline

4.2.17 Leaf division (margin)

See Fig. 1, p.12

- 0 Entire
- 1 Crenate
- 2 Dentate
- 3 Serrate
- 4 Undulate
- 5 Doubly dentate
- 6 Other (specify in the NOTES descriptor, 11)

4.2.18 Leaf division (incision)

See Fig. 6

- 1 Entire
- 2 Sinuate
- 3 Lyrate
- 4 Lacerate
- 5 Other (specify in the NOTES descriptor, 11)

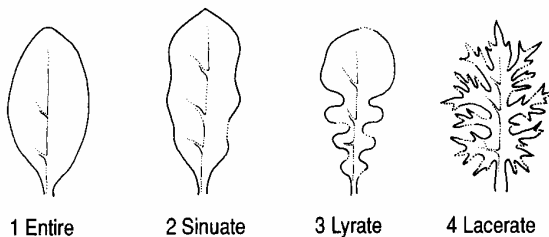


Fig. 6. Leaf division, incision

4.2.19 Leaf apex shape

See Fig. 7

- 2 Acute
- 4 Intermediate
- 6 Rounded
- 8 Broadly rounded

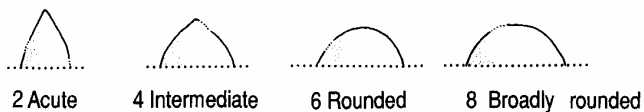


Fig. 7. Leaf apex shape

4.2.20 Leaf blade thickness

Thickness of leaf blade in transverse section

- 3 Thin
- 5 Intermediate
- 7 Thick

4.2.21 Leaf blade blistering

See Fig. 8

- 0 None
- 3 Low
- 5 Intermediate
- 7 High

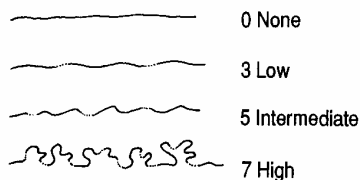


Fig. 8. Leaf blade blistering, in transverse section

4.2.22 Leaf tip attitude

See Fig. 9, opposite

- 3 Curving upwards
- 5 Straight
- 7 Drooping

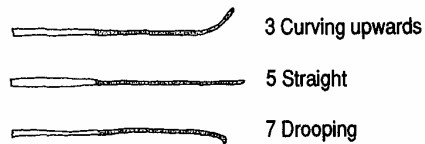


Fig. 9. Leaf tip attitude

4.2.23 Leaf lamina attitude

See Fig. 10

- 3 Convex, curving upward
- 5 Straight
- 7 Concave, drooping

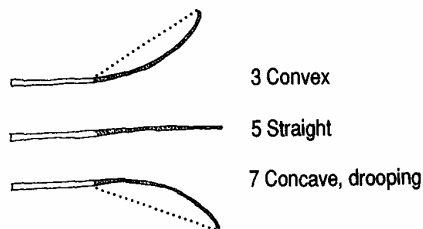


Fig. 10. Leaf blade attitude

4.2.24 Leaf colour

- 1 Yellow green
- 2 Light green
- 3 Green
- 4 Dark green
- 5 Purple green
- 6 Purple
- 7 Other (specify in the NOTES descriptor, 11)

4.2.25 Leaf hairiness

- 0 Absent
- 3 Sparse
- 5 Intermediate
- 7 Abundant

4.2.26 Leaf bloom

- 0 Absent, glossy
- 3 Low
- 5 Intermediate
- 7 High, glaucous

4.2.27 Petiole and/or midvein enlargement

See Fig. 11

- 3 Narrow
- 5 Intermediate
- 7 Enlarged

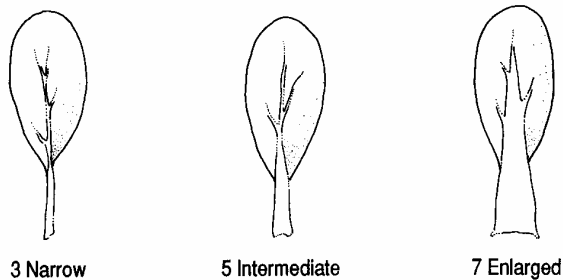


Fig. 11. Petiole and/or midvein enlargement

4.2.28 Petiole length [cm]

See Fig. 4

Measure where blade intercepts with petiole

4.2.29 Petiole width [cm]

See Fig. 4

Measure widest point of widest leaf; measure midrib width when blade extends to the plant axis

4.2.30 Petiole length/width ratio

Compute ratio 4.2.28/4.2.29

4.2.31 Petiole thickness [mm]

See Fig. 12

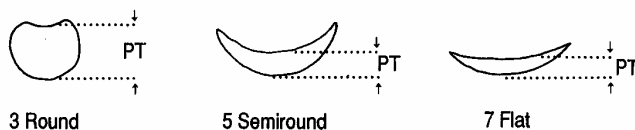
Measure thickest point of petiole or midrib of largest leaf

4.2.32 Petiole section

See Fig. 12

- 3 Round
- 5 Semiround
- 7 Flat

PT = petiole thickness

**Fig. 12. Petiole thickness, section****4.2.33 Petiole and/or midvein colour**

- 1 White
- 2 Light green
- 3 Green
- 4 Purple
- 5 Red
- 6 Other (specify in the NOTES descriptor, 11)

4.2.34 Heading habit

Observe at harvest, head-forming types only

- 0 Nonheading
- 5 Semiheading
- 7 Heading

4.2.35 Head shape in longitudinal section

See Fig. 13

- 1 Triangular
- 2 Ovate
- 3 Obovate
- 4 Elliptic
- 5 Spheric
- 6 Cylindric
- 7 Transverse elliptic
- 8 Other (specify in the NOTES descriptor, 11)

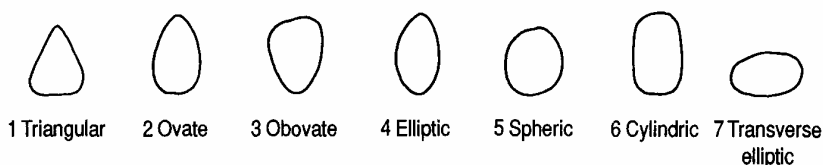


Fig. 13. Head and enlarged bud shape in longitudinal section

4.2.36 Head-forming leaf overlap at terminal region

See Fig. 14

- 1 Leaves curled outwards
- 2 Erect
- 3 Curled inwards
- 4 Slight overlap
- 5 Strong overlap

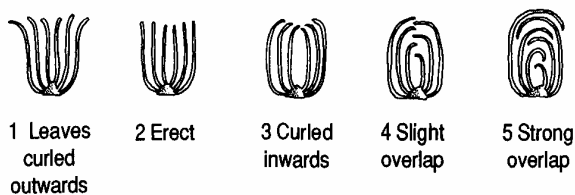


Fig. 14. Head-forming leaf overlap

4.2.37 Head cover from subtending leaves

See Fig. 15

- 3 Exposed
- 5 Intermediate
- 7 Covered

**Fig. 15. Head cover from subtending leaves****4.2.38 Primary colour of outer head leaves**

- 1 Yellow green
- 2 Pale green
- 3 Green
- 4 Dark green
- 5 Red green
- 6 Red or purple

4.2.39 Head size in relation to plant size

- 3 Small
- 5 Intermediate
- 7 Large

4.2.40 Head solidity

- 3 Low (soft, loose)
- 5 Intermediate
- 7 High (firm, hard)

4.2.41 Head length [cm]

See Fig. 16

Measure median transverse section

4.2.42 Head diameter [cm]

See Fig. 16

Measured at widest point

4.2.43 Head length/diameter ratio

Compute ratio 4.2.41/4.2.42

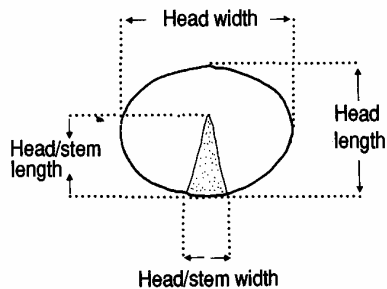


Fig. 16. Head and head-stem measurements

4.2.44 Stem length in head measured [cm]

See Fig. 16

4.2.45 Stem diameter at head base [cm]

See Fig. 16

4.2.46 Head-stem length/head length ratio

Compute ratio 4.2.44/4.2.41

4.2.47 Stem length in head, estimate

See Fig. 17

- 3 Short
- 5 Intermediate
- 7 Long

**Fig. 17. Stem length in head****4.2.48 Primary colour inside cut**

- 1 White
- 2 Yellow
- 3 Pale green
- 4 Green
- 5 Red green
- 6 Red or purple

4.2.49 Tendency for head to split

- 3 Low
- 5 Intermediate
- 7 High

4.2.50 Head holding ability (bolting resistance)

- 3 Low
- 5 Intermediate
- 7 High

4.2.51 Relative time of maturity

- 3 Early
- 5 Midseason
- 7 Late

4.2.52 Stem axis elongation and enlargement

See Fig. 18

Observe at harvest, enlarged or elongate stem types prior to flowering

- 1 Extreme shortening, supporting crown or tight rosette
- 2 Short, supporting rosette or head
- 4 Enlarged, forming tuber-like swelling
- 6 Elongate
- 8 Very elongate

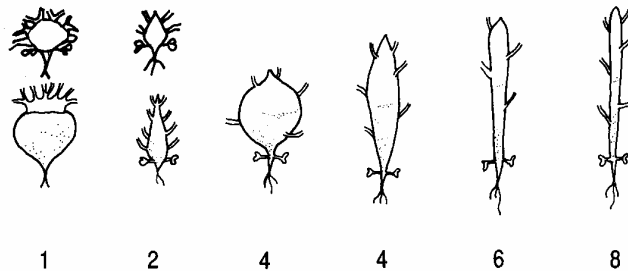


Fig. 18. Stem axis elongation and enlargement

4.2.53 Stem thickening

- 0 Absent
- 3 Slight
- 5 Intermediate (as in marrow-stem kale)
- 7 Extreme (as in kohlrabi)

4.2.54 Vegetative stem length [cm]

Measure from cotyledon to highest point on vegetative or pre-flowering apex

4.2.55 Vegetative stem width [cm]

Measure diameter of widest point on stem

4.2.56 Stem length/diameter ratio

Compute ratio 4.2.54/4.2.55

4.2.57 Stem length under head

- 3 Short
- 5 Intermediate
- 7 Long

4.2.58 Stem width at crown

- 3 Narrow
- 5 Intermediate
- 7 Wide

4.2.59 Stem height of 'neck' above crown

See Fig. 19

- 3 Short
- 5 Intermediate
- 7 Long

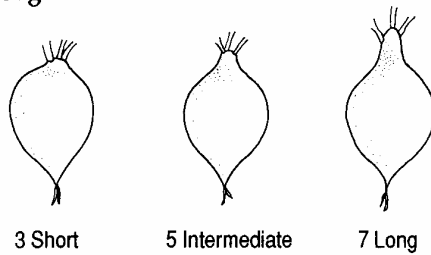


Fig. 19. Stem, height of 'neck' above crown

4.2.60 Stem colour

- 1 Light green
- 2 Green
- 3 Dark green
- 4 Red or purple green
- 5 Red or purple
- 6 Other (specify in the NOTES descriptor, 11)

4.2.61 Leaf retention on stem

- 3 Low
- 5 Intermediate
- 7 High

4.2.62 Axillary stem and bud growth

See Fig. 20

- 0 Absent
- 1 Axillary buds present but remain dormant
- 2 Very short leafy stems forming crown
- 3 Elongate, branching leafy stems
- 4 Elongate branching stems terminating in flower buds or pre floral meristems
- 5 Shoot growth condensed into enlarged vegetative buds (as in Brussels sprouts)

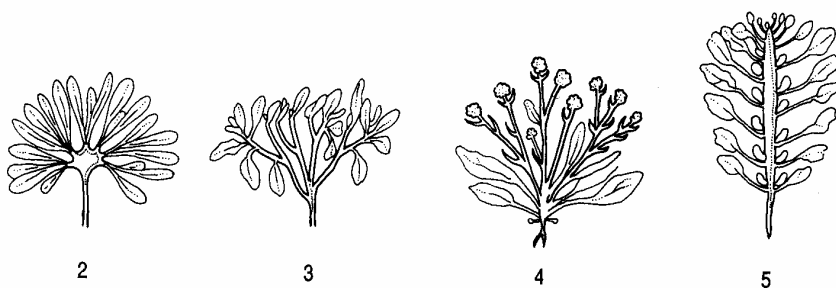


Fig. 20. Axillary stem and bud growth

4.2.63 Number of shoots or enlarged buds

- 3 Few
- 5 Intermediate
- 7 Many

4.2.64 Number of shoots or buds per unit of stem

- 3 Low
- 5 Intermediate
- 7 High

4.2.65 Shape of enlarged vegetative buds

- 1 Transverse elliptic
- 2 Round
- 3 Elliptic
- 4 Ovate
- 5 Obovate

4.2.66 Size of enlarged vegetative buds

- 3 Small
- 5 Intermediate
- 7 Large

4.2.67 Firmness of enlarged vegetative buds

- 3 Loose
- 5 Intermediate
- 7 Firm

4.2.68 Colour of enlarged vegetative buds or shoots

- 1 Light green
- 2 Green
- 3 Dark green
- 5 Red/purple green
- 6 Red/purple

4.2.69 Proportion of stem bearing shoots or buds

Measure and estimate proportion as a decimal fraction (1.0 to <0.1)

4.2.70 Stem length in enlarged buds or shoots

- 3 Short
- 5 Intermediate
- 7 Long

4.2.71 Synchrony of sprout development

- 3 Low
- 5 Intermediate
- 7 High

4.2.72 Floral apex composition

- 1 Flower buds
- 2 Highly proliferating condensed vegetative meristems (as in cauliflower curds)

4.2.73 Floral apex branching pattern

See Fig. 21

- 1 Single flower raceme
- 2 Enlarged stem with terminally branched raceme
- 3 Loosely branched small terminal heads
- 4 Terminal head with smaller heads on axillary shoots
- 5 Compact head of regularly packed subheads
- 6 Single compact head of irregularly packed subheads
- 7 Other (specify in the NOTES descriptor, 11)

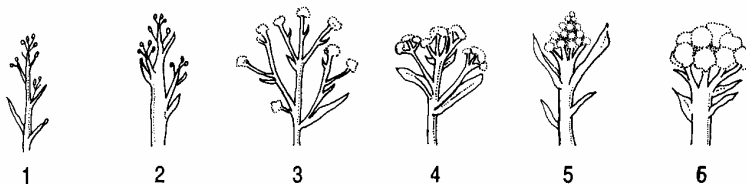


Fig. 21. Floral apex branching pattern

4.2.74 Flowering head size

- 3 Small
- 5 Intermediate
- 7 Large

4.2.75 Flowering head shape in longitudinal section

See Fig. 22

- 1 Concave
- 3 Flat
- 5 Spheric
- 7 Elliptic

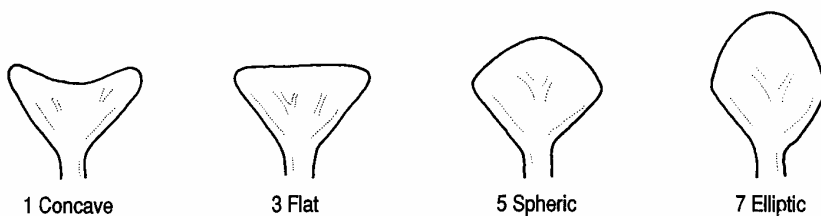


Fig. 22. Flowering head shape in longitudinal section

4.2.76 Flowering head depth

Compare with 'type' for crop

- 3 Shallow
- 5 Deep

4.2.77 Flowering head solidity

Compare with 'type' for crop

- 3 Low (loose)
- 5 Intermediate
- 7 High (solid)

4.2.78 Flowering head colour surface

- 1 White
- 2 Cream
- 3 Yellow
- 4 Yellow-green
- 5 Green
- 6 Pink
- 7 Green-red
- 8 Purple
- 9 Red
- 10 Orange
- 11 Other (specify in the NOTES descriptor, 11)

4.2.79 Bracts in flowering head

- 0 None
- 3 Few
- 5 Intermediate
- 7 High

4.2.80 Precocious flowering tendency

Riciness in cauliflower, irregular bud size in broccoli

- 0 Absent
- 3 Low
- 5 Intermediate
- 7 High

4.2.81 Head cover from subtending leaves

See Fig. 16

- 0 Apex fully exposed
- 2 Low (apex visible)
- 4 Intermediate
- 6 High (only top of head visible)
- 8 Apex fully covered by overlapping or twisted leaves

4.2.82 Root, shape in longitudinal section

See Fig. 23

- 1 Nonswollen tap root
- 2 Triangular
- 3 Cylindric
- 4 Elliptic
- 5 Spheric
- 6 Transverse elliptic
- 7 Inverse triangle
- 8 Apically bulbous
- 9 Horn
- 10 Branched
- 11 Other (specify in the NOTES descriptor, 11)

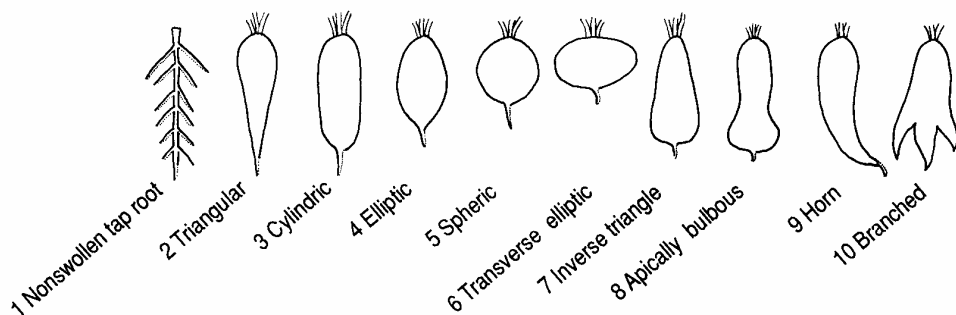


Fig. 23. Root, shape in longitudinal section

4.2.83 Root length in relation to width

- 3 Short
- 5 Intermediate
- 7 Long

4.2.84 Root length [cm]

Measure storage portion

4.2.85 Root diameter [cm]

Measure at widest point

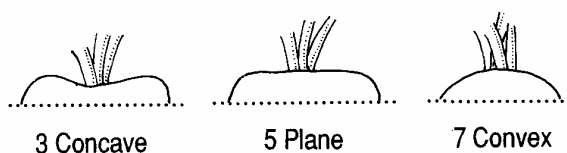
4.2.86 Root width/length ratio

Compute ratio 4.2.85/4.2.84

4.2.87 Root weight [g]4.2.88 Root, shape of shoulder

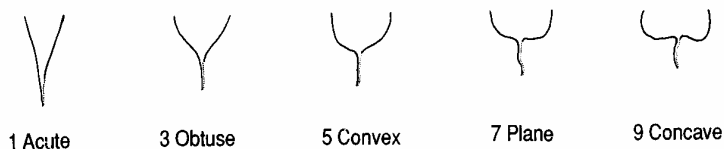
See Fig. 24

- 3 Concave
- 5 Plane
- 7 Convex

**Fig. 24. Root, shape of shoulder**4.2.89 Root, shape at base

See Fig. 25

- 1 Acute
- 3 Obtuse
- 5 Convex
- 7 Plane
- 9 Concave

**Fig. 25. Root, shape at base**

4.2.90 Root skin surface texture

- 3 Smooth
- 5 Intermediate
- 7 Coarse

4.2.91 Root exterior colour pattern

- 0 Uniform
- 1 Bicolour
- 2 Multicolour
- 4 Mixed colours
- 5 Lateral root grooves of different colour than root
- 6 Other (specify in the NOTES descriptor, 11)

4.2.92 Exterior root colour

If more than one colour, specify the colours

- 1 White
- 2 Yellow
- 3 Green
- 4 Pink
- 5 Red
- 6 Purple
- 7 Bronze
- 8 Brown
- 9 Black
- 10 Other (specify in the NOTES descriptor, 11)

4.2.93 Interior root colour

If more than one colour, specify the colour

- 1 White
- 2 Yellow
- 3 Green
- 4 Pink
- 5 Red
- 6 Purple
- 7 Other (specify in the NOTES descriptor, 11)

4.2.94 Root flesh colour distribution in transverse section

See Fig. 26

- 1 Uniform
- 2 Colour in cortex and cambium
- 3 Colour radially distributed in stellate pattern
- 4 Concentric rings of colour
- 5 Irregular distribution
- 6 Other (specify in the NOTES descriptor, 11)



Fig. 26. Root, flesh colour distribution in transverse section

4.2.95 Root flesh texture

- 1 Crisp
- 2 Pithy
- 3 Fibrous

4.2.96 Root pungency

- 3 Mild
- 5 Intermediate
- 7 Strong

4.2.97 Position of 'bulb' in soil

See Fig. 27

- 3 Mostly buried
- 5 Half buried
- 7 Largely above the soil line

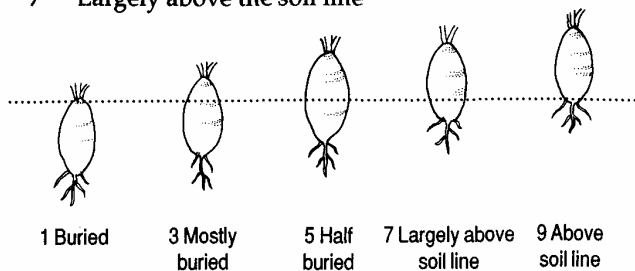


Fig. 27. Position of 'bulb' in soil

4.2.98 Root, lateral root emergence on 'bulb'

See Fig. 28

- 0 Absent
- 3 Lower portion
- 5 Lower half
- 7 More than half

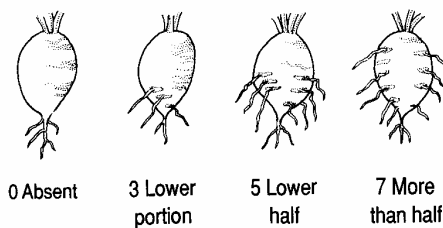


Fig. 28. Root, lateral root emergence in bulb

4.2.99 Lateral root-groove tissue 'scars'

See Fig. 29

- 0 Absent
- 3 Narrow
- 5 Intermediate
- 7 Wide

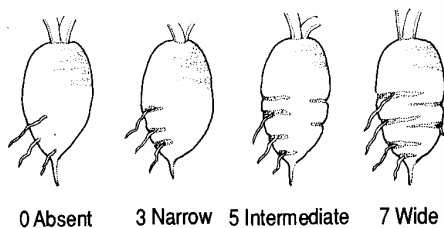


Fig. 29. Lateral root-groove tissue 'scars'

4.3 FLOWERING PLANT CHARACTERISTICS

Observed when plant is in full flower with immature fruit present. Plants should be observed when grown under normal cropping

4.3.1 Flowering behaviour under normal cropping conditions

Without artificial vernalization

- 1 Annual
- 2 Biennial
- 3 Perennial

4.3.2 Days to flowering

Number of days from sowing to when
50% of plants first flower

4.3.3 Mean days to flowering

Measured as mean days from sowing to first
flowering of ≥ 10 plants

4.3.4 Flowering synchrony among plants

- 3 Low (flowering spread over several weeks)
- 5 Intermediate
- 7 High (all plants flowering within a few days)

4.3.5 Flower induction is sensitive to

- 1 Low temperature
- 2 High temperature
- 3 Long photoperiods
- 4 Short photoperiods
- 5 Temperature neutral
- 6 Photoperiod neutral
- 7 Specified combinations of temperature and photoperiod
(in NOTES descriptor, 11)

4.3.6 Duration of flower-inducing environments

- 3 Short
- 5 Intermediate
- 7 Long

4.3.7 Flower stalk colour

Observed at base of stem

- 1 White
- 2 Yellow-green
- 3 Green
- 4 Red green
- 5 Red
- 6 Purple
- 7 Other (specify in NOTES descriptor, 11)

4.3.8 Flower stalk bloom

- 0 Absent, glossy
- 3 Low
- 5 Intermediate
- 7 High, glaucous

4.3.9 Flower stalk length, measured [cm]

Measure from ground to tip of floral apex

4.3.10 Flower stalk length, estimate

- 3 Short
- 5 Intermediate
- 7 Long

4.3.11 Flower stalk internode length

- 3 Short
- 5 Intermediate
- 7 Long

4.3.12 Flower stalk branching habit

- 3 Few
- 5 Intermediate
- 7 Profuse

4.3.13 Flowering plant, degree of branching

- 0 None
- 1 Primary
- 2 Secondary
- 3 Tertiary
- 4 Quarternary
- 5 Further branching

4.3.14 Flowering plant, stalk stiffness

- 3 Low (drooping)
- 5 Intermediate
- 7 High (erect)

4.3.15 Flowering plant hairiness

- 0 Absent
- 3 Few hairs
- 5 Intermediate
- 7 Hairy

4.3.16 Flower colour variability in the crop

- 3 Uniform
- 5 Intermediate
- 7 Highly variable, many colours

4.3.17 Petal colour

- 1 White
- 2 Pale yellow
- 3 Yellow
- 4 Orange yellow
- 5 Pink
- 6 Red
- 7 Purple
- 8 Other (specify in the NOTES descriptor, 11)

4.3.18 Flower scent

- 0 Absent
- 3 Slight
- 5 Intermediate
- 7 Strong

4.3.19 Silique colour before drying

- 1 Yellow green
- 2 Green
- 3 Red green
- 4 Purple green
- 5 Purple
- 6 Other (specify in the NOTES descriptor, 11)

4.4 MATURE PLANT FRUIT AND SEED CHARACTERISTICS

4.4.1 Days to maturity

Number of days from sowing to when 90% of the plants are ready for harvest (yellowing of silique)

4.4.2 Silique length [cm]

See Fig. 30

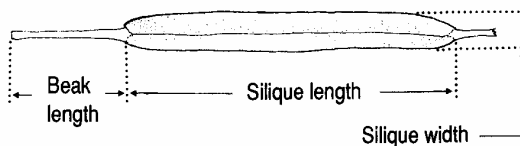


Fig. 30. Silique length/width

4.4.3 Silique width [cm]

See Fig. 30

4.4.4 Beak length [cm]

See Fig. 30

4.4.5 Silique length/width ratio

Including style and carpels. Calculate ratio 4.4.2/4.4.3

4.4.6 Silique length/width ratio, estimate

- 3 Short L/W approx 3 or <3
- 5 Intermediate L/W approx 5
- 7 Long L/W approx 7 or >7

4.4.7 Silique attitude

See Fig. 31

- 1 Erect
- 2 Hanging
- 3 Pointing down

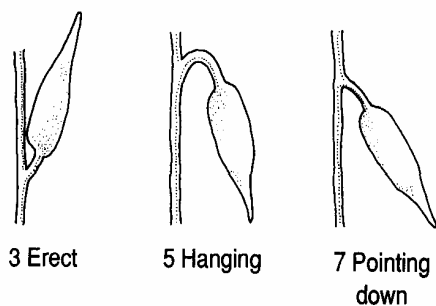


Fig. 31. Silique attitude

4.4.8 Silique surface outline

See Fig. 32

- 3 Smooth
- 5 Undulating
- 7 Constricted between seeds

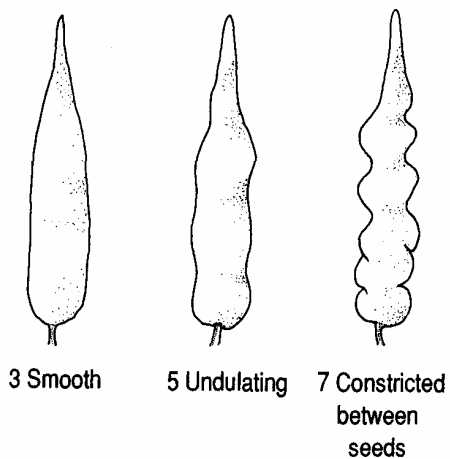


Fig. 32. Silique surface

4.4.9 Silique hairiness

- 0 Absent
- 3 Few hairs
- 5 Intermediate
- 7 Hairy

4.4.10 Silique carination

Keel

- 0 Absent
- + Present

4.4.11 Silique shattering

- 3 Low
- 5 Intermediate
- 7 High

4.4.12 Primary seed coat colour

After drying

- 1 Yellow
- 2 Yellow brown
- 3 Light brown
- 4 Brown
- 5 Dark brown
- 6 Red brown
- 7 Red
- 8 Blue-black
- 9 Gray-black
- 10 Other (specify in the NOTES descriptor, 11)

4.4.13 1000 seed weight [g]

According to ISTA rules 5 to 6% moisture content

4.4.14 Number of seeds per silique

- 3 Few (10 or less)
- 5 Intermediate (11-20)
- 7 Many (21 or more)

FURTHER CHARACTERIZATION AND EVALUATION

5. SITE DATA

- 5.1 COUNTRY
- 5.2 SITE
- 5.3 NAME
- 5.4 SOWING DATE
- 5.5 TRANSPLANTING DATE
- 5.6 FIRST HARVEST DATE
- 5.7 LAST HARVEST DATE

6. PLANT DATA

7. ABIOTIC STRESS SUSCEPTIBILITY

Scored under artificial and/or natural conditions on a 1-9 scale, where

- 3 Low susceptibility
- 5 Medium susceptibility
- 7 High susceptibility

The condition should be clearly specified

- 7.1 LOW TEMPERATURE
- 7.2 FREEZING
- 7.3 GROWTH RATE UNDER LOW TEMPERATURE
- 7.4 HIGH TEMPERATURE
- 7.5 DROUGHT
- 7.6 HIGH WINDS
- 7.7 FLOODING/WATER LOGGING/EXCESS SOIL MOISTURE
- 7.8 HIGH RELATIVE HUMIDITY
- 7.9 HIGH RAINFALL

- 7.10 SOIL SALINITY
- 7.11 SOIL ALKALINITY (pH >8.0)
- 7.12 SOIL ACIDITY (pH <4.0)
- 7.13 NITROGEN DEFICIENCY
- 7.14 PHOSPHOROUS DEFICIENCY
- 7.15 POTASSIUM DEFICIENCY
- 7.16 SULPHUR DEFICIENCY
- 7.17 CALCIUM DEFICIENCY
- 7.18 MAGNESIUM DEFICIENCY
- 7.19 MOLYBDENUM DEFICIENCY
- 7.20 BORON DEFICIENCY
- 7.21 IRON DEFICIENCY
- 7.22 OTHER MICROELEMENT DEFICIENCIES (specify in NOTES descriptor, 11)
- 7.23 ELEMENT TOXICITY (specify in NOTES descriptor, 11)

8. PEST AND DISEASE REACTION

Scored on a 1-9 scale where

- 0 Immunity
- 3 Low susceptibility
- 5 Intermediate susceptibility
- 7 High susceptibility

8.1 INSECTS AND OTHER ARTHROPODS

Where possible, pests should be identified to genus and species

- 8.1.1 Mites (specify in the NOTES descriptor, 11)
- 8.1.2 Springtails (specify in the NOTES descriptor, 11)
- 8.1.3 Capsids (specify in the NOTES descriptor, 11)

- 8.1.4 Thrips (specify in the NOTES descriptor, 11)
- 8.1.5 Aphids (specify in the NOTES descriptor, 11)
- 8.1.6 Lygus bugs (specify in the NOTES descriptor, 11)
- 8.1.7 Whitefly (specify in the NOTES descriptor, 11)
- 8.1.8 Sawfly (specify in the NOTES descriptor, 11)
- 8.1.9 Rootfly (specify in the NOTES descriptor, 11)
- 8.1.10 Leaf minors (specify in the NOTES descriptor, 11)
- 8.1.11 Midges (specify in the NOTES descriptor, 11)
- 8.1.12 Lepidopterous larvae
(specify in the NOTES descriptor, 11)
- 8.1.13 Flea beetles (specify in the NOTES descriptor, 11)
- 8.1.14 Stem and gall weevils
(specify in the NOTES descriptor, 11)
- 8.1.15 Pod weevils (specify in the NOTES descriptor, 11)
- 8.1.16 Wire worms (specify in the NOTES descriptor, 11)
- 8.1.17 Other (specify in the NOTES descriptor, 11)

8.2 FUNGI

- | | |
|-----------------------------------|-----------------------------------------------|
| 8.2.1 <u>Alternaria diseases</u> | <u>Alternaria</u> spp. |
| 8.2.2 <u>Anthrachnose</u> | <u>Colletotrictrum</u>
<u>higginsianum</u> |
| 8.2.3 <u>Black leg</u> | <u>Leptosphaeria maculans</u> |
| 8.2.4 <u>Black mold</u> | <u>Rhizopus</u> spp. |
| 8.2.5 <u>Black root</u> | <u>Aphanomyces raphani</u> |
| 8.2.6 <u>Bottom rot, wirestem</u> | <u>Rhizoctonia solani</u> |
| 8.2.7 <u>Cercospora leafspot</u> | <u>Cercospora brassicola</u> |

- | | |
|-----------------------------------------------------------|------------------------------------------------------|
| 8.2.8 <u>Clubroot</u> | <u>Plasmodiophora brassicae</u> |
| 8.2.9 <u>Damping off</u> | <u>Fusarium</u> spp. |
| 8.2.10 <u>Damping off</u> | <u>Pythium</u> spp. |
| 8.2.11 <u>Downy mildew, staghead</u> | <u>Peronospora parasitica</u> |
| 8.2.12 <u>Gray mold</u> | <u>Botrytis cinerea</u> |
| 8.2.13 <u>Light leafspot</u> | <u>Pyrenopeziza brassicae</u> |
| 8.2.14 <u>Powdery mildew</u> | <u>Erysiphe polygoni</u> |
| 8.2.15 <u>Ring spot</u> | <u>Mycosphaerella brassicola</u> |
| 8.2.16 <u>Root rot, Phymatotrichum</u> | <u>Phymatotrichum omnivorum</u> |
| 8.2.17 <u>Root rot, Phytophthora</u> | <u>Phytophthora megasperma</u> |
| 8.2.18 <u>Sclerotinia stem rot</u> | <u>Sclerotinia sclerotiorum</u> |
| 8.2.19 <u>Southern blight</u> | <u>Sclerotium rolfsii</u> |
| 8.2.20 <u>Verticillium wilt</u> | <u>Verticillium</u> spp. |
| 8.2.21 <u>White rust, staghead</u> | <u>Albugo candida</u> |
| 8.2.22 <u>White leafspot, graystem</u> | <u>Pseudocercospora capsellae</u> |
| 8.2.23 <u>Yellows</u> | <u>Fusarium oxysporum</u> |
| 8.2.24 <u>Other</u> (specify in the NOTES descriptor, 11) | |
| 8.3 BACTERIA AND MYCOPLASMA-LIKE ORGANISMS | |
| 8.3.1 <u>Aster yellows</u> | <u>Mycoplasma-like organism</u> |
| 8.3.2 <u>Bacterial leaf spot</u> | <u>Pseudomonas syringae</u>
pv. <u>maculicola</u> |
| 8.3.3 <u>Bacterial soft rot</u> | <u>Erwinia carotovora</u> |
| 8.3.4 <u>Bacterial soft rot</u> | <u>Pseudomonas marginalis</u> |

- | | | |
|-------|----------------------------------------------------|--------------------------------------------------------|
| 8.3.5 | <u>Black rot</u> | <u>Xanthomonas campestris</u>
pv. <u>campestris</u> |
| 8.3.6 | <u>Crown gall</u> | <u>Agrobacterium</u>
<u>tumefaciens</u> |
| 8.3.7 | <u>Scab</u> | <u>Streptomyces scabies</u> |
| 8.3.8 | <u>Xanthomonas leaf spot</u> | <u>Xanthomonas campestris</u>
pv. <u>armoracea</u> |
| 8.3.9 | <u>Other</u> (specify in the NOTES descriptor, 11) | |
- 8.4 VIRUSES
- | | | |
|-------|----------------------------------------------------|-------------------------------|
| 8.4.1 | <u>Cauliflower mosaic</u> | CaMV |
| 8.4.2 | <u>Radish mosaic</u> | RMV |
| 8.4.3 | <u>Turnip mosaic</u> | TuMV |
| 8.4.4 | <u>Yellows</u> | Beet Western Yellows
Virus |
| 8.4.5 | <u>Other</u> (specify in the NOTES descriptor, 11) | |
- 8.5 NEMATODES
- | | | |
|-------|----------------------------------------------------|--------------------------|
| 8.5.1 | <u>Awl</u> | <u>Dolicodorus</u> spp. |
| 8.5.2 | <u>Cyst</u> | <u>Heterodera</u> spp. |
| 8.5.3 | <u>Pin</u> | <u>Pratylenchus</u> spp. |
| 8.5.4 | <u>Root knot</u> | <u>Meloidogyne</u> spp. |
| 8.5.5 | <u>Root lesion</u> | <u>Pratylenchus</u> spp. |
| 8.5.6 | <u>Sting</u> | <u>Belonolaimus</u> spp. |
| 8.5.7 | <u>Other</u> (specify in the NOTES descriptor, 11) | |
- 8.6 OTHER PESTS
- | | | |
|-------|-------------------------------------------------------|--|
| 8.6.1 | <u>Molluscs</u> (specify in the NOTES descriptor, 11) | |
| 8.6.2 | <u>Birds</u> (specify in the NOTES descriptor, 11) | |

8.6.3 Mammals (specify in the NOTES descriptor, 11)

8.6.4 Other (specify in the NOTES descriptor, 11)

8.7 PHYSIOLOGIC DISORDERS

8.7.1 Tipburn

See Fig. 33

Brown internal breakdown

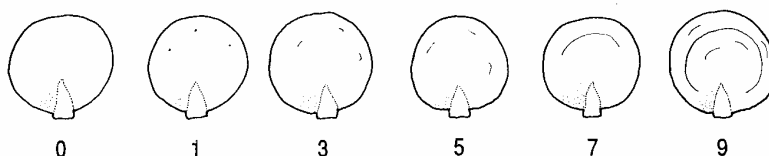


Fig. 33. Tipburn

8.7.2 Pepper spot

Minute black specks on internal and external leaves

8.7.3 Other (specify in the NOTES descriptor, 11)

9. ALLOENZYME COMPOSITION

This may prove to be a useful tool for identifying duplicate accessions

10. CYTOLOGICAL CHARACTERS AND IDENTIFIED GENES

These are listed in the Crucifer Genetics Cooperative Resource Book and other sources

11. NOTES

Give additional information where descriptor state is noted as 'Other' as for example in descriptors 4.1.2, 4.2.8, 4.2.11, etc. Also include here any other relevant information

12. DESCRIPTORS OF NUTRITIONAL IMPORTANCE

Certain characters which have or may have significant nutritional implication for food, animal feed and feed-technology industries and whose assays are technically more demanding should be accumulated by genebank institutions or laboratories, e.g. fatty acids, erucic acid, glucosinolates, S-methyl cysteine sulfoxide, etc.

13. FUTURE DESCRIPTORS

The list will remain open for inclusion of future descriptors such as those pertaining to physiological traits which can be rapidly screened. Most of the characters in the present list are of a visual morphological nature and an appropriate extension would be to use microscopic evaluation of tissue distribution at critical sites. Chemical probes now exist for many compounds, e.g. protein, lipids, starch, lignin, DNA, RNA, as well as specific probes, e.g. radioisotopic and immunofluorescent protein probes. Distribution of many of these compounds is potentially important for stress resistance factors (lignin with lodging for example), quality factors (seed protein distribution) and yield (e.g. stem starch and vascular tissue development)

APPENDIX

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