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ROGUES and ROGUING CEREAL CROPS

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In Canada the officially recognized national organization of seed producers is the Canadian Seed Growers' Association, the sole seed pedigreeing agency. Those seed growers designated as "Select Seed Growers" produce and maintain a unique generation of pedigreed seed, "Select Seed". Breeder seed is multiplied by Select growers as Select seed in order to have sufficient stocks to maintain needs for the variety. The Select seed grower multiplies and processes the plant breeder's material, essentially performing the function that is normally the responsibility of the plant breeder in other countries. The Association and its members thus bear the responsibility of presenting each new crop variety to the farmer in the form of pedigreed seed and the responsibility of maintaining the genetic purity of the variety through all the pedigreed classes.

The purpose of this bulletin is to provide information for the seed grower on the identification of rogues and the techniques of roguing pedigreed cereal crops. Roguing is to the multiplication and maintenance of pedigreed seed what selection is to plant breeding.

WHAT IS A ROGUE?

A rogue is an undesirable plant. There are several types of rogues. The simplest type to recognize is perhaps a barley plant in an oat field, whereas those most difficult to recognize arise from some genetic change within the variety, from mutation, chromosome aberration, or

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from intercrossing. Rogues also result from simple mechanical mixtures of seeds of other varieties, other crops, or weeds difficult to separate. This type of rogue cannot be easily discounted as such admixtures can occur at many stages in the production of seed. Although they are not true off-types, diseased plants and weeds should be rogued when feasible. In fact, any questionable plant should be rogued to assure that the pedigreed seed produced is of the highest quality possible.

CAN ROGUING OF GENETIC VARIANTS HAVE ANY POSITIVE EFFECT?

Mutations, aberration and intercrossing in self-pollinated crops occur at definite measurable frequencies, generally at extremely low levels. The seed grower has the responsibility of keeping these variants at the minimum level. He has the additional responsibility of reporting the type of rogues removed and their incidence to his Association. This information is referred to the Plant Breeder. Further, the Select seed grower supplies CSGA each year with a seed sample for variety verification. This exchange of information between the seed grower, the CSGA, and the plant breeder is mutually rewarding.

WILL ROGUING FOR GENETIC PURITY IN MULTI-LINE VARIETIES MAKE SENSE?

Some modern plant breeders place less emphasis on absolute homozygosity in favor of early release of new varieties. Interspecific crosses tend towards less varietal stability. Current interest in multiple-line varieties will mean less uniformity. Such factors as the foregoing make the pedigreed seed production program increasingly more important. Each step in the program requires more control and care. The norms for the variety will be broader and more complicated and the grower will require more knowledge and more experience to carry out effective roguing.

HOW CAN ROGUES BE DISTINGUISHED FROM THE NORM OF THE VARIETY?

The same characteristics used to distinguish varieties can be used to recognize and describe rogues. The seed grower must know them well. These characteristics provide the seed grower with a means of checking variant plants when he is going through his crops; they tell the grower what is, and what is not a rogue.

To remove genetic rogues, a grower requires a sound knowledge of the plant form of the variety he is producing. Many factors contribute to the general plant form and these plant characters vary individually in their degree of expression and may be influenced and modified by environment, fertility, and stage of growth. Despite these limitations it

is by recognizing a deviation from the general form that a grower will first identify a rogue in the standing crop. The suspect plant can then be checked against the norm to determine if it is in fact a rogue.

A grower must get to know his variety, and to do so should take advantage of organized field days, growers' meetings, and visits to plant breeding stations. At the time of field crop inspection, the grower should accompany the inspector of the Plant Products Division.

WHEN AND HOW SHOULD THE CROP BE ROGUED?

The general form of a plant changes throughout the growing season as the plant grows and matures. Once a crop is established it must be rogued repeatedly and systematically to take advantage of the differences as they appear at each stage of growth. It is not sufficient to rogue only once after the crop is fully ripened. Flower parts can only be checked at heading, pubescence of the stems and leaves is evident in the green crop but may be lost by abrasion as the crop ripes; stem color is best expressed at early ripening; chaff color does not really develop until full ripening. It is quite obvious that a plan must be established and adhered to if roguing is to be successful.

The first rogues that can be removed are plants of other crop kinds, diseased plants and weeds. Some rogues should be removed as soon as they appear, since they will be less visible at a later stage. Plants heading much earlier than the main crop should be removed. Barley plants in an oat crop must be removed as soon as they head prior to the heading of the oat crop. Weeds may be sprayed with a suitable herbicide at the recommended rate. The chemical weed control measures used should be brought to the attention of the inspector of the Plant Products Division. All rogues should be removed from the field and destroyed.

The land requirements for individual crops and classes of seed are specified by regulation. In addition to those requirements and particularly for a Select seed plot, land should be carefully chosen. The Select seed plot should be sown in spaced single rows or in sub-plots to assist roguing. Plots seeded too thinly may be difficult to rogue.

Note for select seed growers:

A record describing the rogues should be kept and recorded on the CSGA form provided for this purpose.

CHARACTERISTICS OF CEREAL PLANTS

The following section deals with characteristics that are useful for distinguishing varieties and indentifying off-types and rogues. Although particular varieties are referred to as examples, a complete outline of variety characteristics is not given. For more information see the

varietal descriptions available from the CSGA or in the Handbook of Canadian Cereal Varieties published by the Canada Department of Agriculture.

STEM

The stem of cereals is typical of the grass family, with solid nodes and hollow internodes. Differences in the plant heights of cereal varieties are readily apparent in contrasting plots but of limited value to the seed grower. However, the short, strong-strawed varieties have typically shortened internodes and often a stronger and more erect branching at the crown or base of the plant. Taller plants noted in the field should be checked against the norm for the variety. Often a short-stemmed variety has a more erect inflorescence. Additional stem characteristics are given under each crop kind.

LEAF

A single leaf arises alternately from each node of the stem and consists of a sheath and blade. Crop kinds can be readily distinguished in the seedling stage by the presence or absence of ligules and auricles. The *ligule* is a collar-like appendage that extends upward above the junction of the leaf blade and sheath. The *auricles* are ear-like appendages that clasp or encircle the stem of barley, wheat and rye.

Oats — Auricles absent, leaf sheath and blade mostly glabrous; a few long hairs on the margins of lower leaf blades and on lower leaf sheath of some varieties. Ligule medium length. Blades with about 12 veins, usually twisted anticlockwise.

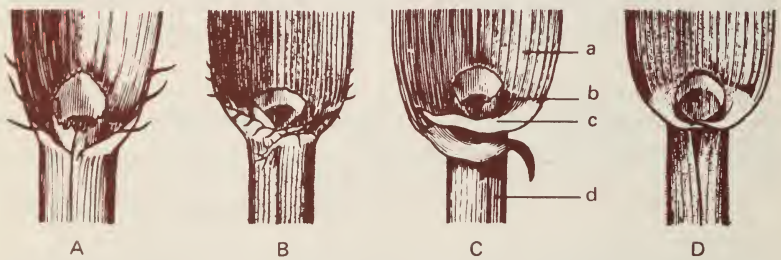


Figure 1 — Junction of leaf blade and sheath:
A, oats; B, wheat; C, barley; D, rye; a, blade; b, ligule; c, auricle; d, sheath.

Wheat – Auricles short, with blunt tips, hairy; leaf sheath and blade covered with short, fine hair (slight to very hairy); ligule medium length. Blades with about 12 veins, twisted clockwise.

Rye – Auricles very short, glabrous; leaf sheath and blade covered with short, fine hair (slight to very hairy); ligule short. Blade with about 12 veins, twisted clockwise.

Barley – Auricles long, slender, glabrous, with pointed tips. Leaf sheath and blade usually glabrous; ligules medium length. Blades with about 20 veins, twisted clockwise.

INFLORESCENCE

Most of the reliable distinguishing characteristics for rogues are found in the inflorescences, and a knowledge of the parts of the inflorescence is important for a cereal seed grower. There are two types of inflorescences, the oat *panicle* with its branched rachis, and the *spike* of wheat, barley, and rye in which the rachis is not branched and its internodes are compacted.

Figure 2 – Inflorescenses: A, spike of wheat; B, rachis of spike; C, panicle of oats.

SPIKELET AND SPIKELET GROUPS

The spikelet or floret group is the basic part of the inflorescence and occurs singly or in multiples at each rachis node of a spike, and singly at the end of each rachis branch of the oat panicle. The spikelet is composed of two outer *glumes* and one to five contained florets on a jointed *rachilla*. The outer glumes must not be confused with the *lemma* and *palea*, which enclose each floret and remain as part of the seed unit of oats and barley.

Wheat — There is a single spikelet at each rachis node. There may be three to five florets per spikelet.

Oats — There is a single spikelet on each rachis branch. The spikelets have three to five florets. The outer glumes are large and papery.

Barley — Six-row barley has three single-flowered spikelets at each rachis joint. In two-row barley the lateral spikelets are sterile and there is then a single fertile floret at each rachis node.

Rye — There is one spikelet at each rachis node, and there are two fertile florets in each spikelet.

CEREAL FLOWER

The cereal flower or floret is similar for each crop kind. The florets are borne on jointed *rachillas*. Barley has only one flower per spikelet

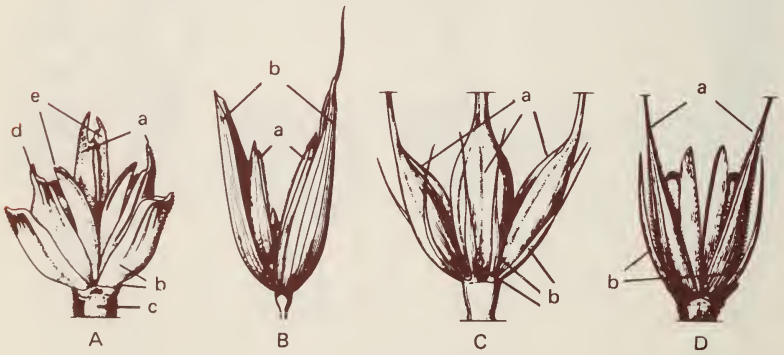


Figure 3 — Spikelet arrangements: A, wheat; B, oats; C, barley; D, rye; a, inner floret; b, outer glumes; c, rachis; d, lemma; e, palea.

and the rachilla remains rudimentary. The rachilla is a useful tool for distinguishing varieties and rogues.

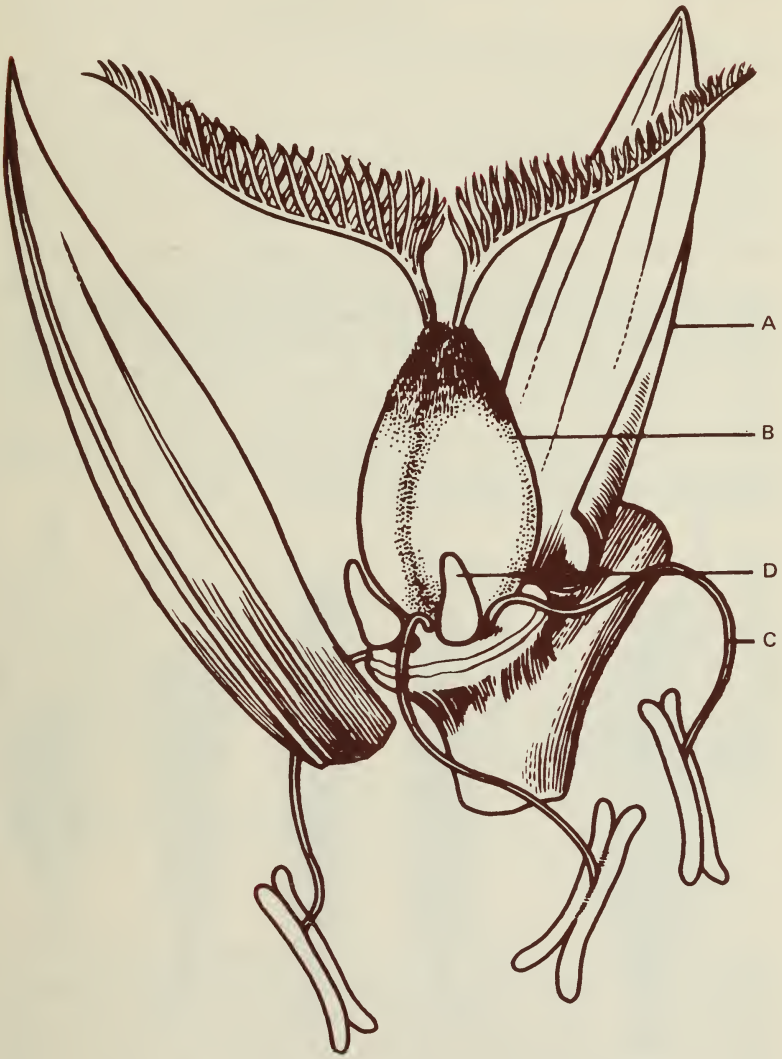


Figure 4 — Cereal floret:
A, palea; B, pistil with ovary and 2 feathery stigmas; C, 3 stamens with filaments and anthers; D, 2 lodicules which are rudimentary in wheat, oats and barley, but in rye they enlarge and open the floret for cross pollination.

WHEAT

PLANT FORM

The trained eye of an experienced seed grower will quickly note rogues and off-type wheat plants in a wheat crop by differences in the general form of the heads. The heads can be awned, tip-awned, or bald. The awns are apical extensions of the lemma midrib; they may vary in length. Awnletted mutants are common rogues in bald varieties. The head form can be densely compacted, clavate or club shaped, or long and lax. The term 'fusiform' is used to describe a head that is widest in the middle and tapers to both its tip and base.

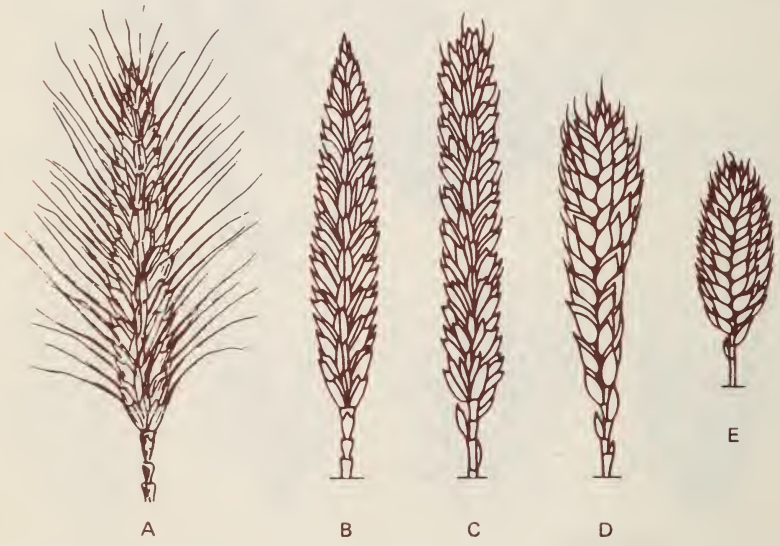


Figure 5 — Spike forms: A, bearded; B, bald; C, tip-awned & elongate; D, clavate; E, club.

The color of wheat heads may vary with variety; the glumes can be red or white quite independently of the red or white kernel colors. Talbot and Genesee are red-chaffed wheats with white kernels, while Kent has both red chaff and red kernels.

The typical wheat stem has hollow internodes but there are a few solid-stemmed exceptions, including the spring wheats Rescue, Chinook and Cypress.

Although the wheat stem is creamy white in most varieties there are a number of purple-strawed varieties, including the winter wheats Kent and Talbot, and yellow-strawed spring wheats Selkirk and Park. The degree of color is dependent on maturity and a number of growth factors. Therefore, colored straw can be interpreted reliably but its absence in an individual plant is not indicative of a rogue.

The sizes, shapes and colors of *kernels* and outer *glumes* are useful identifying characteristics Wheat growers should be thoroughly familiar with the following.

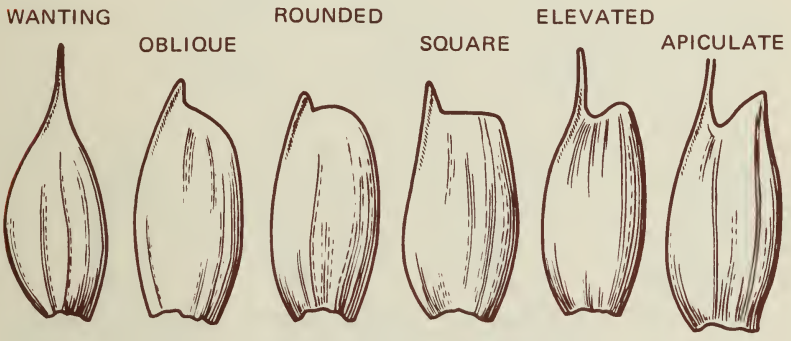
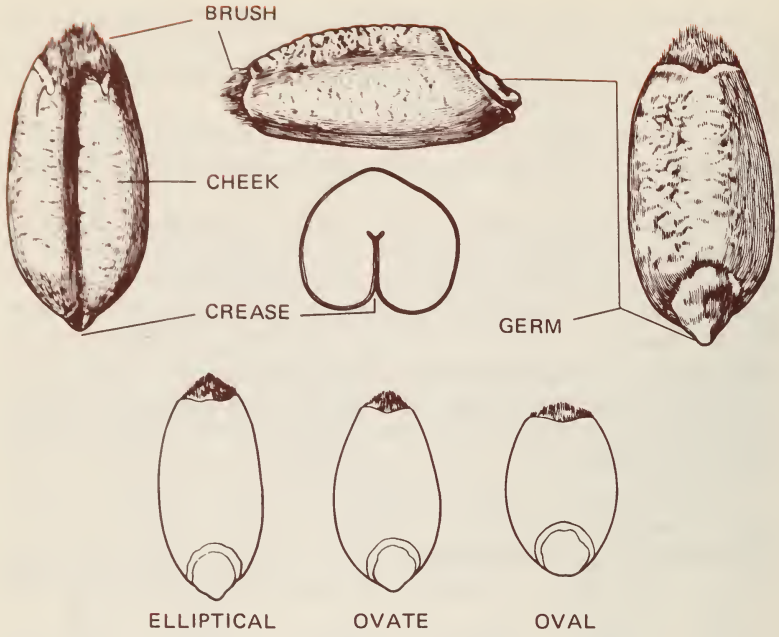


Figure 6 — Glume shoulder shapes.

SPELTOIDS

Speltoids are common rogues in wheat fields. Genetically they result from chromosome aberration similar to fatuoids in oats. Speltoid plants are usually taller and later than normal for the variety. The heads are longer and thinner than heads of the parent variety, with a distinct taper from the base to the tip. Glumes are strongly keeled with a rather square shoulder and generally are stiffer and cannot be bent away from the spikelet without breaking. The speltoid head does not break up easily at threshing so the kernels usually remain in the glumes and are easily removed at cleaning time. Speltoids are usually self-eliminating



GLUME SHOULDER WIDTHS AND BEAK SHAPES

GLUME COVERING

Figure 7 — Wheat kernel and glume forms.

because they are late, hard to thresh, and often have low fertility. However, they may appear in each generation. The detection and elimination of speltoids and related off-types are important points of roguing in wheat.

DISEASE REACTION

Susceptibility or resistance to mildew, rust and smut diseases in some cases may be used as criteria for rogue identification, if the conditions are favorable for the infection and development of these diseases.

DURUM WHEAT

This is a distinct and separate species from the common species of bread and pastry wheats. The heads of the durum wheats are always bearded. The outer glumes are covered with a bloom or, rarely, are pubescent. The kernels are keeled, angular and much larger than common wheat. They are amber, harder and more translucent.

OATS

PLANT FORM

Although the oat plant does not have many distinguishing characteristics there are differences in the general form of the plant that become quite recognizable to the experienced grower. Included are plant height, width of leaf, and maturity, and a special characteristic in oats, *panicle shape*. 'Side oats' have unilateral panicles, giving a 'mane-shaped' appearance. Although all of our present varieties have bilateral and symmetrical panicles, there are degrees of difference that are readily apparent.

Figure 8 — Oat panicle shapes: A, symmetrical (cultivated oat); B, side oat; C, wild oat.

Another useful characteristic is the degree of awnedness. The awn is an extension of the midrib of the lemma, arising from the lemma at the middle of the grain. In wild oats it appears on all grains of the spikelet, and is usually twisted below the bend. In most cultivated varieties the awn is carried only by the lower floret and is usually straight, weak and scarcely twisted.

Hairiness of stems, leaves and nodes is an important distinguishing characteristic. Rodney is an example of a variety of oats that exhibits a significant degree of hairiness of the stem nodes. The pubescence of Rodney is characteristically on the lower part of the node. A few hairs are present at the base of the leaves of Rodney and Stormont. These hairs are readily visible in the green stage but can be lost by abrasion in a ripened crop. However, it is often possible to check an immature tiller for this characteristic (see Figure 9). The variety Dorval has an extremely wide leaf. The wide leaf and long pointed kernel of this variety are sufficient to distinguish it from others.

WILD OATS

This is one rogue that must be removed in the green stage. Wild oats shatter early and will therefore further infest a grower's land if not rogued before shattering. Wild oats are readily spotted by bending low and looking across the crop at the level of the heads. Wild oats are taller and bending with wide pendulous panicles. Each spikelet has two coarse protruding awns. The kernels are slim, normally dark-colored, and have a *sucker mouth*. Care should be taken to remove and destroy the wild

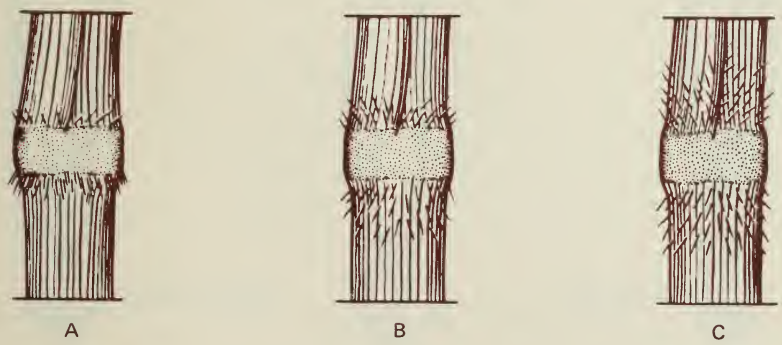


Figure 9 — Hairiness of stem node: A, as a crown below node; B, scattered below node; C, scattered above and below node.

oat rogues completely. Do not drag them through your crop as you rogue, or they will shatter and spread throughout the field and infest following crops.

FATUOIDS

Fatuoids or false wild oats result from chromosome aberration, as do speltoids. Fatuoid plants have the same height, maturity, and general plant form of the variety in which they are found. They do not have the plant form of wild oats and are therefore difficult to rogue. The

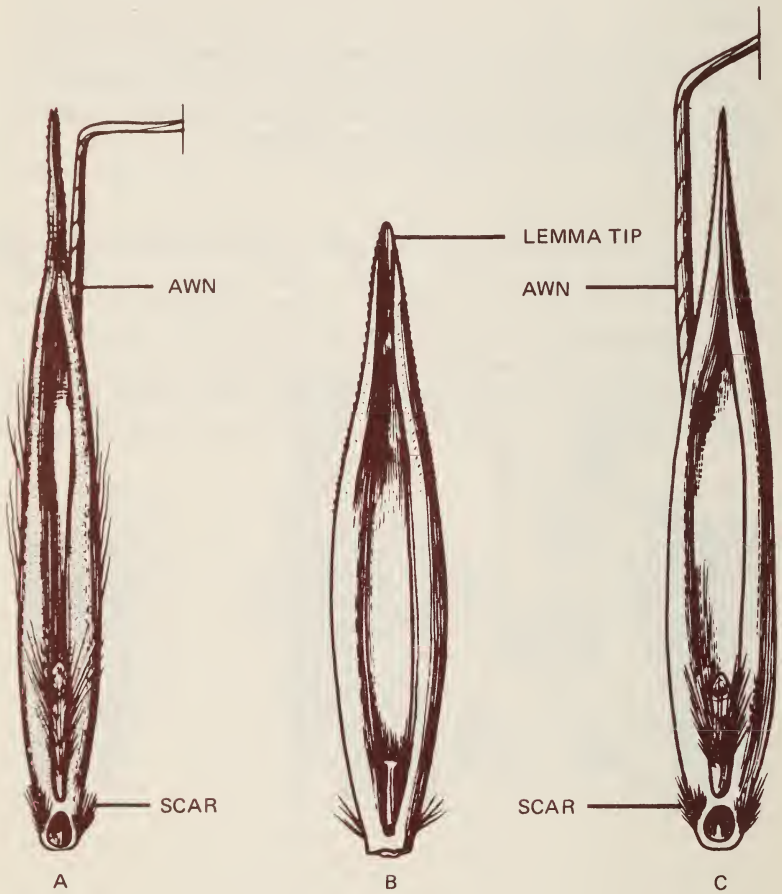


Figure 10 — Oat seeds: A, wild oat; B, cultivated oat; C, fatuoid.

heavier, protruding awns make them readily distinguishable at maturity. There may also be color differences but color is not always a factor. In the threshed grain the awn, scar (sucker mouth), and rachilla are similar to the wild oats, but the general size and surface of the grain resembles those of cultivated oats. The hairs on the scar are very much shorter than those of wild oats. As indicated for speltoids, fatuoids in oats are an important rogue and their occurrence should be brought to the attention of the plant breeder.

DISEASE REACTION

Disease reaction in some cases may be used as a diagnostic characteristic. Resistance or susceptibility to stem rust, leaf rust, smut and mildew may be considered.

KERNEL CHARACTERISTICS

After a plant is suspected as a rogue, there are several kernel characteristics that are useful to check. The number of *lemma veins* or nerves vary with variety from five to ten, although the usual number is seven. Stormont is the only current exception with eight lemma veins. The *lemma tip* may be pointed or blunt as in Rodney and Stormont. The presence or absence of pubesence at the base of the kernel or on the rachilla and the length of the rachilla are useful characters. The general *length and width of the kernels* are useful for gross differences as in the long kernel of Dorval and the short wide blunt kernel of Rodney. Oat kernels are commonly white to creamy white but may be yellow, red, or shades of brown to black.

BARLEY

PLANT FORM

The main difference in plant form is that between *two and six-row* barleys. Within the varieties of each there is a range of differences in the nature and attitude of the spike. The spike may be *lax and nodding* or *star-shaped and erect*. The term star-shaped refers to the compact head of some varieties where the rachis internodes are short and the lateral kernels are well developed and plump, giving a star-shaped appearance to the top of the barley spike. The more recent varieties of six-row barleys tend to be shorter, stronger-strawed, and more erect, as opposed to the older varieties that were tall, with lax and nodding heads. Barley spikes may be borne on straight or snaky *necks*, and the *collar* at the base of the spike may take one of several forms.

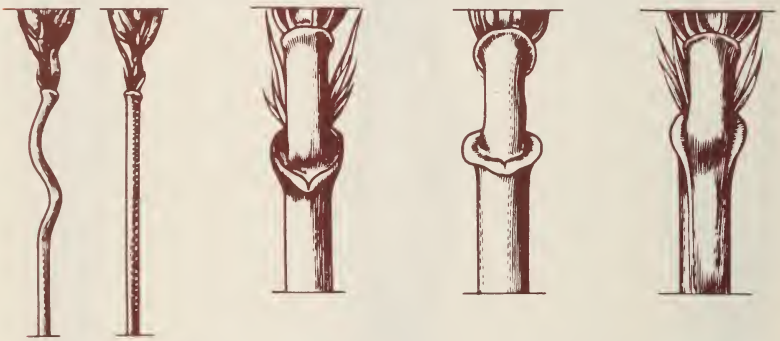


Figure 11 — Neck shapes and collar forms:
A, snaky neck; B, straight neck; C, V-shaped collar; D, closed collar; E, open collar.

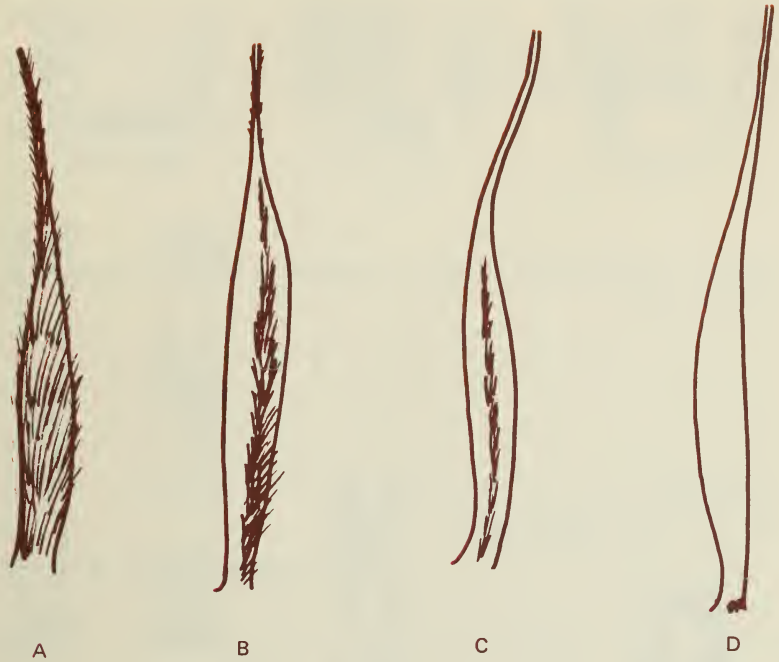


Figure 12 — Hairiness of glumes: A, covered; B, in band; C, on midline; D, without hairs.

The barley spike reveals a number of useful identifying characteristics. The lemma awn can be smooth, rough, or semi-smooth as in Montcalm. The glume awn length (outer glume) varies with variety and is expressed as a fraction or multiple of the glume length. The positioning and degree of hairiness of the glumes, rachillas and rachis edges are useful characteristics.

In six-row barleys, the *central kernels* are slightly larger and plumper than the *lateral kernels*, which also have slightly *twisted bases*. The degree of barbing of the lateral veins and the wrinkling of the hulls are useful identifying characteristics. The *basal marking* on mature kernels may be a horseshoe-shaped depression or a transverse crease, as diagrammed. The aleurone color of the dehulled barley kernel may be yellow-white or a shade of blue.

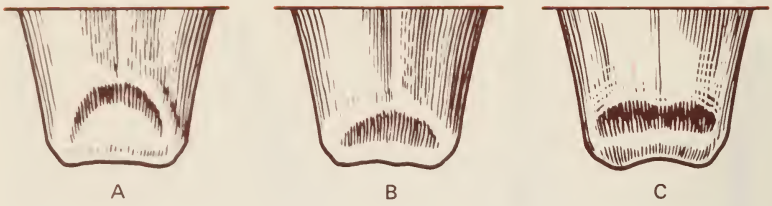


Figure 13 — Basal marking of kernel: A, horseshoe; B, incomplete horseshoe; C, transverse crease.

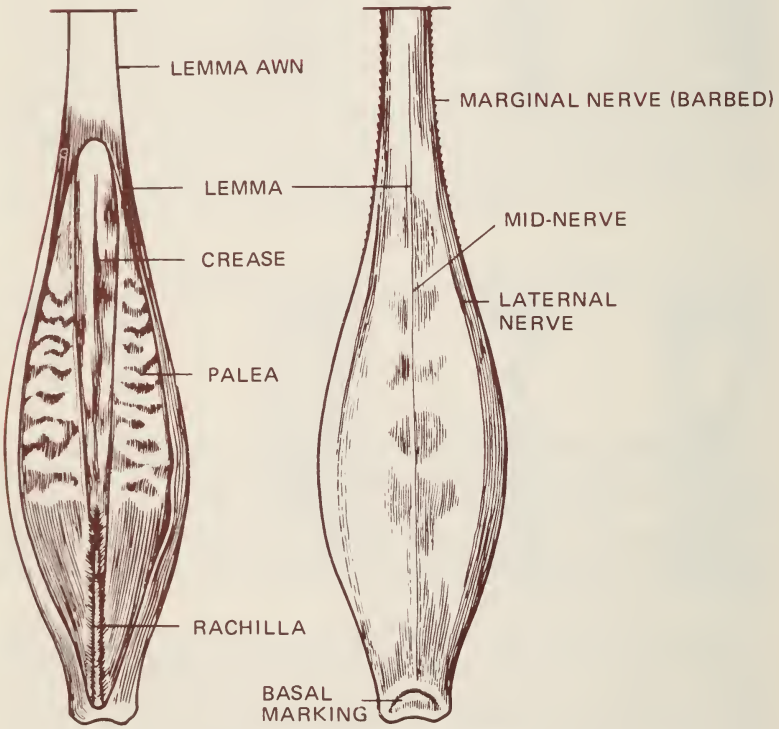


Figure 14 — Barley kernel.

DISEASE REACTION

Susceptibility or resistance to mildew, rust and smut, and to some leaf-spot diseases sometimes may be used as criteria for rogue identification if conditions are favorable for the infection and development of these diseases.

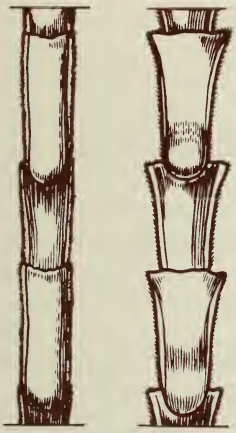


Figure 15 — Rachis internodes: A, parallel sided; B, flared.

RYE

Rye is a cross-pollinated crop and individual plants can be expected to vary. Rye has rather lax spikes with three-flowered spikelets. The central flower of the spikelet, however, is often abortive or minute. The *glumes* are narrow and acute, the *lemmas* longer than the glumes, tapering gradually into long, rather stout awns, and bearing stiff hairs on the keel. The lemma and palea of each floret tend to diverge so that the tip of the mature kernel is clearly visible. The kernel is hulless, longer and more slender than wheat.

Most of our rye varieties have purple pigmentation of the seedling bases. The mature stems of the different varieties vary in length, strength and color. There are also differences in length, width and hairiness of the leaves. Antelope and Frontier have narrow short leaves; Sangaste and Tetra Petkus leaves are wide and long. All the present varieties are awned; their spikes may be fusiform, eliptic or oblong. The spike of Cougar is erect, most other varieties are nodding. Kernel size, shape and the degree of green or bluish coloration provide useful distinguishing criteria.

GLOSSARY

Aleurone — The outer layers of the endosperm of a cereal seed.

Auricles — Ear-shaped appendages of the leaf-sheath encircling the stem at the juncture of the leaf blade and leaf sheath of many cereals.

Chromosomes — Rod-shaped bodies, visible under the microscope, in the nucleus of the cell at the time of cell division. The number of chromosomes in any species is usually constant.

Chromosome aberration — A change in chromosome number or structure resulting in genetic effects.

Culm — The stem of the cereals and grasses.

Floret — Simple flower of the cereals, consisting of the lemma and palea containing an ovary with two feathery stigmas, three stamens, and two lodicules at the base of the ovary.

Gene — The unit of inheritance arranged linearly in the chromosomes.

Homozygous — A plant or variety is homozygous for a given character when all its germ cells transmit identical genes for this character.

Inflorescence — The arrangement of the flowers of a plant.

Internode — The portion of the stem between two nodes.

Lemma — The lower of two bracts enclosing the grass flower, sometimes called the flowering glume.

Ligule — Membranous outgrowth arising from the junction of the leaf blade and leaf sheath in many grasses.

Mutation — A sudden heritable variation that results from changes in a gene or genes.

Node — The point of the stem from which the leaf arises.

Norm — The description of the characteristics of a variety.

Palea — The upper bract enclosing the grass flower.

Rachilla — A secondary axis in the inflorescence of grasses; the axis of a spikelet.

Rachis — The axis of a spike.

Spikelet — A secondary spike, the unit of the inflorescence in grasses, and generally consisting of two outer glumes and one or more enclosed florets.

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