IDENTIFICATION OF THE SEEDS OF SPECIES OF AGROPYRON

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INTRODUCTION

The identification of the "seeds" of the species of Agropyron is an important problem to the farmer, the seedsman, and the seed laboratory. Agropyron repens (quack-grass) is recognized as a dangerous weed, and the similarity between the seed of this species and other common but more desirable species of Agropyron gives rise to confusion. Up to the present time no diagnosis has been discovered which appears to be entirely satisfactory for use in seed-laboratory practice. This paper deals only with the seeds of the species of Agropyron which are common in the Minnesota seed trade—viz, (1) quack-grass (A. repens (L.) Beauv.); (2) western wheat-grass (A. smithii Rydb.); and (3) slender wheat-grass (A. tenerum Vasey). The diagnosis here presented has proved to be not only sound but easily applied in many hundreds of tests made at the Minnesota Seed Laboratory.

HISTORICAL REVIEW

The species of Agropyron are quite easily distinguishable from each other when characteristics of the root systems, leaf characters, spikes, and spikelets are taken into consideration, and these differences are described in standard works on the taxonomy of the flowering plants (1, 2, 3, 4). In so far as the seeds are concerned, however, these published descriptions are not sufficiently detailed for use as a basis for identification of seeds alone. Hillman (5) published detailed descriptions of Agropyron spikelets which agree in every way with the observations of the writer, but do not include individual seed characters in sufficient detail for an accurate diagnosis of the seeds alone.

Stevens (8, p. 113) describes in some detail the empty flowering glumes, the size and shape of the seeds, and the rachilla of several species of Agropyron. His descriptions, except as to the rachilla, agree essentially with those of the writer. The rachilla is described by Stevens as follows:

The footstalk (rachilla) in Agropyron repens is entirely smooth, while in Agropyron occidentale it is rather variable, but commonly with scattered, short, stiff hairs.

While this may appear to be true when seeds are examined under a low-power lens, yet the rachilla of seeds of A. repens when magnified

1 The writer wishes to acknowledge the assistance of Dr. E. M. Freeman, Assistant Dean, and Chief of the Division of Botany and Plant Pathology, and Mr. W. L. Oswald, Chief of the Seed Laboratory, Minnesota Experiment Station, in planning the work and giving suggestions.
2 The word "seeds" is used in this paper in its commercial sense and includes the grain, or caryopsis, inclosed in its persistent glumes, lemma, and palea, with the persistent rachilla segments.
3 Reference is made by number to "Literature cited," p. 281.
4 Syn. Agropyron smithii.
to about 32 diameters exhibits very definite hairy characters, as described below.

Pammel and King (6, p. 170) published a brief account of the seeds of *A. repens* and *A. smithii* in which the main points of difference are pointed out as being found in the shape of the palea and in the hairs on its face and edge. While these distinctions are in the main correct, they are insufficient for a complete diagnosis. As to shape of the seeds, these authors make the following statement:

The seed of quack grass is more slender and spindle-shaped, while that of western wheat grass broadens out somewhat toward the tip, after the manner of brome and some other grasses.

According to the results of the examinations of a large number of seeds, the writer finds that the difference in shape above noted is not constant. Hence, its use as a single determining character is not warranted.

In a taxonomic key of seeds of Agropyron issued by Sarvis (7, p. 2) the rachilla of *A. repens* is described as being "puberulent, each hair being glandular at the base." According to the writer's observations, the rachilla would more properly be described as hirsutulous. Moreover, in order to discern the glands at the base of the hairs, a compound microscope is required, which makes the use of this character impracticable for ordinary seed-laboratory methods. Even with such high power, the glands are not always clearly discernible. A glabrous palea in *A. repens* and a hispid palea in *A. smithii* are indicated by Sarvis as important characters in the determination of the Agropyron species. While this is true for the majority of seeds of these species, the writer has found many seeds in which this distinction does not hold. These characters intergrade to such an extent that they are not only unreliable, but are misleading as a single diagnostic criterion. Sarvis also holds that the tip of the palea of *A. tenerum* is very puberulent. This is true not only for the species above mentioned but also for *A. repens* and *A. smithii*.

**SEED CHARACTERS OF SPECIES OF AGROPYRON**

In the determination of seeds of Agropyron there are no absolutely fast and definite single characters by which a seed of one species may be unfailingly distinguished from the seed of any other species. Variation is found not only in the seed but also in the other unit parts of the plants, particularly in the spikes and spikelets (Pls. XXXIV, XXXV, and XXXVI). Moreover, seeds growing in different localities may exhibit considerable variation. This variation necessitates a close study of numerous characters of each seed, and any diagnosis to be of value must be based on a large number of seeds collected from a wide range and under widely differing conditions.

It is also obvious that the larger the number of seed characters which are studied the greater will be the possibility of making an accurate determination of the species under examination. A single character may vary to such an extent as to be quite untypical of the species, and consequently a determination based upon only one character may be incorrect, and therefore misleading. The necessity for an intimate knowledge of several distinguishing characters is even more
pronounced when Agropyron seeds become so mutilated that portions of the glumes are destroyed, as is frequently the case in commercial seed mixtures. In some cases the glumes are entirely gone, leaving only the grain, and determinations according to characters described below then become impossible. No satisfactory method of real practical value has yet been worked out whereby the seeds without the glumes may be accurately determined, and it seems probable that in such cases one may be compelled to resort to microscopic sections. One characteristic difference may be noted, however—namely, that the color of the matured grain of *A. tenerum* is somewhat lighter than that of either *A. repens* or *A. smithii*. The two latter approximate each other closely in color.

**SOURCE OF SEEDS**

Materials for this work were secured from as many sources as possible, as given in Table I. Only those samples have been considered which were obtained from and determined by a competent botanist, who was sure of the origin of the seed.

**Table I.—Sources of seeds of *Agropyron* spp. used in investigation**

<table>
<thead>
<tr>
<th>Source of seed</th>
<th><em>A. repens</em></th>
<th><em>A. smithii</em></th>
<th><em>A. tenerum</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada (Manitoba)</td>
<td></td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>Illinois (Chicago) b</td>
<td>(a)</td>
<td></td>
<td>(a)</td>
</tr>
<tr>
<td>Iowa</td>
<td>(a)</td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>Michigan</td>
<td>(a)</td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>Minnesota</td>
<td>(a)</td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>New York (Geneva)</td>
<td>(a)</td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>North Dakota</td>
<td>(a)</td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>North Dakota b</td>
<td>(a)</td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>Russia b</td>
<td>(a)</td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>Washington (State)</td>
<td>(a)</td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>Wisconsin b</td>
<td>(a)</td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>(a)</td>
<td>(a)</td>
<td>(a)</td>
</tr>
<tr>
<td>Wyoming</td>
<td>(a)</td>
<td>(a)</td>
<td>(a)</td>
</tr>
</tbody>
</table>

* Sample received.

* From Seed Laboratory of United States Department of Agriculture, Washington, D. C.

**LABORATORY METHODS OF IDENTIFICATION**

It is obviously necessary that all methods of identification, especially for use by farmers or seedsmen and even for seed laboratories, be as simple as possible and that they do not require elaborate or expensive apparatus. If, however, the distinguishing characters are not visible to the naked eye or with the aid of an ordinary magnifying glass, then it becomes absolutely necessary to use a higher power of magnification.

In the identification of seeds of *Agropyron* spp. it is advisable to use a magnification of about 32 diameters for the best results. The Greenough binocular giving the stereoscopic view has proved very satisfactory. It is absolutely necessary when examining seeds under the lens to place them so that the base of the seed is toward the light, in which position the light will be properly reflected from the hairs, making them appear clear and well defined.
SHAPE OF SEED

The seed of *A. repens* (fig. 1, A) has its point of greatest divergence about midway between the base and the tip, differing in this respect from *A. tenerum* (fig. 1, C), which has its point of greatest divergence about one-third of the length of the seed from the tip. The lemma and the palea of the latter species flare out more or less at this point, thus making the seed look flattened and thin. In the majority of cases the seed is unsymmetrical in shape, the top portion of the glumes being affected by a lateral displacement, as shown in the illustration. This makes possible a quick and accurate determination of a bulk lot of seeds of *A. tenerum*. The seed of *A. smithii* (fig. 1, B) has the same general shape as that of *A. repens*, but it is larger and has a more robust appearance.

RACHILLA

It is impossible to describe very definitely the characteristics of the rachilla of the different species of *Agropyron* because of the variation. In a general way the sides of the rachilla of *A. repens* are more nearly parallel, and the rachilla itself is more or less appressed to the palea. In *A. smithii* the sides of the rachilla diverge noticeably more from the point of its attachment. The rachilla stands out more prominently from the seed, being materially different in this respect from *A. repens* (fig. 2). The rachilla of *A. tenerum* has no particularly characteristic shape, varying from the slender to the short, stout, diverging type. A very good idea of relative size and shape of these seeds may also be gained by studying Plate XXXVII, which shows typical seeds, together with a typical spikelet of each of the three species.

The hairs clothing the rachilla constitute a valuable character used in the determination of the seed. However, care and good judgment must be exercised because of the great variation which may occur.

The characteristic rachilla of *A. repens* (fig. 1, A) is sparsely covered with short, minute hairs having a rather large base. Occasionally a glandular structure may be discerned at the base. This, however, can only be seen with a high-power lens and is not considered of sufficient
importance to warrant its use as a determining character. No rachilla of *A. repens* has been found which had the hirsute character of *A. smithii* (fig. 1, B) or the pilose character of *A. tenerum* (fig. 1, C).

The rachilla of *A. smithii* is characterized by hairs of the same general shape as the hairs found on the rachilla of *A. repens*. They are, however, larger and stronger and the number is noticeably greater. This characteristic is fairly uniform.

The rachilla of *A. tenerum* is characterized by hairs of a pilose nature. They are long as compared with those of *A. repens* and *A. smithii*, and may often be distinguished by this feature alone from these two species, as the pilose nature has never been observed on them. However, an absolutely authentic specimen of *A. tenerum* has been examined which had a rachilla much resembling that of *A. repens*. The hairs were short, but were not as large as the base. Other characters on the seed, however, made it possible to place it accurately in the species *tenerum*.

**LEmma**

Another distinguishing character and one which is reliable as to uniformity may be found at the base of the lemma on the ventral side of the seed. In *A. tenerum* (figs. 2, C, and 3, C) there is a line of hairs which extends from the base of the rachilla on the dorsal side of the seed around and entirely across the face of the lemma on the ventral side near the base of the seed. In some cases it may be impossible to distinguish the hairs on the middle of the lemma, but the surface of the lemma at this point is roughened sufficiently so that it is noticeable. This is a fairly definite character.

The seed of *A. repens* (figs. 2, A, and 3, A) has no such characteristic line of hairs, but the basal portion of the lemma is entirely smooth and shiny. This character in the seed of *A. smithii* (fig. 3, B) is somewhat variable and is therefore not of much value. Most commonly, however, it is found that the ring of hairs extends part way around on either side, and on the middle of the lemma there is a space which usually is entirely smooth.
PALEA

The part of the seed which discloses good and reasonably definite characteristic differences is the palea. The face of the palea in *A. repens* and *A. tenerum* (figs. 1, A, and 1, C) is practically glabrous, except near the tip, where it is puberulent. Occasionally there is a small number of hairs distributed over the face of the palea. Since the tips of the paleae in both of these species are always puberulent, this cannot be used as a distinguishing character. The palea of the seed of *A. smithii* (fig. 1, B) is quite hirsute over its entire surface.

The hairs on the edge of the palea have a distinctive shape for each of the three species and are very useful as a determining factor. Those of *A. repens* (fig. 4, A) are rather short, stout, and somewhat blunt. Those of *A. smithii* (fig. 4, B) are about as coarse as those on *A. repens*, but are noticeably longer, thus making them appear more slender. On *A. tenerum* (fig. 4, C) the hairs are finer, closer together, and more acutely pointed than in the case of the two others.

The palea of *A. smithii* (fig. 1, B) has a very characteristic tip, which character runs fairly uniform throughout the species. The tip of the palea is definitely divided, making a well-defined cleft (Pl. XXXVII, 2, a). In some cases it is rather difficult to distinguish this cleft, as the lobes may be slightly overlapped. The tips of the palea of *A. repens* and *A. tenerum* are simply rounded or only slightly indented.

**SUMMARY**

It is possible by careful examination to distinguish in commercial seed mixtures the seeds of the three species of Agropyron: *A. repens*, *A. smithii*, and *A. tenerum*.

There is no one character which can unfailingly be relied upon for this diagnosis, but the combined characters of lemma, palea, and rachilla are necessary for a safe determination.

Probably the nearest approach to a single critical structure is found in the palea, which exhibits fairly definite characters in each of the species. The diagnostic differences are summarized in Table II.
TABLE II.—Diagnostic differences of *Agropyron* spp.

<table>
<thead>
<tr>
<th>Character</th>
<th><em>A. repens</em></th>
<th><em>A. smithii</em></th>
<th><em>A. tenerum</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape of seed</td>
<td>Boat-shaped</td>
<td>Boat-shaped</td>
<td>Widest one-third of distance from the tip, which is more or less flattened.</td>
</tr>
<tr>
<td>Palea Face</td>
<td>Puberulent at tip; otherwise glabrous.</td>
<td>Hirsute over entire face.</td>
<td>Puberulent at tip. Remaining surface glabrous.</td>
</tr>
<tr>
<td>Edges</td>
<td>Characterized by short, stout, and blunt hairs.</td>
<td>Hairs stout, but longer than those of <em>A. repens</em>.</td>
<td>Hairs fine, acute, and close together.</td>
</tr>
<tr>
<td>Tip</td>
<td>Rounded or indented</td>
<td>Usually with a break in the line of hairs on ventral side.</td>
<td>Rounded or indented.</td>
</tr>
<tr>
<td>Lemma</td>
<td>Smooth and shiny at base on ventral side.</td>
<td></td>
<td>Line of hairs extends across lemma at its base.</td>
</tr>
</tbody>
</table>

LITERATURE CITED


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PLATE XXXIV

*Agropyron repens*: Spikes showing degrees of variation which may occur. A, typical spike. A side view of this spikelet may be seen at top portion of this spike. Natural size.
PLATE XXXV

Agropyron smithii: Spikes showing degrees of variation. A, typical spike. Natural size.
PLATE XXXVI

Agropyron tenerum: Spikes showing degrees of variation. A, typical spike. Natural size.
PLATE XXXVII

*Agropyron* spp.: Typical seeds and spikelets. Enlarged.

Fig. 1.—*Agropyron repens*.
Fig. 2.—*Agropyron smithii*.
Fig. 3.—*Agropyron tenerum*. 