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COME OFTEN.
FIELD CROPS LABORATORY MANUAL

By
Warren H. Leonard, Ph. D. (Minnesota)

INTRODUCTION

The laboratory exercises on field crops have been divided into four parts: Botanical Characteristics, Taxonomy or Classification, Judging, and Grain Grading.

The important crop plants will be studied in detail in Section I. Sufficient botany, especially gross morphology, will be given to enable the student to understand the plant. This phase will consist of observations, sketches, and references. A knowledge of the botany of crop plants is a necessary background for crop taxonomy or classification.

The second section will deal with the identification of crop types, species, and varieties. Special emphasis will be placed on the standard varieties grown and recommended in Colorado.

Crop judging is contained in Section III. This includes the judging of both threshed and sheaf material. Score cards are included as guides for the weights to place on various qualities where such are available and suitable. A further aim in this part is to instruct the student in how to prepare crops for exhibition.

(Copyright, 1940, Warren H. Leonard)
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LABORATORY EQUIPMENT AND INSTRUCTIONS

I. Equipment

Each student is required to supply himself as follows:

1. A two-hole notebook cover.
2. Ruled notebook paper (two-hole).
3. Drawing paper (two-hole Botany paper).
4. A No. 3 or 4H pencil.
5. A six-inch celluloid ruler. Usually included in a
6. A pair of forceps (later for grain grades) botanical dissecting set.
7. A scalpel or razor blade.
8. A 6 or 12 power hand lens.

II. Instructions

1. Place name and date in the upper right-hand corner of the sheet - both on drawings and note sheets. Place the number and name of each exercise at the top of the page in the middle of the sheet.

2. All sketches are to be made on drawing paper with a No. 3 or 4H pencil. Label each part carefully to the right. Keep levels in a straight line up and down the sheet. Use words and print them out.

3. Make sketches large and in proportion. Try to arrange them so as to be equally distributed over the sheet. Be neat and accurate.

4. All notes are to be written in ink and on but one side of the paper. Answer all questions in complete sentences, and number them to correspond to the exercise sheet.

5. Laboratory notes will be taken up after a section is completed and an examination given. These sections will be retained until the end of the semester. Arrange laboratory notes as follows: (a) exercise sheets, (b) sketches, (c) notes and answers to questions.

6. All students will work individually unless instructed to do otherwise.

7. Outside references will be assigned from time to time. Ten-minute quizzes may be expected on the days references are due.

8. All absences will be made up, hour for hour, at extra time.
FIELD CROPS LABORATORY MANUAL

Section I

BOTANICAL CHARACTERISTICS OF CROP PLANTS
Exercise I

Structure of Grasses and Legumes*

I. Importance of Grasses and Legumes

The grass family (Gramineae) and the legume family (Leguminosae) contain the majority of the principal crop plants.

The grass family includes all the cereals, many of the annual forage plants, such as the sorghums and millets, and a large number of wild plants used for pasture or hay like the short grasses, buffalo grass, grama grass and, in addition, many weeds such as green foxtail, squirrel-tail grass, and quack grass. Since the vegetative characteristics of all cultivated grasses are very similar, they will be treated in one exercise. Classification into genera, sub-groups, etc., is based almost entirely upon the inflorescence which will be treated in detail under each crop.

The legume family contains many valuable crop plants, such as alfalfa, sweet clover, Red clover, alsike clover, field peas, soybeans, field beans, vetch, and lupines. This group is able to utilize atmospheric nitrogen due to the presence of certain bacteria in nodules which generally appear on the roots.

II. Characteristics of Plant Parts

(a) The Leaf

A leaf generally consists of the blade, petiole, and stipules. The blade is generally a flat appendage while the petiole is the stem-like portion that connects the blade with the plant. Stipules are small appendages, usually two in number, which occur at the base of the petiole, one on either side. The leaf blade may be whole, lobed, or with complete separation into leaflets. The latter are compound leaves which may have their leaflets arranged palmately or pinnately. They are palmately arranged when the midribs of all leaflets center at a common point, and the petiole shows no tendency to continue beyond the point of attachment. The leaflets are pinnately arranged when they are arranged feather-like along the petiole. There are two principal kinds of venation in leaves, reticulated and parallel-veined. The venation is reticulated when the veins branch and intersect in net-like fashion. It is parallel when the more prominent veins are parallel or nearly so.

Supplies necessary: Corn plants with root system, field peas in flower, alfalfa plants or bean plants with roots, wheat or other grass inflorescences.

*Many suggestions were obtained from the Forage Crops Laboratory outline used at the University of Nebraska.
(b) **The Stem**

When the seed germinates, one end of the embryo develops toward light and is called a stem. Stems are divided into sections called internodes. The joints between the internodes are the nodes. Branches sometimes arise from the lower nodes which are called tillers. There are two kinds of modified stem branches. One occurs above ground, called a stolon, and the other below ground called a rhizome. Both have the ability to produce roots and stems at the nodes. This affords a quick and very aggressive method of plant propagation.

(c) **Roots**

There are two great classes of root systems, namely tap and fibrous. Tap-rooted plants have a main root that runs vertically downward. Fibrous-rooted plants have no main root, but many small roots. Nodules may occur on the roots of leguminous plants.

(d) **Inflorescence**

The inflorescence is the flowering region of the plant. There are three principal forms of inflorescence: spike, panicle, and raceme. The parts of a typical flower are the calyx, corolla, stamens, and pistil. Flowers with both stamens and pistils are bisexual, while those with only stamens or pistils are unisexual.

III. **Laboratory Instructions**

1. Collect 5 legumes and 5 grasses and bring them to the laboratory for study. Suggested legumes are: Alfalfa, red clover, sweet clover, alsike clover, field peas or soybeans. Suitable grasses are: Corn, orchard grass, timothy, brome, meadow fescue, Kentucky bluegrass, and redtop. Herbarium specimens may be used under certain conditions.

2. Make a simple diagrammatic sketch of an alfalfa leaf and label the parts. Do the same for a grass leaf.

3. Examine the roots of the plants provided. Sketch: (1) A fibrous root system. (2) Tap root.

4. Examine different types of inflorescence. Make sketches of a spike, raceme, and a panicle.

5. Dissect a pea (or other legume flower) and place the parts as suggested in the diagram.

6. Dissect a grass flower, draw, and label the parts.

7. Make a table and contrast grasses and legumes as to: (1) Root system, (2) Flowers, (3) leaves, and (4) stems.

IV. **Questions to be Answered**

(a) **Leaves**

(1) Do leaves of legumes seem to be universally compound? (2) When
tendrils are present, where are they usually borne? (3) Structurally, tendrils appear to be modifications of what? (4) Classify the legumes observed as to whether they were palmately or pinnately compound. (5) How do simple leaves differ from compound leaves? (6) What is the main difference between the blade of a legume leaf and that of a grass leaf? (7) How does the petiole or sheath of a grass leaf differ from that of a typical legume leaf in shape? (8) Explain how the petioles of grass leaves may affect the strength of the stem. (9) What appears to be the function of the "collar" of the grass leaf? (10) What kind of venation have grasses? Legumes? (11) At what point on stems do leaves originate? (12) Are the leaves arranged alternate or opposite on the stems in grasses? Legumes?

(b) Stems
(1) What is an herbaceous plant? (2) What bearing does the presence of nodes at frequent intervals have upon the strength of stem?

(c) Roots
(1) What is the difference between a root and a stem? (2) Examine and describe the root system of alfalfa. (3) Are legumes as a group tap or fibrous-rooted? (4) What distinguishes a rhizome from a root? (5) Is there any relation between the presence or absence of rhizomes and stolons and the nature of the nod formed?

(d) Inflorescence
(1) How many stamens does a pea flower have? (2) Are legumes bisexual or unisexual? (3) What is a spikelet? (4) What is a floret? (5) How are grasses pollinated? (6) To what family are the grasses most nearly related? Differentiate between them.

References
1. Chase, Agnes. A First Book of Grasses 1921
3. _________. Manual of the Grasses of the United States, pp. 6-10 1935

(2426-36)
Dissected Lorme Flower

Standard
(Largest Petal)

Wing
Free Stamen
United Stamens
Pistil
Wing

Keel
(Boat-shaped petal)

Calyx and pedicel
Dissected Grass Flower

Glume 1  Fertile floret  Glume 2

Sterile floret

Fertile floret

Fertile floret

Lamina

Stamens  Pistil

or

Palea

Caryopsis
## Comparisons of Grasses and Legumes

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Exercise 2

Morphology of the Corn Plant

I. General Description

Corn (Zea mays) belongs to the grass family (Gramineae), and to the genus Zea characterized by monocious flowers. It is distinctly a summer annual with a fibrous root system. The stem is made up of nodes and internodes as in other grasses, but the internodes are not hollow as in many other grasses. The leaves are arranged alternately on the stem and vary in number from 8 to 20. The tassel is the staminate inflorescence, while the ear is the female inflorescence. Cross pollination is the rule in corn.

II. Laboratory Instructions

1. Examine the stem, leaves, roots, and inflorescence of a corn plant.
2. Sketch a cross section of a corn stalk, and label parts as follows: Epidermis, phloem, vascular bundles, and formative groove.
3. Draw a portion of a corn stalk that bears a leaf (phyllotom), and label parts as follows: Leaf-sheath, blade, ligule, auricle, mid-rib.
4. Sketch the roots of a mature corn plant and show Points of root attachment, primary roots, scutellum, secondary or adventitious roots, buttress roots, and base of stalk.
5. Observe that the corn tassel is covered with spikelets. Notice that these spikelets usually occur in pairs, one sessile, the other pedicelled. Dissect one of these spikelets. After the spikelet has been dissected and properly arranged in order, sketch them and label the parts.
6. Examine an ear of corn with the silks attached. The corn kernel is the ovary or pistil. Remove two or three kernels from the ear with the chaff. Separate the parts, draw, and label them.
7. Make a cross-section of an ear. Label the parts as follows: Kernel, vascular bundles, tip-cap of kernels, chaff, woody part, tubes, and pith.
8. Cut a longitudinal section of a corn kernel, sketch, and label parts as follows: Pericarp, endosperm, embryo (scutellum, radicle, and plumule), and tip-cap.

III. Questions to be Answered

(a) Stem or Stalk

(1) Does the culm of a corn plant have the essential characteristics of a true grass? (2) There is a part that connects the ear and the stalk. From what point on the corn stalk does this connection arise? (3) Split and examine the connection. What points in its structure identify it as a stem? In general, what is a stem that arises from a main stem called?

Supplies necessary: (1) Complete corn plants with roots, tassel, ear, and suckers where possible. (2) Tassels at time of fertilization. (3) Immature ears with silks, shank and husks. (4) Ears or kernels of pod corn.
(a) Count the nodes between the point of attachment and the tassel. What is the main difference between the internodes of the connection and those of the main stem? (b) Are the internodes the same length throughout the stalk? Why? (c) Explain how growth takes place in the corn plant. (d) What is the epidermis? (e) What are the vascular bundles and their function? (f) What is the structure and function of the pith?

(b) Leaf or Blade

Observe the leaves of the corn plant. (1) From what points along the main stem do the leaves arise? (2) What are the two main parts of the grass leaf? (3) There is a joint that separates the two parts of the leaf. What is this called? (4) Notice just above this joint and closely fitted around the stem is a projection called the ligule. What is the purpose of the ligule? (5) What gives the wavy effect to the corn leaf? (6) What keeps the leaves from being torn off by the wind? (7) Examine the husks that enclose the ear. From what points on the stem that supports the ear do the husks arise? (8) Is the arrangement of the husks alternate or opposite? (9) What do husks really appear to be? (10) Examine the outer husks of the ears of some of the more primitive corns, such as pod corn, pop corn, flint corn, or sweet corn. Do you find near the outer end of any of the husks a trace of a joint? (11) Can one assume that the parts thus far studied are branches of the main stem of the corn plant? Do they have anything in common as to points of origin?

(c) Roots

Examine what is unquestionably a corn root. (1) In what particulars does its structure differ from that of a grass stem? (2) Observe the large centrally located part of the corn plant which is below the surface of the ground. Split it so that its structure can be observed. Is this part root or stem? Why? (3) From what points along this centrally located part do roots arise? (4) What term will describe the root system of the corn plant? (5) Observe any evidence of roots that may arise from nodes above the surface of the ground. What may be the value of above-ground roots to the plant? (6) At how many nodes do buttress or brace roots appear? (7) Describe in a general way the evolution of the root system of the corn plant from the time of germination to the ripened plant. (8) Where do the first permanent roots appear? When?

(d) Inflorescence

(1) Examine the staminate inflorescence. How many glumes are there per spikelet? How many flowers? (2) Is there a pistil present? (3) How can the lemma and palea be distinguished? (4) What anomalies may occur in the staminate-inflorescence? (5) Examine the ear or pistillate inflorescence. Is there anything about the kernel of ordinary corn that suggests glumes found in the tassel of the corn plant? Explain. (6) How do you explain the fact that when yellow and white corn are planted near each other, kernels with white cob will be found in the yellow corn, while kernels tinged with yellow will be found in the white corn? (7) What is an ear of corn morphologically?

(e) Ear and Kernels

(1) How does each kernel receive its nourishment from the cob? (2) Of what use are the little tubes between the woody part and the pith? (3) Why are there always an even number of kernel rows on an ear of corn? (4) Why are the kernels irregular in the Cornish Gentleman sweet corn? (5) What part of the ear is usually least developed? Why?
References


Exercise 3

Testing Seed Corn for Germination

I. Need for Corn Germination Test

Seed corn is tested for germination to determine what percentage will grow. Some ears of corn may appear to be good seed ears in every respect, and still fail to grow when planted. The only certain way to determine how well corn will grow is to make a germination test before it is planted. An ear test will allow the grower to save and plant only ears which have demonstrated good vitality by showing strong, clean sprouts. Where possible, corn should be tested for germination in April, unless artificially dried. Corn tested in the winter is often injured by frost later. Individual ear tests are the most satisfactory, but, sometimes, unnecessary from a practical standpoint.

II. General Corn Germination Test

An ear-by-ear seed corn germination test is unnecessary when seed corn is mature, picked before frost, stored in a dry, well-ventilated place and protected from freezing temperatures until it is well dried (15 percent moisture). To be absolutely safe, even under such conditions, one should germinate one kernel from each of 200 ears taken at random from the corn to be planted. The kernels may be bulked and tested in the modified ragdoll tester, or soil box. The planter should make a thorough ear-by-ear test of all ears to be planted when less than 90 percent of the kernels in the general test show strong germination. An ear-by-ear test is particularly advisable in years when seed corn has been generally damaged. Corn in unfavorable seasons may show low vitality or abnormalities due to: (a) immaturity, (b) early frost or (c) high moisture content.

III. The Modified Rag Doll Tester.

Probably the cheapest and easiest tester to make and operate is the modified "ragdoll" tester made with paper towels. It is accurate in showing the ability of each ear to grow when ears are taken to keep the "dolls" moist and at the proper temperature, 75 - 85 degrees F. The modified ragdoll tester contains heavy waxed paper beneath the paper towels to insulate each row of kernels from a single ear so that mildew rarely spreads through the doll. This is a prime consideration in the Corn Belt where injurious seedborne diseases like Diplodia, Gibberella, and Fusarium are often present.

Instructions for the Test

1. Select seed ears that are sound and mature.
2. On a paper towel of good grade, start 2.5 inches from the edge and draw lines cross-wise 1.0 inch apart until 10 spaces are provided. A satisfactory size of towel to test 10 ears is 10x15 inches, 3 towels being necessary for one ragdoll.
3. The marked towel and a blank towel are then moistened and placed on a piece of wax paper approximately the same size. The wax paper retains the moisture in the doll.
4. The ears are numbered to correspond to the spaces on the towel.
5. Five kernels are removed from each ear and placed germ side down on the paper in the numbered column that corresponds to the ear number.

Supplies necessary: (a) Roll wax paper, (b) paper towels, (c) soft lead pencils, (d) rulers, (e) corn for germination.
6. The kernels are covered with a third towel after it has been moistened.
7. The ragdolls are then rolled and tied, after which it is kept at room temperature
   for 6 to 8 days. As a part of this exercise, a preliminary reading may be
   made in 6 days, and the final reading in 8 days.

IV. Interpretation of Germination Test.
   Ears with one dead kernel in eight are relatively unfit for seed. Ears
   which show excessive mold growth or root rot are poor seed as these diseases
   will take the strength of young seedlings in the field and cause them to die
   early.

   Kernels may germinate slowly for reasons other than from inherently weak
   stock. (a) Kernels with a horny endosperm germinate slower than those that
   are immature or have a more starchy endosperm. (b) Delayed germination may
   be due to a variation of conditions within the ragdoll in regard to the
   factors for germination, namely, air, moisture, and temperature.

   Ordinarily a seed that produces a plumule and radicle is considered healthy,
   even the delayed in germination. (a) In the first reading classify the seed
   according to: Healthy sprouts and delayed germination. (b) In the final
   reading, usually two days later, classify into: Healthy, abnormal and dead
   kernels. A kernel that fails to send out a plumule or radicle is abnormal
   and should be counted as dead in the calculation of the percent germination.
   Ears that show a percent germination below 90 should not be used for seed
   except in a case of shortage. Ears below 85 percent in germination should be
   discarded at all times, or the planting rate increased to make up for the
   dead kernels.

<table>
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<th>Final Reading (8 days)</th>
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V. Laboratory Instructions
1. Each student will test 10 ears of corn by the modified ragdoll method, and make two readings.
2. In the report, an outline similar to the one given in this exercise will be made for the two readings, and the questions answered.

VI. Questions to be Answered
1. Why should every seed ear be tested for germination?
2. What is the disadvantage of the sawdust box? Soil box?
3. What effect have molds and root rot on seedlings in the field?
4. What are the essential conditions for the germination of seeds?
5. Can a person tell whether or not an ear of corn will germinate by its appearance?
6. Is it always necessary to make an ear-by-ear test? Why?

References
2. Duddleston, B.H. The Modified Ragdoll and Germinator Box, Purdue Univ. Experiment Station Bul. 236. 1920.
Exercise 4

The Wheat Spike

I. Inflorescence

Wheat belongs to the grass family (Gramineae) and to the genus Triticum. It is an annual, although there are winter and spring forms. In common speech, the inflorescence is called the "head" (or "ear" in England) but botanically it is a spike. The groups of flowers are distributed along a common axis. This central zig-zag portion of the culm is known as the rachis. The flowers are without a pedicel, and thus are sessile.

II. Wheat Kernel

The mature kernel of wheat is longer than broad and somewhat flattened from side to side. At the small end of the grain is a tuft of hairs, the brush, and at the opposite end, the embryo. Along the side of the grain next to the palea is a groove or suture. In a cross section of a mature kernel (cut at right angles to its length) these layers are recognized: (1) Pericarp, or ovary wall made up of 3 layers of cells; (2) testa with 2 layers of inner integument; (3) nucellus or remains of nucellar tissue; (4) aleurone layer, outermost layer of the endosperm and composed of a single row of cells; (5) starchy endosperm which embodies all within the aleurone layer.

The bran layer has been defined to include the 3 outer layers of tissue, viz., pericarp, testa, and nucellus. In addition, it may contain all or a part of the aleurone layer and some starchy endosperm. Wheat bran varies in chemical composition, but may contain 14-18 percent protein.

III. Laboratory Instructions

1. Spike
   Remove at least 3 spikelets from near the base of the spike. The 2 sides from which the spikelets were detached are known as the spikelet sides. The other 2 are known as the farrow sides. Notice the zig-zag control rachis from which the spikelets were removed. This axis is simply a continuation of the main culm while the short internodes correspond to the long internodes of the main culm. These internodes or rachis joints have been modified to hold the spikelets. Sketch a naked rachis.

2. Spikelet
   A normal grass spikelet consists of two glumes and all that lies between. In field crops work, a mature kernel together with the lemma and palea is known as a wheat flower. Sometimes a kernel fails to form and a

Supplies necessary: Spikelets of common wheat.
sterile flower results. The central axis of the spikelet is known as the rachilla and is more evident as a support of the sterile flowers. Remove one spikelet from the wheat spike. It will be necessary to remove a joint of the rachis in order to have its parts cohere. Place it on a clean sheet of note paper. Dissect it and arrange the parts in order (as removed from left to right). Sketch them 3 times natural size and label the parts. Observe that modified leaves (bracts) surround each wheat kernel.

3. Kernel or Caryopsis
   (1) Draw a view of the wheat kernel (5X) suture side up. Indicate the location of the brush, suture, and cheek. (2) Make a sketch of a wheat kernel, germ side up. Indicate the location of the germ and the brush. (3) Make a sketch of a cross-section of a wheat kernel cut in two near the middle. Label the suture and cheek. (4) Make a longitudinal section of a wheat kernel. Sketch and indicate the brush, cheek and germ.

IV. Questions to be Answered

1. Is there any tendency for the rachis joints of the wheat spike to increase or decrease in length near the base of the spike?
2. What names are given to the bracts that surround the wheat kernel?
3. Which bract covers the suture side of the kernel?
4. Which bract bears the awn in bearded wheat? Where does it originate?
5. How many fertile flowers were present in the dissected spikelet? How many sterile flowers?
6. Examine spikelets in various parts of the head in order to determine whether or not the number of flowers per spikelet is the same throughout the spike.
7. Is there any variation in the number of glumes per spikelet in wheat? Do they most resemble the lemma or palea?
8. Give a definition of a spikelet.
9. What is the scutellum and what is its function?
10. What is gluten? How is it formed?

References

2. Carleton, M. A. The Small Grains, Chapters 1, 2, and 20 1916
Exercise 5

The Rye Spike

I. General Description
Rye (Secale cereale) is similar in vegetative characteristics to the other cereals. The inflorescence is a spike. Rye is open-pollinated which accounts for the very few distinct varieties described. The kernel is more or less dull in appearance. The color, borne in the aleurone layer, may contain various shades of blue-green, gray, yellow, grayish-brown, and brown.

There are both winter and spring forms altho the former is the most important in Colorado. The two principal varieties are Rosen and Petkus (indistinguishable). The kernels are large and bluish-green in color.

II. Laboratory Instructions
1. Study the spike, spikelet, and kernel of the rye plant. Note the resemblances to wheat. Differences.
2. Dissect a spikelet, draw, and label all parts.
3. Cut a few kernels of rye and note the texture.

III. Questions to be Answered
1. How many spikelets are there at each rachis node?
2. How many florets are there in a spikelet? How many are fertile?
3. Does rye have awns? Describe the lemma.
4. How does the shape of the rye kernel compare with that of the wheat kernel?
5. Summarize the differences between rye and wheat.
6. Why is not rye bread more generally used?

References

1. Carpenter, M.A. The Small Grains, Chapter VI, pp. 147-159. 1916.


Materials necessary: (a) Mature rye spikes, (b) wheat spikes.
The Barley Spike

I. General Description

Barley belongs to the grass family (Gramineae), to the tribe Hordeae, and to the genus Hordeum. The inflorescence of barley is a spike, and the rachis zig-zag as in other members of the tribe Hordeae.

Cultivated barleys may be divided into two classes as to number of rows of grains, 6 and 2-row barleys. Six-row barleys will be found to have 6-rows of grains. It sometimes happens that two pairs of rows overlay giving rise to so-called 4-row barleys. Two-row barleys are readily distinguished from the 6-row barleys by the flatness of the heads and the number of rows of grains.

Barleys can be further divided into hulled and hullless. In the hulled sorts, the lemma and palea adhere to the corypsis while in the hullless the kernel threshes out clean. Some barleys are armed and others hooked, i.e., have a trifurcate appendage in the place of an awn. Recently smooth awn sorts have been developed.

Six-row barley may be distinguished from two-row in threshed samples. In six-rowed barley, the two lateral grains of each triplet at a rachis notch are twisted so that the two halves of each grain when viewed on the furrow side are seen to be dissimilar in size and form. The middle grains in each triplet are symmetrical on both sides of the furrow line and very closely resemble the grains of the two-rowed races.

II. Laboratory Instructions

1. Lay out in good order on a clean piece of paper all the parts which are found at a single rachis joint of 6-row, bearded, hullless barley. Write below each part its proper name. Then remove the bracts and kernels a little to one side and make a careful sketch of each part.

2. Draw the parts at a single rachis joint for 2-row barley. Label all parts.

3. Sketch a barley awn and a hook.

4. Sketch kernels of naked barley and wheat.

5. From a mixture of Oderbrucker, Wisconsin 38, C.A.C. 21, Hannchen, and Trebi, select kernels to illustrate characteristics as follows: (1) Mealy endosperm, (2) "glassy" endosperm, (3) shriveled kernels, (4) discoloration due to scab or blight, (5) discoloration due to weathering. These are to be shown to the instructor.

Materials necessary: (1) Head of 6-row, bearded, hullless barley; (2) heads of 6-row, bearded, hulled barley; (3) heads of 6-row naked barley; (4) heads of 2-row, bearded, hulled barley; (5) mixture of Oderbrucker, Wisconsin 38, C.A.C. 21, Hannchen, and Trebi; (5) heads of bearded wheat.
III. Questions to be answered

1. How many grains are attached to each rachis joint in barley?
2. Name the bracts which together enclose the barley kernel.
3. How many awl-like bracts are attached at each rachis joint? At each grain? What name should be applied to these bracts?
4. How many spikelets occur at each rachis joint?
5. How many fertile spikelets are there per rachis joint in 6-row barley? two-row barley?
6. Distinguish between so-called 4-row and 6-row barley.
7. As shown by its position, the barley hood is a modification of what? Compare the barley stem with that of wheat as to: (1) Place at which it originates, (2) direction relative to spike and to each other, (3) length, (4) shape of cross-section, and (5) barbs.
8. Where is the barley rachilla located? What is its significance?
9. Compare the kernels of naked barley and wheat as to: (1) Length, (2) width, (3) thickness, (4) shape of ends, (5) brush, and (6) depth and width of suture.
10. Explain how the covered barley kernel is enclosed in the hull.
11. Compare two and six-row covered barley kernels. Explain how to distinguish a threshed sample of common 6-row barley from one of common 2-row barley.
12. What qualities are necessary in a good malting barley?
13. Make a list of the observed differences between barley and wheat heads. List their similarities. Particular attention should be given to characteristics as follows: (1) Character of rachis, (2) number of spikelets per node, (3) number of florets per spikelet, (4) character of outer and inner glumes, (5) character of rachilla, (6) shape of kernel from different parts of same spike.

References


(7401-40)
Exercise 7

The Oat Panicle

I. General Description

Oats belong to the tribe Avenae, and to the genus Avena. The inflorescence is a panicle. There are both hulled and hullless varieties. In the former, the kernel is enclosed between the lemma and palea. Most of the cultivated oats belong to the common (Avena sativa) or red oat (Avena byzantina) groups.

Common wild oats (A. fatua) are a serious pest in the United States. In general, the plant characters are similar to cultivated oats. The culms are very long and frequently lighter green in color than the cultivated sorts. The spikelets usually contain 3 florets. The lemmae are more or less dark in color and covered with longitudinal brownish stripes. Each bears a long, stiff, harsh, sharp-pointed awn; the rachilla and base of the lemma are covered with long hairs. The base of the grain is articulated and has what is commonly called a "sucker mouth." An aberrant form known as "false wild oats" sometimes occurs which is probably the result of chromosome aberrations.

II. Laboratory Instructions

1. Draw a spreading oat panicle and a side oat panicle.
2. Draw an oat spikelet intact.
3. Dissect a spikelet of hullless oats, arrange the parts in order, and draw them (2 or 3 times natural size).
4. Draw a floret of a wild oat, both dorsal and ventral surfaces.

III. Questions to be Answered

1. Characterize the genus Avena.
2. What changes would be necessary for a panicle to appear more like a spike?
3. Is the panicle made up of nodes and internodes similar to those of the stem?
4. How do spreading and side oat panicles differ?
5. Compare the awns of oats and wheat as to: Position, length, and straightness.
6. How do hulless and hulled oats differ? How is the kernel held in hulled oats?
7. What relation is found between plumpness of grain and exposure of paleae?
8. How would you distinguish wild oats from common cultivated oats?
9. What are false wild oats? What do they look like?

References:

Supplies necessary: Panicles of naked oats, common hulled oats, side oats, and wild oats. Also threshed grains of Swedish Select Emerson, and Texas Red varieties.

(August, 1936)
Exercise 8

Sorghum Heads and Seeds

I. General Characteristics

Cultivated sorghums are included in the grass tribe Andropogoneae in which the spikelets are borne in pairs along the rachis, one being sessile and fertile, the other pendulous and staminate, or neuter. The sorghums are classified in the genus Sorghum, which comprises tall or moderately tall annuals or perennials with flat blades and terminal panicles. Two botanical species of cultivated sorghums are recognized. The annual sorghums are classified as Sorghum vulgare, while the perennial sorghums such as Johnson grass are placed in S. halepense. Johnson grass is often a troublesome weed due to its extensive rhizomes. It has been known to over-winter as far north as Rocky Ford. Sudan grass is classified as S. vulgare var. sudanense.

The sorghums can be grouped into four general classes: (1) Forage or saccharine sorghums grown primarily for forage or sirup. (2) Grain or non-saccharine sorghum, such as Kafir, in which grain production is the principal objective. (3) Broomcorn valued for the brush of the panicle used in the manufacture of brooms. (4) Grass sorghums used chiefly for hay and pasture. Sudan grass and Johnson grass are included here. The term "sorghum" is a general group name for the four classes. The term "sorgo" is preferable to "cane" for the saccharine or sweet-stemmed varieties.

The Sorgos or forage sorghums differ from grain sorghums as a group in several respects: (1) Panicles of the forage sorghums are less compact. (2) Seed generally does not thresh so readily free from the glumes. (3) Seed is not so palatable to livestock. (4) Forage sorghums do not usually yield so well for seed. (5) The stem is sweeter and usually more juicy. (6) Forage sorghums usually grow taller than the grain sorghums. (7) Because of less careful selection, a forage sorghum variety is less uniform than one of grain sorghum. Some of the more recent sorghum varieties may be considered dual purpose sorghums in that they are selected for both grain and forage value.

The sorghums are sometimes classified agronomically as saccharine and non-saccharine sorghums. The saccharine or sweet-stemmed sorghums (Sorgos) are used primarily for forage and sirup. The non-saccharine sorghums are used for grain, forage, and for the manufacture of brooms.

Supplies necessary: Heads and seeds of the 4 sorghum classes.

1Largely taken from the Crops Laboratory Manual, Kansas State Agricultural College.
II. Laboratory Instructions

1. Draw a panicle of a representative of each of the 4 sorghum classes.
2. Draw a portion of a sorghum inflorescence with a fertile and sterile spikelet, glumes that enclose the seed, and awn if present. The fertile spikelet should be one inch in diameter.
3. Dissect a fertile and a sterile spikelet, arrange in order, draw, and label all parts.
4. Draw a fertile spikelet of sudan grass, and one of Johnson grass. Note the differences.
5. Compare in detail the head, seed, and stem of representatives of the 4 sorghum classes. Use an outline similar to the one attached.

III. Questions to be Answered

1. To what extent do sorghums cross-fertilize?
2. In a general way, how may forage sorghums be distinguished from grain sorghums?
3. What correlation exists between the character of the midrib and the juiciness of the stalk?
4. What are the objections to the pendant position of the heads of sorghums?
5. Into what two botanical species are sorghums divided? What important characteristics differentiate the two groups?
6. Describe the inflorescence of sorghum under the following heads: type of head, number and character of spikelets occurring together, number of flowers per spikelet, character of inner glumes.
7. In what respect does Johnson grass differ from Sudan grass in seed and in plant characters?
8. How does the head of broomcorn differ from that of grain or forage sorghums?
9. What states produce the most broomcorn? Why?

References

3. Piper, C.V. Forage Plants and Their Culture, pp. 322-23. 1924.
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Exercise 9.

The Millets*

I. General Description

Cultivated millets belong to the grass tribe, Paniceae, characterized by 3 glumes. More recently, Hitchcock (1935) interprets Paniceae as a tribe with a perfect terminal floret with a sterile floret (often only a sterile lemma) and two glumes below. Four groups exist, each of which belongs to a different genus. There are two forage millets and two grain millets. Those used for forage are: Foxtail Millet (Setaria italica) and Japanese Millet (Echinochloa crusgalli var. frumentacea). The grain millets are: Proso (Panicum miliaceum) and Pearl Millet (Pennisetum glaucum). The Japanese and Pearl millets are seldom grown in this country as crop plants.

The spikelets of the foxtail millets are subtended by an involucre of bristles. The fruit is smooth or nearly so, falling away from the remainder of the spikelet. There is an involucre of bristles below the spikelet in Pearl millets also. The spikelets are short-pedicled, two in a fascicle. The inflorescence has the appearance of a cat-tail. The other two millets are free of bristles below the spikelet. Japanese millet has the spikelets borne in irregular clusters on one side of the panicle branches. The glumes are minute or very short-scaled. The inflorescence of Proso is an open panicle, although the extent varies with different varieties. The "seeds" are shiny. They differ in color according to variety.

II. Laboratory Instructions

1. Make a diagrammatic sketch of the inflorescence of each of the 4 millet genera.
2. Draw a spikelet intact for each millet genus.
3. Dissect a spikelet of each. Arrange the parts in order, draw, and label.
4. Thresh a few "seeds" of each millet. Make a sketch germ side up. (5X)

III. Questions to be answered

1. In what part of the United States is Proso grown? Why?
2. What are the objections to Pearl millet as a crop?
3. What is the probable origin of the Foxtail millets?
4. What characteristics of the glumes is common to all the millets? Is this characteristic common to any other grass so far studied?
5. What do you observe as to the number of fertile florets throughout the millets? Sterile florets?
6. How does Pearl millet differ from the other millets?
7. Does Pearl millet have a spike? Explain.
8. Which millet bears the most open panicle?
9. Group the millets according to size of "seed" (large, medium, small).
10. Group the millets according to "seed" luster (bright, medium, dull).

Supplies necessary: Inflorescences of the 4 millet genera.*

*Many suggestions were obtained from the Forage Crops Laboratory Manual, University of Nebraska.
11. Does the naked Proso kernel have a well-defined suture? Brush?
12. "Seeds" which are not naked consist of what parts?
13. Compare Pearl millet seed with Proso seed as to: size, shape, color, luster, and percent naked kernels.

References

3. Martin, J. H. Proso or Hog Millet F.B. 1162, U.S.D.A. 1924
Exercise 10.

Alfalfa and Similar Plants

I. General Characteristics

Alfalfa belongs to the legume family (Leguminosae) and to the genus Medicago. The Medics are mostly herbs with pinnately 3-foliolate leaves. The stipules are adnate to the petiole, and the leaflets commonly dentate. The flowers are small, yellow or violet, in axillary heads or racemes. The stamens are diadelphous (nine and one). The seed pods are curved or spirally twisted.

Two botanical species of alfalfa are recognized, (1) common alfalfa (Medicago sativa) with violet flowers, erect growth habit, and spirally twisted seed pods; and (2) Siberian or sickle alfalfa (M. falcata) with yellow flowers, decumbent stems, and sickle-shaped pods. The latter species is not grown commercially in the United States. Five agronomic groups of alfalfa are recognized, viz., common, variegated, Siberian, Turkistan, and non-hardy.

Other Medics are hop clover or yellow trefoil (M. lusulina), toothed bur clover (M. hispida), and spotted bur clover (M. arabica).

II. Laboratory Instructions

1. Draw common alfalfa inflorescence and show its location on the stem.
2. Draw an alfalfa leaf and label all parts.
3. Examine an alfalfa crown and roots. Note the shape of the roots and location of nodules. Make a diagrammatic sketch of a root.
4. Dissect an alfalfa flower, arrange the parts in order, draw, and label.
5. Draw an alfalfa seed pod. Remove a seed, draw, and label the hilum.
6. Draw a seed pod of Siberian alfalfa.
7. Draw a bur clover pod. Remove a seed, draw, and label.

III. Questions to be Answered

1. Describe the alfalfa leaf, stem, inflorescence.
2. Compare the seed pod of alfalfa with bur clover. Seeds.
3. Contrast the seed pods, flowers, and growth habit of Siberian and common alfalfa.
4. How do common and variegated alfalfas differ?

References


Supplies necessary: (1) Common alfalfa plants in bloom, alfalfa roots, alfalfa seed pods, and threshed seed. (2) Siberian alfalfa plants with seed pods and flowers. (3) Bur clover seed.
Exercise II

Sweet Clover

I. General Characteristics

Sweet clovers (Genus Melilotus) are tall, erect, annual or biennial herbs with a fragrant odor. The leaves are pinnately 3-foliate, petioled, and possess large stipules and dentate leaflets. The flowers occur in one-sided axillary racemes. They are white or yellow. The pods are ovoid, small, indehiscent or finally 2-valved, and usually one-seeded.

There are 3 common species: (1) Yellow biennial sweet clover (M. officinalis), (2) white biennial sweet clover (M. alba), and (3) yellow annual sweet clover (M. indica). The first two are the most important agriculturally.

II. Laboratory Instructions

1. Draw a trifoliate leaf of white biennial sweet clover.
2. Examine a plant of biennial sweet clover dug in the fall and contrast it with alfalfa. Draw.
3. Draw a sweet clover inflorescence.
4. Examine sweet clover "seed" in the hull. Draw the hulled and threshed "seed".

III. Questions to be Answered

1. How does sweet clover differ botanically from alfalfa?
2. How do the leaves of sweet clover differ from those of alfalfa?
3. How does the crown of biennial sweet clover differ from that of alfalfa?
   How do new shoots arise?
4. Describe the sweet clover seed pod.
5. In general, how do the biennial white and yellow sweet clovers differ?
6. How can yellow annual sweet clover be detected from white sweet clover?
7. How can sweet clover be detected from alfalfa seed?
8. How do biennial yellow and white sweet clover seeds differ?

References


Supplies necessary: (1) Sweet clover plants with roots, stems, leaves, flowers, and seed pods. (2) Seeds of yellow and white sweet clover and alfalfa. (3) Fall crowns of alfalfa and sweet clover.
Exercise 12.

True Clovers (Trifolium)

I. General Characteristics

The true clovers belong to the genus Trifolium. They are annual or perennial herbs with palmately trifoliate leaves, the stipules of which are adnate to the petiole. The inflorescence is a dense spike or head. The flowers vary in color. The pods are small, mostly one-seeded, indehiscent or open circularly. The seeds are small and kidney shaped.

The principal true clovers are: White, red, alsike, crimson, mammoth, and strawberry. The most common species can be distinguished as follows (after Robbins, 1931):

A. Flowers in spike-like heads, much longer than thick:

--------Crimson Clover (T. incarnatum).

AA. Flowers in globular or ovoid heads.

B. Corolla white or yellowish white, sometimes touched with pink; stems creeping----------------White clover (T. repens)

BB. Corolla red, red-purple, or rose colored; stems erect or nearly so.

C. Flowers pedicelled; stipules acuminate

-------Alsike clover (T. hybridum)

CC. Flowers sessile; stipules abruptly acute.

D. Blades of leaflet marked with large spot; heads sessile----------------Red clover (T. pratense)

DD. Blades of leaflet without spot; heads stalked----------------Mammoth clover (T. medium)

II. Laboratory Instructions

1. Draw leaves of white, red, alsike, crimson, and strawberry clover.
2. Sketch the inflorescence of these clovers.
3. Draw a seed pod of each of the true clovers.
4. Draw seeds of each true clover in comparison with other small-seeded legumes. Use the outline provided on the next page.
5. Separate small-legume-seed mixtures furnished by the instructor.

III. Questions to be Answered

1. How do the true clovers differ from alfalfa?
2. Explain why it is improper to call the "head" of clover a flower.
3. Is it possible to distinguish seedling plants of medium red from mammoth red clover? How?
4. Can alsike be distinguished from medium red? How?
5. How can white clover be distinguished from alsike clover in the seedling stage?
6. What true clovers produce stolons?
7. How can alsike clover be distinguished from white clover seed?
8. How can red clover seed be detected from alfalfa seed?
9. How can crimson clover be distinguished from alfalfa seed?

References


Supplies necessary: (1) Plants with inflorescences of red, white, alsike, crimson, and strawberry clovers. (2) Seeds of these clovers, (3) Seeds of alfalfa.
Exercise 12, continued

**True Clover vs. Alfalfa Seeds**

- White Clover
- Alskoe Clover
- Red Clover
- Crimson Clover
- Strawberry clover
- Alfalfa
Exercise 13.

Large-Seeded Legumes

I. General Characteristics

The large-seeded legumes include several species: field peas (Pisum sativum), field beans (Phaseolus vulgaris), common vetch (Vicia sativa), hairy vetch (Vicia villosa), soybean (Glycine max), and cowpea (Vigna sinensis).

II. Laboratory Instructions

1. Sketch a leaf, flower, and seed-pod of a soybean.
2. Draw a leaf of one of the vetches, a field pea leaf, and a field bean leaf.
3. Sketch seeds of soybeans, cowpeas, field beans, field peas, common vetch, and hairy vetch in the outline provided.

III. Questions to be Answered

1. Describe the soybean plant as to type of growth, pods, and flower colors.
2. What flower characteristic distinguishes the field bean?
3. How do cowpeas differ from field beans?
4. What are tendrils? On what species do they occur?
5. Describe the vetch leaf.
6. How do field peas differ from garden peas?

References

2. Hardenburg, H.V. The Bean. 1926.

Supplies necessary: (1) Soybean plants with flowers, and seed pods; (2) Leaves of vetch, field peas, and field beans; (3) Seeds of cowpeas, field peas, field beans, soybeans, common vetch, and hairy vetch.
Exercise 13, Cont.

Large-Seeded Legumes

Field peas

Field Beans

Soybeans

Common vetch

Hairy vetch

Cowpeas
Exercise 14
(September 1931)

Structure of the Sugar Beet Plant

I. General Description
(a) Classification
The sugar beet belongs to the Chenopodiaceae. The species Beta vulgaris (L.) is rather complex. In the cultivated forms it includes sugar beets, Mangels, common garden beets, and leaf beets. The variety of sugar beet most widely grown in Colorado is the Kleinwanzlebener. The sugar beet is a biennial. It stores up food in the crown and taproot the first year from which aerial seed shoots are produced the second year. The sugar beet has developed from a root with a low percentage of sugar — 6 percent or less — to one with 20 percent or more in some cases.

(b) Roots and Stem (Hypocotyl)
The "root" itself is, for the most part, an enlarged taproot. The root part may be distinguished from the hypocotyl portion (stem) by the two opposite longitudinal rows of Secondary roots. The true root system consists only of the lateral roots and the part of the root which bears them. The taproot extends almost straight downward. The lower part is thread-like and may reach a depth of 4-7 feet. The lateral roots and rootlets are very abundant and may spread horizontally 2-3 feet. The upper part (crown) of the sugar beet is the hypocotyl. It is a very much shorted stem with the leaves crowded at the apex. A transverse section shows a series of concentric rings of firm vascular tissue alternate with rings of soft thin-walled parenchyma. The second year the very short stem sends up, from terminal and axillary buds, stout, angular, branched stons to a height of 3-5 feet on which flowers and seeds are borne.

(c) Leaves
In the first season, a cluster of large leaves is developed from the crown of the beet. Each leaf has a long petiole which broadens out at the base. The blade is large and roughly triangular in shape at the base and longer than broad. The leaves produced on the stems the second year decrease in size rapidly as they approach the top of the stem. They are narrower and more pointed than those of the first year. The sugar is generated in the leaves. The amount of sugar elaborated depends upon the anatomical structure of the leaf, intensity of the light, and temperature. The influence of light depends upon quantity of foliage, position of leaves, age of leaves, period of exposure. In general, beets high in sugar content have abundant foliage. The sugar content is proportional to the size and development of the leaf surface. Leaves flat on the ground produce more sugar than upright ones since the light strikes them more nearly at right angles.

(d) Inflorescence
The inflorescences are loosely spicate and terminal. The flowers are arranged along an axis singly or in dense, sessile clusters, each of which is subtended by a small bract. (a) Flowers: Beet flowers are

Supplies necessary: (a) First year plants of sugar beets and mangels with leaves. (b) Second year sugar beet plants with seeds.
perfect. The perianth consists of 5 greenish parts united below to the base of the ovary. There are 5 stamens opposite to and partially attached to the perianth ring. The anthers are two-celled. The pistil is 3-carpellate with usually 3 short awl-shaped stigmas united to the base. The ovary is half-inferior, that is, partially imbedded in the flesh of the receptacle. It is one-celled and one-seeded. Pollen, i.e., maturation of the stamens before the pistils of the same flower, occurs in the sugar beet. Consequently, self-fertilization almost never occurs. Wind and insects are the chief agents in the distribution of pollen.

(b) Fruit and Seed: The ripened ovary of each flower is imbedded in the receptacle and base of the perianth. The fruit is hard and nut-like and contains a single, dark, smooth seed about the size of a turnip seed. The "seed ball" is a term applied to the beet seed. The "seed ball" usually contains a number of germs. In some cases a single germ is produced. The multiple germ seed arises when the flowers are in clusters. In this case, the parts of the several flowers stick together and form a several-seeded mass, the "seed ball." A single-germ beet seed is produced when the flower stands by itself on the stem. In the single germ beet seed, the 5 parts of the perianth which persist form the 5-pointed star of the seed.

II. Laboratory Instructions

1. Root. (a) Sketch a transverse section of the "beet" and label all parts. (b) Cut a thin slice and view against a black background. Note the width of the vascular tissue. (c) Sketch a longitudinal section and label all parts.

2. Leaves. (a) Sketch a leaf from a first year plant and label all parts. (b) Sketch a leaf from a second year stem.

3. Seed or Fruit. (a) Sketch a complete sugar beet seed capsule (enlarged 8 times). (b) Remove the actual seeds from the capsule. Sketch one eight times natural size.

III. Questions to be Answered

1. Compare sugar beets and mangels. Give the differences that distinguish them.

2. It will be seen that the vascular bundles in the stem are crossed. Account for this phenomenon.

3. Where are the oldest leaves on a first year plant located?

4. Why is a smaller area sufficient for second year beet leaves than for first?

5. What would be the advantage of a strain of sugar beets with single germs? Have such strains been developed?

6. Do all seeds on the stem mature at the same time?

7. Are the growth rings the same distance apart?

References


Exercice 15

Miscellaneous Crop Plants*

I. Flax (Linum usitatissimum)
   1. Make a sketch of the upper portion of the plant to show leaves, branches, flowers, and seed balls or capsules.
   2. Draw a seed capsule (cross section) to show the fine cells in which the seeds are formed.
   3. Draw a seed (front view).

II. Buckwheat (Fagopyrum esculentum)
   1. Sketch the upper part of the plant to show the leaf shape and ochrea (leaf sheath) surrounding the stem, also position where the flowers and mature seeds are borne.
   2. Draw a seed. (a) Surface view. (b) Cross section.

III. Rice (Oryza sativa)
   1. Study the heads of rice provided by the instructor. Note the ligule, short glumes, and the lemma and palea which are similar and fused.

IV. Cotton (Gossypium spp.)
   1. Study the root, stem, and leaf characteristics of the cotton plant. Note the arrangement of branches on the central stem and of the lateral roots on the taproot. Note the difference between vegetative and fruit branches.
   2. Cut a cotton flower through the calyx lobes and note the staminal column, stamens, style, calyx, petals, and bracts. Make a sketch of the cotton flower and show the above parts.
   3. The mature capsule is called a boll. Cut a cross section of a boll, and sketch it. Show the location of the seed and lint.
   4. Examine a single cotton fiber under a microscope. Note its shape and structure.

V. Hemp (cannabis sativa)
   1. Draw a short section of a stem and show leaf attachments.
   2. Draw a leaf.

Note: The exercises on flax, buckwheat, and rice are taken from the Kansas Agricultural College Crops Laboratory Manual. Cotton was taken from the Texas A. and M. Manual.
VI. Questions to be Answered

1. Name 4 characteristics of the flax plant that differentiate it from other plants studied.
2. Compare buckwheat and flax as to ability to combat weeds and in resistance to frost.
3. What is the buckwheat "seed"? How does it differ from a grass "seed"?
4. Describe a rice spikelet. What is paddy?
5. Distinguish between Japanese and Honduras rice.
6. What is the arrangement of the branches on the central stem of cotton?
7. What kind of a root system does the cotton plant possess?
8. How many sepals and petals are there in a normal cotton flower?
9. How are the seeds arranged in a cotton lock?
10. Distinguish between upland and sea island cotton.
11. Describe the hemp inflorescence.
12. Describe the hemp leaf.
13. Tell how hemp is retted.

References

2. How to Grow Rice in the Sacramento River Valley, F.B. 1240, U.S.D.A.
5. Fiber Flax F.B. 569, U.S.D.A.
Exercise 16

Noxious Weeds

I. General Weed Problem

Weeds are recognized as a menace to crop production. Annual weeds, while troublesome, can usually be controlled by cultivation. Perennial weeds with running rootstalks offer a more serious problem. It is often necessary to resort to clean cultivation or chemicals to control them. The student should be able to recognize the more serious weed pests, especially those declared noxious in the state seed law.

Among the more important noxious weeds in Colorado are:

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quack grass</td>
<td>Agropyron repens</td>
</tr>
<tr>
<td>2. Curled dock</td>
<td>Rumex crispus</td>
</tr>
<tr>
<td>3. Bouncing Bet</td>
<td>Saponaria officinalis</td>
</tr>
<tr>
<td>4. Perennial Peppergrass or</td>
<td>Lepidium draba, Lepidium repens,</td>
</tr>
<tr>
<td>Whiteweed</td>
<td>Hymanophysa pubescens</td>
</tr>
<tr>
<td>5. Hare's Ear Mustard</td>
<td>Conringia orientalis</td>
</tr>
<tr>
<td>6. Fanweed</td>
<td>Thlaspi arvense</td>
</tr>
<tr>
<td>7. Tumbling Mustard</td>
<td>Norta altissima</td>
</tr>
<tr>
<td>8. Leafy Spurge</td>
<td>Euphorbia virgata</td>
</tr>
<tr>
<td>9. Poison Milkweed</td>
<td>Asclepias galioidea</td>
</tr>
<tr>
<td>10. Field Bindweed</td>
<td>Convolvulus arvensis</td>
</tr>
<tr>
<td>11. Common Plantain</td>
<td>Plantago major</td>
</tr>
<tr>
<td>12. Broad-leaved Plantain</td>
<td>Plantago rugosii</td>
</tr>
<tr>
<td>13. Narrow-leaved Plantain</td>
<td>Plantago lanceolata</td>
</tr>
<tr>
<td>14. Mouse-ear Fovery Weed</td>
<td>Iva axillaris</td>
</tr>
<tr>
<td>15. Silver-leaf Povery Weed</td>
<td>Franseria discolor</td>
</tr>
<tr>
<td>16. Canada thistle</td>
<td>Cirsium arvense (Carduus arvensis)</td>
</tr>
<tr>
<td>17. Russian knapweed</td>
<td>Centaurea picris or C. repens</td>
</tr>
<tr>
<td>18. Perennial Sow Thistle</td>
<td>Sonchus arvensis</td>
</tr>
<tr>
<td>19. Blue Lettuce</td>
<td>Lactuca pulchella</td>
</tr>
<tr>
<td>20. Perennial ragweed</td>
<td>Ambrosia psilostachya</td>
</tr>
</tbody>
</table>

These weeds are fully described and illustrated in "Colorado Weeds", Colo. Exp. Sta. Bul. 403, (1933).

II. Pressing Plant Specimens

It is generally necessary to press and mount weed specimens to preserve them. A convenient home-made press may be prepared. Procure two boards approximately 16 inches long, 12 inches wide, and one-half inch thick. Between these insert several sheets of blotting paper, a specimen being mounted between each two sheets. Corrugated cardboard inserted throughout the press will greatly facilitate drying of the specimens.

---

1 From Forage Crops Laboratory Manual, University of Nebraska.
Pressure may be placed upon the plants by either a heavy weight, or by
binding the press with two straps. The press should be left in a dry,
well-ventilated room. Under proper conditions of handling, the
specimens should be sufficiently dried in a week or ten days to be
ready for mounting.

The plants should be mounted on regular herbarium paper, or on a light-
weight cardboard. The specimens may be glued down by strips of gummed
paper. The entire plant should be mounted, otherwise sections of the in-
florescence, stems, leaves, and roots should be included. The following
facts concerning each specimen should be noted: (1) Common name, (2)
scientific name, (3) family, (4) length of life, (5) means of propagation,
and (6) date of collection.

III. Laboratory Instructions

1. Press and identify 12 weeds.
2. Identify the weed specimens furnished by the instructor, by use of
   Colorado Experiment Station Bulletin No. 403, or by the text in

IV. Questions to be Answered

1. Distinguish between Canada thistle and Russian Knapweed.
2. How does the mouse-ear poverty weed differ from the silver-leaf poverty
   weed?
3. How does bindweed differ from the common annual morning glory?
4. How do annual weeds spread? Perennial weeds?
5. How do perennial weeds propagate?
6. Why are perennial weeds more difficult to eradicate than annual weeds?
7. Explain how perennial weeds may be eradicated by the use of chemicals,
   or by cultural methods.

References:

2. Robbins, J. W., and Boyack, B. The Identification and Control of
   Colorado Weeds Colo. Exp. Sta. Bul. 251 1919
3. Rogers, C. F. Canada Thistle and Russian Knapweed and their Control
   Colorado Exp. Sta. Bul. 348 1928
4. ____________ et al. Three Important Perennial Weeds of Colorado
   Colorado Exp. Sta. Bul. 313. 1926
   Sta. Bul. 403 1933

(2428-36)
FIELD CROPS LABORATORY MANUAL

Section II

Taxonomy or Classification of Crop Plants
Exercise 17

Groups of Economic Grasses

I. Classification of Grasses

Many of the most important crop plants are grasses. They may be conveniently divided into nine tribes for study purposes, viz., Oryzae, Agrostidiae, Paniceae, Phalaridiae, Andropogonae, Hordeae, Festucae, Chlorideae and Avenae. The most useful classification of grasses for this country is the one by Hitchcock (1935).

Among the economic grasses to be studied are: Timothy, orchard grass, meadow fescue, brome grass, redtop, Kentucky bluegrass, slender wheatgrass, crested wheatgrass, Reed canary grass, tall meadow oat grass, perennial rye grass, grama grass, and Buffalo grass. The cereals, which are also grasses, will be considered in other exercises.

II. Key to the Grass Tribes

The grass family is divided into several tribes which are, in turn, divided into genera. There are 8 important tribes as follows:

1. Spikelets one flowered
   a. Glumes none (except in Oryzae) ................. Oryzae
   b. Glumes two .................................. Agrostidiae
   c. Glumes three? .............................. Paniceae
   d. Glumes four ................................. Phalaridiae

2. Spikelets in pairs (occasionally 3)
   a. One sessile, one pedicillate.
      The pedicillate flower may be sterile, or reduced to a mere pedicel ........... Andropogonae

3. Spikelets two to several flowered
   a. Rachis zigzag .................................. Hordeae
   b. Rachis not zigzag ................................ Festucae
   c. Spikelets on one side of rachis .................. Chlorideae
   d. Lemma awned, awn arising midway between
      base and apex of lemma ...................... Avenae

(There may be exceptions, but for the most part this characterization holds. Zoysieae, Bambuseae, and Maydeae are omitted. In Maydeae, the plants are monoeocious with two florets and two glumes.)

III. Laboratory Instructions

1. Dissect a spikelet of a representative of each of eight grass tribes (Oryzae omitted). Draw the parts in an outline similar to the one at the end of the exercise. Use abbreviations as follows for the parts of a grass spikelet: "g1" and "g2" for glumes, "l1" for lemma, "p" for palea, and "c" for caryopsis.

Note: Key to tribes used by Lute in "Grasses" course.

2. Hitchcock (1935) describes this tribe as 2 membranous glumes, and a sterile lemma like the glumes in texture. Sometimes a sterile palea is also present.
2. Examine a leaf of bromegrass for a means of distinction in the vegetative stage.
3. Collect at least 15 grasses and divide them into tribes (or classify specimens furnished by the instructor).
4. Classify "unknowns" furnished by instructor into genus and species.

IV. Questions to be Answered

1. How would you distinguish between slender and crested wheatgrass in the head?
2. How many glumes does ryegrass have per spikelet? Explain.
3. How do perennial ryegrass and slender wheatgrass differ?
4. What type of inflorescence has timothy?
5. How many flowers do you find in a tall meadow oat grass spikelet? How do they differ?
6. Compare the awn attachment of tall meadow oat grass with that of wild oats.
7. How would you distinguish bromegrass from meadow fescue?
8. What is peculiar about the orchard grass inflorescence?
9. What peculiarity do you observe in the Kentucky bluegrass floret? Is this useful in classification?
10. How does Johnson grass differ from Sudan grass?

References

1. Chase, Agnes. A First Book of Grasses. 1921
<table>
<thead>
<tr>
<th>Tribe: Agrostidaceae</th>
<th>Tribe: Hordeae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spiklet of Redtop</td>
<td>Spiklet of slender Wheatgrass</td>
</tr>
<tr>
<td>Tribe: Paniceae</td>
<td>Tribe: Festucaceae</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Spiklet of Green Foxtail</td>
<td>Spiklet of Bromo Grass</td>
</tr>
<tr>
<td>Tribe: Phalarideae</td>
<td>Tribe: Chlorideae</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Spiklet of Reed Canary Grass</td>
<td>Spiklet of Grama Grass</td>
</tr>
<tr>
<td>Tribe: Andropogoneae</td>
<td>Tribe: Avenace</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Spiklet of Johnson Grass</td>
<td>Spiklet of Tall oat Grass</td>
</tr>
</tbody>
</table>
KEY TO COMMON ECONOMIC GRASS SPECIES

Hordeae

1. Spikelets one flowered
   Spikelets two to several flowered, solitary at each node of the rachis.

2. Spikelets placed edgewise to the rachis. First glume wanting except in the terminal spikelet.

3. Lemmas nearly or entirely awnless
   Lemmas, at least the upper, awned
   (Perennial Ryegrass) Lolium perenne
   (Italian ryegrass) Lolium multiflorum

2. Spikelets placed flatwise to the rachis.

4. Plants with creeping rhizomes.

5. Glumes rigid, gradually tapering into a short awn, culms 30–60 cm tall, exceeding the leaves. Leaves stiff, strongly nerves, usually bluegreen in color.
   Spikelets 5–10 flowered. (Western wheatgrass) Agropyron smithii

5. Glumes not rigid, acute or abruptly awn-pointed.
   Lemmas glabrous, blades lax, flat. Spikelets 1–6 flowered.
   (Quackgrass) Agropyron repens

4. Plants without creeping rhizomes.

   (Crested wheatgrass) Agropyron cristatum

6. Spikelets not much compressed or closely imbricate, awnless or awn-tipped only. Lemmas glabrous, the internodes of the rachis villous. Glumes broad nearly as long as the spikelet.
   (Slender wheatgrass) Agropyron pauciflorum

Chlorideae

1. Plants dioecious. Low stoloniferous perennial. Staminate culms slender, 5–20 cm tall, the spikes 5–15 cm long, pistillate heads 2–4 mm thick.
   (Buffalo grass) Buchloe dactyloides

1. Plants with perfect flowers. Erect. Spikes usually two, racemose along the main axis. Spikelets with only one perfect floret, often with additional imperfect florets above. Spikelets 2–many in each spike, all alike. Spikes falling entire.
   (Blue grama) Bouteloua gracilis

Agrostideae

1. Glumes compressed-carinate; panicle dense, cylindric or ellipsoid.
   Culms 50–100 cm tall, from a swollen or bulb like base. Panicle cylindric, 5–10 cm long. Glumes 3.5 mm long, truncate with a short awn 1 mm long.
   (Timothy) Phleum pratense

1. Glumes not compressed-carinate, not ciliate. Florets without hairs at base, or with short ones. Falica small or wanting. Strong creeping rhizomes. Panicle reddish, as much as 20 cm long.
   (Red top) Agrostis alba

---

1 Modified from Hitchcock (1935)
Aveneae

1. Florets two, one perfect, the other staminate, only one strongly awned. Lower floret staminate, the awn twisted, geniculate. Culms erect, 1-1.5 m tall. Panicle pale or purplish, shining, 15-30 cm. long.
---(Tall oatgrass) *Arrhenatherum elatius*

1. Florets two or more, all alike except the reduced upper ones. Spikelets large, the glumes more than 1 cm long. Plants annual. Awn stout geniculate, twisted, lemma clothed with stiff, brown hair. Culms 30-75 cm tall.
---(Wild oats) *Avena fatua*

Phalarideae

1. Lower florets neuter, reduced to small, awnless, scalelike lemmas. Spikelets green or yellowish, much compressed laterally. Panicle narrow, spreading during anthesis, 7-15 cm. long. Culms 60-150 cm. tall, rhizomes present. Glumes about 5 mm. long. Sterile lemma villous, about 1 mm long.
---(Reed canary grass) *Phalaris arundinacea*

1. Sterile lemmas half as long as fertile.
---(Cana-grass) *P. canariensis*

Festucæae

1. Lemmas keeled on the back.
2. Spikelets strongly compressed, crowded in one-sided clusters, at the ends of the stiff, naked panicle branches. Culms in large tussocks, 60-120 cm. tall. Leaf sheaths laterally compressed.
---(Orchard grass) *Dactylis glomerata*

2. Spikelets not strongly compressed, not crowded in one-sided clusters.
3. Lemmas ached from a minutely bifid apex, 9-12 mm long.
   Spikelets 2-2.5 cm. long. Culms erect 50-100 cm. tall from creeping rhizomes. Ligule 1.5-2 mm. long. Leaf sheath closed.
---(Smooth Brome) *Bromus inermis*

3. Lemmas awnless; spikelets small. Sheaths open. Creeping rhizomes present. Lemmas usually with webbed hair at the base.
---(Canada bluegrass) *Poa compressa*

4. Culms not strongly flattened, usually cylindrical. Lemmas strongly webbed at base. Culms glabrous 30-100 cm. tall. Lower panicle branches in a sheath of usually five.
   Spikelets 3-6 mm. long.
---(Kentucky bluegrass) *Poa pratensis*

1. Lemmas rounded on the back. Pointed, awnless. Spikelets 6-8 flowered, from 8-12 mm long. Culms 50-120 cm. tall. Glumes 3 and 4 mm. long.
---(Meadow fescue) *Festuca elatior*

Panicæae

1. Spikelets surrounded by one to three bristles below. Spikelets 2-2.5 mm long. Fruit finely rugose.
2. Panicle cylindrical, tapering above, green spikelets falling entire.
---(Green foxtail) *Setaria viridis*

2. Panicle lobed or interrupted, often large and heavy. Purple or yellow. Fruit deciduous from glumes and sterile lemmas.
---(Foxtail millet) *Setaria italica*
1. Spikelets not subtended by bristles
   7. Glumes or sterile lemma awned. Blades long 5-15 mm wide.
      Panicle purple tinged 10-20 cm long. Spikelets crowded,
      about 3 mm long, excluding the awns.
      --- (Barnyard grass) Echinochloa crus-galli

   Spikelets 4.5-5 mm long, strongly many nerved. Culms erect 20-100 cm.
   + 1. Panicle 10-30 cm long. --- (Broomcorn millet) Panicum miliaceum

Andropogoneae

1. Racemes of several to many joints, solitary, digitate, or
   aggregate in panicles.
2. Racemes solitary on each peduncle. Culms tufted. Hairs on
   rachis and pedicels 2-3 mm long. Plants green or glaucous,
   often purplish. Culms 50-150 cm tall. Spikelets sessile,
   6-8 mm long. Awn 8-15 mm long.
   --- (Prairie beardgrass) Andropogon scoparius

2. Racemes two-numerous on each peduncle. Rachis joint and
   sterile pedicel ciliate. Awn of sessile spikelet 1-2 cm
   long. Racemes 5-10 cm long, usually purplish in color.
   Sessile spikelet, 7-10 mm long.
   --- (Bluejoint Turkeyfoot) Andropogon furcatus

1. Racemes reduced to one or few joints, these mostly peduncled in a
   subsimple or compound panicle. Pedicellate spikelets staminate.
   Annual, culms 50-150 cm tall. --- (Sudan grass) Sorghum vulgare var.
   sudanense

(7401-40)
Exercise 13

Corn Types and Varieties

I. Corn Types

Corn belongs to the Gramineae or grass family, to the tribe Maydeae, and to the genus Zea. From a strictly botanical standpoint there are no clear-cut species of Zea, although many were recognized 25-30 years ago. Six groups are distinguished by their kernel texture and other kernel characteristics: Pod corn (Zea tunicata), pop corn (Zea esculenta), Flint corn (Zea indurata), Dent corn (Zea identata), Soft corn (Zea yyclacca), and sweet corn (Zea saccharata). These so-called "species groups" classified by Sturtevant are used for convenience.

II. Standards for Colorado Corn Varieties

Certain arbitrary standards for Colorado varieties have been recognized in this state (particularly by corn judges). Their interpretation may vary with different individuals. Corn is a heterozygous crop with the result that varietal distinctions in the field are impossible in dent corn except when differences are large, such as in white, yellow, red, or variegated kernel color.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ear Characteristics</th>
<th>Kernel Characters</th>
<th>Cob Color</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length (In.)</td>
<td>Shape</td>
<td>Color</td>
</tr>
<tr>
<td>Reid Yellow Dent</td>
<td>8-9</td>
<td>Cylindrical</td>
<td>Yellow</td>
</tr>
<tr>
<td>Iowa Silvermine</td>
<td>8-9</td>
<td>Cylindrical</td>
<td>White</td>
</tr>
<tr>
<td>Minnesota 13</td>
<td>7-8.5</td>
<td>Slight taper</td>
<td>Yellow</td>
</tr>
<tr>
<td>Swadelley Dent</td>
<td>7-8.5</td>
<td>Cylindrical</td>
<td>Wh. cap</td>
</tr>
<tr>
<td>White Australian</td>
<td>8-9</td>
<td>Cylindrical</td>
<td>White</td>
</tr>
</tbody>
</table>

Kernel rows on butts and tips should be straight for all varieties. Space between rows should be fairly close.

III. Laboratory Instructions

1. Make a careful study of kernels of each group. Soak the kernels for 15 minutes and make surface sketches (germ side up) of each.

2. Draw cross and longitudinal sections in addition. Show in these the proportions of hard (corneous) endosperm, and parts of the embryo and germ.

Materials necessary: (1) Ears of six corn groups, (2) ear samples of Colorado corn varieties.
IV. Questions to be Answered

1. Does the thickness of the corneous endosperm vary markedly in different kernels?
2. Which has the greatest feed value, a kernel with a large percentage of corneous endosperm or one which is largely white starch?
3. What explains the wrinkled condition of sweet corn?
4. What causes dent corn to dent?
5. What makes pop corn pop?
6. Botanically, what are the pods or husks found on pod corn kernels?
7. How would you distinguish between Minnesota 13 (or Colorado 13) and Reid Yellow Dent?

References

<table>
<thead>
<tr>
<th>Dent-Germ side up</th>
<th>Dent-Longitudinal section</th>
<th>Dent-Cross Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flint-Germ side up</td>
<td>Flint-Longitudinal section</td>
<td>Flint-Cross section</td>
</tr>
<tr>
<td>Soft or</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flour-germ side up</td>
<td>Flour-Longitudinal section</td>
<td>Flour-Cross section</td>
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<tr>
<td>Pod-Germ side up</td>
<td>Pod-Longitudinal section</td>
<td>Pod-Cross section</td>
</tr>
<tr>
<td>Sweet-Germ side up</td>
<td>Sweet-Longitudinal section</td>
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</tr>
<tr>
<td>Pop-Germ side up</td>
<td>Pop-Longitudinal section</td>
<td>Pop-Cross section</td>
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</table>
Exercise 13

Species and Varieties of Wheat

I. Wheat Classification

It is possible to recognize the species of wheat both in the head and threshed grain. The crops student should also become familiar with the general facts as to their importance, distribution, and adaptation. The classical work on wheat classification is the monograph by Percival, but the classification by Clark and Bayles is the most satisfactory for the species and varieties grown in this country.

Wheat belongs to the grass family (Gramineae), to the tribe Hordeae, and to the genus Triticum. The genus Agropyron which contains perennial species, and the genus Aegilops, contain species closely related to wheat.

II. Wheat Species or Sub-Species

The wheat varieties are grouped into 6 species or sub-species. These are: Common (T. vulgare), Club (T. compactum), Spelt (T. spelta), Poulard (T. turgidum), Durum (T. durum), Emmer (T. dicoccum), Polish (T. polonicum), and Einkorn (T. monococcum). They are distinguished as follows:

Key to the Species or Sub-Species

1a. Chromosome number 21 in haploid division.
   2a. Terminal spikelets fertile; palea remaining entire
       at maturity; spikelets with 2 to 5 fertile florets.
   3a. Glumes shorter than the lemma, firm; palea as
       long as the lemma.
       (Triticum sativum L.)
   4a. Rachis tenacious; kernels separating from
       the sheaf when threshed.
   5a. Glumes distinctly keeled only in the
       upper half; lemma awnless or awns less
       than 10 cm. long; straw hollow.
   6a. Spikes usually long, dense to lax,
       somewhat dorsally compressed. (T.
       aestivum L., T. vulgare Vill.)--------Common Wheat
   6b. Spikes short, dense, laterally
       compressed. (T. compactum Host)--------Club Wheat
1b. Rachis fragile; kernels enclosed in glumes
    when threshed.
   5b. Spike lax, narrow; pedicel long,
       wide, attached to face of spikelet below;
       shoulders wide, square. (T. spelta L.)----Spelt
1b. Chromosome number 14 in haploid division.

1Supplies necessary: Spikes of 8 wheat species and of Colorado standard varieties.
2a. Terminal spikelets fertile; palea remaining entire at maturity; spikelets with 2 to 5 fertile florets.
3a. Glumes shorter than the lemmas, firm; palea as long as the lemmas. (Triticum sativum Lam.)
4a. Rachis tenacious; kernels separating from the chaff when threshed.
5b. Glumes sharply keeled at the base; lemmas usually awned; awns 10 to 20 cm. long; straw usually solid.
6a. Glumes and kernels short; kernels ovate, with truncate tips. (T. turgidum L.)----------Poulsard Wheat
6b. Glumes and kernels longer; kernels usually elliptical. (T. durum Desf.)---------------------Durum Wheat
4b. Rachis fragile; kernels enclosed in glumes when threshed.
5a. Spikes dense, laterally compressed; pedicel short, slender, usually attached to base of spikelet; shoulders wanting to narrow, usually oblique. (T. dicoccum Schrank)--------------------------Emmer
3b. Glumes as long as or longer than the lemmas, papery, lanceolate; palea of lower flowers half as long as their lemmas. (T. polonicum L.)---------------------Polish Wheat
1c. Chromosome number 7 in haploid division.
2b. Terminal spikelets sterile, often scarcely visible; palea falling into 2 parts at maturity; spikelets usually with only 1 fertile floret.
3a. (T. monococcum L.)------------------------Einkorn

III. Wheat Varieties

The wide adaptation of wheat to soil and climatic conditions is due to a great extent to the development of varieties for particular conditions. Clark and Bayles (1935) list 201 varieties of Common Wheat alone. Most of these are distinguishable from the plants and seeds when certain other information is available. The most important characters used in classification are: Spike armed or awnless; glumes glabrous or pubescent; glumes white or brown; kernels white or red; kernels soft, semi-hard or hard; and winter habit or spring habit.

The standard wheat varieties in Colorado are: Komar, Ceres, Marquis, Thatcher, Kenrod, Blackhull, Dicklow, and Kubanka.
IV. Laboratory Instructions

1. Sketch a dissected spikelet of each wheat species. Note the distinctive characters and write a brief description of each.

2. Fill out a descriptive blank as follows on the wheat varieties given below:

<table>
<thead>
<tr>
<th>Variety</th>
<th>Species</th>
<th>Color</th>
<th>Color</th>
<th>Beardless neck</th>
<th>Head</th>
<th>Blanks</th>
<th>Shoulders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain</td>
<td>Chaff</td>
<td>Bearded or Compact</td>
<td>Shape</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wheat varieties:

(1) Durum
- Kubanka*
- A-nautka

(2) Club
- Hybrid 128
- Little Club

(3) Common

- Hard Red Spring
  - Marquis*
  - Thatchor*
  - Komar*
  - Ceres*

- Soft Red Winter
  - Fulcaster
  - Harvest Queen
  - Carrall
  - Mediterranean

- Hard Red Winter
  - Kanred*
  - Turkey*
  - Blackhull*

  - Common White
    - Gold Coin
    - Bart
    - Hard Federation
    - Dicklow

3. Make a key to distinguish the Colorado Standard Varieties, i.e., Thatcher, Komar, Dicklow, Ceres, Marquis, Blackhull, Turkey, and Kubanka. Make use of the characters in the above descriptive blank as well as the information in Technical Bul. 459, U.S.D.A.

4. Write a brief description of the Colorado Standard Varieties. Give importance, adaptation, and special advantages and characteristics of each.

5. Be able to use the wheat key (Technical Bul. 459) to identify "Unknowns" furnished by the instructor.

V. Questions to be Answered

1. Where are the winter and spring forms of emmer grown?

2. In what countries are spelt and einkorn grown?

3. Of what value may einkorn or spelt be to the cereal breeder in the United States?

4. What are the important kernel characteristics of einkorn, emmer, spelt, and polish wheats?

5. How would you distinguish these varieties in the head: (1) Ceres from Komar? (2) Turkey from Kanred?
References


Exercise 20

Classification of Barley

I. Need for Classification Scheme

Many new forms of barley have been added in recent years with the result that an orderly classification is necessary to avoid confusion among students and agricultural workers. It will further help to broaden and make more definite agronomic and genetic work in barley.

Harlan (1918) states that "variable characters in barley are numerous and sharp. Few cultivated crops present such contrasts as hulled and naked kernels, awned and hooded lemma, fertile and infertile florets, etc."

Wiggins (1921), who has published another classification, has presented a detailed morphology of the barley plant that is useful in classification studies. Many of the commercial varieties used, however, in his key are selections little grown at the present time. For that reason, Harlan's key has been found most useful for varieties grown in the country as a whole.

The major distinctions useful in the establishment of species and varieties (Harlan, 1918) are: (a) Spikes 6-rowed, intermediate, 2-rowed, and deficient; (b) Kernels hulled and naked; (c) Lemma awned (includes awnless) and hooded; (d) Kernels white (includes blue and purple) and black. Smooth-awned sorts are more recent than Harlan's classification. These have been placed in their proper order in the key as regards other characters as a subdivision. The length of the rachilla hairs is an important characteristic that should be added. The rachilla hairs are either long or short.

The species of barley are of necessity based on fertility. These are H. vulgare, H. intermedium, H. deficiens, and H. distichon. These are based on the characteristics of the spike. The common 6-rowed barley varieties belong to H. vulgare, while the 2-rowed forms are classified as H. distichon. The other two species are not important economically.

Frequently it is necessary to identify barley from threshed material alone. H. distichon cannot be separated from H. deficiens with certainty on the basis of the grain alone. It may well be ignored as few varieties of H. deficiens occur. The first determination is usually as to whether the sample is 2-rowed or 6-rowed. This can be determined readily as to the presence or absence of the lateral kernels (twisted) in the sample.

Supplies necessary: Spikes of 4 barley species, spikes of Colorado varieties, and of various "unknowns".
The adherence of the lemma and palea is obvious in threshed material. The color of the grain is also obvious in a threshed sample. The determination of the awned or hooded condition is usually obvious. Ordinarily enough kernels still bear fragments of awns or hoods to make this character certain.

Harlan (1918) (1a) has divided the four barley species into sub-species based on naked vs. hulled kernels, awned vs. hooded lemmas, and white vs. black kernels.

Some of the important barley varieties grown in the U.S. are: Trebi, Coast, Manchuria, Oderbrucker, Club Mariout, Horn, Velvet, Wisconsin 38, and Tennessee Winter. Those grown in Colorado are: Trebi, Coast, Club Mariout, Lico, Beecher, Wisconsin 38, Velvet, Vance Smyrna, and Colsees.

II. Laboratory Instructions

1. Sketch the spikelets at a rachis joint of H. vulgare, H. intermedium, H. deficiens, and H. distichon.


<table>
<thead>
<tr>
<th>Variety</th>
<th>Species rowed</th>
<th>2 or 6 dense</th>
<th>Hooded or smooth rachilla</th>
<th>Covered Grain</th>
<th>Spike Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Construct a key to fit the above listed Colorado varieties. Make use of information in paragraph 2, and in references.

4. Classify by use of the appended key the "unknowns" furnished, as to species, sub-species, and commercial variety (the latter when called for).

III. Questions to be Answered

1. Distinguish between the four barley species.
2. How would you separate H. intermedium from the other species?
3. Account for the descriptive terms "2-row" and "6-row" barley.
4. Describe what is meant by "density."
5. What color conditions are recognized in barley?
6. What characteristics are unreliable for barley classification? Why?
7. How does Trebi barley differ from Coast?
8. What are some of the advantages of the Colsees variety over Coast?
9. Give a possible explanation for the poor yields of hooded barleys in comparison with awned barleys.
CLASSIFICATION OF COLORADO BARLEYS
(Modified Harlan's Classification to fit Colorado varieties).

Scheme of Classification Founded upon Fertility

<table>
<thead>
<tr>
<th>Genus</th>
<th>Section</th>
<th>Sub-Section</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hordeum</td>
<td>vulgare</td>
<td>Eu - vulgare</td>
<td>---2-vulgare</td>
</tr>
<tr>
<td></td>
<td></td>
<td>intermedium</td>
<td>---intermedium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>distichon</td>
<td>---distichon</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(distichon</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(deficiens</td>
</tr>
</tbody>
</table>

Key to the Species

A. All spikelets fertile (6-rowed barley)
   B. Lemmas of all florets awned or hooded ---vulgare L.
   BB. Lemmas of lateral florets bearing neither awns nor
       hoods ---intermedium Kocks.

AA. Only the central spikelets fertile (2-rowed barley).
   B. Lateral spikelets consisting of outer glumes, lemma, palet, rachilla
      and usually rudiments of the sexual organs ---distichon, L.
   BB. Lateral spikelets reduced, usually to only the outer glumes
      and rachilla, rarely more than one flowering glume present,
      and never rudiments of sexual organs ---deficiens, Steud.

Key to the Sub-Species

A. Hordeum vulgare. Barleys with three fertile spikelets at each node,
   the lemmas of both central and lateral florets bearing awns or hoods.
   B. Kernels hulled.
      C. Lemmas awned
         D. Kernels white, blue or purple ---1. pallidum
         DD. Kernels black ---2. nigrum
      CC. Lemmas hooded
         D. Kernels white, blue or purple ---3. horridianum
         DD. Kernels black ---4. atrum
   BB. Kernels naked
      C. Lemmas awned
         D. Kernels white, blue or purple ---5. coeleste
         DD. Kernels black ---6. duolinigrum
      CC. Lemmas hooded
         D. Kernels white, blue or purple ---7. trifurcatum
         DD. Kernels black ---8. aethiops

AA. Hordeum intermedium. Barleys in which the lateral florets are fertile
   but awnless.
   B. Kernels hulled.
      C. Lemma of central floret awned or awnless.
         D. Kernels white, blue or purple ---9. haxtoni
         DD. Kernels black ---10. mortoni
      CC. Lemma of central floret hooded
         D. Kernels white, blue, or purple ---11. subcornutum
         DD. Kernels black ---12. atricornutum
BB. Kernels naked.
C. Lemma of central floret awned or awnless.
   D. Kernels white, blue, or purple---13. nudihaxtoni
   DD. Kernels black---14. nudimortoni
CC. Lemma of central floret hooded.
   D. Kernels white, blue, or purple---15. cornutum
   DD. Kernels black---16. subaethiops

AAA. Hordeum distichon. Barleys in which the lateral florets are present but sterile.
B. Kernels hulled.
   C. Lemmas awned or awnless.
      D. Kernels white, blue, or purple---17. palmella
      DD. Kernels black---18. nigricans
   CC. Lemmas hooded.
      D. Kernels white, blue, or purple---19. angustispicatum
      DD. Kernels black---20. rimpaul

BB. Kernels naked.
C. Lemmas awned or awnless.
   D. Kernels white, blue, or purple---21. nudum
   DD. Kernels black---22. nigrinudum
CC. Lemmas hooded.
   D. Kernels white, blue, or purple---23. laxum
   DD. Kernels black---24. nigrilaxum

AAAA. Hordeum deficiens. Barleys in which the lateral florets are not only sterile but rudimentary.
B. Kernels hulled.
   C. Lemmas awned or awnless.
      D. Kernels white, blue, or purple---25. deficiens
      DD. Kernels black---26. steudelii
   CC. Lemmas hooded.
      D. Kernels white, blue, or purple---27. tricoros
      DD. Kernels black---28. tridex

BB. Kernels naked.
C. Lemmas awned or awnless.
   D. Kernels white, blue, or purple---29. nudideficiens
   DD. Kernels black---30. decorticatum
CC. Lemmas hooded.
   D. Kernels white, blue, or purple---31. sublaxum
   DD. Kernels black---32. cymnospermum

Key to Commercial Varieties

A. Spikelets all fertile (6-rowed barleys)
B. Lateral florets awned or hooded (sp. vulgare)
C. Kernels hulled.
   D. Lemmas awned.
      E. Kernels white, blue, or purple (var. pallidum)
      F. Kernels white
      G. Spike narrow, lax, nodding---sub-var. typica
      H. Rough awn. Represented by the agricultural varieties Manchuria, Oederbrucker, Tennessee Winter, etc.

HH. Smooth awn. Represented by Velvet, Comfort, Glabron, Moister, Elfry, etc.
GG. Spike wide, very dense, pyramidal, awns widely spreading—sub-var. *pyramidatum*

H. Rough awn. Represented by the agricultural varieties Winter Club (White Winter or Utah Winter), Tapps Winter and Club Haricut.

HH. Smooth awn. Represented by Flynn.

FF. Kernels blue—sub-var. *coeruleascens* Represented by blue-gray strains of Coast, Trebi, and several pedigreed selections of Manchuria.

EE. Kernels black—var. *nigrum*

H. Rough awn. Represented by Black 6-row and Gatami.

HH. Smooth awn. Represented by Lion.

DD. Lemmas hooded—var. *horsfordianum* Represented by the agricultural variety Horsford Beardless: Success and Colssess.

CC. Kernels naked.

D. Lemmas awned.

E. Kernels white, blue, or purple (var. *caeleste*)

F. Kernels white—sub-var. *typica* Represented by Jerusalem barley and other naked varieties, usually not named.

FF. Kernels blue—sub-var. *violaceum* Represented by the agricultural variety Himalaya Hull-less (Guy Kayle).

FFF. Kernels purple—sub-var. *violaceum* Represented by the agricultural varieties Faust and Nepal (White Hull-less).

DD. Lemmas hooded—var. *trifurcatum* Represented by the agricultural varieties Faust and Nepal (White Hull-less).

EE. Lateral florets rounded or pointed, neither awned nor hooded (sp. *intermedium*)

C. Kernels hulled

D. Lemma of central floret awned or awnless (Var. *haxtoni*) Lemma of central floret awnless—sub-var. *caeleste* Represented by the agricultural varieties Arlington Awnless, Famesh, and in the dense form by Nakanohase.

AA. Central spikelets only fertile, lateral sterile or wanting (2-rowed)

EE. Lateral florets are present but sterile (sp. *Distichon*). Barley

C. Kernels hulled

D. Lemmas awned.

E. Kernels white, blue, or purple (var. *valmelle*)
F. Kernels white.
   G. Spike narrow, lax, nodding—sub-var. nutans
      Represented by the agricultural varieties Hanna,
      Hannchen, Moravian, Princess, Chevalier,
      Gold, etc.

Gg. Spike wide, dense, erect—sub-var. erectum
    Represented by the agricultural varieties Smyrna,
    Swanhals, Primus, Goldthorpe, Canada Thorpe, etc.

Ff. Kernels black------------------var. nigricans
    Represented by the agricultural varieties
    Black Smyrna and Black Arabian.

Gg. Kernels naked.
   D. Lomans awned
      E. Kernels white------------------var. nudum
         Represented by the agricultural variety McEwans, etc.

Bb. Lateral florets are not only sterile but rudimentary

C. Kernels hulled
   D. Lomans awned.
      E. Kernels black. Represented by Blackhull
         (steudelii) (Akron, Colo.)
Description of Colorado Barley Varieties

1. Beecher: A 6-rowed, semi-smooth-awned variety recommended for the drylands. The heads are compact. The grains are plump, the aleurone being white. Beecher originated from an Atlas x Vaughn No. 9 cross.

2. Club Mariout: A 6-rowed, hulled and awned barley. The grain is light in color. The awns are stiff and the head is rather dense. The straw is short. This variety matures early under Colorado conditions. The rachilla has long straight hairs. Synonym: Mariout.

3. Coast: A six-rowed bearded barley. The head is slightly lax. The awns are heavy, coarse, rough and persistent. These qualities make it hard to handle and render the straw undesirable as a feed. The awn is tough, which makes it hard to thresh from the grain. The grain is bluish green in color. Synonyms: California Feed, Bay Brewing and Blue.

4. Colcese: A hooded six-rowed barley of hybrid origin. It was produced from a cross between Coast and Success. The grain is hulled and of a bluish green color. The straw and glume color is light yellow. The heads are more compact and darker in color than those of Success. The rachis is rather tough and the head does not shatter easily. The rachilla is covered with short hairs and the outer glume is hairy. The straw is very stiff and it stands up well under irrigation.

5. Lico: A 6-rowed, smooth-awned variety with a white aleurone and lax spike. It is susceptible to loose smut. This variety originated at the Colorado Station from a Lion x Coast cross.

6. Nepal: A hooded, hulless six-rowed barley. It has a light-colored grain which threshes free from the hull. This barley is weak in the straw and it often lodges. It is grown as a hay crop in the higher altitudes. Synonyms: Bald, White Hull-less, U.S. 12709.

7. Trebi: A six-rowed, bearded, hulled barley with heads very similar to those of Coast. Under Colorado conditions (irrigated) the kernels are large and bluish in color. The straw is weak. In threshing the awns break off from the glume more easily than those of the Coast variety.

8. Vance Smyrna: A two-rowed, awned barley. The straw is very short, and the head seldom fully emerges but usually remains about half enclosed in the boot. The awn is partly rough. Synonym: Smyrna.

9. Velveta: A smooth-awned, 6-rowed barley. The kernels are rather plump under irrigated conditions.

10. Wisconsin 38: A smooth-awned, 6-rowed barley which originated from a cross of Oderbrucker x Leierorrhynchum. It resembles Oderbrucker in malt quality. The hybrid has a somewhat looser hull which makes threshing without peeling difficult.
References


Exercise 21

Classification of Oats

I. Reasons for Oat Classification

In recent years the number of varieties of oats has increased tremendously. Much confusion in nomenclature has been the result. Etheridge (1916) has published a classification to meet the need for accurate descriptions, although many new varieties have been introduced since that time. He has divided oats into eight groups or sub-species which are as follows:

Avena nuda, A. byzantina, A. abyssinica, A. strigosa, A. brevis, A. fatua, A. sativa, and A. sativa orientalis. Among the morphological characteristics of major importance in classification are: (1) Free or naked caryopsis, (2) persistence of the upper grains to their rachilla, (3) the distinct articulation between grain and their axes, (4) ear joints or teeth of the lemma, and (5) shape of panicle. Physical properties of the grains, such as weight and proportion of kernel to hull, are too easily influenced by environmental conditions to be of value in classification.

Three groups of oats have been established on the basis of chromosome numbers.

1. Seven haploid chromosomes: Short oat (A. brevis), desert oat (A. wiestii), sand oat (A. strigosa), and small-seeded naked oat (A. nudibrevis).

2. Fourteen haploid chromosomes: Slender oat (A. barbata), and Abyssinian oat (A. abyssinica).

3. Twenty-one haploid chromosomes: Common wild oat (A. fatua), common oat (A. sativa), hulless oat (A. nuda), wild red oat (A. sterilis), and cultivated red oat (A. byzantina). The side oat, A. orientalis, is included under A. sativa.

The principal oat varieties grown in Colorado are: Brunker, Kanota, Colorado 37, Markton, Nebraska 21 and Bliss Side. Kherson and Swedish Select are sometimes grown, but not as extensively as in former years.

II. Laboratory Instructions

1. Make a sketch of the (1) spikelet and (2) kernel of each of the eight types of oats. (3) Dissect one floret. Label all parts.

2. Fill in an outline similar to the one below for these oat varieties: Brunker, Kanota, Colorado 37, Markton, Nebraska 21 and Bliss Side. Make use of the plants themselves and any references available.

<table>
<thead>
<tr>
<th>Sub-species</th>
<th>Grain</th>
<th>Awns</th>
<th>Basal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety</td>
<td>Panicle Shape</td>
<td>or Full Present</td>
<td>Articulation Hairs</td>
</tr>
<tr>
<td>or Group</td>
<td>Color or Absent</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

1Supplies necessary: Panicles of 8 oat groups, the Colorado standard varieties, and various "unknowns."
3. Construct a key to fit the above listed Colorado varieties. Make use of the information in paragraph 2, and that found in the references.

4. Classify by use of the key the unknowns furnished, as to group, and commercial variety (the latter when called for).

III. Questions to be Answered

1. Name the 8 sub-species or groups of oats.
2. How would you distinguish between A. fatua and A. byzantina? A. sativa and A. byzantina?
3. Is it possible to distinguish between A. abyssinica and A. strigosa? Explain.
4. List three characteristics in which A. nuda differs from other oat groups.
5. Give several reasons why a classification of oats is necessary.
6. Why are commercial oat varieties difficult to classify?
7. Briefly describe the standard Colorado oat varieties.
8. How does Nebraska 21 differ from Knerson? What vegetative character is particularly useful in the identification of Markton oats?

References

CLASSIFICATION OF CULTIVATED OATS

Classification into Groups

The principal cultivated varieties of oats, together with their basic wild species may be classified as eight more or less distinct groups (Etheridge) (1).

A. Kernel loose within the surrounding hull; lemma and glumes alike in texture. ........................................... *Avena suda*
   Agricultural varieties: Liberty, hullless oats.

AA. Kernel firmly clasped by hull; lemma and glumes different in texture

3. Upper grains persistent to their rochillas. ... *Avena byzantina*
   Agricultural varieties: This group contains so-called Red, Algerian or Mediterranean oats: Red Rustproof, Fulda, Kanota, Hurl, Brunker, etc.

BB. Upper grains easily separating from their rochillas.

C. Lemma extended as teeth or awn points.
   D. Lemma with 4 teeth or awn points. ... *Avena Abyssinica*
      (No cultivated varieties)

DD. Lemma with two teeth or awn points.
   E. Lemma elongate, lanceolate, with distinct awn points ........ *Avena sitroca*
      Agricultural varieties: Zone, Rough or hord oats.

EE. Lemma short, abrupt, blunt, rather toothed than awned ...... *Avena brevis*
      (No cultivated varieties).

CC. Lemma without teeth or awn points.
   D. Basilar connections of the grain articulate. *Avena sativa*
      (Wild oats).

DD. Basilar connections of the grain solidified.

E. Panicles roughly equilateral, spreading. *Avena sativa*
   Agricultural varieties: Silvermine, Abundance, Banner, Swedish select, Kherson, Nebraska 21, Gold Rain, Joanette, Colorado 37, Swedish Victory, Great Dakota, Markton (smut resistant), etc.

EE. Panicles unilater, suppressed. ... *Avena sativa orientalis*
   Agricultural varieties: White Russian, Blisse side, White Tartar.

Note: (1) Etheridge, W. C., 1916, A classification of the Varieties of Cultivated Oats, Cornell Memoir 10. Agricultural varieties listed include those important in Colorado.
KEY TO VARIETIES IN IMPORTANT AGRICULTURAL GROUPS

Avena Byzantina (1)

Cultivated forms of A. Byzantina are described as follows: Culms spreading or semi-erect in early growth, fine and stiff; leaves narrow; panicles equilateral; glumes usually longer than in other cultivated groups. Awns usually present on outer grain and frequently on inner grain; basal hairs usually present; basilar articulation of outer grain evident; rachilla of outer grain shorter than in most other cultivated forms, while rachilla of either outer or inner grain is so solidified with callus of the succeeding grain that parts do not separate without tearing away the rachilla itself. Caryopsis more elongate than in most other cultivated groups.

Key to Varieties

A. Grains dark-colored, brown or black
   B. Grains black; awn usually present on both the outer and the inner grain..........................Black Algerian (3)
   BB. Grains brown to brownish black; awn seldom present on the inner grain.........................Sterilis Selection

AA. Grains light-colored, yellow or brownish yellow.
   B. Plants spreading in early growth; basal hairs long (3-6 mm.).................................Red Rustproof
   BB. Plants semi-erect in early growth; basal hairs short (1.0-2.5 mm.) or wanting...
      C. Basal hairs present; basilar articulation of outer grain evident; grains dull yellow........Burt
      CC. Basal hairs wanting or seldom present; basilar articulation of outer grain usually solidified; grains usually dun-colored...............Pulphen (2)

AAA. Grains more or less gray............................Brunker (4)

Notes: (1) Called A. Sterilis by Etheridge, but changed to Byzantina by Stanton, ct. al. (2) Listed by Etheridge as King. (3) Listed by Etheridge as A. sterilis nigra. (4) Added to Etheridge.
Avoca Sativa

This group is described as follows: culms spreading; semi-erect, or erect in early growth, large, medium, or small; leaves narrow to medium wide; panicles equilateral. Awns occur only on outer grain and often wanting. Basilar articulation of grains solidified, but upper grains are not persistent to their radillas, as in A. sterilis, and the middle and inner grains are easily removed.

Key to Varieties

A. Culms spreading, or turf-like, in early growth, numerous in each plant (winter oats).
B. Grains dark-colored, black, brown, or gray; culms glabrous; plants late in maturing.
C. Grains black to brownish black; awn present or wanting, seldom geniculate; margins of leaves glabrous.............C. L. 606.
CC. Grains gray to yellowish gray; awn usually present, usually geniculate; margins of leaves ciliate........Winter Turf
EB. Grains light-colored, white to yellowish white; culms hairy near the nodes; plants early in maturing............Culberson
AA. Culms semi-erect or erect in early growth, few to a plant (spring oats).
B. Grains dark-colored, black to brownish red.
C. Awns numerous in the panicle.
D. Grains brownish red to brown; panicles stiff, the branches ascending.........................Black Norway
DD. Grains black or brownish black; panicles lax, the branches drooping from the middle outward,
E. Panicles coarse; glumes 9-10-nerved; plants semi-erect in early growth.........................Victor
EE. Panicles fine; glumes 3-9-nerved, seldom 10-nerved; plants erect in early growth.
F. Grains glaucous; rachilla glabrous........Monarch
FF. Grains not glaucous; rachilla hairy........Black Moosor
CC. Awns wanting or few in the panicle.
D. Lemma laterally beaked with hairs at about its middle.................................................Black Diamond
DD. Lemma glabrous.
E. Grains glaucous..................................................Monarch Selection
EE. Grains not glaucous.
F. Panicles narrow, short; plants semi-erect in early growth; grains black.................Joannette
FF. Panicles wide-spread, long; plants erect; in early growth; grains brownish black to brownish red
G. Grains brownish red; rachilla usually glabrous.............C. L. 620
GG. Grains brownish black; rachilla usually haired.
H. Panicles extremely long, wide-spread, and lax, the branches drooping from the middle outward; hairs of the rachills few and appressed; grains usually 15-18 mm. long.................................Old Island Black
HH. Panicles medium long, stiff, the branches ascending; hairs of rachilla numerous and erect; grains usually 13-22 mm.
I.e. ........................................North Finnish
BB. Grains light-colored, yellow to white.

C. Lowest whorl of panicle branches usually issuing from a geniculate bend in the rachis at which the nodal diaphragm is wanting or rudimentary.

D. Panicles narrow, the branches sharply ascending; rachis scarcely flexuous..................Carton 173.

DD. Panicles wide-spreading, the branches stiff but not sharply ascending; rachis remarkably flexuous...Carton 661

CC. Lowest whorl of panicle branches issuing from a normal node.

D. Panicles short, sparse; culms fine; plants extremely early in maturing...Nebraska 31, Thorson, Early Champion, Sixth-Day.

DD. Panicles medium to extremely long, more or less prolific; culms medium to large; plants medium to late in maturing.

E. Grains bright yellow.

F. Basal hairs numerous.

G. Basal hairs short (1-2 mm.); 3-grained spikelets numerous; panicles stiff, the branches ascending..................Amyless Probstei.

GG. Basal hairs long (2-5 mm.); 3-grained spikelets seldom occurring; panicles lax, the branches drooping from the middle outward...Japan Selection

FT. Basal hairs usually wanting, if present few and weak.

G. Ams usually wanting; spikelets usually 2-grained; glumes extremely short (10-20 mm.).Golden Drop

GG. Ams numerous; 3-grained spikelets numerous; glumes of medium length (20-26 mm.).

H. Ams usually present; spikelets usually 3-grained..................C. I. 603

EH. Ams numerous in the panicle, but frequently wanting in the spikelet; spikelets 2-3-grained.

Green Russian

EE. Grains white to yellowish white.

F. Grains extremely short, outer grains usually less than 15 mm.

G. Leaves, sheaths, and glumes a conspicuous light green at period of full heading; double-grains very numerous..............Canadian

GG. Leaves, sheaths, and glumes dark green at period of full heading; double-grains seldom occurring.

Tobak

FF. Grains medium to extremely long, outer grains usually exceeding 15 mm.

G. Ams usually present and geniculate.

H. Basal hairs numerous, long (2-5 mm.), bushy; grains rather short (15-18 mm.); spikelets 2-3-grained......Silverline Selection

HH. Basal hairs wanting, or few, weak, and short (1-2 mm.); grains long (15-22 mm.); spikelets usually 2-grained..C.I. 602

GG. Ams wanting to numerous in the panicle, seldom geniculate.

H. Basal hairs long (3-6 mm.), numerous

Early Dakota

HH. Basal hairs short or wanting.

I. Panicles long, lax, spreading, the branches often drooping from the middle outward.
J. Awns wanting or few in the panicle ................. Irish Victor
JJ. Awns numerous in the panicle
  K. Grains medium long (16-19 mm) ......... Danish Island
  KK. Grains extremely long (20-22 mm) ... Early Gotland
II. Panicles short to medium long, stiff, compact, the branches ascending.
  J. Awns wanting or few in the panicle ...
     Selya
JJ. Awns few to numerous in the panicle.
  K. Rachilla usually sparsely haired; lemma scarcely concave in the region of the awn; awns few in the panicle.
     L. Grains short-pointed ...
           Silvermine
  LL. Grains long-pointed ...
     Scottish Chief
KK. Rachilla usually glabrous; lemma concave in the region of the awn; awns numerous in the panicle.
     L. Basal hairs usually present; short but bushy and prominent ....... June
     LL. Basal hairs wanting or weak and inconspicuous.
         K. Awns usually strongly twisted; 3-grained spikelets predominating ...
             Swedish Select
             Colorado 37
         KK. Awns straight or somewhat twisted; 2-grained spikelets predominating ...
             Lincoln
Avena Sativa Orientalis

Culms tall, erect in all stages of growth, generally large, thick, coarse, few in a plant. Sheaths usually longer than in A. sativa and A. sterilis. Leaves in most varieties wide and coarse; ligules and auricles absent in some varieties. Panicles unilateral; branches arise from various sides of rachis but converge mostly to one side; usually sharply ascended or appressed. Rachis in some varieties carried by extremely flexuous form and by geniculato bend at which nodal diaphragm is absent or rudimentary, altho at bend issue the lowest whorl of branches. Arms when present on outer grain only, and often absent. Basilar articulation of grains solidified as in A. sativa.

Key to Varieties

A. Grains dark-colored, black, brown, or gray.
   B. Ligules and auricles wanting.
      C. Arms numerous in the panicle; rachilla of first grain 2-3.5 mm. long, sparsely haired; grains elongate.........Garton 744
      CC. Arms wanting or seldom occurring; rachilla of first grain 1-2 mm. long, glabrous; grains plump.............Garton 734

BB. Ligules and auricles present.
   C. Grains gray; rachilla of first grain 1.5-2 mm. long, glabrous; culms usually sparsely haired near the nodes.......Garton Gray
   CC. Grains black to brown; rachilla of first grain 2.5-3.5 mm. long, sparsely haired; culms glabrous.........Black Tartarian

AA. Grains light-colored, white or yellow.
   B. Ligules and auricles wanting.........................Golden Giant
   BB. Ligules and auricles present.
      C. Outer grains remarkably short, rarely exceeding 15 mm. in length; spikelets confused in attitude (pointing in all directions)..........................Sparrowbill.
      CC. Outer grains ranging between 15 and 20 mm. in length, rarely less than 15 mm.; spikelets drooping in attitude.
      D. Nerves in the glume 11-13; branches of the panicle not appressed, usually drooping from the middle outward. Garton 535

DD. Nerves in the glume 6-10; branches of the panicle appressed.
   E. Panicles thickly branched and fruited, compact and stiff, the lowest whorl of branches issuing from a bend in the rachis at which the nodal diaphragm is wanting or rudimentary; margins of leaves ciliate; double-grains very numerous.
   F. Basal hairs wanting; nerves of the lemma 6-10; spikelet usually double-rained........Strom King
   FF. Basal hairs frequently present; nerves of the lemma 7-8; spikelet in about equal numbers double-grained or normal......................Tartar King

EE. Panicles sparsely branched and fruited, elongate, slender, lax, drooping, the lowest whorl of branches issuing at a normal node; margins of leaves glabrous; double-grains few.
   F. Arms rare; 3-grained spikelets rare. Bliss Side, White Tartar
   FF. Arms numerous in the panicle, usually present in each spikelet; 3-grained spikelets frequent..........................Green Mountain
OTHER OAT GROUPS

A. Itdea

Differs from all other species *Avena* by three remarkable characters: (a) Lemma and palea do not clasp kernel as in other forms; kernel is therefore loose or free within hull. (b) Rachillas of three- to many-grained spikelet are so elongate that uppermost grains are borne above glumes. (c) Glumes and lemmas similar in texture.

A. Abyssinica


A. Strigosica

Lanceolate lemma which extends into distinct arm points. Basilar articulation solidified as in *A. sativa*. Little used as cultivated plant.

A. Brevis

Lemma short, abrupt, and blunt, and is rather toothed than arm-pointed altho in one form teeth are considerably extended. Basilar articulation solidified as in *A. sativa*. Little importance as cultivated plant.

A. Fatua

Specifically distinguished by close investment of its kernel, by distinct articulation of all its grains, and by its hairy, single-pointed lemma. *A. sativa* and *A. sativa orientalis* distinguished from *A. fatua* by solidified basilar articulations of their grains. Culms erect in early growth, small to medium large in size, glabrous. Sheaths light green and somewhat glaucous at period full head. Leaves colored as sheaths, narrow, margins glabrous. Panicles equilateral, wide-spread, lax, drooping, the branches drooping from middle outward. Spikelets 2-3 grained, altho inner and middle grains often drop at maturity. Glumes light green and barely glaucous at period full head, 20-25 mm. long, usually 3-nerved. Grains black, brown, yellow, or gray, elongate. Arm present on all grains, twisted and geniculate. Lemma covered with long, stiff hairs; basal hairs present in bushy ring; rachilla covered with hairs. Basilar articulation of grain distinct; all grains readily separate from their axes.
DESCRIPTIONS OF IMPORTANT COLORADO OAT VARIETIES

Oat Varieties Developed in Colorado (1)

Colorado 37 — Selected in 1900 from field commercial oats in San Luis Valley. Midseason white common oat similar to Swedish Select, except that it has decidedly fewer awns and a little shorter culm. Superior characteristics are: high yield, stiff straw, and awnless kernels.

Brunker (C.I. 2034) — Originated as pure line from Burt at Akron, Colorado, 1919. Brunker is very early variety of red oat (A. byzantina) group. Matures even earlier than Fulghum. Straw rather short and slender with typical reddish tinged. Panicles small and equilateral with short, spreading branches. Spikelets usually 2-flowered, sometimes 3-flowered. Lemmas reddish, with occasional slender awn on lower floret of spikelet; basal hairs usually present, nerves somewhat prominent. Has shown considerable resistance to some physiologic strains Ustilago avenae which infect other red oats such as Fulghum.

Other Oat Varieties (2)(3)

Swedish Select — Culms erect in early growth, medium large, stiff, hairy near nodes. Sheaths dark green and glaucous at period in full head. Leaves colored as the sheaths, medium wide, margins glabrous. Panicles medium long, rather broad, somewhat compact, stiff, erect, branches ascending. Spikelets 2-3 grained, 3-grained spikelets predominating. Grains white to yellowish-white, plump, outer grains 16-19 mm. long, short-pointed, the dorsal side concave in the region of the awn. Awns very numerous in the panicle, strongly twisted, black at the base. Basal hairs wanting or extremely short, few, and weak; rachilla of outer grain 2-3 mm. long, usually glabrous. Medium-late maturity.

Markton (C.I. 2053) — Markton is a midseason, mid-tall common oat with culms hairy near the nodes, large drooping panicles, and rather long, slender-to-midplump, yellowish-white kernels. The lower floret of the spikelet usually is awned. Markton is immune to covered smut.

Kanota (C.I. 532) — Kanota is an early red oat of the Fulghum type. The superior characteristics of Kanota are high yield, high test weight, and earliness.

Kherson — Culms erect in early growth, fine, stiff, either smooth or slightly pubescent at the nodes. Sheaths dark green, glaucous. Leaves colored as
the sheaths, fine, narrow, short, margins smooth. Panicles short, sparse, fine, stiff, the branches ascending. 3-grained spikelets numerous in panicle, often predominating over 2-grained spikelets. Glumes dark green and slightly glaucous at time of full heading, 3-nerved, in some cases 8 nerved. Grains yellow, somewhat elongate, outer grains 16-20 mm. long, long-pointed. Lemma of outer grain glabrous with 2-7 obscure nerves. Awns usually wanting, if present short and weak. Basal hairs seldom occurring, if present few and weak. Rachilla of outer grain 2-3 mm. long, glabrous. Extreme early maturity.
Exercise 22

Sorghum Varieties

I. Classification of Varieties

Some of the difficulties in sorghum variety classification are described by Swanson and Laude (1934) as follows: "Exact classification of sorghums is difficult because of confusion in names, the overlapping of groups, and the hybrid derivatives which are constantly arising. A variety is often known under several different names through local custom or the trade names of seedsmen...." For practical purposes, an agronomic rather than a botanical classification, has been advocated by these workers.

The sorghums have been classified botanically, without regard to agronomic groups, by Vinall, Stephens, and Martin (1936).

The principal sorghum varieties grown in Colorado are as follows:

<table>
<thead>
<tr>
<th>Grain Sorghums</th>
<th>Sorgos</th>
<th>Grass Sorghums</th>
<th>Dual Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blackkull Kafir</td>
<td>Leoti Red</td>
<td>Sudan grass</td>
<td>Highland</td>
</tr>
<tr>
<td>Dwarf Yellow Milo</td>
<td>Black Amber</td>
<td></td>
<td>Improved Coes</td>
</tr>
<tr>
<td>Hegari</td>
<td>Red Amber</td>
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<td></td>
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<tr>
<td>Feterita</td>
<td>Red</td>
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<td></td>
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<tr>
<td>Sooner</td>
<td>Atlas</td>
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<tr>
<td>Pygmy</td>
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</tbody>
</table>

II. Laboratory Instructions

1. Study the type of panicle in each of the sorghums provided. Sketch a panicle of each.
2. Draw a fertile spikelet of each variety provided.
3. Draw seeds of each of the sorghums supplied. Sketch them to show the shape of the seed and the position of the germ. Spots or other markings should be shown. Note the difference between Atlas Sorgo and Hegari seed.
4. Prepare a key for Colorado sorghum varieties.
5. Classify sorghum "unknowns" furnished by the instructor.

III. Questions to be Answered

1. What sorghums are best adapted to Colorado for forage? Grain for both purposes?
2. What factors influence the recurring of milo?
3. What sorghums other than milo commonly have recurved heads?
4. How can Hegari and Atlas sorgo seeds be distinguished?
6. Distinguish between standard and dwarf broccorn.
7. How can Black Spanish and Scarborough broccorn varieties be distinguished?
8. Why is it difficult to base a sorghum variety classification on the Agronomic groups?
References


KEY FOR IDENTIFICATION OF COLOMB SORGHUM VARIETIES

A key for the identification of sorghum varieties should preferably be based on easily distinguished kernel characters, so that the varieties can be determined from seed samples, and otherwise on panicle characters which allow for identification from head specimens. Plant characters such as relative dates of maturity, height, and juiciness of the stems, while very important from an agronomic standpoint, are undesirable in an identification key unless taxonomic differences sufficiently definite to distinguish between varieties from seed and panicle characters do not exist.

In the key here presented, those kernel and panicle characters which allow for the greatest contrast are given primary importance and are used in regular order. Minor characters are used when necessary to bring out varietal differences and in no regular order. With a number of closely related varieties and strains within varieties no distinctions other than agronomic could be indicated.

1a. Panicle branches less than 8 inches long.
   2a. Fusellar layer absent.
   3a. Awns absent.
   4a. Kernels white.
      5a. Glumes straw-colored or yellowish white.
          Panicles mid-compact, cylindrical, not well exerted from upper sheath.
      5b. Glumes black or brownish black.
          Kernels approximately same length as or slightly longer than glumes.
          Panicles cylindrical; plants midseason, Reed Kafir mid-tall; stems mid-juicy, not sweet.
      Panicles obovate to cylindrical, relatively short; plants midseason to late, very tall; stems mid-juicy to juicy, sweet.
      Kernels much longer than glumes.
      Panicles ellipsoid to cylindrical, usually tapering at apex and base.
          Plants mid-tall to tall (average 70 inches), midseason to late; stems juicy and sweet.
          Plants mid-tall to tall (average 70 inches), midseason; stems slightly sweet to sweet.
          Plants dwarf to mid-tall (average 48 inches), early to midseason; stems not sweet.
      Panicles cylindrical to clavate, usually slightly flaring at apex.
      Kernels white with dark spots.
          Plants midseason (average 114 days), mid-tall (average 56 inches).
          Plants early to midseason (average 106-110 days), mid-tall (slightly shorter than Standard).
      Western Black-hull Kafir
      Texas Blackhull Kafir
      Dwarf Blackhull Kafir
      Standard Black-hull Kafir
      Standard Kafir
      Dawn Kafir
      Sunrise Kafir
      Atlas Sorgo
Kernels pearly white.
Panicles rather thick and ------------------Pearl Kafir shaped like Blackhull kafir.
Panicles narrower than those of ------------------Rice Kafir Blackhull kafir.

4b. Kernels colored.
5a. Glumes straw-colored to reddish brown.
   Kernels small to mid-size; panicles cylindroid, rather long and narrow; coleoptiles green.
   Kernels pink or nearly white with ------------------Pink Kafir pink flecks; stigmas creamy white.
   Kernels reddish brown to yellowish ------------------Red Kafir red; stigmas yellow.

5b. Glumes dark reddish brown.
   Kernels mid-size to large; panicles cylindroid (shorter and thicker than in Red or Pink kafir); coleoptiles red.
   Kernels yellow; stigmas pale yellow-------------------Wheatland

3b. Awns present.
4a. Kernels white.
3a. Glumes straw-colored or yellowish white.
   Panicles effuse, erect (but in shallu, usually drooping).
   Glumes involute and spreading; kernel ------------------Shallu nels usually rotated and much exposed.
   Glumes not involute, appressed and usually adhering to kernel.
   Plants mid-tall to tall -------------------Freed
   Plants dwarf ---------------------------Dwarf Freed

Panicles compact, inclined to recurved.
Glumes pubescent; kernels much flattened.
Plants mid-tall -------------------------White Durra
Plants dwarf (30-38 inches) -----------------Dwarf White Durra

5b. Glumes black or brownish black.
Transverse wrinkle present; panicles inclined to recurved; coleoptiles red.
Plants midseason, mid-tall.
   Stems mid-stout; stigmas yellow-----------------Standard White Milo
   Stems mid-stout to stout; stigmas----------------Desert Bishop creamy white (panicles slightly longer and more pointed than in Standard White Milo).
   Plants midseason, dwarf (about 48 inches); stigmas yellow.
   Plants early to midseason, mid-tall ------------------Early White Milo Stems mid-slower; stigmas yellow.

Transverse wrinkle absent; panicles not-------------------Bishop recurved; coleoptiles green.

4b. Kernels colored (salmon yellow or reddish yellow).

5a. Glumes straw to reddish brown, not transversely wrinkled.
   Coleoptiles red.
   Panicles mid-compact to effuse, peduncle -------------------Fargo erect but panicle often drooping.
Plants late, mid-tall.
Panicles compact, occasionally inclined or recurved.
Plants early to mid-season, very dwarf—Beaver
(about 30 inches)
Coleoptiles green.
Panicles mid-compact, erect.
Plants late, mid-tall—Hanko

5b. Glumes black to dark reddish brown, transversely wrinkled.
Panicles inclined to recurved, coleoptiles red.
Plants mid-tall (about 62 inches)—Standard Yellow Lilo
Plants dwarf (about 62 inches)—Dwarf Yellow Milo
Panicles occasionally recurved, usually not exerted well from upper sheath; coleoptiles red.
Plants very dwarf (about 30 inches)—Double Dwarf Yellow Milo

2b. Macellar layer present.

3a. Awns absent except for "tip awns" in feterita and hegari.

4a. Kernels white.

5a. Glumes black.
Tip awns absent; kernels dull white.
Kernels approximately same length as or only slightly longer than glumes, mid-size; rachis branches appressed.
Panicles cylindroid; stems dry—Chiltex
Panicles ellipsoid; stems mid-juicy—Premo
Kernels extending beyond apices of glumes and well exposed; glumes not so prominent as in Chiltex and Premo; stems dry.
Panicles cylindroid to ellipsoid;—Wonder rachis branches appressed.
Panicles ovoid to obovoid; rachis—Ajax branches appressed to sometimes partly spreading.
Tip awns present
Kernels very large and flattened on hilum—Standard Feterita side, chalky white; coleoptiles green;
stems dry or only slightly juicy.
Plants early, mid-tall; stems mid-slender to mid-stout.
Plants early to mid-season, mid-tall—Spur Feterita stems mid-stout.
Plants early to mid-season, dwarf—Dwarf Feterita stems mid-stout.
Kernels small to mid-size, not appreciably flattened on hilum side, white;
coleoptiles green; stems mid-juicy.

4b. Kernels colored.

5a. Glumes black.
Endosperms starchy.
Kernels extending well beyond apices of glumes, much exposed.
Kernels intense, very dark reddish brown; coleoptiles red; stems juicy.
Panicles compact, cylindroid, short; kernels small, nearly globose.
Plants midseason to late, tall----------------------Sumac Sorgo
Plants early to midseason, mid-- -------------Early Sumac Sorgo
tall.
Kernels reddish brown; coleoptiles red; stems juicy.
Panicles mid-compact, cylindroid.
Kernels mid-size, obovoid, relatively broad and extending almost half of length beyond apices of glumes; glumes short, broadly ovate.
Kernels small to mid-size, ellipsoid, relatively long and extending less than half of length beyond apices of glumes; glumes relatively narrow, ovate, or ovate-elliptic.
Kernels buff or light brown (not red); coleoptiles green; stems mid-juicy.
Panicles mid-compact, cylindroid to fusiform, usually tapering at apex.
Kernels usually equal to or not so long as glumes.
Coleoptiles red.
Panicles small, mid-compact to effuse, ellipsoid to fusiform; rachis branches, mid-long and appressed or slightly spreading.
Plants very early, mid-tall----------------------Dakota Amber Sorgo
Panicles large, effuse, conoid to ellipsoid; rachis branches mid-long to long and spreading.
Plants early, tall ---------------------------Minnesota Amber Sorge

Panicles mid-compact, cylindroid or approaching cylindroid; rachis branches mid-long, appressed or slightly spreading; glumes sometimes very dark reddish brown.
Plants midseason, tall---------------------------Solger Sorgo
Coleoptiles green.
Panicles small, sometimes effuse and------------------Collier Sorgo
umbelliform, but more often with rachis branches lying close together and drooping to one side; rachis very short; rachis branches long and fruited only near outer ends.
Endosperms waxy.
Kernels usually equal to or shorter than glumes; apices of glumes straw-colored.
Coleoptiles red.
Panicles cylindroid or approaching------------------McLean Sorgo
cylindroid; pedicellate spikelets long, persistent, conspicuous.
Kernels usually longer than glumes.
Coeoptiles green.
Panicles cylindroid to obconoid and ---------------Schrock
various shapes; pedicellate spikelets not conspicuous.
5b. Glumes mostly straw or reddish straw colored but frequently with black
stripes, spots or bases.
Panicles compact; kernels longer than-------------------Brown Durre
glumes, brown, much flattened; glumes straw-colored, pubescent; stems dry.
Panicles mid-compact; stems juicy.
Kernels dull reddish brown, well exposed.
Rachis branches mid-long, loosely
appressed.
Panicles mid-size to small, up-------------------Orange Sorgo
proaching cylindroid but sometimes ellipsoid; plants mid-
season, mid-tall to tall.
Panicles mid-size, thick, cylin-
droid to ellipsoid or tending to
be clavate; plants midseason to late, tall.
Kernels buff or light brown, well ex-
posed.
Rachis branches mid-long.
Panicles ellipsoid to cylindroid;-------------------Sourless Sorgo
Glumes occasionally somewhat
red or with black spots but mostly straw-colored; coele-
ptiles green.
Rachis branches mid-long to long,
frequently drooping to one side.
Panicles ellipsoid to obconoid or-------------------Planter Sorgo
variable in shape and tending
toward effuse; glumes frequently
black at base and sometimes
second glume entirely black;
pedicellate spikelets large,
persistent and conspicuous;
coleoptiles red.
5c. Glumes red or reddish brown.
Panicles mid-compact, cylindroid to fus-
iform, rather narrow; rachis branches
short to mid-long; glumes usually with
straw-colored margins; coeoptiles green.
Kernels undeveloped in many sessile-------------------Denton Sorgo
spikelets; embryos not prominent.
Kernels developed normally in sessile-------------------Alex Sorgo
spikelets; embryos prominent.
Panicles mid-compact, cylindroid to ellip-
soid; rachis branches short to mid-long;
glumes usually without straw-colored edges;
coleoptiles green.
Glumes intense red-----------------------------Colman Sorgo
Panicles effuse, ellipsoid, mid-size to large; rachis branches long; coleoptiles red.
Glumes deep red-----------------------Red Amber Sorgo

3b. Ausn present.

4a. Kernels colored (buff or reddish brown)

5a. Glumes black.
Endosperms starchy.
Kernels usually equal to or sometimes shorter than glumes; glumes intense black and shiny; coleoptiles red; stems juicy.
Panicles mid-compact, obovoid,----------------Gooseneck Sorgo.
   erect to inclined or recurved;
   plants very late, very tall.
Panicles effuse, conoid to ellipsoid,----------Minnesota Amber
   erect; plants early, tall.
   Sorgo
   Waconia Amber Sorgo

Kernels longer than glumes; glumes reddish black to brown; coleoptiles green; stems mid-juicy; midribs sometimes yellow.
Panicles mid-compact, ellipsoid,---------------Darsco
   erect; plants midseason, dwarf to mid-tall.
Endosperms waxy.
Kernels usually equal to or sometimes shorter than glumes; glumes intense black and shiny; coleoptiles red; stems juicy.
Panicles mid-compact, obovoid,----------------Gooseneck Sorgo
   erect to inclined or recurved;
   plants very late, very tall.
Panicles effuse, conoid to various----------Chinese Amber Sorgo
   shapes, erect; plants early, tall.

5b. Glumes red.
Endosperms starchy.
Panicles mid-compact, ellipsoid to----------------Manchu Brown Kaolian
   ovoid; glumes reddish brown to yellow
   or straw; stems dry; plants very early, mid-tall.
Panicles effuse, ellipsoid, mid-size to----------Red Amber Sorgo
   large; glumes deep red; stems juicy;
   plants early, mid-tall to tall.
Panicles very effuse, conoid, large;------------Honey Sorgo
   glumes brownish red; stems juicy;
   plants late, tall.
Endosperms waxy.
Panicles mid-compact tending toward-------------Leotii Sorgo
   effuse, cylindroid to obconoid; glumes
dull yellowish-red; stems juicy; plants
   early to midseason, mid-tall to tall.

1b. Panicle branches more than 8 inches long; rachis very short with branches much extended and usually lying close together, forming a brush; stems dry.

3a. Nucellar layer present.

3a. Long ausn present.

4a. Kernels reddish brown, usually shorter than glumes.

5a. Glumes chocolate or dark brown to black.
Panicles usually completely exerted from sheath.
Peduncles usually 8 inches or longer, firmly attached at base.

Plants early* (82 days), \textit{--Black Spanish Broomcorn}\n\hspace{0.5cm} tall (90 inches); rachis branches 16-22 inches long.

Panicles usually enclosed by upper sheath one-half to two-thirds of length.
Peduncles usually less than 8 inches long, weakly attached base.

Plants early, mid-tall; \textit{--Black Spanish Dwarf Broomcorn}\n\hspace{0.5cm} rachis branches 16-22 inches long.

5b. Glumes tan or straw colored.
Panicles usually completely exerted from sheath.
Peduncles usually 8 inches or longer, firmly attached at base.

Plants early (84 days), tall (88 \textit{California Golden} inches); rachis branches 16-32 \textit{Broomcorn} inches long.

Plants midseason (89 days), tall \textit{--Evergreen Broomcorn}\n(95 inches); rachis branches 16-34 inches long.

Plants late (99 days), very tall (101 \textit{Late Evergreen} inches); rachis branches 18-32 \textit{Broomcorn} inches long.

Panicles usually enclosed by upper sheath from one-half to two-thirds of length.
Peduncles usually less than 8 inches long, weakly attached at base.

Plants midseason (91 days), mid-tall \textit{--Scarborough Broomcorn}\n(53 inches); rachis branches 16-24 inches long; seed borne mostly near tips of branches.

5c. Glumes red or tinged with red.
Panicles usually enclosed by upper sheath from one-half to two-thirds of length.
Peduncles usually less than 8 inches long, weakly attached at base.

Plants midseason (90 days), mid- \textit{--Evergreen Dwarf Broomcorn}\ntall (55 inches); rachis branches 16-32 inches long; seed borne mostly on upper third of branches.

Panicles usually enclosed by upper sheath from two-thirds to three-fourths of length.
Peduncles short and weakly attached at base.

Plants early (99 days), dwarf (41 inches); \textit{--Japanese Dwarf Broomcorn}\npachis branches 12-16 inches long.

\*The descriptive terms used in connection with maturity and height are relative only within the broomcorn group and are not in harmony with the same terms as applied to other sorghums. The number of days is from planting until heading.
Exercise 23

Millet Varieties

I. Variety Classification

The varieties of foxtail millet (Setaria italica) most commonly grown in Colorado are: Common, Dakota Kursk (or Kursk), Siberian, German, and Golden Wonder millet. Millet varieties are often mixed due to natural cross pollination. This adds to the difficulties in classification.

The two proso (Panicum miliiaceum) varieties most widely grown and recommended are: Turghai and Yellow Manitoba. Other varieties are Black Voronezh, Early Fortune, Tambov and Red Russian. Black proso is objectionable to grow for market.

II. Laboratory Instructions

1. Prepare a key to distinguish varieties of proso as follows: Turghai, Yellow Manitoba, Black Voronezh, Early Fortune, Tambov, and Red Russian.
2. Be able to identify by use of the attached key the "unknowns" furnished by the instructor.

III. Questions to be Answered

1. Describe Kursk, German, Red Turghai, and Yellow Manitoba millets.
2. How does the German type of foxtail millet differ from the common type?
3. Distinguish between the "scd" colors found in Siberian, Hungarian, and common foxtail millets.
4. What is Kursk millet?
5. How does Early Fortune proso differ from Turghai?

References:

Key to Millet Groups and Varieties

Principle Economic Types (1)

A. Inflorescence paniculate; (no involucre below the individual spikelets)

B. Inflorescence a raceme of short spikes; empty glumes awned or awn-pointed
   .Echinochloa
   (Barnyard millets and wild barnyard grass) (Hay millet)

C. Awns long; spikelets white. .E. crus-galli
   (Common barnyard grass)

CC. Awns short; spikelets brown. .E. crus-galli var. francigena
   (Japanese millet)

B3. Inflorescence a drooping; panicle; empty glumes not awned
   .Panico millaceum (Proso or Brown corn Millet)
   (Grain Millets)

AA. Inflorescence spicate (spike-like); involucre of bristles below each
   spikelet.

B. Spikelet deciduous, bristles persistent. .Setaria
   (Foxtail millet and Foxtail grass)

C. Panicles usually 1 cm. thick or less; bristles commonly green; spikelets about 2 mm. long
   .S. viridis (Green Foxtail)

CC. Panicles usually 1-3 cm. thick; bristles usually purple; spikelets 2-3 to 3 mm. long
   .S. italica (Foxtail millets) (Hay Millet)

BB. Spikelet and bristles deciduous; spike dense.
   ...Pennisetum glaucum (Pearl Millet) (Grain Millet)

Key to Economic Varieties

Hay Millets

A. Foxtail millets (Setaria italica)

B. Heads small, uniform, compact, seeds yellowish to black with
   usually a very large percentage very dark (mixed colors);
   beards brown or purple. Hungarian Millet.

BB. Heads large, more or less open; seeds more or less bunches.

C. Heads long, slender, very open, lax; drooping; Seed
   groups very distinct. .Aino Millet.

CC. Heads shorter and plump, bushy, erect or slightly
   drooping; seed groups indistinct.

D. Seeds yellow

E. Profusely bearded; medium large heads

F. Heads large, seeds small,
   seed groups more distinct
   German (or Golden) Millet

FF. Heads small, seeds large, seed groups
   less distinct.
   Common Millet.

EE. Sparingly bearded, heads very large.
   Golden Wonder Millet.

DD. Seeds, orange or burnt orange

E. Heads 3-4.5 inches long. .Kurnak

EE. Heads 4.5-6.0 inches long. .Siberian

(1) Modified after Robbins, W. W. Botany of Crop Plants 1931
AA. Barnyard Millet (E. frumentum)

Grain Millets (3)

AAA. Proso, Hag Millet, Broomcorn Millet, (or sometimes called Hercher)
   B. Panicle spreading (Panicum miliaceum effusum Kche.)
      C. Seed white to yellow
      D. Chaff yellowish green.
      E. Early to midseason
      F. Plant short to mid tall
      G. Seed creamy white
         White Ural
         G. Seed brownish yellow
         Russian White Siberian

CC. Seed red to brown
   D. Chaff partly reddish green.
   E. Early to mid season.
   F. Plant short to mid tall.
   G. Seed reddish brown
     Tchibov, Red Russian
     FF. Plant mid tall.
     G. Seed yellowish brown.
     Red Tschai

BB. Panicle loose, one sided (Panicum miliaceum contractum Kche.)
   C. Seed white to yellow
   D. Chaff yellowish green.
   E. Mid season to late.
   F. Plant mid tall to tall.
   G. Seed creamy white.
     White French
     G. Seed yellowish brown
     Yellow Manitoa

CC. Seed red to brown
   D. Chaff yellowish green.
   E. Early to mid season.
   F. Plant short to mid tall.
   G. Seed reddish brown.
     Red Oranbux

CCC. Seed brown to black
   D. Chaff yellowish green.
   E. Mid season to late.
   F. Plant mid tall to tall.
   G. Seed brownish black.
     Tchib Voronezh

BBB. Panicle compact, erect (Panicum Miliaceum compactum Kche.)
   C. Seed red to brown.
   D. Chaff yellowish green.
   E. Early to mid season
   F. Plant short to mid tall.
   G. Seed reddish brown.
     Red Voronezh, Yellow
     Saranta, Early Fortune,
     Red Lamp.

AAAA. Pearl Millet (Pennisetum spicatum) (Rarely grown in U.S.)

(3) Proso or Hog Millet, F.B. 1162.
<table>
<thead>
<tr>
<th>Varieties</th>
<th>Character of Panicle or Head</th>
<th>Color of Outer Chaff</th>
<th>Color of Seed Hull</th>
<th>Season of Maturity</th>
<th>Height of Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Ural</td>
<td>Spreading</td>
<td>Yellowish Green</td>
<td>Creamy White</td>
<td>Early to Mid-season</td>
<td>Short to Midtall</td>
</tr>
<tr>
<td>Hensen White</td>
<td>White Siberian</td>
<td>Yellowish Green</td>
<td>Brownish Yellow</td>
<td>Early to Mid-season</td>
<td>Short to Midtall</td>
</tr>
<tr>
<td>Tambov</td>
<td>Spreading</td>
<td>Reddish Green</td>
<td>Reddish Brown</td>
<td>Early to Mid-season</td>
<td>Short to Midtall</td>
</tr>
<tr>
<td>Red Russian</td>
<td>Spreading</td>
<td>Reddish Green</td>
<td>Reddish Brown</td>
<td>Early to Mid-season</td>
<td>Short to Midtall</td>
</tr>
<tr>
<td>Turghai</td>
<td>Spreading</td>
<td>Reddish Green</td>
<td>Yellowish Brown</td>
<td>Early to Mid-season</td>
<td>Tall</td>
</tr>
<tr>
<td>White French</td>
<td>Loose, one-sided</td>
<td>Yellowish Green</td>
<td>Creamy White</td>
<td>Mid-season Mid-tall</td>
<td>Tall</td>
</tr>
<tr>
<td>Yellow Manitoba</td>
<td>Loose, one-sided</td>
<td>Yellowish Green</td>
<td>Brownish Yellow</td>
<td>Mid-season Mid-tall</td>
<td>Tall</td>
</tr>
<tr>
<td>Red Grenburg</td>
<td>Loose, one-sided</td>
<td>Yellowish Green</td>
<td>Reddish Yellow</td>
<td>Early to Mid-tall</td>
<td>Short to Midtall</td>
</tr>
<tr>
<td>Black Voronezh</td>
<td>Loose, one-sided</td>
<td>Yellowish Green</td>
<td>Brownish Black</td>
<td>Mid-season Mid-tall</td>
<td>Tall</td>
</tr>
<tr>
<td>Yellow Sarepta</td>
<td>Compact erect</td>
<td>Yellowish Green</td>
<td>Reddish Brown</td>
<td>Early to Mid-season</td>
<td>Tall</td>
</tr>
<tr>
<td>Early Fortune</td>
<td>Compact erect</td>
<td>Yellowish Green</td>
<td>Reddish Brown</td>
<td>Early to Mid-season</td>
<td>Tall</td>
</tr>
<tr>
<td>Red Lump</td>
<td>Compact erect</td>
<td>Yellowish Green</td>
<td>Reddish Brown</td>
<td>Early to Mid-season</td>
<td>Tall</td>
</tr>
</tbody>
</table>

Farmer's Bulletin 1162
FIELD CROPS LABORATORY MANUAL

Section III

Field Crop Judging
Exercise 24

Corn Judging

I. Show Corn Standards

The judging of crop seeds has been the subject of much criticism in recent years due to the fact that research has shown the major points of emphasis to be unrelated to the performance of the seed.

A few years ago, corn improvement was sought thru selection of ears for seed with perfectly formed butts and tips, straight kernel rows, deep kernels, high percentage of shelled corn, etc. In fact, corn shows at one time influenced corn growing to the point where seed was sold on the ear, so that the ear could be judged. Corn shows were at their height between 1890 and 1910, and laid great stress on score card points that emphasized the beauty of the ear. The most "perfect" ear at the National Corn Show (now extinct) in 1910 sold for several hundred dollars. When planted in the field, it failed to surpass ordinary corn in either yield or quality.

Uniformity of ear type means little in a corn variety because corn is a cross-fertilized crop. Uniform ears in a variety can hardly be called typical due to the great variation between ears. In view of the lack of evidence of marked consistent superiority for any particular kind of ear, Richey (1927) calls it "unfortunate to teach that uniformity among ears of a variety of corn is desirable by attaching importance to uniformity of samples as is done in corn shows." Moreover, persistent selection to a certain type will bring about an approach to homozygosity with decreased vigor and productiveness as a consequence. Hughes and Robinson (1929) point out that ability of corn to mature is of material value. Correlations of ear characters with yield have been computed by many investigators. The results lacked significance in most cases. It may be concluded that selection of seed ears on the basis of ear characters, as a method of corn breeding, is unwarranted.

To overcome the objections of the artificiality of the old corn score cards, several schools put out "utility" score cards. The one from Illinois has been followed most widely. Such score cards almost always involve a germination test. They stress kernel and ear characteristics correlated with good seed. Maturity and soundness are particularly important. The utility shows are now being displaced by corn yield tests, i.e., performance tests of the seed.

Samples should be judged on a seed and utility basis, but the questionable value of corn judging should be kept in mind.

Supplies necessary: Classes of 4 ten-ear samples of Minnesota 13, Reid Yellow Dent, and Iowa Silvermine.
II. Methods to Judge Corn

(a) Score Card

Much less importance is placed on the score card than formerly because it is impractical for use in comparative judging. Its chief value lies in preliminary work to firmly fix in the mind of the student the points to consider and their relative weights. The score card is most useful when very simple. It has been most satisfactorily used in Colorado (Kezer) where all samples to be judged are ranked for each point in turn, e.g., maturity. The samples are next scored on uniformity, etc. When the main points of the score card are about equal in weight, a total of the placings will give the order in which to place the exhibits. The low-count in the total is the high sample.

(b) Comparative Judging

Most judging is done on a comparative basis. That is, each sample is compared with the others in the class and placed on its relative merits without the use of a score card. A thorough knowledge of the standards for the variety under consideration is essential. Preliminary use of a score card is valuable to fix the principal points in mind. The samples are gone over carefully and placed first, second, third, etc.

III. Disqualification of a Sample

1. Mixture of another variety (shown by xenia).
2. Off-colored cob for the variety.
3. Improper classification as to variety in a variety class.
4. The exhibit must conform to the premium list, e.g., old corn is dis-qualified when the premium list calls for new corn. When a 10-ear sample is prescribed, there must be 10 ears.
IV. Score Card for Seed Corn on the Ear  

(Tentative for Colorado)

<table>
<thead>
<tr>
<th>Main points to be considered</th>
<th>Perfect Score</th>
<th>Exhibit Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Maturity</td>
<td>30</td>
<td>1  2  3  4</td>
</tr>
<tr>
<td>(a) Ear Characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Kernel Characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Soundness</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>(a) Freedom from disease and damage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Germination Percent or condition of embryo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Type</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>(a) Ear length and shape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Kernel size, shape, depth and indentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Color kernels and cob</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) Purity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Uniformity of Sample (or Ear)</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

**TOTALS**

Placing Form for Exhibits

<table>
<thead>
<tr>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Student

Instructor

V. Explanation of Points

1. Maturity

(a) Ear Characteristics — Normal maturity is indicated by a bright color throughout, firmness and dryness on handling together with good weight for the size of the ears. A dull color accompanied by heavy weight due to excessive moisture, or very light weight (chaffy) after dried out, indicates immaturity. A large number of kernel rows, large cobs, deep kernels, and rough indentation indicate late maturity. Kernels that twist on the cob may indicate immaturity under certain conditions.

(b) Kernel Characteristics — Kernels from normally matured ears are lustrous, smooth on the sides, sufficiently plump to fill all space on the ear, particularly the cob, and corneous except at the crown in dent varieties. More than the usual amount of soft starch accompanied by deep indentation indicates immaturity. Blistered or wrinkled gers are indicators of immaturity.
2. Soundness

(a) Freedom from Disease and Damage -- Luster of the kernels and brightness of color of cob, with germs the color and consistency of the interior portions of fresh walnut meat, indicate freedom from disease and damage. Weathering or mold visible at the surface or apparent on any portion of the kernels on cobs upon close examination, wrinkled pericarps, soft and discolored or extremely brittle germs, tip caps adhering to the cob, more than the usual chaff adhering to the kernels, indicate disease or damage. Kernels gnawed by rodents or infested by insects are objectionable. Dull or discolored cobs with shredded or smooth butt attachments slightly pink to slightly brown in color and the pith any other color than pure white indicate the presence of disease or damage. Shank attachments must be intact. Indications of trimming to remove defects will eliminate the sample from consideration.

(b) Germination Percent or Condition of Germ -- Percentage germination and vigor of growth of the seedlings are of primary importance in seed corn. These may be determined best by use of the modified rag doll germinator. Disease in germinated corn is usually seen at the tips and crowns of the kernels in the form of white or pink mold and in the discoloration of the stems and roots of the seedlings. When the kernels show mold or when the seedlings are weak and discolored, the ear from which these kernels came should be discarded. Serious corn ear and stalk rot diseases are not found in Colorado. Blistered kernels indicate low vitality. A yellowish or brownish color of the embryo indicates frozen kernels. Paleness in color usually means loss of vitality, due to long storage.

3. Type

(a) In order to ascertain type of kernel, the exhibitor may remove 1 kernel two inches from the butt, one from the middle and one two inches from the tip of each ear.

(b) Each variety of corn is distinct in one or more of its features, such as size, shape, and color of ear; and indentation, size, and shape of kernels. Uniformity in these features indicates conformity to type as well as care and skill in the selection of the sample. In length and number of rows, nine of the ears in a sample should correspond to the standards for the variety under consideration.

(c) Some varieties carry the circumference to within two or three inches of the tip, while others taper throughout approximately the entire length. The ears should correspond in shape to the standard for the variety.

(d) Size of kernel includes depth, width, and thickness. Depth of kernel varies with variety and climate. A kernel of medium depth usually produces the largest yield of mature corn. Width and thickness of the kernels should correspond to the standard for the variety.

(c) Kernels vary in general shape and shape of shoulder with the variety. A keystone shape of kernel, with shoulders the proper shape for the variety, occupies all the space at the cob and gives the characteristic furrow. The farther to the tip and butt the characteristic kernels extend, the greater the amount of uniform seed corn from the sample. To examine kernels for shape, take out two kernels from the individual ear and place them in front of the individual ears.
(f) Indentation — The kind of indentation is due to the environment and to heredity or breeding. It should be neither too rough nor too smooth. The medium smooth indentation is preferred. Most Colorado varieties should be "Dimple dent." 

(g) The kernels on the ears in any sample should correspond uniformly to the color for the variety. With few exceptions, yellow varieties of corn have red cobs and white varieties, white cobs. Color of cob should be uniform throughout the sample. One or more off-colored cobs for the variety should cause the judge to place the sample down. The kernels of an ear should be free from mixture and true to the variety for color. An exhibit with a yellow kernel on a white variety or a white color on a yellow variety should be placed down. Shade of color shall not be considered. 

VI. Laboratory Instructions.

1. Study the standards for Colorado corn varieties or requirements of the premium list. Ear type samples selected by the Colorado Seed Growers Association should be studied. From the corn provided, select the ear that most nearly approaches the proper type. Compare it with the one selected by your neighbor. Continue until the best ear in the room is found. Be prepared to give reasons in support of the selected ear.

2. Place a class of (a) Yellow dent, (b) White dent, (c) Flint corn, by use of the score card.

3. Place classes designated for comparative judging and turn in placings and reasons on prescribed form "Corn Placing Sheet."

VII. Questions to be Answered

1. Why have corn shows become less and less important?
2. What is meant by utility corn?
3. Why is uniformity of ear size and shape unimportant from the practical standpoint?
4. What point is most important in Colorado? Why?
5. What is the relation between ear length and yield? Indentation? Number of kernel rows?
6. Why are corn yield tests replacing utility corn shows?
7. Why does a "perfect" ear of corn fail to reproduce itself?

References

3. Hayes, H. L., and Garber, R. J. Breeding Crop Plants, Chapter 26 1927
Name of Crop being Placed________________________Name of Student________________________

First Place, Number of Sample______________________________________________________________

Reasons:

Second Place, Number of Sample____________________________________________________________

Reasons:

Third Place, Number of Sample____________________________________________________________

Reasons:

Fourth Place, Number of Sample__________________________________________________________

Reasons:
Exercise 24

Judging Threshed Wheat Samples

I. Basis on which Wheat is Judged

To the untrained, wheat is merely wheat. The kernels have little more individuality than so many shot. A little study and close observation will, however, show that individual kernels may differ greatly from one another.

Wheats vary in color from white to deep red. Color depends to some extent on the variety, and a great deal on environment. Color bears a close relationship to hardness, texture, and gluten content. Darker wheats in general have a higher gluten content. An exception would be in light colored, translucent, hard kernels as found in durum wheats. Yellowberry is objectionable, particularly in hard red wheats. Sound, plump, well-matured wheat normally has a live, glossy appearance. Unsound kernels may be broken, insect-eaten, sprouted, decayed, bin-burnt, or contain scab or smut balls. Wheat should be free from foreign materials and weeds of other types. Weed seeds, trash, or other small grains are objectionable.

Originally, weight per bushel was the quantity of grain which would fill a vessel of a definite volume, i.e., a bushel measure (2150-42 cubic inches). Nowadays a bushel of grain means a certain weight which has been agreed upon and enacted by law. A measured bushel of wheat seldom weighs less than 50 nor more than 52 pounds. The miller buys wheat by weight alone, he still desires that a bushel-measure filled with wheat weigh heavily. Therefore, grain buyers use a small steer-yard and basket, called a tester, to determine how much a bushel of grain actually weighs.

Wheat can be judged as either market or as seed wheat. Ordinarily wheat that is faulty for the miller is at least as faulty for seed purposes. An exception may vary in the kernels and yellowberry kernels which are all right for seed because the condition is due to environment instead of heredity.

Wheat is almost always exhibited in peck samples. A full peck should be shown wherever a peck is called for.

SCORE CARD FOR SEED WHEAT

<table>
<thead>
<tr>
<th>Variety</th>
<th>Class</th>
<th>Perfect Score</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Points Considered</td>
<td></td>
<td>Score</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>1. Weight per bushel</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Uniformity of type and variety</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Soundness</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Freedom from foreign material</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Texture and color</td>
<td></td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The same score card can be used for rye.
III. Explanation of Points

1. **Weight per bushel**: Standard weight is 60 pounds per bushel. Well-developed, plump grains of medium size indicate a high weight per bushel and usually a high yield per acre. Weathered kernels and foreign matter tend to lower the weight per bushel.

2. **Uniformity of type**: Seeds of the different varieties of any particular grain vary in size, shape and natural color. A sample that is well-prepared should show uniformity in the characteristics it represents. There may be a mixture of varieties where the sample lacks uniformity in size, shape and color. It should be scored according to the percentage of mixture. When the variety is unknown, the sample must be judged on uniformity of grains, using as a basis the most uniform size, shape and color. Mixtures of varieties of grains are distinctly objectionable from the standpoint of both seed and market.

3. **Soundness**: Wheat should be plump and bright in appearance. This appearance indicates strong germination. Wheat kernels should not be: damp, stack or bin burned, frosted, colored, wet, sprouted, wormken, broken or sprouted. These conditions indicate low germination and lower the market value. Smut (bunt) can be detected by (a) smut balls, (b) smutty smell of grains, (c) presence of smut on the brushes which can be detected with a hand lens.

4. **Freedom from Foreign Material**: Foreign material includes everything but the grain itself. It includes: (a) weed seeds, (b) other grains, e.g. barley and oats, (c) straw, chaff, sticks, etc. Wild oats, included under weed-seeds are especially noxious and are sufficient grounds to disqualify a sample of wheat. They can be cleaned out of wheat, but their presence in the sample indicates carelessness on the part of the exhibitor.

5. **Texture and color**: (a) wheat kernels vary in texture from flinty to starchy. Hardness in bread wheat indicates qualities valuable in flour making. In any sample the texture should be uniform throughout. Yellowberry indicates poor texture from the standpoint of the miller. It does not affect quality of seed because it is caused by certain soil and climatic conditions. It should, however, be scored against according to the percentage present. (b) Bleached and discolored kernels - as well as discoloration caused by yellowberry - are objectionable.

IV. Grounds for Disqualification of Sample

1. Sample that is badly smutted (more than one smut ball should disqualify).
2. Sample listed in wrong class, in premium list.
3. Sample that is badly frosted.
4. Winter rye in a winter wheat sample (more than one kernel in a peck.)
5. Wild oats in a seed sample (more than one kernel in a peck.)
V. Procedure to Judge Wheat

1. Use of score card: The principal use of the score-card is to firmly fix in mind the points on which to judge and their relative weights. It may be used on a few preliminary samples for this purpose. Each point on the score card, e.g., soundness, is taken in turn and the samples ranked numerically. The low total gives the high sample.

2. Comparative Judging: Carefully read the premium list or instructions as to the class. With the main points of the score-card firmly fixed in mind, look over the samples and set aside those that are obviously disqualified. Look over the remaining samples in detail and place first, second, third, etc.

VI. Questions to be Answered:

1. Discuss foreign material in seed wheat from the practical standpoint.
2. Why is bushel weight important?
3. What differences would you make in judging wheat for seed and for commercial use?
4. Name and describe conditions of unsoundness that may be found in wheat.

References


2. Wilson, H. Z., and Crim, R. F. How to Judge and Identify Farm Crops, Div. Agron. and Pl. Genetics, U. of Minn. (Mimeographed circular)
Exercise 26
Judging Threshed Barley Samples

I. Important Considerations

Before prohibition, barley was judged from the standpoint of the brewer. Discolored or bleached grains in white barley disqualified it for his purpose. From the standpoint of the feeder, slight discoloration is not objectionable. Barley is now judged as to its value for seed or feed.

Bleached and discolored grains due to weather is probably the most common cause of injury in barley. Other forms of injury in barley. Other forms of injury include sprouted, bin-burned, or decayed grains. Among the diseases common in threshed barley are smut and helminthosporium. Smut can be distinguished by the hard, black, caked spore masses. The presence of helminthosporium is indicated by shrunked and brown kernels. It is difficult to detect in a weathered sample. Such characteristics are particularly objectionable in seed barley.

Sometimes barley is threshed too close, that is, many of the awns will be broken so short that the tip of the berry will be exposed, or the hull split down the back. This is sometimes found in samples "rubbed" too much to increase the bushel weight.

Mixtures of 6-row barley in a 2-row sample should be readily detected, but mixtures of 2-row barley in 6-row sample may be impossible to distinguish.

Among other things considered objectionable are: broken kernels, mixtures of other grains, inert matter, and awn too persistent. Sometimes "Coast" is not threshed close enough.

Score Card for Seed Barley

<table>
<thead>
<tr>
<th>Main Points Considered</th>
<th>Perfect Score</th>
<th>Place (use numerals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Weight per bushel</td>
<td>20</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>2. Uniformity of type</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>3. Soundness</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>4. Freedom from foreign material</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>5. Texture</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

(Score card used in the Intercollegiate Crops Contest, International Hay & Grain Show)
II. Explanation of Points

1. **Weight per bushel:** Standard weight per bushel for barley is 48 pounds. Well developed, plump kernels of medium size indicate a high bushel weight. All foreign material should be separated from the barley before the weight per bushel is determined. Sprouted kernels and exposure to weather lower the weight per bushel. Close brushing of barley removes too much of the hull and leaves many of the kernels partly exposed. This increases the weight per bushel but makes the grain less desirable for seed and therefore should be discriminated against under soundness.

2. **Uniformity of type:** Seeds of the different varieties of any particular grain vary in size, shape, and natural color, such as white or black in barley (yellow or green aleurone). A sample of grain that is well prepared should show uniformity of the characteristics it represents. Discoloration due to weathering is not considered under uniformity. If the sample is not uniform in size, shape and natural color there may be a mixture of varieties and it must be scored according to the percentage of mixture. Six-rowed barley is not as uniform in size of kernel as the two-rowed varieties. If the variety is not known, the sample must be judged on uniformity of grains, using as a basis the most numerous size, shape and color.

   Mixtures of varieties in seed grain are objectionable for the following reasons: One variety may ripen several days before the other, which causes loss when either the late or early maturing variety is harvested at the proper time. Mixed grains do not make a good appearance and do not sell well for seed or for other purposes on the large markets. Two-rowed barleys are usually slower in germinating than six-rowed. When the two types are mixed, loss results in the malting process.

3. **Soundness:** The grain should be plump and bright in appearance. This appearance indicates strong germination. The grain should not be damp, bleached, discolored, stack or bin burned, frosted, moldy, musty, sprouted, shrunkken, broken, smutted or weevil-eaten, and these conditions indicate low germination, and lower the market value. Barley with the hull removed so that the kernel is exposed has the vitality lowered and should be discriminated against. Stacked grain usually has a better color and has a lower moisture content than that threshed from the stalk.

4. **Freedom from foreign material:** Foreign material includes everything present except the grain itself. It includes (2) weed seeds, (b) other grains, (c) straw, chaff, sticks, etc. Weed seeds are the most undesirable because they are carried in the seed grain to the fields and make the crop produced less valuable. The presence of other grains lowers the value for seed or market.

5. **Texture:** Barley kernels vary in texture from flinty to starchy. For feeding purposes the flinty kernels are the more valuable. In any sample the texture should be uniform throughout.
III. Disqualification of Sample

1. Severe infection of smut or helminthosporium.
2. Sprouted kernels.
3. Sample in wrong class as shown by premium list.
4. Wild oats in a seed sample (2 or more)

IV. Procedure to Judge

The bushel weights will be given for each sample.
All samples will be judged comparatively and reasons written for each
class as in wheat.

V. Questions to be Answered

1. How would you distinguish 2-row barley from 6-row barley in a
   threshed sample?
2. What diseases can be detected in a barley seed sample?
3. Why is high bushel weight important in brewing barley?
4. Why do brewers object to barley that has been severely rubbed?
5. What factors must be considered in soundness of barley?

References

1. Lyon, T. L., and Montgomery, E. G. 1977, Examining and Grading Grains,
   pp. 75-80.

2. Wilson, H. K., and Crim, R. F. How to Judge and Identify Farm Crops,
   Div. Agron. and Pl. Genetics, U. of Minn. (mimeographed circular)
Exercise 27

Judging Threshed Oat Samples

I. General Considerations

Oats are commonly judged for feed or seed, but probably good seed should receive the greatest emphasis. In threshed samples, oats may be either hulled or unhulled. In the latter, the hull is removed when threshed. Hullled varieties may be white, gray, red, and black in color. Good oat grains (kernel with lemma and palea) should be plump, have a thin hull, and weigh 32 or more pounds per measured bushel. In Colorado, oats grown in the higher altitudes often weigh over 40 pounds.

II. Score Card for Seed Oats

<table>
<thead>
<tr>
<th>Main Points Considered</th>
<th>Perfect Score</th>
<th>Place (Use numerals)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Weight per Bushel</td>
<td>25</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>2. Uniformity of typ. (or variety)</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>3. Soundness</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>4. Freedom from foreign material</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

III. Explanation of Points

A. Weight per Bushel

As a rule, bushel weight is a fair criterion of feed value. A high bushel weight indicates a greater proportion of kernel to hull. Large amounts of "pin oats" or unfilled oats lessen the bushel weight. Sprouted kernels and exposure to the weather lower the weight per bushel. The standard bushel weight is 32 pounds. Sometimes oats are "clipped" or "rubbed" to increase bushel weight with the result that the tips of the kernels are exposed. The sample should be graded down when the kernels are exposed.

B. Uniformity

Good samples should show uniformity in shape, size, and color of kernels. Mixtures of different types is objectionable. Oats as they come from the threshing machine always contain primary and secondary grains in approximately equal numbers. Therefore they are not uniform in size until graded. Discoloration due to weather is not considered under uniformity. If the sample is not uniform for kernel size, shape, and natural color, there may be a mixture of varieties. It must then be scored according to the percentage of mixture.
C. Soundness

The grain should be plump and bright in appearance. Decayed and weathered grains give a poor appearance and, in addition, lower the feed value. Immaturity, as shown by green kernels, is objectionable. Sprouted kernels or mustiness are other unsalable characteristics. Distinct odor of smut is a serious condition.

D. Freedom from Foreign Material

Foreign material includes everything but the grain itself. Cuts should be free from trash, pieces of stone, noxious weeds like wild oats, and other crop seeds.

IV. Grounds for Disqualification

An oat sample may be disqualified when: (1) it contains sprouted kernels, (2) has wild oats in a seed sample (two kernels or more), or (3) sample is in wrong class as shown in premium list.

V. Procedure to Judge

The bushel weight will be given for each sample. All samples will be judged comparatively and reasons written for each class as in wheat.

References


2. Lyon, T. L., and Montgomery, E. G. Examining and Grading Grain, pp. 59-63. 1937

Exercise 26
(September 1921)

Sugar Beet Juicing:

I. Excellence in Sugar Beets

(a) Shape and Structure

There is a great variation in the size and shape of sugar beets. This is determined largely by the variety and the environmental conditions under which grown. There seems some justification for the belief that the best beets are long with a gradual taper from the crown to the tip of the root. Other things being equal, they will generally yield a larger tonnage than beets that taper suddenly. Beets with large crowns are undesirable because of the low sugar percent of crown tissue and the high percentage of inorganic salts and other impurities it contains. Branched roots are very undesirable. They usually give small tonnage and carry dirt and stones which increase the tare. Actual experiments, however, show little or no correlation between beet shape and sugar content.

(b) Sugar Content

Pack believes weight of the beet should be given more consideration. He found percent sucrose positively correlated with sugar content. In general, the percent sucrose decreases as the weight increases. The percent sugar has been found to increase from the crown and the tip of the beet towards the middle, being highest at a point about midway above the middle. The axis or central core is less rich in sugar than the zone that surrounds it. The percentage increases from the axis to a point somewhat nearer to the epidermis than the axis. It has been found that the pith next to the vascular rings is higher in sugar and that the percentage decreases as the distance from the rings increases. This indicates that, all other things equal, the beet with the greatest number of rings will test higher. Since the number of rings does not vary directly with the size of the beets, the percentage of sugar would tend to be higher in the smaller beets because they contain a greater amount of pith near to the vascular rings. Artschwager found some support for the belief that there exists a correlation between flesh color and sugar content. The flesh of rich beets was more uniform white while that of poor beets was watery yellow.

(c) Size of Exhibit

Sugar beets are usually exhibited as 1 or 1½ roots with the tops removed. The roots should be firm and clean. The dirt should be brushed and not washed off. Washed roots are discriminated against by judges.

II. Score Card for Sugar Beet Samples

<table>
<thead>
<tr>
<th>Points</th>
<th>Sample #1</th>
<th>Sample #2</th>
<th>Sample #3</th>
<th>Sample #4</th>
<th>Sample #5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Shape</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Sizc</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Maturity</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Tare</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Uniformity</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Supply Necessary: 15 to 50 well-shaped sugar beets for samples.
III. Explanation of Points

1. **Shape**
   (a) Crown: Small and oval or slightly conical with area where leaves are attached relatively small. Ground line should coincide with the lower point of attachment of the leaves.
   (b) Root: The length should be about three times the greatest diameter, with a gradual and uniform taper from the crown to the tip without contraction or bulging. It should be slightly flattened on two sides, each flattened side bearing a row of fibrous rootlets so arranged as to give a slightly spiral or twisted appearance to the root. Turnip, mangold-shaped or other misshapen roots tend to be low in percent of sugar and purity of the juice. Forked or branched roots with too heavy a growth of fibrous rootlets tend to hold soil and stones which increases the tare and gives trouble when washed and sliced. Such roots are usually low in yield and in sugar due to a coarse and fibrous nature.

2. **Size**
   The weight for light beets is between 1.5 and 5.5 lbs. Those over 5 lbs. are considered heavy beets.

3. **Maturity**
   The degree of maturity affects the percent of sugar and the percent of purity. A mature beet is less watery than an immature one. It is solid and brittle.

4. **Tare**
   A large proportion of the impurities of the juice are found in the crown, the amount being larger in the green exposed portions. Flat or turnip shaped crowns increase the tare because more is removed in topping.

5. **Uniformity**
   Sugar beets should be uniform in size, shape, color and weight. The sample that shows the most uniformity through should be given the award in uniformity.

III. Laboratory Instructions

1. Score individual beets provided. Call "uniformity" on the score card. The beet which is best in shape shall be given the first place, the next best, second place, and so on. Write the rank for each beet on each point in the proper place on the outline. Use figures, as 1, 2, 3, etc., to designate rank. The low total gives the high beet.

2. Judge 4 ten-beet samples provided. Write out reasons for the placings.

References

Judging Small-Seeded Legumes

I. Value of Judging Small Seeds

The actual judging of seed samples will teach the student the principles of recognizing good from inferior seed. Close attention must necessarily be given to the identification of the variety mixtures of other crop seeds and weeds, presence of inert matter, and the viability and quality of the seed. Certain factors, such as weed seeds, are often much more difficult to detect when sprinkled through a crop seed sample.

II. Score Card for Small-Seeded Legumes

The following score card provides a basis for considering and evaluating points:

<table>
<thead>
<tr>
<th>Main Points to be Considered</th>
<th>Perfect Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Purity</td>
<td></td>
</tr>
<tr>
<td>1. Freedom from mixtures</td>
<td>10</td>
</tr>
<tr>
<td>2. Freedom from weed seeds and foreign material</td>
<td>20</td>
</tr>
<tr>
<td>II. Condition</td>
<td></td>
</tr>
<tr>
<td>1. Color and luster</td>
<td>15</td>
</tr>
<tr>
<td>2. Percentage of germination after scarification</td>
<td>15</td>
</tr>
<tr>
<td>3. Freedom from damaged seeds</td>
<td>15</td>
</tr>
<tr>
<td>4. Maturity</td>
<td>15</td>
</tr>
<tr>
<td>III. Uniformity</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

III. Explanation of Points

1. Purity: Freedom from all mixtures of seeds of other kinds particularly similar appearing seeds of other crops or seeds of other varieties is important. The presence of weed seeds of any kind and particularly those of plants of a noxious nature lowers the grade of the sample materially. Inert material of any kind particularly sand or similar material which increases the weight per bushel is undesirable.

2. Condition: Color and luster. Bright color and good luster in-

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3. Taken largely from the Forage Crops Laboratory Manual, University of Nebraska.
dicate that the seed is of the current crop. Dull color and lack of
lustre indicate either weathering in the field or old seed.
Percentage of germination after scarification: indicates the intrinsic
seed value provided the purity is satisfactory.
Freedom from damage: Damaged seeds are of no value from the seed stand-
point.
Maturity: Plump seeds of average size that have come to full maturity
give good weight per bushel, and usually produce a high percentage of strong
seedlings.

3. Uniformity: Similar color and size of all seeds in a sample give
it an attractive appearance.

V. Judging Procedure

1. The judging classes will ordinarily consist of four samples each. Each
sample will be identified by a number or letter. These will be con-
tained in small pans or boxes. A hand lens will be convenient for the
study of samples.

2. Reasons will usually be given on all classes. It is just as important
to know why a class is placed in a certain order as it is to have it
placed correctly. Even the expert judges may disagree on a placing, they
usually see the same factors but evaluate them differently. The des-
crptive type of reasons will be required.

Questions to be Answered

1. What mixtures are generally found in alfalfa seed?
2. What is the importance of color in red clover seed?
3. How would you detect sweet clover in an alfalfa seed sample?
4. Can you distinguish red clover in an alfalfa seed sample? How?
I. Value of Exhibits

Sooner or later agricultural teachers and county agents are called upon to either prepare exhibits of field crops for shows and fairs or to show others how to prepare them. Farmers often find the preparation of exhibits for local shows and fairs a distinct advantage as an advertisement. Prospective buyers are assured that he has confidence in his own products when he will match them against competitors. Additional proof of the quality of his crops is evident should he win prizes. Premiums often depend upon an attractive exhibit which can usually be prepared thru the observance of a few simple rules.

II. Preparation of Small Grain Sheaves

(a) Preliminary Work

With professional exhibitors, the preparation of the sheaf sample often begins far in advance of the show. One may plant thin to encourage maximum plant development and thus improve quality. After the grain is ripe, he should select desirable heads in the field and cut single stems. This is usually done with a hand sickle. Uniform type in wheat is most readily obtained at the yellow-ripe stage when it is just past the hard-dough stage. One should select only plants that are true to variety, have good color, long and stiff straw, and well-filled heads free from disease. Cuts may be cut quite green in wet weather. Ordinarily, cuts should be cut after they have turned, otherwise the straw and heads may be discolored. The plants may be dried in the sun for a day or two when one is certain they will not be wet. Sunshine on wet straw will cause it to bleach. When dried indoors, small grains should be hung heads down in small bunches to avoid molding. The sheaf should be made after the grain is thoroughly dry.

(b) Types of Sheaves

(1) Heads even and but slightly rounded. (2) Conical head type. The center bunch is placed up to form a cone. (3) Extended head type. The area of heads extend 3 to 5 times the length of single heads in the sheaf; the center is pushed up and layer after layer added. About one-half inch is dropped each time around the bundle. It is usually necessary to tie the bundle as one adds to it in order to keep the heads in place. This is a very difficult type of sheaf to make, but can be made very attractive.

(c) Method of Making a Sheaf

(1) Remove only the blade and leave the leaf-sheath on the stem. The sample is hard to handle when the sheath is stripped to the joint,
and moreover, it involves a large amount of tedious work. The sheaf
looks nearly as well by mere removal of the blades. (2) Lay the
straws or culms on a table. Keep the heads straight. Build up in
a heap. Fold in the edges after sufficient culms are collected for
the sheaf. The top of the pile thus becomes the center of the sheaf.
Enough material should be provided to make a sheaf 2.5 to 4 inches in
diameter at the center. (3) The sheaf should be bound in 3 places.
One person may hold the bundle in place while another ties the bottom
band as tightly as possible. The middle band should be tied snug
and the top one loose to avoid breaking the straw. (4) Great care
should be exercised so that the beards and heads will not be broken
off or the grain shattered. (5) The "Rheem sheafmold" is a device
that will facilitate sheaf-making. The straws are put in, a few at
a time, and the bundle constantly turned as it is built up. When
full, it is clamped down and the bundle tied perfectly round. (6)
After the bundle is tied, it may be placed on a block of wood and the
butt ends of the straw chopped off with a hand axe.

(d) Packing Sheaves for Shipment
Dampen the ground and lay out the bundles in 2-3 layers. Spread damp
burlap sacks over them and allow them to stand over night. Keep off
free water as it causes discoloration. This procedure will moisten
the bundles and reduce shattering. Tightly pack the bundles in the
box for shipment. Nine out of ten persons fail at this point. Use
care to overlap bundles. Alternate oats and grasses with beardless
and bearded grains to avoid breaking of heads, mixtures, etc.

III. Preparation of Forage Sheaves

(a) Grasses
Select extra leafy material in the early bloom stage. It should have
as many green blades as possible and still have full growth. Place
in a dark room or shed after harvest to cure without bleaching. Arrange
material in small bunches to dry. To make up the sheaf either
(1) wait for humid weather or (2) lay the bunches on damp ground the
night before and cover with damp sacks. Make as leafy an appearance
as possible on the outside of the bundle. A leafy bundle, bright
green in color, with good length gives the impression of tonnage with
high quality. Size of sheaf, number of bands, etc., is the same as
in cereals.

(b) Other Plants
   (1) Legumes
       These are hardest to prepare. The sheaf should be made up of
       fine stems which should still be leafy with adequate length to
       indicate high tonnage.

       (2) Fodder corn
       Much fodder corn is shown in Colorado county fairs because ear-
corn is generally immature at the time of fairs. The stalk
should be of good size, full of broad leaves and have one good
ear. A substantial stalk indicates good silage value. Select
when the husks are turning yellow, the ear is mature, and the leaves still green.

3) Soybeans, Field Peas, etc.
Plants of such crops should be pulled while the leaves are still green and the seed hard. They should be bound in very loose bundles and cured in a dark, dry place. The purpose is to show a maximum of good forage and a good yield of ripe seed.

IV. Root Exhibits

Variety and type should be kept in mind in root exhibits as well as uniformity of sample. Sugar beets and mangelos should be uniform in shape and weight. The root should taper gradually and uniformly from the crown without contractions or bulges. A good length is about three times the diameter. The ideal weight, when sugar content is considered, is 1.5-5.0 pounds. Usually five or ten single roots comprise an exhibit. Remove the tops from root crops as soon as they are pulled but avoid cutting into the crown. Pull beets in fairly dry weather when possible. Avoid the use of water to clean roots. When possible use a cloths or a brush instead. Washed roots are sufficient grounds for the judge at a fair to throw out the entry. Avoid bruises and scratches.

Sack several distinct varieties in a burlap sack for shipment. Keep the beets or roots covered with sacks to reduce transpiration. Dampen the sacks in dry weather. Some exhibitors pack beets in damp sawdust for long shipment.

V. Ear-Corn Samples

(a) Fall Fairs

Early fall fairs generally present a problem to the corn exhibitor due to the fact that corn is seldom mature by most fair dates. Immature corn is generally loose on the cob. For fall fairs, leave ear corn on the stalks as long as possible. Snap the ears and leave on the husks. For a 10-ear sample select and take 20-30 ears to the fair. Husk out and make the selection of the ears for exhibit as late as possible. Corn even slightly immature shows to better advantage before it has had an opportunity to shrink. Ear corn should be true to type, free from mixture, uniform, and as mature as possible. Guard against heating when immature corn is shipped. Spread out at the earliest moment after shipment to allow a free circulation of air.

(b) Seed Shows
Corn for seed shows and late fairs must be dry and solid on the cob.

VI. Threshed Samples

(a) Preparation of Samples
For show purposes, experienced exhibitors often plant grain thin to allow the maximum development of individual plants. A patch of grain may be selected in a favorable part of the field, and allowed to stand
until dead ripe. The latter is especially desirable in winter wheat where yellowberry kernels are apt to be present. To avoid broken kernels, hand thresh with a flail, as screens will not remove all broken kernels from threshed grain. Use plenty of wind in the cleaning of grain for show purposes to remove inert matter and light kernels. Avoid smut, weed seeds, and varietal or other grain mixtures in show samples. One peck is generally the size of sample exhibited for small grain. Uncleaned grain direct from the separator should not be considered by a judge.

(b) "Rubbing" Oats and Barley
It is legitimate to "rub" oats and barley samples, although some authorities frown on the practice. The peck sample may be put in an ordinary burlap sack, placed on a hard floor and the grain spread out so that it is about one inch thick. Rub gently with one foot. This breaks off the awns and glumes up to the grain and thus increases the bushel weight. Avoid rubbing so close that kernels are broken. The kernel must not show as a result of rubbing or it may be disqualified. Grain should be very dry before it is rubbed.

VII. Laboratory Instructions

1. Prepare a small grain sheaf for exhibit.
2. Prepare a forage sheaf for exhibit.
3. Prepare a small grain sample for exhibit.

VIII. Questions to be Answered

1. How may an exhibit mislead on quality of a farmer's crop? Why?
2. What advantages may a farmer gain from an exhibit?
3. Why are the leaves left on for a forage sheaf?
4. How would you prepare a fodder sample of sorgho for exhibit? Seed sample?
5. How is the best way to remove the leaves in the preparation of a small grain sheaf? Why?
6. How is grain "rubbed"? Why?

References


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FIELD CROPS LABORATORY MANUAL

Section IV

Appendix
<table>
<thead>
<tr>
<th>Variety of Crop</th>
<th>Latin Name</th>
<th>States and regions where most widely grown</th>
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<td>7. Cocke's Prolific Corn</td>
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<td>39. Fulghum Oats</td>
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COLORADO JUDGING CONTEST

Scoring Table on Placings
(From College of Agriculture, University of Wisconsin)

**Table 1 - 1.2.3.4**

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GLOSSARY OF TECHNICAL TERMS

A
Abortive - imperfectly formed or rudimentary.
Achen - A one-seeded, dry, indehiscent fruit in which the testa and pericarp are not firmly attached.
Acicular - Needle-shaped.
Acropetal - Developing from the outside (below) toward the inside (above).
Acuminate - Tapering at the end.
Acute - Sharp pointed.
Adnate - Adhering closely.
Adventitious - Out of the ordinary place, as applied to buds or roots.
Aggregate - A mass or assemblage.
Agrostology - That branch of systematic botany which treats of grasses.
Aleurone - Nitrogen particles found in definite layers in seeds.
Alluvial - Pertaining to deposits made by flowing water.
Alternate (buds, flower parts, leaves, etc.) - One after another singly at the nodes.
Anastomosing - Joining or uniting.
Androecium - The stamens collectively.
Annual - Of one year's duration.
Annular - Forming a ring or circle, as embryo of beet.
Anther - The part of the stamen which contains the pollen.
Anthesis - The time of expansion of a flower.
Apetalous - Without petals, as in buckwheat, etc.
Apex - Tip, point, angular summit.
Apiculate - With a minute pointed tip.
Appendages - Something added to a greater thing.
Appressed - Lying close and flat against.
Appressed-hispid - Rigid hairs lying flat or close against a surface.
Aristate - Tipped by an awn or bristle.
Articulate - Jointed.
Articulations - Joints.
Ascending - Rising obliquely - curving upward.
Asymmetric - Not symmetrical.
Attenuate - Tapering; becoming very narrow.
Auricle - Ear-like structure.
Autogamy - Pollination in which pollen is transferred from the anthers to the stigma of the same flower.
Awn - A slender bristle-like organ.
Axis - A line passing thru a structure about which the parts are arranged.

B
Barb - A rigid point or short bristle.
Barbed - Furnished with barbs.
Beaked - Ending in a prolonged tip.

1Made up from the glossary used by Anna M. Late, Botany Department, Colorado State College, in the "Grasses" course, together with the one in "Botany of Crop Plants" by W. W. Robbins, pp. 509-618.
Bearded - Bearing long or stiff hairs.
Biconvex - Doubly convex - i.e., convex on both sides.
Bidentate - Two toothed.
Biennial - Of two years' duration; the first year from seed, the second year
flowering and fruiting, then dying; as in sugar beet.
Bifid - Two cleft.
Blade - The expanded portion of a leaf.
Bloom - The whitish, powdery, and waxy secretion of epidermal cells.
Bony-indurate - Much hardened.
Bract - Small leaf belonging to inflorescence.
Bristle - Short, stiff hair.
Bulbous - Similar to a bulb; having a bulb.

C

Callus - The tough, often hairy area at the base of the lemma.
Campanulate - Bell-shaped.
Capillary - Hair-like.
Capitate - Arranged in a head or dense cluster.
Capsule (pod) - A dry, dehiscent fruit of two or more carpels.
Carinate - Having a keel, a longitudinal ridge.
Cartilaginous - Firm and tough.
Caryopsis - A seed-like fruit with the thin pericarp adnate to the contained
seed.
Chartaceous - Having the texture of writing paper.
Chartaceous-indurate - Somewhat firmer than Chartaceous.
Clavate - Marginally fringed with hairs.
Citation - Enumeration, mention.
Claw - The narrow or stalk-like base of some petals.
Cleft - Cut about half way to the middle.
Clesitogamous - Applied to flowers which do not open and are fertilized in
the bud by their own pollen.
Coleoptile - Leaf sheath in grasses.
Coleorrhiza - A sheath about the root.
Collar - The modified area between the sheath and blade of a leaf.
Compressed - Flattened.
Concavity - A hollow, a recess.
Connate - United; used especially of similar organs.
Contiguous - Touching; in actual contact.
Contracted - Drawn together.
Convex - Bulging, arched out.
Convolute - Rolled up longitudinally.
Copious - Abundant.
Cordate - Heart-shaped.
Coricaceous - Leathery.
Coricaceous-indurate - Somewhat harder than leathery.
Cyp rate - Horn.
Corolla - The inner of two series of floral leaves.
Crateriform - In the shape of a saucer or cup.
Cylm - The stem of grasses and sedges.
Cuticle - A thin covering of a waxy substance called cutin on the outer wall
of epidermal cells.
Cylindric - Having the form of a cylinder.
Deciduous – Not persistent; falling away at maturity.
Decumbent – Reclining; but with the tip ascending.
Dehiscent – The opening of a fruit or anther.
Deciduous – Splitting open.
Dentate – Sharp-toothed; teeth directed forward.
Denticulate – Diminutive of dentate; furnished with very small sharp teeth.
Depressed – Somewhat flattened from above.
Dichogamous (stamens) – United into two sets, as in many legumes.
Dichogamy – A condition in which stamens and pistils do not mature simultaneously.
Diffuse – Widely or loosely spreading.
Digitate – Diverging like the fingers spread.
Dioscyrous – Bearing staminate flowers on one plant and pistillate on another.
Disarticulate – To come apart at a joint.
Distichous – Arranged in two rows.
Divergent – Diverging at a wide angle.
Divergent – Deviating gradually from a given point.
Dorsal – On the back.
Dorsiventral – From back to front.

Ecocentric – Deviating from the center.
Ellipsoid – A solid body elliptic in section.
Elliptic – Oblong with rounded ends.
Elongate – Lengthening.
Emergent – Notched at the apex.
Embryonic – Rudimentary plant within the seed.
Endosperm – Nutritive tissue formed within the embryo sac in seeds.
Entire – Without divisions, lobes or teeth; usually refers to margins of leaves, petals, and sepals.
Eroded – Margin irregular, as if gnawed.
Eroded dentate – Irregularly toothed.
Etiolated – To whiten, or blanch, by the exclusion of light.
Evanescent – Tending to disappear.
Excurrent – Running out as a nerve of a leaf margin; cut beyond the margin.
Exserted – Protruded past surrounding organs.
Extravaginal – Referring to branches in flowers which force their way out thru the base of the leaf sheath.

Falcatate – Shaped like a scythe.
Fascicles – A dense cluster.
Fertile – Capable of bearing fruit or seed; applied to flowers with pistils or to anther with pollen.
Fertilization – A sexual process in which two dissimilar gametes fuse.
Fibrous – Fiber-like, usually referring to root system or many small thread-like roots.
Filament – Thread; stalk of stamen.
Flagellate ) - Fan-shaped.
Flagelliform ) - Fan-shaped.
Flexuous - Unstiff.
Florot - A small flower.
Foliaceous - Leaf-like in texture or appearance.

G
Geitonogamy - A method of pollination in which pollen is taken from anther to stigma of another flower on same plant.
Geniculate - Bent abruptly like a knee.
Genera - Plural.
Genus - Singular.
Gibbous - Enlarged or swollen on one side.
Glabrous - Smooth, without hairs.
Glandular - With glands.
Glaucescent - Covered with bluish or white bloom.
Globose - Spherical or nearly so.
Glumes - Bracts at the base of a spikelet.
Gregarious - Growing in groups or colonies.
Gynoecium - The carpels taken collectively.

H
Halophytic - Growing naturally in saline soils.
Head - An indeterminate type of inflorescence in which the flowers are in a dense cluster, as in Compositae.
Herbaceous - Herb-like; that is, stems do not develop woody tissue.
Hermaphrodite (flowers) - Perfect, both stamens and pistils present.
Heterogeneous - Dissimilar.
Hilum - The scar left by breaking the attachment of a seed in the fruit.
Hispid - With rigid or bristly hairs.
Hispid-ciliate - With bristles on the margin.
Hyaline - Thin and translucent.
Hydrophytic - Growing in water or saturated soil.
Hygroscopic - Readily absorbing and retaining moisture.
Hypocotyl - That portion of the embryo stem below the cotyledons.
Hygrogyrous - Ovary superior; flower parts attached below the ovary.
Hirsute - Covered with stiff hairs.
Homogamy - The anthers and stigmas mature at the same time.

I
Indehiscent - Not splitting open.
Inbricated - Overlapping.
Indigenous - Native to the region of growth.
Indurate - Hardened.
Inferior (ovary) - Below the other flower parts.
Inflated - Hollow and distended.
Inflated saciform - Distended in sac shape.
Inflated ventricose - Inflated or swollen on one side.
Inflorescence - The flowering parts of plants.
Inrolled - Rolled from edges toward middle.
Integument - Skin; coat of protecting layer.
Internode - Portion of culm between two nodes.
Intervaginal - Referring to branches in grasses which grow out between the leaf sheath and the culm (stem).
Involucral - A whorl of bracts surrounding a flower or a cluster of flowers.
Involute - Rolled inwardly.
Irregular (flower) - One or more of the parts of a series are dissimilar.

J

K

Keel - A central ridge like the keel of a boat.

L

Laciniate - Cut into narrow lobes or segments.
Lanceolate - Several times longer than wide, tapering from base to apex.
Lanceolate - Woody.
Leaves - The lower of the two bracts enclosing a grass flower.
Lenticular - Shaped like a double-convex lens.
Liniate - Strap-shaped.
Lind - A thin projection from the summit of the sheath in grass leaves.
Linear - Long and narrow, its sides nearly parallel.
Lobed - Divided to about the middle.
Lodicule - A delicate scale inside of the palea, probably in a vestigial perianth.
Lunate - Crescent shaped.

M

Marginal - Near the edge.
Medulla - Pith.
Membranaceous - Thin, rather soft, more or less translucent.
Mesocotyl - Axis between base of coleoptile and grain, in grasses.
Mesophytes - A plant growing under medium moisture conditions.
Mid-vein ) - Central vein or rib of a leaf or bract.
Midrib ) - Central vein or rib of a leaf or bract.
Moniliform - Like a string of beads.
Monococious - Bearing stamens and pistils in separate flowers on the same plant.
Monotypic - A tribe with only one genus or a genus with only one species.
Macro - an abrupt point or tip.
Macronate - Having a macro.

N

Navicular - Boat shaped.
Nerve - Vein.
Neutre - Having imperfect stamens or pistils.
Node - The junction of two internodes in a culm; point of origin of a leaf.
Nucellus (megasporangium) - The ovule tissue within the interaments.
Obcordate - Heart-shaped, with broad end at the tip.
Oblique - Slanting.
Oblong - Longer than broad with sides nearly parallel.
Oblanceolate - Lanceolate with broadest part toward the apex.
Obovate
Obovoid - Egg-shaped with broadest part toward the apex.
Obsolete - Gone, or vestigial.
Obtuse - Blunt or rounded.
Ovary - The ovule-bearing part of the pistil.
Ovate
Ovoid - Egg-shaped, broadest part at base.
Ovule - The structure which after fertilization becomes the seed.

Palea - The upper of the two bracts which surround the grass flower.
Palmate - Leaf segments or leaflets radiate from a point like the fingers from the palm of the hand.
Panicle - A loose irregularly compound inflorescence with pedicillate spikelets.
Panicleate - Borne in panicles.
Papery - Of the thinness of paper.
Papillate - Covered with small projections.
Papillose - With minute blunt projections.
Pappus - Bristle-like, awn-like scaly structures (modified calyx) at the tip of the ovary in Compositae.
Pectinate - Comb-like.
Pedicillate - Borne on a pedicel.
Pedicel - The stalk of a single spikelet.
Peduncled - A stalk supporting a single spikelet or a branch.
Pendant - Hanging.
Perennial - Living year after year.
Perfect - Having both stamens and pistil in each floret.
Perianth - The floral envelope (calyx and corolla).
Pericarp - The matured ovary.
Persistent - Long; continuous; not deciduous.
Peticle - The stalk of a leaf.
Pinnae (leaf) - Leaflets arranged along the sides of an axis.
Pistil - The seed-bearing organ of a flower.
Pistillate - Having a pistil.
Plano-convex - Plane on one side, convex on the other.
Plumose - Having fine hairs like a feather.
Prostrate - Lying flat on the ground.
Protandry - In which the anthers of a flower shed their pollen before the stigmas are receptive.
Protogyny - In which the stigmas of a flower are receptive before its anthers shed their pollen.
Puberulent - Minutely pubescent.
Pubescent - Covered with soft hairs.
Pyramidal - Shape of a pyramid.
Prototype - Primary form and pattern.
Raceme - A simple inflorescence with spikelets borne on pedicels along an axis.
Racemose - In racemes.
Rachilla - The axis of a spikelet.
Rachis - The main axis of grass inflorescence.
Radical - Seeming to come from the root. Leaves arising from the base of stem, close to the ground line, and said to be radical, as contrasted with those on the stem (cauline).
Recurred - Curved backward.
Reflexed - Bent backward abruptly.
Regular (flower) - The parts of each whorl similar.
Reniform - Kidney-shaped.
Reticulate - Netted.
Retorsely - Turned backward or downward.
Rhizomes - A subterranean stem.
Rigid - Stiff, not flexible.
Ruderal - Growing in waste places; weed.
Rudiment - A beginning.
Rugose - Wrinkled.

Runner - A prostrate, slender, above-ground stem, such as in the strawberry.

S

Saccate - Sack-shaped.
Scabrous - Rough to the touch.
Scale - Reduced leaf that appears lower on the stem than the foliage leaves.
Scarious - Thin, dry, membranaceous, not green.
Sclerotic - Hard, indurate.
Scutellum - Morphologically, the octyledon of the grass embryo.
Seminal - Belonging to the seed.
Serrulate - Finely serrate.
Sessile - Without stalk of any kind.
Setaceous - Bristle-like.
Sheath - A tubular envelope.
Spicate - Spike-like.
Spike - A simple inflorescence with spikelets borne sessile along a rachis.
Spikelets - A group of florets subtended by one or more glumes.
Squarrose - Rough with divergent processes.
Stamen - One of the pollen bearing organs of a flower.
Staminate - Bearing stamens.
Standard - The large petal in the flowers of Leguminosae.
Sterile - Flower without pistil, stamen without anther.
Stigma - The part of a pistil to which pollen grains become attached.
Stipe - Stalk.
Stipitate - Having a stalk.
Stolon - A trailing stem, above ground, that easily takes root at the nodes when it touches the ground.
Stooling - Production of secondary branches from lowermost nodes, as in grassy tillering.
Stramineus - Straw-colored.
Strigose - With appressed or ascending stiff hairs.
Subacute - Somewhat acute.
Subcircular - Somewhat rounded.
Subcylindric - Somewhat cylindrical.
Subdigitate - Somewhat digitate.
Subglabrous - Somewhat glabrous.
Subglobose - Somewhat spherical.
Subscarios - Somewhat scarious.
Subsessile - Nearly sessile.
Subsimple - Nearly simple.
Subtend - To grow under, or be adjacent to, as a bract subtending a flower.
Subulate - Nearly terete.
Subulate - Awl shape.
Subvelutinous - Slightly velvety.
Succulent - Soft and juicy.
Sucker - Rapidly growing shoots from roots or from stems underground.
Superior (flower) - Ovary appearing above the other parts of the flower.
Suppressed awn - Nearly obsolete awn.
Sympetal - Petals united.
Suture - A line of splitting.

T

Tassel - Staminate inflorescence in corn.
Taxonomy - Classification.
Tendril - Slender, coiled organ used in climbing.
Terete - Having a circular cross section.
Terminal - At the end.
Testa - Seed coat.
Tillering - Production of branches from the lowest nodes, as in grasses.
Tomentose - Covered with dense wool-like hair.
Translucent - Partially transparent.
Trifid - Three parted.
Trifoliate - With three leaflets, as in clover.
Truncate - Ending abruptly.
Tufted - In bunches.
Turgid - Tightly drawn, swollen.
Tussock - Tuft, dense bunch.

U

Undulate - With wavy margin.
Unilateral - One sided.
Utricle - Small bladdery one seeded fruit.

V

Vernation - The arrangement of veins.
Ventral - The inner face of an organ.
Ventricle - Inflated on one side.
Ventral - Pertaining to spring.
Ventricillate - Whorled.
Vestigial - Remnant.
Villosus - Bearing long soft hairs.

Wing - Lateral petal in the flower of Leguminosae.
Whorl - Arranged in a circle around a stalk.

Xerophytes - Plants adapted to dry situations.