VARIATION IN THE KHERSON OAT AT AKRON, COLORADO[1]

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INTRODUCTION

Few oat varieties grown in the United States surpass the Kherson in economic importance or in potential value. It is one of the most widely distributed early varieties, especially in the Corn Belt and the central section of the Great Plains area. The extensive distribution of Kherson and Sixty-Day oats in the United States in 1919 is shown by the map (fig. 1) prepared from statistics obtained in an oat varietal survey conducted by the Office of Cereal Investigations in cooperation with the then Bureau of Crop Estimates. Among the 10 leading varieties in 1919, Kherson and Sixty-Day ranked fourth in acreage. When the acreages of important selections such as Albion (Iowa No. 103), Iowar, Gopher, Richland (Iowa No. 105), and States Pride (Wisconsin No. 7) are added to those of the original variety, this type of oat easily ranks third in importance in the United States, being exceeded only by Silvermine and Red Rustproof.

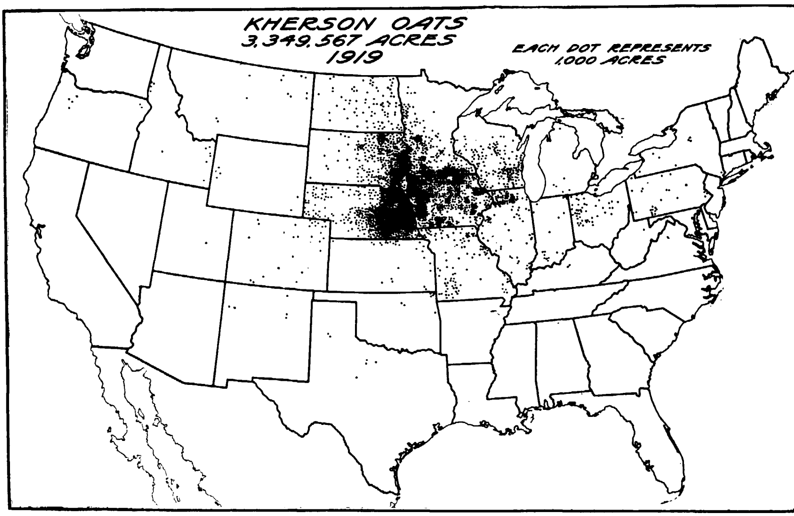

Fig. 1.—Outline map of the United States, showing the distribution of Kherson (Sixty-Day) oat in 1919

REVIEW OF LITERATURE

Carleton (*2*, *3*)[3], Lyon (*15*), Warburton (*24*), and Warburton and Stanton (*26*) have presented historical accounts of the introduction of the Kherson and Sixty-Day into the United States. All of the foregoing writers, and also Etheridge (*5*), have classified Kherson as belonging to *Avena sativa* and have published general or botanical descriptions of the variety. Warburton and Stanton (*26*) state that "botanically the Kherson and Sixty-Day oats can not be distinguished one from the other, * * * the varieties are

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[3] Reference is made by number (italic) to "Literature cited," p. 1081.

identical and the names, therefore, are synonymous * * *." They are so considered in this paper.

Norton (*18*) points out that most oat varieties probably consist of numerous strains. The work of Coffman, Parker, and Quisenberry (*4*) shows this to be especially true of the Burt variety, which was found to consist of numerous distinct types, some of which differ widely. Warburton and Stanton (*26*) have stated that both white-kerneled and yellow-kerneled selections have been made from Kherson or Sixty-Day. Stanton (*19*) and many others have made reports on experiments conducted with selections from this variety. Reports by Love (*10, 11, 12*), Williams and Welton (*28*), Warburton, Burnett, and Love (*25*), Surface and Zinn (*21*), Welton and Gearhart (*27*), Kiesselbach and Ratcliff (*8*), Burnett (*1*), Hayes and Garber (*7*), Leith and Delwiche (*9*), and Burnett, Stanton, and Warburton[4] have described selections made from Kherson or Sixty-Day.

Panicles and spikelets of important selections from Kherson or Sixty-Day are shown in Plate 1.

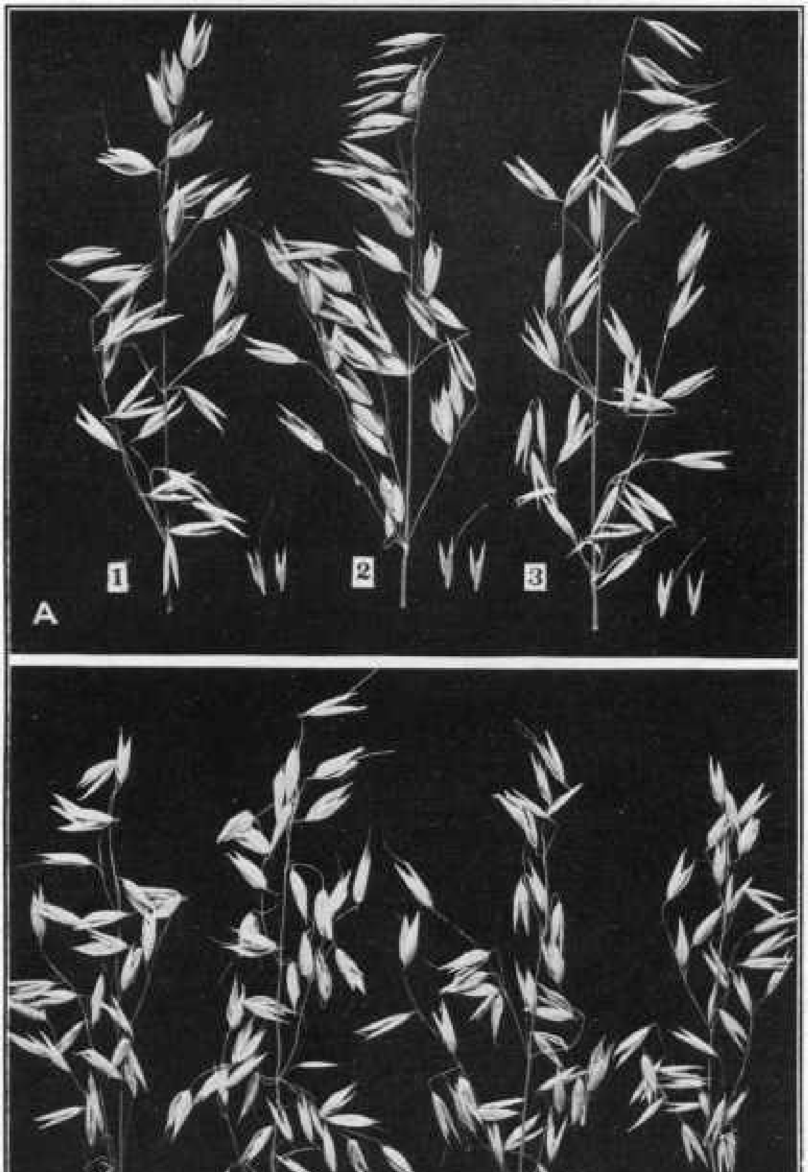
Many investigators have used strains of Kherson or Sixty-Day as parental material in oat hybridization, both with the object of producing improved economic varieties and for genetic studies. A correct knowledge of the variety itself is therefore of considerable importance.

Surface (*20*) made one of the first reports on a cross in which the Kherson oat was studied genetically. He crossed this variety on *Avena fatua*, the common wild oat. He states that the pure-line selection of Kherson used in this cross had been grown for five years and had always bred true for all characters. According to him the awn was seldom present in this strain of Kherson. When present it was found only on the lower kernel and then was very weak. The kernels of this selection had no basal scar and seldom had basal hairs, although spikelets having lower kernels with one or two long hairs on the side of the callus occasionally were found. He further states that all cultivated varieties of oats which have come to his notice may have this slight pubescence at the base of the lower grain and that some varieties have it more marked than others. Surface also found the F_1 of his cross to be intermediate between the two parents in nearly all respects. In F_2 he observed that the basal scar segregated into a ratio of one prominent, two intermediate, and one absent. He observed linkage between basal scar and the presence of hairs on the base. The absence of basal scar was found to be apparently dominant, or at least partially so, over the "wild" type of base having a very pronounced scar. No marked relation was noted between the yellow color of the Kherson strain he used and absence of awns. He attributed the fact that F_2 awnless plants failed to breed true in F_3 either to the presence of additional genes or to the explanation of Nilsson-Ehle (*17*) that external conditions may greatly affect the production of awns in cultivated oats. Surface further states: "General observations also indicate that the character of awning varies widely even within a pure line, and it may happen that plants which are genetically awned will, because of environmental or other conditions, show no awns." He found evidence of linkage between cultivated base form and absence of hairs and also between yellow color and absence of basal scar.

Love and Fraser (*13*) crossed awnless Sixty-Day with Burt and with Red Rustproof (Red Texas), both of which bore awns of the "weak" type. The F_1 of both crosses was almost awnless. They observed that awnless F_2 plants did not always produce progeny all of which were awnless in F_3, a fact which they attribute to environmental factors preventing or obscuring the production of awns in the F_2 generation. They believe the "strong" awn type to be recessive, but the awnless condition could not be considered as being entirely dominant. Apparently the explanation of Nilsson-Ehle (*17*), which assumes that yellow color in oats is linked with an inhibitory factor for awn production, is favored. It is suggested by Love and Fraser that probably the results obtained by Surface (*20*) in crossing Kherson oats with the wild *Avena fatua* may be similarly explained—i. e., Kherson may carry a factor inhibitory to awning.

Love and Craig (*14*) report results obtained in crossing *Avena fatua* × *Avena sativa* variety Sixty-Day. Their results, however, do not agree with those of Surface. They point out that in view of the possibility of obtaining different strains from a variety, particularly so far as the inheritance is concerned, as shown by yield, etc., it is not surprising that these results should not agree. Love and Craig conclude that the Sixty-Day strain they used

[4] BURNETT, L. C., STANTON, T. R., and WARBURTON, C. W. IMPROVED OAT VARIETIES FOR THE CORN BELT U. S. Dept. Agr. Bul. 1343. 1925. (In press)



Panicles and spikelets of Kherson and some yellow and white kerneled selections

A. (1) Kherson; (2) Richland (Iowa No. 105); and (3) States Pride (Wisconsin No. 7)
B. (1) Albion (Iowa No. 103); (2) Iowar; (3) Nebraska No. 21; and (4) Cole

carries an inhibitor for awning which is linked with yellow color, and state that the third generation tends to substantiate the conclusions drawn from the study of the second generation. They also observed in F_2 and F_3 correlation between yellow color and the absence of basal scar as well as between yellow color and absence of basal hairs.

Fraser (*6*) discusses the results obtained in the study of crosses, Sixty-Day × Burt and Sixty-Day × Early Ripe (Burt). He believes that the Sixty-Day carries the factor for awning, but that it is prevented from operating in the cross by an inhibitor which is closely linked with the factor for yellow color in the Sixty-Day variety. He attributed the production of awns in the first generation to the extent to which this inhibitor (I), is dominant over its normal allelomorph (i), which in turn is probably dependent to a large extent on environmental factors. He believes that environment influences the production of awns and states that, though experimental evidence is lacking, increased moisture and fertility of the soil tend to decrease their number. According to Fraser, the variety Sixty-Day would have the genetic formula for color rryyYY as contrasted with the formula RRYYyy of the variety Burt. He states further:

> Other workers have shown that the variety Sixty-Day carries with it a factor which inhibits the production of awns, which factor is closely linked with the factor for yellow color. Because of the yellow in the variety Burt, which carries no inhibitor, the inhibitory effect of the Sixty-Day factor was obscured.

Fraser says that considerable variation in kernel color is to be noticed even within the same pure line during different seasons or under strikingly different environments. He speaks of Sixty-Day as being a yellow variety and found white F_2 plants which failed to breed true in F_3. The difficulty of making exact color classification due to gradation is also pointed out. Linkage was observed between the fully awned condition, the presence of midlength basal hairs, and the Burt (sterilis) type of articulation.

CHARACTERS OF THE KHERSON SPIKELET

A brief description of the oat spikelet is given to make clear the discussion of the experiments which follow. The principal spikelet characters studied, as in previous similar investigations by Coffman, Parker, and Quisenberry (*4*), were spikelet disarticulation, floret disjunction, basal hairs, awns, and lemma color.[5]

The oat spikelet is borne on the end of the pedicel, terminating in the lower segment of the rachilla. Each spikelet contains two or more florets, of which usually only the two lowest are fertile, the lower one of the two being the larger and longer. The outer or empty glumes are thin, membranous, broadly lanceolate, pointed, glabrous, and broadly arched. The upper is a little longer than the lower and both exceed the lemma or flowering glume in length, except in the hull-less or naked group. There are no varieties bearing exclusively one, two, or three kernels per spikelet. Two or more usually occur and may or may not be separated in threshing. The florets are connected by the clavate segments of the jointed rachilla, each segment of which supports a single floret.

SPIKELET DISARTICULATION

The separation of the spikelet from the plant by disarticulation at the juncture of the lower floret and its supporting rachilla segment has been fully discussed in the previous paper on the Burt oat (*4*). In the present study only two distinct forms of lemma base resulting from spikelet disarticulation were recognized. The oval smooth-edged and rather prominent cavity or scar resulting from abscission, usually found in oat kernels of the Red Rustproof type, was not observed in this study of Kherson. In the present study, therefore, spikelet disarticulation was classed as by semiabscission and by fracture. The pointed form of base resulting from fracture is commonly associated with oats of the *Avena sativa* group. The term semiabscission was used for those kernels which showed a slight or poorly developed basal cavity resulting partly from abscission and partly from fracture.

FLORET DISJUNCTION

The manner of separation of the kernels of the spikelet varies with the species. In some species, as in *Avena fatua* and its derivatives, disjunction of the upper floret from its supporting rachilla segment takes place in approximately the same manner as does that of the spikelet. In *Avena sterilis* and its derivatives the rachilla and the lemma of the upper kernel are solidly grown together; the kernels do not

[5] For assistance in determining the morphologic characters of the oat spikelet and for the terminology used the writers are greatly indebted to C. R. Ball, senior agronomist in charge of Cereal Investigations.

separate readily in threshing, but the rachilla segment tears away at or near its base. At other times disjunction may result by the connecting segment splitting lengthwise or breaking at or near the mid-point.

Floret disjunction in this study was described as resulting by disarticulation when the separation left the rachilla segment attached to the face of the lower floret; by heterofracture when the rachilla segment broke at or near the mid-point, making exact classification in either of the other classes impossible; and by basifracture when the rachilla broke off at the base and remained attached to the second floret.

BASAL HAIRS

Most species of wild oats are characterized by hairiness of the lemma, callus, and rachilla. The callus often bears more or less conspicuous hairs or bristles, usually conveniently called basal hairs. Their presence may be observed readily without magnification. These hairs vary in number and length. Different authors have classified them in different ways, but all have used the length or number or combinations of these in making their classifications.

In the Kherson variety all hairs are short, with but few exceptions. On an occasional individual they might be termed midlength, but none observed were of sufficient length to be classed as long. As a result classification of basal hairs in the present study is based almost entirely on numbers of hairs. The occasional kernel with midlength hairs was arbitrarily thrown into the class with short hairs. All gradations from the very shortest hairs visible to the eye up to those of midlength were observed. In this study of Kherson the basal hairs were described as abundant, few, and absent.

AWNS

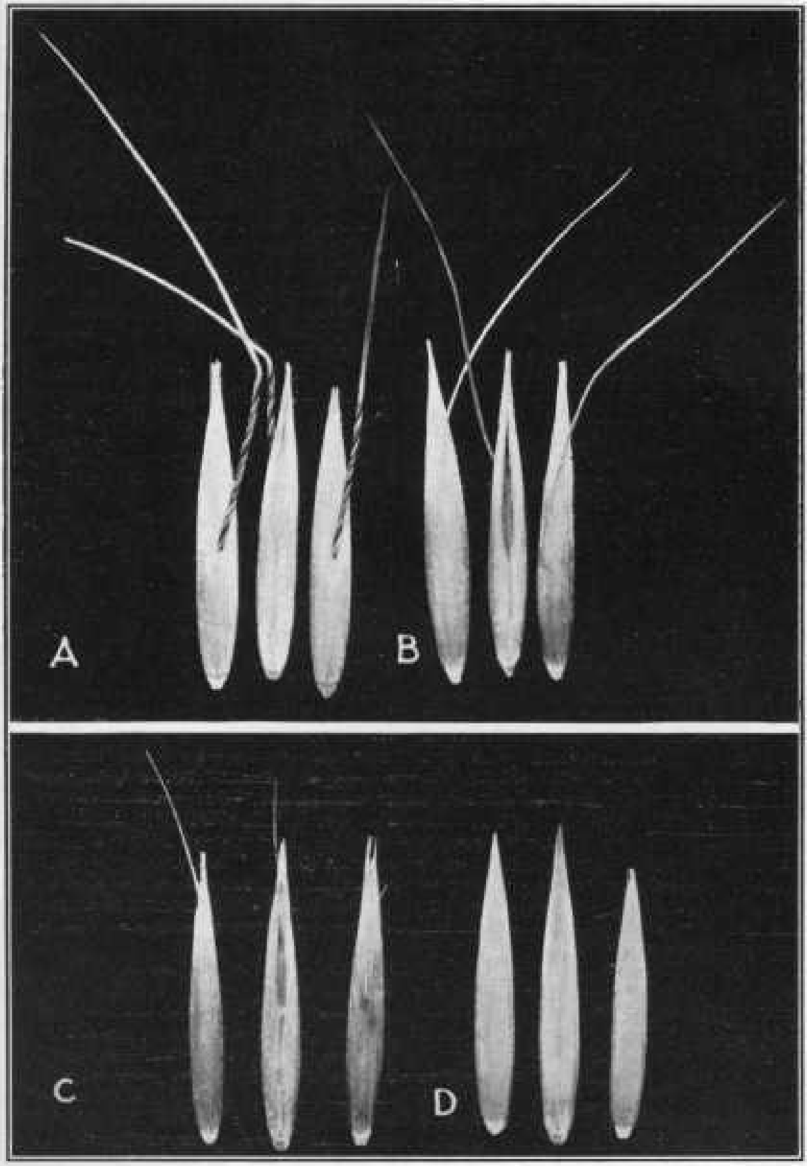
In Avena the awn is an extension of the midrib of the lemma arising from the epidermis at a point usually slightly above the middle of the dorsal surface of the kernel. In the various wild forms awns also occur on the second and third kernels. In such forms the awn usually is stout and long and the basal portion strongly twisted in a clockwise direction. The upper portion usually is bent or geniculate. In most of our cultivated varieties the awn occurs on only the lower kernel of the spikelet, which may be twisted or nontwisted and straight. In practically all the varieties of *Avena sativa* the awn occurs only on the lower lemma, and there are some varieties in which awns occur only occasionally or rarely even on the lower floret. In the varieties of *A. byzantina* awns often occur on both florets, and in the less variable varieties such as Red Rustproof and Red Algerian the awn usually is straight and rarely twisted. Trabut (*22*, *23*) observed a series of oat forms ranging from the wild red oat, *A. sterilis*, to the cultivated red oat which he called *A. sterilis culta*, and noted gradual reduction in the number of awns per spikelet and in the amount of twisting and geniculation. The occurrence of numerous twisted geniculate awns in cultivated oats is believed by some to indicate degeneracy resulting primarily from an unfavorable environment.

Various authors have used different terms to describe the nature of the awn. Etheridge (*5*) used the following terms: Twisted geniculate, strong, and weak. Fraser (*6*) in his studies of the inheritance of what he called the weak awn in certain oat crosses used the terms strong, intermediate, and weak to designate different awn types.

The following terms, indicating four classes, have been used in the present investigations: Twisted; nontwisted, long; nontwisted, short; and absent (awnless) (pl. 2). While the twisted geniculate awn usually is associated with wild forms, some cultivated varieties, such as Swedish Select, frequently show this type of awn to a marked degree. In the present study all awns showing some twisting were classed as twisted, regardless of the degree of geniculation. The nontwisted long awns often were as long as the twisted awns but were never twisted. The nontwisted short awns varied from approximately 15 mm. in length to mere bristlelike appendages.

LEMMA COLOR

In oat varieties the lemma varies in color. The principal colors recognized in descriptions of oat lemmas are black, red, gray, yellow, and white. Lemma colors in the Kherson variety were described in this study as reddish yellow or orange, yellow, and white. Lemmas called reddish yellow are of a dark orange or reddish color. The yellow class included all lemmas showing yellow color and varied from a rich cream to dark lemon-yellow. Lemmas classed as white were of an ivory or light cream color. Pure white lemmas probably do not exist in oats.



Awn types of Kherson oat

A. Twisted
B. Nontwisted long
C. Nontwisted short
D. Absent (awnless)

EXPERIMENTAL METHODS

The review of selection and other experiments has shown conclusively that the Kherson variety contains different types. The experiments described in this study were started at the Akron Field Station in 1921 to obtain information on the genetic constitution of Kherson, particularly with regard to certain spikelet and floret characters.

Kernels used in starting this study were selected singly from a bulk sample of Kherson oat, C. I. No. 459,[6] grown at the Akron Field Station in 1920. The kernels were classified and described by the system outlined by Coffman, Parker, and Quisenberry (*4*) in studies of the Burt oat.

The same general system in choosing seed and in planting was used each year. In all cases the crop was grown in the screened breeding garden at the Akron Field Station. In making the original seedings, kernels having an identical classification were sown together as a group. About 125 kernels were sown in 1921. The kernels were spaced at 3-inch intervals in rows 10 inches apart. The seed was sown on May 12 and the seedlings emerged May 21. The date of heading of each plant was recorded on a tag attached to the plant. Some plants did not mature seed because of unfavorable weather conditions.

The different plants showed considerable variation in time of heading and ripening. The earliest plants started to head July 2, while the latest date of heading was July 20. Most of the plants headed between July 10 and 16. At harvest the plants were pulled, and those of each group were tied together and stored. Later, each plant of the group was numbered, and the height of culms, number of culms, number of panicles, length of main panicle, and date of heading were recorded.

The primary floret in the spikelets, rather than the plant, was used as the unit throughout this study. In 1921 each of the primary florets from the main panicle of each plant was described. In succeeding years 25 florets per plant were described, and where the main panicle contained less than 25 spikelets more than one panicle on the same plant was used in order to obtain a sufficient number for accurate classification. The characters recorded were the same as those used in describing the original seed.

All of the distinct characters and, so far as practicable, all of the different combinations of these characters were included in the 1922 studies. In making the selections for seeding in 1922 there were sown not less than 5 nor more than 10 kernels having the same classification and from any one plant. In a few cases two groups of five kernels each from a single parent plant were sown. In such cases these groups differed in one or more characters, e. g., group 34 and group 35 both came from plant 8 of the 1921 crop (plant 8, group 14). Kernels in group 34 bore long awns in 1921, while those in group 35 were awnless.

About 250 kernels were sown in the 1922 experiments. The seed was sown April 22 and the plants emerged May 5. An excellent stand was obtained and the plants made rapid growth. As the season was dry, it was necessary to irrigate them several times.

In 1923 20 groups of kernels were sown. The seed was sown on May 7 and the plants emerged May 15. Excellent stands were obtained and the plants in most rows made very satisfactory growth.

EXPERIMENTAL RESULTS

About 7,000 kernels were described in the course of this experiment, and it is impracticable to include more than a general summary of the data obtained. In discussing the results the characters studied have been considered separately.

SPIKELET DISARTICULATION

In these experiments no florets were found which had a prominent basal cavity or scar resulting from disarticulation by abscission, such as is characteristic of *Avena sterilis*, *A. fatua*, and some varieties of *A. byzantina*. Should kernels of this type occur in the Kherson oat, it might well be considered evidence of mechanical mixture or of hybridization. Only two methods of spikelet disarticulation were observed in Kherson. These were semiabscission, resulting in a slight or indistinct cavity, and fracture, resulting in a rough surface with no visible scar. The data obtained in 1921, 1922, and 1923 on the inheritance of spikelet disarticulation are shown in Table I. It appears evident that heritable variations exist in the method of spikelet disarticulation of different pedigreed strains of Kherson oat. Apparently a strong tendency exists for disarticulation by semiabscission and by fracture to be transmitted to the progeny in a high proportion of cases.

[6] Accession number of the Office of Cereal Investigations.

TABLE I.—*Inheritance of spikelet disarticulation in strains of the Kherson oat grown at the Akron Field Station, Akron, Colo., in 1921, 1922, and 1923*

DATA FOR 1921

Spikelet disarticulation of parent and group number	Spikelet disarticulation in progeny: Number of kernels disarticulating by— Semiabscission	Number of kernels disarticulating by— Fracture	Percentage of kernels disarticulating by— Semiabscission	Percentage of kernels disarticulating by— Fracture
Semiabscission:				
4	1	18	5.3	94.7
5	124	13	90.5	9.5
12	55	55	50.0	50.0
All groups	180	86	67.7	32.3
Fracture:				
1	------	86	------	100.0
2	25	53	32.1	67.9
3	5	8	38.5	61.5
6	23	40	36.5	63.5
7	31	107	22.5	77.5
8	42	28	60.0	40.0
9	------	71	------	100.0
10	------	37	------	100.0
11	------	42	------	100.0
13	8	54	12.9	87.1
14	112	78	58.9	41.1
15	34	18	65.4	34.6
All groups	280	622	31.0	69.0

DATA FOR 1922

Semiabscission:				
6	38	36	51.4	48.6
7	17	55	23.6	76.4
8	50	107	31.8	68.2
9	84	1	98.8	1.2
10	35	34	50.7	49.3
11	23	57	28.8	71.2
14	20	10	66.7	33.3
15	25	72	25.8	74.2
22	80	20	80.0	20.0
23	52	12	81.2	18.8
24	68	3	95.8	4.2
32	78	2	97.5	2.5
33	58	17	77.3	22.7
34	119	5	96.0	4.0
35	58	------	100.0	------
37	49	32	60.5	39.5
40	97	33	74.6	25.4
41	66	9	88.0	12.0
All groups	1,017	505	66.8	33.2
Fracture:				
1	------	223	------	100.0
2	------	105	------	100.0
3	------	64	------	100.0
4	4	80	4.8	95.2

TABLE I.—*Inheritance of spikelet disarticulation in strains of the Kherson oat grown at the Akron Field Station, Akron, Colo., in 1921, 1922, and 1923*—Continued

DATA FOR 1922—Continued

Spikelet disarticulation of parent and group number	Spikelet disarticulation in progeny: Number of kernels disarticulating by— Semiabscission	Number of kernels disarticulating by— Fracture	Percentage of kernels disarticulating by— Semiabscission	Percentage of kernels disarticulating by— Fracture
Fracture—Continued.				
5	61	44	58.1	41.9
12	3	97	3.0	97.0
13	73	122	37.4	62.6
16	------	26	------	100.0
17	66	50	56.9	43.1
18	5	108	4.4	95.6
19	3	64	4.5	95.5
20	29	57	33.7	66.3
25	34	66	34.0	66.0
26	40	38	51.3	48.7
27	------	56	------	100.0
28	------	127	------	100.0
29	16	57	21.9	78.1
30	16	59	21.3	78.7
31	14	102	12.1	87.9
38	------	30	------	100.0
39	------	17	------	100.0
All groups	364	1,592	18.6	81.4

DATA FOR 1923

Semiabscission:				
4	2	123	1.6	98.4
5	93	4	95.9	4.1
10	80	45	64.0	36.0
11	118	7	94.4	5.6
15	37	15	71.2	28.8
16	75	4	94.9	5.1
18	112	------	100.0	------
19	100	------	100.0	------
20	78	------	100.0	------
All groups	695	198	77.8	22.2
Fracture:				
1	------	93	------	100.0
2	91	34	72.8	27.2
3	36	66	35.3	64.7
6	18	51	26.1	73.9
7	------	52	------	100.0
8	------	136	------	100.0
9	5	133	3.6	96.4
12	------	109	------	100.0
13	------	85	------	100.0
14	2	41	4.7	95.3
17	------	125	------	100.0
All groups	152	925	14.1	85.9

In 1921 parental florets disarticulating by semiabscission produced progeny of which two-thirds disarticulated by semiabscission and one-third by fracture. Parental florets disarticulating by fracture produced progenies in 1921 of which one-third disarticulated by semiabscission and two-thirds by fracture. The results obtained in 1921 indicate that a definite relation exists between parent and progeny in spikelet disarticulation. Each parental type produced a much larger percentage of progeny spikelets of its own kind of disarticulation than of the other type.

The 1922 data on the inheritance of spikelet disarticulation supported the conclusions drawn from the 1921 data on the inheritance of this character in Kherson. Eighteen progeny groups were grown in 1922 from parental florets disarticulating by semiabscission. Approximately 67 per cent of the progeny disarticulated in the same way. In only 4 of the 18 progeny groups was less than 50 per cent of the spikelet disarticulation by semiabscission, while in 5 strains more than 90 per cent, and in 1 group all progeny, were so classified.

Spikelets in which disarticulation was by fracture produced progenies in 1922 of which 81.4 per cent disarticulated by fracture and 18.6 per cent by semiabscission. The relation between parent and progeny for this character appears to be a definite one. In 8 of 21 groups sown from parental spikelets disarticulating by fracture spikelet disarticulation in all progeny was by fracture, while in only 3 of the other 13 groups did less than 50 per cent of the progeny separate by fracture. From these data it seems evident that two types of spikelet disarticulation exist in the Kherson variety. Both of these appear to be heritable to a large extent. It appears possible to isolate by selection pure-breeding lines of either type. Strains breeding true for spikelet disarticulation by fracture appear to be more numerous in Kherson than are those in which spikelet disarticulation is by semiabscission. It is impossible to determine the genetic constitution of Kherson on the basis of the data presented, but it appears evident that at least two factors are involved in the inheritance of spikelet disarticulation. The two methods of disarticulation in Kherson oat are shown in Plate 3.

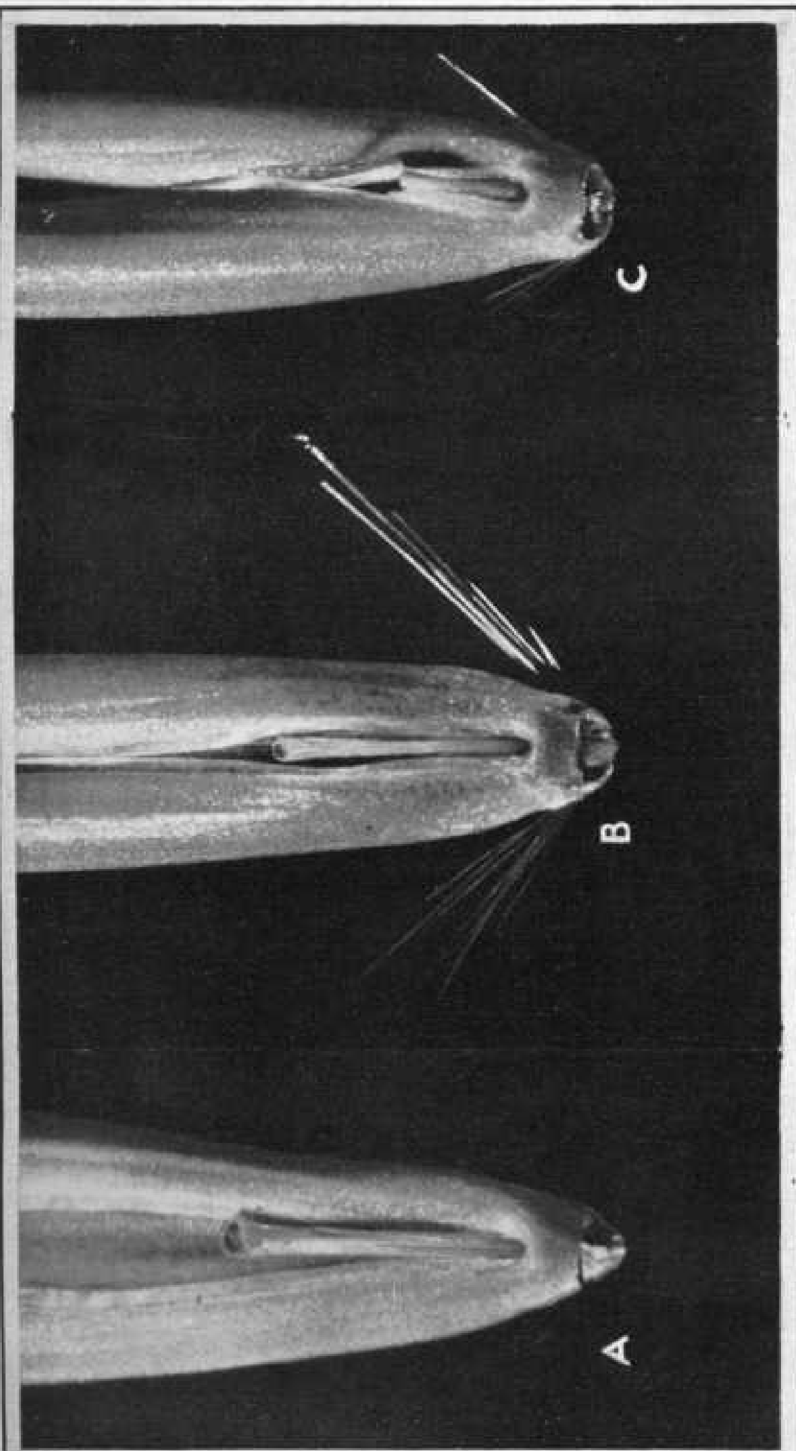
Of the 11 progeny groups grown in 1923 from parental kernels in which the spikelet disarticulated by fracture, 6 bred true and 2 groups produced progeny of which more than 95 per cent were like the parent. One group produced progeny of which nearly three-fourths disarticulated by semiabscission and one-fourth by fracture. Approximately 65 and 74 per cent, respectively, of the two remaining groups disarticulated the same in progeny as in parent.

Of the 9 groups of kernels in which spikelet disarticulation in the 1922 parental kernels was by semiabscission, 1 group produced progeny nearly all of which disarticulated by fracture, 2 produced progeny of which about 64 and 71 per cent, respectively, were of the parental description, 3 produced progeny of which approximately 95 per cent was like the parent, and in 3 groups all progeny were like the parent.

As a whole in 1923 spikelets in which disarticulation was by semiabscission produced progenies of which 77.8 per cent also disarticulated by semiabscission and 22.2 per cent by fracture. Of the parental kernels in which disarticulation was by fracture 85.9 per cent of the progeny was similar, only 14.1 per cent disarticulating by semiabscission. Compared with the data obtained the two previous seasons, progress toward homozygosity is clearly shown.

FLORET DISJUNCTION

Disjunction of the second florets from their supporting rachilla segments is one of the most important characters studied, as it is fundamental in the classification of Avena. The data on this character for 1921, 1922, and 1923 are shown in Table II. The floret disjunction in the 1921 crop was predominantly by disarticulation, although approximately 20 per cent of the progeny disjoined by heterofracture or by basifracture. Except for the 1922 data, it might have been believed that Kherson was heterozygous for floret disjunction. The 1922 and 1923 data are similar and show conclusively that the second florets of the Kherson variety separate by disarticulation, the common method in the species *Avena sativa*.



(For explanatory legend see p. 1073)

TABLE II.—*Inheritance of floret disjunction in strains of the Kherson oat grown at the Akron Field Station, Akron, Colo., in 1921, 1922, and 1923*

DATA FOR 1921

Floret disjunction of parent and group number	Floret disjunction in progeny					
	Number of kernels disjoining by—			Percentage of kernels disjoining by—		
	Basifracture	Heterofracture	Disarticulation	Basifracture	Heterofracture	Disarticulation
Disarticulation:						
1	1	10	75	1.2	11.6	87.2
2	2	34	42	2.6	43.6	53.8
3	1	1	11	7.7	7.7	84.6
4	----	3	16	----	15.8	84.2
5	9	27	101	6.6	19.7	73.7
6	1	11	51	1.6	17.5	80.9
7	3	30	105	2.2	21.7	76.1
8	1	7	62	1.4	10.0	88.6
9	2	5	64	2.8	7.1	90.1
10	1	4	32	2.7	10.8	86.5
11	----	8	34	----	19.0	81.0
12	2	27	81	1.8	24.6	73.6
13	1	7	54	1.6	11.3	87.1
14	1	29	160	.5	15.3	84.2
15	1	3	48	1.9	5.8	92.3
All groups	26	206	936	2.2	17.7	80.1

DATA FOR 1922

Floret disjunction of parent and group number	Basifracture	Heterofracture	Disarticulation	Basifracture	Heterofracture	Disarticulation
Heterofracture:						
33	----	6	69	----	8.0	92.0
Disarticulation:						
1	1	18	204	0.4	8.1	91.5
2	----	3	102	----	2.9	97.1
3	----	2	62	----	3.1	96.9
4	----	2	82	----	2.4	97.6
5	----	2	103	----	1.9	98.1
6	----	19	55	----	25.7	74.3
7	----	3	69	----	4.2	95.8
8	----	2	155	----	1.3	98.7
9	----	15	70	----	17.6	82.4
10	----	----	69	----	----	100.0
11	----	----	80	----	----	100.0
12	----	5	95	----	5.0	95.0
13	----	9	91	----	9.0	91.0
14	----	----	30	----	----	100.0
15	----	3	94	----	3.1	96.9
16	----	----	26	----	----	100.0
17	1	15	100	.9	12.9	86.2
18	----	10	103	----	8.8	91.2
19	----	7	60	----	10.4	89.6
20	----	13	72	----	15.3	84.7
22	----	5	95	----	5.0	95.0
23	----	6	58	----	9.4	90.6
24	1	10	60	1.4	14.1	84.5
25	----	6	95	----	5.9	94.1
26	----	8	70	----	10.3	89.7

TABLE II.—*Inheritance of floret disjunction in strains of the Kherson oat grown at the Akron Field Station, Akron, Colo., in 1921, 1922, and 1923*—Continued

DATA FOR 1922—Continued

Floret disjunction of parent and group number	Floret disjunction in progeny					
	Number of kernels disjoining by—			Percentage of kernels disjoining by—		
	Basifracture	Heterofracture	Disarticulation	Basifracture	Heterofracture	Disarticulation
Disarticulation—Continued.						
27	----	----	56	----	----	100.0
28	2	9	116	1.6	7.1	91.3
29	----	10	63	----	13.7	86.3
30	1	7	67	1.4	9.3	89.3
31	----	7	109	----	6.0	94.0
32	1	8	71	1.3	10.0	88.7
34	----	3	121	----	2.4	97.6
35	----	4	54	----	6.9	93.1
37	1	9	71	1.2	11.1	87.7
38	----	----	30	----	----	100.0
39	----	----	17	----	----	100.0
40	----	11	119	----	8.5	91.5
41	----	1	74	----	1.3	98.7
All groups	8	232	3,068	.3	7.0	92.7

DATA FOR 1923

Floret disjunction of parent and group number	Basifracture	Heterofracture	Disarticulation	Basifracture	Heterofracture	Disarticulation
Heterofracture:						
3	----	28	74	----	27.5	72.5
15	----	2	50	----	3.8	96.2
All groups	----	30	124	----	19.5	80.5
Disarticulation:						
1	----	----	93	----	----	100.0
2	----	9	116	----	7.2	92.8
4	1	4	120	0.8	3.2	96.0
5	----	10	87	----	10.3	89.7
6	----	8	61	----	11.6	88.4
7	----	----	52	----	----	100.0
8	----	4	132	----	2.9	97.1
9	----	6	132	----	4.3	95.7
10	1	9	115	.8	7.2	92.0
11	1	13	111	.8	10.4	88.8
12	----	12	97	----	11.0	89.0
13	----	4	81	----	4.7	95.3
14	----	1	42	----	2.3	97.7
16	----	10	69	----	12.7	87.3
17	----	5	120	----	4.0	96.0
18	----	1	111	----	.9	99.1
19	----	3	97	----	3.0	97.0
20	----	----	78	----	----	100.0
All groups	3	99	1,714	.2	5.5	94.3

EXPLANATORY LEGEND FOR PLATE 3

Spikelet disarticulation, floret disjunction, and basal hairs of Kherson oat

A. Spikelet disarticulation by fracture, floret disjunction by disarticulation, basal hairs absent
B. Spikelet disarticulation by semiabscission, floret disjunction by disarticulation, basal hairs abundant
C. Spikelet disarticulation by semiabscission, floret disjunction by heterofracture, basal hairs few

It is reasonable to assume that the comparatively small percentage of kernels in which floret disjunction was by basifracture and by heterofracture in all years can be accounted for by chance variations or as due to accidental causes in the breaking apart of the two kernels of the spikelet rather than to a hereditary cause. It is believed, therefore, that these data show conclusively that the Kherson oat used in these experiments belongs to the *Avena sativa* group in which floret disjunction usually is by disarticulation and that it contains few, if any, strains in which floret disjunction is by basifracture, as in the *A. sterilis* group. The different methods of floret disjunction are shown in Plates 3 and 4.

BASAL HAIRS

The results obtained on the inheritance of basal hairs are presented in Table III. These data show that parental florets classed as having few basal hairs produced progeny in 1921 of which about three-fourths had either few or abundant basal hairs and about one-fourth had the basal hairs absent. Parental florets with hairs absent produced progenies of which only about 40 per cent had hairs absent, while over 60 per cent had basal hairs present. These data indicate that a tendency exists for parental kernels having basal hairs to produce progeny having basal hairs. The fact that in 1921 parental kernels without hairs produced in many cases progeny having basal hairs either few or abundant may be accounted for by the fact that the original material was machine-threshed. As a result some parental kernels which originally bore basal hairs may have had them rubbed off in threshing (Table III).

The 1922 data show that 14 of the 25 groups of parental kernels described as having few basal hairs produced progeny largely or wholly of that description, one group having all progeny like the parents. In 9 of the remaining 11 groups more progeny kernels had basal hairs absent than bore few basal hairs, 3 of these groups showing no kernels with such hairs. In 2 groups about half of the progeny were of each class.

TABLE III.—*Inheritance of basal hairs in strains of the Kherson oat grown at the Akron Field Station, Akron, Colo., in 1921, 1922, and 1923*

DATA FOR 1921

Basal hairs of parent and group number	Basal hairs in progeny: Numher of kernels having hairs: Abundant	Few	Absent	Percentage of kernels having hairs: Abundant	Few	Absent
Few:						
4	----	14	5	----	73.7	26.3
6	3	44	16	4.8	69.8	25.4
9	----	40	31	----	56.3	43.7
10	11	22	4	29.7	59.5	10.8
12	----	87	23	----	79.1	20.9
15	----	52	----	----	100.0	----
All groups	14	259	79	4.0	73.6	22.4
Ahsent:						
1	----	42	44	----	48.8	51.2
2	2	48	28	2.6	61.5	35.9
3	----	3	10	----	23.1	76.9
5	8	68	61	5.9	49.6	44.5
7	4	55	79	2.9	39.9	57.2
8	----	57	13	----	81.4	18.6
11	----	11	31	----	26.2	73.8
13	----	42	20	----	67.7	32.3
14	----	155	35	----	81.6	18.4
All groups	14	481	321	1.7	59.0	39.3

EXPLANATORY LEGEND FOR PLATE 4

Description of lemma color and other characters in Kherson florets

A. Yellowish white, hasal hairs ahsent, awn twisted
B. Yellow, hasal hairs ahsent, awn twisted
C. Reddish yellow, hasal hairs ahsent, awn ahsent
D. White, hasal hairs ahsent, awn nontwisted long
E. Yellowish white, spikelet disarticulation hy fracture, floret disjunction hy disarticulation
F. Yellow, spikelet disarticulation hy fracture, floret disjunction hy hasifracture
G. Reddish yellow, spikelet disarticulation hy fracture, floret disjunction hy heterofracture, hasal hairs ahsent, awn nontwisted long
H. White, spikelet disarticulation hy fracture, floret disjunction hy heterofracture, hasal hairs ahsent, awn nontwisted short
I. Yellowish white, spikelet disarticulation hy fracture, floret disjunction hy disarticulation, hasal hairs few, awn nontwisted long
J. Yellow, spikelet disarticulation by fracture, floret disjunction hy disarticulation, hasal hairs ahsent, awn ahsent
K. White, spikelet disarticulation hy fracture, floret disjunction by disarticulation, hasal hairs ahsent, awn ahsent
L. White, spikelet disarticulation hy fracture, floret disjunction hy disarticulation, hasal hairs ahundant, awn ahsent

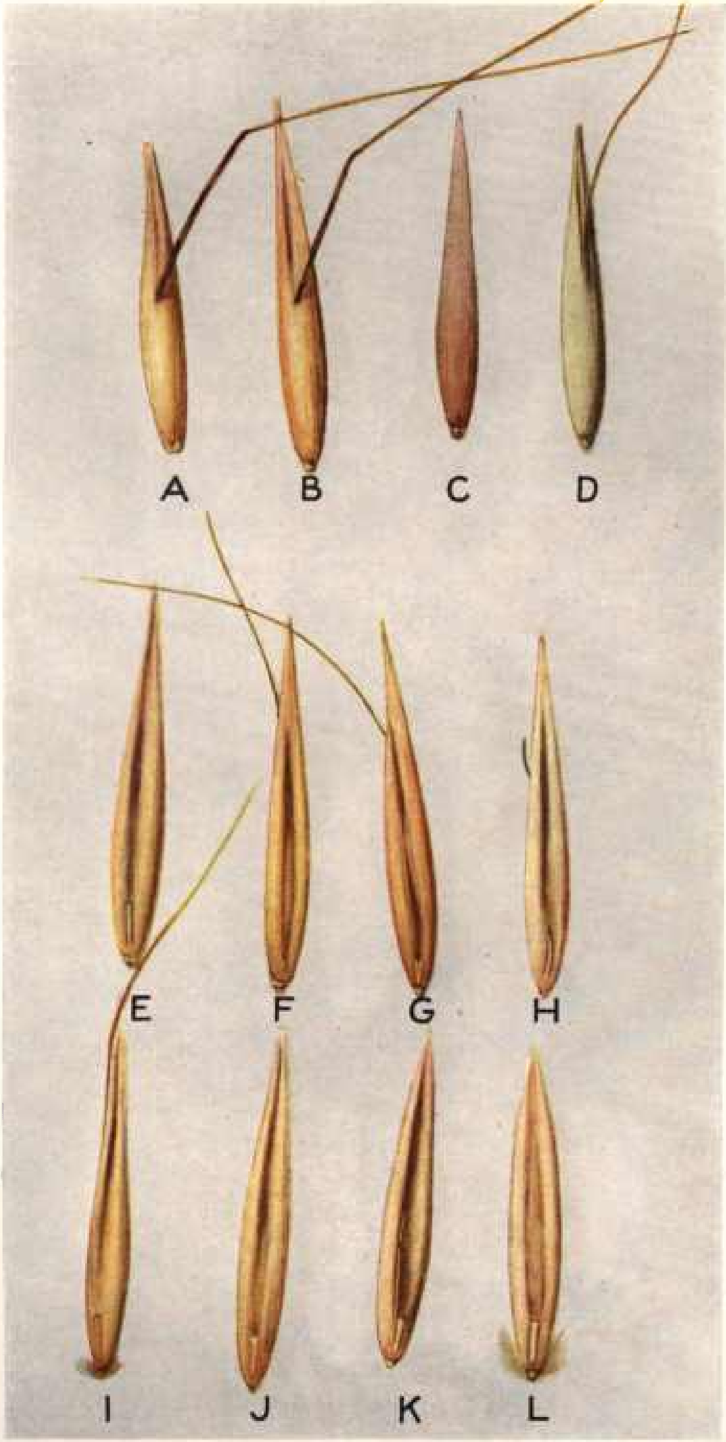


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TABLE III.—*Inheritance of basal hairs in strains of the Kherson oat grown at the Akron Field Station, Akron, Colo., in 1921, 1922, and 1923*—Continued

DATA FOR 1922

Basal hairs of parent and group number	Basal hairs in progeny					
	Number of kernels having hairs			Percentage of kernels having hairs		
	Abundant	Few	Absent	Abundant	Few	Absent
Few:						
2	----	14	91	----	13.3	86.7
3	----	9	55	----	14.1	85.9
5	----	58	47	----	55.2	44.8
6	----	38	36	----	51.4	48.6
7	----	----	72	----	----	100.0
9	----	32	53	----	37.6	62.4
10	----	----	69	----	----	100.0
13	----	69	131	----	34.5	66.5
14	----	5	25	----	16.7	83.3
15	----	----	97	----	----	100.0
17	24	81	11	20.7	69.8	9.5
18	----	9	104	----	8.0	92.0
22	----	84	16	----	84.0	16.0
23	----	62	2	----	96.9	3.1
24	----	70	1	----	98.6	1.4
25	----	90	10	----	90.0	10.0
26	----	63	15	----	80.8	19.2
29	3	52	18	4.1	71.2	24.7
30	----	51	24	----	68.0	32.0
31	----	85	31	----	73.3	26.7
32	----	78	2	----	97.5	2.5
33	----	73	2	----	97.3	2.7
34	----	124	----	----	100.0	----
35	----	55	3	----	94.8	5.2
37	----	76	5	----	93.8	6.2
All groups	27	1,278	920	1.2	57.4	41.4
Absent:						
1	----	5	218	----	2.2	97.8
4	----	22	62	----	26.2	73.8
8	----	3	154	----	1.9	98.1
11	4	2	74	5.0	2.5	92.5
12	----	35	65	----	35.0	65.0
16	----	2	24	----	7.7	92.3
19	----	7	60	----	10.4	89.6
20	----	30	56	----	34.9	65.1
27	----	----	56	----	----	100.0
28	----	----	127	----	----	100.0
38	----	2	28	----	6.7	93.3
39	----	----	17	----	----	100.0
40	----	1	129	----	.8	99.2
41	----	----	75	----	----	100.0
All groups	4	109	1,145	.3	8.7	91.0

DATA FOR 1923

Basal hairs of parent and group number	Basal hairs in progeny					
	Number of kernels having hairs			Percentage of kernels having hairs		
	Abundant	Few	Absent	Abundant	Few	Absent
Abundant:						
5	----	107	18	----	85.6	14.4
Few:						
11	----	116	9	----	92.8	7.2
14	----	25	18	----	58.1	41.9
15	----	44	8	----	84.6	15.4
16	----	78	1	----	98.7	1.3
18	----	112	----	----	100.0	----
19	----	100	----	----	100.0	----
20	----	53	25	----	67.9	32.1
All groups	----	528	61	----	89.6	10.4

TABLE III.—*Inheritance of basal hairs in strains of the Kherson oat grown at the Akron Field Station, Akron, Colo., in 1921, 1922, and 1923*—Continued

DATA FOR 1923—Continued

Basal hairs of parent and group number	Basal hairs in progeny					
	Number of kernels having hairs			Percentage of kernels having hairs		
	Abundant	Few	Absent	Abundant	Few	Absent
Absent:						
1	----	12	81	----	12.9	87.1
2	----	86	39	----	68.8	31.2
3	----	39	63	----	38.2	61.8
4	----	8	117	----	6.4	93.6
5	----	47	50	----	48.5	51.5
6	----	26	43	----	37.7	62.3
7	----	11	41	----	21.2	78.8
8	----	10	126	----	7.4	92.6
9	----	9	129	----	6.5	93.5
12	----	5	104	----	4.6	95.4
13	----	39	46	----	45.9	54.1
17	----	----	125	----	----	100.0
All groups	----	292	964	----	23.2	76.8

Of the 14 groups of the 1922 crop having parental kernels with basal hairs absent all progenies in four groups had no hairs. In only four groups were found florets having basal hairs to any considerable degree. This shows that a strong tendency exists for parental kernels without hairs to produce progeny of that description, while parental kernels with hairs show a marked tendency to produce progeny which segregate into the few and absent classes for basal hairs.

The comparatively few kernels which were described as having abundant basal hairs in this study may easily be accounted for as chance variations in all cases. There seemed to be one exception to this tendency, group 17 of the 1922 crop, but the results obtained in 1923 indicated that these few kernels also were due to chance variation and not to any heritable difference.

The data obtained in 1923 in the study of basal hairs in progeny of kernels bearing few hairs indicate that this character is more definitely inherited than was shown by similar studies in previous years. Between 85 and 90 per cent of the progeny from parental kernels bearing hairs was described as bearing hairs. However, in 11 of the 12 groups in which the parental kernels were described as having no hairs some progeny kernels were produced which bore a few hairs. Although, in 1922, 91 per cent of the progeny of kernels with hairs absent was described as without hairs, in 1923 only 76.8 per cent of the progeny of parental kernels without hairs was so described. The fluctuations in the percentages of true breeding progeny from parental kernels described as having basal hairs absent probably indicates that this character is influenced by environmental or physiological factors.

The results, however, apparently indicate the possibility of isolating strains of Kherson oats which will breed comparatively pure for few as well as for no basal hairs. Presumably pure-breeding strains having few basal hairs are as numerous in the Kherson variety as grown at Akron as those having no basal hairs. The variation in length and abundance of basal hairs found in Kherson oats is shown in Plates 2 and 4.

AWNS

The present study was conducted chiefly to obtain data on the inheritance of awning in Kherson oats. Nilsson-Ehle (*16*) apparently first stated the belief that yellow color had an inhibitory effect on awn development. The writers may be misled, but it appears that this theory possibly was advanced on the results observed by Nilsson-Ehle in a cross in which less than 25 plants with yellow kernels were produced in the F_2 generation, and of these few progeny plants some were awned. The results obtained by Surface (*20*) in his cross of *Avena fatua* with the cultivated variety Kherson did not support this theory of Nilsson-Ehle.

The results of Love and Fraser (*13*), Love and Craig (*14*), and Fraser (*6*) all fail to show conclusively that the Kherson or Sixty-Day oat contains an inhibitor for awns linked with yellow color. The failure to observe the expected inhibitory effect is explained by these writers largely on the basis that the Burt oats used in their crosses carried no such inhibitor, and thus obscured the effect of the inhibitor carried by the Kherson or Sixty-Day variety. They further explain their failure to obtain an inhibitory effect from Sixty-Day in their crosses of Sixty-Day × Burt as being partially due to climatic conditions, which may favor the production of awns in one season or cause kernels which carry the gene for awns to fail to produce awns in other seasons.

The results obtained in the present experiment do not indicate either the linkage of awnlessness and yellow color or the inhibitory effect of yellow color for the production of awns in the Kherson variety.

The data obtained in the study of awns in the Kherson oat in 1921, 1922, and 1923 are presented in Table IV.

Parental florets having twisted awns produced progenies in 1921, of which about 48 per cent had twisted, 20 per cent had nontwisted long, 2 per cent nontwisted short awns, and 32 per cent was awnless. Parental florets having nontwisted long awns produced progenies of which 7.5 per cent had twisted awns, 45.2 per cent nontwisted long, 1.4 per cent nontwisted short, and 45.9 per cent had absent awns. Awnless parental florets produced progeny of which about 90 per cent were awnless, 7 per cent had nontwisted long awns, 1.6 per cent had nontwisted short awns, and 1.8 per cent had twisted awns. The data obtained in 1921 indicated that the twisted, nontwisted long, and absent awns differed in their hereditary behavior. It appeared that the absence of awns was more constant in breeding behavior than the others and that the nontwisted long awn differs genetically from the twisted awn. Both types appeared similar in the production of florets with nontwisted short or absent awns.

Much more definite data were obtained on the inheritance of awns in Kherson oats in 1922. These data indicate that the twisted awn possibly is recessive to the nontwisted long awns and to awnlessness. Nearly 95 per cent of the progeny of parental florets having twisted awns had twisted awns, while a very few had nontwisted long or short awns, and only about 5 per cent was awnless. The studies in Burt oats by Coffman, Parker, and Quisenberry (*4*) have shown the tendency of kernels in that variety having the twisted awn to produce progeny with awns of that character or no awns at all. Parental kernels of Kherson oats having nontwisted long awns produced progeny in 1922 of which 64.9 per cent had nontwisted long awns, 12 per cent had twisted awns, 10.1 per cent had nontwisted short awns, and 13 per cent was awnless.

The failure of awnless parental kernels to produce progeny all of which were awnless has been noted by previous investigators. In the 1922 crop of Kherson oats grown at Akron 74.3 per cent of the progeny of awnless parental kernels was awnless, 5.8 per cent had nontwisted short awns, 18.7 per cent had nontwisted long awns, and 1.2 per cent had twisted awns.

TABLE IV.—*Inheritance of awns in strains of the Kherson oat grown at the Akron Field Station, Akron, Colo., in 1921, 1922, and 1923*

DATA FOR 1921

Awn of parent and group number	Awns in progeny: Number of kernels having awns: Twisted	Nontwisted: Long	Nontwisted: Short	Absent	Percentage of kernels having awns: Twisted	Nontwisted: Long	Nontwisted: Short	Absent
Twisted:								
4	-----	8	-----	11	-----	42.1	-----	57.9
5	96	-----	-----	41	70.1	-----	-----	29.9
8	61	4	3	2	87.1	5.7	4.3	2.9
12	38	35	2	35	34.6	31.8	1.8	31.8
14	31	62	6	91	16.3	32.6	3.2	47.9
15	48	2	-----	2	92.3	3.9	-----	3.8
All groups	274	111	11	182	47.4	19.2	1.9	31.5
Nontwisted:								
3	6	1	-----	6	46.2	7.7	-----	46.1
9	-----	40	1	30	-----	56.3	1.4	42.3
13	5	25	1	31	8.1	40.3	1.6	50.0
All groups	11	66	2	67	7.5	45.2	1.4	45.9
Absent:								
1	-----	9	2	75	-----	10.5	2.3	87.2
2	-----	-----	-----	78	-----	-----	-----	100.0
6	5	15	5	38	7.9	23.8	7.9	60.4
7	-----	6	-----	132	-----	4.3	-----	95.7
10	-----	-----	-----	37	-----	-----	-----	100.0
11	3	1	-----	38	7.1	2.4	-----	90.5
All groups	8	31	7	398	1.8	7.0	1.6	89.6

DATA FOR 1922

Awn of parent and group number	Twisted	Long	Short	Absent	Twisted	Long	Short	Absent
Twisted:								
7	65	-----	-----	7	90.3	-----	-----	9.7
8	155	-----	-----	2	98.7	-----	-----	1.3
10	69	-----	-----	-----	100.0	-----	-----	-----
11	78	-----	-----	2	97.5	-----	-----	2.5
14	29	-----	-----	1	96.7	-----	-----	3.3
15	86	-----	-----	11	88.7	-----	-----	11.3
22	90	1	1	8	90.0	1.0	1.0	8.0
23	64	-----	-----	-----	100.0	-----	-----	-----
34	120	1	1	2	96.8	.8	.8	1.6
37	67	2	3	9	82.7	2.5	3.7	11.1
All groups	823	4	5	42	94.1	.5	.6	4.8
Nontwisted:								
16	-----	22	2	2	-----	84.6	7.7	7.7
24	3	64	1	3	4.2	90.2	1.4	4.2
25	21	63	9	7	21.0	63.0	9.0	7.0
26	29	38	6	5	37.2	48.7	7.7	6.4
29	-----	42	17	14	-----	57.5	23.3	19.2
31	21	60	9	26	18.1	51.7	7.8	22.4
32	12	63	5	-----	15.0	78.8	6.2	-----
33	-----	74	-----	1	-----	98.7	-----	1.3
38	-----	10	20	-----	-----	33.3	66.7	-----
41	1	34	4	36	1.4	45.3	5.3	48.0
All groups	87	470	73	94	12.0	64.9	10.1	13.0

TABLE IV.—*Inheritance of awns in strains of the Kherson oat grown at the Akron Field Station, Akron, Colo., 1921, 1922, and 1923*—Continued

DATA FOR 1922—Continued

Awn of parent and group number	Awns in progeny							
	Number of kernels having awns				Percentage of kernels having awns			
	Twisted	Nontwisted		Absent	Twisted	Nontwisted		Absent
		Long	Short			Long	Short	
Absent:								
1		66	25	132		29.6	11.2	59.2
2	3	47	15	40	2.9	44.7	14.3	38.1
3				64				100.0
4				84				100.0
5				105				100.0
6	4	1		69	5.4	1.4		93.0
9	3	1		81	3.5	1.2		95.2
12			1	99			1.0	99.3
13				200				100.0
17				116				100.0
18		30	10	73		26.5	8.9	64.0
19			7	60			10.4	89.6
20	3	60	8	15	3.5	69.8	9.3	17.6
27		22	11	23		39.3	19.6	41.4
28	5	26	5	91	3.9	20.5	3.9	71.1
30		21	12	42		28.0	16.0	56.7
35	3	8	2	45	5.2	13.8	3.4	77.6
39	1	15		1	5.9	88.2		5.9
40		55	14	61		42.3	10.8	46.9
All groups	22	352	110	1,401	1.2	18.7	5.8	74.3

DATA FOR 1923

Awn of parent and group number	Twisted	Long	Short	Absent	Twisted	Long	Short	Absent
Twisted:								
4	124			1	99.2			0.8
9	137			1	99.3			.7
15	34	14	2	2	65.4	26.9	3.9	3.8
18	59	17	15	21	52.7	15.2	13.4	18.7
19	72	11	2	15	72.0	11.0	2.0	15.0
20	18	11	3	46	23.1	14.1	3.8	59.0
All groups	444	53	22	86	73.4	8.8	3.6	14.2
Nontwisted:								
1	2	29	9	53	2.2	31.2	9.7	56.9
14	8	21	11	3	18.6	48.8	25.6	7.0
16	10	66	1	2	12.7	83.5	1.3	2.5
17		18	3	104		14.4	2.4	83.2
All groups	20	134	24	162	5.9	39.4	7.1	47.6
Absent:								
2			1	124			.8	99.2
3	3		1	98	2.9		1.0	96.1
5	7	5	3	82	7.2	5.2	3.1	84.5
6				69				100.0
7			1	51			1.9	98.1
8				136				100.0
10				125				100.0
11				125				100.0
12		1	1	107		.9	.9	98.2
13		2	1	82		2.3	1.2	96.5
All groups	10	8	8	999	1.0	.8	.8	97.4

The data obtained on the inheritance of awns in the Kherson oat in 1923 were similar to those of previous seasons in many respects. Although the percentage of progeny of kernels described as bearing twisted awns was smaller in 1923 than in 1922, it was much larger than that of 1921. The breeding behavior of the kernels having nontwisted long awns was very similar in 1923 to that of 1921, and awnless parental kernels indicated a very strong tendency to produce only awnless progeny.

The data on inheritance of awns clearly indicate that genetically three types of awns exist in the Kherson oat. All three types tend to breed true. The twisted awn appears to breed as a recessive. Possibly because of physiological influences, some kernels which carry the factor for producing this type of awn fail to produce awns at all or produce the other types. The nontwisted long awn in Kherson is much less definite in breeding behavior than is the twisted awn. The nontwisted short awn in Kherson probably results from chance variation. Its genetic constitution probably is similar to the nontwisted long awn. It appears probable that pure-breeding strains which bear long awns can be isolated from the variety. The data for each group show more clearly than do the summaries for all groups that many pure-breeding awnless strains exist in Kherson oat, although not all awnless strains breed true for that condition.

Nilsson-Ehle (*17*) has stated that external conditions may greatly influence the production of awns in cultivated oat varieties. The junior author in classification studies of oats conducted at widely separated points in the United States has observed that the number of awns in some varieties and strains varies apparently with environmental conditions. For this reason it can not be assumed that these Kherson strains would show a similar behavior for awns under a decidedly different set of conditions.

The awn types found in the present study of Kherson oats are shown in Plates 2 and 4.

LEMMA COLOR

Only three lemma colors have been recognized in this study of the Kherson variety. These colors, reddish yellow, yellow, and white, have been described previously (pl. 4). Table V presents the data on color in 1921, 1922, and 1923, and shows conclusively that the yellow color is the most stable in breeding behavior. Both of the other kernel colors tend to break up and produce more progeny described as yellow than of the other types. The distinctions between the different color classes in oats are often difficult to make, as the colors grade into one another. This is due partly to the effects of physiological influences, which may cause genetically white kernels to be called yellow or yellow kernels to appear either reddish yellow or white.

TABLE V.—*Inheritance of lemma color in strains of the Kherson oat grown at the Akron Field Station, Akron, Colo., in 1921, 1922, and 1923*

DATA FOR 1921

Color of parental lemmas and group number	Lemma color in progeny					
	Number of lemmas			Percentage of lemmas		
	Reddish yellow	Yellow	White	Reddish yellow	Yellow	White
Reddish yellow:						
8	3	45	12	5.0	75.0	20.0
Yellow:						
1	11	69	6	12.8	80.2	7.0
9	5	66	----	7.0	93.0	----
10	25	12	----	67.6	32.4	----
11	9	30	3	21.4	71.4	7.2
12	34	76	----	30.9	69.1	----
13	1	54	7	1.6	87.1	11.3
14	78	112	----	41.1	58.9	----
15	45	7	----	86.5	13.5	----
All groups	208	426	16	32.0	65.5	2.5
White:						
2	----	44	34	----	56.4	43.6
3	6	7	----	46.2	53.8	----
4	1	10	----	9.1	90.9	----
5	4	19	97	3.4	15.8	80.8
6	18	27	4	36.7	55.1	8.2
7	2	136	----	1.4	98.6	----
All groups	31	243	135	7.6	59.4	33.0

DATA FOR 1922

Color of parental lemmas and group number	Reddish yellow	Yellow	White	Reddish yellow	Yellow	White
Reddish yellow:						
2	6	99	----	5.7	94.3	----
17	----	116	----	----	100.0	----
22	3	97	----	3.0	97.0	----
24	----	71	----	----	100.0	----
27	----	56	----	----	100.0	----
31	8	105	3	6.9	90.5	2.6
32	2	78	----	2.5	97.5	----
33	----	75	----	----	100.0	----
37	9	72	----	11.1	88.9	----
All groups	28	769	3	3.5	96.1	.4
Yellow:						
1	20	203	----	9.0	91.0	----
3	----	64	----	----	100.0	----
4	44	40	----	52.4	47.6	----
12	----	43	57	----	43.0	57.0
13	----	155	45	----	77.5	22.5
15	17	64	16	17.5	66.0	16.5

TABLE V.—*Inheritance of lemma color in strains of the Kherson oat grown at the Akron Field Station, Akron, Colo., in 1921, 1922, and 1923*—Con.

DATA FOR 1922—Continued

Color of parental lemmas and group number	Lemma color in progeny: Number of lemmas: Reddish yellow	Number of lemmas: Yellow	Number of lemmas: White	Percentage of lemmas: Reddish yellow	Percentage of lemmas: Yellow	Percentage of lemmas: White
Yellow—Contd.						
16	1	25	----	3.8	96.2	-----
18	11	102	----	9.7	90.3	-----
19	41	26	----	61.2	38.8	-----
20	2	84	----	2.3	97.7	-----
23	----	64	----	------	100.0	-----
25	----	100	----	------	100.0	-----
26	----	78	----	------	100.0	-----
28	----	127	----	------	100.0	-----
29	----	73	----	------	100.0	-----
30	4	71	----	5.3	94.7	-----
34	31	93	----	25.0	75.0	-----
35	----	58	----	------	100.0	-----
38	2	28	----	6.7	93.3	-----
39	----	17	----	------	100.0	-----
40	----	130	----	------	100.0	-----
41	----	75	----	------	100.0	-----
All groups	173	1,720	118	8.6	85.5	5.9
White:						
5	----	105	----	------	100.0	-----
6	42	32	----	56.8	43.2	-----
7	20	37	15	27.8	51.4	20.8
8	6	81	70	3.8	51.6	44.6
9	4	55	26	4.7	64.7	30.6
10	2	54	13	2.9	78.3	18.8
11	----	34	46	------	42.5	57.5
14	12	18	----	40.0	60.0	-----
All groups	86	416	170	12.8	61.9	25.3

DATA FOR 1923

Color of parental lemmas and group number	Number of lemmas: Reddish yellow	Number of lemmas: Yellow	Number of lemmas: White	Percentage of lemmas: Reddish yellow	Percentage of lemmas: Yellow	Percentage of lemmas: White
Reddish yellow:						
3	----	------	102	------	------	100.0
13	----	85	----	------	100.0	-----
All groups	----	85	102	------	45.5	54.5
Yellow:						
1	----	93	----	------	100.0	-----
2	----	44	81	------	35.2	64.8
4	----	------	125	------	------	100.0
5	----	------	97	------	------	100.0
6	----	19	50	------	27.5	72.5
7	----	------	52	------	------	100.0
8	----	118	18	------	86.8	13.2
10	----	125	----	------	100.0	-----
11	----	125	----	------	100.0	-----
12	----	109	----	------	100.0	-----
14	----	43	----	------	100.0	-----
15	----	52	----	------	100.0	-----
16	----	79	----	------	100.0	-----
17	----	125	----	------	100.0	-----
18	----	112	----	------	100.0	-----
19	----	100	----	------	100.0	-----
20	----	78	----	------	100.0	-----
All groups	----	1,222	423	------	74.3	25.7
White:						
9	----	------	138	------	------	100.0

The parental groups in which the lemma color was described as reddish yellow in 1922 produced progenies of which over 96 per cent of the lemmas was yellow. White parental kernels produced progenies in which about 62 per cent of the lemmas was yellow and 13 per cent reddish yellow. Parental kernels classed as yellow produced yellow progeny very largely.

It would be difficult to explain on a factorial basis the data on lemma color shown in Table V. All classes tended to produce a high percentage of yellow kernels. Most of the reddish-yellow lemmas in Kherson apparently are due to physiological causes. The white kernels appeared unstable in breeding behavior in 1921 and 1922, as they produced many of the yellow and reddish-yellow types. In 1923, however, parental white kernels produced only white progeny. Probably many genetic yellows were incorrectly described as white in the 1921 crop, due to physiological influences. This condition is very evident in the progeny of groups 5, 6, and 14, from which no white kernels whatever were produced in 1922. The parent kernels, apparently, were simply bleached yellow.

These data indicate that at least two genetic color types exist in the Kherson oat—yellow and white. The yellow type apparently is decidedly more numerous and also less influenced by physiological factors than the white. Possibly some of the yellows are heterozygous, which would account for the occurrence of white kernels in the progenies of parental kernels described as yellow. Physiological factors may account for some of the progeny of white kernels being described as yellow and reddish yellow in 1921 and 1922.

SUMMARY

The Kherson and Sixty-Day oats are identical for all characters. Together with the pure-line selections developed from them, they constitute a very important agronomic group, occupying about 14 per cent of the oat acreage in the United States in 1919.

Several valuable selections have been made from the variety, among which Albion (Iowa No. 103), Richland (Iowa No. 105), Iowar, Nebraska No. 21, and States Pride (Wisconsin No. 7), are the most important.

The variability of the variety and the possibility of making selections from it have long been recognized.

Numerous crosses using strains of the variety have been made, and the genetic constituton of some of the result-

ant strains has been rather definitely stated. Only a few of these crosses have produced strains of any economic promise.

Spikelet disarticulation by abscission, so characteristic of Red Rustproof oats, does not occur in Kherson. Disarticulation by semiabscission breeds true in some strains, but shows apparent segregation in others. Most strains show the more or less rough and pointed base resulting from fracture, which is characteristic of *Avena sativa* varieties.

Floret disjunction in strains of Kherson oat is predominantly by disarticulation, as in *Avena sativa,* and probably is homozygous. The very small percentage of kernels showing floret disjunction either by basifracture, as in *A. sterilis*, or by heterofracture, an intermediate type, can be explained on the principle of chance variation.

Basal hairs appear exceedingly complex in their mode of inheritance. With few exceptions all basal hairs in the Kherson oat are midlength to short. Several factors apparently are involved and further study is necessary to determine their true genetic behavior.

The inheritance of awn type apparently shows no definite relation between the presence of awns and kernel color. This is contrary to the results obtained by certain other investigators. The data obtained in the present investigations indicate that the yellow color of the Kherson strain used does not carry an inhibitor for awns, as all types of awns have been found on yellow kernels. It has been shown further that it is possible to isolate yellow-kerneled strains which apparently are homozygous for certain awn types as well as for practically complete awnlessness. Several factors apparently are concerned in the production of awns in Kherson oats. Further investigations are necessary to determine the genotypic constitution of strains having different awn types and the influence of physiological factors on awn production.

Apparently only two factors for color exist in Kherson oat lemmas—viz., one for yellow and one for white. Some strains evidently are heterozygous for lemma color, but yellow is predominant, and many yellow strains are homozygous, as shown by their breeding behavior. Some white strains exist in Kherson, but they are much less numerous. Apparently physiological influences often cause genetically yellow kernels to be classed as phenotypically white kernels and vice versa.

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