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High Value Agriculture Project in Hill and Mountain Areas (HVAP)

CATALOG OF SELECTED WINTER VEGETABLES



Project Implementation Unit

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Catalog of Selected Winter Vegetables Commonly Grown in Nepal



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Catalog of Selected Winter Vegetables Commonly Grown in Nepal

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This catalog of notified and promising varieties of winter vegetable crops commonly grown in Nepal is the result of the combined efforts of many actors. It is one of the major output of the action research project on varietal characteristics of common winter vegetables. The project was funded by HVAP under Sector Development Fund (Grant Agreement # SDF/AR/SSSC/2071/72).

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SEAN Seed Service Centre Ltd., Kathmandu

Foreword

Horticultural crops particularly the vegetables are most suitable to bring in an inclusive growth to benefit commercial growers. Vegetable growing is most preferred by small and marginal land holders due to quick and high returns and several vegetable crops are preferred in crop diversification. Vegetables are important in human nutrition as they are rich sources of vitamins, minerals, food fiber and nutraceuticals.

There are 341 varieties of vegetables have been released and registered at Seed Quality Control Centre by FY 2072/73. Most of them are registered varieties for import and very few are released by the National Seed Board. However, most of the released varieties are released before 2051 BS. Varietal characters of particular variety are very important while maintaining their true to type in seed production and quality assurance. Field inspection and roguing is merely based on the known characters for distinctness, uniformity and stability. In Nepal reference document, however, for the varietal characteristics is lacking.

The varietal catalog of selected winter vegetables commonly grown in Nepal is prepared as the major output of the action research project by High-Value Agriculture Project in Hill and Mountain Areas (HVAP) under Sector Development Fund. This catalog has compiled major morphological and agronomical characters of studied varieties. Out of studied 16 varieties, 4 common varieties like broccoli var. Green Sprouting, Manakamana Rayo, coriander var. Kalami, and faba bean var. Kathmandu Local are very common in the local seed market but not registered/released yet. We believe that this catalog will be very useful to students, scientists, farmers, teachers, extension workers, crop inspectors, and all who are interesting in horticulture.

We complement all the contributors to this book for their painstaking efforts, especially scientists from SEAN Seed Service Centre Ltd. (SSSC) who led the characterization of 16 varieties of 10 winter season vegetables, and collaborating scientists from HVAP, Horticulture Research Division of Nepal Agriculture Research Council (NARC), Seed Quality Control Centre (SQCC) and Vegetable Development Directorate (VDD).

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SEAN Seed Service Centre Ltd.

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Introduction

Characterization is the description of plant germplasm placed by breeders or farmers by whom variety was selected or developed or cultivated for long period of time. It determines the expression of highly heritable characters ranging from morphological or agronomical features to molecular markers. New plant varieties are tested to determine if they are unique, to allow a botanical description to be compiled, and, in the case of agricultural crops, to ensure they have agronomic merit in the recommended domain.

Genetic character governs yields and market values. If there is any variation in characters it is known as deterioration of the particular variety. It affects quality, consumer test, market value, production potential as well as other agronomical performances. So, it is equally important to maintain the genetic quality to ensure varietal purity in production cycle.

A variety catalog details the particular variety of interest. Genetic, morphological and agronomical information of the variety distinguishes among the varieties within a species and enables an easy and quick discrimination among phenotypes. It facilitates a check on the trueness-to-type, uniformity, allowing detection of offtypes or duplicates among the phenotypes. This is very important to monitor the genetic stability of the particular crop variety.

Variety descriptor helps scientist to identify off-type and stay on true-to-type lot. Field crop inspection is largely rely on varietal characteristics so that crop inspector can decide morphological variation among the genotypes. A descriptive publication on varietal characteristics of major vegetables can be a useful reference material for all concerned stakeholders and scientists in the respective field.

Materials and methods

In this action research on characterization of major winter vegetables common in Nepal, plants were observed through its ontogeny. Seeds of studied crop (10 crops) varieties (16 varieties) were collected from source farms under Nepal Agriculture Research Council (NARC), Department of Agriculture (DOA) and SEAN Seed Service Centre Ltd. (SSSC). Equipment and tools like digital camera, measuring tape, scale, vernier calipers, digital balance, etc. were used during the characterization where meaningful.

Twenty plants per entry per replication were grown in a plot of 5m x 1m. Six sets of blocks with 16 such plots were prepared and varieties were randomized completely within the blocks. The first three replications were continued up to flowering to collect floral and seed data. Plants grown in the rest three replications were observed for destructive measurements. This study was conducted in Thankot (1,350 m), Kathmandu. It is also assumed that studied species are adapted to and major traits are expressed at Thankot condition.

Complementary characterization method was followed to capture the full information on varieties. It included morphological descriptors, agronomical attributes, and digital images. A set of morphological descriptors used to describe the phenotype. Generally, standard protocol developed by Horticulture Research Division (HRD) under Nepal NARC, Asian Vegetable Research and Development Centre (AVRDC)/World Vegetable Centre and International Board for Plant Genetic Resources (IBPGR) were followed to record data. For harmonization in crop descriptor and data recording methods, an orientation training program was conducted and discussed among scientists from NARC and SSSC before the characterization started. Plant, stem, leaf, root, curd, flower, pod and seed traits were scored or measured and expressed in numeric values. Obtained means were analyzed using R for Windows version 3.0.3. Calculated averages were checked with previously published records where meaningful and finally presented in the range. Descriptive traits such as flower and fruit color were, however, be expressed as a narrative term (qualitative values). Special focus was given while measuring the economic parts. Sufficient detail captured in images to taxonomically identify the plant and demonstrated the traits that show distinctness. The images stored in a database linked with the morphological data. Images were taken especially for those character(s) which were difficult to describe verbally for example images of whole plant, racemes, flowers, pods and seeds. Finally, obtained data and observations were discussed among scientists and horticulturists at Seed Quality Control Centre for verification. The main objectives were to produce data sufficient to prepare variety descriptor of studied varieties (as mentioned in annex) and to prepare varietal characteristics booklet of the same.

Characteristic features of some common winter vegetables

Cauliflower (*Brassica oleracea* var. *botrytis* L.) variety: Kathmandu Sthaniya

Seedling characteristics

Hypocotyl is purplish green in color, the seedling leaf is light green having entire leaf margin. Seedlings are glabrous and slow in juvenile development (the rate of covering the ground).



Figure 1: Seedlings of Kathmandu Sthaniya

Vegetative characteristics

Long stem (17 - 24 cm), long internode (2 - 2.7 cm), average diameter of the stem at the base of the curd is 3.8 cm (3.2 - 4.5 cm). It has short non-branching stem supporting leafy rosette, uniform plant morphotype, average plant height is 68.1 cm (varies in the range 61 - 80 cm) and diameter is 70 cm (ranges between 55 cm and 80 cm), low lodging, intermediate in number of leaves per plant with average 29 leaves (ranging from 22 - 35), average leaf length (largest leaf including petiole) is 57.4 cm (53 - 62 cm) and leaf blade width is 20.4 cm (14 - 30 cm) at its widest point of largest leaf.

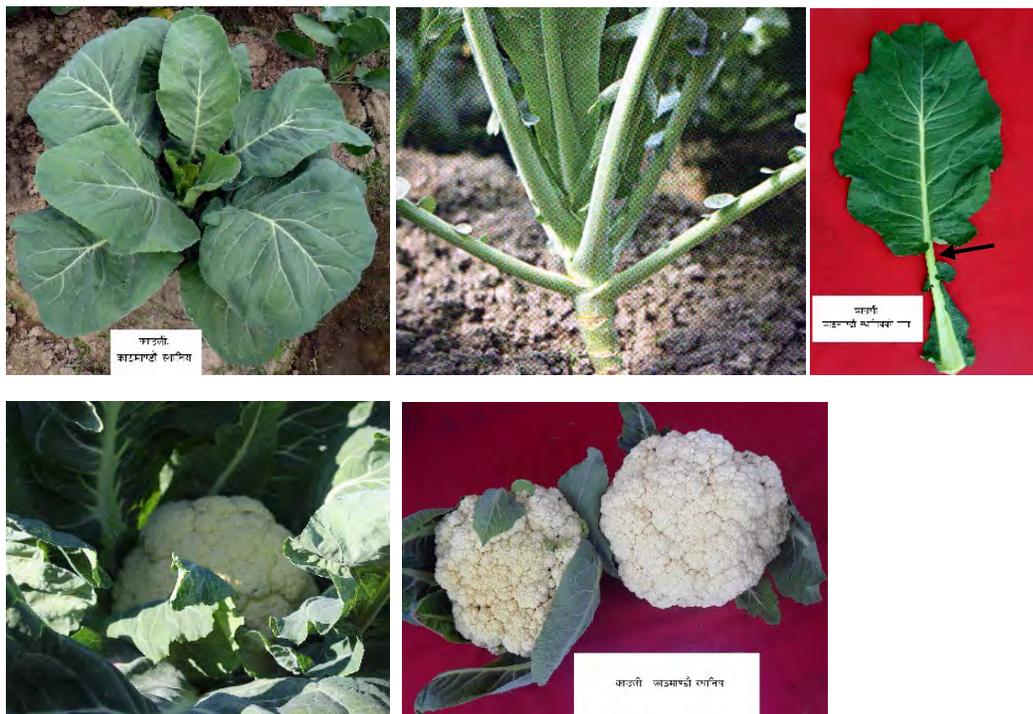


Figure 2: Plant at vegetative stages (aboveleft and middle, and below left), deeply narrow leaf lamina near to petiolar end as shown by arrow (above right) and harvested curd (below right)

Semi-prostrate leaves (~45° leaf angle), leaf shape (outline) is obovate, entire leaf margin with sinuate leaf division. Leaf lamina near to petiolar base is deeply narrow (i.e. the lower portion, one-third from petiole end, of the leaf lamina is deeply serrated). Leaf apex shape is rounded with thick leaf blade. No leaf blistering. Leaf tip attitude is straight but leaf lamina attitude is drooping. Light green leaf color, leaf pubescence absent, intermediate leaf bloom, petiole enlargement is intermediate with average length 17.55 cm (16 - 20 cm) and width 11.65 cm (10 - 13 cm), very little petioles overlap with the semi-round cross section and white petiole color. Side shoot may appear from lower nodes of the stem.

Head characteristics

It develops head before initiation of floral stalks. Obovate head shape in longitudinal section, head-forming leaf overlap at terminal region is curled halfway inward (leaf raised straight upward, covers head halfway), small leaves surround the curd, sometimes come side-halfway of the curd, intermediate in head cover from subtending leaves, primary color of outer head leaves is pale green. Side shoots develop from the lower portion of the stem. Synchrony in head formation is low.

Head length varies from 10.4 to 14.9 cm (average 12.2 cm), width varies from 12.6 to 17.5 cm (average 14.76 cm). Primary color of inside cut is white, head is semi-firm and its solidity is graded medium. Short stem length is observed in head. It takes 100 - 115 days for fresh curd harvesting. Curd color is milky white. Good cooking quality, fresh head weight varies 1 - 3 kg, mid-season variety, productivity 20 - 30 MT/ha.

Stem axes elongation and enlargement is short, the average length of vegetative stem from cotyledon to tip is 53.1 cm (ranges from 32 to 70 cm) and its average width is 3.8 cm (3.2 - 4.5 cm), leaf retention on the stem is intermediate, green stem, synchrony in sprout development is low.

Flower and seed characteristics

Floral apex is loosely branched, with small terminal heads. Flowering head size is intermediate and shape is spheric, surface color of flowering head is cream.



Figure 3: Floral bud initiation (left), pre-floral branching (middle) and flowering plant

Flowering behavior is annual, takes around 166 days (165 - 170 days) from sowing to the appearance of first flower in 50% of plants, flowering stalk is green with average length 30.33 cm (28.5 - 33 cm), and flowering stalk internodes are long. Intermediate in branching habit and stalk bloom. Petals are yellow.

The number of days from sowing to the 90% of plants ready for seed harvest is 235 - 240 days (205 - 210 days after transplanting). Average silique length is 6.47 cm (6 - 7.2 cm) and the diameter is 4.59 mm (4 - 6 mm), beak length is 1.14 cm (1 - 1.8 cm), and silique color before drying is yellowish green.



Figure 4: Green pods (left) and matured seeds

Silique attitude is erect and the surface outline is constricted between seeds, no hair presents, silique shattering is intermediate, the number of seeds per silique is 9 - 12, primary color of the seed coat is reddish brown, and the seed is round in shape. Thousand seed weight is 2.8 - 3 g at the 6.6% moisture level.

Distinct characters:

- Hypocotyl is purplish green in color
- Stem and internodes are long
- Leaf lamina near to petiolar base is narrow
- Small leaves surround the curd, sometimes come side-halfway of the curd
- Mid-season variety with milky white curd
- Can tolerate water logging condition and black rot disease

Broccoli (*Brassica oleracea* var. *italica* L.) variety: Green Sprouting

Seedling characteristics

Light purple color of hypocotyl, seedling leaf color is light green, seedling leaf margin is crenate type and seedlings are glabrous.



Figure 5: Seedlings of Green Sprouting

Vegetative characteristics

Plant growth habit is elongate, branching stems terminate in enlarged curd (pre-floral apex), and plant morphology is uniform.



Figure 6: Plant at vegetative stage, head ready to harvest (left); measuring the head diameter (middle) and initiation of floral buds shown by arrow (right)

Average plant height (measure at extremity of plant) 69.2 cm (ranges from 40 cm to 95 cm) and average width 61.7 cm (varies from 50 - 67 cm), low lodging, number of leaves (per plant) ranges from 22 to 26, average leaf length (largest leaf including petiole) 68.59 cm (65 - 73 cm) and leaf blade width (the widest point of the largest leaf) is 22.23 cm (19 - 26.6 cm). Leaf angle (angle between petiole and stem) is open type (~67°). Stem length ranges from 18 cm - 28 cm and its average diameter at the base of the curd is 4.6 cm (3.9 - 5.3 cm).

Leaf shape (outline) is spatulate. Crenate leaf margin, lyrate type of leaf division, rounded leaf apex shape, thick leaf blade, and no blistering on the leaf blade. Leaf tip and attitude of leaf lamina are drooping. Leaf color is dark green, leaf pubescence is absent, leaf bloom is intermediate, and little pigmentation is found on leaves. The average length of leaf petiole is 20.24 cm (15 - 25 cm) and width is 1.3 cm (1.09 - 1.45 cm). Petiole and or mid-vein enlargement is intermediate, very little petiole overlapping, semi-round petiole section, and petiole is light green in color.

Head characteristics

Heading habit is semi-heading (observed at harvest). Head (or curd) shape in longitudinal section is obovate, head forming leaf curled outward at the terminal region leaving the curd exposed. Primary color of outer head leaves is green. Average head length is 23.75 cm (20.8 - 26 cm) and head diameter is 15.68 cm (11.9 - 18 cm). Primary color inside cut is light green, head solidity is low, and stem length in the head is short. Shape of enlarged vegetative bud is round and intermediate in size. It is mid-season maturing variety. Side shoots develop after removing the main shoot, cumulative fresh weight (including side shoots) is about 600 - 700 g per plant, and the productivity is 16 - 18 MT/ha.

Leaves retention on floral stem (enlarged stem and bud) is low, light green stem color, axillary stem, and elongate bud growth terminating on flower buds, number of shoots or enlarged buds is few, synchrony in sprout development is intermediate. Color of vegetative shoots is green.

Flower and seed characteristics

Floral apex loosely branched with small terminal heads, flowering head size is intermediate, the flowering head shape is spheric, and the flowering head surface color is yellow.



Figure 7: Flowering plant (left), immature green pods (middle) and seeds

Annual in flowering habit, no vernalization required for flowering, number of days required from seed sowing to the appearance of first flower in 50% of plants is 145 - 150 days. The color of flowering stalk is green with average length of 23.73 cm (21.2 - 25.6 cm). Flowering stalk internode length is intermediate and is profusely branching. Petal color is yellow. Flower stalk bloom is intermediate.

Green Sprouting is mid-season in maturity for fresh production, ready at 90 - 100 days after sowing, multiple harvest is possible due to the emergence of side shoots after the main shoot is cut off. The number of days from sowing to the 90% of plants ready for seed harvest is 225 - 230 days (210 - 220 days after transplanting). A silique is 6.22 cm (5 - 7 cm) long and 3.34 mm (3.2 - 4.2 mm) wide on an average, beak length averages 0.92 cm (0.7 - 1.1 cm), silique color is green before drying, silique attitude is erect with surface outline constricted between seeds, primary color of the seed coat is reddish brown, and thousand seed weight ranges from 2.6 - 2.8 g at the 5.5% moisture level.

Distinct characters:

- Light purple color of hypocotyl
- Mid-season in maturity
- Lodging resistant
- Suitable for multiple harvest (side shoots develop after harvesting the main shoot)
- Thick leaf blade, little pigmentation found on leaves
- Head cover from subtending leaves is exposed

Broad Leaf Mustard (*Brassica juncea* var. *rogusa* L.) variety: Khumal Rato Pat

Seedling characteristics

Hypocotyl is purple in color. Leaves are also purplish green. Seedling leaf margin is dentate type and pubescence is absent on leaf surface.



Figure 8: Seedlings of Khumal Rato Pat

Vegetative characteristics

Short and non-branching stem supports leafy rosette. Plants are uniform in morphology. Average plant height is 19.9 cm (14.7 - 26 cm) with a diameter of 88.9 cm (80 - 100 cm) when measuring at the extremity of the plant. Low lodging recorded. An average of 27 leaves (varies from 21 - 34) with average leaf length 52.2 cm (46 - 60 cm) and average width of leaf blade 20.8 cm (12 - 30 cm) at the widest point of the largest leaf. Leaf angle is semi-prostrate (~45°). Leaf shape is obovate with dentate margin and sinuate type of leaf division. Leaf apex is broadly rounded.



Figure 9: Plant at vegetative stage (left), purple leaf veins (middle), and leaves showing deeply serrated lamina near to the petiolar end (right)

Leaf blade thickness averages 0.8 mm (0.6 - 1 mm), intermediate blistering, leaf tip attitude is straight but leaf lamina attitude is drooping. Leaves are dark green in color with purple veins. Leaf pubescence and leaf bloom are absent. The glossiness of leaf is high. Petiole or mid-vein are intermediately enlarged (flat) with an average span of 2.78 cm (2.6 - 3 cm) and average petiole length is 1.8 cm (1.3 - 2.2 cm). Cross section of the petiole is semi-round (cup shaped). Petiole color is white and intermediately overlapped. Petiole and main vein axis is little wavy. Leaf lamina at petiolar end is deeply serrated.

The plant physiologically matures (ready for fresh leaf harvest) within 30 - 40 days after transplanting. Average leaf weight is 50 - 60 g. A late season or long duration variety and fresh leaf production ranges from 25 to 30 MT/ha.

Flower and seed characteristics



Figure 10: Pre-floral branches (left), flowering branches (middle), green pods (right) and seeds

Floral apex is loosely branched with small terminal heads. An annual plant, no need of vernalization for flowering, 50% flowering takes place in 120 - 125 days from seed sowing. Flower stalks are green in color with an average length of 105.3 cm (97 - 118 cm). Flowering stalk internode length is intermediate and the branching habit is also intermediate. Petals are yellow in color and flower stalk bloom is intermediate. Comparatively late bolter than Khumal Chauda Pat in Thankot, Kathmandu condition.

The number of days from seed sowing to 90% of plants ready for seed harvest is 185 - 190 days (160 - 165 days after transplanting). Average silique length is 2.8 cm (2.5 - 3 cm) and the diameter is 3.64 mm (3 - 4 mm). Beak length is about 0.77 cm (0.7 - 0.9 cm). Silique is green in color before maturity, erect in attitude,

siliqua surface outline is constricted between seeds without the presence of hairs, and the siliqua is intermediate in shattering. The number of seeds per siliqua is 13 (12 - 15), primary color of the seed coat is black. Thousand seed weight is 1.5 - 1.7 g at the 5.7% moisture level.

Distinct characters:

- Hypocotyl is purple in color
- Leaf blistering is intermediate
- Leaf is dark green in color with purple veins, leaf glossiness is high
- Cross section of the petiole is cup shaped and main vein axis is little wavy
- Leaf lamina at petiolar end is highly serrated
- Late bolter than Khumal Chauda Pat

Broad Leaf Mustard (*Brassica juncea* var. *rugosa* L.) variety: Manakamana

Seedling characteristics

Hypocotyl is pale green in color, seedling leaf margin is serrated, seedling leaf color is purple green, and no pubescence on leaf surface.



Figure 11: Seedling of Manakamana

Vegetative characteristics

Plant growth habit is short and non-branching stem supports leafy rosette, uniform plant morphotype, suitable for autumn planting with 45 cm × 30 cm crop geometry, average plant height (while measuring the extremity of plant before the initiation of flowering stalk) is 64 cm (51 - 69 cm) and width is 41 cm (24 - 50 cm), low lodging, average number of leaves per plant is 37 (ranging from 17 to 40 leaves), leaf length (largest leaf including petiole) is 42 cm (35 - 45 cm) and leaf blade width (widest point of largest leaf) is 18 cm (15 - 20 cm), leaves are erect in position (angle of petiole to the main stem axis is about 35°), leaf shape is obovate with serrated margin and sinuate type of leaf division. Leaf glossiness is low (not smooth and shiny as Khumal Rato Pat and Khumal Chauda Pat). It is difficult to detach leaves during the harvest of fresh leaves.



Figure 12: Leaves showing purple leaf veins (above left), plants ready to fresh leaf harvest (above right), crop at the field (below left) and leaves showing serrated leaf margin (below right)

Leaf apex is intermediate in shape. Leaf blade is thin and low blistering on its surface. Leaf tip attitude is straight but leaf lamina attitude is convex and curving upward. Green leaves with purple veins, leaf bloom absent, and intermediate leaf pubescence and leaf pigmentation.

Petiole/mid-vein enlargement is intermediate, average length and width of petioles are 1 cm (0.5 - 2.5 cm) and 15 mm (11.3 - 17.4 mm) respectively. Petiole is semi-round in cross section, light green in color, and intermediately overlapped to each other. No tillering is characterized. This is an early maturing variety, fresh leaf becomes ready for harvesting in 25 - 30 days after transplanting and fresh leaf production ranges from 30 to 35 MT/ha.

Flower and seed characteristics

Floral apex is loosely branched with raceme inflorescence. Annual in flowering and takes 85 - 95 days from seed sowing to the appearance of first flower in 50% of plants. Flowering stalk color is yellow-green and the average length of flower stalk is 33.7 cm (20 - 45 cm). Flowering stalk internode length and branching habit are intermediate. Yellow petal color and low bloom (wax) in flower stalk.



Figure 13: Pre-floral branching (left), flowering plant (middle), green pods (right) and seeds

Crop matures (number of days from seed sowing to 90% of plants ready for seed harvest) in 175 - 180 days. The average length of silique is 3.46 cm (3 - 4 cm) and width (diameter) is 4.18 mm (3.8 - 4.8 mm). Beak length of the silique is 0.78 cm (ranging from 0.6cm to 0.9 cm). Silique color before drying is green, attitude is erect. Pod surface outline is constricted between seeds without the presence of hairs. There is no or very low pod shattering. The average number of seeds per silique is 19 (from 17 to 22).

Primary color of the seed coat is reddish brown, and thousand seed weight is 1.4 - 1.5 g at the 6% moisture level.

Distinct characters:

- Pale green hypocotyl
- Serrated leaf margin
- Low leaf glossiness
- Leaf detachment is hard
- Early in maturity, early bolter than Khumal Chauda Pat

Broad Leaf Mustard (*Brassica juncea* var. *rogusa* L.) variety: Khumal Chauda Pat

Seedling characteristics

Pale green hypocotyl color, green seedlings, crenate type of seedling leaf margin, glabrous seedlings, and no pigmentation on leaves are the major seedling characteristics.



Figure 14: Seedlings of Khumal Chauda Pat

Vegetative characteristics

Short and non-branching stem supports leafy rosette and uniform plant morphotype. Average plant height is 36.12 cm (27.8 - 47.5 cm), and diameter is 55.6 cm (49 - 63 cm) measured at the extremity of the plant. Low lodging. The average number of leaves is 30 (ranging from 25 to 35 leaves) and considered intermediate. The average length of leaf is 49.22 cm (43 - 52 cm) (the largest leaf including petiole) and width (the widest point of the largest leaf) is 24.98 cm (23 - 27 cm). Leaf glossiness is moderately high.



Figure 15: Plants at vegetative stage (left and middle) and leaf showing crenate type of leaf margin (right)

Semi-prostrate ($\sim 45^\circ$) leaf angle, leaf shape (outline) is obovate with crenate leaf margin. Leaf division is sinuate. Leaf apex shape is broadly rounded. Intermediate in leaf thickness and high in leaf blade blistering. Leaf tip attitude is drooping, leaf lamina attitude is concave drooping. Leaf is green in color, leaf pubescence and waxiness both absent and no pigmentation on leaves.

Leaf petioles are intermediately enlarged with average petiolar length of 2.62 cm (2 - 3.6 cm) and width of 25.44 mm (23.8 - 28 mm) with semi-round petiole cross-section. Petiole color is white and is intermediately overlapped. No tillering, variety is intermediate in maturity, can harvest first fresh leaf in 30 - 35 days after transplanting, able to produce 30 - 40 t fresh leaves per hectare.

Flower and seed characteristics

Floral apex is loosely branched with small terminal heads. Annual in flowering behavior (without vernalization), number of days from sowing to the emergence of first flower in 50% of plants is 110 - 115 days.



Figure 16: Pre-floral branching (left), flowering plants (middle), green pods and seeds (right)

Flowering stalk is green in color with an average length of 89.7 cm (80 - 94 cm). Flowering stalk internodes are intermediately long, branching habit is intermediate. Petals are yellow and flower stalk bloom is low. The number of days from seed sowing to 90% of plants ready for seed harvest is 180 - 200 days.

Average silique length is 3.65 cm (3.2 - 4.1 cm) and width is 3.55 mm (3.3 - 3.9 mm). Average beak length of the silique is 0.79 cm (0.5 - 1.0 cm). Silique color before drying is green, erect in attitude, surface outline is constricted between seeds, hairs absent, and intermediate in shattering. The average number of seeds per silique is 11 (10 - 15). Primary color of the seed coat is dark gray. Thousand seed weight at the 5.3% moisture level is 1.6 - 1.7 g.

Distinct characters:

- Hypocotyl color is pale green
- Leaf glossiness is moderate
- Large leaf, leaf apex shape is broadly rounded
- High in leaf blade blistering
- Medium in bolting habit (earlier than Khumal Rato Pat and later than Manakamana)

Coriander (*Coriandrum sativum* L.) variety: Kalami

Seedling characteristics

Hypocotyl is purplish green in color. Seedling leaf color is light green. The margin of the seedling leaf is serrated and the seedling is glabrous.



Figure 17: Seedlings of Kalami

Vegetative characteristics

Plant growth habit is short and non-branching stem supports leafy rosette. Plant morphotype is uniform. No tillering occurs. Kalami is intermediate in maturity. Average plant height (measurement of the extremity of plant) is 25.5 cm (24 - 33 cm) and plant diameter (measurement of the extremity of plant) is 13.7 cm (12 - 16 cm).

Lodging is intermediate. Leaf length (largest leaf including petiole) is 22.55 cm (18 - 28 cm) and leaf blade width (widest point of largest leaf) is 4.2 cm (3 - 6 cm).



Figure 18: Plants at vegetative stage

Leaves are erect in position with leaf angle about 30° to the main stem axis. Leaf shape (outline) is more or less elliptic. Leaf margin is serrated with lacerate type of leaf division. Shape of leaf apex is rounded. Leaf blades are intermediately thick without blistering.

Leaf lamina and leaf tip both show drooping attitude. Leaves are dark green in color with purplish veins and petioles. Leaf pubescence and leaf bloom both are absent. Leaves are slightly pigmented. The number of leaves per plant ranges from 9 to 18 during the second harvesting time. The average number of leaves before bolting is 19 (ranges from 16 to 24). Petiole/mid-vein enlargement is narrow. Petioles are 7.7 cm (5 - 15 cm) long and 2.6 mm (2 - 3 mm) wide with semi-round shape of cross section. The petiole is purple in color and intermediately overlapped. It takes about 40 days for fresh leaf harvest after seed sowing and average fresh leaf production is 10 MT/ha.



Figure 19: Pre-floral branching showing purplish green floral stalk (left), flowering branches showing green floral stalk with slightly pigmented nodes (middle), and seeds showing mericarps at outer ring (right)

Flower and seed characteristics

Flowering behavior is annual and takes normally 130-135 days from seed sowing to the emergence of first flower in 50% of plants. Flowering stalk color before flowering is purplish green, pigmentation on floral stalk decreases gradually as flowering advances but nodes remain pigmented. The average length of the floral stalk is 59.6 cm (41 - 76 cm).

The average number of umbels in flowering stalk is 6 (4 - 7) and the average number of flowers in an umbel is 8 (4 - 11). Petal color is pinkish white and flower stalk bloom absent. The number of days from seed sowing to 90% of plants ready for harvest is 160 - 165 days.

Fruit /seed shape is elliptic, seed surface is medium smooth with yellowish green ground color before drying. The fruit consists of two mericarps (half single seed) i.e. a fruit with two seeds split during maturity. Primary color of the seed coat is yellowish brown. The average diameter of seeds is 3.1 mm (3 - 3.4 mm), and length is 4.2 mm (4 - 4.5 mm). Thousand seed weight is 8 - 8.3 g at the 6% moisture level.

Distinct characters:

- Hypocotyl is purplish green in color
- Strong aroma of leaf and fruit
- Dark green leaf with purplish veins and pigmented petioles
- Floral stalk color before flowering is purplish green then the pigmentation gradually reduces and changes to light green
- Petal color is pinkish white

Coriander (*Coriandrum sativum* L.) variety: American Long Standing

Seedling characteristics

Hypocotyl is pale green in color. Seedling leaf is purple-green in color with serrate leaf margin and glabrous.



Figure 20: Seedlings

Vegetative characteristics

Plant growth habit is short and non-branching stem supports leafy rosette. Plant morphotype is uniform. No tillering occurs. Plants are intermediate in maturity, ready for fresh harvest in 45 - 50 days after sowing and average fresh leaf production is 12 MT/ha.

Average plant height (measuring the extremity of plant) at vegetative stage is 39.4 cm and flowering stage is 121 cm (110 - 130 cm). Plant diameter (measuring extremity of plant) is 18.5 cm (16 - 21 cm). Plant lodging is intermediate. Leaf length (largest leaf including petiole) is 52.55 cm (48 - 57 cm) and the width of leaf blade (widest point of largest leaf) is 8.5 cm (7 - 12 cm). Leaves are semi-erect in position with average leaf angle 40°.



Figure 21: Leaf (left) and plant at vegetative stage

Leaf shape (outline) is obovate. Leaf margin is serrated with lacerate type of leaf division. The shape of leaf apex is rounded. Leaf blades are intermediately thick without blistering. Leaf lamina and leaf tip both show drooping attitude. Leaves are dark green in color and both leaf pubescence and leaf bloom are absent. The number of leaves per plant ranges from 14 - 21 at second harvesting stage and 27 - 32 before bolting. Petiole/mid-vein enlargement is narrow. Petioles are 14.1 cm (11 - 17 cm) long and 3.1 mm (2.5 - 3.5 mm) wide with semi-round shape of cross section. The petiole is dull purplish green in color and intermediately overlapped.

Flower and seed characteristics

Flowering behavior is annual and takes normally 160 - 165 days from seed sowing to the emergence of first flower in 50% of plants. Due to this characteristic, it is also known as 'Slow Bolting'. Flowering stalk color before blooming is slightly pigmented in internodes. This intermodal pigmentation decreases as flowering occurs and branches become green. However, nodes remain slightly pigmented during flowering too. The average length of the floral stalk is 68.6 cm (65 - 70 cm). The average number of umbels in flowering stalk is 7 (6 - 8) and the average number of flowers in an umbel is 8 (7 - 9). Petal color is pinkish white and flower stalk bloom absent. The number of days from seed sowing to 90% of plants ready for seed harvest is 185 - 190 days. Fruit /seed shape is globular and seed surface is medium smooth.



Figure 22: Flowering plant (left), umbel of flowers and fruits (middle) and seeds (right)

The number of mericarps is two and fruit color before drying is yellowish green. Primary color of the seed coat is brown. The average diameter of seeds is 3.46 mm (3.3 - 3.6 mm), and length is 3.39 mm (3.6 - 4.1 mm). Thousand seed weight is 10 - 11 g at the 6% moisture level.

Distinct characters:

- Hypocotyl color is pale green
- Weaker aroma of leaf and fruit than variety 'Kalami'
- Produces ample leaves in vegetative phase
- Leaves are dark green in color with dull purplish green petiole
- Petal color is pinkish white
- Late bolter than the variety 'Kalami'

Onion (*Allium cepa* L.) variety: Red Creole

Seedling characteristics

Hypocotyl color is pale green, seedling leaf color is light green, and 'knee-bend' is common in seedlings during sprouting.



Figure 23: Seedlings of Red Creole showing 'Knee-bends' at early stage of germination (left) and growing at nursery (right)

Vegetative characteristics

Dark green foliage color, weak in cracking, intermediate plant vigor, medium leaf thickness, leaf length 35 - 50 cm, medium width, 25 - 30 leaves per pseudostem, and intermediate foliage attitude. Leaf angle (angle of petiole with horizontal axis) is open (~67 °C), leaf apex is acute in shape and straight in attitude. The attitude of leaf lamina is straight. Petiole overlapping is very little.



Figure 24: Plants at vegetative stage (above left), plants showing the foliage attitude (above right), plant showing pseudostem (below left), and harvested bulbs at market outlet (below right)

Leaf bending is little, degree of leaf waxiness is medium, plant height (when ready for fresh harvest) ranges from 65 to 70 cm, pseudostem diameter at the vegetative stage is intermediate (1.5 - 2.5cm) and its length

(from soil surface to the highest green leaf base) is intermediate. On an average, the pseudostem is 6 - 7 cm long. Light anthocyanin pigmentation is present at the base of pseudostem (near to the bulb) during the vegetative stage while in the upper part there is no such pigmentation and green stripes are present in the white background (as shown in Fig. 24). Low lodging during the vegetative stage of the growth period.

Bulb characteristics

Pseudostem thickness is intermediate, narrow and tight when dry. Color at the base of the pseudostem when dry is red. Anthocyanin pigmentation (as a stripe) present on dry external scales of the bulb (at harvesting time), cracking of bulb skins is rare. Bulb pungency and odor is strong. Bulbs are medium, moderately tight in texture, and outer scale (dried) is moderately tight. The bulbs are dark red in color at maturity.



Figure 25: Harvested bulbs stored in the kitchen

The shape of bulb top is slightly raised and flat globular in shape. Average bulb weight is 100 - 120 g and fresh production is 10 - 15MT/ha. It is a late maturing variety. Days to maturity (bulb harvest) ranges from 150 to 160 days after seedling transplantation. For seed harvest, the crop matures at 250 - 290 days after bulb transplanting. Plant morphotype is uniform. The shape of mature dry bulb is flat globe. The shape of bulb in longitudinal section is transverse broad elliptic and circular in cross-section. Bulb base is round. The position of root disc is flat. The average diameter of onion bulb is 6.1 cm (4.4 - 7.6 cm).

Flower and seed characteristics

Onion is an annual plant. Bolting is occasional when the crop ready for fresh bulb harvest (up to 41% plants may bolt before harvesting time). Height of floral stalk (scape) ranges from 120 to 180 cm. Flower stalk diameter varies from 1.8 to 2.2 cm.



Figure 26: Bolted plants in the field (left), buds at early stage (middle) and buds before anthesis (right)



Figure 27: Flowering umbel, arrows show dull green stripe in the mid of the petal (left), scape showing swollen part near to the base (middle), and seeds (right)

The curvature of flowering stem is minor. Swelling of the scape near to the basal part (one fourth of scape from the bulb neck) occurs and gradually tapers towards the floral end. Floral bud at early vegetative stage is yellowish green. The sepals at the top of the bud are pointed. At the later stage of bud maturity (before flowering) anthocyanin pigmentation (in narrow to wide pigmented stripes) develops on the white background of sepals. Flowering stalk color is green and petals are white in color with dull green stripes in the middle. Very low bloom presents on the flower stalk.

Seed shattering is low at normal harvesting time. Primary seed coat color is black. Thousand seed weight at the 6.7% moisture level is 2.9 - 3.2 g. Number of seeds per umbel ranges from 700 to 800 and the average weight of seed is about 2.4 g.

Distinct characters:

- 'Knee-bend' common in seedlings during sprouting
- Anthocyanin pigment presents only at the base of the pseudostem
- When outer scale of bulb dries, neck becomes narrow, tight and red in color
- Swelling of the scape near to the basal part (one fourth of scape from the bulb neck)
- Petals are white with dull green stripes in the middle
- Anthocyanin pigmentation present on external dried scales of bulb

Field Pea (*Pisum sativum* L.) variety: Sikkime

Vegetative characteristics

The hypocotyl is light green in color and leaves are dark green with little bloom.



Figure 28: Seedling of Sikkime (left) and close view of foliar (right)

Vegetative characteristics

From the view point of growth habit, Sikkime is an indeterminate climber vine. Branching occurs both from the basal and upper node. The average number of branches from the basal node is 3 and from upper nodes is 2 (excluding small floral branches develop in the upper foliage).



Figure 29: Plants at field (left) and compound leaf showing 3 pairs of leaflets (right)

Leaflet shape is elliptic, leaf color and the intensity of color of the whole plant is light green, and leaf surface is abundantly waxed. Number of leaves per plant varies from 215 to 832. Leaf-tendrils (near to the first flowering node) generally develop 3-pair of sub-branches and the tendrils are dull green in color.



Figure 30: Leaf tendrils

Plants are tall, average height of the plant is 204.9 cm (160 - 235 cm), internode length (above and below the first flower node) is intermediate (ranges from 16 to 20 cm). Leaflets normally appear in pairs. The number of pairs of leaflets of the leaf of first flowering node is 2 - 3 with large stipules. Stipules are elliptical in shape. The shape of stipules' apex is acute. The average thickness of the stem (above and below first flower node) is 6.87 mm (5.2 - 7.9 mm). The stem has light anthocyanin pigmentation.

Sikkime is a late maturing variety and takes 100 - 110 days for fresh pod harvesting. The fresh pod yield is 10 - 12 MT/ha.

Flower and seed characteristics

Flower color is white and 1 - 2 flowers appear per inflorescence. In Thankot condition, 70% plants possess two flowers per inflorescence during the year 2014/15. Flowering days varies from 85 to 90 days after seed sowing.



Figure 31: Flowers (left) and acute apex of leaf stipule shown by an arrow (right)

There are one to two pods per inflorescence, average pod length is 7.99 cm (6 - 8.4 cm) and thickness is 13.3 mm (12.8 - 13.9 mm), anthocyanin pigmentation is absent in pods, however, these pods look waxy. The tumor on the pod surface is absent. Pod apex is medium and shape is slightly curved. Pod surface is slightly wavy. Pod color is light green. The average number of seeds per pod is 6 (5 - 7). Hundred fresh seed weight is 60 g.



Figure 32: Green pods (from left to right), immature seeds, mature pods and seeds showing black eyes

Plant becomes ready for seed harvest in 150 - 160 days of seed sowing. Length and width of mature seed is 8.82 mm (8.2 - 10 mm) and 8.1 mm (7.9 - 8.4 mm) respectively with an average diameter of 7.5mm (7 - 9.2 mm). Smooth and shiny seed surface with round shape. The seed is bold and ground color of the seed is yellowish-white (ghee color). There are no speckles on the seed coat. Seed hilum color is black (black ring around the eye). Thousand seed weight at the 11.2% moisture level is 250 - 260 g.

Distinct characters:

- Branches develop from basal and upper nodes
- Leaf tendrils develop 5 - 7 sub-branches and acute stipule apex
- Seed color is yellowish white (ghee color)
- Bold and shiny seed, seed hilum color is black ('gajale' in Nepali)

Faba bean (*Vicia faba* L.) variety: Kathmandu Local

Seedling characteristics

Hypocotyl color is purplish green with light green leaves.



Figure 33: Seedling of Faba bean Kathmandu Local

Vegetative characteristics

Determinate growth habit with lower node branching. The number of tillers per plant ranges from 4 to 7. The shape of leaflet is ovate, the leaf is light green in color, no waxy layer in the leaf surface, and the color intensity of plant is dull green. The average number of leaves per plant is 102 (71 - 130). Anthocyanin pigmentation on leaf, petiole, and stem is medium. The average number of leaflets per leaf is 5 (5 - 6). This variety is medium in maturity and the first harvesting of fresh pods can be started in 120 - 150 days of seed sowing. The yield of fresh pods is 12 - 16MT/ha.



Figure 34: Flowering plants on the field (left), pod position on the stem (middle) and freshly harvested green pods (right)

Flower and seed characteristics

Flowers are white. Floral wings are purplish white and are striped with black pigment. The number of days from seed sowing to first flowering is 70 - 75. The variety takes about 180 - 210 days for seed harvesting. The number of pods per inflorescence is one to two. Among them, 40% inflorescence possesses 2 pods and the remaining 60% bears a single pod. The average number of pods per plant is 23 (ranging from 12 to 32).



Figure 35: Purplish white floral wings (left), flower standards striped with black pigment (middle) and seeds showing wavy surface (right)

The average length and width of pods are 9.81 cm (7.5 - 10.5 cm) and 1.64 cm (1.5 - 1.8 cm) respectively. The average thickness of pod is 1.18 cm (1 - 1.3 cm). Pod apex is pointed and shape is slightly curved (similar to Sikkime pea). Pod surface is wavy. Pods are light green in color. The average number of seeds per pod is 5 (4 - 6). The average weight of 100 fresh pods is 722 g (646 - 805 g). Pods are glabrous. The average length of mature seed is 15.85 mm (15 - 17 mm), width is 11.47 mm (10.9 - 12.9 mm), and thickness/diameter is 6.1 mm (5.2 - 6.8 mm). Seed surface is wavy and seed shape is elliptic. The ground color of seeds is yellowish green. Hilum color is black and color dots are absent. Thousand seed weight is 570 - 640 g at the 12.3% moisture level.

Distinct characters:

- Hypocotyl is purplish green
- Determinate, tillering from lower node
- Floral wings purplish white and standards are striped with black pigmentation
- Outer surface of pod is wavy and smooth

Radish (*Raphanus sativus* L.) variety: Chalis Dine**Seedling characteristics**

Hypocotyl color is pale purple, leaves are light green with entire leaf margin, and seedlings are glabrous.



Figure 36: Seedlings of Chalis Dine

Vegetative characteristics

Plant growth habit is short and non-branching stem supports leafy rosette. The plant morphotype is uniform and no tillering occurs. Average plant height (while measuring the extremity of plants) is 30 cm (28 - 33 cm) at the vegetative stage with an average diameter (measuring the extremity of plants) of 40 cm (37 - 43 cm), and resistant to lodging.

The number of leaves is intermediate, leaf length (largest leaf including petiole) is 40.7 cm (ranges from 36 cm to 47 cm), and leaf blade width (at the widest point of largest leaf) is 15.4 cm (14 - 18 cm). The type of leaf angle is open (~67°). Leaf shape (outline) is spatulate, leaf margin is entire with the sinuate type of leaf division. The shape of leaf apex is broadly rounded and the leaf blade is thick with low blistering. The attitude of leaf tip is straight, but the attitude of leaf lamina is drooping. Leaves are light green in color. Leaf pubescence and leaf bloom are absent. The average number of leaves at the vegetative stage is 18 (16 - 19). Petiole and /or mid-vein enlargements are narrow. The average length and width of petioles are 5 cm (4 - 7 cm) and 9 mm (8.8 - 10.2 mm) respectively. The shape of petiole cross section is round, petiole color is light green, and very little overlapping.



Figure 37: Chalis Dine ready for fresh root harvest on the field (left) and its matured leaf (right)

Enlarged root characteristics

Primary root is modified to store food. Root shape is elliptic, shoulder shape (head) is convex (tapering slightly towards the basal part of the stem), and root shape is obtuse at the base, root is curved at the tapering end. The texture of root skin surface is smooth, exterior and interior color of the root is white, the color pattern is uniform, and the texture of flesh is crispy. Root length (measurement of storage portion) ranges from 15 to 20 cm and the diameter at the widest point is 32 - 54 mm. Fresh root weight is 160 - 170 g, fresh root production is 25 - 30MT/ha, and root pungency is mild. The position of 'bulb' in soil is half buried and lateral roots emerge on 'bulb' from the lower portion. Lateral root-groove tissue 'scars' is absent. This is an early maturing and early season variety. Fresh roots become ready to harvest in 35 - 40 days after seed sowing.



Figure 38: Roots of Chalis Dine showing curved portion at the tapering end

Flower and seed characteristics

Floral apex is loosely branched with small terminal heads. Leaf retention on floral stalk is intermediate. Flowering behavior is annual. The number of days from seed sowing to the emergence of first flower on 50% of plants is 80 – 85. Flowering stalk is light green in color and average length of floral stalk is 65 cm (58 - 71 cm) with low bloom and short internode. Petals are white.



Figure 39: Pre-floral (left) and floral branches (right)

The number of days from seed sowing to 90% of plants ready for seed harvest is 185 - 190 days (150 - 160 days after root transplanting). The average length and width of silique is 3.79 cm (3 - 4.1 cm) and 9.9 mm (9.8 - 10.1 mm) respectively. Silique color before drying is purplish green. The beak length of silique is 1.6 cm (0.9 - 2.1 cm). Siliques are erect in position and shattering resistant. Silique outline is constricted between seeds, primary seed coat color is reddish brown, seeds per silique are 5 - 8, and thousand seed weight is in the range of 12.1 to 13.6 g at the 6.1% moisture level.



Figure 40: From left: developing pods, detached green pods, matured pods and seeds

Distinct characters:

- Hypocotyl color is pale purple
- Spatulate leaf shape (outline), entire leaf margin, sinuate type of leaf division
- Root shape is elliptic, shoulder shape is convex, root shape at the base is obtuse
- Root curved at the tapering end
- Petals are white
- Seed color is reddish brown

Radish (*Raphanus sativus* L.) variety: Pyuthane Rato

Seedling characteristics

Hypocotyl color is red, seedling leaf color is green with reddish green petiole, the margin of the seedling leaf is crenate, and seedling pubescence is sparse.



Figure 41: Seedlings of Pyuthane Rato, uprooted (left), and on the field (right)

Vegetative characteristics

Plant growth habit is short and non-branching stem supports leafy rosette, uniform plant morphotype, and very low root lodging.



Figure 42: Growing plants on the field (left) and mature root ready for fresh harvest (right)

The plant height (measurement of the extremity of plants) is 20 - 40 cm and the plant diameter (measurement of the extremity of plants) is 37 - 58 cm. Leaf length (largest leaf including petiole) is 35 - 40 cm and leaf blade width at the widest point of the largest leaf is 12 - 15 cm. Leaf angle is open (~67 °C) type. Spatulate leaf shape with crenate leaf margin and sinuate leaf division. The shape of leaf apex is rounded, leaf blade thickness is intermediate with no blistering on the leaf surface. The attitude of leaf tip is drooping, but the attitude of leaf lamina is straight. Leaf color is dark green with reddish leaf veins. Leaf pubescence is sparse and leaf bloom is absent. Leaf pigmentation is intermediate (with red leaf vein). The average number of leaves per plant is 16 (14 - 17). Petiole and/or mid-vein enlargements are narrow. The length of petiole is 9 - 13 cm and width is 6.1 - 11.4 mm. The cross section of petiole is round, petiole color is red, and very little overlapping. No tillering occurs.

Enlarged root characteristics

Overall root is horn shaped with convex shoulder and the root shape at the base is acute. The texture of root skin surface is smooth. Exterior color of the root is mixed i.e. the upper portion (above the soil surface) is red (dominating), but the lower portion is reddish white. The exterior color of the root is bicolor, but interior root color is white. This variety is mild in root pungency. The position of 'bulb' in the soil is half buried and lateral roots emerge from the lower portion of the bulb. Root-groove tissue scars are narrow. The texture of root flesh is crispy.



Figure 43: Uprooted roots showing root hairs and lateral grooves

Average root length (measurement of storage portion) is 38.8 cm (22 - 47 cm) and the average diameter at the widest point is 49.6 mm (48.08 - 52.4 mm). This is a late maturing variety and fresh roots become ready to harvest in 65 - 75 days after seed sowing. Average fresh root weight is 519.9 g (402 - 689 g). Fresh root production is 40 - 45MT/ha.

Flower and seed characteristics

Floral apex is loosely branched with small terminal heads. Flowering behaviour is annual. Number of days from seed sowing to the emergence of first flower on 50% of plants is 110 - 115. Flowering stalk is reddish green with intermediate bloom and the average length of flowering stalk is 60.8 cm (48 - 78 cm). Internode length is intermediate i.e. 6 - 7 cm long. Petals are pinkish white.



Figure 44: Pre-floral branch (left), flowering branch, growing green pods & detached green pods (middle) and seeds (right)

The variety takes about 205 - 210 days after seed sowing and 170 - 190 days after root transplanting to become 90% of plants ready for seed harvest. Siliques have reddish stripes in the light green background (turns brown when ripening). The average length of silique is 3.47 cm (3.1 - 3.9 cm) and width is 8.4 mm (7.3 - 9.9 mm). Average beak length is 1.4 cm (1.2 - 1.6 cm). The attitude of silique is erect and surface outline is undulating. The silique is shattering resistant. Primary color of the seed coat is light brown. Seeds are small

and flat in comparison to Chalis Dine and Mino Early and the average number of seeds per silique is 8 (5 - 9). Thousand seed weight is in the range from 11.3 to 13.1 g at the 6.4% moisture level.

Distinct characters:

- Hypocotyl is red in color
- Leaf shape (outline) is spatulate, crenate leaf margin with sinuate type of leaf division
- Leaf color is dark green with reddish veins
- Root shape is horn, shoulder shape is convex, root shape at the base is acute
- Exterior root color above soil surface is red and reddish white in underground portion
- Petals are pinkish white
- Light brown seed color

Radish (*Raphanus sativus* L.) variety: Mino Early

Seedling Characteristics

Hypocotyl color is pale green with normal green seedling leaf color. The margin of the seedling leaf is crenate with sparse pubescence on the leaf surface.



Figure 45: Seedlings of Mino Early, uprooted (left) and on the field (right)

Vegetative Characteristics

Plant growth habit is short and nonbranching stem supports leafy rosette. Plant morphotype is uniform. Average plant height (measurement of the extremity of plants) is 48.1 cm (ranges from 30 to 55 cm) and average diameter is 46 cm (25 - 53 cm). The variety is lodging resistant. Average leaf length (largest leaf including petiole) is 45.55 cm (39 - 50 cm) and average width of leaf blade (widest point of largest leaf) is 9.76 cm (9 - 10.4 cm). Leaf angle is open type (~67°). Leaf shape is spatulate and leaf margin is crenate with lyrate type of leaf division. The shape of leaf apex is round and blistering on the leaf blade is low. The attitude of leaf tip is straight, but the attitude of leaf lamina is drooping. Leaf color at the vegetative stage is dark green, leaf pubescence is sparse and leaf bloom is absent. Little leaf pigmentation can be seen. The number of leaf count, when the root is ready for fresh harvest, is 30 - 35. Petiole and /or mid-vein enlargements are intermediate. Average petiole length is 7.32 cm (5 - 9.2 cm) and the average width is 10 mm (9.9 - 10 mm). The petiole is light green in color and its section is semi-round. Petioles are intermediately overlapped. No tillering occurs.



Figure 46: Plants at vegetative stage



Figure 47: Leaf lamina (left) and petiole (right)

Enlarged root characteristics

Root shape is cylindrical, shoulder shape of root is plane, and the shape at the base is acute. The texture of root skin is smooth. Both the exterior and interior color of root is white and color pattern is uniform, crispy flesh. Root pungency is mild and sweet in taste. The position of 'bulb' in the soil is mostly buried (two - third of the root remains under the soil). Lateral roots emerge from lower portion of the modified root and lateral root- groove tissue scars are narrow.



Figure 48: Enlarged root at vegetative stage (left) and at flowering stage (right)

The length of the root (measurement of storage portion) ranges from 35 cm to 40 cm and the diameter at the widest point ranges from 8 cm to 10 cm. Fresh root is medium tight in solidity and its weight ranges from 550 g to 693 g. This is a mid-season (medium late) variety and its roots become ready to harvest in 55 - 60 days after seed sowing. Fresh root yield is 55 - 60MT/ha.

Flower and seed characteristics

Floral apex is loosely branched with small terminal heads. Presence of leaves on the floral stalk is intermediate. Flowering behaviour is annual.



Figure 49: Pre-floral branch (above left), flowering plant (above middle), flower (above right), detached green pods (below left) and seeds (below right)

The number of days from seed sowing to the emergence of first flower on 50% plants is 135 - 140 days. The number of days from seed sowing to 90% of plants ready for seed harvest is 210 - 215 days (180 - 200 days after transplanting). The color of flowering stalk is green and the stalk has short internodes. The average length of flowering stalk is 82.1 cm (60 - 101 cm). Floral stalk branches profusely. Petals are white. Silique is green in color before drying, average length is 4.9 cm (4.5 - 5.5 cm), and average width is 9.6 mm (9.3 - 9.9 mm). The attitude of silique is erect and possesses undulating surface. The length of beak is 1.65 cm (1.5 - 1.8 cm). Silique shattering is intermediate. The average number of seeds per silique is 8 (ranges from 7 - 10). Primary color of the seed coat is reddish brown. Seeds are bold and the weight of thousand seeds ranges from 24.4 g to 24.9 g at the 7.7% moisture level.

Distinct characters:

- Hypocotyl is pale green, spatulate leaf shape, crenate leaf margin with lyrate type of leaf division
- Root shape is cylindrical, shoulder shape is plane, acute at the base
- Petals are white
- Late bolter than Chalis Dine and Pyuthane Rato (80 - 100 days)

Swiss Chard (*Beta vulgaris* var. *cicla* L.) variety: Susag

Seedling characteristics

Hypocotyl is pink in color, but the seedlings are light green with undulate leaf margin. Seedlings are glabrous.



Figure 50: Seedlings of Susag

Vegetative characteristics

Plant growth habit during the vegetative stage is short and non-branching stem supports leafy rosette. Plant population is uniform, average height of the plant is 73.5 cm (67 - 81 cm), and average diameter of the plant (while measuring the extremity of plants) is 66 cm (65 - 90 cm). Lodging is low. The average number of leaves during the vegetative stage is 87 (ranging from 58 to 115), average fresh leaf production is 30 - 35MT/ha, leaves are very long (60 - 75 cm including petiole), and the width of leaf blade at its widest point is in the range of 24 to 39 cm. Leaves are erect in position with leaf angle $\sim 30^\circ$. Leaf shape is spatulate with sinuate type leaf division.



Figure 51: Plants on the field ready for fresh leaf harvest (left), harvested leaves (middle), flat leaf petiole (right)

Leaf margin is undulating, leaf apex is broadly rounded, and leaf blade is thick with high blistering on the leaf surface. Leaf blade is smooth and easily breakable when folding. The attitude of both the leaf tip and leaf lamina is drooping. Leaf color is dark green. Leaf pubescence and leaf bloom are absent. Petiole and mid-vein are enlarged. The average length and width of petiole are 39.1 cm (36 - 43 cm) and 5.32 cm (5 - 6 cm) respectively. The shape of petiole cross section is semi-round. Petiole color is white. Petioles are intermediately overlapped. The attitude of leaf lamina is concave and drooping. The plants of this variety also produce tillers at the late vegetative stage. Stem cross-section is star shaped.

Flower and seed characteristics

Floral apex is loosely branched with small terminal heads. The size of flowering head is small. Flowering behaviour is biennial and flowering takes place without vernalization. The number of days from seed sowing to flowering is 220 - 225 days, but it takes 260 - 265 days for 90% of plants to become ready for seed crop

harvest and just 47 days (40 - 50 days) on an average for fresh leaf harvest. The color of flowering stalk is yellowish green and the length of flowering stalk varies from 108 to 116 cm.



Figure 52: Flowering stalk (left), star-shaped stem cross section (left middle), branches bearing fruits (right middle), and seeds (right)

During reproductive stage, 2 - 3 branches are appeared at lower, middle and upper nodes of the flowering stalk. Among them, smaller branches are observed at upper nodes and most of them contain floral apex. Top most inflorescence matures first and subsidiary inflorescences mature subsequently. Flowering stalk branches profusely and the internodes of flowering stalk are short (3 - 6 cm). Petal color is yellow. Flowering stalk bloom is glossy. Primary color of the seed coat is light brown. The average diameter of seeds is 4.4 mm (4 - 5 mm). Pod (seed) shattering is low. Thousand seed weight is 18 - 20 g at the 7% moisture level.

Distinct characters:

- Hypocotyl color is pink
- Erect leaves, spatulate leaf shape, undulate leaf margin and sinuate leaf division
- Leaf blade smooth and easily breakable when folding
- White and broad petiole
- Flowering habit, stem cross section is star shaped
- Tillering occurs

Turnip (*Brassica rapa* var. *rapifera* L.) variety: Kathmandu Rato

Seedling characteristics

Hypocotyl color is pink. Seedling leaf color is normal green with crenate type of leaf margin. Pubescence on seedling leaves is sparse.



Figure 53: Seedlings of Kathmandu Rato

Vegetative characteristics

Plant growth habit is extremely short and branching stem forms leaf crown. Plant morphotype is uniform. Average plant height (measurement of the extremity of plants) is 30.71 cm (27.3 - 31 cm) and average plant diameter is 22.9 cm (19 - 26 cm). Lodging is low. Average leaf length (largest leaf including petiole) is 30.6 cm (27 - 35 cm) and the average width of leaf blade (at the widest point of largest leaf) is 8.93 cm (7 - 10.1 cm). The type of leaf angle is open (~67°).



Figure 54: Leaves (left), uprooted roots (middle), and plants on the field (right)

Leaf shape is spatulate and leaf margin is crenate with sinuate type of leaf division. The shape of leaf apex is round, thickness of leaf blade is intermediate, and low blistering on the leaf surface. The attitude of leaf tip and leaf lamina is drooping. Leaves are dark green in color with sparse pubescence. Leaf bloom is absent. The average number of leaves per plant is 16 (10 - 18). Petiole enlargement is narrow. The average length and width of petiole is 9.49 cm (7 - 11 cm) and 5.46 mm (4.5 - 6.5 mm) respectively. Petiole cross-section is round. Petiole is light green in color and intermediately overlapped. No tillering occurs. This is an early maturing variety and fresh roots become ready for harvest in 50 - 60 days of seed sowing.

Enlarged root characteristics

Root shape is transverse elliptic. Shoulder shape of the root is concave, but the shape at the base is plane. The texture of root skin surface is smooth and the surface is dark pinkish red in color. Color pattern on the root skin surface is uniform. The interior color of the root is white and flesh texture is crispy. Root pungency is

mild. Position of bulbs in the soil is largely above (more than three-fourth). Lateral roots emerge from the lower portion of the bulb and contain narrow scars.



Figure 55: Showing characters of modified root

The average length of roots (storage portion) is 16.9 cm (13 - 23 cm) and width (diameter at the widest point) is 7.5 cm (7.2 - 10 cm). The average fresh root weight is 200 g (190 - 225 g) and the yield is more than 25 MT/ha. This is an early variety and ready for fresh harvest from 50 - 60 days after seed sowing.

Flower and seed characteristics

Floral apex is an enlarged stem with terminal raceme. Presence of leaves on the floral stalk is intermediate. Flowering behaviour is annual.



Figure 56: Flowering plant, matured and dried pods, and seeds

The variety flowers generally on 80 - 85 days (from seed sowing to the emergence of first flower on 50% of plants). The color of flowering stalk is light green. The average length flowering stalk is 74.24 cm (65 - 83.4 cm). The length of internodes on flowering stalk is short (4 - 6 cm) and intermediately branched. Flowering stalk bloom is intermediate. Petals are yellow.

Number of days from seed sowing to 90% of plants ready for seed harvest is 160 - 165 days. The average length and width of silique is 3.89 cm (3.6 - 4.2 cm) and 6.28 mm (5.9 - 6.8 mm) respectively. Average beak length is 0.86 cm (0.7 - 1 cm). Silique color before drying is green and erect in position. The outline of the silique is undulating without hairs on its surface. The average number of seeds per silique is 18 (13 - 24 seeds). Silique shattering is very low. Primary color of the seed coat is mixed type. Thousand seed weight is in the range of 1.5 - 1.7 g at the 5.6% moisture level.

Distinct characters:

- Hypocotyl color is pink
- Spatulate leaf shape (outline), crenate leaf margin, and sinuate leaf division
- Root shape is transverse elliptic, concave shape of shoulder and plane at base
- Root exterior color is dark pinkish red
- Silique shattering is low
- Primary seed coat color is mixed type

Turnip (*Brassica rapa* var. *rapifera* L.) variety: Purple Top

Seedling characteristics

Hypocotyl color is purple. Seedling leaf color is dark green with crenate type of leaf margin. Seedlings are glabrous.



Figure 57: Seedlings of Purple Top

Vegetative characteristics

Plant growth habit is short and non-branching stem supports leafy rosette. Plant morphotype is uniform. Average plant height (measurement of the extremity of plants) is 47.29 cm (40.9 - 60 cm) and the average diameter is 44.2 cm (33 - 48 cm). Lodging is low. Average leaf length (largest leaf including petiole) is 45.51 cm (41 - 57 cm) and average width of leaf blade at the widest point of the largest leaf is 14.15 cm (12 - 17 cm). Leaf angle (angle of petiole with stem) is semi-prostrate (~45°). Leaf shape is spatulate with dentate margin and lyrate type of leaf division. The thickness of leaf blade and blistering is intermediate. The attitude of leaf tip and leaf lamina is drooping. Leaves are dark green in color. Leaf bloom is absent. Leaf pigmentation is intermediate.



Figure 58: Plants growing on the field

The average number of leaves per plant is 25 (21 - 30). Petiole or mid-vein enlargement is narrow. The average length and width of petiole are 12.28 cm (6 - 19 cm) and 6.74 mm (5 - 8 mm) respectively. Petiole

color is purplish white and cross section is semi-round. Petioles are intermediately overlapped. No tillering occurs.

Enlarged root characteristics

Root shape is spheric with convex shoulder and obtuse base. The texture of root skin is intermediate (slightly rough). There is mixed type of exterior root color (upper portion is purple and lower portion is white), so the pattern is bicolor. The interior color of the root is white. The root has crispy flesh texture with mild pungency. Position of bulbs is largely above the soil surface. Lateral roots emerge from the lower portion of the bulb and root groove tissue scars is narrow.



Figure 59: Enlarged root characters

The length of roots (storage portion) ranges from 5.5 to 8 cm and average diameter at the widest point is 12 cm (ranges from 6.5 to 13 cm). Average fresh weight of the root is 347.78 g (315 - 375 g). Fresh root can be harvested in 60 - 70 days after seed sowing. Fresh root yield is 25 - 30 MT/ha.

Flower and seed characteristics

Floral apex is loosely branched with small terminal heads. Leaf retention is higher on this variety. Flowering behaviour is annual. The number of days from seed sowing to the emergence of first flower in 50% of plants is 115 - 120 days. The color of flowering stalk is purplish green, however, pigmentation develops as an early response to biotic stress (aphids, etc.). The average length of floral stalk is 69.76 cm (64.3 - 74 cm). The length of internodes on floral stalk is intermediate (6.4 - 9.2 cm). Petals are yellow. Floral stalk bloom is low.



Figure 60: From left: flowering plant, flowers, dried pods and seeds

Number of days from seed sowing to 90% of plants ready for seed harvest is 180 - 185 days (110 - 120 days after root transplanting). The average length of silique is 4.67 cm (4.3 - 4.8 cm) and the average width is 6.14 mm (4.2 - 7.2 mm). Average beak length is 1.56 cm (1.5 - 1.6 cm). The silique remains green before drying and erect in position on floral stalk. The surface outline of the silique is undulating and hairs on the surface remains absent. The number of seeds per silique ranges from 20 to 27. Silique shattering is high in this variety. Primary color of the seed coat is reddish-brown. Thousand seed weight is in the range of 1.5 - 1.7 g at the 5.5% moisture level.

Distinct characters:

- Hypocotyl color purple
- Spatulate leaf shape with dentate margin and lyrate leaf division
- Late in maturity, ready for fresh harvest in 60 - 70 days
- Spheric root shape, convex shoulder and obtuse base
- Upper portion of the root is purple and lower portion is white in color
- Floral stalk color is purplish green, pigmentation develops as an early response to biotic stress (aphids, etc.)
- Silique shattering is high

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Annexes

Annex A: Notification status of the studied varieties

S.N.	Crop	Varieties	Year of notification	Status	Recommended domain
1	Couliflower	Kathmandu Sthaniya	2046	Released	Terai, mid- and high hills
2	Broccoli	Green Sprouting	na	na	na
3	Broad Leaf Mustard	Khumal Chauda Pat	2046	Released	Terai, mid- and high hills
		Khumal Rato Pat	2051	Released	Mid- and high hills
		Manakamana	na	na	na
4	Coriander	Kalami	na	na	na
		American Long Standing	2070	Registered	Terai and mid-hills
5	Onion	Red Creole	2046	Released	Terai, mid- and high hills
6	Pea	Sikkime	2051	Released	Terai, mid- and high hills
7	Faba Bean	Kathmandu Local	na	na	na
8	Radish	Chalis Dine	2051	Released	Terai and mid-hills
		Mino Early	2046	Released	Irrigated land in terai, mid- and high hills
		Pyuthane Rato	2051	Released	Mid-hills
9	Swiss Chard	Susag	2051	Released	Terai, mid- and high hills
10	Turnip	Kathmandu Rato	na	na	Terai, mid- and high hills
		Purple Top	2046	Released	Terai, mid- and high hills

NB: na = not available, those varieties are commonly growing in various range of agro-climatic zones

Annex B: Sketches of character descriptors

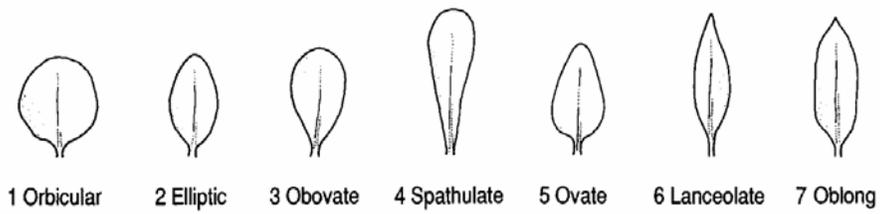


Fig. 1: Leaf shape (outline)

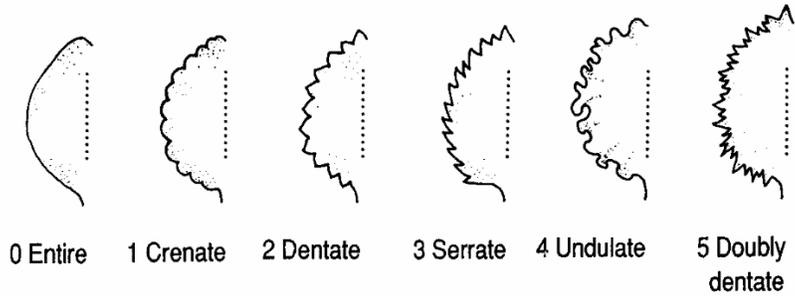


Fig. 2: Leaf margin

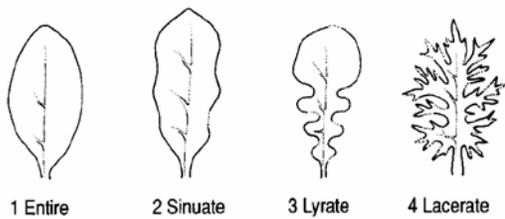


Fig. 3: Leaf division

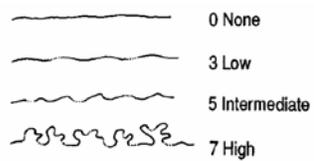


Fig. 4: Leaf blade blistering

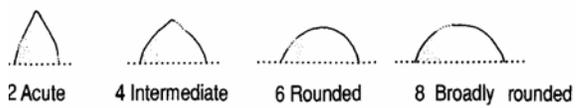


Fig. 5: Leaf apex shape

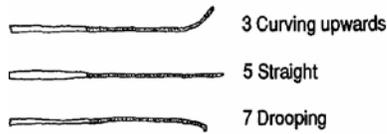


Fig. 6: Leaf tip attitude

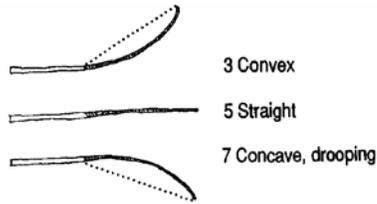


Fig. 7: Leaf lamina attitude

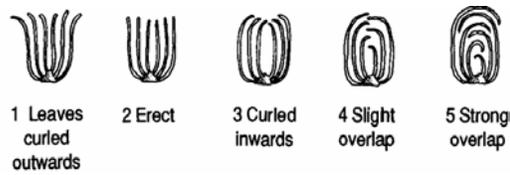


Fig. 8: Head forming leaf overlapping



Fig. 9: Headcover from subtending leaves

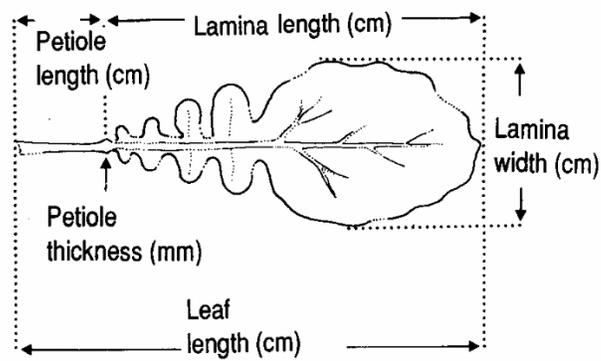


Fig. 10: Dimensions of leaf lamina and petiole

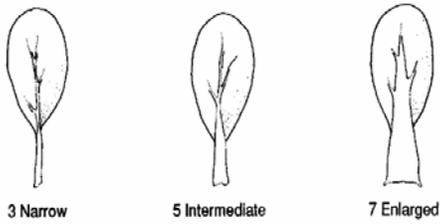


Fig. 11: Leaf petiole enlargement

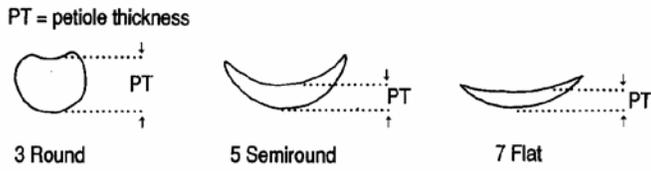


Fig. 12: Petiole cross section 3 round, 5 semi-round, 7 flat

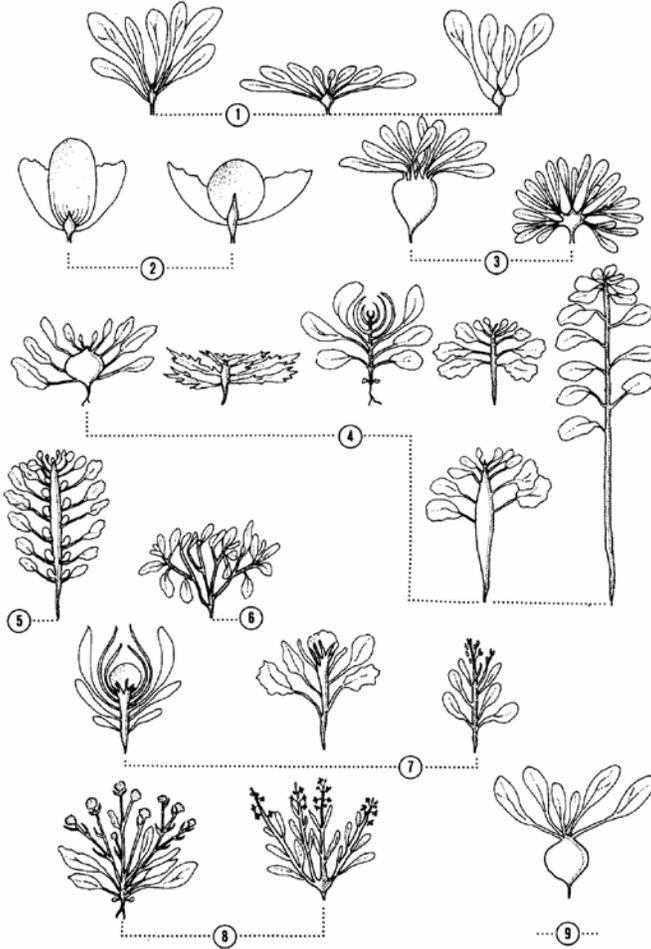


Fig. 13: Plant growth habit

1=Shortened branching 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) ...

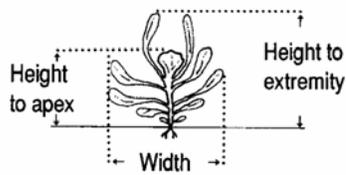


Fig. 14: Plant height, diameter

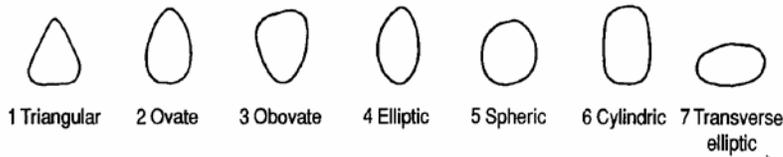


Fig. 15: Head and enlarged bud shape in longitudinal section (1 = Triangular, 2 = Ovate, 3 = Obovate, 4 = Elliptic, 5 = Spheric, 6 = Cylindrical, 7 = Transverse elliptic, 8 = Others, X = Mixture)

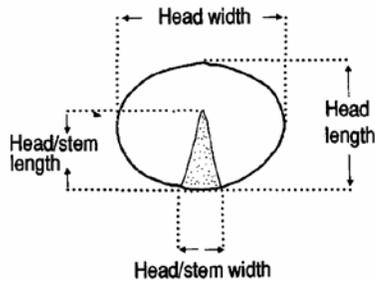


Fig. 16: Head and head-stem measurement



Fig. 17: Stem length in head (estimate)

- 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

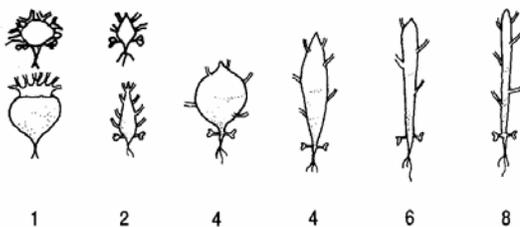


Fig. 18: Stem axis elongation and enlargement (1 = Extreme shortening, supporting crown or tight rosette, 2 = short, supporting rosette or head, 4= enlarged, forming tuber-like swelling, 6= elongate, 8= very elongate)

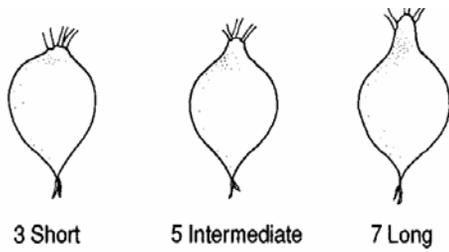


Fig. 19: Stem height of neck above crown

- 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)

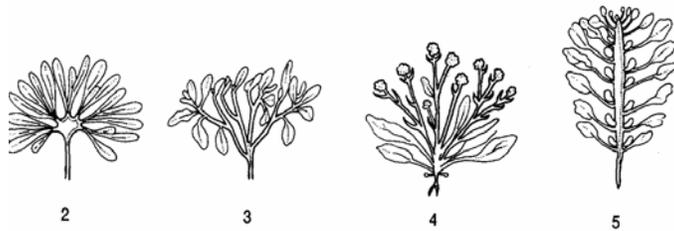


Fig. 20: Axillary stem and bud growth

- 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)

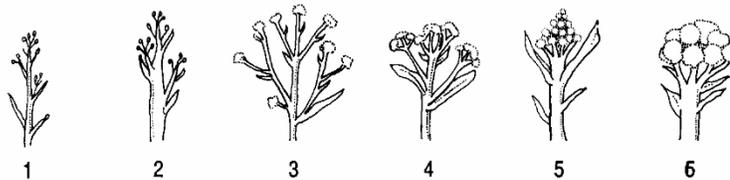


Fig. 21: Floral apex branching pattern

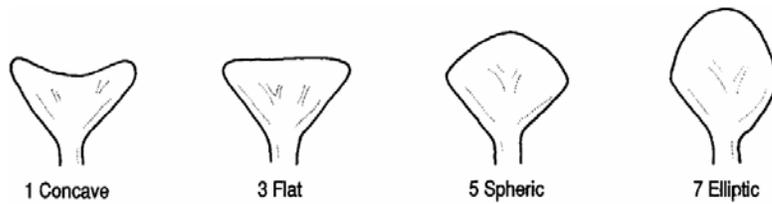


Fig. 22: Flowering head shape in longitudinal section

- 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. 23: Root flesh color distribution in transverse section

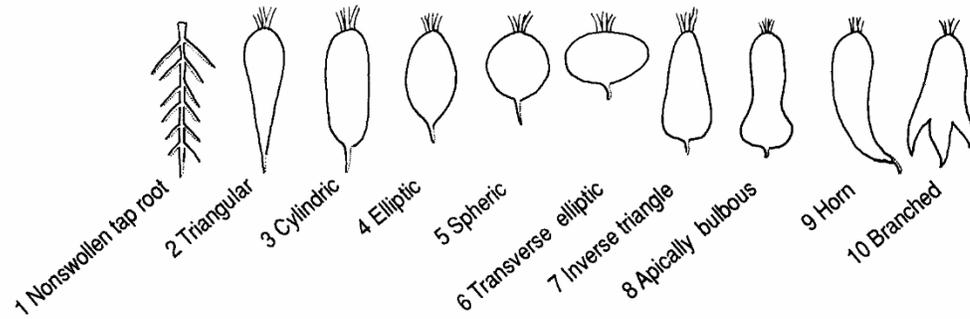


Fig. 24: Root shape in longitudinal section

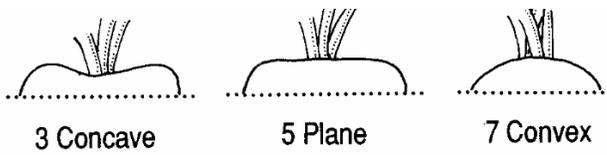


Fig. 25: Root shape at shoulder

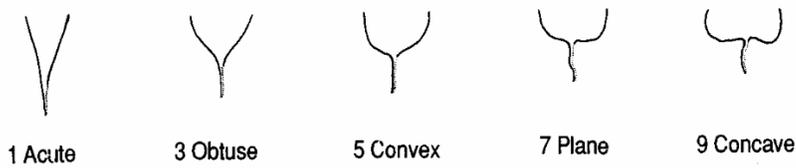


Fig. 26: Root shape at base

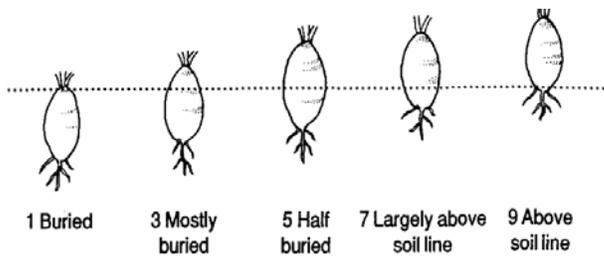


Fig. 27: Position of bulb in soil

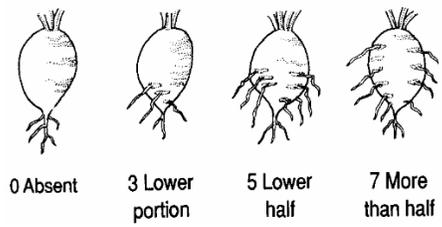


Fig. 28: Root, lateral root emergence on bulb

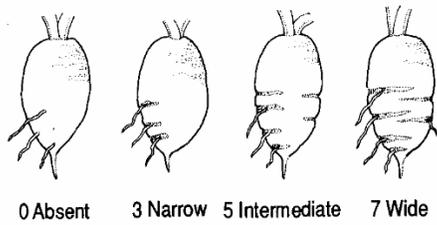


Fig. 29: Lateral root-groove tissue 'scars'

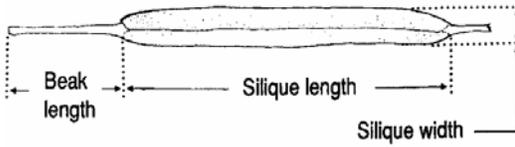


Fig. 30: Silique dimension

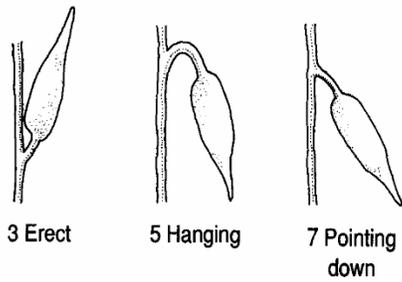


Fig. 31: Silique attitude

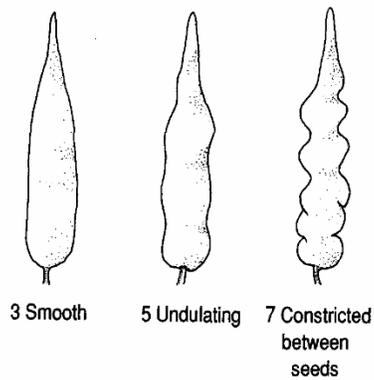


Fig. 32: Silique surface outline



Fig. 33: Foliage cracking in onion 3 = Weak, 5 = Medium, 7 = Strong

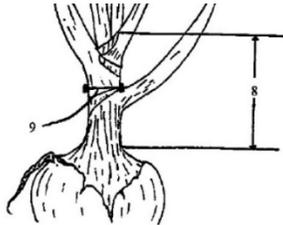


Figure 2. Pseudostem length (8) and diameter (9)

Fig. 34: Pseudo stem length (from soil level to highest green leaf base)

3 = Short (<8 cm) 5 = Intermediate 7 = Long (>18 cm)

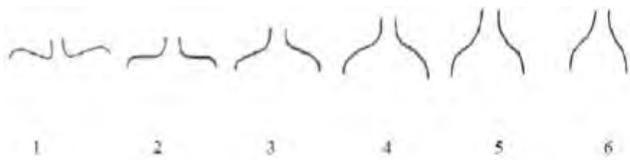


Fig. 35: Shape of bulb top 1 = Depressed 2 = Flat 3 = slightly raised 4 = Rounded 5 = slightly sloping 6 = strongly sloping

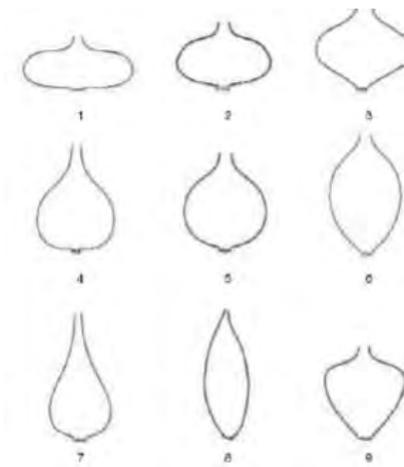
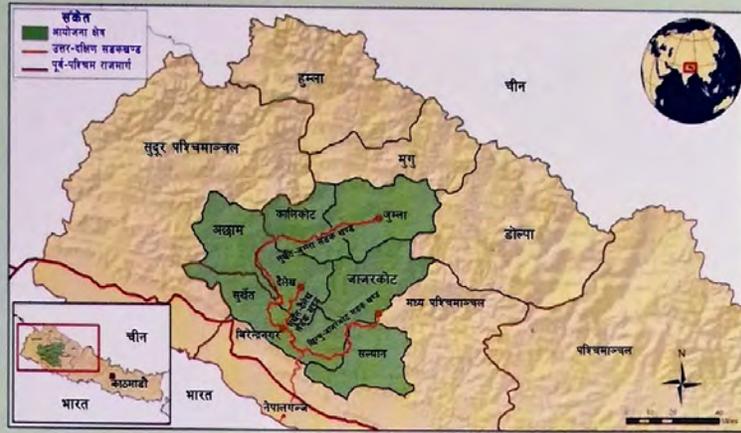


Fig. 36: Shape of matured dry bulb

1 = Flat 2 = Flat globe 3 = Rhomboid 4 = Broad oval 5 = Globe 6 = Broad elliptic 7 = Ovate (elongated oval) 8 = Spindle 9 = High top



Fig. 37: Shape of bulb base 1 = recessed 2 = flat 3 = round 4 = weakly tapered 5 = strongly tapered



चित्र नं. १ आयोजना क्षेत्रको नक्शा

कृषि बीमा गरौं, लगानीको जोखिमलाई न्यून गरौं ।



चित्र नं. २ आयोजनाले सहयोग गर्ने मूल्य श्रृंखलाहरू

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