Specific work instructions (SWI 142.1.2-2): Cereals and small grains seed crop inspection procedures

Updated: April 1, 2023

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

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1.0 Scope

This Seed Program specific work instruction (SWI) outlines the procedures that a seed crop inspector will follow when inspecting pedigreed status seed crops of barley, oats, triticale, wheat, rye, buckwheat, canary seed, flax, hybrid wheat, and hybrid rye. These seed crop inspection procedures provide the CSGA with confidence that production has been measured against the requirements for seed crop varietal purity and seed crop production 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.

In addition the following were also used:

- Fehr, Walter, R. Principles of Cultivar Development, Volume 2, Crop Species. London. 1987.
- Stoskopf, Neal C. Cereal Grain Crops. Virginia. 1985.
- Hervey-Murray, CG. The Identification of Cereal Varieties. 1980.
- Stallknecht, GF, Gilbertson KM, Ranney JE. Alternative Wheat Cereals as Food Grains: Einkorn, Emmer, Spelt, Kamut, and Triticale. Progress in new crops. Alexandria, VA. 1980.
- UPOV 2017. Wheat and barley guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva.

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:

Aleurone
granular protein in the outermost layer of the endosperm of many seeds or cereal grains; colour variation of the aleurone layer is used to distinguish barley varieties

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

Anthesis
the flowering stage when the anthers burst, pollen is shed and the stigma is ready to receive the dispersed pollen

Anthocyanin
plant pigment ranging from red to violet to blue

Awn
conspicuous prolongation of the glume or lemma measuring greater than 30 mm

Awnlet
short awn, measuring between 5 mm and 30 mm

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

Chaff
fragments of straw including the glume and hull removed from cereal grains in threshing or processing

Cytoplasmic male sterility
the inability of a plant to produce viable pollen occurring as a result of maternally transmitted cytoplasmic factors

Fatuoid
a common mutant found in oat crops; may be called a 'false wild oat'; usually has heavier protruding black awns distinguishable at maturity

Floret
the stamens, pistils and lodiculae enclosed by the lemma and palea

Glabrous
having no projections or pubescence

Glume
2 bracts found at the base of a grass or cereal spikelet

Giant oats
a common mutant found in oat crops; may be called a vegetative or monster oat; these mutants are much larger than normal oat plants with a very wide leaf; the plants are usually greener and much later than the rest of the plants; they may or may not produce panicles, and if they do produce panicles, they often don't produce seed before harvest.

Hull
the outer covering of a seed made up of the lemma and palea which may be removed freely as in wheat, or adhere as in hulled barley

Hulless
a seed which has no outer covering or has an outer covering which is easily removed

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

Inflorescence
the head of cereal crops consisting of flowers grouped on the rachis, the central axis

Lemma
the lower or dorsal bract of the spikelet enclosing the seed; in wheat, it is readily removed with threshing, but may adhere in hulled barley and oats

Lodiculae
small scales at the base of the ovary in a grass flower; believed to be a rudimentary perianth

Monoecious
having male and female reproductive organs borne on a single plant

Nodes
the point on a stem from which leaves, shoots, or flowers grow

Palea
the upper bract that, with the lemma, forms 2 bracts that enclose the grass floret

Panicle
the inflorescence of oats consisting of a main stem with branches and sub-branches arising from a central axis

Pollination
the process by which pollen is transferred from the anther (male part of a flower) to the stigmatic surface of the pistil (female part of a flower)

Rachilla
the axis of the spikelet that bears the florets

Rachis
an extension of the stem on which the spikelets are found

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

Speltoid
common mutants in wheat crops; can appear in a number of different forms, the most common and readily visible being the "tall late" which is taller and later than normal for the variety; the heads are longer and thinner with a distinct taper from base to tip; glumes are strongly keeled with a square shoulder and generally are stiff and cannot be bent away from the spikelet without breaking; speltoids tend to be self-eliminating because they are late maturing, hard to thresh, small seeded and often have low fertility

Supernumerary spikelets
spikelets arising from the nodes below and at right angles to the normal spikelets; produced in a large proportion of certain wheat and triticale varieties; vary in size and development; in varieties which produce many supernumerary spikelets, the ears look ragged or untidy because the

supernumerary spikelets arise at random up the length of the ear disturbing the normal neat alternate arrangement of spikelets

3.1 Common morphological synonyms

- awn and beard
- chaff and glumes
- culm, straw and stem
- glabrous and bald
- glaucosity and waxiness
- head, spike, ear, inflorescence and flower
- hulled, covered
- hulless, naked
- lemma, lower bract
- node, joint
- palea, upper bract
- pubescent, hairy

4.0 Specific inspection procedures

Inspection of pedigreed seed crops of cereals and small grains should be conducted in accordance with SWI 142.1.1 Pedigreed Seed Crop Inspection, as well as the instructions provided in this SWI.

Specific conditions or requirements for different crop types are addressed in crop-specific sections of this document.

4.1 Inspection requirements

Each cereal crop will require 1 inspection performed between the time of heading and maturity.The inspection of traditional cereal crops is conducted after anthesis, and when distinguishing characteristics are visible. Durum wheat must be inspected when awn colour is visible. Oats are best inspected when the plants are still green to distinguish differences in the colour of the plants. However, when oats are ripe, it is easier to find fatuoid oats since the top florets shell out and the empty glumes are most visible. In all cases, the inspection should not be left so late in the season that the plant parts are degraded and the characteristics cannot be easily observed. Refer to section 4.1.1 for specific inspection timing of certified hybrid cereals and section 4.1.2 for the timing of hybrid cereal parent lines.

Most cereal crops are self-pollinated and therefore usually only require small isolation distances from different varieties or non-pedigreed crops of the same crop kind. Rye, however, is a cross-pollinated crop and requires a larger isolation distance from different varieties or non-pedigreed crops of rye.

Seed crop inspectors should refer to Circular 6 for details on isolation requirements, previous land use and other requirements for inspection of specific crop kinds.

The seed crop inspector should refer to appendices I to V for general descriptions of cereal species to assist in varietal identification.

For buckwheat and canary seed, 1 inspection must be conducted when the crop is in bloom. Flax crops must be inspected at full bloom and the inspection should take place in the morning. Refer to appendix VI for descriptions, diagrams, and diseases of buckwheat, canary seed, and flax.

4.1.1 Crop inspection of hybrid cereal certified production

For certified production, the 2 parent lines about 92% male sterile (female parent) and 8% male fertile (male parent/pollen shedding parent) are blended (comingled) and planted in the field as a technical blend. Another production method would be to plant seed of separate R-line (male seed parent) and A-line (female seed parent) in rows or bays.

Variety descriptions for both parent lines are required for comparison during the inspection. The variety description for the resulting progeny (Certified hybrid seed) isn't used during the inspection. For Certified seed, counts are conducted in both the fertile and sterile lines like varietal blend production when seeded as a technical blend (comingled). If seeded in bays or rows then formal counts are only made in the A-line as the R-line plants are usually removed before seed set and harvest for seed production. Impurities in the R-line are reported only when these impurities are not observed in the count area.

When partial fertile A-line plants or fertile A-line plants are observed, they are reported as off-types in hybrid cereals.

Border rows are not considered part of the field. When border rows are present, the inspector should verify that the variety planted in the border row matches the variety description for the male parent. The border should also be checked for other varieties of the inspected crop kind that could cross pollinate with the inspected crop.

Certified hybrid rye inspection timing

Hybrid rye crops must be inspected during anthesis. The fertile line (male parent) will be flowering while the sterile line (female parent) has little to no pollen shed. Pollen shedding off-types that differ from the fertile line are visible at this time.

Certified hybrid wheat inspection timing

Inspection timing differs for hybrid wheat planted as a technical blend (comingled) production or in bay and row production in the field. Technical blend (comingled) production of crops for Certified production of Cytoplasmic male sterility (CMS) hybrid wheat must be inspected at least once by an authorized inspector after plants assume mature colour, to report off-types. Bay or row production (i.e. individual parent production) of crops for Certified production of CMS hybrid wheat must be inspected at least twice by an authorized inspector. The first inspection must be completed during anthesis to report pollen shedders in the A-line. The second inspection

must be completed after plants assume mature colour to report off-types. Variety descriptions may include more requirements.

4.1.2 Crop inspection of hybrid parent lines

A-line hybrid parent seed production

Seed of separate B-line (male seed parent) and A-line (female seed parent) are usually planted in rows or bays. Formal counts are only made in the A-line as the B-line plants are usually removed before seed set and harvest for seed production. Variety descriptions for both parent lines are required for comparison during the inspection.

Border rows are not considered part of the field. When border rows are present, the inspector should verify that the variety planted in the border row matches the variety description for the male parent. The border should also be checked for other varieties of the inspected crop kind that could cross pollinate with the inspected crop.

When partially fertile A-line plants or fertile A-line plants are observed, they are reported as off-types.

Hybrid rye A-line parent seed production timing

Plots containing male sterile (female seed parent) A-line plants shall be completed during anthesis to report pollen shedders in A-line plants.

Hybrid wheat A-line parent seed production timing

Plots containing male sterile (female seed parent) A-lines require 2 inspections. First inspection must be completed during anthesis to report pollen shedders in A-line plants. Second inspections must be completed after heads assume a mature colour to report off-types.

B-line and R-line hybrid parent seed production

For both hybrid rye and wheat plots of (male maintainer) B-lines or (restorer) R-lines parent require 1 inspection. Timing of inspection for hybrid wheat B-lines and R-lines shall be completed after heads assume mature colour, to report off-types and other varieties. Timing of inspection for hybrid rye B-line and R-line parents shall be done after heading, when the plants are mature enough to show varietal characteristics.

4.2 Crop inspection of plant pest tolerance management varietal blends

Pedigreed seed of pest tolerant wheat varieties is sold as a part in a varietal blend with seed of a small proportion of a susceptible variety (refuge variety) to prolong the utility of the tolerance trait. In cases where the pests do not travel very far beyond their emergence site, the refuge variety is planted interspersed with the pest tolerant variety rather than as a border or in a block.

If pest tolerant varieties are planted in monocultures, the selection pressure in the pest population for mutations to overcome the tolerance trait is increased. In most cases, 5% to 15% of the varietal blend must be made up of the susceptible variety to provide an effective refuge.

Note: Seed crop inspectors are not expected to verify the relative proportions of tolerant and susceptible varieties in the inspected crop.

Seed crop inspectors must refer to the descriptions of the variety (DoVs) for both varieties in the varietal blend. When encountering plants that do not conform to the DoV, seed crop inspectors must determine whether the deviant plant is a plant of the interspersed susceptible variety, a described variant of either the tolerant or susceptible variety or an off-type. The seed crop inspector must provide as much detail as possible on how the deviant plants differ from the norm of the variety.

4.3 Completing the Seed Crop Inspection Report

In addition to the general instructions provided in SWI 142.1.1 Pedigreed Seed Crop Inspection, the following are key factors in completing the Seed Crop Inspection Report for specific crops:

All cereals – reporting of tall plants

Crop inspectors do not need to report plants as tall if they are shorter than the definition listed in appendix I (and otherwise conform) even if they are described in the variety description as variants. Inspectors must report a second characteristic to describe the tall plant, or note “otherwise conforms” as the second characteristic.

Barley

If smut is observed in a barley crop, it is to be documented in the Seed Crop Inspection Report in the "Disease" field of the "Condition of Crop" section. The location of the disease in the field and the frequency (trace, few, numerous) must also be reported.

Oats

When fatuoids (false wild oats) or giant oats are observed in a crop of oats, they are to be included in counts as off-types. Wild oats are reported by frequency.

Rye

As rye is an open-pollinated crop, particular attention must be paid during inspection to the neighboring crop. This requires stating the variety of, the distance to, and the pedigreed status (if any) of other crops of the same kind adjacent to the crop. If a portion of the inspected crop is removed in lieu of an isolation the inspector must state the distance that has been removed.

On the Seed Crop Inspection Report, the inspector must add a comment in the "Isolation Comments / Open Pollinated Crop Isolation Section"; for example, "None within 500 m."

Wheat

When speltoids or wheat with awns at upper half (half-awned wheat) are observed, they are to be reported as off-types.

When partial fertile male sterile (A-line) plants or fertile male sterile (A-line) plants are observed, they are reported as off-types in hybrid wheat for certified and male sterile (A-line) parent plot production. Hybrid wheat and A-line parents have large isolation distances to other varieties of wheat. On the Seed Crop Inspection Report, the inspector must add a comment in the "Isolation Comments / Open Pollinated Crop Isolation" section; for example, "None within 100 m."

Hybrid cereals – reporting of border rows

As border rows are not considered part of the field, if they are used they will form the isolation strip and should be reported as in the following example:

Strip width	Strip description	Condition	Adjacent crop description
3 m	border rows	Good	corn

If off-types or harmful contaminants are found in the border rows or in the required isolation distance, the isolation condition must be rated as "Poor."

Buckwheat

Buckwheat is an open-pollinated crop and requires a large isolation distance. On the Seed Crop Inspection Report, the inspector must add a comment in the "Isolation Comments / Open Pollinated Crop Isolation" section; for example, "None within 200 m."

Flax

For flax, the time of day the crop was inspected and the percentage of plants in flower must be recorded in the "Comments" section of the Seed Crop Inspection Report.

It is not necessary to report flax plants with fasciated stems.

4.4 Previous land use

The seed crop inspector should refer to Circular 6 to determine the conditions for the production of a pedigreed seed crop on land previously planted to similar crops kinds.

Appendices

Appendix I: Descriptions of cereal species

The following section outlines the characteristics displayed at the time of inspection for cereal species commonly grown for pedigreed status seed.

The seed crop is inspected for varietal purity and varietal identity based on a comparison with the descriptions of specific morphological characteristics provided in the DoV for the variety.

The following table lists common visual morphological characteristics of multiple cereal species that are useful in inspecting pedigreed status seed crops of cereals. Other characteristics which are unique to a single cereal species are outlined in appendices II to V.

Table 1. Cereal crop specific visual morphological characteristics and descriptions

Species	Characteristic	Characteristic description
wheat, durum, spelt, triticale	straw pith	Cut the straw cleanly at a mid-point between the ear and the upper stem node. The thickness of the wall of the stem depends on the amount of soft tissue beneath the hard epidermis and is classified as either thin, medium, and thick or filled. This characteristic must not be regarded as definitive as variations occur as a result of different environmental and climatic conditions. In sawfly resistant varieties, the pith is always thick or filled as a defence mechanism against the sawfly. (See appendix II)
wheat, durum, spelt, barley, triticale, rye	spike attitude (at maturity)	Spike attitude descriptions include: erect, semi-erect, inclined, horizontal, semi-nodding, nodding.
wheat, durum, spelt, barley, triticale, rye	spike shape	The spike shape is often determined by the density of the grains. A very dense grain arrangement on a short spike usually results in a clavate shaped spike.
wheat, durum, spelt, rye, triticale	spike density	Spike density is determined by the relative length of the rachis segments, and ranging from lax to dense. Varieties with visible spaces between grains when viewed from the side as a result of long rachis segments within the spike are described as lax. (See appendix II)

Species	Characteristic	Characteristic description
oats, barley	hulledness	Varieties of hulless oats and barley are essentially 'naked' and the seeds are released easily from the lemma and palea. Varieties of hulled oats and barley have lemma and palea which adhere tightly to the seed.
wheat, durum, spelt, barley, triticale	lower glume pubescence	Glumes of certain uncommon varieties are covered with a mat of fine hairs which resemble felt or fine fur. Glume pubescence is a very distinct character that is classified as absent or present.
wheat, durum, spelt, barley, triticale	awn length	The actual length of the awns as they extend beyond the spike can vary from extending longer than the length of the spike itself to extending less than the length of the spike. Awns are at least 30 mm in length.
wheat, durum, spelt, triticale	awnlet length	The length of an awnlet is between 5 mm and 30 mm. If less than 5 mm, the spike is considered to have awnlets and awns absent.
wheat, durum, spelt barley, triticale	glaucosity	Many varieties have a coating of wax on leaves, stems and other surfaces. Non-waxy or non-glaucous surfaces actually have a glossy appearance whereas 'waxy' surfaces have a thin deposit of dull waxy powder which is white, pale-grey or light blue in colour. Flag leaves and spikes without a waxy surface appear 'yellow-green' instead of 'blue-green'. The best places to find a waxy surface are the base of the ventral sides of the lemma, the lower part of the palea, or the stem. The location of wax may be influenced by the environment.
wheat, durum, spelt, barley, triticale, oat	plant height (tall off-types or variants)	If the plant is significantly taller than the crop in the immediate area and the plant population is uniform, height can be a characteristic for describing varietal purity. As a guideline for assessing 'talls' all the spikes on the plant should be: • wheat, 2 to 3 spikes taller (spike only, excluding awns) • barley, 1 to 2 spikes taller • triticale, at least 3 spikes taller • oats, 1 panicle taller
wheat, spelt durum, triticale, spelt	glume internal imprint	These clearly marked areas are caused by the pressure of the external surface of the lemma. This area can be seen as dark shadowy areas between the veins or nerves which run from the base of the glume to the beak and shoulder margins and are classified as absent, small, medium or large.

Appendix II: Wheat, durum, spelt and triticale description and diagrams

Following the 2019 changes in variety description requirements, the wheat, durum, spelt, triticale, barley and oats descriptors and diagrams in this document have been updated to show the way varieties are described in 2019 onward. Some descriptions of varieties issued before 2019 have been updated. Inspectors must use the newer (current) terms listed in this document to describe off-types/variants on the Seed Crop Inspection Report.

Wheat, durum and spelt description

Wheat is a monoecious plant with perfect flowers (both male and female reproductive parts in the same flower). It reproduces sexually as a self-pollinated crop. Cross pollination occurs at usually less than 3%, however may be as high as 10% in some varieties and/or environments. The inflorescence of wheat is a determinate composite spike. Spikelets are alternately arranged on the rachis. Each spikelet has 2 bract-like empty glumes that enclose 2 to 9 florets. The outer parts of each floret consist of a lemma and a palea.

There are 3 types of wheat: spring wheat, winter wheat and durum wheat. Winter wheat is the same species as spring wheat (*Triticum aestivum*) and shares the same identification characters. Winter wheat differs from spring wheat in that it has a winter habit, requiring vernalization, wherein the exposure to cool temperatures and short day initiates reproduction. Winter wheat is planted in the late summer, overwintering as an herbaceous plant, and then flowers and sets seed the following summer, earlier than spring planted varieties of spring wheat.

Durum wheat (*Triticum turgidum* spp. *durum*) is a separate species from spring and winter wheats. The spike and neck of durum wheat are more compact than those of common wheat and appear squarish in cross section. Durum wheat is always awned. Different varieties of durum can sometimes be distinguished by their awn colour (black or white) which is expressed as the plants near maturity. The awn colour may be affected by frost (bleaches out the colour) or other environmental influences.

The seed crop inspector, inspecting seed crops of cereal species should be familiar with einkorn, emmer and spelt species which are precursors to modern cereals. Einkorn along with emmer and spelt are often referred to as 'the covered wheats', since the kernels do not thresh free of the lemma, palea, and glume upon harvesting. Small quantities of these crop kinds are certified in Canada, therefore there is the potential that they may be present as impurities during crop inspection.

Care should be taken when a wheat plant with a bleached white spike is discovered as this may not be an off-type. Bleached white spikes are most commonly caused by *Fusarium*, but may also be caused by diseases such as take-all, eyespot, or cephalosporium stripe, by insects such as sawfly, or stem maggots, by environmental conditions or herbicide exposure. For more information, see CropPest Ontario, volume 16, issue 6 (June 17, 2011).

Triticale description

Triticale (*Triticosecale*) is a cross between wheat and rye. Morphologically it resembles its wheat parent, but exhibits the more vigorous growth characteristics of rye. Triticale has either a spring or winter growth habit, has variable plant height and tends to tiller less than wheat.

The inflorescence of triticale is a spike resembling that of wheat more than rye, and is often considerably larger than that of wheat or rye. As with both parents, the spike of triticale is composed of a series of some 30 to 40 spikelets arranged alternately on each side of the rachis. Each spikelet consists of 4 to 8 florets, of which usually only 3 are fertile. Each spikelet is surrounded by 2 glumes of chaff, and the lemma and palea enclose each floret in the spikelet. The lemmas generally taper into a 7 cm to 10 cm long awn. The awn length vary between varieties. Due to its free-threshing property, the lemma and palea do not adhere to the kernel during threshing.

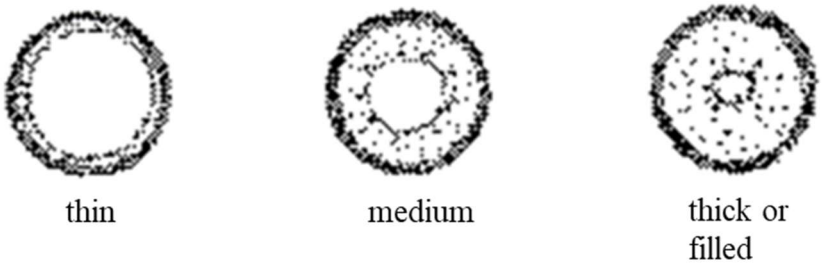
It is a self-pollinating species with the pollen being released within the floret. The period of anthesis in triticale varies among varieties but generally is longer than in wheat and thus triticale is more susceptible to out-crossing. Anthesis normally begins in the central portion of the spike when the spike has completely emerged from the leaf sheath. Triticale varieties are often 1 or 2 weeks later maturing than wheat.

List of traits to consider when inspecting wheat, spelt and triticale varieties

- plant height (stem plus spike, excluding awns)
- straw pith thickness
- culm uppermost node characteristics
    - pubescence
    - glaucosity
- spike characteristics
    - attitude
    - awnedness and location of awns and awnlets
    - colour
    - density
    - length (excluding awns)
    - shape
    - glaucosity
- awn or awnlet characteristics
    - attitude
    - colour
    - length
- lower glume characteristics (best observed on spikelets in the middle third of the spike)
    - length and width
    - beak shape
    - beak length
    - shoulder shape and shoulder width
    - pubescence

Wheat, durum, spelt and triticale diagrams

Straw pith thickness (in cross section of the straw at middle of internode below the neck)



Description of diagram of straw pith thickness:
This diagram shows the different straw pith thicknesses (in cross section at middle of internode below the neck) - thin, medium and thick or filled (filled, or nearly filled with pith).

Spike density (head density)

Description of diagram of spike density:
This diagram shows 3 types of spike density - lax, medium, and dense.

Spike awnedness and location of awns on spike

Table 2. Comparison of pre-2019 and current spike awnedness descriptors

Pre-2019 spike awnedness descriptors	awnless	apically awnletted	n/a	awnletted	apically awned or tip awned	half-awned	awned
							
Current descriptors spike awnedness + location on spike	awnlets and awns absent	awnlets at tip	awnlets at upper half	awnlets on full length	awns at tip	awns at upper half	awns on full length

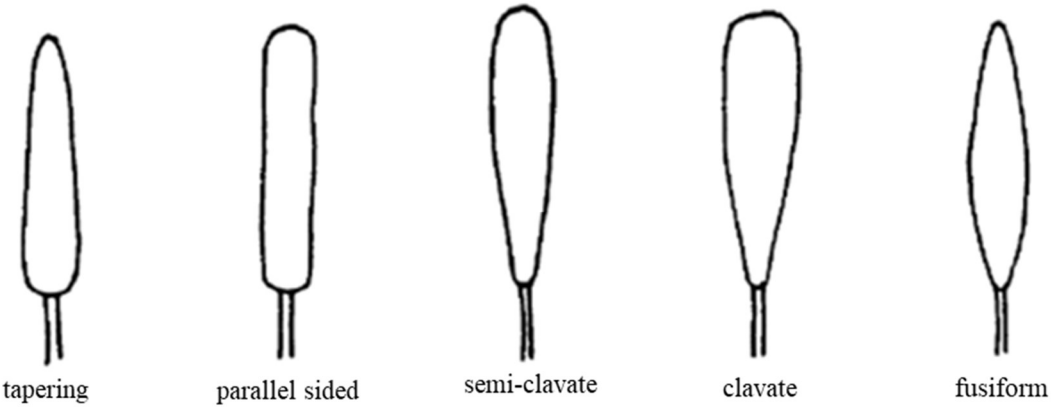
Source: Adapted from International Union for the Protection of New Varieties of Plants (UPOV), 2017. Wheat guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva.

Description of table of spike awnedness:
This table shows 7 types of spike awnedness, as described using current descriptors and pre-2019 descriptors - awnlets and awns absent (awnless), awnlets at tip (apically awnletted), awnlets at upper half (n/a), awnlets on full length (awnletted), awns at tip (apically awned or tip awned), awns at upper half (half awned), and awns on full length (awned).

When using the current descriptors, “awnedness” is combined with “location of awns or awnlets on spike” to create a full description.

An awnlet can measure 5 mm to 30 mm. An awn is greater than 30 mm long.

Spike shape (head shape)



Source: UPOV, 2017.Wheat guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva.

Description of diagram of spike shape:
This diagram shows 5 wheat spike shapes - tapering, parallel sided, semi-clavate, clavate, and fusiform.

Lower glume beak shape

Table 3. Comparison of pre-2019 and current lower glume beak shape descriptors

Pre-2019 lower glume beak shape descriptors	n/a	obtuse	acute	acuminate	n/a
					
Current lower glume beak shape descriptors	straight	slightly curved	moderately curved	strongly curved	geniculate

Source: Adapted from UPOV, 2017.Wheat guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva.

Description of table of lower glume beak shape:
This table shows 5 types of lower glume beak shape: straight, slightly curved, moderately curved, strongly curved and geniculate, as well as the descriptors used before 2019: obtuse, acute, acuminate.

Lower glume beak length

Source: UPOV, 2017.Wheat guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva.

Description of diagram of wheat lower glume beak length:
This diagram shows 5 different glume beak lengths: very short, short, medium, long and very long.

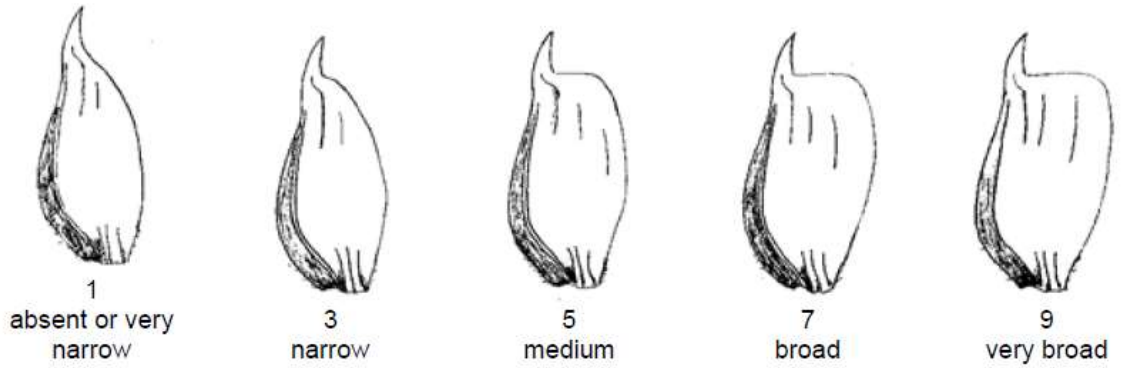
Table 4. Lower glume shoulder shape

Pre-2019 descriptor	wanting	oblique or rounded	square	elevated	apiculate
					
Current descriptor	strongly sloping	slightly sloping	straight	slightly elevated	strongly elevated

Source: Adapted from UPOV, 2017.Wheat guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva.

Description of table of wheat glume shoulder shape:
This table shows 5 types of lower glume shoulder shape: strongly sloping, slightly sloping, horizontal, slightly elevated and strongly elevated, as well as the descriptors used before 2019: wanting, oblique or rounded, square, elevated and apiculate.

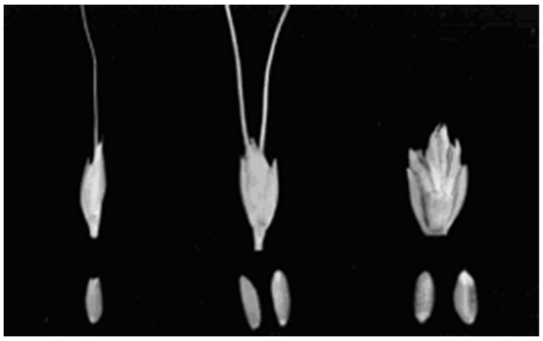
Lower glume shoulder width



Source: UPOV, 2017.Wheat guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva.

Description of diagram of wheat lower glume shoulder width:
This diagram shows 5 types of glume shoulder width: absent or very narrow, narrow, medium, broad and very broad.

Spike and spikelet of einkorn, emmer and spelt



Einkorn Emmer Spelt Einkorn Emmer Spelt

Description of photos of the spike and spikelet of einkorn, emmer and spelt:
2 photographs are presented; the first a photo of the spikes of einkorn, emmer and spelt; the second a photo of the spikelets of einkorn, emmer and spelt.

Appendix III: Barley descriptions and diagrams

There are 2 main types of cultivated barley: 2-row and 6-row. Each type has 3 spikelets at each rachis node (1 central and 2 laterals), and each spikelet contains 1 floret. Groups of spikelets are arranged in an alternate and opposite fashion on the rachis. The lateral spikelets of 2-rowed barley are sterile and the central is fertile, resulting in 2 rows of kernels on the rachis. All florets of 6-rowed barley may be fertile, resulting in 6 rows of kernels when viewed in cross section or from the top of the spikelet. Cultivated barley species are naturally self-pollinating.

In addition to the main 2-row versus 6-row distinguishing factor, barley varieties also vary in that they may be winter or spring, hulled or hulless, for forage or grain, and for malting or feed purposes. Some forage barley varieties have increased isolation requirements as specified by the variety developer. This additional requirement can be found in the "Additional comments" section of the DoV.

Unlike wheat, the characteristics identifying barley are considered as definitive in that they do not vary over a range, resulting in greater certainty when identifying varieties. The following characteristics are to be considered for observations of varietal purity and identity during seed crop inspection.

Barley plant characteristics after heading

Many characteristics useful in distinguishing barley varieties are best observed when the seeds on the spikes are ripe. These characteristics may not be present if inspections are conducted before the seed has fully matured. For this reason, some of the following information may not be entirely useful as seed crop inspections are usually conducted after the grains begin to mature.

Kernel: In 6-row varieties, the central kernels are slightly larger and plumper than the lateral kernels, while the kernels of 2-row varieties are all uniform in shape and size. The length of hair on the rachilla can be useful in distinguishing between varieties. It ranges from short to long and sometimes there is a mix of both length. In these cases, the percentage of each will be indicated. The colour of the aleurone layer of a dehulled barley kernel may be yellow, white or a blue shade.

Lemma awns: In some varieties, especially those with dense spikes, the awns tend to spread out like a fan. In certain varieties, the lemma awns are discarded as the grain ripens. This 'dropping-off' of awns can also occur in normal varieties under certain climatic conditions such as extreme drought.

Lemma awns may be described as awns absent (awnless), awnlets present, awns present (short, medium, long), or hooded. Hooded varieties and awnless varieties are not common but may be found as off-types.

Lemma awns can be very smooth, smooth, semi-smooth, rough, or very rough, depending on the presence of lemma awn barbs.

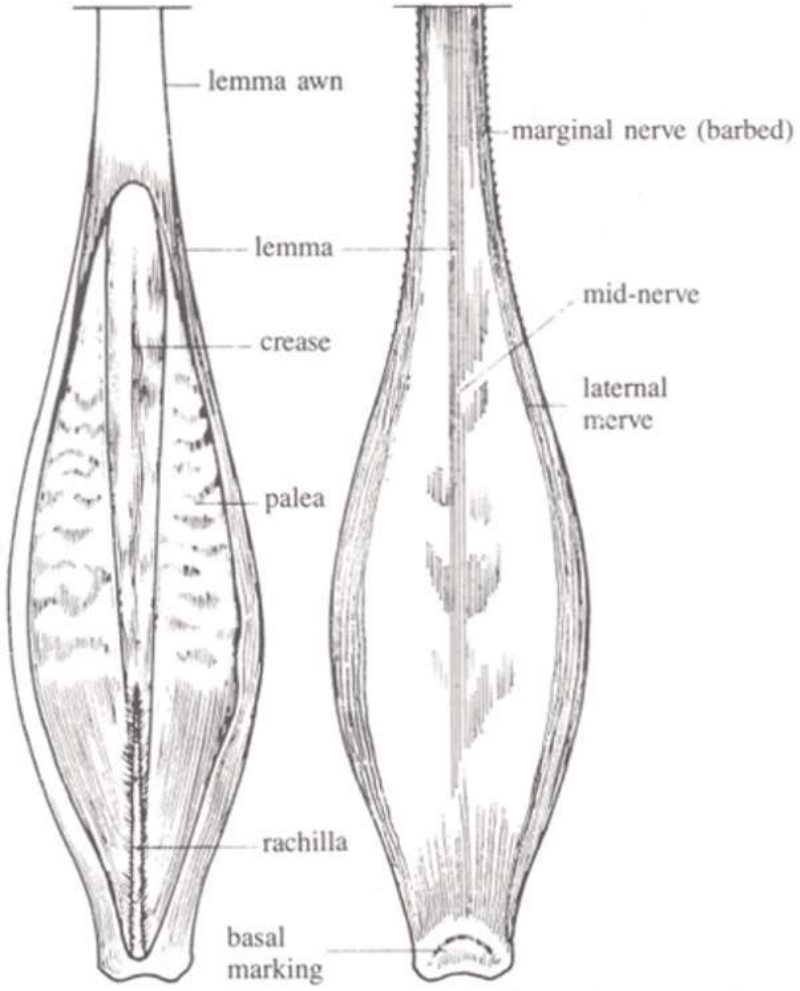
Anthocyanin: Many varieties contain this purple or red pigment in various parts of the plant in the vegetative and reproductive stages. Most pigmented varieties tend to lose this colour as the plants ripen, but some will retain the pigment in the 5 dorsal lateral nerves of the developing grain. Positive identification of non-pigmented varieties by reference to fully mature grain is impossible, but the anthocyanin pigment's presence can be detected in growing plant material. The best places to look are in the basal leaf sheath of the first leaf, the stem nodes and auricles, and especially in the tips of the lemma awns if the plant is still green.

List of traits to consider when inspecting barley varieties

- plant height (stem plus spike)
- spike characteristics
    - attitude
    - length (excluding awns)
    - shape
    - waxiness
    - lemma awn tip colour (anthocyanin)
    - lemma awn/awnlet length
    - lemma awn attitude
    - lemma awn barbs
    - glume awn length
- kernel characteristics
    - aleurone colour
    - rachilla hair length

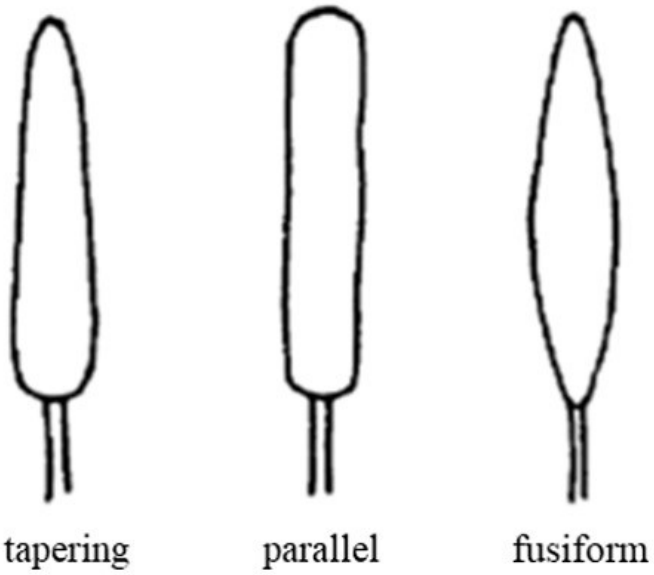
Barley diagrams

Barley kernel



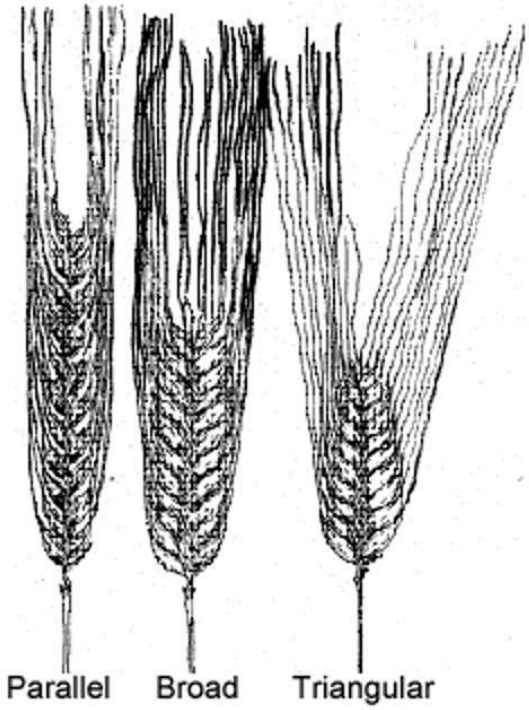
Description of diagram of barley kernel:
The diagram depicts a whole barley kernel and identifies the lemma awn, lemma, crease, palea, rachilla, marginal nerve (barbed), mid-nerve, lateral nerve and the basal marking.

Barley spike shape



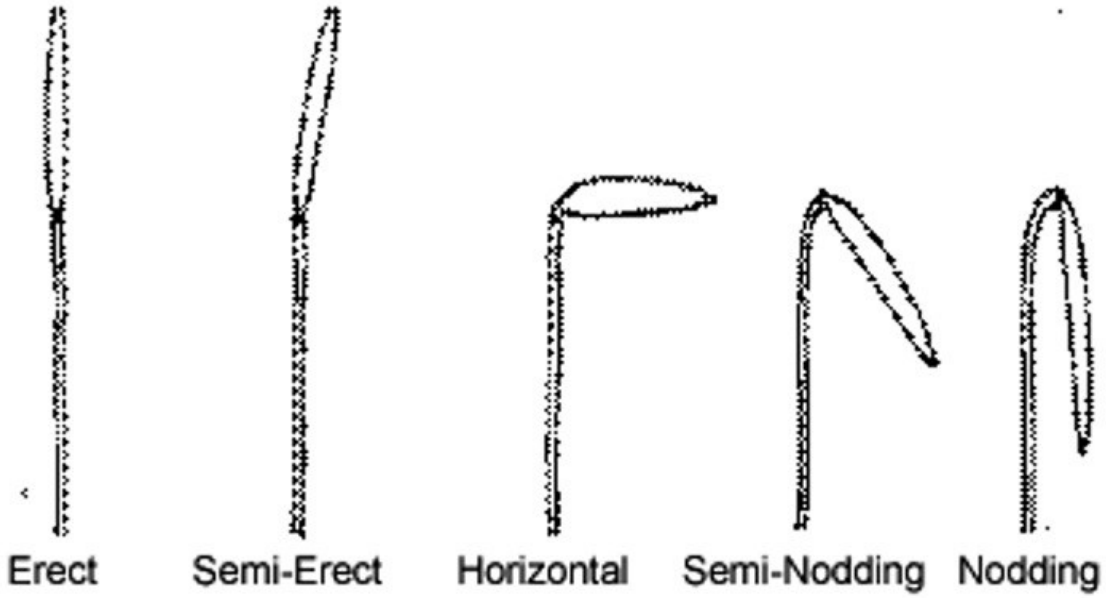
Description of diagram of barley spike shape:
This diagram shows 3 different spike shapes – tapering, parallel, and fusiform.

Barley awn attitude



Description of diagram of barley awn attitude:
This diagram shows 3 different attitudes of the awns of barley - parallel, broad, and triangular.

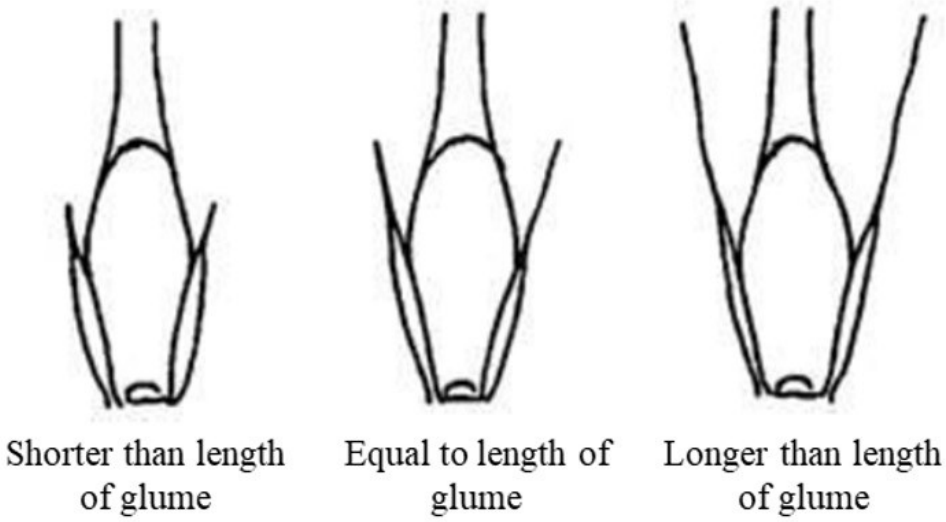
Barley spike attitude



Adapted from UPOV, 2017. Barley guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva

Description of the diagram of barley spike attitude:
This diagram shows 5 different barley spike attitudes – erect, semi-erect, horizontal, semi-nodding, and nodding.

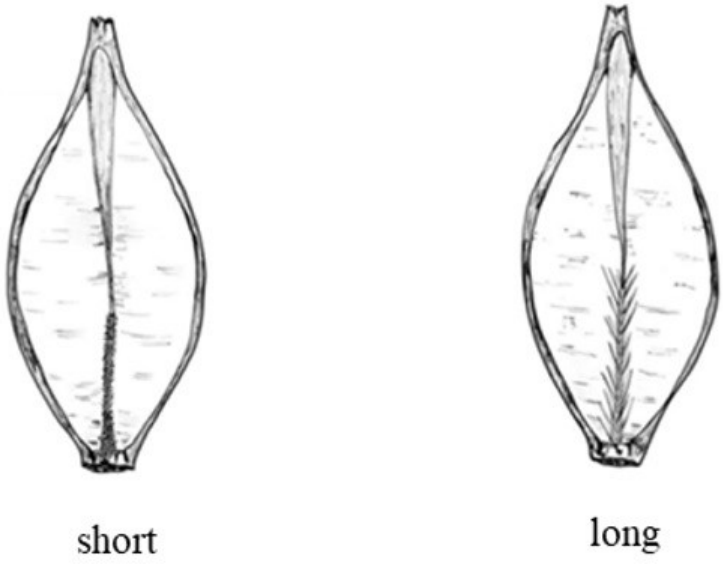
Barley glume awn length



Adapted from UPOV, 2017. Barley guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva

Description of diagram of barley glume awn length:
This diagram shows 3 different lengths of the glume awns of barley - shorter than length of glume, equal to length of glume, and longer than length of glume.

Barley rachilla hair length



Source: UPOV, 2017. Barley guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva

Description of the diagram of barley rachilla hair length:
This diagram shows short and long hair on the rachillas.

Appendix IV: Oats description and diagrams

Oat is an annual, self-pollinating grass for which out-crossing seldom exceeds 0.5%. The stem is composed of a series of nodes and internodes with alternate leaves. The stem usually contains 4 to 7 elongated internodes and the uppermost internode is often as long as the combined length of all other internodes.

Mature stems terminate in a loose, open panicle. The main axis of the panicle terminates in a single spikelet. Alternate groups of branches arise from the main axis and each branch terminates in a single spikelet. The number of spikelets per panicle normally ranges from 25 to 45 depending on genotype and growing conditions. Each spikelet usually contains from 1 to 3 florets enclosed in empty glumes with the tip of 1 glume extending slightly above the other. Usually only the 2 basal florets are fertile, but on occasion 3 or more are fertile.

Each flower is perfect and has 3 stamens, 1 pistil and 2 lodicules. The flower is enclosed by 2 bracts, the lemma and palea, which are known as the hulls on the harvested oat grain. While both spring and winter types of oats exist, winter hardiness in oats is not sufficient to allow winter crops of oats to survive in Canada.

There are 2 types of oats. *Avena sativa* which is a covered oat species (hulled oats) and *Avena nuda* (hulless oats).

Oat plant characteristics after heading

The following characteristics are to be considered for observations of varietal purity and identity during seed crop inspection.

Panicle type: Varieties can be divided into 2 groups according to their panicle type. Varieties whose panicles are equilateral (symmetrical) give the general appearance of a triangle or cone. This arrangement is the most common.

Varieties whose panicles are unilateral (side panicle) appear 1-sided so that all the branches tend to be on 1 side of the main rachis of the panicle. These varieties are sometimes referred to as "side oats". Unilateral panicles tend to lean over due to the lop-sided weight of the grains and can be easily identified when found as a contaminant in a crop of plants with equilateral panicles. Sometimes, however, this trait is not the result of a contaminant, but a border row effect whereby equilateral varieties resemble unilateral varieties along the outside of border rows due to excess water along the field's edge. Unilateral panicles may possess a thickened swelling or false node below the lowest whorl of branches.

Semi-unilateral and sub-unilateral varieties, also described as intermediate, exist in that some branches do not conform entirely to the unilateral characteristic. A few varieties change from the equilateral type to semi-unilateral as they ripen.

Rachilla characteristics: (observe at green stage shortly after heading) The rachillas on the upper region of the panicles possess certain features which can be used in the observation of varietal purity and identity.

Rachilla length of grooves: In many varieties the rachilla has 2 longitudinal depressions down each side of a central raised section. These depressions are often grooved and the extent to which they extend down the rachilla is a varietal characteristic.

Rachilla pubescence: In most varieties the rachilla is glabrous, though some varieties have short hairs, spines or barbs which are attached to the surface of the rachilla and their presence can be described from sparse to dense.

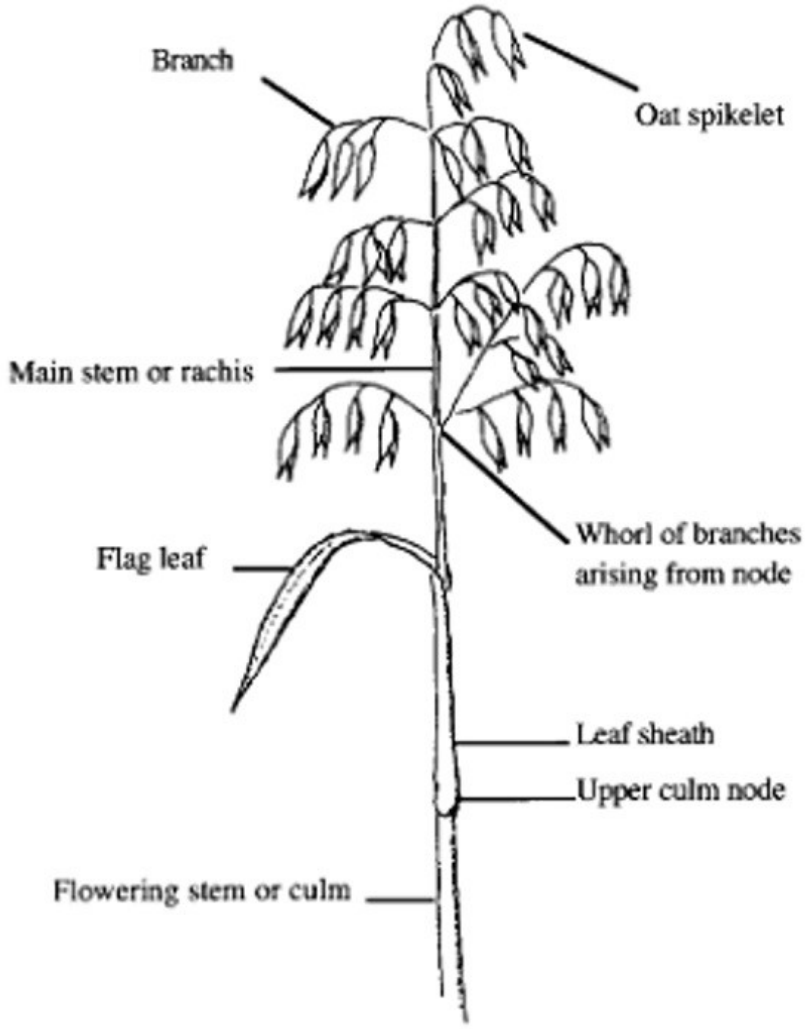
Lemma tendency to be awned: In certain varieties, most primary grains may have awns arising from the median nerve on the dorsal side of the lemma. The presence or absence of awns and the number of primary grains producing these awns can be influenced by environmental factors thus caution should be used when observing this characteristic.

List of traits to consider when inspecting oat varieties

- plant height at maturity (culm plus panicle)
- upper culm node pubescence
- panicle characteristics
    - panicle length
    - panicle orientation of branches
    - panicle attitude of branch position
    - side branch angle (angle between rachis and dominant side branch)
    - average number of grains per spikelet
- kernel characteristics
    - hulled or hulless
    - basal hair presence

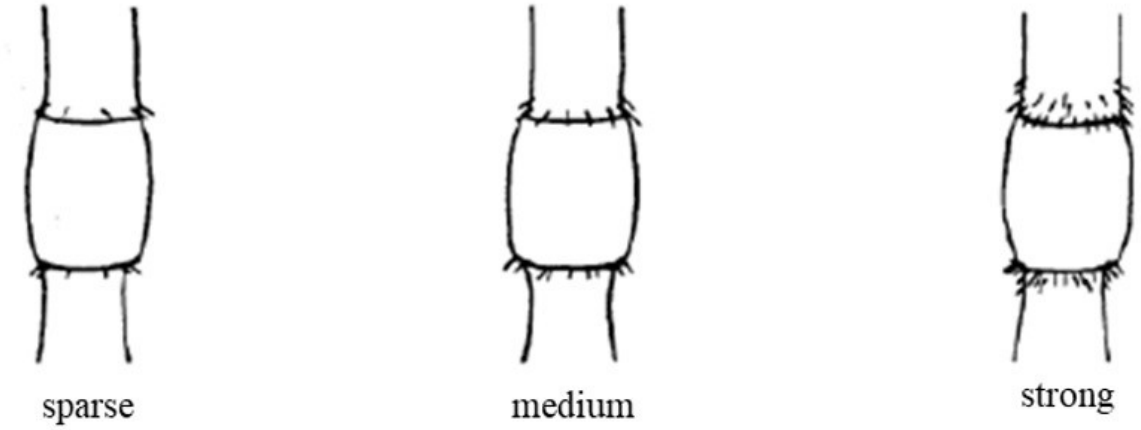
Oat diagrams

Oat panicle characteristics



Description of the diagram of the oat panicle characteristics:
The diagram shows the oat panicle characteristics – flowering stem or culm, upper culm node, leaf sheath, flag leaf, whorl of branches arising from node, main stem or rachis, branch (of rachis), and oat spikelet.

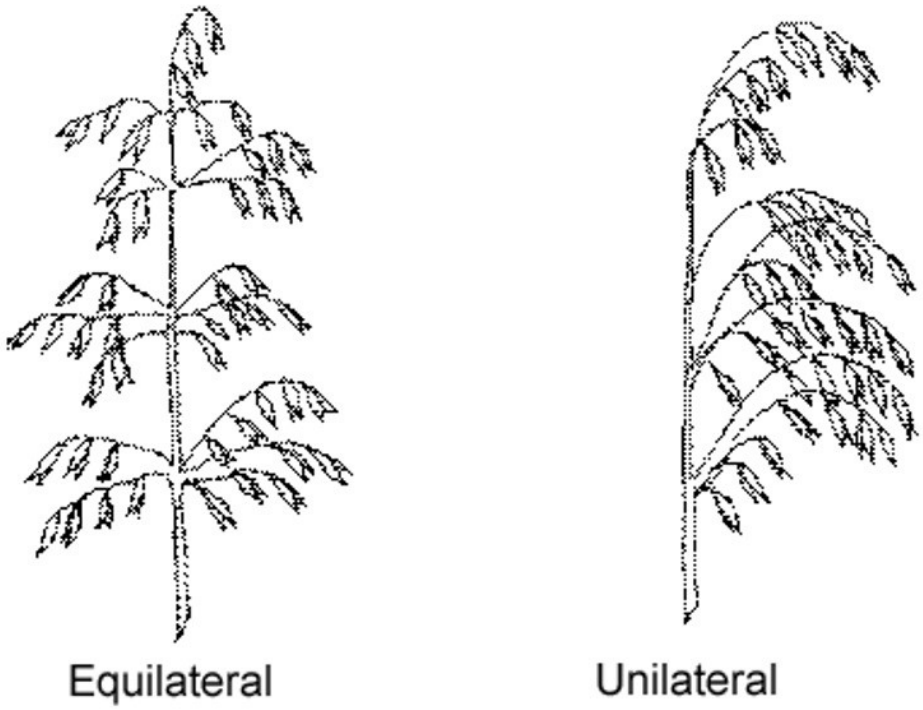
Oat upper culm node pubescence



Source: UPOV, 2017. Oats guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva

Description of diagram of oat upper culm node pubescence:
This diagram shows 3 different intensities of upper culm node pubescence: sparse, medium and strong.

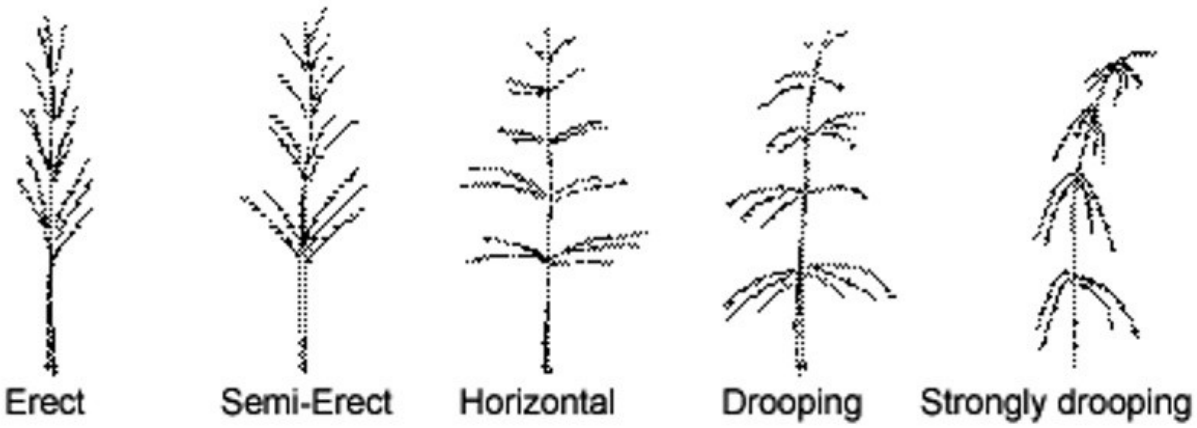
Oat panicle orientation of branches



Source: UPOV, 2017. Oats guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva

Description of diagram of oat panicle orientation of branches:
This diagram shows 2 different oat panicle orientations of branches – equilateral (symmetrical) and unilateral (side panicle).

Panicle attitude of branch position



Source: UPOV, 2017. Oats guidelines for the conduct of tests for the distinctness, uniformity and stability. TG/3/12 Geneva

Description of diagram of panicle attitude of branch position:
This diagram shows 5 different positions – erect, semi-erect, horizontal, drooping, and strongly drooping.

Appendix V: Rye description and diagrams

Of all the cereals, rye most closely resembles wheat morphologically. Although the leaves are similar in shape to those of wheat, they tend to exhibit a typical bluish colour. Rye is typically taller and tillers less profusely than wheat. The fine pubescence covering the sheath of rye seedlings distinguishes them from other cereal seedlings. The plants have numerous, highly branching, deep roots.

The inflorescence is a rather lax, slender spike, 10 cm to 15 cm long. The spikelets at each node of the rachis usually contain 3 florets, with the 2 outer florets being fertile and the central 1 being sterile. As in wheat, the lemma and palea which enclose the floret are free-threshing. The lemmas which are longer than the glumes, taper gradually and often bear barbs on the keel, and awns of intermediate length. The kernels are longer and more slender than those of wheat.

Rye differs from other small grains in that the crop is largely cross-pollinated, as most rye plants are self-sterile, and characteristically some florets fail to set seed. The spike attitude varies with variety and can be erect or nodding. Rye varieties can be distinguished from 1 another by observing their spike form (fusiform, elliptic or oblong), the kernel size and shape, and the degree of blue or green colouration.

The open glume orientation of rye renders it highly susceptible to ergot. Rye has a tendency to ripen quickly which makes the heads more prone to shattering, and allows only a narrow window of time for inspection of seed crops of rye.

List traits to consider when inspecting rye varieties

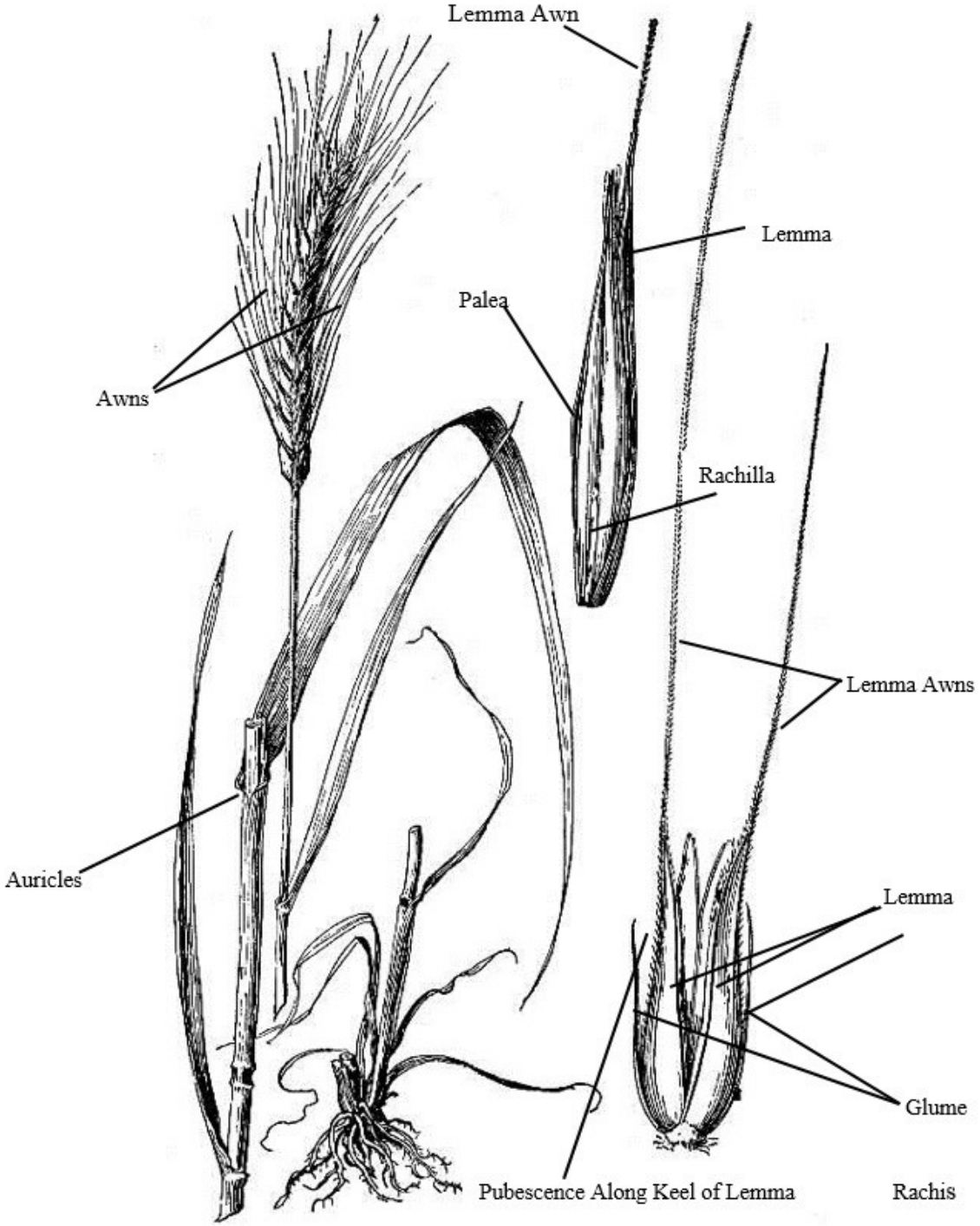
- plant height (stem plus head)
- stem pubescence
- degree of colouration
- head characteristics
    - attitude
    - awns
    - density
    - length (excluding awns)
    - shape
    - waxiness

Rye diagram

Rye plant

Description of photo of rye plant:
The picture depicts the head of a rye plant.

Diagram of rye plant parts



USDA-NRCS PLANTS Database / Hitchcock, A.S. (rev. A. Chase).1950. Manual of the grasses of the United States. USDA Miscellaneous Publication No. 200. Washington, DC.

Description of diagram of rye plant parts:
A rye plant showing the awns on the head and the auricles, and details of the spikelet and floret (including the lemma, palea, glumes, rachis and rachilla).

Appendix VI: Buckwheat, canary seed, and flax descriptions, diagrams, and diseases

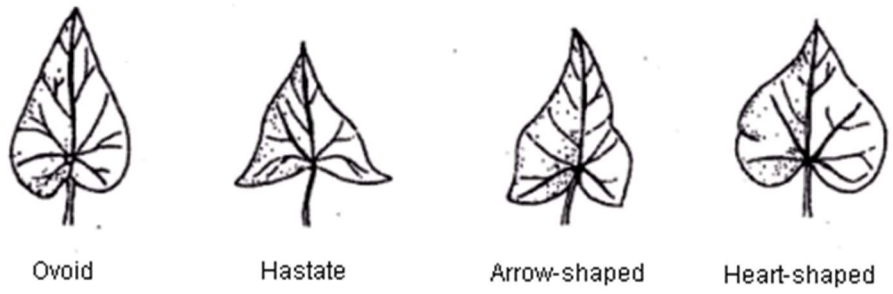
Buckwheat

Common buckwheat (Fagopyrum esculentum) likely originated in central and western China and was brought to Europe during the Middle Ages. It is not a member of the grass family and thus is not a "true" cereal. The erect plant grows from 0.6 m to 1.5 m and has heart-shaped leaves and brown, gray-brown or black triangular seeds. Buckwheat performs best in cool, moist climates. It has a short growing period of 80 to 90 days. Because its growth habit is indeterminate, its seed crop does not mature all at 1 time. Buckwheat is an open-pollinated crop.

Distinguishing characteristics:

- stem colour
- stem thickness
- leaf size
- leaf shape
- leaf colour
- plant height
- flower colour
- terminal inflorescence density
- seed colour
- seed shape

Buckwheat leaf shape



Description of diagram of buckwheat leaf shape:
4 leaf shape diagrams are presented – ovoid, hastate, arrow-shaped, and heart-shaped

Buckwheat terminal inflorescence density

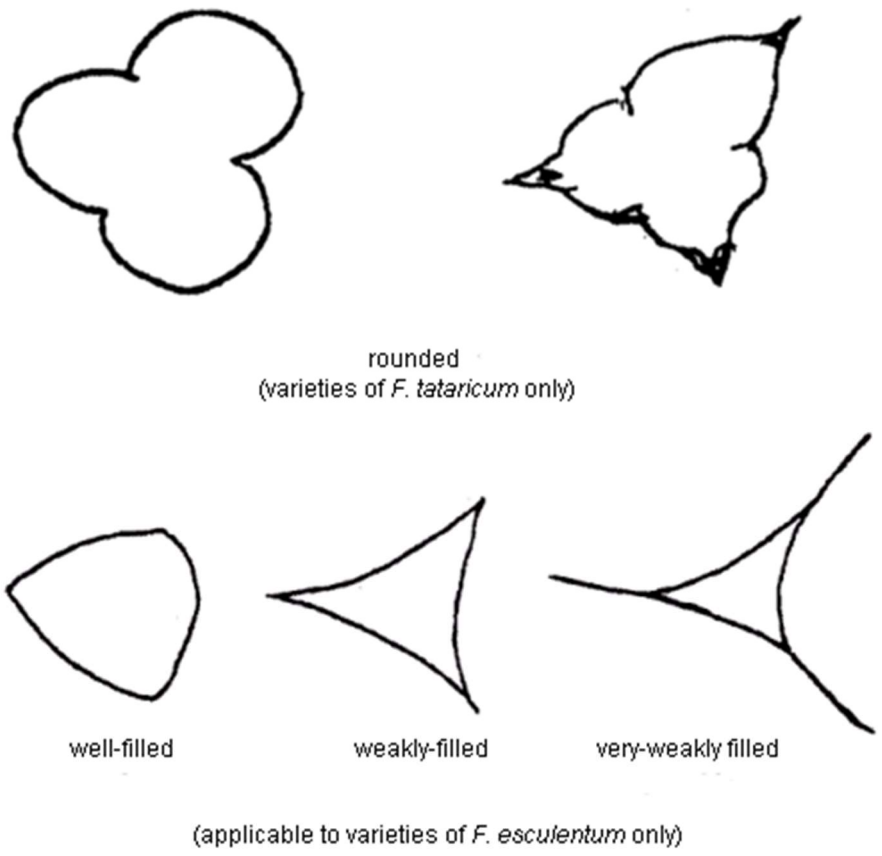
loose umbel

semi-compact umbel

compact umbel

Description of diagram of buckwheat terminal inflorescence density:
3 diagrams of terminal inflorescence density are presented – loose umbel, semi-compact umbel, and compact umbel

Buckwheat degree of seed filling



Description of diagram of buckwheat degree of seed filling:
5 diagrams of degree of seed filling are presented – 2 rounded (varieties of *F. tataricum* only) and 3 filled (well-filled, weakly-filled, and very-weakly filled) (applicable to varieties of *F. esculentum* only)

Buckwheat disease

Downy mildew

Symptoms can be seen at all growth stages. Large chlorotic lesions and stunting are characteristic symptoms.

Canary seed

Canary seed (*Phalaris canariensis*), or annual canarygrass, is a major component of feed mixtures for caged and wild birds. The seedlings resemble green foxtail or corn seedlings, are finely leafed, and purple to red at the base of the stem. Mature plants are approximately 1 m in height and have small compact heads. Tiny, sharp hairs made of silica at the base of the seed of older varieties make canary seed dust very irritating to the skin during harvest and handling. Canary seed is a self-pollinated crop. Note that reed canarygrass (*Phalaris arundinacea*) is a forage grass, and information regarding this crop can be found in SWI 142.1.2-5.

Distinguishing characteristics:

- leaf length and width
- inflorescence length and width
- plant height
- maturity date
- pubescence of lemma, palea and glumes

Canary seed disease

Septoria leaf mottle

Lower leaves that have been shaded by a dense canopy may have a distinctive symptom - "green islands". Green islands are infected spots that remain green as the rest of the leaf yellows. Close inspection of the diseased area or discoloured leaf tips will reveal a large number of pycnidia (small black spore-producing bodies) that look like pepper sprinkled on the leaf. A magnifying glass will assist in identifying pycnidia that are embedded within the leaf. Under wet conditions, pycnidia ooze golden brown globs of spores that spread to healthy leaves by rain splash. In severe infestations, the pycnidia can cover the entire plant including the head.

Flax

Flax is an annual plant that grows to a height of 40cm to 91 cm, depending on variety, plant density, soil fertility and available moisture. Flax is self-pollinating, but from 0.3 to 2% outcrossing may occur under normal circumstances. Insects are the primary agents of outcrossing. The life cycle of the flax plant consists of a 45 to 60 day vegetative period, a 15 to 25 day flowering period and a maturation period of 30 to 40 days). Water stress, high temperature and disease can shorten any of these growth periods. Although there is a period of intense flowering, a small number of flowers may continue to appear right up to maturity. During the ripening process, under high soil moisture and fertility, stems may remain green and new growth may occur leading to a second period of intense flowering.

The flax plant has 1 main stem, but 2 or more branches (tillers) may develop from the base of the plant when plant density is low and soil nitrogen is high. The main stem and branches give rise to a multi-branched, irregular arrangement of flowers. Flower opening begins shortly after sunrise on clear, warm days and petals are shed in the early afternoon. The flower parts, (petals, sepals and anthers) all occur in units of 5.

Flax varieties may be distinguished by the colour of the flower parts which can range from a dark to a very light blue, white or pale pink. The anthers are a shade of blue or are yellow. The style and filaments that bear the anthers are blue or colourless.

The mature fruit of the flax plant is a dry boll or capsule. Ripening of the boll begins 20 to 25 days after flowering. The boll has 5 segments which are divided by a wall (septum). Each segment produces 2 seeds separated by a low partition called a "false septum", whose margin may be hairy or smooth, depending on the variety. With complete seed set, the boll contains 10 seeds, though an average of 6 to 8 seeds per boll is usual. When ripe, the bolls of Canadian varieties are slightly gaping, that is, the boll opens at the apex and the 5 segments separate slightly along the margin. The bolls rarely open so far as to allow the seeds to fall out.

Flax seeds are flat, oval, and are pointed at 1 end. A thousand seeds weigh from about 5 g to 7 g, depending on variety and growing conditions. Seed of different varieties range in colour from light to dark reddish brown or yellow. Mottled seed, a combination of yellow and brown on the same seed, is the result of external, environmental conditions and is not an inherited characteristic. The seed is covered with a coating (mucilage) that gives it a high shine and causes the seed to become sticky when wet. At times, this mucilage absorbs moisture from the air, causing the mature seeds to stick to the boll surface. This removes the shine on the seeds, giving them a scabby appearance which results in a reduced grade.

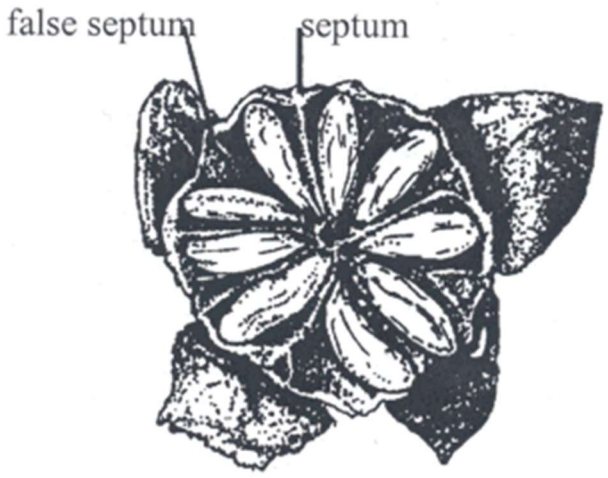
Distinguishing characteristics:

- hypocotyl anthocyanin
- plant height
- flower shape
- corolla size
- petal length/width/colour
- sepal dotting
- filament tip colour
- filament base colour
- anther colour
- style tip and base colours
- capsule size
- ciliation of false septa
- seed colour

Flax flower shape

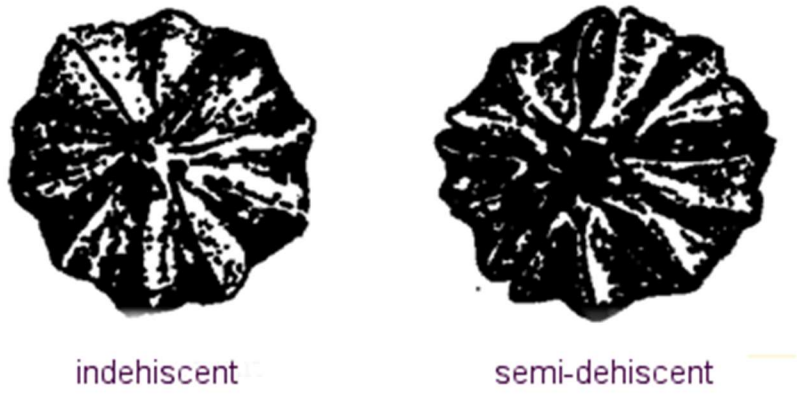
Description of diagram of flax flower shape:
3 diagrams of flower shape are presented – flattened disk, funnel form, and star shape

Flax ciliation of false septa in capsule



Description of diagram of flax ciliation of false septa in capsule:
flax capsule is presented with false septum and septum identified

Flax capsule dehiscence



Description of diagram of flax capsule dehiscence:
2 diagrams of capsule dehiscence are presented – indehiscent and semi-dehiscent

Flax diseases

Aster yellows

The symptoms of aster yellows infection in flax are easy to recognize and are most conspicuous during and after flowering. Leaves in the upper half of affected shoots are a bright yellow and do not turn brown. Flower parts all become leaf like and are greenish yellow. Healthy and diseased shoots may occur on the same plant. Severely diseased plants are stunted.

Crinkle

Crinkle in flax is characterized by stunting, reduced tillering, puckering of leaves and reduced seed production, although flowers may appear normal.

Phialophora asteris

Symptoms appear near flowering time when leaves turn a dull, light green. Large areas of the leaf soon turn dull yellow, usually starting at the apex and leaf margins and extending inwards. The vascular tissue turns brown. Symptoms develop first on the lower leaves and then on leaves higher up the stem. Severely diseased plants are stunted and flower heads may be sterile.