Classification of Wheat Varieties
Grown in the United States
in 1949

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NEED FOR CLASSIFICATION

The varieties of wheat grown in the United States show a great diversity of type. This diversity is natural, as wheat is produced commercially in most of the 48 States under a wide range of environmental conditions. More than 200 distinct varieties are grown. Many of these are adapted only locally, whereas others are well adapted to a wide range of varying conditions. Adaptation of varieties is an important factor, as it affects the yield and profitableness of the crop and the standardization of varieties. The choice of varieties for specific conditions and purposes is therefore usually given careful consideration by growers. The choice is partly dependent, however, upon the determination of identity.

The identification of varieties requires some knowledge of the appearance of plant and kernel and is assisted by information regarding history or distribution. Wheat varieties are most generally designated by names, which are established through publication and usage. Confusion in names is frequent in the United States, where the number of varieties is very large. This confusion occurs in two principal ways: (1) The same name is applied to distinctly different varieties in different parts of the country, and (2) the same

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variety is grown under several different names in different parts of the country or even in the same area. Identification is difficult in cases of similar or closely related varieties and is confused by the multiplicity of names. Inability to identify varieties leads to duplication in varietal experiments and the fraudulent or unknowing exploitation of old varieties under new names.

There is need, therefore, for a practical and usable system of classification that will standardize the varietal nomenclature and enable growers to identify varieties with which they are concerned. The purpose of this bulletin is to provide such a classification of the wheat varieties that are grown commercially in the United States or may be so grown soon. The classification has been made by using only such characters as can be distinguished by the naked eye, no instrument other than a measuring rule having been used in the investigations. The names of varieties have been standardized insofar as practicable in accordance with a code of nomenclature.

PREVIOUS INVESTIGATIONS

Foreign Classifications

The existence of many different varieties of wheat has been recognized for more than 2,300 years. Theophrastus (306, p. 167), a pupil of Plato, in his Enquiry into Plants, written about 300 B.C., states:

There are also many kinds of wheat which take their names simply from the places where they grow, as Libyan, Pontic, Thracian, Assyrian, Egyptian, Sicilian. They show differences in color, size, form, and individual character, and also as regards their capacities in general and especially their value as food.

Theophrastus mentioned many of the differences between these kinds of wheat. In the writings of Varro, Pliny, and Columella, in the first century B.C. and the first century A.D., the observations of Theophrastus were repeated, rearranged, and amplified. The following notes, based on the writings of Varro and others, as well as those of Columella, were presented in the translation, in 1745, of Columella’s book entitled “Of Husbandry” (62, p. 60):

Triticum, common bare wheat, which has little husk upon it, was, according to Varro, a name given formerly to all sorts of grain beaten or bruised out of ears by trituration or threshing; but afterwards it was given to a peculiar species of grain, of which there are many sorts, which take their name from the places where they grow; as African, Pontic, Assyrian, Thracian, Egyptian, Sicilian, etc., which differ from one another in colour, bigness, and other properties, too tedious to relate. One sort has its ears without beards, and is either of winter or summer. Another sort is armed with long beards, and grows up sometimes with one, sometimes with more ears. Of these the grains are of different sorts; some of them are white, some reddish, some round, others oblong, some large, others small. Some sorts are early ripe, others late in ripening; some yield a great increase, some are hungry, and yield little; some put forth a great ear, others a small. One sort stays long in the hose (folliculo); another frees itself very soon out of it. Some have a small stalk or straw; others have a thick one, as the African. Some are clad with few coats, some with many, as the Thracian. Some grains put forth only one stalk, some many stalks. Some require more, some less time to bring them to maturity. For which reason some are called trimestrian, some bimestrian; and they say, that, in Euboea, there is a sort, which may be brought to perfection in 40 days; but most of these sorts, which ripen in a short time, are light, unfruitful, and yield very little, tho’ they are sweet and agreeable to the taste and of easy digestion.

In the early Roman literature mentioned, reference is found to two groups of wheat; namely, triticum and adoreum, or far. Col-
umella referred to the far as bearded wheat. The grain of *Triticum* was separated from the chaff in threshing, whereas that of far was not, indicating that the former consisted of true wheats, but the latter was emmer or spelt.

Columella recognized three types of *Triticum*, *robos* (red), *siligo* (white), and *trimestrian* (spring), and in addition four types of bearded wheat (spelt or emmer), viz. (62, pp. 61-62):

Clusinian, of a shining, bright, white colour; a bearded wheat, which is called *venuculum*. One sort of it is of a fiery red colour, and another sort of it is white; **. The *trimestrian seed*, or that of 3 months' growth, which is called *halicastrum* **.**

It is evident from these quotations that many of the leading characters of the wheat plant were recognized in this early period. What attention was given to studies of wheat during the Dark Ages no one can say. With the revival of learning the botanists and medical men began the publication of the folio and royal octavo herbals, many of them illustrated with woodcuts. In these, wheat species were included, the forms mostly being those described by Theophrastus, Pliny, and Varro, but from time to time new ones were added. There is little advantage in trying to guess what particular form of common wheat each so-called species represented. More recent botanical writers described species that can now be recognized. Principal among these writers was Tournefort (209), who in 1719 listed 14 species of *Triticum*.

The classification of wheat practically began with the work of Linnaeus in 1753. In his Species Plantarum (134, p. 85) he described seven species of *Triticum*: *T. aestivum*, *T. hybernum*, *T. turgidum*, *T. polonicum*, *T. spelta*, and *T. monococcum*, the species *T. polonicum* having been added. Linnaeus divided the common wheat into two species—*T. aestivum*, awned spring, and *T. hybernum*, awnless winter—apparently believing that all spring wheats were awned and all winter wheats awnless. Writers who followed him usually have not recognized these distinctions.

Lamarck in 1778 (127) created the species *T. sativum* to include both the species *T. aestivum* and *T. hybernum* that Linnaeus had adopted. Each species and sub-species was described according to the presence or absence of awns, the color and covering of the glumes, the color, size, and density of the kernels, the solidity of the stem, and several other characters.

Villars in 1787 (214-) divided the common wheats into two species, *T. vulgare* and *T. touzelle*. The latter consisted of awnless wheat having white kernels.

Schrank in 1789 (182, pp. 387-389) arranged the cultivated wheats in three species. For common wheat he established the name "*Triticum cereale*" and placed *T. aestivum* and *T. hybernum* under it as varieties. The second species was *T. spelta* and the third *T. dicoccum*. Schrank, the cultivated emmer.

Desfontaines in [1798] (67, p. 114) established the species *T. durum* for the group of wheats having long awns and long vitreous kernels.

Host in 1805 (107, v. 3) was the first to include the *T. aestivum* and *T. hybernum* of Linnaeus as one species under the name *T. vulgare*. Host's name *T. vulgare* is still com-
monly used by geneticists, agronomists, and cereal taxonomists for the species _T. aestivum_. He also described and named the species _T. compactum_ to include the club wheats (107, v. 4) and in addition recognized 10 other species of the genus _Triticum_ (107, v. 3, v. 4).

Seringe in 1818 (187) arranged the common and club wheats together into 10 groups, based on lax or dense and awned or awnless spikes, white or brownish kernels, and glabrous or pubescent glumes. He listed varieties from Switzerland, France, Germany, and England.

Metzger in 1824 (141), at Heidelberg, followed essentially the same system as Seringe, but in addition considered winter or spring habit of growth. The 10 groups of Seringe were further subdivided, making 18 groups. The kernels were described as white, yellow, and reddish.

Metzger in 1841 (142) reedited his classification of 1824, making some changes and adding more varieties.

Seringe in 1841 (188) published a revision of his previous work of 1818, in which he classified and partly described a large number of varieties of wheat.

Alefeld in 1866 (7) classified the wheats into two genera and species, _Triticum vulgare_ and _Deina polonica_. The latter contained four subspecies or varieties of Polish wheats, _T. polonicum_, and the former was divided into many subspecies and varietal groups containing all other species of _Triticum_. Each of these was described in detail.

Heuze in 1872 (99) grouped the wheats into 7 species. He listed 700 varietal names of wheat, 602 of which belong to the species _T. sativum_, which included both common and club wheats. He described 47 varieties in this species, and the remaining 555 names were considered as synonyms.

Körnicke in 1873 (125) and Körnicke and Werner in 1885 (126) prepared the most complete classification of wheat yet published. They followed Alefeld's system of applying Latin names to the botanical groups. The groups keyed by them included 22 of _vulgare_, 21 of _compactum_, 26 of _turgidum_, 24 of _durum_, 12 of _spelta_, 20 of _dicoecum_, 21 of _polonicum_, and 4 of _monococcum_. Named varieties included in each botanical group were described in detail, and the history, synonyms, and source of each were given. Much of this latter information had been published in the works of Alefeld and Heuze.

Harz in 1885 (94) classified and described a large number of wheats in a manner similar to that of Körnicke and Werner. The common and club wheats were considered as a single species.

Hackel in 1890 (91) classified the genus _Triticum_ according to a key very similar to the one adopted by Körnicke and Werner. Hackel recognized three species, _sativum_ Lam., _monococcum_ L., and _polonicum_ L.; and three races of _sativum_, namely, _spelta_, _dicoecum_, and _tenax_. In the latter he included _vulgare_, _compactum_, _turgidum_, and _durum_ as subspecies.

Vilmorin in 1889 (215) grouped the wheats into 50 sections, according to their leading characters. Each section was briefly described and the synonyms were given. The common and club wheats were considered as one species.

Eriksson in 1895 (74) subdivided the botanical groups of Körnicke and Werner into smaller groups, which he called subvarieties, based chiefly on the density of the spike, the thickness of the kernel, and the length of the rachis. He also gave an excellent review of the literature on wheat classification.
Heuzé in 1896 (100) published a second edition of his Les Plantes Céréales, in which rather complete histories and descriptions of the varieties of wheat were included.

Cobb in 1896 (57) keyed 54 varieties of wheat that he was growing in New South Wales, Australia, using the leading plant, spike, and kernel characters. In 1905 (60) he proposed to classify wheat varieties by a microscopic examination of the aleurone layer.

Howard and Howard in 1909 (109) classified the wheats of India largely according to the methods of Körnicke and Werner and of Eriksson. They (108) also considered in detail the characters used in classification.

Richardson in 1913 (171) described many of the wheats of Australia and gave the history of each variety. He did not arrange them in a classified order.

Flaksberger in 1915 (77) published extensive treatises on the taxonomy of Russian wheat forms.

The Union of South Africa in 1919 (182) published descriptions and synonyms of the wheat varieties of South Africa and also designated the areas where the varieties should be grown in that country.

Ducellier in 1920 (72) published a classification and description of the wheats of the Hoggar and oasis regions of Algeria. Only a few varieties were fully described.

The Institute of Science and Industry, of Australia, in 1920 (12) classified and described 48 of the leading wheats of Australia in a manner similar to that used by the writers of this bulletin.

Percival in 1921 (162) described and classified a large number of wheat varieties of the world and discussed fully the morphology of the wheat plant.

The Institute of Science and Industry, of Australia, in 1923 (13) revised and extended the classification of 1920 to include 82 varieties. Data were also presented on the agricultural characters of these varieties.

Zhukovsky in 1928 (233) described a new species, *T. timopheevi* Zhuk., which has 14 haploid chromosomes and is very resistant to several diseases.

Newman in 1928 (149) discussed the value of characters used by Clark, Martin, and Ball (48) for classifying Canadian varieties and reported extensive studies on the effect of environment on glume characters and on variability in Marquis seed stocks.

Papadakis in 1929 (158) published a classification of the wheats grown in Greece.

Miège in 1930 (144) described the principal varieties of common and durum wheat grown in Morocco.

Vavilov and associates in 1931 (213) published a contribution to the knowledge of the 28 chromosomes group of cultivated wheats.

Gurney in 1932 (90) published a key and detailed descriptions for the wheat varieties grown in South Australia.

Histories and descriptions and colored plates of heads of the wheat varieties developed by Strampelli are given in the appendix of a report by the National Institute of Genetics as Related to the Cultivation of Cereals in Rome in 1932 (200).

McMillan in 1933 (133) presented a genealogical chart showing the history of Australian wheat varieties.

Vasconcelos in 1933 (212) described the native and other varieties of wheat that have been grown in Portugal for a long period. Varieties of the following species were included: *vulgare, compactum, turgidum, durum*, and *polonicum*.

Voss in 1933 (219) described and grouped the wheat varieties of Germany.
Zhukovsky in 1933 (234) published a botanical classification of the wheat varieties of Anatolia.

Hudson in 1933 and 1934 (110) described and classified the wheat varieties of England.

Kalt in 1934 (118) described briefly the wheat varieties grown in Chile.

Flaksberger in 1935 (78, 79) presented the results of extensive studies on the origin and classification of the species and varieties of wheat of the world.

Jonard in 1936 (115) classified and gave the origin, synonymy, and description of the common wheats grown in France.

Newman, Fraser, and Whiteside in 1936 (150) classified and described the spring wheat varieties of Canada and gave a brief account of the origin and distribution of each. Their work was revised in 1939 and 1946.

Barbacki and coworkers in 1937 (20) classified and described the wheats of Poland.

Wenholz and others in 1938-41 (225), in a series of articles beginning in the November 1, 1938, issue of the Agricultural Gazette of New South Wales, gave a brief history of the named varieties of wheat grown in Australia.

Maugini in 1939 (140) described the wheats of Abyssinia and Eritrea, which included the following species: *dicoecum*, *durum*, *pyramidale* Perc., *turgidum*, *polonicum*, *vulgare*, and *compactum*.

Parrera and Palau in 1939 (159) classified, described, and gave a brief account of the origin of the wheat varieties grown in Argentina.

Flaksberger and coworkers in 1939 (80) revised and enlarged his earlier publications on the species and varieties of wheat of the world. He and his associates have given more attention to a study of the species of wheat than other recent workers, and his classification of the species of the genus *Triticum* is followed by the writers.

Patrón in 1940 (160) described 35 varieties of wheat grown commercially in Argentina.

The adaptation, disease reaction, quality, and a description of the varieties of wheat grown in Chile was presented by the Ministry of Agriculture (38) about 1941.

Horovitz (106) in 1945 described the principal varieties of wheat grown in Argentina.

Jonard in 1951 (116) presented the results of studies on the morphological and physiological characteristics and on the diseases of wheat. He also discussed the adaptation of varieties, presented keys for their identification, and described each variety.

**Domestic Classifications**

Harmon in 1844 (92) published descriptions and histories of about 30 varieties of wheat that he had grown in Monroe County, N. Y.

Klippart in 1858 (124) described a large number of wheat varieties grown in Ohio and grouped them into a partly classified order.

Todd in 1868 (208, p. 88) described a number of wheat varieties, most of the descriptions, however, being obtained from agricultural literature of the time. He suggested that the Government "take hold of this subject [the nomenclature of wheat] in a proper manner and establish a common standard of merit and an intelligible description of each variety ***".

Killebrew in 1877 (123) described a number of American wheats, most of which had been described previously by Klippart or Todd. He grouped the varieties into two families, winter wheats and spring wheats. The winter wheats were divided into six classes based upon their kernel characters, white, amber, and red, and upon the
awned or awnless character. The spring wheats, which were all regarded as being awned, were placed in three classes, with white, amber, or red kernels.

Tracy in 1881 (210) listed a number of wheat varieties grown by him at the Missouri Agricultural Experiment Station. The varieties were partly described, showing the "bearded" or "smooth" heads and the color and size of the kernels. He mentions several varietal names as being synonyms.

Devol in 1887 (68) and in 1888 (69) published a classification of the wheat varieties being grown at the Ohio Agricultural Experiment Station. This classification was further developed by Hickman (102), who in 1889 divided the varieties into eight morphological groups.

Plumb in 1889 (163) described a large number of wheat varieties, chiefly American, and gave the histories of many of them.

Blount in 1892 (22) listed 478 varieties of wheat that he was growing experimentally in New Mexico. Histories of some of these were given.

Carleton in 1900 (35) summarized the varietal information of that time, listed about 350 varieties, gave their source by countries and their principal characters, and grouped them by districts of the United States to which they were best adapted.

Scofield in 1902 (183) classified and described a large number of durum wheats grown in Algeria, many of which were introduced into the United States about 1901. He also described the characters used in classification. In 1903 Scofield (184) prepared a detailed list of characters to be used in the description of wheat varieties. He did not publish the descriptions of any varieties at that time. The application of the terminology was partly illustrated by plates accompanying the article.

Williams in 1905 (228) listed and partly described about 60 varieties of wheat that were under study at the Ohio Agricultural Experiment Station at that time.

Hume, Center, and Hegnauer in 1908 (111) briefly classified the wheat varieties grown in experiments in Illinois and gave the history and partial descriptions of some of the Russian and American varieties.

Scherffius and Woosley in 1908 (180) published illustrations of 36 varieties of wheat grown by the Kentucky Agricultural Experiment Station.

Noll in 1913 (152) presented a tabular description of varieties grown by the Pennsylvania Agricultural Experiment Station.

Leighty in 1914 (133) gave a list of the leading varieties of wheat grown in the eastern half of the United States, arranging them in classified groups by kernel and spike characters.

Schafer and Gaines in 1915 (178) recorded brief descriptions of the principal wheat varieties of Washington, together with their histories.

Nelson and Osborn in 1915 (148) gave a brief tabular description of the wheat varieties grown at the Arkansas Agricultural Experiment Station during the period from 1908 to 1914.

Reisner 3 in 1915 compiled much valuable information on the description and history of varieties grown in New York.

Ball and Clark in 1915 (14) presented keys to the groups of hard red spring wheat and the durum wheats grown in the United States and described and gave the histories of the more important varieties.

Carleton in 1916 (37) listed the

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leading wheat varieties of the world, including American varieties. They were grouped into the botanical groups used by Körnicke and Werner. No attempt was made to distinguish between the closely related agricultural varieties.

Stanton in 1916 (196) grouped a large collection of wheat varieties grown in experiments in Maryland and Virginia in accordance with some of the most obvious taxonomic characters.

Jones in 1916 (117) presented a brief key to the groups of common spring and durum wheats grown in experiments in Wyoming.

Ball and Clark in 1918 (17) published a key to the groups and varieties of durum wheat grown in the United States.

Grantham in 1918 (89) listed a large number of varieties that were being grown at the Delaware Agricultural Experiment Station and stated whether they were bearded or smooth, the color of the grain and chaff, the height of the plant, and the weight of the kernels.

Clark, Stephens, and Florell in 1920 (56) gave a tabular description of more than 150 samples of Australian wheat varieties grown in experiments in the Pacific coast area of the United States.

Clark, Martin, and Smith in 1920 (50) keyed the groups of common spring and durum wheat grown in experiments in the northern Great Plains area of the United States and gave the histories of the principal varieties.

Stewart in 1920 (198) presented keys and brief descriptions of the commercial wheat varieties grown in Utah.

Clark, Martin, and Ball in 1922 (48) presented detailed keys, descriptions, histories, distributions, and synonyms of the wheat varieties grown commercially in the United States.

Schafer, Gaines, and Barbee in 1926 (179) keyed and presented tabular descriptions of the wheat varieties of Washington.

Hill in 1930 (104) presented the results of a survey showing the percentage of the total production for the wheat varieties grown in each county in Oregon in 1929.

Gaines and Schafer in 1931 (85) presented results of a similar survey for Washington, giving the percentages of the total acreage and production for the varieties in each county in that State in 1929.

The Northwest Crop Improvement Association of Minneapolis, Minn. (H. R. Sumner, secretary), issued a Dictionary of Spring Wheat Varieties in the United States in 1933 (154). Revisions were issued (H. D. Putnam, secretary) in 1941 (155) and 1949 (156).

Gaines and Schafer in 1936 (86) presented results of a survey showing the production of the wheat varieties grown in each county in Washington in 1934.

Reitz in 1945 (168) gave detailed descriptions and enlarged drawings of the kernels of the important varieties of hard red winter and soft red winter wheat grown in Kansas.

Crawford in 1947 (63) gave the origin, distribution in 1946, description, and identifying characteristics and milling and baking characteristics of the varieties grown in the Pacific Northwest.

Dines in 1948 (70) studied the kernel characteristics of the hard red winter wheats and published very accurate and useful drawings and descriptions of each of the important varieties.

Summary of Previous Classifications

From the beginning of botanical classification there was a tendency to regard the different forms of *Triticum* as distinct species.
Toward the end of the 19th century, there became evident a tendency toward the more reasonable view that comparatively few species were involved and that the evident major groups were mostly to be regarded as subdivisions of the species *sativum* of Lamarck or *vulgare* of Host.

The designating of botanic species of wheat was carried to great lengths by the botanists of 100 to 200 years ago, who did not recognize that the characters sufficient to separate species of wild plants were sufficient to separate only agronomic and horticultural varieties of domesticated plants. Before this fact was recognized and botanists very largely had ceased to deal with the forms of cultivated plants, some 50 or 60 supposed species of wheat had been described. In the works of most of the botanists there was little effort to study and describe the farm varieties of wheat. However, Heuze, Körnicke and Werner, Eriksson, Richardson, and others described many varieties, and some of their descriptions were fairly complete. No attempt had been made, however, to show by detailed keys and by uniform descriptions the minor differences that separate closely related varieties.

There has been wide diversity among botanists in the taxonomic use of the various morphological characters of the wheat plant and seed. Only a few authors have given attention to the winter or spring habit of growth in wheat varieties. Some, as Eriksson, have placed undue importance on differences in spike density.

The classification of Körnicke and Werner (126) is the most extensive of the earlier studies and the first one that made a definite attempt to describe and classify foreign and domestic farm varieties. Although conservative as to the extent of reduction of the number of species, these authors still maintained a complete Latin nomenclature for forms as far as the fifth rank. They, as well as other early investigators, were handicapped by making their studies in only one locality. In the present work, the varietal descriptions are based on the expression of each variety under widely varying conditions of environment in the United States.

The recent work of Flaksberger and his associates (80) is an outstanding contribution to the classification of species and varieties of wheat throughout the world.

**PRESENT INVESTIGATIONS**

The present investigations were started in 1915 with the object of making a classification of the wheats of the world. During the first 2 years much time was devoted to a study of foreign varieties, and several hundred introductions were added to the large collection of foreign wheats previously obtained. In the third year the study was devoted largely to diverse botanical types obtained from hybrids or distinct types found as mixtures in wheatfields in the western part of the United States. It was soon found, however, that if the studies were to be of economic value they must be limited to the principal cultivated varieties. All available domestic varieties were first grown in classification nurseries, where they were studied, described, and classified, and herbarium specimens were prepared and preserved in a classified order. New varieties were added from time to time as soon as they became known, and each year varieties studied during the

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4 The plan to classify wheat varieties was evolved by Carleton R. Ball, then agronomist in charge of western wheat investigations, Office of Cereal Investigations, Bureau of Plant Industry.
preceding season, together with the new ones, were grown to allow comparisons. By this means the classification became more complete each year.

Clark, Martin, and Ball in 1922 (48) presented descriptions, histories, distributions, and synonyms of 230 varieties grown up to 1919. Clark and Bayles in 1935 (43) included 77 new varieties and omitted 68 of the 230 varieties no longer grown commercially in the United States, thus making a total of 239 varieties. A second revision in 1942 (44) included 50 new varieties and omitted 74 (43). Thus, a total of 215 varieties were discussed. The present revision includes 81 new varieties, and 72 of the varieties discussed in 1942 are omitted (44). Thus, a total of 224 varieties are discussed in this bulletin.

CLASSIFICATION NURSERIES

The classification nurseries were grown in widely separated areas of the United States. This was necessary in order to determine the development of varietal differences under many environments and thus provide a classification that would be usable wherever the varieties happened to be grown. It also served to guard against the loss of certain varieties.

During the years 1915–50, some 40,000 separate sowings were made at experiment stations in all parts of the United States. Nurseries grown from 1946 to 1950, preparatory to the revision of Technical Bulletin 795 (44), were sown at the Pendleton Branch Experiment Station, Pendleton, Oreg.; Washington Agricultural Experiment Station, Pullman, Wash.; Nebraska Agricultural Experiment Station, Lincoln, Nebr.; New York Agricultural Experiment Station, Ithaca, N. Y.; and Montana Agricultural Experiment Station, Bozeman, Mont. Plant characters and colors develop more distinctly at many points in the Western States, because summer rains are rare and growing conditions favorable. The nurseries were sown in short rows, usually not exceeding 5 feet in length and a foot or 18 inches apart (fig. 1). At the stations where all varieties were grown from both fall and spring sowing, each variety was seeded in the spring on one end of the row sown in the fall.

ASSISTANCE RECEIVED

The first important task was to obtain samples of the different wheat varieties. This was accomplished with the assistance of many individuals and institutions. The classification nurseries at the various stations usually were sown by local representatives. They also took notes on emergence, heading, ripening, and height of the many varieties. During the summer the writers visited the various points and took additional notes on the characters of the varieties. The descriptions of the varieties were written largely in the field, and from these descriptions keys were designed to distinguish the different varieties. The descriptions were checked and rechecked at the various points, and the different descriptive classes were established on a basis that is believed to be broad enough to include the varieties wherever grown.

NATURE OF THE MATERIAL

The early studies showed the necessity of working with pure types. When bulk seed was used it often consisted of mixed varieties, and a wrong description might easily become applied to a variety. The same variety was often represented by different lots of seed
FIGURE 1.—Wheat-classification nursery: A, Varieties of winter wheat grown from (1) spring and (2) fall sowing; B, varieties of spring wheat grown from (1) spring and (2) fall seeding.
obtained from different sources. These lots were identified by different C. I. numbers, which are accession numbers of the Division of Cereal Crops and Diseases. The varieties, however, have always been known by names rather than by numbers. The records also show the source of the seed and the original source of the variety. After different seed lots of the same variety were grown for a few years, one was selected as the standard for the variety. The descriptions here recorded, therefore, should represent the true type of the variety. In certain cases, however, material was limited to samples obtained from only one or two sources; in these cases, the judgment of the writers in selecting the strain to represent the variety may not be so accurate as in instances where more samples of the same variety were available.

Some varieties here described are badly mixed in commercial fields wherever they are grown. Mention of this sometimes is made in the descriptions. This may account for differences observed between a variety as commonly grown and its description as here recorded. In other cases, all the characters here recorded may not become apparent in some localities, and this may cause some confusion. The failure of stem and glume colors to develop in some sections is an example of this.

Natural crossing between wheat plants occurs quite commonly in some sections of the United States. This natural crossing has caused some difficulty in describing varieties, especially since hybridization between closely related varieties could not always be detected.

Several hundred mixtures obtained from experimental plots and commercial fields were grown in the classification nurseries for identification. A few proved to be mechanical mixtures of varieties grown in the locality, but most of these were new types. These probably originated, for the most part, from natural hybrids, with possibly an occasional mutation. Many of the types continued to segregate, thus proving their hybrid origin. Many of them closely resembled commercial varieties but were not identical in all characters.

Nearly every field of wheat contains some plants that cannot be identified. Many of these, in all probability, are the result of natural hybrids.

**DESCRIPTION, HISTORY, AND DISTRIBUTION**

For each variety this bulletin gives the description, the history so far as known, the distribution in the United States, and the synonymy.

**DESCRIPTION**

The detailed descriptions, which include the more important taxonomic characters, contain much more information than do the keys. The descriptions are intended to be sufficiently inclusive to provide a comprehensive knowledge of the different varieties.

Following the description of many varieties is a paragraph showing the chief characters that distinguish the variety from closely related ones. Mention is also made of known resistance to diseases and of high- or low-baking properties or other qualities.

**HISTORY**

The history of the origin of varieties cannot be neglected in a classification, as many varieties are scarcely or not at all distinguishable, by observable characters, from similar or closely related varieties and differ only in their origin and
other qualities. In this study much attention has been given to the history of varieties, and to many readers it probably will be the most interesting and valuable part of the classification. The compiling of these histories has required a review of the literature on wheat varieties written during a period of more than 200 years. The sources of this information are varied. Introductions of foreign varieties have been recorded by the Division of Plant Exploration and Introduction, Bureau of Plant Industry, Soils, and Agricultural Engineering. Frequent reference is made to the accession numbers and published inventories of that Division. Many bulletins of the State agricultural experiment stations contain valuable information on the origin of domestic varieties. Agricultural papers have been reviewed, and much information as to the origin of varieties has been obtained from that source. There is still much to learn concerning the origin of cultivated varieties. The origin of many probably has never been recorded; but for others, though their origin has not been determined, there is probably a recorded history somewhere. The origin and history of the varieties that have appeared in recent years are much more complete than for the older varieties.

**DISTRIBUTION**

The commercial distribution, production, and grain quality of different varieties are the economic factors with which this classification is concerned. Those varieties that are most widely grown usually are the most valuable. Varieties that are more productive may be in existence, but until they become known and widely grown they are of little value. New varieties are being produced continually. Some are of little or no value. Others are an improvement over the old standard varieties, as their use improves the quality or increases the efficiency of production.

To determine the acreage and distribution of the commercial varieties of wheat in the United States, surveys have been made at 5-year intervals since 1919 in cooperation with the Bureau of Agricultural Economics. The methods of conducting the surveys and the results have been published (45, 48, 49, 52-55). By means of these surveys a record of the increase of new varieties and the decrease of old varieties is made possible.

In 1919, 1924, 1929, 1934, 1939, 1944, and 1949, respectively, 139, 152, 190, 213, 208, 216, and 199 distinct varieties were reported. In the 7 surveys 353 distinct varieties were reported. Maps are included to show the acreage distribution of the more important varieties, the county acreage having been used as a basis. The scale used on the varietal maps is 1 dot for 1,000 acres. A dot is shown in each county from which a variety was reported, even though less than 500 acres were grown in the county.

**VARIETAL NOMENCLATURE**

A standardized nomenclature is important because names are used by agronomic workers, growers, seedsmen, and the grain trade. The form and appropriateness of these names, therefore, are of general interest. It is desirable that they be short, simple, and appropriate, easily spelled, and easily pronounced. It also is desirable that a single name be accepted and used for each recognized variety.

The multiplication of names and other designations for crop varieties has sometimes been carried to extremes, resulting in great confusion. Some varietal designations
are merely descriptive phrases that are often long and cumbersome. Others are only numbers, which sometimes are equally long and cumbersome or are easily confused. Because of this condition, a code of nomenclature was proposed by Ball and Clark (18) and presented to the American Society of Agronomy at its annual business meeting on November 13, 1917. With a few minor changes, the code was adopted. It was also published in Department Bulletin 1074 and Technical Bulletin 459.

Since the adoption of this code simple names have been given to most of the new American varieties. Examples are Brevor, Cadet, Ceres, Forward, Mida, Nebred, Pawnee, Reward, Ridit, Thatcher, and Vigo.

**REGISTERED VARIETIES**

Through a cooperative agreement between the Bureau of Plant Industry, Soils, and Agricultural Engineering, and the American Society of Agronomy, the 230 varieties described in Department Bulletin 1074 (48) were registered (46) as standard varieties. Thirty-five additional varieties mentioned in Technical Bulletin 459 have also been registered as standard varieties (42). Eighty varieties that originated through introduction, selection, or hybridization have been registered as improved varieties (41, 47, 51).

**SYNONYMY**

Many varieties are known by several names. The names here used for the recognized varieties are the original names or the names now most commonly used or are the new or simplified names, as provided for by the code of nomenclature. All other names used for the varieties here described are considered synonyms.

**THE WHEAT PLANT**

The different cultivated varieties of wheat vary greatly in their habit, form, and structure, but all are annual grasses. The principal parts are the roots, culms, leaves, and spikes. There are two sets of roots—the first, or seminal or seed, roots, and the second, or coronal, roots which arise from the crown of the stem. The culm usually is a hollow, jointed cylinder comprising three to six nodes and internodes. The upper internode of the culm, which bears the spike, is called the peduncle. The leaves are composed of the sheath, blade, ligule, and auricle. The spike is made up of the rachis and spikelets, the latter in turn comprising the rachillas, glumes, lemmas, paleas, and the sexual organs (the three stamens and the single ovary with its style and stigma). Each of these parts may show distinct characters in different varieties. Those characters that do not vary in different varieties or are not readily observed are of little value in classification. The root characters, for example, cannot be conveniently used, and no attention has been given to them in this work. Other characters, such as those of the sheaths, ligules, and auricles, are not generally used because they show very slight differences in different varieties.

The keys and descriptions used here to identify varieties are based on characters that show constant differences and are therefore of value in identifying them.

**TAXONOMIC CHARACTERS**

Taxonomic characters of the wheat plant as have been found in the present study to be most useful are described in detail. The characters used to distinguish the different species, subspecies, and lesser groups in the genus *Triticum* are often of no higher rank than the
characters used to distinguish the cultivated varieties.

Because different strains, particularly of the older varieties, may differ slightly in some characters, the C. I. number of the particular strain described is given in the history of each variety.

In the preparation of the keys certain primary characters have been used in a regular sequence. Certain other characters are used to separate further the closely related varieties. For this purpose any character is used that serves to distinguish the varieties under discussion. The same characters are not necessarily used in two successive cases, and they are not used in any definite order. The general principle followed in the choice of characters was to progress from those most easily observed and most often occurring to those least easily observed or least often occurring. The principle governing the sequence of characters is to progress from the absence of the character, as awnlessness, to the presence of the character, and from the smaller size to the greater.

The descriptions of the wheat varieties are arranged in a logical order of plant development. The major and minor characters used in the key are included in their proper places in the descriptions, as are many minor characters not used in the keys.

All the characters used in the keys and the descriptions of cultivated varieties are considered in the following paragraphs in the order of their appearance in the descriptions.

PLANT CHARACTERS

Certain plant characters that are genetically different in the several varieties are of value for classification purposes. These are the habit of growth, the period of growth, and the height of the plant.

HABIT OF GROWTH

All wheat varieties are here classified as having winter habit, intermediate habit, or spring habit of growth. In the keys to the cultivated varieties this character occupies the seventh and last major position.

Varro (in Columella, 62), writing before the beginning of the Christian era, called the spring wheats trimestrian, because they matured in 3 months from sowing. Linnaeus (134) treated them as separate species in his Species Plantarum, but combined the awned factor with the spring habit in his species aestivum and the winter habit with the awnless factor in his species hibernum. Few agronomic writers have recognized these forms as distinct species. The existence of winter and spring forms has been recognized by most authors but recently has not been used as a character for separating species or even as an important character for separating varieties. When considering the United States as a whole, the writers regard these distinctions as less valuable for classification purposes than several spike and kernel characters, although the winter- or spring-growth habit is a very important separation in some areas. In the southern part of the United States, both east and west, several varieties of spring wheat are fall-sown, and growers do not know whether they have a spring wheat or a fall wheat. The Purplestraw variety of the Southeastern States has a spring intermediate habit, although it has been grown from fall sowing in that section for more than 150 years. Nearly all the varieties grown in Arizona and

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2 C. I. refers to accession number of the Division of Cereal Crops and Diseases.
California are spring wheats, but they are fall-sown.

Winter, intermediate, and spring habits of growth are inherited characters. They are the characters shown first in the descriptions, as they are first apparent in the growth of the plant. In the keys the wheats having a winter habit are listed before those having a spring habit, because there are more fall wheats than spring wheats and because fall wheat is of much greater importance in this country than spring wheat.

The intermediate types retain a prostrate habit of growth in most localities when sown late in the spring, but will head normally when sown early. Some early winter-wheat varieties also have a short prostrate or dormant period and, when early spring-sown, begin heading soon after intermediate wheats have headed. There are also certain varieties of wheat grown commercially that are mixtures with respect to growth habit. The different classes for growth habit are not clear-cut, as there is a more or less complete series of types from true winter to spring and their expression depends upon temperature, length of day, and date of seeding. However, for the varieties reported in this bulletin the differences have been carefully determined by sowing varieties on one or more dates in the spring and observing their behavior. Varieties classified as winter wheats do not produce seed when sown at normal dates for spring seeding. Winter wheats can be produced successfully in the principal wheat areas of this country only from fall sowing. When spring-sown they usually remain prostrate on the ground throughout the growing season and produce no culms or spikes. In some sections or in some years, winter-wheat varieties, sown very early in the spring, will head and produce seed, but heading in such cases is often irregular and usually occurs very late in the season.

All varieties of wheat classified as spring wheats can be grown successfully from fall sowing only in mild climates, such as the southern parts of the United States and in the Pacific Coast States. In parts of this territory they sometimes winterkill. When spring-sown their early growth usually is erect.

**TIME OF HEADING AND RIPENING**

The relative dates on which varieties head and ripen when sown at the normal time in regions where they are adapted are useful in identifying varieties. The heading date ordinarily is more useful than the ripening date. The relative order of maturity is indicated by classing varieties as early, mid-season, or late. The relative time of heading and ripening is somewhat dependent on time of seeding and also varies somewhat in different areas. More than usual caution, therefore, must be exercised in making use of these characters.

**HEIGHT**

The height of the plant also is often an important factor in wheat production, because it may determine the method or ease of harvesting and the susceptibility of varieties to lodging. Height is measured from the surface of the ground to the tip of the spike, not including the awns of awned varieties. All varieties of wheat have been placed in three classes—short, mid-tall, and tall. These are characters of minor value for classification and are used only for separating or distinguishing otherwise closely related varieties.

Since plant height influences susceptibility to lodging, several new varieties bred for resistance to lodging have short stems. Although there was formerly a widely
held opinion that tall plants were essential for the production of high yields in wheat, varieties with short stiff straw have been developed recently in several sections of the country that outyield the taller varieties. The principles governing the grouping of varieties as early, midseason, and late apply here also. As an example, under California conditions wheats from 12 to 36 inches in height would be classed as short, wheats from 24 to 48 inches in height would be called midtall, and wheats from 36 to 60 inches high would be considered tall. In many sections of the country these differences would not be so great. In order to use the height of the plant for classification, the height of certain varieties must be determined and used for comparison. There are also cases where the relative height is changed when the varieties are grown in different sections of the country; for example, some of the club wheats are usually short when grown east of the Rocky Mountains but relatively tall when grown west of these mountains.

STEM CHARACTERS

Three characters of the stem of wheat varieties are useful in classification; namely, color, strength, and degree of hollowness.

COLOR

All varieties of wheat are here classified as having white or purple stems. These characters are of minor importance in classification, for in many localities and in some seasons the purple color common to a large number of wheat varieties does not become apparent. This is often the case under conditions of extreme drought and also under conditions of excessive moisture. Under favorable conditions, however, this stem color may be clearly seen for a week or 10 days prior to maturity. When apparent, the color differences are very useful in distinguishing varieties. The color is usually most distinct on the peduncle, or uppermost internode supporting the spikes, but often continues downward to the sheaths of the lower leaves.

Those varieties here described as having white stems may have a stem color ranging from a cream to a golden yellow. Few, if any, have stems that are truly white.

The varieties classed as having purple stems may have a stem ranging in color from a pale violet to a dark purple. In some varieties this coloring may occur only in a short portion of the peduncle. It sometimes does not occur in the peduncle and is present only in the sheaths. Körnicke and Werner (126) used color differences in describing many of the varieties with which they worked. Heuze (100) pointed out two contrasting characters, which he called "white" and "reddish."

STRENGTH

The strength of the stem usually is an important character. In many localities lodging is one of the most serious problems in wheat production, as many varieties lodge under conditions of excessive moisture. All varieties here discussed are classified into three groups, having weak, midstrong, or strong stems, respectively. Stems classed as weak are also usually slender, with very thin walls. Varieties with such stems have a greater tendency to lodge, which in turn causes harvest losses and increases the cost of harvesting. The successful cultivation of weak-stemmed varieties usually is limited to semiarid or arid regions.

The varieties classed as having
midstrong stems usually will not lodge under conditions where wheat is grown extensively. In this class are included the greatest number of varieties. A considerable variation exists within this group, and in humid or irrigated sections varieties here described as having midstrong stems might more properly be classed as weak. In dry-farming sections certain of these stems might more properly be classed as strong.

The varieties here described as having strong stems are those that will not lodge readily under excessively humid conditions. Only by severe rain, by hail, or by windstorm can the stems of these varieties be bent or broken down. Comparatively few of the cultivated wheats come in this class.

HOLLOWNESS

The stems of most varieties of wheat are solid at the nodes, but the internodes are hollow. Some varieties of durum and poulard wheat and a very few of common wheat have stems that are solid or nearly so in the internodes. It has been found that in some cases hollowness is associated with resistance to the wheat stem sawfly.

LEAF CHARACTERS

The principal parts of the leaves of wheat plants are the sheath, blade, ligule, and auricle. None of these parts usually show differences that are of even minor value for distinguishing cultivated varieties.

The blades of wheat varieties vary considerably in their dimensions, in the shade of green color, and in the angle to the culm maintained during the successive periods of growth. These differences, however, are usually apparent during only a short period. As the plant matures, the blades dry and frequently break off. In this bulletin very little use is made of leaf characters. A few varieties are noted as having especially broad or narrow blades. The presence or absence of pubescence on the leaves is a useful character in identifying plants of some varieties.

Körnicke and Werner (126) and others have described the color of the blades of both the seedlings and the partly grown plants. This also was attempted in the present studies, but the differences were found to be so slight and unpredictable that no definite classes could be established by using the character. Few persons can agree as to the various shades of green shown by the blades of wheat, even when a standard color chart is used. The color varies with the condition of the plant as affected by the temperature, the soil moisture, and the soil solution. The appearance of the color is changed by the character of the venation and of the blade surface. The plants appear to have a different color in the sunlight from that in the shade, and the value changes also according to the position of the observer with regard to the direction of the rays of the sun.

In general, the hard red winter wheats have dark-green blades, whereas all durum varieties have blades with a light-green color.

The blade widths are mentioned in describing only a few varieties, because nearly all varieties are very much alike in this character. The hard red winter wheats are distinctly narrowleaved, and the soft varieties, like Sol and Red Russian, have wide leaf blades. Winter varieties having the narrowest blades usually are most resistant to low temperatures. The length of the blade has not shown sufficiently constant differences for taxonomic purposes.

The terminal leaf or flag leaf of
some varieties of wheat is erect and in others it is drooping at various angles. These differences are greatest just previous to the heading period but frequently are not apparent a few days later. Chiefly because of the instability of this character, it is not used in this classification. In some varieties like Hard Federation and White Federation the flag leaf is curled or twisted, whereas in most varieties it is flat.

The sheaths normally enclose about the lower two-thirds of the culm, although in dry seasons the spike sometimes is not entirely exserted. The edges of the sheath overlap on the side opposite the blade. The sheaths may be either white or purple. During early growth they usually are quite scabrous, but they become smoother at maturity. There are some differences in these characters in the cultivated varieties, but they are few and minute. After a careful study the writers decided not to include any sheath characters in the descriptions.

The same decision was reached in regard to the minute differences observed in the ligules and auricles. The ligules usually are short, varying from 1 to 2 mm. long and becoming lacerate as the plant matures. Auricles always are present on wheat leaves. They are narrow to midwide, usually strongly curved, with a few long strigose hairs on the outer margin. The auricles often are purple in the young stage, sometimes changing to white as the plant matures.

SPIKE CHARACTERS

The entire inflorescence on one culm is called the spike. It is made up of separate groups of flowers known as “spikelets.” These are borne singly on alternate sides of a zigzag, flattened, channeled, jointed rachis, parallel to its flat surface. At the base of each spikelet, on the apex of each rachis joint, a tuft of short hairs usually occurs. These hairs may be white or brown in color, but the differences are difficult to distinguish, partly because the hairs frequently are discolored.

Spikes differ greatly in form and degree of compactness. Club wheats (Triticum compactum) have been separated from common wheats (T. vulgare) principally because of their distinctly compact or dense spikes.

In distinguishing the cultivated varieties, five spike characters are used. These are awnedness, shape, density, position, and shattering of the spikes.

AWNEDNESS

Awns are sometimes of importance agriculturally and are usually the character most readily apparent. For these reasons awnedness is given precedence over all others in preparing the keys. Some earlier writers, as previously stated, used this character for separating so-called species.

Varieties are separated into two major groups on the basis of the awnedness character, namely, awnless to awnleted, and awned. As a minor character in the key and in the descriptions the awnless to awnleted group is subdivided into awnless, apically awnleted, and awned. The awn types are shown in figure 2, A. Awnless varieties have no awnlets or very short apical awnlets. Apically awnleted varieties have short awnlets 1 to 15 mm. long at the apex of the spike. Awnleted varieties have awnlets 3 to 40 mm. long, the shorter ones occurring near the base of the spike and the length increasing toward the apex. The length of the awnlets and their relative number is given.
Figure 2.—Wheat varieties: A, Awn types—(1) Supreme, (2) Onas, (3) Thatcher, and (4) Ceres; B, spike shapes—(1 and 2) fusiform, (3 and 4) oblong, (5 and 6) clavate, and (7) elliptical.
Awned varieties are those that have an awn or beard that terminates the lemmas on all spikelets. These awns usually increase in length from the basal part of the spike upward. In the common wheats, awns seldom, if ever, exceed 10 cm. in length. In durum and poulard wheats, however, they usually range from 10 to 20 cm.

SHAPE

Spikes differ greatly in shape, length, and width. They may be flattened parallel or at right angles to the plane of the face of the spikelets. Those flattened parallel to this plane are widest when seen in face view and can be said to be dorsoventrally compressed. The spikes of all varieties of common wheat are thus formed, except those that are clubbed at the tip, in which case they are only partly so. Spikes that are flattened at right angles to the plane of the face of the spikelets are narrow when seen in face view and may be described as laterally compressed. The club, durum, and poulard wheats are separated from the common wheats partly on the basis of having such spikes.

In general, spikes vary in length from 5 to 15 cm., but are usually 8 to 12 cm. long. They vary in width or thickness from 1 to 3 cm. The differences in length and width are not used in themselves, but are often combined with the spike shape in a compound descriptive word.

Whether dorsoventrally or laterally compressed, whether long or short, or narrow or wide, spikes are classified in the keys as having the following four general shapes—fusiform, oblong, clavate, and elliptical. These shapes are shown in figure 2, B. For all common wheats these shapes are determined from a face view of the spikelets and for all club, durum, and poulard wheats from an edge view of the spikelets.

Heuzé (100) used several different spike shapes as the leading characters in separating varieties within the species. The shapes mentioned, however, are here considered only as minor characters; nevertheless, they are very useful in distinguishing varieties.

Spikes classed as fusiform taper toward the apex or from the middle toward both base and apex. A majority of the varieties of common wheat have spikes of this shape.

Spikes described as oblong are usually uniform in width and thickness throughout the length of the spike but are always several times longer than wide.

Varieties classed as having clavate spikes are clubbed, that is, distinctly larger and more dense at the apex. This is caused by a shortening of the rachis internodes in that part of the spike, which results in a change from dorsoventral to lateral flattening and a broadening of the upper part of the spike.

Elliptical spikes are short and uniformly rounded at both the base and apex but are flattened on the sides. Most varieties of club wheat have spikes of this shape.

In the descriptions of varieties these designations of spike shapes have sometimes been modified to take into account the length and width of the spikes and the overlapping of shapes that occurs in some varieties.

Spikes that are usually long are described as linear fusiform, linear oblong, or linear clavate. If spikes are unusually short, that fact is included in the description. Broad spikes may be described as broadly fusiform, broadly oblong, or broadly clavate; and narrow spikes as narrowly fusiform, narrowly oblong, or narrowly clavate.

Varieties that are nearly intermediate between any of the shapes are sometimes described as oblong fusiform or oblong to subclavate.
By the use of these compound descriptive terms spike shapes are more accurately presented in the description than they can be in the keys, where brevity is imperative.

**Density**

The differences in shape of spikes shown above are the result in part of differences in density. All spikes are described as of three density classes—lax, middense, and dense. These are minor differences that are used to advantage in distinguishing varieties. Seringe (187) separated the common wheats into two groups, having lax and dense spikes, respectively. Körnicke and Werner (126) described the spikes of many varieties according to different degrees of density. Neergaard (146) suggested a formula for use in measuring the density of the spike. Eriksson (74) subdivided the botanical groups of Körnicke and Werner on the basis of density into subvarieties called laxum, densum, and capitatum. He measured the density of spikes by determining the number of spikelets in 100 mm. of rachis length. Heuze (100) used the spike density along with spike shape as the leading character in separating varieties. Boshnakian (25) described means of measuring density and suggested the name *Triticum compacto-capitatum* for varieties of club wheat having clavate heads.

Many measurements have been made by the writers to determine the difference in density of the spikes of the varieties here described. The most definite differences were found comparable at 1 station for 1 year, but otherwise these measurements were of little value. It was found necessary to establish density classes of rather indefinite limits. In this way allowance was made for the varying conditions. The density classes were fixed as lax, middense, and dense by determining the number of millimeters occupied by 10 internodes of the rachis measured in the center of the spikes. By this method spikes are classed as·lax when 10 internodes occupy from 50 to 75 mm., as middense when 10 internodes occupy from 35 to 60 mm., and as dense when 10 internodes occupy from 20 to 45 mm. A majority of the varieties are included in the middense class, which, according to the above measurements, overlaps both the dense and lax classes by two-fifths of their entire range.

**Position**

The position of the spike at maturity is often distinctly different in different varieties. Spikes are here described as erect, inclined, or nodding. Heuze (100) used essentially these same distinctions in describing his varieties.

Those varieties described as having erect spikes mature with the spike in an approximately vertical position. The spikes of these varieties seldom, if ever, are inclined more than 15° from the vertical at maturity. Spikes of varieties that are described as inclined usually mature at an angle of approximately 15° to 45° from the vertical, but sometimes are nearly erect and under some conditions will become slightly nodding. The majority of wheat varieties come within this class. Varieties that are described as having nodding spikes usually mature with the spike in a drooping position, the apex of the spike being lower than the base. Spikes of such varieties sometimes are only inclined if they are not well filled with grain when ripe.

**Shattering**

Glumes of different varieties vary in the tenacity or firmness of attachment to the rachis, in the
tightness with which they clasp the kernels, and in size in relation to size of the kernels. These and possibly other characters cause varieties to differ greatly in their resistance to shattering. The durum varieties usually do not shatter easily. Most commercial varieties of common and club wheats are resistant, but some varieties are subject to loss of grain by shattering if allowed to stand in the field after they reach maturity. Such varieties are not adapted for harvesting with the combine. This character is usually mentioned only for the varieties that shatter easily.

GLUME CHARACTERS

The unit of the spike is the spikelet. It consists of several flowers or florets attached alternately to opposite sides of a central axis or rachilla. These flowers, two to five in number, are subtended by two empty scales, called the glumes, the keel of each glume terminating in a tooth or beak. Each floret consists of a flowering glume, called the lemma, and a thin two-keeled glume, called the palea. These two glumes enclose the sexual organs. The lemma encloses the back, dorsal, or outer portion of the mature kernel, and in the awned varieties it terminates in an awn. The lemma itself is of little or no use in classification. The palea protects the inner or crease side of the kernel. It differs from the lemma in having its back instead of its face toward the rachilla or axis of the spikelet. Like the lemma, it is not used in distinguishing varieties. The outer glumes, however, are much used.

The covering and coloring of the glumes are major characters of the second and third place, respectively. The length and width of the glumes also are used but are of only minor importance.

COVERING

Glumes of all varieties here discussed are described as glabrous or pubescent (fig. 3). Host (107, v. 4).

![Figure 3.-Glume covering: a, Glabrous; b, pubescent. (X 1 and X 3.)](image)

Glumes described as glabrous are without any covering of hairs. Those described as pubescent are more or less covered with hairs of varying length. Pubescence usually is readily apparent. The degree of pubescence varies in the different varieties. On some the hairs are much longer and more numerous than on others. Glumes of some durum varieties are partly glabrous and partly pubescent but are classed as pubescent. In such varieties the pubescence is most often found on the edge of the glumes.

COLOR

Differences in glume color were early recognized. Lamarck (127)
used these distinctions in classifying varieties. Glume color is here used as a major character and occupies third position in the key because of the distinct differences that are readily apparent when the plants are mature. This is also in accord with the usage of Körnick and Werner (126). All glumes are classed as white, yellowish, brown, or black.

Glumes classed as white may vary in color from a cream or pale-straw color to a dark yellow. Practically no glumes are without color. Within the class, however, there are two rather distinct shades. Some taxonomists have classified them separately as white and yellowish. In the present bulletin, however, both shades are placed in the same class and described only by the term “white” except in the case of the durums, which are classed separately as white and yellowish. In the descriptions the glumes of some varieties of common wheat are described as being yellowish white, indicating a darker glume than those described as white. A few varieties have white or yellowish glumes with brown or black stripes or nerves, or the glumes are sometimes tinged on the edges with brown or black. Such varieties are placed in the white-glumed class and the peculiar markings are indicated in the descriptions. The Blackhull variety has glumes that usually are tinged with black but sometimes are almost entirely black. The Rudy variety has black stripes along the edges of the glumes.

Glumes of durum varieties classed as yellowish are much darker than those of the common wheats classed as white but similar to those described as yellowish white. This yellowish class, therefore, is quite distinct. It may range in color from yellow to buff.

The brown-glumed class usually is still darker than the yellowish class and may vary in shade from light to dark brown and bluish brown, and in some varieties there is a reddish or mahogany tinge. For the latter reason some taxonomists have used the term “red,” but in the present work the writers prefer the term “brown,” as it more accurately describes the glume color of the class as a whole.

There are no commercial varieties grown in the United States having glumes that are entirely black.

**LENGTH**

Glume length is used as a minor character in the varietal descriptions. Usually small-kerneled varieties have short glumes and large-kerneled varieties long glumes, but there are exceptions to this. The glumes are usually about three-fourths the length of the lemmas, although in some long-glumed varieties the glumes and lemmas more nearly approach the same length. Polish wheat (Triticum polonicum) has glumes as long as or longer than the lemmas and is separated from the other species principally on this distinction. The length of the glume is here described as short, midlong, or long. These length differences are illustrated in figure 4.

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*Figure 4.—Glume length: a, Short; b, midlong; c, long. (× 1 and × 3.)*
Houze (100) and Scofield (184) used essentially these same terms. Most varieties of wheat have mid-long glumes. A few varieties, however, are distinct in having either short or long glumes. Short glumes may have lengths varying from 6 to 10 mm. Midlong glumes may vary from 8 to 12 mm, and long glumes from 11 to 15 mm. The glumes of Polish wheat exceed this latter measurement and are described as very long.

WIDTH

The width of glumes is used in the same manner as the length. All glumes are described as being narrow, midwide, or wide (fig. 5).

These differences were pointed out by Scofield (184). The width of the glume is here determined across its center from the keel to the margin of the outer side. Narrow glumes may vary in width from 2 to 4 mm., midwide ones from 3 to 5 mm., and wide ones from 4 to 6 mm. The differences are small and much overlapping of the classes occurs. Wide glumes nearly cover the lemma at the point of measurement, whereas narrow glumes usually cover less than a third of it.

SHOULDER CHARACTERS

The shoulder as here considered is the more or less rounded end of the glume from the beak to the lateral margin, including the part referred to by Körnicke and Werner (126), Hackel (91), and others as side teeth. Scofield (184) applied the name "shoulder" to this part of the glumes.

Considerable variation exists in shoulder width and shape in different varieties and also in different spikes of the same variety and even among the glumes on a single spike. Although variable, they are of some value in classification.

WIDTH

The shoulder widths often differ from the glume widths. For this reason they are described separately but on the same basis of measurement and by the use of the same terms—narrow, midwide, and wide (fig. 6).

SHAPE

Shoulder shapes are described in overlapping terms that allow for a considerable variation, which is nearly always present in the same spike. The terms used are wanting, oblique, rounded, square, elevated, and apiculate (fig. 7).
BEAK CHARACTERS

The word “beak” is used here for the short projection that terminates the keel of the outer glume. In some varieties it approaches an awn in appearance. Scofield (184) first used the term “beak,” previous authors having referred to it as a tooth or point. The beaks vary in width, shape, and length. These characters are of considerable importance in identification and are used in the descriptions of the varieties.

WIDTH

Beak widths are described as narrow, midwide, and wide (fig. 8). The average beak is only 1 mm. wide, so the variations are very small, and general observation is the only basis for describing them. Those that are wider than the average are called wide and those that are narrower are called narrow.

SHAPE

The apex of the beak varies considerably in shape. It is described as obtuse, acute, and acuminate (fig. 9). Obtuse beaks are blunt at the apex. Acute beaks come to a point at the apex. Acuminate beaks are narrowly and
very sharply pointed. All awned spikes have acuminate beaks.

LENGTH

Beak lengths are quite variable, especially in the awned varieties, and are considerably influenced by environment. In general, conditions that increase or decrease the length of the beak affect nearly all varieties to a similar degree. In the awnless, apically awnleted, and awnleted wheats the differences in length are not great, but in many varieties they are quite distinct. The length of the beak is measured from the shoulder of the glume upward. On most awned wheats the length increases from the base of the spike to its apex. The range of difference varies greatly with the variety. For this reason no single measurement is used in describing the lengths, but instead the average maximum and minimum lengths are given. None of the awnless varieties here described has beaks longer than 3 mm. Variations in beak lengths are shown in figure 10.

COLOR

In the key to the varieties of durum wheat the awn color is used as the fourth major character. This method was followed by Körnicke and Werner (126). For the other species and subspecies the awn color is used only as a minor character. All awns are described as white or black. The white class may include yellowish shades, and the black class may include shades of brown and blue. Few varieties of common wheat have really black awns.

LENGTH

The length of the awn in awned varieties is of slight value in classification. No attempt has been made in these studies to separate these varieties into classes with respect to awn length. In all descriptions, however, the average extreme lengths are recorded in centimeters.

KERNEL CHARACTERS

The kernel color, length, and texture are the most constant of all the kernel characters. These are used as major distinctions. The shape of the kernel is considered of only minor importance, as are certain differences of the germ, crease, cheeks, and brush.

COLOR

Kernel colors were early recognized as important characters in
separating varieties. Most varieties were observed to have either white or red kernels but were sometimes regarded as being yellow or brown. The kernel color was used by Körnicke and Werner (126) and by Vilmorin (215) as one of the leading taxonomic characters of wheat. Heuze (100) and Körnicke and Werner have indicated various shades of white or yellow and of red in the descriptions of the kernel color. Eriksson (74) believed that white wheat becomes red and states that the color of grain is useless in distinguishing a variety. Cobb (57) arranged the wheats he was growing according to the color tint from lightest to darkest. Howard and Howard (109, p. 228) regard the wheat kernel as being either white or red. They state that “the particular tone of colour depends partly on the consistency of the grain.” Hayes, Bailey, Arny, and Olson (96) proposed the use of the terms “red” and “white” in describing the presence and absence of a brownish-red pigment in the bran layer. The use of the modification “light red” was suggested where the degree of pigmentation was less than usual in the red wheats. Three varieties of Abyssinian wheat having violet-colored kernels were mentioned by Körnicke and Werner (126). The writers have grown purple-kerneled wheats from Ethiopia (Abyssinia), but they are not considered in the present classification.

Kernels of all varieties are grouped into two classes, described as white and red, and, as in the glume colors, many different shades are present. In general, however, the two classes distinctly separate all wheats.

Kernels of the white class may vary from cream to yellowish, or they may be white, without pigment. White or faintly pigmented kernels may appear to have different shades of yellow color because of differences in texture of the endosperm.

Kernels of the red class may vary from light brown to the darker shades of red. The variations are due to varietal differences and environment. Differences in texture, due to varying conditions, may cause “yellow berries,” which sometimes give the kernels a mottled appearance. Some samples have been received for identification in which kernels appeared to be partly red and partly white. This condition has been found to be the result of environment, as such kernels produce plants with only red kernels.

Many writers have classed some varieties as “amber.” This usually refers to a white kernel having a translucent or vitreous endosperm. The term “amber” is used to designate a certain subclass of durum wheat in the United States official grain standards. Until recent years hard red kernels sometimes were referred to as amber-colored. The word “amber” also has been used as a part of a varietal name, such as Martin Amber, which is a soft white wheat, and Michigan Amber, which is a soft red wheat. Because of this ambiguity and because wheats usually are either red or white, the word “amber” is not used in this bulletin in describing wheat kernels.

LENGTH

The length of the kernel is used as a major character in distinguishing varieties.

Körnicke and Werner (126), in their descriptions of wheat varieties, indicated the average length and width of the kernels in millimeters and the average number of kernels in 10 grams. The kernels were described as very small, small,
large, and long. Heuze (100) described the kernels as short, medium, or long. The size of the kernels of any variety varies when grown in different sections or in different years in the same section. From necessity, therefore, the limits of the classes in which varieties are placed must be overlapping. A kernel of wheat reaches its maximum length several days before ripening. The length, therefore, is fairly constant, even when it is considerably shrunken, and is the most valuable of the kernel dimensions for taxonomic purposes. In making measurements only the normal kernels should be used. The kernels from the tip spikelets on a spike and from the upper florets in the spikelet are below average length.

In the keys two classes are made, namely, kernels short to midlong and kernels midlong to long. In the descriptions three classes—short, midlong, and long—sometimes are mentioned separately. These kernel lengths are shown in figure 11.

![Figure 11](image)

**Figure 11.**—Kernel lengths: a, Short; b, midlong; c, long. (Upper row, x 3; lower row, x 1.)

The short to midlong class includes varieties the kernels of which measure within the limits of 4 to 7.5 mm. in length. The midlong to long class includes varieties the kernels of which come within the limits of 6.5 to 10 mm. For individual samples more definite limitation is possible. For this purpose the term “short” is used for kernels ranging from 4 to 6 mm. in length, “midlong” for those ranging from 6 to 8 mm., and “long” for those ranging from 8 to 10 mm.

**Texture**

The texture of wheat kernels is an important character in classification. It has an economic value, as most wheat is marketed in commercial classes, which are fixed largely on a basis of texture because hard wheats generally are better for bread making than soft wheats.

Two texture classes are used—kernels soft to semihard and kernels semihard to hard. Here, as with size, overlapping class limits were found necessary. In general, all wheat varieties can be classed readily in one or the other of these two groupings. In describing specific samples, and in individual description of varieties, three classes are used separately, as soft, semihard, and hard. A soft kernel is one that, when normally developed, has an endosperm entirely soft, mealy, or starchy. A hard kernel, when normally developed, has a corneous, horny, or vitreous endosperm throughout. A semihard kernel has an endosperm that is intermediate between the other two.

The species *Triticum durum* was so named by Desfontaines (67) because of the hardness of the kernels. Metzger (142) divided the white-kerneled wheats into two groups on the basis of texture, the starchy ones being considered as yellow. Körnicke and Werner (126) described the kernels of different varieties as being entirely mealy, nearly entirely mealy, partly mealy, partly glassy, mostly glassy, nearly entirely glassy, and entirely glassy. The texture of the same variety varied in different seasons.
These authors, as well as Eriksson (74), Fruwirth (83), and Howard and Howard (109, p. 232), conclude that kernel texture is useless as a varietal character and that it depends on environment. Hayes, Bailey, Arny, and Olson (96) suggest the terms corneous, subcorneous, substarchy, and starchy for describing the texture of the wheat kernel. The writers have concluded that because of the variability in texture under different environments one can separate varieties of wheat accurately into only two classes and fairly accurately into three classes. Soft-kerneled varieties grown under very dry conditions will sometimes become brittle and slightly subcorneous. When hard-kerneled varieties are grown under humid conditions or in soil deficient in nitrogen they sometimes become starchy, semistarchy, or mottled, the condition being designated as "yellow berry," and the kernels are then rather soft.

The difficulty of numerous investigators in determining the kernel texture has been caused by the failure to dissociate softness from starchiness or yellow berry. Freeman (82, pp. 224-225) has shown the nature of hardness in the wheat kernel. The following is quoted from his conclusions:

1. The hardness of a wheat is determined by the solidity of the grain, and this, in turn, by the nature and relative proportions of gluten and starch in the endosperm.

2. When the ratio of gluten to starch is sufficiently high, the entire cell contents are cemented together solidly as the grain dries out in ripening. It, therefore, takes on a hard, glassy, semitranslucent texture. In the absence of a sufficient proportion of gluten to hold the cell contents together, the shrinkage in drying does not fully compensate for the loss of water, and air spaces appear within the cells. These open spaces render the grain soft and, also, since they serve as refracting surfaces, make it opaque. We are, therefore, accustomed to associate softness, opaqueness, and low gluten content in wheats.

3. There are two types of soft grains among the wheats included in these experiments.
(a) A type designated by the writer as "true softness" in which the air spaces in the endosperm are diffuse and finely scattered. This type of softness is only slightly affected by environic conditions.
(b) A type commonly called "yellow berry," in which the air spaces within the endosperm occur in flake-like groups with quite definite margins. The opaqueness thus arising may be confined to a small spot only or may include the entire endosperm. This type of softness is very sensitive of environic conditions.

In this bulletin soft texture refers to the condition designated above as "true softness" and must not be confused with yellow berry.

True kernel texture, therefore, cannot be determined on yellowberry kernels, because they always are soft. It usually is possible, however, to select from a sample a few kernels that are not wholly starchy and that can be accurately used for texture determinations. Roberts (172) attempted to measure hardness mechanically by determining the crushing strength. This is not entirely accurate, as the shape of the kernel influences its crushing strength and, in addition, soft-wheat varieties grown under dry-land conditions are quite brittle and difficult to crush. The particle-size determination of Cutler and Brinson (65) and the pearling test of Taylor, Bayles, and Fifield (204) are useful in determining the texture of kernels of varieties. Texture in the present studies was determined by cutting kernels not affected by yellow berry and examining the endosperm.

SHAPE

The shape of the kernel is described as ovate, elliptical, or oval (fig. 12). These terms refer only to the outline of the kernel as viewed from the dorsal surface, and not to


The kernel as a whole. When egg-shaped in outline, the germ end being the broader, it is described as ovate. An elliptical kernel is one the length of which is more than twice the width and that has sides somewhat curved and both ends rounded. An oval kernel is broader, like the ovate, but with both ends of nearly equal width. Modifications of these shapes are indicated by describing kernels as narrowly or broadly elliptical, ovate, or oval, as the case may be. A few varieties, as Baart, show other characteristic shapes, which are given in the descriptions of these varieties.

Most kernels are classified as ovate, but in a few varieties a considerable part of the kernels may have one or the other of the shapes just noted. The shape of the wheat kernel is influenced by the position in the spikelet, the position in the spike, and the degree of plumpness. Boshnakiyan (26, P. 205) has shown that spikelet characters that affect the shape of the wheat kernel are mainly—

(1) The stiffness of the glumes, (2) the size and shape of the space in which the grain develops, (3) the number of grains in the spikelet and their position, (4) the density of the head, (5) the pressure caused by the growth of different parts of the head, and (6) the species which produces the kernel.

The kernels from the base or tip spikelets on the spike are shorter in proportion to width than the others. The kernels from club wheat or from the tip spikelets of clavate spikes of common wheats are usually laterally compressed or "pinched." Shrunken kernels usually have an elliptical shape because of being narrow. As the width of a kernel of wheat depends largely upon the degree of development of plumpness, this character has very little taxonomic value.

The tip, or brush, end of nearly all varieties is rounded, but the kernels of a few varieties, in which the tips are square rather than rounded, as seen from the dorsal view, are described as truncate. Kernels of a few varieties have acute or pointed tips, as seen in both dorsal and lateral views, and such tips are described as acute.

The shape of the kernel as seen in the lateral view is important in only a few varieties. Many varieties, especially durums and emmers, are more or less keeled on the dorsal surface. Normally the kernels of wheat, in dorsoventral diameter, are thickest near the base; just above the germ. In a few varieties the kernels are strongly elevated on the dorsal side of this basal portion and they are popularly known as "humped." That term is used in describing such kernels. When the dorsal portion is less keeled than normal the kernel is described as flattened. Where only the tip of the kernel is thus flattened it is described as having a flattened tip. The kernels of a few varieties when viewed from the side have a depressed dorsal surface about midway between the ends. This feature is referred to as sway-backed.

\[260503-54-\]
The shape of the kernel has been used as a distinguishing character by only a few authors. Könnike and Werner (126) recorded the lengths and widths of the kernels and referred to some as roundish or elongated. Eriksson (74) used the number of kernels in 100 mm., placed side by side, to indicate the width of the kernel. This character is, however, of value only in comparing varieties grown under identical conditions. Heuze (100) described the shape of kernels of each variety, using such terms as elongated, short, angular, compressed, ovoid, oblong, and swollen. Scofield (184) suggested 16 descriptive terms to be applied to the shape of wheat kernels. Wheat kernels cannot be accurately described according to shape unless they are normally developed, that is, neither shrunken nor excessively plump.

GERM CHARACTERS

The size and shape of the germ, or embryo, of the wheat kernel have seldom been used as characters in classification. After examining thousands of samples, the writers have concluded that the size of the germ is one of the most constant of minor kernel characters. There is considerable variation among the individual kernels of a bulk sample, but typical kernels of a pure variety have a characteristic size of germ. The germ is developed earlier than the endosperm and consequently is of almost normal size even in shrunken grain.

The germ is here described as small, midsized, or large (fig. 13). A small germ is one that occupies less than one-sixth of the area of the dorsal surface of the kernel or the area visible in dorsal view. A midsized germ occupies from one-sixth to one-fourth of the dorsal area of the kernel. A large germ occupies one-fourth or more of the dorsal area.

Figure 13.—Germ sizes: a, Small; b, midsized; c, large. (Upper row, × 3; lower row, × 1.)

The limits of the three size groups overlap. Most kernels have a midsized germ, so these characters are not much used in distinguishing varieties. For some varieties, however, they can be used to advantage.

CREASE CHARACTERS

The crease, or sulcus, on the ventral side of the wheat kernel is rather variable but is of value in distinguishing a few varieties. The chief taxonomic characters are the width and the depth. Shrunken kernels nearly always have a relatively wide and deep crease, whereas in extremely plump or yellow-berry kernels the crease is narrow and shallow, because the space beneath the bran is occupied by large starch cells and air spaces.

WIDTH

The width of the crease is determined by the distance between the crests of the cheeks on each side of the crease. Creases are described as narrow, midsized, and wide (fig. 14). A narrow crease is about two-thirds or less of the total width of the kernel in ventral view. The midsized crease, which is typical of most varieties, is usually about four-fifths of the total kernel width. A wide crease is almost the total width of the kernel.
The depth of the crease in this classification has been determined by an external examination rather than by a cross section of the kernel. The depth, therefore, is judged from the crest of the cheeks to the position where the crease is closed. No measurements of the portion of the crease below the surface of the kernel have been considered. Crease depths are described as shallow, middeep, and deep (fig. 15).

A shallow crease has a depth of 20 percent or less of the dorsoventral thickness of the kernel. A middeep crease has a depth of from 15 to 35 percent of the thickness of the kernel, and a deep crease has a depth of 30 to 50 percent of the thickness of the kernel.

The depth of the crease is of taxonomic value only when the kernels are normally developed and is a distinguishing character in only a few varieties. It is sufficiently constant, however, to be of use in describing varieties grown under identical and normal conditions. Nearly all of the durum and club wheats have a shallow crease. A few varieties of common wheat have been described as having a “pitted” crease. This is characterized by having a distinct opening near the center of the crease (fig. 15, d). The sides of the opening usually are wrinkled. The pitted character is most marked on the kernels of the Humpback (no longer grown commercially) and the Huston varieties.

CHEEK CHARACTERS

The cheeks of a kernel are the ridges along each side of the crease on the ventral surface of the kernel. The most distinguishing character of the cheek is the outline of the crest in cross section. This is rounded or angular (fig. 16). Extremely starchy (yellow berry) kernels always have rounded cheeks, whereas the cheeks of shrunken kernels are always angular. It is necessary, therefore, to examine normally developed kernels in order to recognize the differences. All of the durum wheats have angular cheeks. Most of the common wheats have cheeks that are more or less angular, but a few varieties, such as Turkey, consistently have rounded cheeks. There is no sharp distinction between the angular and the rounded cheeks.

BRUSH CHARACTERS

The brush of the kernel is the hair at the tip or the end opposite the germ. Cobb (59) described in detail the brush of 51 varieties of wheat grown in Australia.
SIZE

The size of brush refers to the area that it occupies on the kernel. It is described as small, midsized, and large (fig. 17). A small brush occupies only a part of the tip of the kernel. In kernels that are distinctly pointed at the tip, however, it may cover all of the end. A midsized brush covers the tip of the kernel. Nearly all varieties of wheat come within this class. A large brush is one that extends partly over the sides of the kernel, chiefly along the crease.

LENGTH

The length of brush refers to the average length of hairs, which are described as short, midlong, and long (fig. 18). In short brush the hairs are less than 0.5 mm. long, in midlong brush from 0.5 to 1 mm. long, and in long brush more than 1 mm. long. A few very long hairs may be present in a short brush.

All durum wheats and some varieties of common wheat, such as Red Bobs, have a short brush. Both size and length of brush are very constant characters, probably the most constant kernel characters aside from color and size. In machine threshing, part of the hairs of the brush frequently are removed.

COLLAR

The brush area of some varieties is here described as "collared" (fig. 17, d). Cobb (59) referred to this as an abrupt margin. This refers to the presence of a distinct raised collar or flange of bran along the margin of the brush area. This is most noticeable on shrunken kernels, but is very distinct on normal kernels of a few varieties, such as Goldcoin.

OTHER CHARACTERS

Several characters of wheat varieties of interest to growers cannot be observed in a morphological examination. These differences often are of great economic importance but, are of little value in classification. Following the descriptions of many of the varieties, therefore, other characters of importance, such as productivity, quality, resistance to low temperatures, and resistance to diseases and insects, are mentioned.

PRODUCTIVITY

A comparison of yield of different varieties of wheat is of value only when the varieties are grown under identical conditions, as side by side, on identical soil, and in one locality in the same season. Under certain conditions it is possible for almost
any variety to outyield all others, and consequently an expression of yield is of little taxonomic importance. Körnicke and Werner (126) recorded the yields of the varieties grown at Poppelsdorf in the description of each variety. In the present work the writers have mentioned productivity or yield of only those varieties that experiments have shown to be distinctly high or low in yield in certain areas.

QUALITY

Next to productivity, the value of wheat varieties for milling and for making bread, cake, pastries, macaroni, and other baking products is of the greatest economic importance, as these are the principal uses for wheat. Flour from hard red winter, hard red spring, and hard white varieties is used mostly for breadmaking. The soft white common, club, and soft red common varieties are used mostly for the manufacture of cake, cooky, pastry, biscuit, and cracker flours, for breakfast cereal products, or for bread when blended with high protein hard wheats. Durum varieties are used for macaroni and similar products. Varieties differ greatly in their usefulness for these various products. As with yield, these differences can be accurately determined only by careful experiments, conducted with comparably grown samples. The percentage of protein in grain is determined chiefly by the environment under which it is grown, but some varieties are consistently higher or lower than others. The quality of the protein is determined chiefly by variety. Where quality differences are known to exist they are pointed out, following the descriptions.

HARDINESS

Hardiness is the ability of the plant to resist low temperature, heaving, winter drought, and many other factors that may cause injury or death to the plant. In the case of winter wheats, resistance to low temperatures consists of the ability to survive low winter temperatures; in the case of spring wheats, it is the ability to resist injury from spring, summer, or fall frosts. Winterkilling in the hard red winter region is more commonly caused by low temperatures and drought, while in the more humid soft winter wheat region of the Eastern States it is often caused by heaving as well as low temperatures without snow cover. Following the varietal descriptions, the writers have indicated a few varieties that are known to be especially winter-hardy or nonhardy, but otherwise the character is not mentioned.

RESISTANCE TO DISEASE AND INSECTS

Wheat varieties are known that have more or less resistance to each of the many diseases of wheat and to some insects. Nearly all varieties of wheat herein considered have been grown in nurseries where they were inoculated either naturally or artificially with stem rust, leaf rust, stripe rust, bunt or stinking smut, loose smut, flag smut, powdery mildew, and mosaic or were exposed to infestation by hessian fly or greenbugs. Immunity and resistance can be determined when varieties are exposed equally to a disease or insect under conditions favorable for its development. When a variety is known to be resistant to a disease or some races or to an insect, this fact is noted following the varietal descriptions.

CLASSIFICATION OF THE GENUS TRITICUM

Wheat belongs to the grass family Gramineae (Poaceae) and to the tribe Hordeae, in which the one-to several-flowered spikelets are sessile
and alternate on opposite sides of the rachis, forming a true spike. Wheat is located in the genus *Triticum*, where the solitary two-to several-flowered spikelets are placed sidewise against the curved channeled joints of the rachis.

Wheat is characterized as a mid-tall annual grass with flat blades and a terminal spike. The spikelets are solitary, one- to five-flowered, sessile, arranged alternately on the nodes of a zigzag, channeled, articulate rachis; the glumes keeled, rigid, three- to several-nerved, obtuse, acute or acuminate; the lemma keeled or rounded on the back, many-nerved, ending in a single tooth or awn.

The following eight divisions of the genus *Triticum* were used by Hackel (91, pp. 180–187) and recognized by others for many years:

\[
\begin{align*}
&T. sativum L. \\
&T. tenax Schrank \\
&T. dicoccum Schrank
\end{align*}
\]

\[
\begin{align*}
&T. vulgare Vill. \\
&T. compactum Host. \\
&T. turgidum L. \\
&T. durum Desf.
\end{align*}
\]

\[
\begin{align*}
&T. polonicum L. \\
&T. monococcum L.
\end{align*}
\]

In recent years the species of wheat have been classified on the basis of chromosome numbers. Sakamura in 1918 (174) reported the numbers for each of the above species or subspecies and his counts have since been verified by Sax (177), Kihara (119, 120, 121), Watkins (224), and others.

New species of wheat have been described since 1920 and the classification of Flaksberger and co-workers, 1939 (80), includes all those known at the present time. The species recognized by Flaksberger, grouped according to chromosome number, with their common names used in the United States, are as follows:

**Diploid series**

14 chromosomes

- *T. spontaneum* Flaks., wild "einkorn.
- *T. monococcum* L., einkorn.

**Tetraploid series**

28 chromosomes

- *T. dicocoides* Körn., wild emmer.
- *T. timopheevi* Zhuk., timopheevi.
- *T. dicoccum* Schrank, emmer.
- *T. durum* Desf., durum wheat.
- *T. abyssinicum* Steud., Abyssinian wheat.
- *T. turgidum* L., poulard wheat.
- *T. polonicum* L., Polish wheat

**Hexaploid series**

42 chromosomes

- *T. spelta* L., spelt.
- *T. vulgare* (Vill.) Host (*T. aestivum* L.), common wheat.
- *T. compactum* Host, club wheat.
- *T. spheeroaxococcum* Perc., shot wheat.
- *T. macha* Dek. & Men., macha.
A translation of the key to the species of *Triticum* prepared by Flaksberger et al. (80) was given by Clark and Bayles (44, pp. 38-40).

**Spelt**

Spelt may be of either winter or spring habit and awnless or awned. It has a long, narrow, lax spike and a brittle rachis. The pedicel (internode of the rachis) is long and wide, and after threshing remains attached to the face of the spikelet below the one that it bears. The spikelets are two-kernelled, arched on the inner side, and closely appressed to the rachis. The kernels, which remain enclosed in the glumes after threshing, are pale red, long, and laterally compressed, and have an acute tip and a narrow, shallow crease.

Spelt is grown commercially only to a slight extent in the United States. Spikes, glumes, a spikelet, and kernel of the Red Winter variety of spelt are shown in figure 19, A.

**Emmer**

Emmer is often incorrectly called "speltz" in the United States. Emmer may be of either winter or spring habit and usually is awned. The culms often are pithy within, and the leaves usually are pubescent. The rachis is brittle. The spikes are very dense and laterally compressed, being narrow when viewed from the face of the spikelet and wide from the edge view. The pedicel (internode of rachis) is short, narrow, and pointed and remains attached to the base of the spikelet which it bears. The spikelets are flattened on the inner side and usually contain two flowers. The kernels, which remain enclosed in the glumes after threshing, are red or white, long, and slender, with both ends acute.

Emmer is distinguished from spelt by the shorter, denser spikes, which are laterally compressed. The pedicel of emmer is shorter and narrower and is usually attached to the base of the spikelet which it bears, whereas in spelt the pedicel remains attached to the face of the next lower spikelet. The inner side of the spikelet is flat instead of arched, and the kernel usually is darker red than that of spelt. A spike, glumes, a spikelet, and kernel of the Vernal variety of emmer are shown in figure 19, B.

In the United States only a very small acreage of emmer is grown, and it is used as feed for livestock.

**Poulard Wheat**

The poulard wheats may be of either winter or spring habit and usually are tall with broad leaves. The culms are thick, usually solid, but sometimes pithy. The spikes are long and occasionally compound or branched. The spikelets are compactly arranged on the spike, and the glumes are short and sharply keeled. The kernels are thick, humped, and mostly hard, but usually are very starchy (yellow berry). A spike, glumes, and kernels of the Alaska variety of poulard wheat are shown in figure 20, A.

The poulards are most closely related to the durums. The glumes and kernels usually are shorter and the kernels thicker in the dorsal-ventral diameter and are somewhat softer. In many instances the varieties of poulard and durum are so nearly alike that it is difficult to distinguish them.

Only a very limited acreage of poulard wheat is cultivated in the United States, and the grain is of no commercial value except as feed for stock.
Figure 19.—A, Red Winter spelt and B, Vernal emmer: Spikes and glumes, × 1; kernels, × 3.
Figure 20.—A, Alaska (poulard) wheat and B, timopheevi: Spikes and glumes, × 1; kernels, × 3.
**Polish Wheat**

Polish wheat has a spring habit, tall stems, and a pithy peduncle. The spike is awned, large, and lax. The glumes are papery, very long, and narrow. The length of the glume equals or exceeds the length of the lemmas. The kernel is long and narrow, sometimes nearly a half inch long, is hard, and has a shape somewhat similar to that of a kernel of rye. A spike, glumes, and kernels of the White Polish variety of Polish wheat are shown in figure 21, A.

Polish wheat usually yields less than other adapted varieties. It also is of inferior value for bread or macaroni manufacture. Polish wheat is seldom grown in the United States.

**Timopheevi**

Timopheevi wheat, which was only recently discovered by Zhukovsky (233), is of particular interest because of its resistance to several diseases of wheat. It is very highly resistant to stem rust, leaf rust, stinking smut, and mildew. The cytological studies of Kihara (122) have shown that it belongs to the emmer group but contains one genome not present in other species of *Triticum*. It is a late-maturing spring type. The grain does not thresh free of the glumes. The glumes are densely pubescent, and the leaves have hairs on both upper and lower surface. A spike, spikelets, and kernels of timopheevi are shown in figure 20, B.

**Einkorn**

Einkorn, or one-grained wheat, has no English name but is called einkorn in German, and that name has become fairly well known in North America. The spikes are awned, narrow, slender, and laterally compressed. The spikelets usually contain only one fertile floret, for which reason it is called one-grained wheat. The terminal spikelets are aborted. The palea splits into two parts at maturity. The kernels that remain in the spikelets after threshing, are pale red, slender, and very much compressed. The kernel crease is almost wanting. A spike, glumes, a spikelet, and kernels of einkorn are shown in figure 21, B.

Einkorn is not grown commercially in North America, and the species itself has no economic importance.

**Common Wheat**

In the Species Plantarum, Linnaeus in 1753 (134) first used the name *Triticum aestivum* for a part of the common and club wheats. This name originally referred to the awned spring forms. It has been given priority use by botanists for the name of the species more commonly recognized as *T. vulgare*. This name was applied to the common wheats by Host in 1805 (107, v. 3) when it became apparent that Linnaeus’ separations were not logical or correct. As the name *T. vulgare* is in general use among cereal agronomists the world over, the writers give preference to that form, which has also been accepted by Flaksberger and associates (80). Common wheat has pairs of 21 chromosomes and is distinguished from club wheat, which it most closely resembles, by a spike long in proportion to its thickness. The spike is usually dorsally compressed and is thus wide when seen in face view of the spikelets instead of narrow, as with those of some other divisions. The spikelets are two- to five-flowered, far apart, only slightly overlapping, pressed close to the rachis, and nearly erect. The glumes are keeled only in the upper half, shorter than the lemmas,
Figure 21.—A, White Polish (Polish) wheat and B, einkorn: Spikes and glumes, × 1; kernels, × 3.
firm, and either glabrous or pubescent. The lemmas are awnless or have awns less than 10 cm. long. The palea is as long as the lemmas and remains entire at maturity. The culm of the plant usually is hollow, but occasionally is pithy within, and varies in strength and height. The blades of the leaves are usually narrower than those of the durum and poulard wheats. The kernels may be either soft or hard and white or red.

The characteristic of common wheat of greatest economic value is its well-known quality for breadmaking, as common wheat excels all the other divisions of the genus in this respect. It is also the best known and most widely cultivated of all the species. The varieties are most nearly related to the club wheats (T. compactum.) These two divisions have the same chromosome number and cross readily. There are intermediate types that resemble both common and club wheats.

Common wheat is adapted to widely varying climatic conditions and possesses more diverse characters than any of the other divisions. The 204 varieties cultivated in the United States are distinguished by the accompanying key.

### KEY TO THE VARIETIES OF COMMON WHEAT

1a. Spike awnless to awnleted.
2a. Glumes glabrous.
3a. Glumes white.
4a. Kernels white (Triticum vulgare albidiun Alef.).1

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CLASSIFICATION OF WHEAT VARIETIES GROWN IN 1949

KEY TO THE VARIETIES OF COMMON WHEAT—Continued

1a. Spike awnless to awnleted—Continued
2a. Glumes glabrous—Continued
3a. Glumes white—Continued
4a. Kernels white—Continued
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| Susceptible to leaf rust. | Purplestraw | 76 |
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KEY TO THE VARIETIES OF COMMON WHEAT—Continued

1a. Spike awnless to awnleted—Continued
2a. Glumes glabrous—Continued
3a. Glumes short to midlong—Continued
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KEY TO THE VARIETIES OF COMMON WHEAT—Continued

1a. Spike awnless to awnleted—Continued
2a. Glumes glabrous—Continued
3b. Glumes brown—Continued

4b. Kernels red (T. vulgare miltura Alef.).
   Kernels short to midlong.  
   Winter habit.  
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   Spike fusiform.  
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   Spike fusiform.  
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   tall.  
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   Plant early.  
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   mm. long.  
   Plant midseason.  
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   Awnlets several, 5 to 25  
   mm. long.  
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   Kernels soft to semihard.  
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   Spike oblong; beaks acuminate.  
1b. Spike awned.
2a. Glumes glabrous.
3a. Glumes white.
4a. Kernels white (T. vulgare graceum  
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KEY TO THE VARIETIES OF COMMON WHEAT—Continued

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   2a. Glumes glabrous—Continued
      3a. Glumes white—Continued
         4a. Kernels white—Continued
            Kernels long.
               Kernels semi-hard.
               Spring habit.
                  Susceptible to rust and bunt: Baart
                  Resistant to some races of rust and bunt.
            4b. Kernels red (T. vulgare erythrospermum Koern.):
               Kernels soft to semi-hard.
               Winter habit.
                  Stem white.
                     Beaks 1 to 3 mm. long Gladdlen
                     Saline
                     Blackhawk
                     Beaks 2 to 8 mm. long.
                        Plant midtall Gipsy
                        Plant midtall to tall Royal
                        Plant tall
                           Valley
                  Stem purple.
                     Spike fusiform.
                        Beaks 1 to 3 mm. long Kawvale
                        Beaks 2 to 8 mm. long
                           Plant midtall.
                              Plant midseason Mammoth Red
                              Plant late Fulcaster
                              Plant tall
                                 Nudel
                                 V. P. I. 131
                     Spike oblong.
                        Beaks 1 to 2 mm. long Butler
                        Beaks 2 to 10 mm. long Nittany
                     Spring habit.
                        Beaks 2 to 10 mm. long Progress
               Kernels semi-hard to hard.
               Winter habit.
                  Stem white.
                     Plant very early.
                        Glumes white Triumph
                        Glumes white with black pigment.
                           Kernels short to midlong Wichita
                           Kernels midlong Early Blackhull
                     Plant early.
                        Glumes white.
                           Kernels short to midlong.
                              Beaks 8 to 5 mm. long Pawnee
                              Beaks 5 to 15 mm. long Ponca
                              Spike fusiform Westar
                              Spike oblong.
                                 Winter habit. Comanche
                                 Winter intermediate Quanah
                        Winter habit.
                           Kernels midlong.
                              Beaks 5 to 10 mm. long Apache
                              Glumes white with black pigment.
                              Kernels midlong.
                                 Beaks 2 to 3 mm. long Kiowa
See footnote at end of key.
KEY TO THE VARIETIES OF COMMON WHEAT—Continued

1a. Spike awned—Continued
  2a. Glumes glabrous—Continued
  3a. Glumes white—Continued
  4b. Kernels red—Continued
    Kernels short to midlong—Continued
      Kernels semihard to hard—Continued
      Winter habit—Continued
      Stem white—Continued
      Plant midseason.
      Glumes white.
      Stem white.
    Beaks 1 to 2 mm. long.
      Spike inclined
      Spike nodding
    Beaks 2 to 5 mm. long.
      Spike fusiform.
      Spike middense
      Spike lax
      Spike oblong to fusiform, dense.
    Beaks 2 to 8 mm. long.
      Spike fusiform, middense.
      Beaks 3 to 30 mm. long.
      Kernels short to midlong.
      Kernels midlong.
        Spike fusiform.
        Spike lax
        Spike middense.
        Glumes white
        Glumes yellowish.

Stem purple.
  Beaks 2 to 8 mm. long.
    Wisconsin Pedigree No. 2
  Beaks 2 to 25 mm. long.
    Spike inclined
    Spike nodding
  Glumes white with black pigment.
  Stem white.
  Beaks 1 to 3 mm. long.

Plant late.
  Spike lax, beaks 2 to 3 mm. long.
  Kernels midlong, semihard
  Kernels midlong to long, Stafford.

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CLASSIFICATION OF WHEAT VARIETIES GROWN IN 1949

KEY TO THE VARIETIES OF COMMON WHEAT—Continued

1b. Spike awned—Continued

2a. Glumes glabrous—Continued

3a. Glumes white—Continued

4b. Kernels red—Continued

Kernels short to midlong—Continued

Spring habit.

Spike fusiform.

Stem white.

Plant midseason.

Beaks 0.5 mm. long __________ Spinkcota _______________ 133

Beaks 1 to 5 mm. long.

Kernels short. __________ Sturgeon _______________ 133

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Spoke oblong to fusiform, stem white, plant early.

Kernels midlong to long.

Kernels soft to semihard.

Winter habit.

Stem purple.

Glumes white. __________ Nigger _______________ 140

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3b. Glumes brown.

'4a. Kernels white (T. vulgare erythroolecon Koern.).¹

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Kernels soft.

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Spring habit. __________ Sevier _______________ 141

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Kernels short to midlong.

Kernels soft.

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Winter habit.

Kernels short.

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  2a. Glumes glabrous—Continued
  3b. Glumes brown—Continued
  4b. Kernels red—Continued
     Kernels soft to semi-hard.

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1 The correct botanical name for common wheat is *Triticum aestivum* L. The trinomials made by Alefeld and others under *T. vulgare* cited in the key have never been transferred to *T. aestivum* and are quoted in the form in which they were originally published.

DESCRIPTION, HISTORY, DISTRIBUTION, AND SYNONYM OF COMMON WHEAT VARIETIES

YORKWIN

Description.—Plant winter habit, midseason, mid-stall; stem white, midstrong to strong; spike awned, fusiform to oblong, middense, inclined; glumes glabrous, white, short to midlong, midwide; shoulders midwide, oblique to square; beaks wide, obtuse, 0.5 mm. long; awnlets few, 5 to 15 mm. long; kernels white, midlong, soft, elliptical; germ midsized; crease midwide, middeep; cheeks rounded; brush midsized, midlong. (See fig. 22, A.)

History.—Yorkwin (C. I. 11855) was selected from a cross between Dietz (Fulcaster) and Goldcoin made in 1919. The last selection was made in 1924, and the strain was distributed to growers in 1936 (137). Prior to being named Yorkwin the strain was known as No. 254A1–101–19. Yorkwin was developed by the Cornell University Agricultural Experiment Station in cooperation with the United States Department of Agriculture. On account of its winter hardiness and high yield, Yorkwin became the leading variety in New York and Michigan.

Distribution.—Estimated area in 1949 was 1,107,530 acres (fig. 23).
Figure 22.—A, Yorkwin and B, Brevor wheats: Spikes and glumes, × 1; kernels, × 3.
Description.—Plant winter habit, mid­spason; stem glaucous, white, midstrong to strong; spike awnleted, oblong to fusiform, middense, erect to inclined; glumes glabrous, white, midlong, wide; shoulders wide, square to elevated; keel straight above; beaks wide, obtuse, 1 mm. long; awnlets few, 2 to 20 mm. long, somewhat incurved; kernels white, midlong, soft, ovate, acute; germ mid­sized; crease midwide, deep; cheeks rounded; brush small, midlong.

As grown commercially, Greeson contains a mixture of red kernels.

History.—Greeson (C. I. 6320) (reg. 64) was recorded by J. I. Wagoner, county agent of Guilford County, N. C. (220, p. 10). George Greeson of that county found a plant of wheat growing beside an old stump in his apple orchard in 1896. He increased the seed and distributed it under the name Wild Goose. After the death of Mr. Greeson in 1899, the variety was called Greeson.

Distribution.—Estimated area in 1949, 2,452 acres, grown in North Carolina.

Synonyms.—Gleason, Greensboro.

WHITE WINTER

Description.—Plant winter habit, late, mid­summer, midtall; stem white, very strong; spike awn­leted, oblong, dense, erect; glumes glabrous, white, midlong, broad at base; shoulders wanting to oblique; keel incurved above; beaks wide, obtuse, 1 mm. long; awnlets few, 3 to 20 mm. long; kernels white, short to midlong, soft, ovate, slightly humped; germ small.

The leaves of Brevor have a characteristic flecking, particularly noticeable after heading. It is resistant to 23 of the 25 races of common bunt and moderately resistant to the other two races, L-8 and T-16. It is moderately resistant to dwarf bunt. It averaged among the highest yielding strains in tests covering 4 years both on dry land and under irrigation in the Pacific Northwest. The kernels of Brevor appear uniform in texture. It has only fair milling quality but has good quality for bread, family, and cake flours.

History.—Brevor (C. I. 12385) was Selection 1-3-11-5 from a cross between Brevon, a selection from a cross between (Turkey-Florence X Fortyfold-Federation), and an F1 from the cross (Oro X Turkey-Florence) X (Oro X Fortyfold-Federation). The cross was made in 1938 at Pullman, Wash. (217). Brevor was released by the Washington Agricultural Experiment Station in cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, United States Department of Agriculture.
within the variety.

Crops and Diseases.

13) is the result of a cross of White Ham­
burg and Golden Drop, made by Cyrus

that there are several different strains

small crease wide, mid deep; cheeks usu­
ally white, midlong, soft, ovate, usually
awnlets.

season midtall to tall; stem white, weak

obtuse somewhat incurved, 1 mm. long;

awnlets few, 5 to 20 mm. long; kernels

white, midlong, soft, ovate; germ usually

small; crease wide, middeep; cheeks usu­
ally angular; brush midsized, midlong.

Defiance wheat is variable in many of

the characters above described, indicating

that there are several different strains

within the variety.

History.—Defiance (C. I. 6477) (reg.

19) is the result of a cross of White Ham­
burg and Golden Drop, made by Cyrus

G. Pringle, in the Champlain Valley, near

Charlotte, Vt., in 1871. It was first dis­
tributed in 1878 by B. C. Bliss & Sons, as

Pringle’s Defiance. It showed three dis­


tinct types of grain. A. E. Blount took

some of this wheat to the Colorado Agri­

cultural Experiment Station, where he
grew it during a number of years and

made careful selections. Three other

commercial varieties—Early Defiance,

Escondido, and Regenerated Defiance—
have been developed from it.

Distribution.—Estimated area in 1949,

1,488 acres, grown in Colorado.

Synonyms.—Pringle’s Defiance.

RINK

Description.—Plant spring habit, mid­
season, midtall; stem white, strong; spike
awnleted, broadly fusiform, mid­
dense to dense, inclined; glumes glabrous,

yellowish white, midlong, midwide;

shoulders wide, usually square; beaks

wide, acute, curved, 1 to 1.5 mm. long;

awnlets many, 2 to 10 mm. long, oc­
curring throughout the spike and dis­
tinctly incurved; kernels white, short

to midlong, soft, ovate, slightly humped;

germ usually small; crease midwide,

deep; cheeks rounded; brush midsized,

midlong to long.

This variety is distinct in having in­
curved awnlets throughout the length

of the spike.

History.—The origin of Rink (C. 1.

5868) (reg. 14) is undetermined. It

was reported to have been grown in

Washington County, Oreg., since 1909.

Distribution.—Estimated area in 1949,

959 acres, grown in western Oregon.

IDAED

Description.—Plant spring habit, early,

short; stem white, midstrong; spike

awnless, fusiform to oblong, dense, erect;

glumes glabrous, white, midlong, mid­
wide; shoulders midwide, oblique to

square; beaks wide, obtuse, 0.5 mm.

long; awnlets wanting; kernels white,

short, soft to semihard, ovate; germ

midsized; crease midwide, middeep;

cheeks angular; brush midsized, midlong.

History.—Idaed (C. I. 11706) was

developed in the coordinated wheat

improvement program of the State

agricultural experiment stations in the

western region and the Division of

Cereal Crops and Diseases. It resulted

from a cross between Sunset and Boadi­

cena (two Australian varieties) made

at Davis, Calif., in 1920. The hybrid

was carried in bulk until 1927 when a

number of heads were selected. Selec­

tion 20172 VII-I, which was later named
FIGURE 24.—A, Wilhelmina and B, Lemhi wheats: Spikes and glumes, × 1; kernels, × 3.
Idaed, showed considerable promise and was taken to Moscow, Idaho, for testing in 1931. Its value and adaptation were determined in the coordinated regional program. It was increased by the Idaho Agricultural Experiment Station and distributed in 1938.

**Distribution.**—Estimated area in 1949, 166,418 acres, grown in Idaho, Washington, and Oregon.

**LEMHI**

**Description.**—Plant spring habit, early to midseason, short; stem white, strong; spike awnless, oblong, dense, erect to inclined; glumes glabrous, white, midlong, midwide; shoulders midwide, oblique; beaks wide, obtuse, 0.5 mm. long; awnlets wanting; kernels white, short to midlong, soft, oval to ovate; germ midsized; crease wide, deep; cheeks rounded to angular; brush midsized, midlong. (See fig. 24, B.)

Lemhi combines the short stiff straw of Federation with the Dicklow characteristic of producing white flour low in carotenoid pigments. It is slightly earlier than Federation.

**History.**—Lemhi (C. I. 11415) was developed in cooperative investigations of the Idaho Agricultural Experiment Station and the Division of Cereal Crops and Diseases at the Aberdeen substation, from a cross between Federation and Dicklow made in 1921. The cross was grown in bulk until 1927 when heads were selected. The selection later named Lemhi was grown in the uniform irrigated nursery in the western region in 1931 and was so promising that it was made a uniform variety in field plots in 1935. It was released to growers in the irrigated districts of southern Idaho in the spring of 1939.

**Distribution.**—Estimated area in 1949, 202,256 acres, grown in seven States (fig. 25).

**ONAS**

**Description.**—Plant spring habit, early to midseason, short to midtall; stem white, strong; spike apically awnleted, oblong, dense, erect; glumes glabrous, white, short, wide; shoulders wide, oblique to square; beaks midwide to wide, obtuse, 0.5 mm. long; apical awnlets few, 0.5 to 5 mm. long; kernels white, short to midlong, soft, ovate; germ midsized; crease wide, middle; cheeks rounded; brush small, midlong. (See fig. 26, A.)

**History.**—Onas (C. I. 6221) (reg. 252) was developed (166) by F. Coleman, of Tuela, Saddleworth, South Australia, from a cross between Federation and Tarragon, the latter in turn from a cross between Improved Fife and Tardent's Blue. Onas was introduced from Australia by the United States Department of Agriculture (211, P. I. 46796) in 1918. After having been tested in cooperative experiments in the Pacific Coast States seed was distributed from University Farm at Davis, Calif., in 1923.

**Distribution.**—Estimated area in 1949, 49,661 acres, grown in California, Montana, and Wyoming.

**ONAS 41**

**Description.**—Onas 41 is resistant to several races of bunt but is otherwise similar to Onas.

**History.**—Onas 41 (C. I. 12229), which has the Martin factor for resistance to bunt, was developed in the backcrossing program of the California Agricultural Experiment Station. According to Sune son (201) it is a composite of 115 F₃ bunt-resistant lines grown in 1941 from the backcross (Martin-White Federation³) X Onas⁴. It was distributed in 1942 and probably comprised most of the acreage reported as Onas in California in 1949.

³ P. I. refers to accession number of the Division of Plant Exploration and Introduction (formerly Foreign Plant Introduction).
Figure 26.—A, Onas and B, Bunyip wheats: Spikes and glumes, \( \times 1 \); kernels, \( \times 3 \).
BUNYIP

Description.—Plant spring habit, early, midtall; stem white, strong; spike awnless, oblong, dense, erect; glumes glabrous, yellowish white (brown-striped), midlong, midwide; shoulders midwide, oblique to square; beaks narrow to midwide, acute, 0.5 mm. long; awnlets few, 3 to 12 mm. long; kernels white, midlong, soft to semi-hard, ovate; germ midsized; crease midwide, middeep; cheeks rounded; brush midmidsized, midlong.

The glumes of this variety are distinctly brown-striped, which sometimes gives it the appearance of a brown-glumed variety.

History.—Bunyip (C. I. 5125) (reg. 15) is an Australian variety originated by William Farrer, the well-known plant breeder of New South Wales, Australia. Its origin has been recorded (203, p. 189) as follows:

It is a crossbred, produced as the result of mating two other crossbreds, Rymer and Maffra, together. Rymer, the mother plant, was produced as the result of crossing Purplestraw [a white grain Australian variety] on to Improved Fife, the latter being a Manitoba variety. Maffra was the product of King's Jubilee, mated with an unnamed crossbred (Blount's Lambrigg X Hornblende). . . . The cross was made in 1897, and named in 1901.

Bunyip was first introduced into the United States (211, P. I. 38345) in May 1914 by the United States Department of Agriculture. In 1915 a sample of the variety was included in the Australian exhibit at the Panama-Pacific International Exposition at San Francisco, Calif. A part of this seed was obtained, together with that of several other varieties, by the Sperry Flour Co., and grown on their experiment station near Stockton, Calif. Of several varieties grown, Bunyip was selected as the most promising and was increased and distributed for commercial growing in California.

Distribution.—Estimated area in 1949, 13,541 acres, grown in California.

MARFED

Description.—Plant spring habit, midseason, midtall; stem white, strong; spike awnless, oblong to fusiform, lax, inclined; glumes glabrous, white, midlong, wide; shoulders midwide, oblique to rounded; beaks midwide, obtuse, 0.5 mm. long; awnlets few, 5 to 15 mm. long; kernels white, short, soft to semi-hard, ovate; germ midsized; crease midwide, middeep to deep; cheeks rounded; brush midsized, midlong.

Marfed is resistant to 13 of 25 races of bunt to which it has been tested and is moderately resistant to mildew. It has a good test weight, but some lots do not mill so well as Federation. Marfed, while a spring wheat, is slightly more winter-hardy than Federation and may be fall-sown in areas with mild winters. It has outyielded Federation, especially from late-spring seedings.

History.—Marfed (C. I. 11919) was developed by the Washington Agricultural Experiment Station in cooperation with the Division of Cereal Crops and Diseases from a cross between a Marquis-Florence selection and Federation made at Pullman in 1931. The selection, Washington 3348, which resulted in Marfed was made in 1936. Two thousand bushels were distributed in Washington for growing in 1947 (218).


CASCADE

Description.—Plant spring habit, midseason, tall; stem white, strong; spike apically awnless, oblong to fusiform, lax, inclined; glumes glabrous, white, midlong, wide; shoulders midwide, oblique to rounded; beaks wide, obtuse, truncate, 0.5 to 1 mm. long; awnlets several, 8 to 20 mm. long; kernels white, midlong, soft to semi-hard, ovate; some-

History.—Cascade (C. I. 12376) (C. A. N. 3593) (reg. 345) was developed by the Cereal Division, Central Experimental Farm, Ottawa, Ontario, Canada, from the cross [(Quality A-Pacific Bluestem) X C-26-59.2D] X Onas made in 1936 (81). The C-26-59.2D was a selection from a Hope × Reward cross. Cascade was licensed in Canada in 1947, distributed in 1948, and is recommended for growing in the eastern Provinces and in British Columbia.

PACIFIC BLUESTEM

Description.—Plant spring habit, late, tall; stem white, midstrong; spike awnless, linear-oblong, dense, erect to inclined; glumes glabrous, yellowish white, sometimes becoming a light brown, midlong, wide; shoulders wide, square to elevated; beaks wide, obtuse to truncate, 0.5 to 1 mm. long; awnlets several, 8 to 20 mm. long; kernels white, midlong, soft to semi-hard, ovate, some-
FIGURE 27.—A, Pacific Bluestem and B, Dicklow wheats: Spikes and glumes, × 1; kernels, × 3.
times becoming oval; germ midsized; crease midwide to wide, middeep; cheeks usually angular; brush midsized, midlong. (See fig. 27, A.)

This variety can be easily identified by its broad, square to elevated shoulders and broad, blunt beaks.

**History.**—Pacific Bluestem (C. I. 4067) (reg. 16) is an old wheat of the Pacific coast area, most commonly known as Bluestem and White Australian. The variety came to North America from Australia. White Lamma was the leading wheat variety of Australia during the earliest years of wheat production in that country. According to Cobb (58, p. 9), White Australian of California is identical with White Lamma. It apparently was introduced into the United States in the early fifties as White Australian or Australian. During the period from 1852 to 1866 (9, p. 138; 73, p. 586; 190, p. 176) its culture became established in California under the name White Australian. Bluestem is the name under which the variety became established in Washington and Oregon. According to W. P. Church, of Walla Walla, Wash., the wheat known as Bluestem in the section came from two introductions, the first from Australia in 1882 and the second from New Zealand in 1896. A more complete history is given in Technical Bulletin 459 (43).

**Distribution.**—Estimated area in 1949, 11,007 acres, grown in Washington, Oregon, and Idaho.

**Synonyms.**—Australian, Bluestem, Palouse Bluestem, White Australian, White Lamma.

**PACIFIC BLUESTEM 37**

**Description.**—Pacific Bluestem 37 is very similar to Pacific Bluestem, except in being resistant to some races of bunt.

**History.**—This strain (C. I. 11903) of Pacific Bluestem is the result of a cooperative program of the California Agricultural Experiment Station and the Division of Cereal Crops and Diseases, at Davis, Calif., to develop strains of the important commercial varieties of California resistant to bunt. The original cross, Martin × Pacific Bluestem, was made in 1922. Bunt-resistant lines were backcrossed to Pacific Bluestem 6 times. Following the sixth backcross a composite of 78 resistant F3 lines was released for production in the foothill area of the Sacramento Valley and in northern California counties in 1937 (201).

**Distribution.**—Estimated area in 1949, 26,773 acres, grown in California and Nevada.

**MAJOR**

**Description.**—Plant spring habit, early to midseason, midtall; stem white, strong; spike apically awnleted, oblong to clavate, dense, erect; glumes glabrous, white, midlong, midwide; shoulders narrow, oblique to elevated; beaks narrow, acute, 0.5 to 1 mm. long; awnlets few, 3 to 5 mm. long; kernels white, midlong, soft, ovate; germ midsized; crease midwide to wide, middeep; cheeks rounded; brush midsized, midlong.

**History.**—Major (C. I. 4984) was bred at Dookie Agricultural College, Victoria, Australia, from a cross between Federation and Wallace (166). It was introduced by the United States Department of Agriculture in 1916 as P. I. 42107 (211). The variety was distributed by the Branch Experiment Station at Water ville, Wash., about 1929.

**Distribution.**—Estimated area in 1949, 1,474 acres, grown in Washington.

**OREGON ZIMMERMAN (ZIMMERMAN)**

**Description.**—Plant spring habit, midseason, tall; stem white, strong; spike awnleted, clavate, midsdense to dense at apex, inclined; glumes glabrous, white, midlong, midwide; shoulders midswide, oblique; beaks midswide, obtuse, 1 mm. long; awnlets several, 5 to 25 mm. long; kernels white, short to midlong, soft; germ elliptical, midsized; crease wide, deep, cheeks angular; brush midlong.

**History.**—Ed. Zimmerman, of Shedd, Oreg., developed this variety from a single plant and first distributed it about 1921. As the Surprise variety has been grown in this locality, it is probable that Oregon Zimmerman (C. I. 7359) (reg. 281) is a selection from it. Oregon Zimmerman is grown in Oregon under the name "Zimmerman." It has white kernels and should not be confused with the soft red winter variety bearing the latter name.

**Distribution.**—Estimated area in 1949, 21,309 acres, grown in the Willamette Valley of Oregon.

**Synonym.**—Zimmerman.

**DICKLOW**

**Description.**—Plant spring habit, late, midtall to tall; stem glaucous before maturity, white, midstrong to strong; leaves broad; spike awnleted, clavate, dense, erect; glumes glabrous, white, midlong, midwide, shoulders midwide, oblique to square; beaks wide, obtuse, 1 mm. long; awnlets several, 3 to 15 mm. long; kernels white, short to midlong, soft, oval to ovate; germ small to midsized; crease wide, deep; cheeks
round to angular; brush midsized, midlong. (See fig. 27, B.)

Dicklow produces a low-protein, very white soft flour of good quality.

History.—Dicklow (C. I. 3663) (reg. 21) is a selection from Surprise. Its origin has been recorded by Aicher (6, p. 20) as follows:

Mr. James Holly, of Utah County, Utah, obtained some California Club wheat from northern California and seeded it on his farm. Excellent results were obtained, and he called the attention of his neighbor, Mr. Richard Low, to his new wheat. Mr. Low obtained some and grew it. He noticed that the wheat contained different types and proceeded to select the type which he liked best. He grew this selection for several years, and the neighbors soon began clamoring for "Dick" Low's wheat. As the wheat became spread over that section of Utah, it lost its personal connection with "Dick" Low and became known simply as Dicklow wheat.

Irwin Dicklow is the name used for a selection of Dicklow developed by Carl D. Irwin, Twin Falls, Idaho, and is even more uniform than Dicklow itself.


Synonyms.—Irwin Dicklow, Jim Holly.

Florence (Quality)

Description.—Plant spring habit, early, short to midtall; stem white, strong; spike awnless, oblong, midsized, erect to inclined, easily shattered; glumes glabrous, yellowish white, short, wide; shoulders wide, oblique to square; beaks wide, acute, 0.5 mm. long; awnlets wanting or nearly so; kernels white, short, hard, ovate, with truncate tip; germ midlarge; crease midwide, middeep; cheeks rounded; brush midsized, midlong. (See fig. 28, B.)

Florence is resistant to some races of bunt.

History.—Florence (C. I. 4170) (reg. 23) (P. I. 38849) was introduced from Australia in 1914 by the United States Department of Agriculture (211) and was tested at experiment stations in the Western States, but results did not warrant its distribution for commercial growing. It was, however, used extensively in the breeding program because of its bunt resistance. This variety under the name "Quality" was distributed by Luther Burbank, of Santa Rosa, Calif., in 1918 (29), as one of his productions and was grown in the United States for several years before it was recognized as being identical with the Australian variety Florence. The Pillsbury Flour Mills Co., of Minneapolis, Minn., distributed seed under the name "Quality" or "Burbank's Quality" in North Dakota, South Dakota, and Minnesota in 1923.

Florence was produced by William Farrer, of New South Wales, Australia, as the result of a successful attempt to produce a bunt-resistant variety. The cross was made in 1901 and Florence was reported to have been distributed in 1907. According to Sutton (203, p. 288), its pedigree is as follows:

(White Naples ² × Improved Fife) ×
(Improved Fife × Eden)

Distribution.—Estimated area in 1949, 5,797 acres, grown in Montana, Idaho, South Dakota, and Oregon.

Synonyms.—Burbank's Quality, Quality.

White Federation

Description.—Plant spring habit, early, short to midtall; stem white, strong; spike awnless, oblong, midsized, erect; glumes glabrous, white, short, wide; shoulders wide, square; beaks narrow, acute, 0.5 mm. long; awnlets wanting or nearly so; kernels white, short, hard, ovate, with truncate tip; germ midlarge; crease midwide, middeep; cheeks rounded; brush midsized, midlong. (See fig. 28, B.)

This variety is very similar to Hard Federation, except that it has white instead of brown glumes, and is taller and more uniform in height. The kernels are not quite so hard. It has proved to be a high-yielding wheat in some sections of California, Oregon, and Washington.

History.—White Federation (C. I. 4981) (reg. 25) is a selection from Federation (139). The following indicates its origin (4, p. 664): "The seed [hard kernels selected from Federation by Mr. J. T. Pridham, from which Hard Federation originated] was propagated, and in 1910 the occurrence of white heads was noticed and from then until 1912 distinctly white heads were common among the brown..."

The name "White Federation" has been used for this variety at the Cowra Experiment Farm, New South Wales, Australia, since 1915, when a field of 3 acres was grown (165).

It was introduced into the United States by the United States Department of Agriculture (211) in 1916 (P. I. 42104) from Victoria, Australia. It was first grown at the Sherman Branch Experiment
Figure 28.—A, Florence and B, White Federation wheats: Spikes and glumes, $\times$ 1; kernels, $\times$ 3.
Station, Moro, Oreg., in 1916. In 1918 it was first grown at the United States Plant Introduction Garden, Chico, Calif., and because of its high yield at that point it was increased and distributed in 1920 for commercial growing in California (56).

Distribution.—Estimated area in 1949, 5,417 acres, grown in Utah and Nevada.

WHITE FEDERATION 38

Description.—This variety is very similar to White Federation except in being resistant to stem rust and some races of bunt.

History.—This strain (C. I. 11906) of White Federation was developed in cooperative investigations of the California Agricultural Experiment Station and the Division of Cereal Crops and Diseases at Davis, Calif. A program was begun in 1922 to develop, by backcrossing, strains of the important commercial wheat varieties in California that would be resistant to bunt. In 1930 a similar project was begun to add stem rust resistance to the most important varieties. White Federation 38 is the result of backcrossing Martin X White Federation 5 times with White Federation to obtain bunt-resistant White Federation and backcrossing Hope X White Federation 4 times with White Federation to obtain rust-resistant White Federation. Each backcross was made to segregates resistant to bunt or stem rust, depending on the cross. The bunt-resistant and stem-rust-resistant strains were then crossed, and 182 of the F2 segregates, homozygous for resistance to both diseases, were bulked and increased in 1938. The variety was distributed to growers in the fall of 1939.

Distribution.—Estimated area in 1949, 241,675 acres, grown in three States (fig. 29).

PILCRAW (THOMPSON CLUB)

Description.—Plant spring habit, midseason, midtall; stem white, strong; spike awnleted, clavate, dense, erect; glumes glabrous, white to yellowish, short, wide; shoulders midwide to wide, square to elevated; beaks narrow, acute, 0.5 to 1 mm. long; awnlets several, 8 to 40 mm. long; kernels white, midlong to long, soft, ovate, distinctly humped; germ midsized; crease midwide, middeep to deep, pitted; cheeks rounded; brush large, midlong to long.

History.—Hugh A. Crawford, Napa, Calif., obtained Pilcraw (C. I. 5540) (reg. 29) from a neighbor who said he had noticed an unusual stool of wheat near an unfrequented road and who cut it when ripe and started experimenting with it. Mr. Crawford bought the original seed in 1913 and increased it until in 1917 he had 360 acres growing at Winters, Calif. He distributed it under the name Pilcraw Enormous.

Distribution.—Estimated area in 1949, 2,138 acres, grown in Washington, California, and Oregon.

Synonyms.—Pilcraw Enormous, Thompson, Thompson Club, White Russian.

RICE

Description.—Plant winter habit, very early (except in Northern States), short to midtall; stem white, midstrong; spike awnleted, fusiform, dense, erect; glumes glabrous, white, short to midlong, narrow to midwide; shoulders narrow, oblique to slightly elevated; beaks obtuse, 0.5 to 1 mm. long; awnlets few, 2 to 15 mm. long; kernels pale red, short to midlong, soft, ovate; germ small to midsized; crease angular; cheeks rounded; brush midsizeci, midlong. (See fig. 30, A.)

The plants of Rice are pale green as contrasted with the dark green of most varieties. Under some conditions it appears to make a more rapid growth in the spring. It heads about a week earlier than Trumbull at Columbia, Mo., but when grown in the Northern States, they head on about the same date.

History.—The origin of Rice (C. I. 5734) (reg. 30) is undetermined, although it is known to be an old variety in the
Figure 30.—A, Rice and B, Leap wheats: Spikes and glumes, $\times$ 1; kernels, $\times$ 3.

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United States. In 1883, it was first reported as a new variety tested by M. F. P., Mount Pleasant, Ontario County, N. Y. (157), and it also was mentioned in that year by C. S. Plumb (163, p. 310) in a paper entitled “The Wheats of the World,” read at the Batavia Institute.

Rice is very similar if not identical with the variety Zimmerman, which is reported to have been originated about 1837 near Frederick, Md., by Henry Zimmerman, who noticed three heads of singular appearance near the edge of one of his wheatfields (105). References in literature show that it was widely grown in Maryland, Virginia, and Pennsylvania about 1850, and that it was an important variety in Kansas in the early nineties. In the South Central States, the name Red May is applied to a variety apparently identical with Rice.

Distribution.—Estimated area in 1949, 11,114 acres, grown in eight Southern States.

Synonyms.—Early May, Early Rice, bittle May, May, Red May.

**EARLY PREMIUM**

Description.—Early Premium is very similar to Rice in all taxonomic characters, although it may be a day or two earlier.

History.—Early Premium (C. I. 11858) was selected from a field of “May” wheat (probably Rice) on the farm of J. A. Houston, Platte County, Mo., in 1924. It was found by the Missouri Agricultural Experiment Station, Columbia, to be about 8 days earlier than such varieties as Fulcaster and was increased and distributed in the fall of 1937 (75).

Distribution.—Estimated area in 1949, 1,675 acres, grown in Missouri.

Synonym.—Missouri Early Premium.

**LEAP**

Description.—Plant winter habit, early, midseason; stem white, midstrong; spike awnleted, fusiform, lax to middense, erect; glumes glabrous, white, midlong, midwide; shoulders midwide, oblique to square; beaks midwide, obtuse, 0.5 mm. long; awnlets several, 5 to 20 mm. long; kernels red, midlong, soft to semihard, ovate; germ midsized; crease medium; cheeks usualy angular; brush medium, midlong.

Vahart is resistant to mosaic, to some races of loose smut, and is somewhat resistant to mildew.

History.—Vahart (C. I. 12537) resulted from a head selected from the original Redhart at the Virginia Agricultural Experiment Station at Blacksburg in 1930 and is similar to that strain of Redhart (197). It was released to growers in 1945. It is recommended for growing in all sections of Virginia.

**KANQUEEN**

Description.—Plant winter habit, midseason, midtall; stem white, midstrong; the five heads gathered in 1901, Mr. Leap increased the wheat until 1905, when he threshed 190 bushels grown from 10 bushels of seed. T. W. Wood & Sons, seedsmen, of Richmond, Va., first distributed the variety as Leap’s Prolific. General distribution of the wheat started about 1907, and it later became very popular (181, p. 44).

Distribution.—Estimated area in 1949, 127,489 acres, grown in 10 Eastern States, the largest acreage being in Virginia.

Synonyms.—Hastings Prolific, Leap’s Prolific, Woods Prolific.

**LEAPLAND**

Description.—Leapland is similar to Leap in appearance except in having awnlets, several, 5 to 25 mm. long, and in being taller and more uniform. Its growth is more prostrate from spring seeding, but from fall seeding it appears to make a more rapid growth early in the spring and has produced higher yields than Leap in Maryland.

History.—Leapland (C. I. 11762) was the best line developed from 2,000 spaced plants of Leap grown at the Maryland Agricultural Experiment Station, College Park, Md., in 1924. It was distributed to farmers in 1932.

Distribution.—Estimated area in 1949, 48,949 acres, grown in nine Eastern States, the largest acreage being in Maryland.

**VYHART**

Description.—Plant winter habit, midseason, midtall; stem white, midstrong; spike awnleted, fusiform, lax to middense to lax, inclined to nodding, easily shattered; glumes glabrous, yellowish white, midlong, midwide; shoulders midwide, oblique to square; beaks midwide, acute, 0.5 mm. long; awnlets few, 3 to 10 mm. long; kernels red, midlong, soft; ovate; germ small; crease midwide to wide, middoep; cheeks usually angular; brush small, midlong. (See fig. 30, B.) Leap is resistant to loose smut.

History.—Leap (C. I. 4823) (reg. 35) is reported to have originated from a single plant found in a field of Mediterranean by a son of J. S. Leap, of Virginia. From
Figure 31.—A, Vigo and B, Fairfield wheats: Spikes and glumes, $\times$ 1; kernels, $\times$ 3.
INDEX TO VARIETIES AND SYNONYMS

Recognized varieties are in capitals; varietal synonyms are in capitals and lower case, and common names of species are in italic capitals. Of the two page references given for recognized varieties, the first refers to the key and the second to the description, history, distribution, and synonymy. Each page reference given for a synonym is to the recognized variety for which the name is a synonym.

Where two or more page numbers are given, therefore, the name is a synonym of more than one variety.

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