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INTERNATIONAL BOARD FOR PLANT GENETIC RESOURCES

and

ASIAN VEGETABLE RESEARCH AND DEVELOPMENT CENTER

DESCRIPTORS FOR BRASSICA CAMPESTRIS L.

IBPGR
Rome, November 1987

The International Board for Plant Genetic Resources (IBPGR) is an autonomous international scientific organization under the aegis of the Consultative Group on International Agricultural Research (CGIAR). The IBPGR was established by the CGIAR in 1974. The basic function of the IBPGR is to promote and coordinate an international network of genetic resources centres to further the collection, conservation, documentation, evaluation and use of plant germplasm and thereby contribute to raising the standard of living and welfare of people throughout the world. Financial support for the core programme is provided by the Governments of Australia, Austria, Belgium, Canada, China, Denmark, France, Federal Republic of Germany, India, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom, and the USA as well as the World Bank. FAO of the United Nations provides the Headquarters.

The Asian Vegetable Research and Development Center (AVRDC) is the international agricultural research center (IARC) with a mandate for vegetable crops research and development in the humid and subhumid tropics. Established in 1971, its activities include: germplasm collection and enhancement, varietal improvement, production technology improvement, environmental and nutritional studies, technology transfer, and training for national program personnel.

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PREFACE

This descriptor list has been prepared in an IBPGR standard format following testing of descriptors and descriptor states through characterization works on this species carried out at AVRDC and advice from crop experts (see Acknowledgement, next page).

Although the suggested coding should not be regarded as the definitive scheme, this format has the full backing of the 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.

ACKNOWLEDGEMENT

The first draft of this descriptor list was assembled by Dr. A.M. Dourado, former IBPGR Research Intern at AVRDC, with the assistance of Dr. R.T. Opeña, Director of the Crop Improvement Program, AVRDC, based on the two previous lists: (1) Descriptors for Cruciferous Crops (In, Genetic Resources of Cruciferous Crops, IBPGR Secretariat, Rome, 1980) and (2) Crucifer Descriptors (IBPGR Secretariat, Rome, 1982). The draft was sent to numerous scientists working on this crop for comments. Further revisions were carried out by Dr. C.S. Tay, Head of Genetic Resources and Seed Unit, AVRDC, and the descriptors and descriptor states were extensively tested in the field by Miss W.S. Kuo under the supervision of Dr. Tay. The final list was prepared by Dr. Tay and reviewed by Dr. Opeña and Dr. J.Y. Yoon, Associate Plant Breeder (Chinese cabbage), AVRDC.

DESCRIPTOR LIST FOR BRASSICA CAMPESTRIS L.

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 and other scientists within the discipline. The data from further evaluation should be fed back to the curator who will maintain a data file.

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 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 + (present) and 0 (absent);

(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 accessions 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 genebank or national system (e.g. MG indicates that an accession comes from the genebank 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 collections for this accession, e.g. USDA Plant Inventory number (not collector's 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

1.5.1 Genus

1.5.2 Species

1.5.3 Subspecies

1.5.4 Cultivar group

1.6 PEDIGREE/CULTIVAR NAME

Nomenclature and designations assigned to breeder's material

1.6.1 Pedigree number

1.6.2 Cultivar name

1.7 ACQUISITION DATE

The date at 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

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 WAS 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

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 market
7 Institute
8 Other (specify in the NOTES descriptor, 11)

2.11 STATUS OF SAMPLE

1 Wild
2 Weedy
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 Both

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 so, 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 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

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

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 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 name for the processed product)
2 Oil
  2.1 Edible oil
  2.2 Industrial oil
3 Condiment
4 Forage
5 Green manure
6 Other (specify in the NOTES descriptor, 11)

2.23 MINOR CROP USAGE

1 Vegetable
  1.1 Unprocessed
  1.2 Processed (specify local name for the processed product)
2 Oil
  2.1 Edible oil
  2.2 Industrial oil
3 Condiment
4 Forage
5 Green manure
6 Other (specify in the NOTES descriptor, 11)

2.24 OTHER NOTES FROM COLLECTORS

Collectors will record ecological information. For cultivated crops, cultivation practices such as irrigation, season of sowing, etc. will be recorded

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

Observe at the 5–leaf stage

4.1.1 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)

4.1.2 Seedling leaf margin serrations

See Fig. 1

0 No serration
1 Crenate
2 Dentate
3 Doubly dentate
4 Other (specify in the NOTES descriptor, 11)

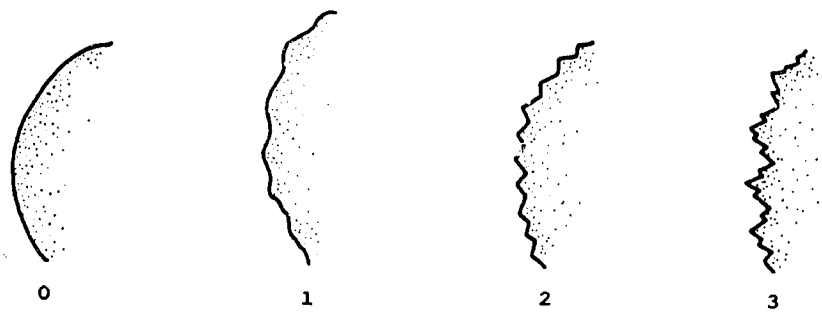

Fig. 1. Seedling leaf margin serrations

4.1.3 Intensity of seedling leaf margin serrations

3 Slight
5 Intermediate
7 High

4.1.4 Seedling pubescence

0 Glabrous
1 Very sparse (leaf margin only)
3 Sparse
5 Intermediate
7 Abundant

4.2 MATURE PLANT

Observe immediately before harvest in non–flowering plant

4.2.1 Growth habit

Angle of outermost fully expanded leaf petioles with soil surface

1	Erect	(>85°)
3	Open	(~65°)
5	Semi–prostrate	(~45°)
7	Prostrate	(<30°)

4.2.2 Mature leaf shape

See Fig. 2

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

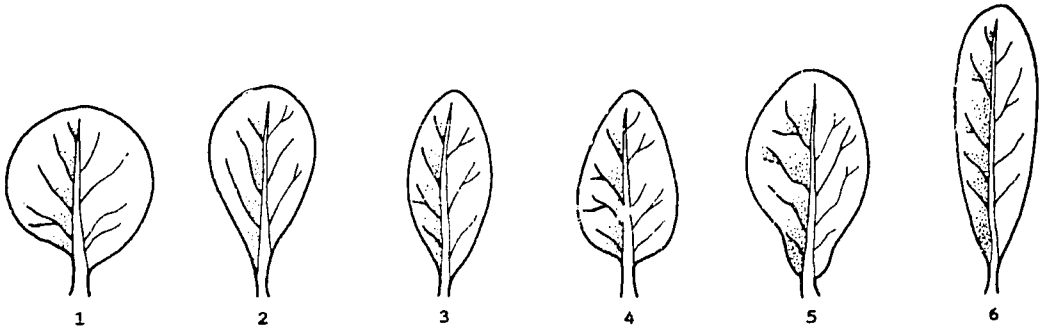

Fig. 2. Mature leaf shape

4.2.3 Mature leaf dissection

See Fig. 3

1 Entire
2 Auricular
3 Lyrate
4 Parted
5 Other (specify in the NOTES descriptor, 11)

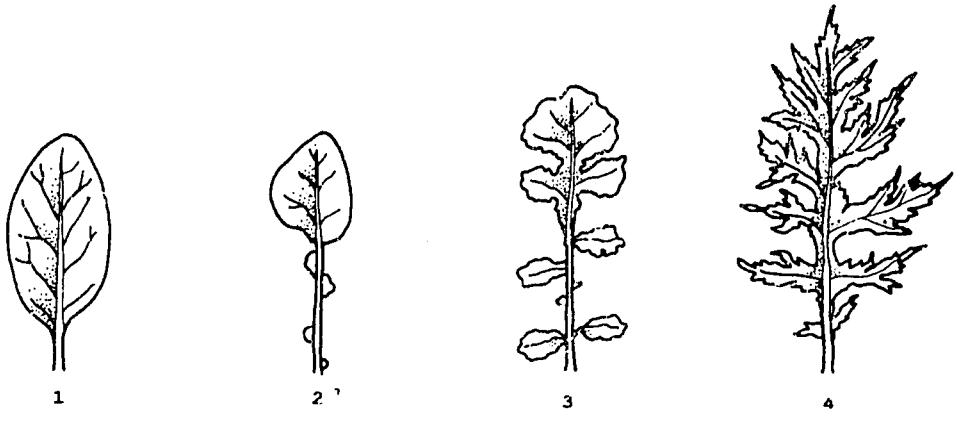

Fig. 3. Mature leaf dissection

4.2.4 Mature leaf colour

Outer non-wrapper leaves

1 Whitish green
2 Green
3 Purple green
4 Purple
5 Other (specify in the NOTES descriptor, 11)

4.2.5 Intensity of mature leaf colour

3 Light
5 Intermediate
7 Dark

4.2.6 Petiole colour

Midrib colour in subspp. pekinensis and rapa

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

4.2.7 Leaf pubescence

On the underside

0 Glabrous
3 Sparse
5 Intermediate
7 Abundant

4.2.8 Mature plant height

From soil level to the tallest point of a standing intac plant

1 <20 cm
2 20–30 cm
3 30–40 cm
4 40–50 cm
5 50–60 cm
6 60–70 cm
7 >70 cm

4.3 FLOWER AND SILIQUE

4.3.1 Petal colour

1 Light yellow (Methuen 2A7)
2 Yellow (Methuen 3A7)
3 Deep yellow (Methuen 3A8)
4 Other (specify in the NOTES descriptor, 11)

4.3.2 Petal shape

See Fig. 4

1 Round
2 Elliptical
3 Thin elliptical
4 Other (specify in the NOTES descriptor, 11)

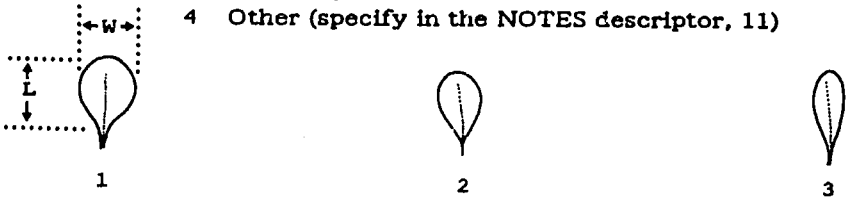

Fig. 4. Petal shape

4.3.3 Silique colour

Mature, but not dried

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

4.3.4 Beak shape

See Fig. 5

1 Stumpy
2 Intermediate
3 Slender
4 Other (specify in the NOTES descriptor, 11)

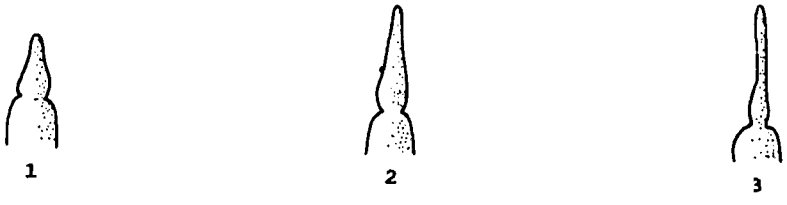

Fig. 5. Beak shape

4.4 HEAD

Observe at harvest, head-forming types only

4.4.1 Heading habit

0 Non-heading
5 Semi-heading
7 Heading

4.4.2 Head shape

See Fig. 6

1 Round
2 Elliptical
3 Ovate
4 Obovate
5 Oblong
6 Cylindrical
7 Other (specify in the NOTES descriptor, 11)

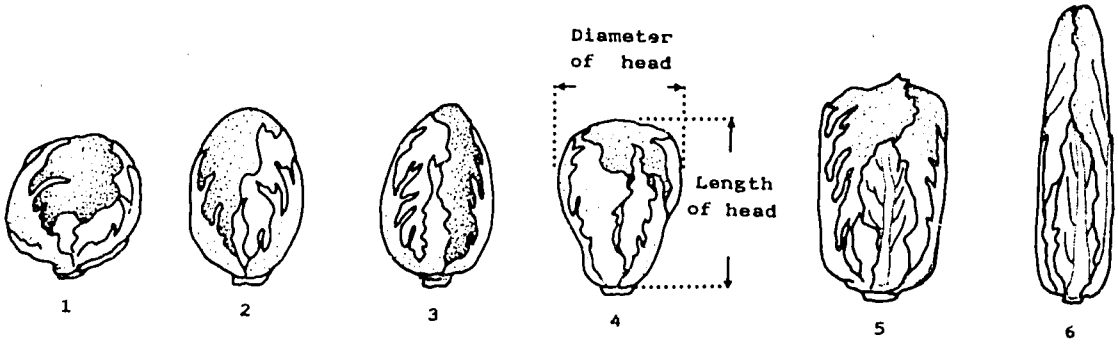

Fig. 6. Head shape

4.4.3 Head-forming leaf overlap at terminal region

See Fig. 7

1 Terminal leaves curled outwards
2 Erect
3 Curled inwards
4 Almost touching
5 Slight overlap
6 Intermediate
7 Considerable overlap

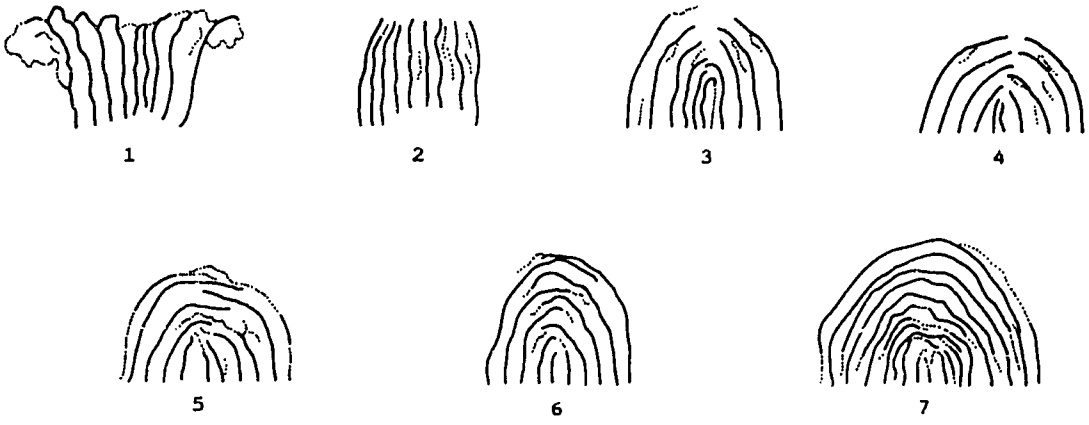

Fig. 7. Head-forming leaf overlap at terminal region

4.5 ROOT

4.5.1 Enlarged root

0 Absent
1 Enlarged
2 Marketable root

4.5.2 Skin colour pattern

1 Uniform
2 More than one colour

4.5.3 Base colour of skin

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

4.5.4 Intensity of base colour of skin

3 Light
5 Intermediate
7 Dark

4.5.5 Secondary colour of skin

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

4.5.6 Intensity of secondary colour of skin

3 Light
5 Intermediate
7 Dark

4.5.7 Base colour of flesh

1 White
2 Greenish white
3 Pink
4 Purple
5 Other (specify in the NOTES descriptor, 11)

4.5.8 Secondary colour of flesh

1 White
2 Greenish white
3 Pink
4 Purple
5 Other (specify in the NOTES descriptor, 11)

4.5.9 Root shape

See Fig. 8

1 Oblate
2 Globular
3 Conical
4 Tapered
5 Cylindrical
6 Other (specify in the NOTES descriptor, 11)

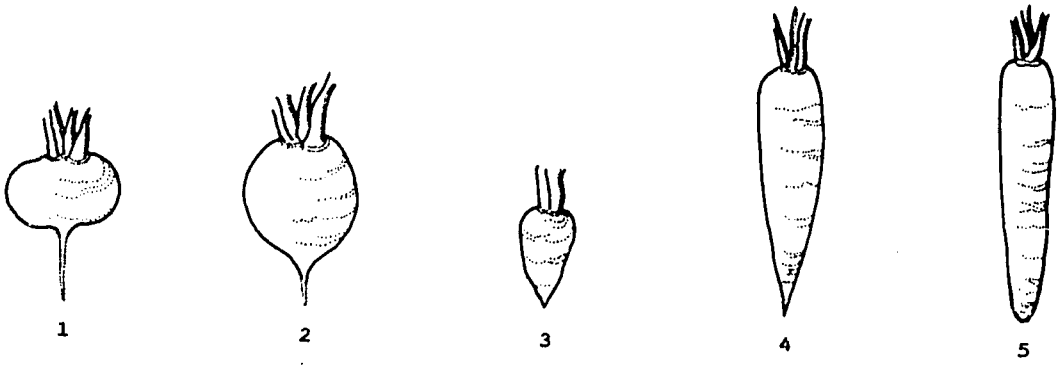

Fig. 8. Root shape

4.5.10 Shape of crown

See Fig. 9

1 Straight
3 Convex
5 Plane
7 Concave

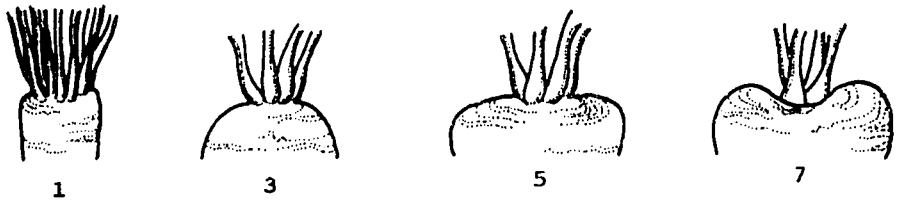

Fig. 9. Shape of crown

FURTHER CHARACTERIZATION AND EVALUATION

5. SITE DATA

5.1 COUNTRY OF FURTHER CHARACTERIZATION AND EVALUATION

5.2 SITE (RESEARCH INSTITUTE)

5.3 NAME OF PERSON IN CHARGE OF EVALUATION

5.4 SOWING DATE

5.5 TRANSPLANTING DATE

5.6 FIRST HARVEST DATE

5.7 LAST HARVEST DATE

6. PLANT DATA

6.1 SEEDLING

Observe at 5-leaf stage

6.1.1 Cotyledon length [mm]

See Fig. 10

6.1.2 Cotyledon width [mm]

See Fig. 10

6.1.3 Cotyledon notch depth

See Fig. 10

3 Shallow
5 Intermediate
7 Deep

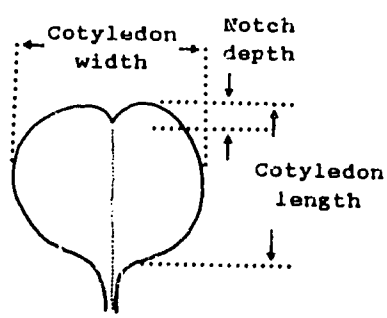

Fig. 10. Cotyledon length and width, and notch depth

6.1.4 Hypocotyl colour

1 White
2 Greenish white
3 Light green
4 Green
5 Light purple green
6 Purple green
7 Purple
8 Other (specify in the NOTES descriptor, 11)

6.1.5 Anthocyanin pigment at seedling stage

0 Absent
1 Hypocotyl
2 Hypocotyl and petiole
3 Hypocotyl and petiole and blade
4 Other (specify in the NOTES descriptor, 11)

6.2 MATURE PLANT

Observe immediately before harvest in non-flowering plants

6.2.1 Morphotype uniformity

After discarding obvious off-types

1 Uniform
2 Continuous variation
3 Two or more distinct types

6.2.2 Basal side shoot development

0 Absent
3 Sparse
5 Intermediate
7 Abundant

6.2.3 Weight of whole plant without root [g]

6.2.4 Number of non-wrapper leaves

6.2.5 Leaf length [cm]

See Fig. 11

Measure largest leaf

6.2.6 Leaf width [cm]

See Fig. 11

Measure widest point of largest leaf

6.2.7 Petiole length [cm]

See Fig. 11

Measure portion where leaf blade intercepts the petiole or is supposed to intercept, but not due to the presence of wing to petiole base of largest leaf

6.2.8 Petiole width [cm]

Measure widest point of petiole of largest leaf; midrib width in subspp. pekinensis and rapa

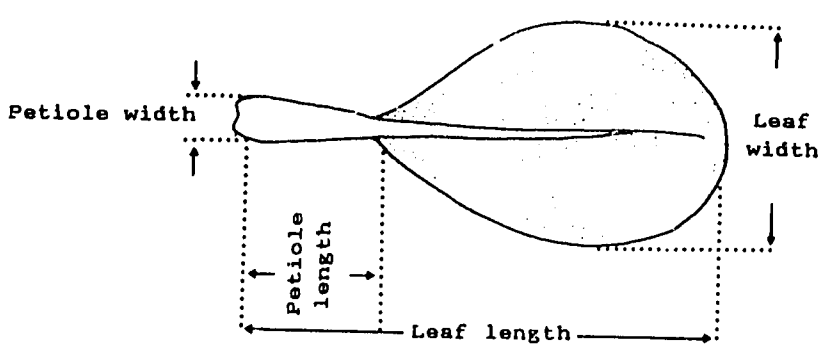

Fig. 11. Mature leaf length and width, and petiole length and width

6.2.9 Petiole thickness [mm]

See Fig. 12

Measure thickest point of petiole of largest leaf; midrib thickness in subspp. pekinensis and rapa

6.2.10 Cross-sectional view of petiole

See Fig. 12

Take the widest part of the midrib in subspp. pekinensis and rapa

3 Round
5 Semi-round
7 Flat

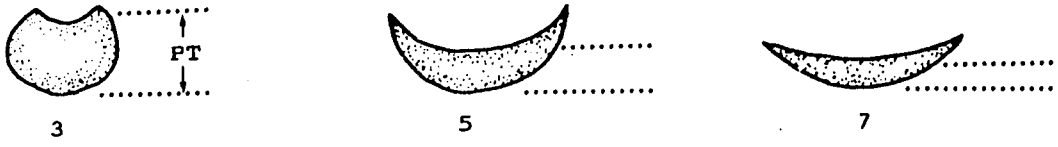

Fig. 12. Petiole thickness (PT) and cross-sectional view

6.2.11 Leaf blade thickness

3 Thin
5 Intermediate
7 Thick

6.2.12 Leaf blade blistering

0 No blistering
3 Slight
5 Intermediate
7 High

6.2.13 Leaf margin undulation

See Fig. 13

0 Absent
3 Low
5 Intermediate
7 High

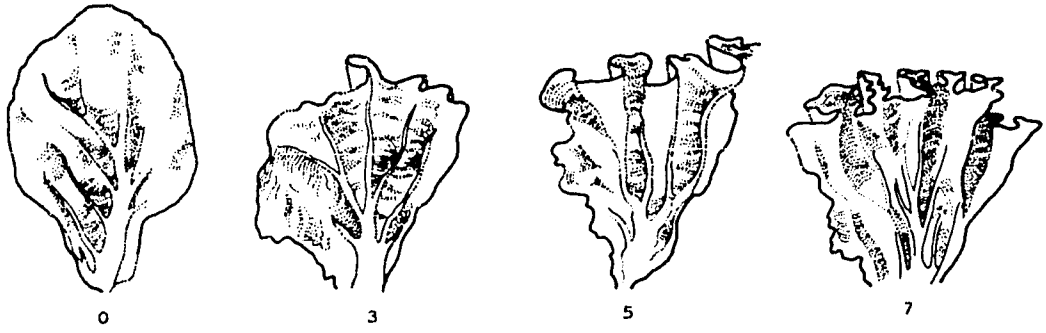

Fig. 13. Leaf margin undulation

6.3 INFLORESCENCE, SILIQUE AND SEED

6.3.1 Bolting behaviour under natural conditions [%]

Without artificial vernalization

6.3.2 Petal length [mm]

See Fig. 4

6.3.3 Petal width [mm]

See Fig. 4

6.3.4 Silique length [cm]

Seed bearing portion only

See Fig. 14

6.3.5 Silique width [cm]

Seed bearing portion only

See Fig. 14

6.3.6 Length of beak [cm]

See Fig. 14

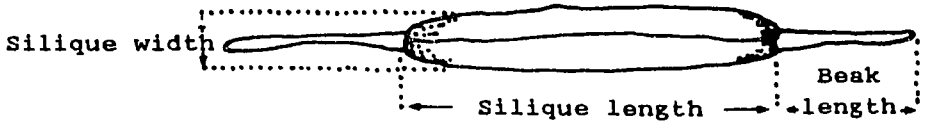

Fig. 14. Silique width and length, and length of beak

6.3.7 Number of mature seeds per silique

6.3.8 Dominant seed coat colour

After drying

1 Yellow
2 Red brown
3 Brown
4 Dull grey
5 Almost black
6 Other (specify in the NOTES descriptor, 11)

6.3.9 1000 seed weight [g]

According to International Seed Testing Association (ISTA) rules; 5–6% moisture content 'wet weight'

6.3.10 Seed oil content

Analytical technique to be specified in NOTES descriptor, 11

6.4 HEAD

Observe at harvest, head-forming type only

6.4.1 Head weight [g]

Non-wrapper leaves removed

6.4.2 Length of head [cm]

Non-wrapper leaves removed

6.4.3 Head diameter [cm]

Non-wrapper leaves removed

6.4.4 Axillary bud growth

Before trimming

3 Inconspicuous
5 Intermediate
7 Clear

6.4.5 Heading ability under high temperature

At mean temperature of 25°C or above

3 Poor
5 Intermediate
7 Excellent

6.5 ROOT

Observe at harvest on enlarged root-forming types only

6.5.1 Root length [cm]

Storage portion

6.5.2 Root diameter [cm]

Largest point

6.5.3 Root weight [g]

7. 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 conditions should be clearly specified

7.1 LOW-TEMPERATURE INJURY

7.2 GROWTH RATE UNDER LOW TEMPERATURE

7.3 HIGH-TEMPERATURE INJURY

7.4 DROUGHT

7.5 FLOODING/WATERLOGGING/EXCESS SOIL MOISTURE

7.6 SOIL SALINITY

7.7 SOIL ACIDITY

7.8 MICROELEMENT DEFICIENCY

7.9 MICROELEMENT TOXICITY

7.10 TIPBURN

Internal rot

8. PEST AND DISEASE SUSCEPTIBILITY

Scored on a 1–9 scale, where

0 Immunity
3 Low susceptibility
5 Medium susceptibility
7 High susceptibility

8.1 PESTS

8.1.1	Brevicoryne brassicae	Cabbage aphid
8.1.2	Hellula undalis	Cabbage webworm
8.1.3	Myzus persicae	Green peach aphid
8.1.4	Pieris rapae	Imported cabbage worm

	8.1.5	Plutella xylostella	Diamondback moth
	8.1.6	Pyllotretra striolata	Cabbage flea beetle
	8.1.7	Spodoptera litura	Tobacco cutworm
	8.1.8	Trichoplusia ni	Cabbage looper
	8.1.9	Other (specify in NOTES descriptor, 11)	
8.2	FUNGI		
	8.2.1	Albugo candida	White rust
	8.2.2	Alternaria spp.	Black spots
	8.2.3	Colletotrichum higginsianum	Anthracnose
	8.2.4	Erysiphe polygoni	Powdery mildew
	8.2.5	Leptosphaeria maculans	Black leg
	8.2.6	Peronospora parasitica	Downy mildew
	8.2.7	Plasmodiophora brassicae	Club root
	8.2.8	Sclerotinia sclerotiorum	Sclerotinia rot
	8.2.9	Other (specify in the NOTES descriptor, 11)	
8.3	BACTERIA		
	8.3.1	Erwinia carotovora	Soft rot
	8.3.2	Pseudomonas marginalis	Soft rot
	8.3.3	Pseudomonas syringae pv. maculicola	Leaf spot
	8.3.4	Xanthomonas campestris	Black rot
	8.3.5	Xanthomonas vesticatoria	Leaf spot
	8.3.6	Other (specify in the NOTES descriptor, 11)	
8.4	NEMATODES		
	8.4.1	Meloidogyne spp.	Root knot

9. ALLOENZYME COMPOSITION

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

10. CYTOLOGICAL CHARACTERS AND IDENTIFIED GENES

11. NOTES

Give additional information where descriptor state is noted as "Other" as, for example, in descriptors 4.1.2, 4.2.2, 4.2.3, etc. Also include here any other relevant information

12. DESCRIPTORS OF NUTRITIONAL IMPORTANCE OTHER THAN UNDER 6.3

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 genebanks or laboratories, e.g. erucic acid, glucosinolate, 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. Fluorescent probes now exist for many compounds, e.g. H_2O, protein, lipids, starch, lignin, DNA, RNA, as well as specific probes, e.g. 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). These tissue distributions are genetically controlled and not subject to great environmental interaction