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OATS: A STANDARDIZED
SYSTEM OF NOMENCLATURE
FOR GENES AND
CHROMOSOMES
AND CATALOG OF GENES
GOVERNING CHARACTERS

IN COOPERATION WITH IOWA AGRICULTURE
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This publication was prepared by the Science and Education Administration's Federal Research staff, which was formerly the Agricultural Research Service.

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Oats: A Standardized System Of Nomenclature For Genes And Chromosomes And Catalog Of Genes Governing Characters

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INTRODUCTION

In 1966, a set of rules for symbolization of genes governing characters in oats and a list of genes were published by a committee that had been assigned this task (Simons, Zillinsky, and Jensen, 1966).³ This publication emphasized the need for a unified system, and noted that standardized systems of genetic nomenclature had been established for corn (Emerson, Beadle, and Fraser, 1935), barley (Robertson, Wiebe, and Immer, 1941), and wheat (Ausemus, Harrington, Reitz, and Worzella, 1946). These and other reports on gene nomenclature were studied before the rules for oat genes were adapted from the guide by the International Committee on Genetic Symbols and Nomenclature (Tanaka *et al.*, 1957).

Experience has shown that this system is basically sound. It can be used with ease by people who are interested in the facets of basic and applied genetics of oats. Since publication of the original set of rules and list of genes, however, several errors have been noted, and many new genes have been discovered. Evidence shows that the rules needed certain minor revisions and some expansion to cover additional aspects of oat genetics. Also, new or revised systems, reflecting new developments and concepts in the field, have been published or proposed for wheat (Kimber and Sears, 1968; McIntosh, 1973), and for barley (Ramage, 1972).

With these thoughts in mind, a second committee, consisting of the authors, was formed, and this publication is the result of their work.

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³Authors and year of publication (*italic*) in parentheses refer to References, p. 24.

RULES FOR SYMBOLIZING GENES AND CHROMOSOMES OF OATS

The rules for oat gene nomenclature published in 1966 (Simons, Zilinsky, and Jensen, 1966) were based on the report (Tanaka *et al.*, 1957) of a committee appointed by the Permanent International Committee for Genetics Congresses. The general rules established by the Tanaka Committee remain as the basic guide to the rules for oat gene nomenclature. Rules for nomenclature of aneuploids in wheat were established by Kimber and Sears (1968). A summary of the most applicable of these rules, adapted for oats, also is included in our list of rules. (The original publication should be consulted when additional details or examples of the symbolization of aneuploids are needed.)

1. Symbols of genes, derived from the English name of the character involved or from the Latin name of the organism, as in the case of reaction to a pathogen or insect, will be written in Roman letters. The basic symbol will begin with a capital letter, and, with the exception of genes for reaction to living organisms, this symbol will stand for the dominant allele where only two alleles, one dominant, are known. A recessive allele may be indicated by starting the symbol with a small letter. Symbols for all alleles for reaction to living organisms will start with a capital letter (see rule 2). Each symbol will be short, suggestive, different from all other symbols used for oat genes, and contain not more than one capital letter.

2. Two or more genes governing expression of the same character, or otherwise conditioning phenotypically similar effects, will be designated by a common basic symbol. This means that all genes governing reaction to a specific disease organism, without reference to races of the pathogen or cultivars of the host, will have the same basic symbol. Similarly, all genes governing electrophoretically detectable isozymes of the same enzyme will have the same basic symbol. Within a basic symbol, nonallelic loci will be distinguished by an Arabic numeral on the same line after a hyphen following the basic symbol. The first locus discovered for a character will be assigned the number 1, the second 2, and so on. Members of allelic series will be distinguished by small letters that follow immediately after the locus number. The letters a and b will refer to the original allele-pair. For alleles governing reaction to living organisms, the letter a will refer to the allele conditioning resistance and b for the allele conditioning susceptibility, regardless of dominance relationships.

3. Genes identified by use of aneuploids will be given symbols on the same basis as any other genes. Descriptions of such genes will indicate that they were identified by means of aneuploidy and include monoeffect and nullieffect, where appropriate.

4. Inhibitors, suppressors, enhancers, lethals, and sterility genes will be designated, by the symbols I, Su, En, L, and S, or if they are recessive,

i, su, en, l, and s followed by a hyphen and the symbol of the gene affected.

5. No "wild type" will be recognized as a standard type, and genes occurring in diploid, tetraploid, and hexaploid species will be included in a single system.

6. Linkage groups and corresponding chromosomes will be designated by Arabic numerals.

7. Genic formulas will be written as fractions, with the maternal alleles written as numerators. Each fraction will correspond to a single linkage group. Different linkage groups written in numerical sequence are separated by semicolons. Symbols of unlocated genes will be placed within parentheses at the end of the formula. In euploids and aneuploids, the gene symbols will be repeated as many times as there are homologous loci.

8. Symbols of extrachromosomal factors will be enclosed within brackets and will precede the formula.

9. Chromosomal aberrations will be indicated by abbreviations: Df for deficiency, Dp for duplication, In for inversion, T for translocation, and Tp for transposition. A summary of rules specifically for nomenclature of aneuploids are:

a. Complete chromosomes will be designated by Arabic numerals. This rule will apply to chromosomes paired in homologous bivalents, trivalents or other multivalents, and also in the unpaired monosomic condition.

b. Telocentric chromosomes will be designated by the letter t, whether or not the telocentric chromosome is involved in a pairing configuration. If the telocentric chromosome is paired with a complete chromosome, the telocentric designation will precede the complete chromosome designation.

c. Isochromosomes will be designated by the small letter i, whether or not the isochromosome is involved in a pairing configuration.

d. Nullisomics will be indicated by the symbol O, followed by the symbols indicating which chromosome is absent.

e. The ability of chromosomes to pair will be indicated by superscripts following the chromosome symbols. For example, a euploid plant of *Avena sativa* will be designated as $2l''$, and a monosomic deficiency as $20'' + 1'$.

f. At the time this is being written, there is no consensus among different investigators regarding numbering schemes for the chromosome complement. Therefore, rules on designation of chromosomes are being delayed until a standard numbering system can be devised.

10. The zygotic number of chromosomes will be indicated by $2n$, the gametic number by n , and the basic number by x .

OAT GENES AND ASSIGNED SYMBOLS

A survey of literature reporting genetic studies of oats attempted to determine which reports duplicated the discoveries of earlier investigators. This often necessitated making more or less arbitrary decisions. In general, for genes governing disease reaction, a gene reported by second and subsequent investigators in the same or obviously related cultivars was assumed the same as the gene first reported in that cultivar for that character unless a different gene was evident. Genes conditioning the same basic character, but reported from unrelated cultivars, were assumed to be neither identical nor allelic unless there were some reason.

For genes of characters other than disease reaction, genes governing expression of the same character were assumed identical if they were reported from oats having the same genome constitution, unless there were some reason to think otherwise.

The genes, or loci, recognized are listed alphabetically by symbol. The reference given after each symbol is usually, but not always, the earliest reported discovery of the gene based on the committee's investigations. References listed after the description report additional studies of the gene or pertain to genes now tentatively regarded as the same gene. Future investigations or a more critical examination of existing data may show that some of these reports actually dealt with distinct genes. When this occurs, such genes will be assigned their own numbers. Descriptions, symbols, and pages on which they appear follow:

Awnedness (A)	5
Awn pubescence (Ap)	6
Basal articulation (Ba)	6
Blast (Bl)	7
Chlorophyll deficiency-albino (Cda)	7
Chlorophyll deficiency-chlorina (Cdc)	7
Chlorophyll deficiency-lutescens (Cdl)	7
Chlorophyll deficiency-netting (Cdn)	8
Chlorophyll deficiency-stripe (Cds)	8
Chlorophyll deficiency-albovirescens (Cdv)	8
<i>Ditylenchus dipsaci</i> reaction (Dd)	8
Dwarfness (Dw)	8
Esterase (E)	8
<i>Erysiphe graminis</i> reaction (Eg)	8
Floret disjunction (Fd)	9
Floret development (Fl)	9
Fatuoid (Ft)	9
Gametophyte (Gf)	9
Giantism (Gi)	9

<i>Heterodera avenae</i> reaction (Ha)	9
<i>Helminthosporium victoriae</i> reaction (Hv)	9
Peduncle development (Kn)	9
Kernel pubescence (Kp)	10
Lethal (L)	10
Lemma color (Lc)	10
Lemma fluorescence (Lf)	11
Ligule development (Lg)	11
Leaf necrosis (Ln)	12
Lemma pubescence (Lp)	12
Lemma waxiness (Lw)	12
Maturity (Ma)	12
Multiple glumes (Mg)	12
Male sterility (Ms)	12
Naked seed (N)	13
Nonheading (Nh)	13
Nodal pubescence (Np)	13
Phosphatase (P)	13
<i>Puccinia coronata</i> reaction (Pc)	13
<i>Puccinia graminis</i> reaction (Pg)	18
<i>Pseudomonas coronafaciens</i> reaction (Psc)	20
Panicle type (Pt)	20
Peroxidase (Px)	20
Rachilla pubescence (Rp)	21
Straw color (Sc)	21
Synapsis (Syn)	21
<i>Toxoptera graminum</i> reaction	21
<i>Ustilago kolleri</i> and <i>U. avenae</i> reaction	22

Gene

Symbol

Reference and description

- A-1. Norton (1907). Gene conditioning awnedness in cultivated hexaploid oats. Dominance and expressivity variable. Nilsson-Ehle (1914), Surface (1916), Zinn and Surface (1917), Love and Fraser (1917), Wilds (1917), Love and Craig (1918b), Fraser (1919), Henning (1924), Reed and Stanton (1925), Cotner (1929), Tschermak (1929), Shaw and Bose (1933), Philp (1933), Johnson (1933), Aamodt *et al.* (1934), De Villiers (1935), Tang (1938), Torrie (1939), Ko *et al.* (1946), Coffman (1964).

- A-2. Zade (1912). Gene conditioning awnedness in wild hexaploid oats. Dominance and expressivity variable. Possibly pleiotropic for basal articulation. Surface (1916), Love and Fraser (1917), Wilds (1917), Love and Craig (1918b), Tschermak (1929), Philp (1933), Aamodt *et al.* (1934).
- A-3. Wiggans (1918). A second gene conditioning awnedness in wild hexaploid oats. Dominance and expressivity variable. Possibly pleiotropic for basal articulation. Reed and Stanton (1925), Tschermak (1929), Coffman (1964).
- A-4. Jones (1940). Gene conditioning awnedness in diploid and tetraploid oats. Possibly pleiotropic for basal articulation. Dyck (1966).
- A-5. Nishiyama (1933). Gene for absence of awns on primary and secondary floret. Discovered by monosomic analysis.
- ap-1. Tang (1938). Recessive gene conditioning awn pubescence in strains of *A. sterilis macrocarpa*.
- Ba-1. Surface (1916). A generally partly dominant gene conditioning the "cultivated" type of basal articulation of the primary floret in crosses with species and varieties having "wild" type basal articulation. Wilds (1917), Wiggans (1918), Love and Craig (1918b), Fraser (1919), Henning (1924), Coffman *et al.* (1925), Goulden (1926), Tschermak (1929), Ma (1933), Philp (1933), Shaw and Bose (1933), Aamodt *et al.* (1934), Middleton (1938), Tang (1938), Hayes *et al.* (1939), Torrie (1939), Ko *et al.* (1946), Kehr and Hayes (1950), Day (1963), Coffman (1964).
- Ba-2. Tschermak (1929). Second gene conditioning "cultivated" type of basal articulation of the primary floret in crosses between *A. sativa*, and between *A. fatua* and *A. sterilis*.
- Ba-3. Ko *et al.* (1946). Gene conditioning "cultivated" type of basal articulation of the primary floret in SD334, complementary with Ba-4.
- Ba-4. Ko *et al.* (1946). Gene conditioning "cultivated" type of basal articulation of the primary floret in SD334, complementary with Ba-3.
- Ba-5. Jones (1940). Dominant gene conditioning "wild" type basal articulation of the primary floret in diploid and tetraploid species of *Avena*, complementary with Ba-6. Designated "X."
- Ba-6. Jones (1940). Second dominant gene conditioning "wild type" basal articulation of the primary floret in diploid and tetraploid species of *Avena*, complementary with Ba-5. Designated "Y."
- Ba-7. Nishiyama (1973). Gene for wild type of basal articulation of

- primary and secondary florets, in progeny of *A. barbata* x *A. strigosa*. Designated "W."
- Ba-8. Nishiyama (1973). Complementary gene conditioning, with ba-7b, basifracture of the secondary floret, hypostatic to Ba-7, in progeny of *A. barbata* x *A. strigosa*. Designated "B."
- Ba-9. Nishiyama (1933). Dominant gene for the cultivated type of basal articulation of the primary and secondary floret. Discovered by monosomic analysis.
- B1-1. Mackie (1928). Partly dominant gene for resistance to blast in Kanota.
- cda-1. Nishiyama (1941). Gene for chlorophyll deficiency-albino, linked to ma-1 and L-1, in progeny of *A. barbata* x *A. strigosa*. Designated "al," "G," and "C." Nishiyama (1934).
- cda-2. Nishiyama (1957). Gene for chlorophyll deficiency-albino, linked to Lp-9 and Lc-12, in progeny of *A. barbata* x *A. strigosa*.
- cda-3. Smith (1938). Recessive gene for chlorophyll deficiency-albino found in progeny of Victoria.
- Cda-4. McGinnis and Taylor (1961). Gene for normal chlorophyll production (nullieffect). ST chr 21 (Rajhathy's karyotype, 1963). McGinnis *et al.* (1963).
- Cda-5. McGinnis and Andrews (1962). Gene for normal chlorophyll production (nullieffect). SM chr 15 (Rajhathy's karyotype, 1963).
- Cda-6. McGinnis (1966). Gene for normal chlorophyll production (nullieffect) reported by Dyck and Rajhathy (1965). McGinnis *et al.* (1968).
- cdc-1. Åkerman and Froier (1941). Gene conditioning chlorophyll deficiency-chlorina in Golden Rain. Designated "Chlor 1." Froier (1946), Morey and Earhart (1952).
- cdc-2. Åkerman and Froier (1941). Gene conditioning chlorophyll deficiency-chlorina in Golden Rain. Designated "Chlor 2." Froier (1946).
- cdc-3. Åkerman and Froier (1941). Gene conditioning chlorophyll deficiency-chlorina in Golden Rain. Designated "Chlor 3." Froier (1946).
- cdc-4. Nishiyama (1957). Recessive gene for yellow plant color, in progeny of *A. barbata* x *A. strigosa*.
- cdl-1. Froier (1946). Gene conditioning chlorophyll deficiency-lutescens in Novahavre. Designated "Lp." Åkerman (1922).
- cdl-2. Froier (1946). Second gene conditioning chlorophyll deficiency-lutescens in Novahavre. Designated "Ln." Åkerman (1922).
- cdl-3. Froier (1946). Gene conditioning chlorophyll deficiency-

- lutescens in the variety Swedish. Designated "Ls." Åkerman (1922).
- cdn-1. Chang and Sadanaga (1964). Gene conditioning chlorophyll deficiency-netting in A 382-91-2, on Monosome A. Designated "nt-1."
- cdn-2. Chang and Sadanaga (1964). Gene conditioning chlorophyll deficiency-netting in A 382-91-2.
- cds-1. Coffman (1964). Gene conditioning chlorophyll deficiency-stripe (yellow) in Burt.
- cds-2. Coffman (1964). Second gene conditioning chlorophyll deficiency-stripe (yellow) in Burt.
- cds-3. Coffman (1964). Third gene conditioning chlorophyll deficiency-stripe (yellow) in Burt.
- cdv-1. Froier (1948). Gene conditioning chlorophyll deficiency-albovirescens. Abrams *et al.* (1964).
- Dd-1. Griffiths and Holden (1957). Dominant gene carried by Gray Winter for resistance to the stem eelworm, *Ditylenchus dipsaci* (Kühn). Filipjev.
- dw-1. Warburton (1919). Recessive gene conditioning grassy dwarfness in plants derived from Victory.
- Dw-2. Stanton (1923). Gene for semidwarfness in progeny of Winter Turf x Sixty Day. Designated "D." Cotner (1929), Florell (1931), Litzenberger (1949b).
- Dw-3. Stanton (1923). Gene for semidwarfness in progeny of Aurora x Pringle Progress. Cotner (1929), Florell (1931), Litzenberger (1949b).
- Dw-4. Derick (1930). Gene for semidwarfness in Trelle Dwarf. Patterson *et al.* (1963).
- dw-5. Nishiyama (1957). Recessive gene for dwarfness, in progeny of *A. barbata* x *A. strigosa*.
- Dw-6. Brown and McKenzie (1976).⁴ A completely dominant gene for dwarfness in a Harmon derivative induced by irradiation.
- E-1. Marshall and Allard (1969). Gene for esterase in certain strains of *Avena barbata*. Designated "E₄."
- E-2. Marshall and Allard (1969). Gene for esterase in certain strains of *Avena barbata*. Designated "E₉."
- E-3. Marshall and Allard (1969). Gene for esterase in certain strains of *Avena barbata*. Designated "E₁₀."
- Eg-1. Jones and Griffiths (1952). Gene for resistance to *Erysiphe graminis* DC. in Cc4146.
- Eg-2. Jones and Griffiths (1952). Gene for resistance to *Erysiphe graminis* in *A. strigosa*.

⁴Personal communication.

- Eg-3. Hayes and Jones (1966). Gene for resistance to races 2 and 3 of *Erysiphe graminis* in Cc4347.
- Eg-4. Thomas, Leggett, and Jones (1975). Gene for resistance to all currently prevalent races of *Erysiphe graminis* in *Avena barbata* Cc4897. Was transferred to *A. sativa* Manod.
- Fd-1. Wiggans (1918). Gene for type of secondary floret disjunction. Henning (1924), Cotner (1929), Tschermak (1929), Florell (1931), Ma (1933), Torrie (1939), Hayes *et al.* (1939), Ko *et al.* (1946), Coffman (1964).
- Fd-2. Ko *et al.* (1946). Second gene for type of secondary floret disjunction. See "Fd-1" for possible additional references.
- fl-1. Dyck (1968). Recessive gene affecting the normal development of florets of *A. strigosa* spikelets are completely lacking on plants of this mutant.
- I-Ft-1. Huskins (1927). Gene that inhibits the expression of fatuoid characters (nullieffect). Heterozygote fatuoid (monoeffect). Nishiyama (1931), Hacker and Riley (1965), Singh and Wallace (1967), Thomas and Mytton (1970), Chang and Sadanaga (1964).
- Gf-1. Nishiyama (1973). Gametophyte gene effecting preferential fertilization of pollen, in progeny of *A. barbata* x *A. strigosa*. Designated "g."
- Gi-1. Zhegalov (1920). Dominant gene for giantism in *A. orientalis*.
- gi-2. Zillinsky (1959). Recessive gene ("monster") for giantism in progeny of Clintland-Garry x Laurel-Klein 69B.
- Ha-1. Andersen (1961). Gene in Grise de Houdan for resistance to the cereal root eelworm, *Heterodera avenae* Woll.
- Ha-2. Andersen (1961). Dominant gene in certain American oat varieties for resistance to the cereal root eelworm, *Heterodera avenae* Woll.
- Ha-3. MacKey (1975).⁵ Gene for resistance to the oat cyst nematode (*Heterodera avenae* Filipjev) derived from the *Avena sterilis* cv. Ronda.
- Hv-1. Murphy and Meehan (1946). Dominant gene in Victoria for susceptibility to Victoria blight, caused by *Helminthosporium victoriae* Meehan and Murphy. May be pleiotropic or closely linked to Pc-2. Litzenberger (1949a), Finkner (1953), Welsh *et al.* (1954).
- kn-1. Gauthier and McGinnis (1965). Gene for normal peduncle (neck) development (nullieffect—distinct kinking of the neck). Hacker and Riley (1965).

⁵Personal communication.

- Kp-1. Nilsson-Ehle (1908). Gene for long hairs (kernel pubescence) at base of kernel. Zinn and Surface (1917).
- Kp-2. Nilsson-Ehle (1908). Gene for short hairs (kernel pubescence) at base of kernel. Zinn and Surface (1917).
- Kp-3. Zade (1912). Gene for heavy kernel pubescence in *A. fatua*. Wilds (1917), Tschermak (1929), Jones (1930), Federova (1930), Philp (1933), Aamodt *et al.* (1934).
- Kp-4. Wiggans (1918). Gene for kernel pubescence in Red Texas. Fraser (1919), Schafer (1923), Henning (1924), Cotner (1929), Shaw and Bose (1933), Ma (1933), Tang (1938), Middleton (1938), Torrie (1939), Hayes *et al.* (1939), Ko *et al.* (1946), Litzemberger (1949b), Kehr and Hayes (1950), Craigmiles (1952), Coffman (1964).
- Kp-5. Wiggans (1918). Second gene for kernel pubescence in Red Texas. Shaw and Bose (1933), Tang (1938).
- Kp-6. Henning (1924). Gene for dense kernel pubescence in *A. sterilis nigra*.
- Kp-7. Federova (1930). Gene modifying kernel pubescence. Designated "m₁." Ma (1933).
- Kp-8. Federova (1930). Second gene modifying kernel pubescence. Ma (1933).
- Kp-9. Ko *et al.* (1946). Complementary gene conditioning, with Kp-10, kernel pubescence in cross between Bond and SD334.
- Kp-10. Ko *et al.* (1946). Complementary gene conditioning, with Kp-9, kernel pubescence in cross between Bond and SD334.
- Kp-11. Nishiyama (1933). Gene for glabrous base of primary and secondary floret. Discovered by monosomic analysis.
- 1-1. Nishiyama (1934). Lethal gene, linked to Ma-1 and Cda-1, in progeny of *A. barbata* x *A. strigosa*. Nishiyama (1941).
- 1-2. Nishiyama (1934). Lethal gene, linked to Ba-7, in progeny of *A. barbata* x *A. strigosa*. Designated "1." Nishiyama (1973).
- Lc-1. Wilson (1904). Incompletely dominant gene for black or dark lemma color. Norton (1907), Wilson (1907), Nilsson-Ehle (1909), Surface (1916), Zinn and Surface (1917), Wilds (1917), Love and Craig (1918b), Caporn (1918), Wakabayashi (1921), Gaines (1924), Quisenberry (1926), Meurman (1927), Garber and Quisenberry (1928), Hayes *et al.* (1928), Odland (1928), Federova (1930), Welsh (1931), Florell (1931), Robb (1932), Ru (1933), Johnson (1933), Philp (1933), Ma (1933), Aamodt *et al.* (1934), De Villiers (1935), Åkerman and Bader (1937), Tang (1938), Middleton (1938), Patel (1941), Åkerman (1948), Coffman (1964).
- Lc-2. Nilsson-Ehle (1909). Gene for gray lemma color expressed only in the absence of black. Designated "Gr." Surface (1916),

- Wilds (1917), Love and Craig (1918b), Caporn (1918), Henning (1924), Meurman (1927), Federova (1930), Welsh (1931), Robb (1932), Johnson (1933), Philp (1933), Ma (1933), Aamodt *et al.* (1934), Coffman (1964).
- En-Lc-2. Meurman (1927). Gene that intensifies gray lemma color in the presence of Lc-2. Designated "Z."
- Lc-3. Nilsson-Ehle (1909). Second gene for black lemma color. Designated "S₂." Robb (1932), Akerman (1948), Coffman (1964).
- Lc-4. Nilsson-Ehle (1909). Gene for yellow lemma color. Designated "G." Surface (1916), Wilds (1917), Love and Craig (1918b), Fraser (1919), Cotner (1929), Ma (1933), Torrie (1939), Coffman (1964).
- Lc-5. Fraser (1919). Second gene for yellow lemma color. Designated "Y."
- Lc-6. Fraser (1919). Gene for red lemma color. Designated "R." Schafer (1923), Henning (1924), Cotner (1929), Torrie (1939), Ko *et al.* (1946), Coffman (1964).
- Lc-7. Cotner (1929). Second gene for red lemma color. Coffman (1964).
- Lc-8. Welsh (1931). Dominant gene for white lemma color.
- Lc-9. Welsh (1931). Second dominant gene for white lemma color.
- Lc-10. Ko *et al.* (1946). Complementary gene conditioning, with Lc-11, white to yellowish lemma color.
- Lc-11. Ko *et al.* (1946). Complementary gene conditioning, with Lc-10, white to yellowish lemma color.
- Lc-12. Nishiyama (1934). Gene for light-brown lemma color, dominant over gray lemma color of *A. strigosa*, linked to Lp-9 and cda-2, in progeny of *A. barbata* x *A. strigosa*. Designated "B1." Nishiyama (1957).
- Lf-1. Finkner, Murphy, Atkins, and West (1954). Dominant gene for lemma fluorescence under UV. Designated "F." May be associated with lemma color.
- Lf-2. Finkner, Murphy, Atkins, and West (1954). Second dominant gene for lemma fluorescence under UV. Designated "L." May be associated with lemma color.
- Lg-1. Nilsson-Ehle (1909). Dominant gene for presence of ligule in open panicle oats. Designated "L₁." Love and Craig (1918a), Garber (1922), Meurman (1927), Odland (1928), Akerman and Muhlow (1933).
- Lg-2. Nilsson-Ehle (1909). Second dominant gene for presence of ligule in open panicle oats. Designated "L₂." Love and Craig (1918a), Garber (1922), Meurman (1927), Odland (1928), Akerman and Muhlow (1933).

- Lg-3. Nilsson-Ehle (1909). Third dominant gene for presence of ligule in open panicle oats. Designated "L₃." Meurman (1927), Åkerman and Muhlow (1933).
- Lg-4. Nilsson-Ehle (1909). Fourth dominant gene for presence of ligule in open panicle oats. Designated "L₄."
- ln-1. Sadanaga (1971). Recessive gene conditioning leaf necrosis, which is temperature sensitive.
- Lp-1. Bartlett (1916). Dominant gene for lemma pubescence in *A. fatua*. Surface (1916), Wilds (1917), Love and Craig (1918b), Federova (1930), Florell (1931), Ma (1933), Philp (1933), Aamodt *et al.* (1934), De Villiers (1935).
- I-Lp-1. Barlett (1916). Gene inhibiting expression of Lp-1. Love and Craig (1918b), Federova (1930), Ma (1933), De Villiers (1935).
- Lp-2. Wilds (1917). Second dominant gene for lemma pubescence in *A. fatua*. Philp (1933).
- Lp-3. Cotner (1929). Gene for Lemma pubescence in *A. sterilis*. Tang (1938).
- Lp-4. Cotner (1929). Second gene for lemma pubescence in *A. sterilis*. Tang (1938).
- Lp-5. Tang (1938). Third gene for lemma pubescence in *A. sterilis*.
- Lp-6. Nishiyama (1934). Gene for prostrate hairs of lemma, dominant over glabrous in progeny of *A. barbata* x *A. strigosa*. Designated "P₁."
- Lp-7. Nishiyama (1934). Complementary gene conditioning, with Lp-6 and Lp-8, erect hairs on lemma, in progeny of *A. barbata* x *A. strigosa*. Designated "C."
- Lp-8. Nishiyama (1934). Complementary gene conditioning, with Lp-6 and Lp-7, erect hairs on lemma, in progeny of *A. barbata* x *A. strigosa*. Designated "E."
- Lp-9. Nishiyama (1957). Dominant gene for slight pubescence on lemma, linked to Lc-12 and cda-2, in progeny of *A. barbata* x *A. strigosa*. Designated "P₂."
- Lw-1. Nilsson-Ehle (1908). Gene for lemma waxiness. Meurman (1927).
- Ma-1. Nishiyama (1941). Dominant gene for early maturity, linked to Cda-1 and l-1, in progeny of *A. barbata* x *A. strigosa*. Designated "Re."
- mg-1. Dyck (1968). Recessive gene conditioning complete sterility, with floral parts replaced by a series of glumes, in *Avena strigosa*.
- ms-1. Nishiyama (1957). Recessive gene for male sterility in progeny of *A. barbata* x *A. strigosa*. Meiosis usually stops at diakinesis.
- ms-2. Sadanaga (1965). Recessive gene for partial male sterility in X-irradiated Saia (*Avena strigosa*).

- N-1. Norton (1907). Gene, with variable dominance, conditioning naked seed and multiflorous spikelet. Tschermak (1910), Gaines (1917), Zinn and Surface (1917), Caporn (1918), Love and McRostie (1919), Reed (1925), Lebedeff (1930), Chou (1932), Clamont (1969), Moule (1972), Boland and Lawes (1972), Atiyya and Williams (1976).
- N-2. Moule (1972). Secondary gene that modifies the expression of the N-1 gene.
- N-3. Moule (1972). Further secondary gene that modifies the expression of the N-1 gene.
- nh-1. Nishiyama (1934). Recessive gene for nonheading, in progeny of *A. barbata* x *A. strigosa*. Nishiyama (1957).
- Np-1. Florell (1931). Gene for nodal pubescence in *A. sterilis* and *A. byzantina*. Litzenger (1949a), Craigmiles (1952).
- P-1. Marshall and Allard (1969). Gene for phosphatase in certain strains of *Avena barbata*. Designated "P_s."
- Pc-1. Davies and Jones (1927). Dominant gene for resistance to crown rust, caused by *Puccinia coronata* Cda. var. *avenae* Fraser and Led., in Red Rustproof. Designated "S" by Dietz and Murphy (1930).
- I-Pc-1. Dietz and Murphy (1930). Dominant gene inhibiting Pc-1. Designated "I."
- Pc-2. Murphy *et al.* (1937). Partially dominant gene for resistance to *P. coronata* race 1 in Victoria. Is pleiotropic or closely linked with Hv-1. Waterhouse (1939), Weetman (1942), Cochran *et al.* (1945), Murphy and Meehan (1946), Litzenger (1949b), Vallega (1951), Finkner (1953), Griffiths (1953), Finkner (1954), Welsh *et al.* (1954), Simons (1956), Craigmiles (1956), Chang (1959), Chang and Sadanaga (1964).
- Pc-2b. Finkner (1954). Gene for resistance to *P. coronata* race 57 in Anthony-Bond x Boone. Designated "V₁" and is not associated with susceptibility to *Helminthosporium victoriae*.
- Pc-3. Hayes *et al.* (1939). Complementary gene conditioning, with Pc-4, resistance to *P. coronata* in Bond. Torrie (1939), Weetman (1942), Cochran *et al.* (1945), Ko *et al.* (1946), Litzenger (1949b), Kehr and Hayes (1950), Griffiths (1953), Sebesta (1976).
- Pc-3c. Weetman (1942). Complementary gene conditioning, with Pc-4c, resistance to some isolates of *P. coronata* race 1 in Ukraine. Upadhyaya and Baker (1962b).
- I-Pc-3. Cochran *et al.* (1945). Dominant gene in Richland-Fulghum that inhibits Pc-3. Designated "C."
- Pc-4. Hayes *et al.* (1939). Complementary gene conditioning, with Pc-3, resistance to *P. coronata* in Bond. Torrie (1939), Weet-

- man (1942), Cochran *et al.* (1945), Ko *et al.* (1946), Litzenberger (1949b), Kehr and Hayes (1950), Griffiths (1953), Šebesta (1976).
- Pc-4c. Weetman (1942). Complementary gene conditioning, with Pc-3b, resistance to some isolates of *P. coronata* race 1 in Ukraine. Upadhyaya and Baker (1962b).
- I-Pc-4. Cochran *et al.* (1945). Dominant gene in Richland-Fulghum that inhibits Pc-4. Designated "D."
- Pc-5. Litzenberger (1949a). Dominant gene for resistance to *P. coronata* races 1 and 45 in Landhafer. Kehr and Hayes (1950), Finkner (1954), Simons and Murphy (1954), Baker (1955), Craigmiles (1956), Chang (1959), Rivers (1959), Upadhyaya and Baker (1962b), Patterson *et al.* (1963), Chang and Sadanaga (1964).
- Pc-6. Litzenberger (1949b). Dominant gene for resistance to *P. coronata* races 1 and 45 in Santa Fe. Designated "S." Osler and Hayes (1953) designated it "S"; Finkner (1954) designated it "M₁"; Simons and Murphy (1954), Baker (1955), Finkner *et al.* (1955), Craigmiles (1956), and Chang (1959) designated it "M." Upadhyaya and Baker (1962b).
- Pc-6c. Finkner (1954). Dominant gene for resistance to *P. coronata* race 57 in Ukraine. Designated "M" and is linked to Pc-9. Finkner *et al.* (1955), Sanderson (1960), Upadhyaya and Baker (1962b).
- Pc-6d. Finkner (1954). Dominant gene for resistance to *P. coronata* race 57 in Trispermia and Anthony-Bond x Boone. Designated "M₂." Simons and Murphy (1954), Baker (1955), Craigmiles (1956), Upadhyaya and Baker (1962b).
- Pc-7. Osler and Hayes (1953). Complementary gene conditioning, with Pc-8, resistance to *P. coronata* races 45 and 57 in Santa Fe. Designated "D."
- Pc-8. Osler and Hayes (1953). Complementary gene conditioning, with Pc-7, resistance to *P. coronata* races 45 and 57 in Santa Fe. Designated "D."
- Pc-9. Finkner (1954). Second dominant gene for resistance to *P. coronata* race 57 in Ukraine. Designated "U" and is linked to Pc-6c. Finkner *et al.* (1955), Sanderson (1960), Upadhyaya and Baker (1962b).
- Pc-9c. Simons and Murphy (1954). Gene for resistance to *P. coronata* races 45 and 101 in a derivative of Santa Fe. It is linked to Pc-6. Finkner *et al.* (1955) designated it "U," and Chang (1959) used the same symbol.
- Pc-10. Finkner (1954). Dominant gene for resistance to *P. coronata* race 57 in Klein 69B. Designated "K." Sanderson (1960).

- I-Pc-10. Finkner (1954). Dominant gene in Clinton inhibiting Pc-10. Designated "I_k."
- Pc-11. Welsh *et al.* (1954). Dominant gene for resistance to *P. coronata* races 1 and 45 in Victoria. Waterhouse (1939), Vallega (1951), Chang and Sadanaga (1964).
- Pc-12. Welsh *et al.* (1954). Second dominant gene for susceptibility to *P. coronata* races 1 and 45 in Victoria.
- Pc-13. Finkner *et al.* (1955). Dominant gene for resistance to *P. coronata* race 109 in Clinton. Designated "A." Chang (1959) designated it "b^R."
- Pc-13c. Chang (1959). Gene for susceptibility to *P. coronata* race 258 De Argelia and Dom Pedrito. Designated "B."
- Pc-13d. Chang (1959). Second gene for susceptibility to *P. coronata* race 258 De Argelia and Dom Pedrito. Designated "b."
- I-Pc-13. Chang (1959). Dominant gene inhibiting Pc-13, in Gopher and other lines.
- Pc-14. Simons (1956). Dominant gene for resistance to *P. coronata* race 202 in Ascencao. Designated "E." Chang (1959).
- I-Pc-14. Chang (1959). Dominant gene inhibiting Pc-14, in Gopher and other lines. Designated "I_E."
- Pc-15. Murphy *et al.* (1958). Dominant gene for resistance to *P. coronata* races 202 and 258 in the diploid Saia. Simons *et al.* (1959), Marshall and Myers (1961), Dyck and Zillinsky (1962), Dyck and Zillinsky (1963).
- Pc-16. Murphy *et al.* (1958). Second dominant gene for resistance to *P. coronata* races 202 and 258 in the diploid Saia. Marshall and Myers (1961).
- Pc-17. Murphy *et al.* (1958). Third dominant gene for resistance to *P. coronata* races 202 and 258 in the diploid Saia.
- Pc-18. Simons *et al.* (1959). Dominant gene for resistance to *P. coronata* races 205, 216, and 264 in the diploid Glabrota. Marshall and Myers (1961).
- Pc-19. Simons *et al.* (1959). Dominant gene for resistance to *P. coronata* races 205, 227, and 264 in the diploid C.I. 3815. Marshall and Myers (1961).
- Pc-20. Simons *et al.* (1959). Gene for resistance to *P. coronata* races 202, 203, 205, 216, and 264 in the tetraploid C.I. 7233.
- Pc-21. Chang (1959). Gene for resistance to *P. coronata* races 203, 216, and 258 in Santa Fe. Designated "S."
- Pc-22. McKenzie (1961). Incompletely dominant gene for resistance to *P. coronata* races 264, 279, and 290 in Ceirch dubach.
- Pc-23. Dyck and Zillinsky (1963). Gene for resistance to *P. coronata* race 264 (but not race 294) in the diploid C.D. 3820.
- Pc-24. Upadhyaya and Baker (1960). Complementary dominant gene

- conditioning resistance, with Pc-25, to *P. coronata* races 203, 226, 230, 237, and 286 in Garry. Designated "Vc_a." Upadhyaya and Baker (1962b).
- Pc-25. Upadhyaya and Baker (1960). Complementary dominant gene conditioning resistance, with Pc-24, to *P. coronata* races 203, 226, 230, 237, and 286 in Garry. Designated "Vc_b." Upadhyaya and Baker (1962b).
- Pc-26. Upadhyaya and Baker (1960). Gene for resistance to *P. coronata* in Garry. Designated "Vc₂." Upadhyaya and Baker (1962b).
- I-Pc-26. Upadhyaya and Baker (1960). Gene inhibiting Pc-26. Designated "IVc₂."
- Pc-27. Upadhyaya and Baker (1960). Gene for adult resistance to *P. coronata* in Garry. Designated "Vc₁." Upadhyaya and Baker (1962b).
- Pc-28. Upadhyaya and Baker (1960). Second gene for adult resistance to *P. coronata* in Garry. Designated "Vc₃." Upadhyaya and Baker (1962b).
- Pc-29. Marshall and Myers (1961). Second gene for resistance to *P. coronata* race 216 in the diploid Glabrota.
- Pc-30. Marshall and Myers (1961). Second gene for resistance to *P. coronata* races 216 and 276 in the diploid C.I. 3815.
- Pc-31. Marshall and Myers (1961). Dominant gene for resistance to *P. coronata* races 203, 216, and 276 in the diploid C.I. 4746.
- Pc-32. Marshall and Myers (1961). Dominant gene for resistance to *P. coronata* races 203, 216, and 276 in the diploid Ceirch Llwyd.
- Pc-33. Marshall and Myers (1961). Second dominant gene for resistance to *P. coronata* race 216 in the diploid Ceirch Llwyd.
- Pc-34. McKenzie and Fleischmann (1964). Gene for resistance to *P. coronata* races 203, 205, 264, 276, and 279 in D-60.
- Pc-35. McKenzie and Fleischmann (1964). Dominant gene for resistance to *P. coronata* races 203, 205, 264, 276, and 279 in *A. sterilis* D-137 collected in Israel. Fleischmann *et al.* (1971a). Allelic or closely linked to Pc-54. McKenzie and Martens (1976).⁶
- Pc-36. Simons (1965). Dominant gene for resistance to crown rust races 203, 216, 264, 290, and 321 carried by C.I. 8081 (*A. sterilis* selection from P.I. 267989).
- Pc-37. Dyck (1966). Dominant gene for resistance to crown rust race 294 carried by diploid C.D. 7994.
- Pc-38. Fleischmann and McKenzie (1968). Gene carried by *A. sterilis*

⁶Personal communication.

- CW491-4 for resistance to crown rust races 264, 290, 295, 332, and 446—susceptible to race 202.
- Pc-39. Fleischmann and McKenzie (1968). Dominant gene for resistance to *P. coronata* races 264, 290, 295, 332, and 446 in *A. sterilis* F366 collected in Israel. Allelic or closely linked to Pc-55. Kiehn *et al.* (1976).
- Pc-40. Fleischmann and McKenzie (1968). Dominant gene for resistance to *P. coronata* races 290, 295, 332, and 446 in *A. sterilis* F83 collected in Israel.
- Pc-41. Fleischmann and McKenzie (1968). Gene carried by *A. sterilis* F83 for resistance to crown rust races 290, 295, and 332.
- Pc-42. Fleischmann and McKenzie (1968). Gene carried by *A. sterilis* F83 for resistance to crown rust race 332 but not 264, 290, 295, or 446.
- Pc-43. Fleischmann and McKenzie (1968). Gene carried by *A. sterilis* F83 for resistance to crown rust race 290, but not 264, 295, 332, and 446.
- Pc-44. Martens, McKenzie, and Fleischmann (1968). Dominant gene in Kyto for resistance to crown rust races 210, 228, 239, 297, 330, 341, 342, and 453.
- Pc-45. Fleischmann *et al.* (1971a). Dominant gene in *A. sterilis* F-169 for resistance to crown rust races 239, 264, 290, 326, 330, and 332.
- Pc-46. Fleischmann *et al.* (1971a). Dominant gene for resistance to *P. coronata* races 239, 264, 290, 326, 330, and 332 in *A. sterilis* F290 collected in Israel. Allelic or closely linked to Pc-50.
- Pc-47. Fleischmann *et al.* (1971b.). Dominant gene in C. I. 8081A, for resistance to crown rust, from P.I. 267989-*A. sterilis*, probably identical to Pc-36.
- Pc-48. Fleischmann *et al.* (1971b). Dominant gene in *A. sterilis* F-158 for resistance to crown rust.
- Pc-49. Fleischmann *et al.* (1971b.). Dominant gene for resistance to *P. coronata* races 216, 326, 330, 332, and 446 in *A. sterilis* F158 collected in Israel. Subsequent pathological and genetic data (McKenzie and Martens, unpublished) indicate Pc-49 is identical to Pc-40.
- Pc-50. Fleischmann *et al.* (1971b). Dominant gene for resistance to *P. coronata* races 216, 264, 305, 326, and 330 in *A. sterilis* CW 486 collected in Tunisia. Allelic or closely linked to Pc-46.
- Pc-51. Browning (1971).⁷ Dominant gene for resistance from *A. sterilis*, Wahl No. 8, carried by Iowa Midseason isoline X 270, and early isoline X 434.

⁷Personal communication.

- Pc-52. Browning (1972).^{*} Dominant gene for resistance from *A. sterilis*, Wahl No. 2, carried by Iowa Midseason isolate X-421.
- Pc-53. Simons (1976).^{*} Single gene, lacking clear dominance, derived from *A. sterilis* 6-112-1-15 via H441.
- Pc-54. McKenzie and Martens (1976).^{*} Incompletely dominant gene for resistance to cultures of *P. coronata* races 239, 264, and 295 in *A. sterilis* CAV 1830 and CAV 1832 collected in Turkey. Allelic or closely linked to Pc-35.
- Pc-55. Kiehn *et al.* (1976). Incompletely dominant gene for resistance to cultures of *P. coronata* races 203, 211, 239, 259, 264, 295, and 326 in *A. sterilis* CAV 4963 collected in Israel. Allelic or closely linked to Pc-39.
- Pc-56. Kiehn *et al.* (1976). Gene for crown rust resistance in *Avena sterilis* CAV 1964.
- Pc-57. Simons (1976).^{*} Gene conditioning resistance at high temperatures to crown rust race 264A and many other races. Derived from *A. sterilis* D-94 (C.I. 8295) via H-555.
- Pc-58. McDaniel (1976).^{*} Gene carried by TAM-O-301 for resistance to race 264B and many other races of crown rust. Derived from *Avena sterilis* P.I. 295919 (C.I. 8387).
- Pc-59. McDaniel (1976).^{*} Gene carried by TAM-O-312 for resistance to race 264B and many other races of crown rust. Derived from *Avena sterilis* P.I. 296244 (C.I. 8393).
- Pc-60. McDaniel (1976).^{*} Gene carried by Coker 227 for resistance to many races of crown rust. Derived from *Avena sterilis* P.I. 287211.
- Pc-61. McDaniel (1976).^{*} Gene carried by Coker 234 for resistance to many races of crown rust. Derived from *Avena sterilis* P.I. 287211.
- Pg-1. Garber (1921). Dominant gene for resistance to stem rust, caused by *Puccinia graminis* Pers. f. sp. *avenae* Erikss, and E. Henn., races 1, 2, 5, 8, 8A, 9, 10, and 11 in White Russian. Designated "S" by Dietz (1928) and "D" by Murphy and Coffman (1961). Griffiee (1922), Hayes *et al.* (1928), Smith (1934), Cochran *et al.* (1945), Kehr *et al.* (1950), Myers *et al.* (1955), Koo *et al.* (1955), Koo *et al.*, (1956), McKenzie and Green (1962), Upadhyaya and Baker (1962a).
- I-Pg-1. Dietz (1928). Dominant gene inhibiting the expression of Pg-1 and Pg-2, in Burt.
- Pg-2. Dietz (1928). Dominant gene for resistance to *P. graminis* races 1, 2, 3, 5, 7, 7A, and 12 in Green Russian. Designated

^{*}Personal communication.

- "A" by Welsh and Johnson (1954). Welsh (1931), Gordon and Welsh (1932), Smith (1934), Torrie (1939), Litzenger (1949b), Myers *et al.* (1955), Koo *et al.* (1955), Baker (1955), Koo *et al.* (1956), McKenzie and Green (1962), Upadhyaya and Baker (1962a). Allelic or closely linked with Pg-1 and Pg-8.
- Pg-3. Waterhouse (1930). Dominant gene for resistance to *P. graminis* races 1, 3, 4, and 11 in Joannette. Designated "E" by Welsh and Green (1958). Welsh (1931), Gordon and Welsh (1932), Welsh and Johnson (1951), McKenzie and Green (1962). Allelic or closely linked with Pg-9.
- Pg-4. Welsh and Johnson (1954). Dominant gene for resistance to *P. graminis* races 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, and 13 in RL1225 (derived from Hajira). Designated "B." Litzenger (1949b), Welsh and Johnson (1951), Baker (1955), Upadhyaya and Baker (1960), McKenzie and Green (1962). Allelic or closely linked with Pg-13.
- Pg-5. Welsh and Johnson (1954). Dominant gene for resistance to certain races of *P. graminis* in RL1225 (derived from Hajira). Designated "C" and may be the same as Pg-4. Litzenger (1949b), Welsh and Johnson (1951), Baker (1955), Upadhyaya and Baker (1960), Upadhyaya and Baker (1962a) designated it "G."
- Pg-6. Zillinsky *et al.* (1956). Dominant gene for resistance to *P. graminis* races 6, 7, 7A, and 8 in the diploid CD3820. Sadanaga *et al.* (1960), Dyck and Zillinsky (1962).
- Pg-7. Zillinsky *et al.* (1956). Second dominant gene for resistance to *P. graminis* races 6, 7, 7A, and 8 in the diploid CD3820.
- Pg-8. Browning and Frey (1959). Recessive gene for resistance to *P. graminis* races 1, 2, 6, 6A, 7, 7A, 8, 8A, 10, 13, and 13A. Designated "F" by Welsh *et al.* (1961). Browning and Frey (1962) suggested it may be allelic or closely linked with Pg-1 and Pg-2.
- Pg-9. McKenzie and Green (1965). Recessive gene for resistance to *P. graminis* races 6F and 6AF in C.I. 4529 and other lines. Designated "H." Allelic or closely linked with Pg-3.
- Pg-10. Pavék and Myers (1965). Dominant gene for mesothetic reaction to *P. graminis* race 13A in C.I. 1575 and other lines. Designated "G."
- Pg-11. McKenzie and Martens (1968). Incompletely recessive gene conferring adult plant resistance to a wide range of *P. graminis* races. Derived from C.I. 3034. Independent of the Pg-2, Pg-4, and Pg-9 loci.
- Pg-12. Martens, McKenzie and Fleischmann (1968). Recessive gene

- conferring seedling resistance (which changes to moderate susceptibility in the adult plant stage) to a wide range of *P. graminis* races. Derived from C.I. 8250 (cv. Kyto from Yugoslavia). Independent of the Pg-2, Pg-4, and Pg-9 loci.
- Pg-13. McKenzie, Martens and Rajhathy (1970). Recessive gene conferring resistance to a wide range of *P. graminis* races. Derived from *A. sterilis* CAV 2647, Beja, Tunisia. Allelic or tightly linked with Pg-4.
- Pg-14. MacKey and Mattsson (1972). Dominant or semidominant gene, carried by S 81 and other lines, that confers resistance to Swedish oat stem rust isolate Leijerstam 6AB 26-59. Designated "N."
- Psc-1. Griffiths (1961). Partially recessive gene in Cc4146 for resistance to halo blight (*Pseudomonas coronafaciens* (Elliott) Stevens).
- Psc-2. Cheng and Roane (1968). Gene in Dubois, linked to Psc-3, for resistance to halo blight (*Pseudomonas coronafaciens*).
- Psc-3. Cheng and Roane (1968). Gene in Victorgrain, linked to Psc-2, for resistance to halo blight (*Pseudomonas coronafaciens*).
- Pt-1. Nilsson-Ehle (1909). Gene for open panicle type. Designated "A₁." Norton (1907), Wakabayashi (1921), Garber (1922), Quisenberry (1926), Odland (1928), Coffman (1964).
- Pt-2. Nilsson-Ehle (1909). Second gene for open panicle types. Designated "A₂." Quisenberry (1926), Coffman (1964).
- Pt-3. Nilsson-Ehle (1909). Third gene for open panicle type. Designated "A₃." Coffman (1964).
- Pt-4. Patterson *et al.* (1959). Dominant gene for dense or cluster panicle type in Milford.
- Pt-5. McGinnis and Lin (1966). Gene for equilateral panicle in Garry (nullieffect and monoeffect).
- pt-6. Dyck (1968). Recessive gene for cluster panicle in *A. strigosa*—a mutation produced by X-rays.
- pt-7. Nishiyama (1957). Recessive gene for spear-shaped panicle in progeny of *A. barbata* x *A. strigosa*.
- Px-1a. Marshall and Allard (1969). Slower migrating allele (Rf = 0.85) of a gene for anodal peroxidase in *Avena barbata*. Designated APX₅.
- Px-1b. Marshall and Allard (1969). Faster migrating allele (Rf = 0.88) of a gene for anodal peroxidase in *Avena barbata*. Designated APX₅.
- Px-2. Levings, Stuber, and Murphy (1971). Dominant gene for an auxin inducible peroxidase in certain winter oat cultivars.
- Px-3a. Smith (1972). Active allele of a gene for peroxidase in certain oat cultivars. Designated "PA₁."

- Px-3b. Smith (1972). Inactive allele of a gene for peroxidase in certain oat cultivars. Designated "Pa₁."
- Px-4a. Smith (1972). Active allele of a gene for peroxidase a₁ in certain oat cultivars. Designated "PXA₁."
- Px-4b. Smith (1972). Active allele of a gene for peroxidase a₂ in certain oat cultivars. Designated "PXA₂."
- Px-4c. Smith (1972). Inactive allele for peroxidase in certain oat cultivars. Designated "PXA."
- Px-5a. Yen (1975). Fast allele of a gene for peroxidase in certain oat cultivars.
- Px-5b. Yen (1975). Medium allele of a gene for peroxidase in certain oat cultivars.
- Px-5c. Yen (1975). Null allele of a gene for peroxidase in certain oat cultivars.
- Px-6a. Yen (1975). Medium allele of a gene for peroxidase in certain oat cultivars.
- Px-6b. Yen (1975). Null allele of a gene for peroxidase in certain oat cultivars.
- rp-1. Henning (1924). Recessive gene for rachilla pubescence. Odland (1928), Hayes *et al.* (1928), Ma (1933), Philp (1933), Aamodt *et al.* (1934), Tang (1938).
- Rp-2. Johnson (1933). Dominant gene for long, abundant rachilla pubescence. Designated "N." Coffman (1964).
- Rp-3. Johnson (1933). Gene conditioning short rachilla pubescence, hypostatic to Rp-2. Designated "F."
- Rp-4. Coffman (1964). Second dominant gene for long, abundant rachilla pubescence.
- Rp-5. Nishiyama (1933). Gene for glabrous rachilla segment. Discovered by monosomic analysis.
- sc-1. Pridham (1916). Recessive gene for pinkish straw color in Algerian.
- Syn-1. Nishiyama (1931). Dominant gene for regular chromosome pairing (nullieffect). Nishiyama (1933), Huskins and Hearne (1933), Hacker and Riley (1965), Thomas and Mytton (1970).
- syn-2. Dyck and Rajhathy (1965). Recessive gene conditioning desynapsis during meiosis in *A. strigosa*.
- syn-3. Thomas and Rajhathy (1966). Recessive gene conditioning desynapsis during meiosis in tetraploid oats. Designated ds₂.
- Syn-4. Hacker and Riley (1965). Dominant gene for regular chromosome pairing (nullieffect).
- Syn-5. Hacker and Riley (1965). Dominant gene for regular chromosome pairing (nullieffect).
- Tg-1. Gardenhire (1964). Dominant gene for resistance to *Toxoptera graminium* Rond. (Greenbug) in Russian 77.

- U-1. Wakabayashi (1921). Dominant gene for resistance to covered smut, caused by *Ustilago kollerii* Wille., in Red Rustproof. Gaines (1925), Nicolaisen (1931), Schattenberg (1934).
- U-2. Wakabayashi (1921). Second dominant gene for resistance to *U. kollerii* in Red Rustproof. Gaines (1925), Nicolaisen (1931), Schattenberg (1934).
- U-3. Wakabayashi (1921). Third dominant gene for resistance to *U. kollerii* in Red Rustproof. Gaines (1925), Schattenberg (1934).
- U-4. Barney (1924). Dominant gene for resistance to loose smut, caused by *Ustilago avenae* (Pers.) Rostr., in Black Mesdag. Reed (1925), Reed (1928), Garber *et al.* (1928), Garber *et al.* (1929), Rosenstiel (1929), Nicolaisen (1931), Johnson (1933), Stanton *et al.* (1934), Reed (1934), Schattenberg (1934), Reed (1935), Reed (1941), Cherewick and McKenzie (1969).
- U-5. Barney (1924). Dominant gene for resistance to *U. avenae* in Fulghum.
- U-6. Barney (1924). Second dominant gene for resistance to *U. avenae* in Fulghum. Cochran *et al.* (1945).
- U-7. Barney (1924). Dominant gene for resistance to *U. avenae* in Burt.
- U-8. Barney (1924). Second dominant gene for resistance to *U. avenae* in Burt.
- U-9. Barney (1924). Dominant gene for intermediate reaction to *U. avenae* in Golden Rain.
- U-10. Reed (1928). Dominant gene for resistance to *U. kollerii* in Early Gothland. Reed (1931), Reed and Stanton (1937).
- U-11. Reed (1928). Dominant gene for resistance to *U. avenae* in Monarch. Reed (1931), Schattenberg (1934), Reed (1941).
- U-12. Gaines and Smith (1929). Gene for resistance to *U. kollerii* in Markton. Coffman *et al.* (1931), Schattenberg (1934), Reed and Stanton (1938), Cherewick and McKenzie (1969).
- U-13. Gaines and Smith (1929). Second gene for resistance to *U. kollerii* in Markton. Coffman *et al.* (1931), Schattenberg (1934), Reed and Stanton (1938).
- U-14. Nicolaisen (1931). Dominant gene for resistance to *U. avenae* in Black Mesdag. Johnson (1933), Schattenberg (1934).
- U-15. Nicolaisen (1931). Second dominant gene for resistance to *U. avenae* in Black Mesdag. Schattenberg (1934).
- U-16. Schattenberg (1934). Dominant gene for resistance to *U. avenae* in Markton. Reed and Stanton (1938).
- U-17. Schattenberg (1934). Gene for resistance to *U. avenae* in Gopher.
- U-18. Reed and Stanton (1937). Gene for resistance to *U. kollerii* in Rossman.

- U-19. Reed and Stanton (1937). Gene for resistance to *U. kolleri* in Danish.
- U-20. Reed and Stanton (1937). Gene for resistance to *U. kolleri* in Scottish Chief.
- U-21. Reed and Stanton (1937). Gene for resistance to *U. kolleri* in Seizure.
- U-22. Hayes *et al.* (1939). Gene for resistance to *U. avenae* and *U. kolleri* in Bond. Torrie (1939), Cochran *et al.* (1945).
- U-23. Torrie (1939). Gene for partial resistance to *U. avenae* and *U. kolleri* in Bond.
- U-24. Torrie (1939). Gene for resistance to *U. avenae* and *U. kolleri* in Victoria. Patel (1941), Cochran *et al.* (1945), Cherewick and McKenzie (1969).
- U-25. Torrie (1939). Gene for partial resistance to *U. avenae* and *U. kolleri* in Victoria.
- U-26. Reed (1942). Gene for resistance to *Ustilago* species in Navarro. Narain (1966).
- U-27. Reed (1942). Gene for resistance to *Ustilago* species in Navarro. Narain (1966).
- U-28. Reed (1942). Gene for resistance to *Ustilago* species in Navarro.
- U-29. Reed (1942). Gene for resistance to *Ustilago* species in Navarro.
- U-30. Reed (1942). Gene for resistance to *Ustilago* species in Navarro.

CATALOGING AND SYMBOLIZING GENES DISCOVERED IN THE FUTURE

We propose that we continue to serve as a committee, and that we catalog genes in oats that are discovered and reported in the future. Investigators wishing to have new genes cataloged would send pertinent data to a member of the committee. The committee will then see that the symbols assigned do not duplicate previous symbols. We further propose that new genes be listed annually in the *Oat Newsletter*.

REFERENCES

Åkerman, A.

1922. Untersuchungen über eine in direktem Sonnenlichte nicht lebensfähige Sippe von *Avena sativa*. *Hereditas* 3:147-177.

1948. Genetiska undersökningar av den svarta skalfärgen hos havre. [Genetic analyses on black hull color of oats.] *Kungliga Lantbruksakademiens Tidskrift* 87:450-458.

_____ and M. Bader.

1937. Über Kreuzungen zwischen *Avena sativa* and *Avena fatua* und einige Untersuchungen über Fatuoiden. (Hybrids between *A. sativa* and *A. fatua* and some investigations on fatuoids.) *Zeitschrift fuer Zuechtung, Reihe A, Pflanzenzuechtung* 22:1-44.

_____ and K. Froier.

1941. Studien über eine spontane chlorina-Mutation in *Avena sativa*. *Hereditas* 27:371-404.

_____ and J. Muhlow.

1933. Über die Vererbung des Ligulamerkmals beim Hafer. *Hereditas* 18:140-144.

Aamodt, O. S., L. P. V. Johnson, and J. M. Manson.

1934. Natural and artificial hybridization of *Avena sativa* with *A. fatua* and its relation to the origin of fatuoids. *Canadian Journal of Research* 11:701-727.

Abrams, R., R. Grindeland, and K. J. Frey.

1964. Inheritance of an induced chlorophyll mutant in oats (*Avena sativa*). *Journal of Agriculture of the University of Puerto Rico* 48:243-246.

Andersen, S.

1961. Resistens mod havreol. *Heterodera avenae*. Kongelige Veterinærnogo Landbohøjskole, Afdeling Landbrukshegsk Meddelelser 68: 179. In *Plant Breeding Abstract* 32: 322. 1962. (Original not seen.)

Atiyya, H. S., and W. Williams.

1976. Genetic control of the nuda character complex in the genus *Avena*. *Journal of Agricultural Science* 86:329-334.

Ausemus, E. R., J. B. Harrington, L. P. Reitz, and W. W. Worzella.

1946. A summary of genetic studies in hexaploid and tetraploid wheats. *Journal of the American Society of Agronomy* 38:1082-1099.

Baker, E. P.

1955. Genetics and plant breeding. University of Sydney School of Agriculture, Report 1:56-65.

Barney, A. F.

1924. The inheritance of smut resistance in crosses of certain varieties of oats. *Journal of the American Society of Agronomy* 16:283-291.

- Bartlett, H. H.
1916. Linkage and crossing-over in oats. *Botanical Gazette* 62:323-325.
- Boland, P., and D. A. Lawes.
1972. The inheritance of the nakedgrain character in oats studied in a cross between the naked variety Caesar and the husked variety Bo 1/11. *Euphytica* 22:582-591.
- Browning, J. A., and K. J. Frey.
1959. The inheritance of new sources of oat stem rust resistance. *Plant Disease Reporter* 43:768-771.
- and K. J. Frey.
1962. Genetics of oat stem rust resistance. I. Inheritance of reaction to races 6, 8, and 13A in C.I. 3039. *Iowa State Journal of Science* 36:483-489.
- Caporn, A. S.
1918. The inheritance of tight and loose palea in *Avena nuda* crosses. *Journal of Genetics* 7:229-246.
- Chang, T. D., and K. Sadanaga.
1964. Crosses of six monosomics in *Avena sativa* L. with varieties, species, and chlorophyll mutants. *Crop Science* 4:589-593.
- Chang, T. T.
1959. Analysis of genes conditioning resistance of oat varieties to races of *Puccinia coronata* Cda. var. *avenae* F. and L. Dissertation Abstracts 20:1133. (Ph.D. thesis, University of Minnesota, St. Paul. 1959.)
- Cheng, C. and C. W. Roane.
1968. Sources of resistance and inheritance of reaction to *Pseudomonas coronafaciens* (Elliott) F. L. Stevens in oats. *Phytopathology* 58:1402-1405.
- Cherewick, W. J., and R. I. H. McKenzie.
1969. Inheritance of resistance to loose smut and covered smut in the oat varieties, Black Mesdag, Camas, and Rodney. *Canadian Journal of Genetics and Cytology* 11:919-923.
- Chou, C. Y.
1932. A study of the inheritance of hull character and resistance to loose smut in oats from a cross between *A. sativa* var. Smut Resistant and *A. nuda* var. Hulless 407a1-18. (Ph.D. thesis, Cornell University, Ithaca, N.Y.)
- Clamont, G.
1969. Etude de l'hérédité du caractère "grain nu" chez l'avoine. *Bulletin des Recherches Agronomiques de Gembloux* 4:323-338.
- Cochran, G. W., C. O. Johnston, E. G. Heyne, and E. D. Hansing.
1945. Inheritance of reaction to smut, stem rust, and crown rust in four oat crosses. *Journal of Agricultural Research* 70:43-61.
- Coffman, F. A.
1964. Inheritance of morphologic characters in *Avena*. U.S. Department of Agriculture, Technical Bulletin 1308, 100 pp.

-
- J. H. Parker, and K. S. Quisenberry.
1925. A study of variability in the Burt oat. *Journal of Agricultural Research* 30:1-64.
-
- T. R. Stanton, and B. B. Bayles.
1931. Inheritance of resistance in oats to *Ustilago levis*. *Journal of Agricultural Research* 43:1085-1099.
- Cotner, J. B.
1929. Inheritance in Ruvia oats. (Ph. D. thesis, Cornell University, Ithaca, N.Y.)
- Craigmiles, J. P.
1952. Inheritance of resistance to Victoria blight and Race 45 of crown rust of oats; yield losses due to Victoria blight. (Ph. D. thesis, Cornell University, Ithaca, N.Y.)
-
1956. Oat disease studies. Georgia Agricultural Experiment Station, Technical Bulletin (n.s.) 7, 36 pp.
- Davies, D. W., and E. T. Jones.
1927. Further studies on the inheritance of resistance to crown rust (*P. coronata* Corda) in F3 segregates of a cross between Red Rustproof (*A. sterilis*) Scotch Potato oats (*A. sativa*). *Welsh Journal of Agriculture* 11: 232-235.
- Day, A. D.
1963. Inheritance of seed dehiscence in a cross between *Avena byzantina* C. Koch and *Avena fatua* L. *Crop Science* 3:165-166.
- Derick, R. A.
1930. A new "dwarf" oat. *Science in Agriculture* 10:539-542.
- De Villiers, P. J. R.
1935. A genetic study of the inheritance of the various characters in certain *Avena* hybrids. Union of South Africa, Department of Agriculture, Science Bulletin 140, 90 pp.
- Dietz, S. M.
1928. Inheritance of resistance in oats to *Puccinia graminis avenae*. *Journal of Agricultural Research* 37:1-23.
-
- and H. C. Murphy.
1930. Inheritance of resistance to *Puccinia coronata avenae*, p. f. III. (Abstract) *Phytopathology* 20:120.
- Dyck, P. L.
1966. Inheritance of stem rust resistance and other characteristics in diploid oats, *Avena strigosa*. *Canadian Journal of Genetics and Cytology* 8:444-450.
-
1968. Three morphological mutants in *Avena strigosa*. *Canadian Journal of Botany* 46:867-868.
-
- and T. Rajhathy.
1965. A desynaptic mutant in *Avena strigosa*. *Canadian Journal of Genetics and Cytology* 7:418-421.

-
- _____ and F. J. Zillinsky.
1962. Segregation for crown and stem rust resistance in diploid and autotetraploid *Avena strigosa*. Canadian Journal of Genetics and Cytology 4:469-474.
-
- _____ and F. J. Zillinsky.
1963. Inheritance of crown rust resistance transferred from diploid to hexaploid oats. Canadian Journal of Genetics and Cytology 5:398-407.
- Emerson, R. A., G. W. Beadle, and A. C. Fraser.
1935. A summary of linkage studies in maize. Cornell University, N.Y. Agricultural Experiment Station Memoirs 180, 83 pp.
- Federova, N.
1930. (Hybridization of *Avena sativa* with *Avena fatua*. I. Quantitative characters.) Leningrad Bureau of Genetics Bulletin 8:47-61. (In Russian.)
- Finkner, R. E., R. E. Atkins, and H. C. Murphy.
1955. Inheritance of resistance to two races of crown rust in oats. Iowa State College Journal of Science 30: 211-228.
-
- _____ H. C. Murphy, R. E. Atkins, and D. W. West.
1954. Varietal reaction and inheritance of fluorescence in oats. Agronomy Journal 46:270-274.
- Finkner, V. C.
1953. Inheritance of susceptibility to *Helminthosporium victoriae* in crosses involving Victoria and other crown rust resistant oat varieties. Agronomy Journal 45:404-406.
-
- _____ 1954. Genetic factors governing resistance and susceptibility of oats to *Puccinia coronata* Corda var. *avenae* F. and L., Race 57. Iowa Agricultural Experiment Station, Research Bulletin 411: 1039-1063.
- Fleischmann, G. and R. I. H. McKenzie.
1968. Inheritance of crown rust resistance in *Avena sterilis*. Crop Science 8:710-713.
-
- _____ R. I. H. McKenzie, and W. A. Shipton.
1971a. Inheritance of crown rust resistance in *Avena sterilis* L. from Israel. Crop Science 11:451-453.
-
- _____ R. I. H. McKenzie, and W. A. Shipton.
1971b. Inheritance of crown rust resistance genes in *Avena sterilis* collections from Israel, Portugal, and Tunisia. Canadian Journal of Genetics and Cytology 13:251-255.
- Florell, V. H.
1931. Inheritance of type of floret separation and other characters in interspecific crosses in oats. Journal of Agricultural Research 43:365-386.
- Fraser, A. C.
1919. The inheritance of the weak awn in certain *Avena* crosses and its relation to other characters of the oat grain. Cornell University Agricultural Experiment Station Memoirs 23:635-676.

Fröier, K.

1946. Genetical studies on the chlorophyll apparatus in oats and wheat. *Hereditas* 32:297-406.

-
1948. The oat chlorophyll mutations *albovirescens*, *luteomaculata*, and *tigrina*-1. *Hereditas* 34:60-82.

Gaines, E. F.

1917. Inheritance of wheat, barley, and oat hybrids. Washington Agricultural Experiment Station, Annual Report 27, Bulletin 135:47-60.

-
1924. Inheritance studies and crop breeding. Washington Agricultural Experiment Station, Annual Report 34, Bulletin 187:54-55.

-
1925. Resistance to covered smut in varieties and hybrids of oats. *Journal of the American Society of Agronomy* 17:775-789.

_____ and W. K. Smith.

1929. Resistance to covered smut (*Ustilago levis*) in oats. Washington Agricultural Experiment Station, Annual Report 39, Bulletin 237:16.

Garber, R. J.

1921. A preliminary note on the inheritance of rust resistance in oats. *Journal of the American Society of Agronomy* 13:41-43.

-
1922. Inheritance and yield with particular reference to rust resistance and panicle type in oats. Minnesota Agricultural Experiment Station, Technical Bulletin 7, 62 pp.

_____ N. J. Giddings, and M. M. Hoover.

1928. Breeding for disease resistance with particular reference to the smut of oats. *Science in Agriculture* 9:103-115.

_____ N. J. Giddings, and M. M. Hoover.

1929. Transgressive segregation for susceptibility to smut in an oat cross. *Journal of Agricultural Research* 39:953-962.

_____ and K. S. Quisenberry.

1928. A study of correlated inheritance in a certain *Avena* cross. West Virginia Agricultural Experiment Station, Bulletin 217, 47 pp.

Gardenhire, J. H.

1964. Inheritance of greenbug resistance in oats. *Crop Science* 4:443.

Gauthier, F. M., and R. C. McGinnis.

1965. The association of "kinky" neck with chromosome 20 of *Avena sativa* L. *Canadian Journal of Genetics and Cytology* 7:120-125.

Gordon, W. L., and J. N. Welsh.

1932. Oat stem rust investigations in Canada. *Science in Agriculture* 13:228-235.

Goulden, C. H.

1926. A genetic and cytological study of dwarfing in wheat and oats. Minnesota Agricultural Experiment Station, Technical Bulletin 33, 37 pp.

- Griffee, F.
1922. Breeding oats resistant to stem rust. *Journal of Heredity* 13:187-190.
- Griffiths, D. J.
1953. Varietal resistance and susceptibility of oats to crown rust. *Plant Pathology* 2:73-77.
-
1961. Cereals, beans, and Brassicae breeding. Welsh Plant Breeding Station (Aberystwyth), Report 1960:41-52.
-
- _____ and J. H. W. Holden.
1957. Investigations on resistance of oats to stem eelworm, *Ditylenchus dipsaci* Kuhn. *Annals of Applied Biology* 45:709-720.
- Hacker, J. B., and R. Riley.
1965. Morphological and cytological effects of chromosome deficiency in *Avena sativa*. *Canadian Journal of Genetics and Cytology* 7:304-315.
- Hayes, H. K., F. Griffee, F. J. Stevenson, and A. P. Lunden.
1928. Correlated studies in oats of the inheritance of reaction to stem rust and smuts, and of other differential characters. *Journal of Agricultural Research* 36:437-457.
-
- _____ M. B. Moore, and E. C. Stakman.
1939. Study of inheritance in crosses between Bond, *Avena byzantina*, and varieties of *A. sativa*. Minnesota Agricultural Experiment Station, Technical Bulletin 137. 38 pp.
- Hayes, J. D., and I. T. Jones.
1966. Variation in the pathogenicity of *Erysiphe graminis* D. C. f. sp. *avenae* and its relation to the development of mildew resistant cultivars. *Euphytica* 15:80-86.
- Henning, L. J.
1924. A study of the inheritance of color and other characters of the spikelet in a cross: *Avena sterilis nigra* x *A. orientalis* var. Early New Market. (M.S. thesis, Cornell University, Ithaca, N.Y.)
- Huskins, C. L.
1927. On the genetics and cytology of fatuoid or false wild oats. *Journal of Genetics* 18:315-364.
-
- _____ and E. M. Hearne.
1933. Meiosis in asynaptic dwarf oats and wheat. *Journal of the Royal Microscopical Society* 52:109-117.
- Johnson, L. P. V.
1933. Studies on the inheritance of covered smut reaction, lemma color, awn development, and rachilla pubescence in oats. *Canadian Journal of Research, Section C*, 9:519-541.
- Jones, E. T.
1930. Morphological and genetical studies of fatuoid and other aberrant grain types in *Avena*. *Journal of Genetics* 23:1-68.

1940. A comparison of the segregation of wild versus normal or cultivated base in the grain of diploid, tetraploid, and hexaploid species of oats. *Genetica* 22:419-434.
- and D. J. Griffiths.
1952. Varietal resistance and susceptibility of oats to powdery mildew (*Erysiphe graminis*). *British Mycological Society Transactions* 35:71-80.
- Kehr, W. R., and H. K. Hayes.
1950. Study of inheritance in crosses between Landhafer, *Avena byzantina* K., and two selections of *A. sativa* L. *Agronomy Journal* 42:71-78.
- H. K. Hayes, M. B. Moore, and E. C. Stakman.
1950. The present status of breeding rust resistant oats at the Minnesota Station. *Agronomy Journal* 42:356-359.
- Kiehn, F. A., R. I. H. McKenzie, and D. E. Harder.
1976. Inheritance of resistance to *Puccinia coronata avenae* and its association with seed characteristics in four accessions of *Avena sterilis*. *Canadian Journal of Genetics and Cytology* 12:230-236.
- Kimber, G., and E. R. Sears.
1968. Nomenclature for the description of aneuploids in the Triticinae. In *Third International Wheat Genetics Symposium Proceedings*. (Eds.) K. W. Finlay and K. W. Shepherd. Australian Academy of Science, Canberra. pp. 468-473.
- Ko, S. Y., J. H. Torrie, and J. G. Dickson.
1946. Inheritance of reaction to crown rust and stem rust and other characters in crosses between Bond, *Avena byzantina*, and varieties of *A. sativa*. *Phytopathology* 36:226-235.
- Koo, K. S., M. B. Moore, W. M. Myers, and B. J. Roberts.
1955. Inheritance of seedling reaction to races 7 and 8 of *Puccinia graminis avenae* Eriks. and Henn. at high temperature in three oat crosses. *Agronomy Journal* 47:122-124.
- M. B. Moore, W. M. Myers, and B. J. Roberts.
1956. II. Genetic studies of the white Russian and Rainbow genes for stem rust resistance. *National Oat Conference, National Oat Newsletter* 6:55. (Processed.)
- Lebedeff, V. N.
1930. (Factorial analysis of characters of distinction between hulled and hull-less varieties of oats.) *Bulletin Belaya Tserkov Plant Breeding Station* 1930:5. (In Russian.)
- In Plant Breeding Abstract* 2:127. 1932.
- Levings, C. S., C. W. Stuber, and C. F. Murphy.
1971. Inheritance of an auxin inducible peroxidase in oats. *Crop Science* 11:271-272.
- Litzenberger, S. C.
- 1949a. Nature of susceptibility to *Helminthosporium victoriae* and resistance to *Puccinia coronata* in Victoria oats. *Phytopathology* 39:300-318.

-
- 1949b. Inheritance of resistance to specific races of crown and stem rust, to Helminthosporium blight, and of certain agronomic characters of oats. Iowa Agricultural Experiment Station, Bulletin 370:453-496.
- Love, H. H., and W. T. Craig.
- 1918a. Small grain investigations. *Journal of Heredity* 9:67-76.
-
- _____ and W. T. Craig.
- 1918b. The relation between color and other characters in certain *Avena* crosses. *American Naturalist* 52:369-383.
-
- _____ and A. C. Fraser.
1917. The inheritance of the weak awn in certain *Avena* crosses. *American Naturalist* 51:481-493.
-
- _____ and G. P. McRostie.
1919. The inheritance of hull-lessness in oat hybrids. *American Naturalist* 53:5-32.
- Ma, P. C.
1933. A study of the inheritance of spikelet characters in the cross, *Avena sativa* var. *Cornellian* by *A. sterilis ludoviciana*. (Ph.D. thesis, Cornell University, Ithaca, N.Y.)
- McGinnis, R. C.
1966. Establishing a monosomic series in *Avena sativa* L. In *Chromosome Manipulations and Plant Breeding*. R. Riley and K. R. Lewis (eds.). Oliver and Boyd, Edinburgh and London. pp. 86-97.
-
- _____ and G. Y. Andrews.
1962. The identification of a second chromosome involved in chlorophyll production in *Avena sativa*. *Canadian Journal of Genetics and Cytology* 4:1-5.
-
- _____ G. Y. Andrews, and R. I. H. McKenzie.
1963. Determination of the chromosome arm carrying a gene for chlorophyll production in *Avena sativa*. *Canadian Journal of Genetics and Cytology* 5:57-59.
-
- _____ P. L. Dyck, S. G. Hildebrandt, and C. C. Lin.
1968. The association of a third chromosome with chlorophyll production in *Avena sativa*. *Canadian Journal of Genetics and Cytology* 10:228-231.
-
- _____ and C. C. Lin.
1966. A monosomic study of panicle shape in *Avena sativa*. *Canadian Journal of Genetics and Cytology* 8:96-101.
-
- _____ and D. K. Taylor.
1961. The association of a gene for chlorophyll production with a specific chromosome in *Avena sativa*. *Canadian Journal of Genetics and Cytology* 3:436-443.
- McIntosh, R. A.
1973. A catalogue for gene symbols for wheat. In *Proc. Fourth International Wheat Genetics Symposium*. Missouri Agricultural Experiment Station, Columbia, Mo. pp. 893-937.
- McKenzie, R. I. H.
1961. Inheritance in oats of reaction to race 264 of oat crown rust. *Canadian Journal of Genetics and Cytology* 3:308-311.

- _____ and G. Fleischmann.
1964. The inheritance of crown rust resistance in selections from two Israeli collections of *Avena sterilis*. Canadian Journal of Genetics and Cytology 6:232-236.
- _____ and G. J. Green
1962. Further studies on the genes in oats for resistance in stem rust. Canadian Journal of Genetics and Cytology 4:394-401.
- _____ and G. J. Green
1965. Stem rust resistance in oats. I. The inheritance of resistance to race 6AF in six varieties of oats. Canadian Journal of Genetics and Cytology 7:268-274.
- _____ and J. W. Martens.
1968. Inheritance in the oat strain C.I. 3034 of adult plant resistance to race C10 of stem rust. Crop Science 8:625-627.
- _____ J. W. Martens and T. Rajhathy.
1970. Inheritance of oat stem rust resistance in a Tunisian strain of *Avena sterilis*. Canadian Journal of Genetics and Cytology 12:501-505.
- MacKey, J., and B. Mattsson.
1972. Rasspecifik resistensförädling mot skavdinavisk harvesvartrost. Sveriges Utsädesförenings Tidskrift. pp. 82-203.
- Mackie, W. W.
1928. Inheritance of resistance to blast in oats. Phytopathology 18:948.
- Marshall, D. R., and R. W. Allard.
1969. The genetics of electrophoretic variants in *Avena*. I. The esterase E4, E9, E10, phosphatase P5 and anodal peroxidase APX5 loci in *A. barbata*. Journal of Heredity 60:17-19.
- Marshall, H. G., and W. M. Myers.
1961. A cytogenetic study of certain interspecific *Avena* hybrids and the inheritance of resistance in diploid and tetraploid varieties to races of crown rust. Crop Science 1:29-34.
- Martens, J. W., R. I. H. McKenzie, and G. Fleischmann.
1968. The inheritance of resistance to stem and crown rust in Kyto oats. Canadian Journal of Genetics and Cytology 10:808-812.
- Meurman, O.
1927. Beiträge zur Faktorenanalyse des Hafers Zeitschrift fuer Zuechtung. I. Reihe A. Pflanzenzuechtung 12:1-29.
- Middleton, G. K.
1938. Inheritance in a cross between *Avena sativa* and *A. sterilis ludoviciana*. Journal of the American Society of Agronomy 30:193-208.
- Morey, D. D., and R. W. Earhart.
1952. Golden oats. Journal of Heredity 43:181-182.
- Moule, C.
1972. Contribution a l'étude de l'hérédité due caractère "grain nu" chez l'avoine cultivée. Annales de L'Amélioration des Plantes. 22:335-360.

Murphy, H. C., and F. A. Coffman.

1961. Genetics of disease resistance. In F. A. Coffman, (ed.), Oats and Oat Improvement. pp. 207-226. (American Society of Agronomy, Madison, Wis.)

_____ and F. Meehan.

1946. Reaction of oat varieties to a new species of *Helminthosporium*. (Abstract) Phytopathology 36:407.

_____ T. R. Stanton, and H. Stevens.

1937. Breeding winter oats resistant to crown rust, smut, and cold. Journal of the American Society of Agronomy 29:622-637.

_____ F. J. Zillinsky, M. D. Simons, and R. Grindeland.

1958. Inheritance of seed color and resistance to races of stem and crown rust in *Avena strigosa*. Agronomy Journal 50:539-541.

Myers, W. M., F. K. S. Koo, M. B. Moore, and B. J. Roberts.

1955. Breeding oats for stem rust resistance. Minnesota Farm and Home Science 12(2):6-7.

Narain, A.

1966. Inheritance of host reaction to races A20 and A22 of *Ustilago avenae* (Pers.) Rostr. Current Science 35:493-494.

Nicolaisen, W.

1931. Beitrag zur Immunitätzüchtung des Hafers gegen *Ustilago avenae* (Pers.) Jens. Zeitschrift fuer Zuechtung, Reihe A, Pflanzenzüchtung 16:255-278.

Nilsson-Ehle, H.

1908. Einige Ergebnisse von Kreuzungen bei Hafer und Weizen. Botaniska Notiser 6:257-294.

1909. Kreuzungsuntersuchungen an Hafer und Weizen. Lunds Universitetets Arsskrift, Afdelningen 2, Ed. 5, No. 2, 122 pp.

1914. Über einen als Hemmungsfaktor der Begrannung auftretenden Farbfaktor beim Hafer. Zeitschrift fuer Induktive Abstammungs-und Vererbungslehre 12:36-55.

Nishiyama, I.

1931. The genetics and cytology of certain cereals, II. Karyo-genetic studies of fatuoid oats, with special reference to their origin. Japanese Journal of Genetics 7:49-102.

1933. The genetics and cytology of certain cereals, IV. Further studies of fatuoid oats. Japanese Journal of Genetics 8:107-124.

1934. The genetics and cytology of certain cereals, VI. Chromosome behavior and its bearing on inheritance in triploid *Avena* hybrids. Memoirs of the College of Agriculture, Kyoto University 32:1-157.

-
1941. Cytogenetical studies on *Avena*, IV. Distorted Mendelian ratios due to the differential fertilization. Japanese Journal of Genetics 6:247-264.
-
1957. Cytogenetical studies on *Avena*, VII. Mutations in the progeny of triploid *Avena* hybrids. Cytologia, Supp. Vol. :318-320. 1957. International Genetics Symposia Proceedings, Tokyo, 1956.
-
1973. Disturbed genetic behavior of the kernel separation in diploid oat hybrids. Seiken ziho 24:33-44. (Report of Kihara Institute Biological Research.)
- Norton, J. B.
 1907. Notes on breeding oats. American Breeders Association Proceedings 3:280-285.
- Odland, T. E.
 1928. The inheritance of rachilla length and its relation to other characters in a cross between *Avena sativa* and *Avena sativa orientalis*. West Virginia Agricultural Experiment Station, Bulletin 219, 55 pp.
- Osler, R. D., and H. K. Hayes.
 1953. Inheritance studies in oats with particular reference to the Santa Fe type of crown rust resistance. Agronomy Journal 45:49-53.
- Patel, N. M.
 1941. Inheritance of loose smut reaction in crosses with Victoria and smut-resistant (Cornell)-6 under field conditions of growth and infection (Ph. D. thesis, Cornell University, Ithaca, N.Y.)
- Patterson, F. L., J. F. Schafer, R. M. Caldwell, and L. E. Compton.
 1959. Breeding for straw strength in oats. (Abstract) Journal of the American Society of Agronomy, 1959:64.
-
- J. F. Schafer, R. M. Caldwell, and L. E. Compton.
 1963. Inheritance of panicle type, height, and straw strength of derivatives of Scotland Club oats. Crop Science 3:555-558.
- Pavek, J. J., and W. M. Myers.
 1965. Inheritance of seedling reaction to *Puccinia graminis* Pers. f. sp. *avenae* race 13A in crosses of oat strains with four different reactions. Crop Science 5:501-504.
- Philp, J.
 1933. The genetics and cytology of some interspecific hybrids of *Avena*. Journal of Genetics 27:133-179.
- Pridham, J. T.
 1916. Oat breeding experiments. Agricultural Gazette of New South Wales 27:457-461.
- Quisenberry, K. S.
 1926. Correlated inheritance of quantitative and qualitative characters in oats. West Virginia Agricultural Experiment Station, Bulletin 202, 55 pp.

Ramage, R. T.

1972. Report from the Barley Genetics Committee of the American Barley Research Workers' Conference. Colorado Department of Agronomy, Fort Collins. Barley Genetics Newsletter 2:10-15.

Reed, G. M.

1925. The inheritance of resistance of oat hybrids to loose smut. *Mycologia* 17:163-181.

-
1928. The inheritance of resistance of oat hybrids to loose and covered smut. *Annals of the New York Academy of Sciences* 30:129-176.

-
1931. Inheritance of smut resistance in hybrids of Early Gothland and Monarch oats. *American Journal of Botany* 18:803-815.

-
1934. Inheritance of resistance to loose and covered smuts in hybrids of Black Mesdag with Hull-less, Silvermine, and Early Champion oats. *American Journal of Botany* 21:278-291.

-
1935. Inheritance of resistance to loose smut in hybrids of Fulghum and Black Mesdag oats. *Memoirs of the Torrey Botanical Club, Bulletin* 62:177-188.

-
1941. Inheritance of smut resistance in some oat hybrids. *American Journal of Botany* 28:451-457.

-
1942. Inheritance of smut resistance in hybrids of Navarro oats. *American Journal of Botany* 29:308-314.

_____ and T. R. Stanton.

1925. Relative susceptibility of selections from a Fulghum-Swedish Select cross to the smuts of oats. *Journal of Agricultural Research* 30:375-391.

_____ and T. R. Stanton.

1937. Inheritance of resistance to loose and covered smuts in oat hybrids. *Journal of the American Society of Agronomy* 29:997-1006.

_____ and T. R. Stanton.

1938. Inheritance of resistance to loose and covered smuts in Markton oat hybrids. *Journal of Agricultural Research* 56:159-175.

Rivers, G. M.

1959. Inheritance of resistance to *Helminthosporium* blight, crown rust race 216, and stem rust race 7A in oats. *Agronomy Journal* 51:601-603.

Robb, W.

1932. Notes on the inheritance of grain color in certain oat hybrids. *Journal of Genetics* 26:231-238.

Robertson, D. W., G. A. Wiebe, and F. R. Immer.

1941. A summary of linkage studies in barley. *Journal of the American Society of Agronomy* 33:47-64.

Rosenstiel, K. V.

1929. Untersuchungen über die Widersandsfähigkeit von Haferarten und-sorten gegen Haferflugbrand. (*Ustilago avenae* (Pers.) Jens.) und ihre Vererbung. *Phytopathologische Zeitschrift* 3:317-360.

Ru, S. H.

1933. Inheritance of the fatuoid characters in *Avena*. (Ph.D. thesis, Cornell University, Ithaca, N.Y.)

Sadanaga, K.

1965. A partially male-sterile diploid oat. *Crop Science* 5:279.

1971. A temperature-sensitive leaf necrosis mutation in hexaploid oats. *Crop Science* 3:416-419.

H. C. Murphy, and R. Grindeland.

1960. Inheritance of stem rust resistance of C.I. 7232, a derived tetraploid oat. *Phytopathology* 50:779-781.

Sanderson, K. E.

1960. Inheritance of reaction to several races of crown rust, *Puccinia coronata avenae*, Erikss. in two crosses involving Ukraine oats. *Canadian Journal of Plant Science* 40:345-352.

Schafer, E. G.

1923. Inheritance studies. Washington Agricultural Experiment Station, Annual Report 33 (Bull. 180):31.

Schattenberg, H.

1934. Untersuchungen über des Verhalten von Sorten, Kreuzungsnachkommenschaften und Kreuzungpopulationen gegenüber verschiedenen Herkunften von Haferflugbränden. *Kuehn-Archiv* 34:411-449.

Sebesta, J.

1976. The inheritance of resistance in oats to Central European crown rust races. Fourth European and Mediterranean Cereal Rusts Conference Proceedings, Interlaken, Switzerland, pp. 156-158.

Shaw, F. J. F., and R. D. Bose.

1933. Studies in Indian oats. *Indian Journal of Agricultural Sciences* 3:754-807.

Simons, M. D.

1956. The genetic basis of the crown rust resistance of the oat variety Ascencao. *Phytopathology* 46:414-416.

1965. Seedling resistance to *Puccinia coronata avenae* race 264 found in *Avena sterilis*. *Phytopathology* 55:700-701.

- _____ and H. C. Murphy.
1954. Inheritance of resistance to two races of *Puccinia coronata* Cda. var. *avenae* Fraser and Led. Iowa Academy of Science Proceedings 61:170-176.
- _____ K. Sadanaga, and H. C. Mrphy.
1959. Inheritance of resistance to strains of diploid and tetraploid species of oats to races of the crown rust fungus. Phytopathology 49:257-259.
- _____ F. J. Zillinsky, and N. F. Jensen.
1966. A standardized system of nomenclature for genes governing characters in oats. U.S. Department of Agriculture, Crops Research, ARS 34-85, 22 pp.
- Singh, R. M., and A. T. Wallace.
1967. Monosomics of *Avena bysantina* C I. Karyotype and chromosome pairing studies. Canadian Journal of Genetics and Cytology 9:87-96.
- Smith, D. C.
1934. Correlated inheritance in oats of reaction to diseases and other characters. Minnesota Agricultural Experiment Station, Technical Bulletin 102, 38 pp.
- _____
1938. Occurrence of albino seedlings in Victoria oats. Journal of Heredity 29:63-64.
- Smith, R. L.
1972. The inheritance of two peroxidases in oat leaves. Journal of Heredity 63:317-320.
- Stanton, T. R.
1923. Prolific and other dwarf oats. Dominant dwarfness observed in two oat crosses. Journal of Heredity 14:301-305.
- _____ G. M. Reed, and F. Coffman.
1934. Inheritance of resistance to loose smut and covered smut in some oat hybrids. Journal of Agricultural Research 48:1073-1083.
- Surface, F. M.
1916. Studies on oat breeding. III. On the inheritance of certain glume characters in the cross *Avena fatua* x *A. sativa* var. Kherson. Genetics 1:252-286.
- Tanaka, Y., B. Ephrussi, E. Hadorn, and others.
1957. Report of the International Committee on Genetic Symbols and Nomenclature. In Union Internationale des Sciences Biologiques, Serie B, (Colloques) No. 30, 6 pp.
- Tang, S. Y.
1938. Inheritance of spikelet characters in oat crosses involving Early Ripe and two strains of *Avena sterilis macrocarpa*. (Ph. D. thesis, Cornell University, Ithaca, N. Y.)
- Thomas, H., J. M. Leggett, and I. T. Jones.
1975. The addition of a pair of chromosomes of the wild oat *Avena barbata* (2N = 28) to the cultivated oat *A. sativa* L. (2N = 42). Euphytica 24:717-724.
- _____ and J. Mytton.
1970. Monosomic analysis of fatuoids in cultivated oat *Avena sativa*. Canadian Journal of Genetics and Cytology 12:32-35.

-
- _____ and R. Rajhathy.
1966. A gene for desynapsis and aneuploidy in tetraploid *Avena*. Canadian Journal of Genetics and Cytology 8:506-515.
- Torrie, J. H.
1939. Correlated inheritance in oats of reaction to smuts, crown rust, stem rust, and other characters. Journal of Agricultural Research 59:783-802.
- Tschermak, E. von.
1910. Allgemeines über die Bastardierung und die Vererbungsgesetze beim Getreide. In Fruwirth. Die Zuchtung der Landwirtschaftlichen Kulturpflanzen. Aufl. 2, Bd. 4:76-106, 360-365. Berlin.
-
1929. Kultur- und Wildhaferbastarde und ihre Beziehungen zu den sogenannten Fatuoiden. Zeitschrift fuer Induktive Abstammungs- und Vererbungslehre 51:450-481.
- Upadhyaya, Y. M., and E. P. Baker.
1960. Studies on the mode of inheritance of Hajira type stem rust resistance and Victoria type crown rust resistance as exhibited in crosses involving the oat variety Garry. Linnean Society of New South Wales Proceedings 85:157-179.
-
- _____ and E. P. Baker.
1962a. Studies on the inheritance of rust resistance in oats. I. Inheritance of stem rust resistance in crosses involving the varieties Burke, Laggan, White Tartar and Anthony. Linnean Society of New South Wales Proceedings 87:141-147.
-
- _____ and E. P. Baker.
1962b. Studies on the inheritance of rust resistance in oats. II. The mode of inheritance of crown rust resistance in the varieties Landhafer, Santa Fe, Utica Ukraine, Tri-spertia, and Victoria in their crosses with susceptible varieties. Linnean Society of New South Wales Proceedings 87:200-219.
- Vallega, J.
1951. Herencia de la resistencia a "*Puccinia coronata avenae*" y "*P. graminis avenae*". Revista de Investigaciones Agropecuarias, Serie 5:523-539.
- Wakabayashi, S.
1921. A study of hybrid oats, *Avena sterilis* x *Avena orientalis*. Journal of the American Society of Agronomy 13:259-266.
- Warburton, C. W.
1919. The occurrence of dwarfness in oats. Journal of the American Society of Agronomy 11:72-76.
- Waterhouse, W. L.
1930. Initial results of breeding for rust resistance. Linnean Society of New South Wales Proceedings 55:596-636.
-
1939. Some aspects of plant pathology. Australian Association for the Advancement of Science. Report 24:234-259. (Original not seen.) Cited by Upadhyaya, Y. M., and E. P. Baker. Studies on the mode of inheritance of Hajira type stem rust resistance and Victoria type crown rust resistance as exhibited in crosses involving the oat variety Garry. Linnean Society of New South Wales Proceedings 85:157-179. 1960.

Weetman, L. M.

1942. Genetic studies in oats of resistance to two physiologic races of crown rust. (Abstract) *Phytopathology* 32:19.

Welsh, J. N.

1931. Inheritance of stem rust and smut reaction and lemma color in oats. *Scientific Agriculture* 12:209-242.

_____ and G. J. Green.

1958. Genes in oats for resistance to stem rust races, and the genetics of host reaction. (Abstract) 10th International Congress of Genetics Proceedings 2:311.

_____ G. J. Green, and R. I. H. McKenzie.

1961. New genes for resistance to races of oat stem rust. *Canadian Journal of Botany* 39:513-518.

_____ and T. Johnson.

1951. The source of resistance and the inheritance of reaction to 12 physiologic races of stem rust, *Puccinia graminis avenae*. (Erikss. and Henn.) *Canadian Journal of Botany* 29:189-205.

_____ B. Peturson, and J. E. Machacek.

1954. Associated inheritance of reaction to races of crown rust, *Puccinia coronata avenae* Erikss, and to Victoria blight, *Helmintho sporium victoriae* M. and M., in oats. *Canadian Journal of Botany* 32:55-68.

_____ and T. Johnson.

1954. Inheritance of reaction to race 7A and other races of oat stem rust *Puccinia graminis avenae*. *Canadian Journal of Botany* 32:347-357.

Wiggans, R. G.

1918. The inheritance of certain characters in a cross between Red Texas and Swedish Select oats. (Ph. D. minor thesis, Cornell University, Ithaca, N. Y.)

Wilds, G. J.

1917. Inheritance of glume characters in *Avena*. (M.A. thesis, Cornell University, Ithaca, N. Y.)

Wilson, J. H.

1904. Variation in oat hybrids. *Nature* 69:413.

1907. The hybridization of cereals. *Journal of Agricultural Science (England)* 2:68-88.

Yen, S.

1975. Genetic and cytogenetic studies of leaf peroxidases and esterases in *Avena* spp. (Ph. D. thesis, Iowa State University, Ames, Iowa) 102 pp.

Zade, A.

1912. Die Zwischenformen von Flaughäfer (*Avena fatua*) und Kulturhafer (*Avena sativa*). *Fuhling's Landw. Ztg.* 61:369-384.

Zhegalov, S. I.

1920. (On genetics of oats *Avena byzantina* x *A. fatua* and *A. byzantina* x *A. sativa*.) All-Russian Conference on Plant Breeding Report 3:80-86 (Saratov). (In Russian.)

Zillinsky, F. J.

1959. Monster mutant oats. *Cereal News* 4 (2):7-11.

——— H. C. Murphy, and R. Grindeland.

1956. Inheritance of seed color and resistance to races of stem and crown rust in diploid *Avena strigosa*. (Abstract) *Journal of the American Society of Agronomy* 1956:74.

Zinn, J., and F. M. Surface.

1917. Studies on oat breeding-V: the F1 and F2 generations on a cross between a naked and a hulled oat. *Journal of Agricultural Research* 10:293-312.