Specific work instructions (SWI 142.1.2-4): Cruciferous seed crop inspection procedures

The purpose of pedigreed seed crop inspection is to provide an unbiased inspection and complete a Report of Seed Crop Inspection for the Canadian Seed Growers' Association (CSGA) on the isolation, condition, and purity of the seed crop. It is the seed crop inspector's responsibility to describe the seed crop and its surroundings as observed at the time of inspection.

Updated: April 1, 2023

On this page

1.0 Scope

This SWI outlines the procedures that a seed crop inspector will follow when inspecting pedigreed status seed crops of canola/rapeseed, mustard, oilseed radish, and carinata. These seed crop inspection procedures provide the CSGA with confidence that the production has been measured against the requirements for seed crop varietal purity and seed crop standards as specified by the CSGA's Canadian Regulations and Procedures for Pedigreed Seed Crop Production (Circular 6).

2.0 References

The publications referred to in the development of this SWI are those identified in Seed Program Regulatory Authority (SPRA) 101 – Definitions, Acronyms and References for the Seed Program as well as:

- L. Kott, Plant Breeders' Rights Descriptors for Brassica napus, University of Guelph, 1994
- P. Thomas, Canola Growers' Manual, Canola Council of Canada, 1984
- The Biology of Brassica juncea (Canola/Mustard), Biology Document BIO2007-01, Canadian Food Inspection Agency
- The Biology of Brassica napus L. (Canola/Rapeseed), Biology Document BIO1994-09, Canadian Food Inspection Agency
- The Biology of Brassica rapa L., Biology Document BIO1992-02, Canadian Food Inspection Agency

3.0 Definitions

For the purposes of this SWI, the definitions given in SPRA 101, in the CSGA's Circular 6 and the following apply:

A-line
male sterile line; line or population which is male sterile; female plants which don't produce pollen; the female line from which the progeny seed is harvested

B-line
male fertile line or population capable of maintaining male sterility in the progeny of the A-line; line or population which, when crossed with male sterile plants (A line), maintains male sterility; male line which produces viable pollen

Composite variety
a plant population in which at least 70% of progeny result from a crossing of the parent lines; a variety produced through planting a physical blend of specific proportions of parental lines

Double-cross hybrid
the first generation of a cross between 2 Foundation single-cross hybrids

Foundation single-cross
a single cross used in the production of a double cross, a Foundation 3-way cross hybrid or a top-cross hybrid

Heterosis
a marked vigour or capacity for growth often shown in the progeny of a sexual cross between organisms of diverse genetic backgrounds; the increase in vigour of hybrids over their parental inbred types

Hybrid
the first generation progeny of a cross between 2 different plants of the same species often resulting in a plant that is more vigorous and productive than either parent

Hybridization
the crossing of genetically unlike individuals to obtain varieties with new genetic recombinations

Restorer-line
line or population used as male parent which has the capability of restoring fertility to male sterile lines/populations when crossed onto them

Single-cross hybrid
the first generation of a cross between 2 specified inbred parent lines or relatively homogeneous parent populations

Synthetic Select
a physical blend of specific proportions of seed harvested from Breeder or Foundation status plots used in the production of Certified status seed crops of composite varieties; crops sown with Synthetic Select seed are for Certified status only

3-way cross hybrid
the first generation of a cross between an inbred parent line or parental population and a Foundation single-cross

Top-cross hybrid
the first generation progeny of a cross between an inbred parent line and an open pollinated variety

4.0 Specific inspection procedures

Inspection of cruciferous pedigreed seed crops should be carried out as described in SWI 142.1.1 Pedigreed seed crop inspection, with the additional conditions and information provided in the following sections.

4.1 Preparation for inspection

Flowering begins with the opening of the lowest buds on the main stem and continues upward with 3 to 5 or more flowers opening daily. Brassica crops should be inspected when the first few flowers have opened on the lowest part of the main stem. For spring planted crops, days to first flower (days from planting to when 50% of plants show 1 or more open flowers) can range from 30 to 50 days in *B. rapa* and mustards, and 40 to 60 days for *B. napus*. The inspector must refer to the application for inspection to determine the planting date. The description of the variety (DoV) provides information on the days to flowering for each variety. This can be used to determine the optimal time for seed crop inspection for the variety.

4.2 Inspection requirements

Cruciferous crop requires inspection when the plants are in flower. The earliest possible time for inspection is when all plants in the field have at least 1 flower open.

Cruciferous crops are inspected for isolation, seed crop varietal purity, other crop kinds, difficult to separate crop kinds, prohibited noxious and reportable weeds, and sources of contaminating pollen. Isolation distances are large compared to most other crop kinds. When species which may cross pollinate with the cruciferous crop are found in the isolation distance, additional inspection time will be required to verify the condition of the isolation. The seed crop inspector must refer to Circular 6 for the minimum isolation distances to potentially contaminating crops.

The combination of yellow flowers and intense sunlight can be straining on the eyes. The crop can be dense and tall making it extremely difficult to walk through. The flowers produce abundant nectar that is sticky and readily catches the pollen from the crop.

Seed crop inspectors must take precautions to prevent transferring pollen between different varieties. Wherever possible, the seed crop inspector should organize inspections of the same variety for the entire day. If this is not possible, the inspector should wear waterproof pants that may be rinsed with a cleanser between crops or wear disposable Tyvek suits that are changed between varieties.

Herbicide tolerant canola refers to canola that is tolerant of an herbicide to which tolerance is not native to the North American population of canola. Due to the biology of canola, it is difficult to achieve canola seed that is completely herbicide tolerant. As a result, breeders will specify a maximum allowable percentage of plants in the variety that are susceptible to the herbicide but that otherwise conform to the norm of the variety. These plants are considered variants rather than off-types and may exhibit visible morphological effects of herbicide treatments that can be used to identify them in the field. The maximum level of variants is described in the DoV and depends, to a large extent, on whether the variety is a hybrid, a composite or an "open-pollinated" variety.

4.2.1 Hybrid and composite seed crops

Hybrid seed crops must be inspected when the A-line plants are in flower. Seed crops of single parental lines should be inspected in the same way as open-pollinated cruciferous crops.

Seed of hybrid crops is produced by the controlled cross of 2 inbred parental lines. The seed must meet specific standards for the percentage of hybrid plants in the seed sold. Seed of separate male and female parental inbred lines are generally planted in defined rows or bays within the seed production field and is often surrounded by border rows of the male parental line. When inspecting hybrid seed crops in which male and female parental seed is planted separately in rows or bays, formal counts are made only in the A-line as the B-line and R-line plants are usually removed prior to seed set and not harvested for seed production. Impurities in the B-line and R-line are reported only when these impurities are not observed in the count area.

For composite crop kinds, seed of the parental lines is blended by the breeder in specific proportions and planted as a blend. The required percentage of hybrid plants in the resulting material is usually lower. The seed crop inspector is not required to determine the relative percentages of plants of the male and female parental lines in fields producing composite varieties. When inspecting crops producing composite varieties or hybrid varieties using a mixed parent seed methods, counts for impurities (off-types, difficult to separate crops and weeds) are taken in a representative manner throughout the field.

The DoV supplies limited information on the mechanism of controlled pollination of the hybrid as this is considered confidential business information. There are 2 main types of pollination control: genetic male sterility and cytoplasmic male sterility. Within each main type, there are several specific types. Knowledge of the sterility system used in the hybrid system is useful in seed crop inspection as some sterility systems have specific morphological characteristics associated with them.

Seed crop inspectors may encounter plants with mis-formed petal arrangements, extra petals or deformed petals. These may be more prevalent in some pollination control systems. The seed crop inspector must use his/her knowledge of the pollination control mechanism to determine if these plants are off-types to be reported in counts.

When the seed crop inspector encounters male fertile plants in the A-line, the inspector must make a judgement on how much male fertility is evident in the A-line and whether these plants should be counted as off-types or whether they are the result of a breakdown of male sterility caused by environmental factors. If all the flowers on the plant are male fertile, it is considered an off-type. If only some flowers on the plant are male fertile, this may indicate the breakdown of male sterility due to environmental conditions or, in some production systems, incomplete removal of herbicide susceptible fertile plants. This should be reported in the Comments section of the Report of Seed Crop Inspection.

The seed crop inspector may encounter male sterile plants in the A-line that are waxy and darker green than the norm of the variety. These plants should be recorded in counts as "off-types/variants."

The seed crop inspector should refer to Circular 6 to determine the appropriate isolation distance for each seed crop. For hybrid canola and mustard, a cursory verification of the entire isolation distance is performed and the area 200 m to 800 m from the crop is observed closely only if a problem is identified during the cursory inspection.

4.2.2 Inbred lines

The seed crop inspector should inspect fields of inbred parental lines in the same way as other cruciferous crops. In some cases inbred lines are hybrids of 2 other inbred lines and should be inspected in the same way as other hybrid canola crops. In other cases, seed of an inbred line is planted as a single variety and these should be inspected as open-pollinated crops.

4.2.3 Plot inspection

Seed crop inspectors must be specially trained and licensed to inspect plots. See SWI 142.1.1 for detailed instructions on inspection of plots.

Border rows for plots must be planted with the same seed as the pollen (male) parent rows. The border rows must be planted such that synchronous flowering occurs at the same time as the pollen (male) parent rows and, more importantly, at the same time as flowering of the receptive female parent plants of the inspected crop.

Seed of high generation cruciferous species may be produced in isolation cages or under tents. In general inspections procedures are the same, however, isolation distances are smaller and the seed crop inspector must check the integrity of the tent material (holes or gaps). Detailed tent inspection procedures are available from CSGA.

4.3 Completing the Seed Crop Inspection Report

For all cruciferous crops, the inspector must perform counts of off-types/other varieties of the same species, plants of species that may cross-pollinate (CP), plants of species with difficult-to-separate (DTS) seeds, and weeds to be reported in counts as specified in SWI 142.1.1 appendix VII.

The "Open Pollinated Crop Isolation Section" of the Seed Crop Inspection Report is used to report what is found within the isolation distances to other varieties or crops that may cross-pollinate (distances of 100 m to 800 m as listed in Circular 6). Always report the largest required isolation listed in Circular 6 for the crop being inspected. For example, if a crop requires a 100 m isolation distance from 1 species but 200 m from another, the inspector should report on 200 m.

Where cleavers (*Galium aparine*) and wild mustard (*Sinapis arvensis*) are found within 3 m of the inspected crop, the isolation must be rated as "Poor".

4.3.1 Reporting hybrid cruciferous crops

Off-type plants found in the A-line that are sources of contaminating pollen are reported in the "Impurities" section of the Report of Seed Crop inspection.

Partially male fertile female plants (producing some viable pollen) are counted as off-types. When these are found outside of the counts, they are recorded in the "Comments" section of the Report of Seed Crop inspection.

For hybrid production, distance to potentially contaminating crops is recorded in the "Open Pollinated Crop Isolation Section." For example, B. carinata, 25 plants, 50 m to north, at rosette stage. If none, state " hybrid production, distance to potentially contaminating crops is recorded in the "Open Pollinated where x metres is the largest isolation requirement for that crop.

Where crops planted with Certified status seed of the same variety are planted within the minimum isolation distance, the pedigreed status of the Certified seed must be verified and the isolation distance must be free from any other contaminating pollen sources.

If blended seed was planted to produce a hybrid crop, this must be noted in the "Comments" section of the Report of Seed Crop Inspection.

Where border rows are used, planted with the seeds of the male parental line, the border rows are inspected as part of the field and contaminants found in the border rows are recorded in the "Comments" section of the Report of Seed Crop Inspection. In some cases, the producers may choose to not include the area of the border rows in their record of the total acreage of the field and this may appear as a discrepancy in the acreage of the inspected field.

Appendices

Appendix I: Brassica biology

Both *Brassica napus* and *B. rapa* (also known as *B. campestris*) are referred to as canola or rapeseed. In Canada, these crops are known commonly as Argentine rape and Polish rape respectively, however, the use of these terms is not widespread outside of Canada.

Brassica crops are also classified according to their end-use. Although Canadian production of canola is primarily for oil and feed purposes, varieties of *B. napus* may also be produced for forage purposes. Some varieties of *B. rapa* may be grazed as pasture and grown for their edible roots; these are referred to as swede rape or turnip rape or forage turnip.

Other Brassica and related crops are being bred to produce canola quality oil. Canola quality *B. juncea* varieties have been developed and other species of canola type material are under development.

There is also Canadian production of high erucic acid rapeseed (HEAR) types of oilseed rape varieties for industrial oil. Varieties of canola quality *B. juncea* and HEAR types have been granted contract registration and are required to be produced under a quality management system.

Many varieties of canola are plants with novel traits (PNTs). A PNT is a plant that contains a trait which is both new to the Canadian environment and has the potential to affect the specific use and safety of the plant with respect to the environment and human health. These traits can be introduced using biotechnology, mutagenesis, or conventional breeding techniques and have some potential to impact weediness, gene flow, plant pest potential, non-target organisms or biodiversity.

Brassica napus is a predominantly self-pollinated crop, however, in some environments outcrossing rates of up to 27% can occur. *B. rapa* is an obligate cross-pollinator. Both winter and spring types of *B. napus* are grown in Canada. While the spring type is predominantly grown, both open-pollinated and hybrid types of winter canola are commercially available. Winter canola requires a period of cold temperatures in order to flower and is not to be confused with the fall seeding of spring canola seed that is protected by a polymer coating to provide for early spring germination.

Flowering begins with the opening of the lowest bud on the main stem and continues upward with 3 to 5 or more flowers opening per day. Flowering at the base of the first secondary branch begins 2 to 3 days after the first flower opens on the main stem. Under reasonable growing conditions, flowering of the main stem will continue for 2 to 3 weeks in both *B. napus* and *B. rapa*.

Flowers begin opening early in the morning and, as the petals completely unfold, pollen is shed and dispersed by both wind and insects. Flowers remain receptive to pollen for up to 3 days after opening. If favourable, warm, dry weather occurs, nearly all the pollen is shed the first day the flower opens. In the evening, the flower partially closes and opens again the following morning. Fertilization occurs within 24 hours of pollination. After fertilization, the flower remains closed and the petals wilt and drop. A young pod becomes visible in the centre of the flower a day after the petals drop.

During flowering, the branches continue to grow longer as buds open into flowers and as flowers develop into pods. In this way, the first buds to open become the pods lowest on the main stem or secondary branches. Above them are the open flowers and above them the buds which are yet to open. All of the buds that will develop into open flowers on the main stem will likely be visible in *B. napus* within 3 days of the start of flowering and within 10 days in *B. rapa*.

Characteristics of Brassica crops

The following table details the characteristics that can be used to differentiate between crops of *B. rapa*, *B. napus*, *B. juncea*, *Sinapis alba* and *B. carinata*.

Characteristics of Brassica crops

Trait	B. rapa	B. napus	B. juncea	Sinapis alba	B. carinata
Seedling Leaves	spiny underside, wrinkled	glabrous underside, smooth	glabrous underside, smooth	spiny underside, very wrinkled	glabrous underside, smooth
Leaves	yellow-green to green, upper leaves clasping stem	waxy, blue-green, partially clasping stem	green, terminate above stem, lower leaves lobed, upper leaves narrow and entire	light green, deeply lobed, terminate above stem	blue-green, glabrous, unlobed, terminate above stem, may have purple tinge
Flowers	smaller, deeper yellow petals, compact bud clusters, buds borne below open flowers (umbrella shape)	larger, lighter yellow petals, buds borne above uppermost open flowers	pale yellow flowers similar to B. rapa	smaller, mid yellow flowers, elongated racemes	yellow, pale yellow, or white, elongated up the stem, buds borne above uppermost open flowers (Yellow and cream flowers of B. carinata will often turn white a day or 2 after opening.)
Stems	smooth	smooth	smooth	hairy	smooth

Characteristics of Brassica crops

Trait	B. rapa	B. napus	B. juncea	Sinapis alba	B. carinata
Pods	smaller, shorter pod, smooth long conical beak, right angles to raceme	larger, medium pod, smooth medium conical beak, right angles to raceme	smooth, long conical beak partially appressed to raceme	spiny long flat beak right angles to raceme	smooth, long with conical beak, partially appressed to raceme
Pollination	must cross pollinate	predominantly self-pollinating	predominantly self-pollinating	must cross pollinate	predominantly self-pollinating
Attitude	many branches, up to 20, leads to less structured look, more difficult to identify main stem, height 50 cm - 125 cm	fewer branches, thicker, taller, height 75 cm - 175 cm	fewer branches, long and upright, intermediate height	fewer branches, upright, shorter	moderate to heavy branching, medium to tall in height

Appendix II: Diseases that may affect plant appearance

Alternaria black spot – Alternaria brassicae

- black, brown or greyish spots on leaves, stems and pods
- pod splitting may occur

Aster yellows - Phytoplasma

- infected plants fail to set pods or produce blue-green, sterile, hollow bladders in place of normal pods
- normal pods may be present on the lower portions of infected plants

Blackleg - virulent - Leptosphaeria maculans

- whitish spots on leaves and stems with small dark fruiting bodies
- deep stem cankers that are brown with a dark rim
- may cause severe lodging and ripening with shrivelled seed

Blackleg - weakly virulent - Leptosphaeria maculans

- whitish spots on leaves and stems peppered with small dark fruiting bodies
- stem lesions may be shallow and grey or black

Brown girdling root rot - Rhizoctonia solani with secondary infections by Fusarium spp.

- light brown lesions on tap root and at bases of larger roots
- tap root girdled, leaving a stump

Clubroot - Plasmodiophora brassicae

- severely affected plants are stunted and wilt under moisture stress because much of the taproot is destroyed

Foot rot – complex of Rhizoctonia solani, Fusarium spp. and Pythiuim spp.

- hard brown lesions at stem base
- salmon coloured spore masses often present

Fusarium wilt - Fusarium avenaceum and F. oxysporum

- yellow or reddish-brown streaks, often occurring only on 1 side of the stem and/or on the branches
- some plants may have an orange discolouration at the base of the stem
- severely infected plants die prematurely
- stems and/or branches turn brown, but plants remain upright with roots intact
- there are no visible lesions on stems or roots

Sclerotinia stem rot - Sclerotinia sclerotiorum

- premature ripening of plants
- bleached stems that tend to shred
- hard black sclerotia inside stems near stalk base and other bleached areas

White leaf spot or Grey stem - Pseudocercosporella capsellae

- white leaf spots
- large purple to grey speckled stem lesions

White rust (Staghead) - Albugo candida

- white to cream-coloured masses or pustules of "white rust" on the underside of leaves from the seedling stage onward
- following infection of the stems and pods, raised green blisters form that turn white during wet weather
- the most conspicuous symptom is the presence of swollen, twisted and distorted inflorescences called "stagheads" that become brown, hard and dry as they mature

Appendix III: Nutritional deficiencies that may affect plant appearance

Sulphur deficiency symptoms

On fields marginally deficient in sulphur, canola plants may show no obvious visual symptoms, but can have seriously reduced yields. When visual symptoms of sulphur deficiency are noticeable, the canola crop is severely lacking in sulphur. Symptoms are most likely seen at the bud and flowering growth stages because of the crop's high need for sulphur during this period. Sulphur is a constituent of protein and is not mobile in the plant. This means it does not move readily from lower leaves to younger upper leaves. Therefore, the new leaves, flowers and pods at the top of the growing branches are more likely to be deficient in sulphur than the older leaves at the bottom of the plant. When soil sulphur supplies are limited, the youngest, last formed tissue goes without.

A deficiency of sulphur will cause a general yellowing of younger leaves in the initial stages because sulphur is required for the formation of chlorophyll. This yellowing gradually progresses to all leaves. With a severe deficiency the leaves tend to be poorly developed and cupped, particularly in the upper portion of the plant, with a purple colour on the undersides of the leaves. The symptoms are less severe on the bottom of the plant than the top of the plant.

In a moderate sulphur deficiency the upper leaves may be cupped while the lower leaves appear healthy. The flowers are often paler than normal for the variety; pale yellow instead of dark yellow, or almost white instead of pale yellow. Flowering is delayed and prolonged so that at maturity, which is delayed, the plants are carrying both mature and green seed pods, flowers and buds. There is a reddish-purple tinge to the leaves, stems and pods. Pods form slowly and are small and poorly filled with shrunken and shriveled seeds. The number of pods decreases towards the upper part of the plants with many seeds aborted or the pods totally empty. The plants tend to stand erect because there is little weight in the pods and the stems are shorter and tend to be woody. These symptoms commonly occur in patches in the crop and are easily seen at maturity; however, on severely deficient soils entire crops can be affected.

Nitrogen deficiency symptoms

Vigorous, healthy growing canola plants with adequate nitrogen usually have a deep green colour. When a plant is not able to get enough nitrogen from the soil to satisfy its needs, the first symptoms of deficiency are a light green coloration to the leaves and stem. The nitrogen in older leaves is redistributed to younger leaves to maintain growth. As a result, the older leaves first show the characteristic yellowing which indicates nitrogen deficiency. Other leaves may become greenish-yellow often showing a purple discoloration. Older leaves may wither. The plants grow poorly, with short, thin main stems and few branches, and the crop canopy remains thin and open. Flowering takes place over a short period of time and pod numbers are low.

Phosphorous deficiency symptoms

Lack of available phosphorus restricts root and top growth, resulting in poorly developed root systems; spindly, thin, erect stems with few branches and small narrow leaves. A severe phosphorus deficiency may show up as a dark bluish-green coloration of the leaves, often accompanied by purplish tinges. The stems may also be bluish-green sometimes with purple or reddish coloration as well.

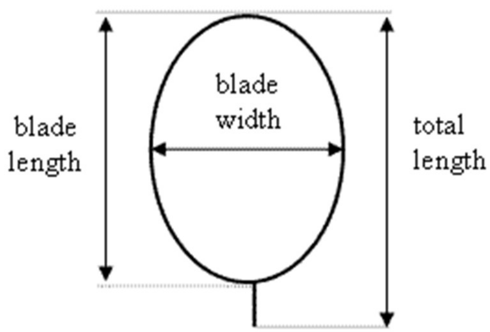
Potassium deficiency symptoms

When a soil is deficient in potassium, plant growth is reduced resulting in smaller leaves and thinner stems. Also, responses to nitrogen and phosphorus will be limited. Plants tend to wilt. In severe cases of potassium deficiency, the edges of older leaves will become yellow or scorched and may die completely but remain attached to the stem.

Appendix IV: Mustard and canola/rapeseed diagrams

Leaf:

- **total length**, measured from the base of the petiole to the leaf apex.
- **lamina length**, measured from the attachment point of the petiole on the blade to the leaf apex.
- **blade width**, measured across the widest point of the leaf.

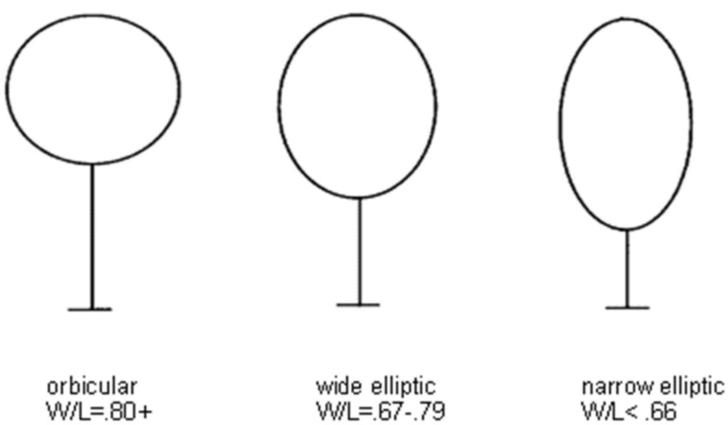


Description of diagram of mustard and canola leaf:
An oval leaf is depicted with measurements indicated for the blade length (not including the petiole), total length (including the petiole) and the blade width.

Leaf: blade shape

The **overall blade shape** is determined by the blade width/lamina length ratio

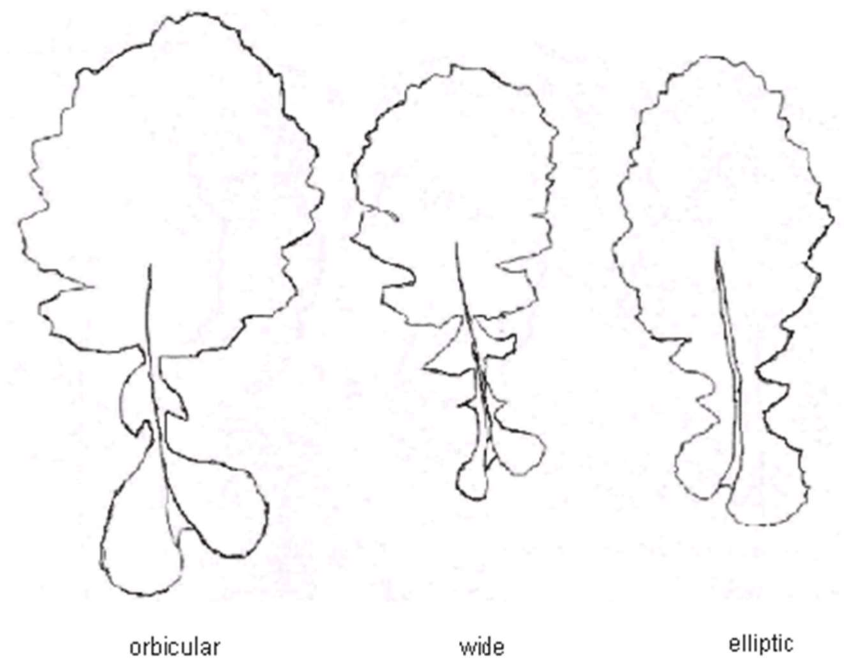
- Orbicular shape has a width/lamina length ratio of more than 0.80.
- Wide elliptic shape has a width/lamina length ratio of 0.67 to 0.79.
- Narrow elliptic shape has a width/lamina length ratio of less than 0.66.



Description of diagram of leaf blade shape:
3 leaves are depicted, orbicular (roughly circular), wide elliptic (oval) and narrow elliptic (narrow oval).

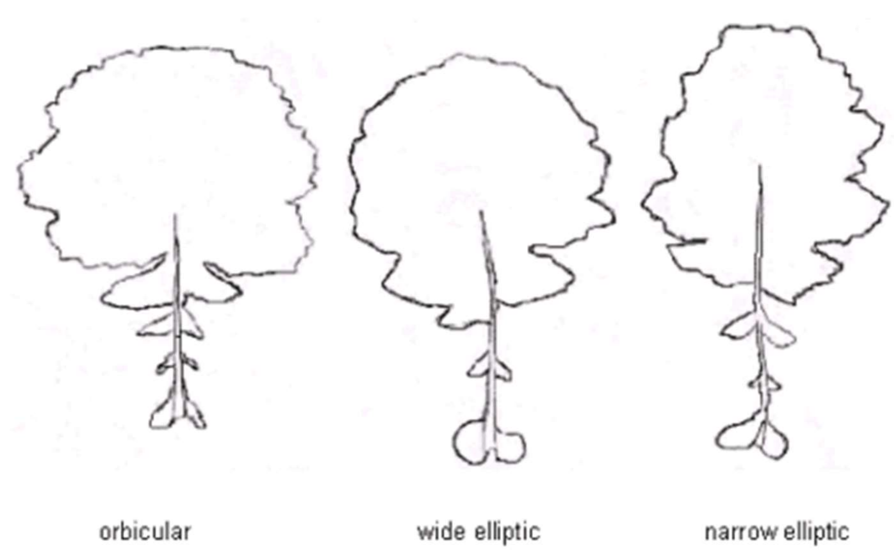
Leaf: Petiolate and lyrate

Lyrate leaves have laminar tissue continuing along the whole length of the petiole.



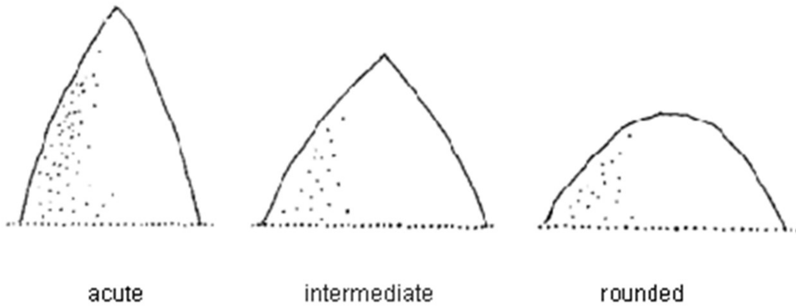
Description of diagram of lyrate leaves:
3 leaves are depicted, all with laminar tissue attached along the whole length of the petiole: orbicular (roughly circular), wide (oval) and elliptic (narrowly oval).

Petiolate leaves have a distinct and mostly naked petiole; some discrete petiolar bracts may be present.



Description of diagram of petiolate leaves:
3 leaves are depicted with no, or little laminar tissue along the petiole: orbicular (roughly circular), wide elliptic (oval) and narrow elliptic (narrowly oval).

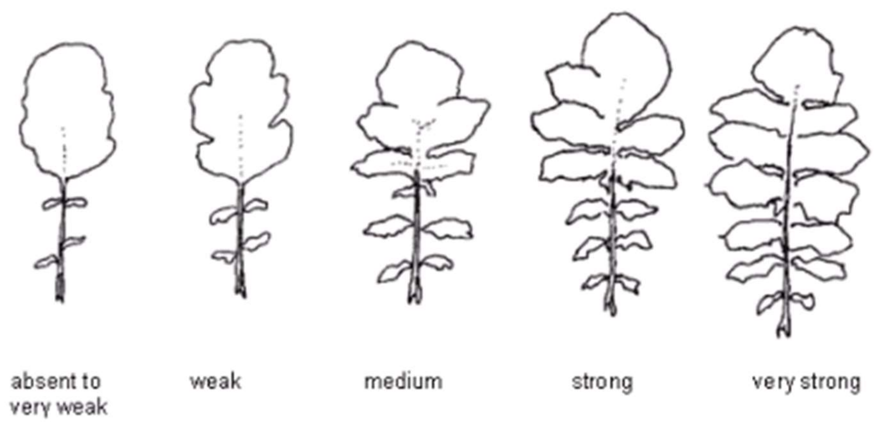
Leaf: apex shape



Description of diagram of leaf apex shape:
The tips of 3 leaves are depicted: acute with a sharply pointed tip, intermediate with a wider, less sharply pointed tip, and rounded.

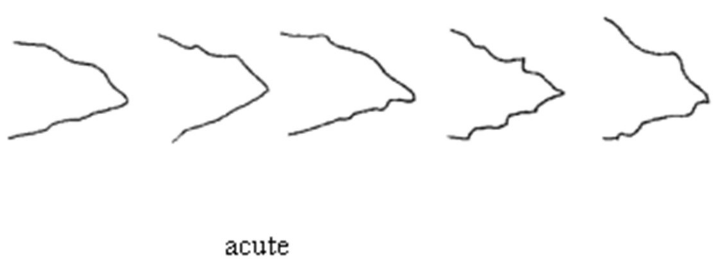
Leaf lobe development

A **lobe** is counted when the leaf tissue is more than 2 cm in length and is cut on both sides to at least half the distance to the midrib. The upper part of the leaf is counted as a lobe.



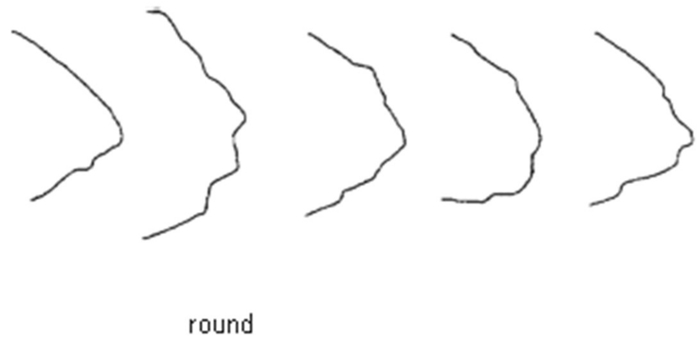
Description of diagram of leaf lobe development:
5 leaves are depicted ranging from 1 with absent to very weak lobes, weakly lobed, medium, strongly lobed, and very strongly lobed (with multiple and deeply indented lobes).

Shape of leaf lobes: acute shaped lobes



Description of diagram of acute shaped lobes:
5 leaf lobe shapes are depicted, all with acute angled tips, varying from a smooth margined leaf to ones that have more undulating margins.

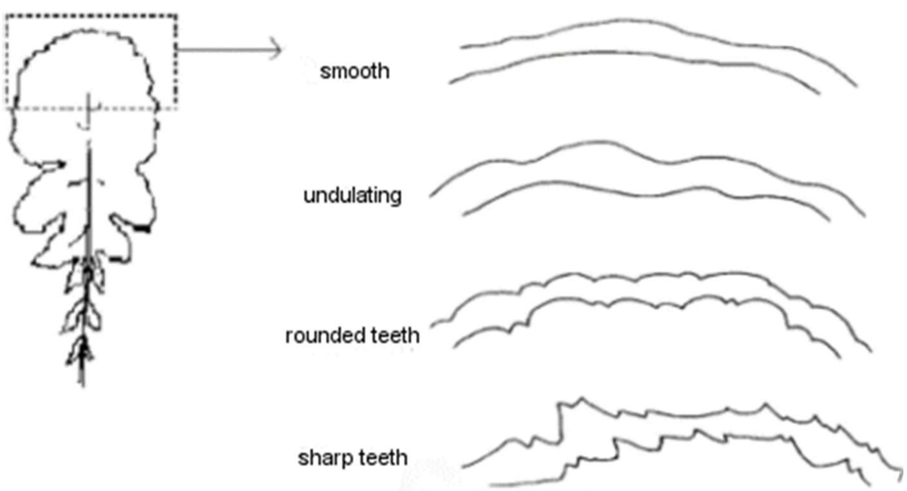
Shape of leaf lobes: round shaped lobes



Description of diagram of round shaped lobes:
5 rounded lobes are depicted ranging from one with a smooth margin to ones with more undulating margins.

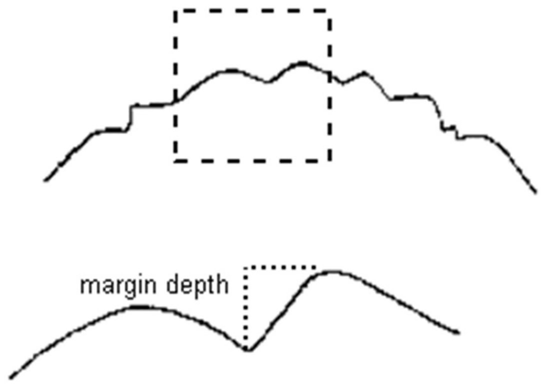
Leaf margin shape

Margin characteristics should be evaluated on the upper third of the largest leaf.



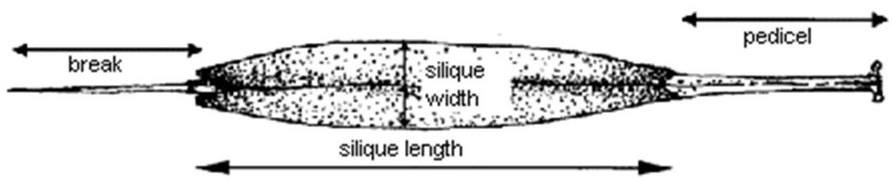
Description of the diagram of the leaf margin shape:
A diagram of a single leaf with the upper third of the leaf delineated and 4 margin shapes ranging from smooth, undulating, rounded teeth and sharp teeth.

Leaf margin indentation



Description of diagram of margin indentation:
One diagram delineates a section of the margin of a leaf and a second diagram indicates the measurement from the outer edge of the margin to the inner edge of the indentation.

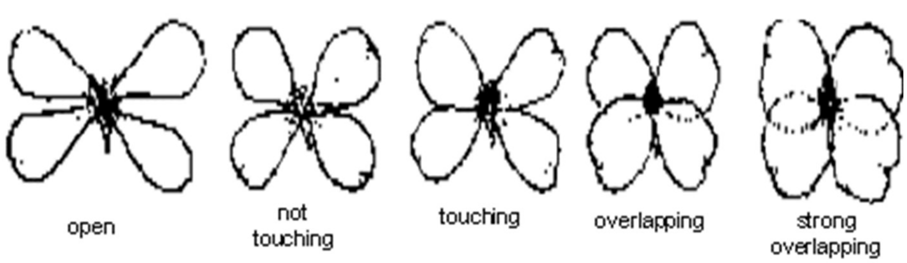
Pod (silique): Length, width, beak length, pedicel length



Description of diagram of the silique:
The silique is a thin elongated oval with a fine pointed beak at 1 end, and a wider, blunt pedicel at the other end.

Flowers: petal spacing

Observe **petal spacing** only on fully opened flowers.

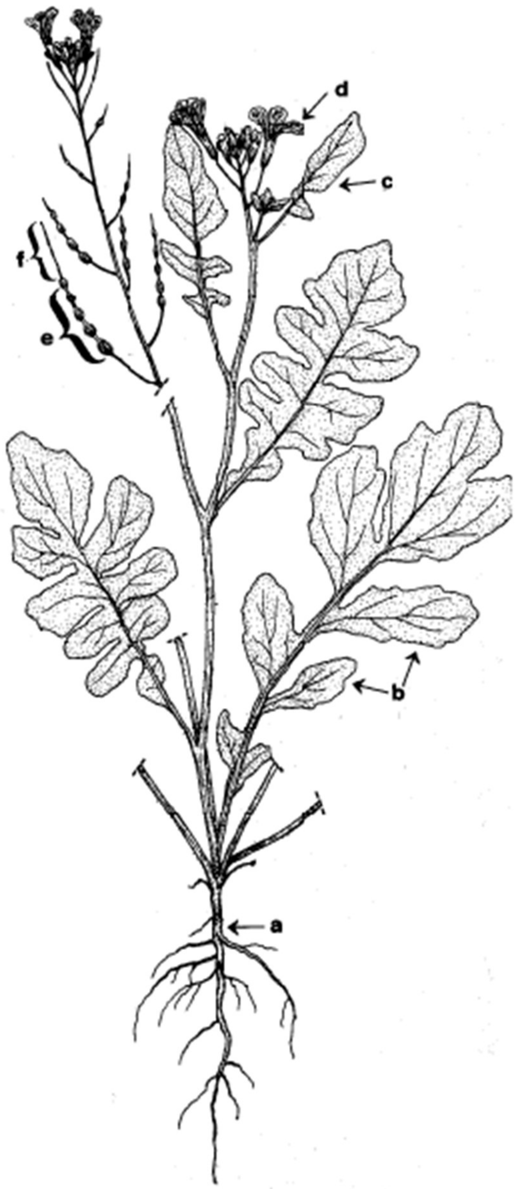


Description of diagram of petal spacing:
5 flowers are depicted with various types of flower petal spacing - open, no touching, touching, overlapping, and strong overlapping

Plant: total plant height (cm)

Measure a minimum of 30 plants at maturity. **Total plant height** is the distance from the ground to the tip of the longest shoot. To measure total plant height all side shoots should be pulled to the vertical in order to measure the longest shoot.

Appendix V: Cultivated radish (*Raphanus sativus*) diagram



Description of diagram of cultivated radish plant:
the whole plant is depicted from root to flowering tip and is labelled as follows:

a. taproot
b. large leaf segments
c. small leaf segments
d. petals
e. seed pods
f. seedless beak