Gene List for Watermelon

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This is the latest version of the gene list for watermelon (*Citrullus lanatus* (Thunb.) Matsum. and Nakai). The watermelon genes were originally organized and summarized by Poole (1944).). The list has been expanded by Robinson et al. (1976), the Cucurbit Gene List Committee (1979, 1982, and 1987), Henderson (1991 and 1992), Rhodes and Zhang (1995), and Rhodes and Dane (1999). The current list provides an update of the known genes of watermelon. This year, the list has 162 total mutants, grouped into seed and seedling mutants, vine mutants, flower mutants, fruit mutants, resistance mutants, protein (isozyme) mutants, DNA (RFLP and RAPD) markers, and cloned genes.

Researchers are encouraged to send reports of new genes, as well as seed samples of lines containing the gene mutant to the watermelon gene curator (Todd C. Wehner), or to the assistant curator (Stephen R. King). Please inform us of omissions or errors in the gene list. Scientists should consult the list as well as the rules of gene nomenclature for the Cucurbitaceae (Cucurbit Gene List Committee, 1982; Robinson et al., 1976) before choosing a gene name and symbol. Please choose a gene name and symbol with the fewest characters that describes the recessive mutant, and avoid use of duplicate gene names and symbols. The rules of gene nomenclature were adopted in order to provide guidelines for naming and symbolizing genes. Scientists are urged to contact members of the gene list committee regarding rules and gene symbols. The watermelon gene curators of the Cucurbit Genetics Cooperative are collecting seeds of the type lines for use by interested researchers, and would like to receive seed samples of any of the lines listed.

This gene list has been modified from previous lists in that we have 1) added or expanded the description of the phenotypes of many of the gene mutants, 2) added descriptions for phenotypes of interacting gene loci, 3) identified the type lines that carry each form of each gene, 4) identified the gene mutant lines that are in the curator collections, and 5) added genes that have not previously been described (*cr, Ctr, dw-3, eg, ms2, Ti, ts and zym*). Initially, we had intended to include a review of gene linkage, but few reports were found except for sets of molecular markers in wide crosses of *Citrullus*. Additional work is needed in this area to measure linkages and clarify gene interactions. Finally, we attempted to correct some of the errors in gene descriptions or references from previous lists.

Table 1. The genes of watermelon.

Gene	Synonym	Character	References[z]	Supplemental references[z]	Available[y]
a	-	*andromonoecious*; recessive to monoecious; *a* from 'Angeleno' (black seeded); *A* from cultivars 'Conqueror' and 'Klondike'.	Rosa, 1928	Porter, 1937; Poole, 1944	C
Aco-1	-	*Aconitase-1*.	Navot et al., 1990	-	M
Aco-2	-	*Aconitase-2*.	Navot et al., 1990	-	M
Adh-1	-	*Alcohol dehydrogenase-1;* one of five codominant alleles, each regulating one band	Navot and Zamir 1986, 1987; Zamir et al., 1984	-	M
Adh-1^1	-	*Alcohol dehydrogenase-1*^{1}*;* one of five codominant alleles, each regulating one band; found in *C. lanatus* var. *citroides* and *C. colocynthis*.	Navot and Zamir 1986, 1987; Zamir et al., 1984	-	M
Adh-1^2	-	*Alcohol dehydrogenase-1*^{2}*;* one of five codominant alleles, each regulating one band; found in *C. lanatus* var. *citroides* and *C. colocynthis*.	Navot and Zamir 1986, 1987; Zamir et al., 1984	-	M
Adh-1^3	-	*Alcohol dehydrogenase-1*^{3}*;* one of five codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot and Zamir 1986, 1987; Zamir et al., 1984	-	M
Adh-1^4	-	*Alcohol dehydrogenase-1*^{4}*;* one of five codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot and Zamir 1986, 1987; Zamir et al., 1984	-	M
Af	-	*Aulacophora faveicollis* resistance; resistance to the red pumpkin beetle; dominant to susceptibility; *Af* from Sl.72 and Sl.98 inbreds; *af* from 'Sugar Baby'.	Vashishta and Choudhury, 1972	-	?
Aps-1	*Acph-A*	*Acid phosphase*-1.	Navot et al., 1990; Navot and Zamir 1986, 1987; Zamir et al., 1984	-	M
Aps-2^1	-	*Acid phosphatase*-2^1; one of two codominant alleles, each regulating one band; found in *C. lanatus* and *C. colocynthis*.	Navot et al., 1990; Navot and Zamir 1986, 1987	-	M
Aps-2^2	-	*Acid phosphatase-2*^{2}; one of two codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot et al., 1990; Navot and Zamir 1986, 1987	-	M
Ar-1	*B,Gc*	*Anthracnose resistance to races 1* and *3* of *Glomerella cingulata* var. *orbiculare* (*Colletotrichum lagenarium*); *Ar-1* from 'Africa 8'*, 'Africa 9'*, and 'Africa 13'* and 'Charleston Gray'**; *ar-1* from 'Iowa Belle 476', 'Iowa Belle 487'* and N.C.9-2, N.C.11, and 'New Hampshire Midget'**.	Layton 1937*	Hall et al., 1960; Robinson et al., 1976; Winstead et al., 1959**	C
Ar-2^1	-	*Anthracnose resistance to race 2* of	Winstead et al., 1959*	Love and	P

		Colletotrichum lagenarium; *Ar-2-1* from W695 citron* and PI 189225, PI 271775, PI 271779, and PI 299379**; *ar-2-1* from 'Allsweet', 'Charleston Gray', and 'Florida Giant'; resistance in *Citrullus colocynthis* is due to other dominant factors; resistance from R309***; susceptibility from 'New Hampshire Midget'.		Rhodes, 1988***, 1991; Sowell et al., 1980**; Suvanprakorn and Norton, 1980	
B	*Y*	*Yellow flesh*; *Wf* is epistatic to *B* (*Y* renamed *B* by Henderson); *WfWf BB* or *WfWf bb* white fleshed; *wfwf BB* yellow fleshed; *wfwf bb* red fleshed; *B* from breeding line V.No.3 and *b* from V.No.1; flesh color segregated into 12 white, 3 yellow and 1 red in the F2.	Shimotsuma, 1963	Henderson, 1992	?
C	-	*Canary yellow flesh*; dominant to pink; *i* inhibitory to *C*, resulting in red flesh; in the absence of *i*, *C* is epistatic to *Y*; *CC* from 'Honey Cream'*, *cc* from 'Dove'*; *CC YY I-C I-C* from 'Yellow Baby' F1** and 'Yellow Doll' F1**; *cc* $y^o y^o$ *I-C I-C* from 'Tendersweet Orange Flesh'**; *cc yy I-C I-C* from 'Golden Honey'**; *cc YY i-C i-C* from 'Sweet Princess'**.	Poole, 1944*	Henderson et al., 1998**	C
Ctr		*Cool temperature resistance*; *Ctr* from line PP261-1 (a single plant selection of PI 482261 from Zimbabwe); *ctr* from 'New Hampshire Midget'; resistant to leaf mosaic injury when grown at air temperature below 20°C.	Provvidenti, 1992	Provvidenti, 2003	P
cr		*cracked seed coat*; recessive to *Cr* (non-cracked) seed coat; *cr* from 'Leeby' and *Cr* from 'Kaho' and 'Congo'.	El-Hafez et al., 1981	-	?
d	-	*dotted seed coat*; black dotted seeds when dominant for color genes *r, t,* and *w; d* is a specific modifier of black seed coat color wherein *RR TT WW DD* is solid black and *RR TT WW dd* is dotted black seed coat; *d* from 'Klondike' and 'Hope Giant'; *D* from 'Winter Queen'.	Poole et al., 1941	Poole, 1944; Kanda, 1951	C
db	-	*Resistance to gummy stem blight* caused by *Didymella bryoniae*; *db* from PI 189225; *Db* from 'Charleston Gray'.	Norton, 1979	-	P
dg	-	*delayed green*; cotyledons and young leaves are initially pale green but later develop chlorophyll; first reported to be hypostatic to *I-dg*; more recent evidence indicates a simple recessive; *dg* from breeding line 'Pale 90'; *Dg* from 'Allsweet'.	Rhodes, 1986	-	?
Dia-1	-	*Diaphorase-1*	Navot et al., 1990	-	M
dw-1	-	*dwarf-1*; short internodes, due to fewer and shorter cells than normal forms; allelic	Mohr, 1956	Liu and Loy, 1972	C

		to *dw-1^s*; *dw-1* from 'Bush Desert King'; *Dw-1* from 'Sugar Baby' and 'Vine Desert King'.			
dw-1^s	-	*short vine;* allelic to *dw-1*; vine length intermediate between normal and dwarf; hypocotyl somewhat longer than normal vine and considerably longer than dwarf; *dw-1^s* recessive to normal; *dw-1^s* from 'Somali Local' (All-Union Research Institute of Plant Growing No.4641).	Dyutin and Afanas'eva, 1987	-	?
dw-2	-	*dwarf-2*; short internodes, due to fewer cells; *dw-1* from inbred line WB-2; *Dw-2* from 'Sugar Baby' and 'Vine Desert King'.	Liu and Loy, 1972	Mohr and Sandhu, 1975	?
dw-3		*dwarf-3*; dwarf with fewer leaf lobes (intermediate between normal leaf and non-lobed leaf); *dw-3* from 'Dwarf Male-Sterile Watermelon (DMSW)'; *Dw-3* from 'Changhui', 'Fuyandagua', and 'America B'.	Hexun et al., 1998	-	?
e	*t*	*explosive rind*; thin, tender rind, bursting when cut; *e* from 'California Klondike'; *E* from 'Thurmond Gray'.	Porter, 1937	Poole, 1944	?
eg	-	*egusi seed*; immature seeds with fleshy pericarp, becoming normal at maturity; *eg* from PI 490383 selection NCG-529 and PI 560006; *Eg* from 'Calhoun Gray' and 'Charleston Gray'.	Gusmini et al., 2003	-	C
Est-1	-	*Esterase-1*; one of six codominant alleles, each regulating one band; found in *C. lanatus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Est-1^1	-	*Esterase-1^1*; one of six codominant alleles, each regulating one band; found in *C. lanatus* var. *citroides* and *C. colocynthis*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Est-1^2	-	*Esterase-1^2*; one of six codominant alleles, each regulating one band; found in *C. colocynthis*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Est-1^3	-	*Esterase-1^3*; one of six codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Est-1^4	-	*Esterase-1^4*; one of six codominant alleles, each regulating one band; found in *C. ecirrhosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Est-1^5	-	*Esterase-1^5*; one of six codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Est-2	-	*Esterase-2*; one of five codominant alleles, each regulating one band; found in *C. lanatus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Est-2^1	-	*Esterase-2^1*; one of five codominant alleles, each regulating one band; found in *C. colocynthis*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Est-2^2	-	*Esterase-2^2*; one of five codominant	Navot et al., 1990;	-	M

		alleles, each regulating one band; found in *C. colocynthis*.	Navot and Zamir, 1986, 1987		
Est-2^{3}	-	*Esterase-2*^{3}; one of five codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Est-2^{4}	-	*Esterase-2*^{4}; one of five codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
f	-	*furrowed fruit surface*; recessive to smooth; type inbreds not given; *f* like 'Stone Mountain' or 'Black Diamond'; *F* like 'Mickylee'.	Poole, 1944	-	?
Fdp-1	-	*Fructose 1,6 diphosphatase-1*.	Navot et al., 1990; Navot and Zamir, 1986	-	M
Fo-1	-	*Fusarium wilt resistance for race 1*; dominant gene for resistance to race 1 of *Fusarium oxysporum* f. sp. *niveum*; *Fo-1* from 'Calhoun Gray' and 'Summit'; *fo-1* from 'New Hampshire Midget'.	Henderson et al., 1970	Netzer and Weintall, 1980	C
For-1	-	*Fructose 1,6 diphosphatase-1*.	Navot et al., 1990	-	M
Fwr	-	*Fruit fly resistance caused by Dacus cucurbitae*; dominant to susceptibility; *Fwr* from breeding lines J 18-1 and J 56-1; *fwr* from 'New Hampshire Midget', 'Bykovski', 'Red Nectar' and breeding line 'J 20-1'.	Khandelwal and Nath, 1978	-	?
g	*d*	*light green fruit rind pattern*; light green fruit recessive to dark green (*G*) and striped green (g^{s}); *g* from 'Thurmond Gray' and *G* from 'California Klondike'.	Weetman, 1937	Poole, 1944; Porter, 1937	?
g^{s}	d^{s}	*striped green fruit rind pattern*; recessive to dark green but dominant to light green skin; g^{s} from 'Golden Honey'; *G* from 'California Klondike'.	Weetman, 1937	Poole, 1944	C
Gdh-1	-	*Glutamate dehydrogenase-1*; isozyme located in cytosol.	Navot and Zamir, 1986	-	M
Gdh-2	-	*Glutamate dehydrogenase-2*; isozyme located in plastids.	Navot et al., 1990; Navot and Zamir, 1986	-	M
gf	-	*light green flower color*; *gf* from 'KW-695' and 'Dalgona'; *Gf* from Korean watermelon accession 'SS-4'.	Kwon and Dane, 1999	-	?
gms	ms_{g}	*glabrous male sterile;* foliage lacking trichomes; male sterile caused by chromosome desynapsis (named glabrous male sterile by Robinson*); *gms* from 'Sugar Baby' irradiated with gamma rays.	Watts, 1962, 1967	Robinson et al., 1976*; Ray and Sherman, 1988	?
go	*c*	*golden yellow color of older leaves and*	Barham, 1956	Robinson et al.,	C

		mature fruit; (named golden by Robinson*); *go* from 'Royal Golden'; *Go* from 'NC 34-9-1' and 'NC 34-2-1'.		1976*	
Got-1	-	*Glutamate oxaloacetate transaminase-1*; one of four codominant alleles, each regulating one band; found in *C. lanatus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Got-1^1	-	*Glutamate oxaloacetate transaminase-1*; one of four codominant alleles, each regulating one band; found in *C. colocynthis* and *Praecitrullus fistulosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Got-1^2	-	*Glutamate oxaloacetate transaminase-1^2*; one of four codominant alleles, each regulating one band; found in *C. lanatus* var. *citroides*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Got 1^3	-	*Glutamate oxaloacetate transaminase-1^3*; one of four codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Got-2	-	*Glutamate oxaloacetate transaminase-2*; one of five codominant alleles, each regulating one band; found in *C. lanatus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Got-2^1	-	*Glutamate oxaloacetate transaminase-2^1*; one of five codominant alleles, each regulating one band; found in *C. colocynthis*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Got-2^2	-	*Glutamate oxaloacetate transaminase-2^2*; one of five codominant alleles, each regulating one band; found in *C. ecirrhosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Got-2^3	-	*Glutamate oxaloacetate transaminase-2^3*; one of five codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Got-2^4	-	*Glutamate oxaloacetate transaminase-2^4*; One of five codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Got-3	-	*Glutamate oxaloacetate transaminase-3.*	Zamir et al., 1984	-	M
Got-4	-	*Glutamate oxaloacetate transaminase-4.*	Navot et al., 1990; Zamir et al., 1984	-	M
hsp-70	-	*heat shock protein 70*; one gene presequence 72-kDa hsp70 is modulated differently in glyoxysomes and plastids.	Wimmer et al., 1997	-	M
i-dg	-	*inhibitor of delayed green*; Epistatic to *dg*; *I-dg I-dg dgdg* plants are pale green; and *i-dg i-dg dgdg* plants are normal; *dg* from breeding line Pale 90; *Dg* from 'Allsweet';	Rhodes, 1986	-	L

		i-dg gene was lost when advanced inbreds were made.			
Idh-1	-	*Isocitrate dehydrogenase-1*	Zamir et al., 1984	-	M
i-C	*i*	*inhibitor of canary yellow*, resulting in red flesh (renamed by Rhodes and Dane*); *CC YY I-C I-C* from 'Yellow Baby' F1 and 'Yellow Doll' F1; *cc* $y^o y^o$ *I-C I-C* from 'Tendersweet Orange Flesh'; *cc yy I-C I-C* from 'Golden Honey'; *cc YY i-C i-C* from 'Sweet Princess'.	Henderson et al., 1998	Rhodes and Dane, 1999*	C
ja	-	*juvenile albino*; chlorophyll in seedlings, leaf margins, and fruit rind reduced when grown under short days; *ja* from 'Dixielee mutant' and 'G17AB' F2; *Ja* from 'Sweet Princess' and '20J57'.	Zhang et al., 1996b	-	?
l	-	*long (or large) seeds;* interacts with *s*; long recessive to medium or short; *LL SS* for medium, *ll SS* for long, and *LL ss* or *ll ss* for short seed; *ll SS* from 'Peerless'; *LL SS* from 'Klondike'; *LL ss* from 'Baby Delight'.	Poole et al., 1941	-	?
Lap-1	-	*Leucine aminopeptidase-1*.	Navot et al., 1990; Navot and Zamir, 1986	-	M
m	-	*mottled skin*; greenish white mottling of fruit skin; *m* from 'Iowa Belle' and *M* from 'Japan 4'.	Weetman, 1937	Poole, 1944	?
Mdh-1	-	*Malic dehydrogenase-1*; one of two codominant alleles, each regulating one band; found in *C. lanatus*.	Navot and Zamir, 1987; Zamir et al., 1984	-	M
Mdh-1^1	-	*Malic dehydrogenase-1*^{1}; one of two codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot and Zamir, 1987; Zamir et al., 1984	-	M
Mdh-2	-	*Malic dehydrogenase-2*; one of three codominant alleles, each regulating one band; found in *C. lanatus*.	Navot and Zamir, 1987	-	M
Mdh-2^1	-	*Malic dehydrogenase-2*^{1}; one of three codominant alleles, each regulating one band; found in *C. colocynthis*.	Navot and Zamir, 1987	-	M
Mdh-2^2	-	*Malic dehydrogenase-2*^{2}; one of three codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot and Zamir, 1987	-	M
Me-1	-	*Malic enzyme-1;* one of three codominant alleles, each regulating one band; found in *C. lanatus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Me-1^1	-	*Malic enzyme-1*^{1}*;* one of three codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Me-1^2	-	*Malic enzyme-12*; one of three codominant	Navot et al., 1990;	-	M

		alleles, each regulating one band; found in *C. colocynthis*.	Navot and Zamir, 1986, 1987; Zamir et al., 1984		
Me-2	-	*Malic enzyme-2.*	Zamir et al., 1984	-	M
ms-1	*ms*	*male sterile;* plants with small, shrunken anthers and aborted pollen; *ms-1* from 'Nongmei 100'; *Ms* from most cultivars, e.g. 'Allsweet'.	Zhang and Wang, 1990	Zhang et al., 1994b	?
ms^{dw}	-	*male sterile, dwarf;* ms^{dw} from 'Dwarf Male-Sterile Watermelon (DMSW)'; non-dwarf fertile from 'Changhui', 'Fuyandagua', and 'America B'.	Huang et al., 1998	-	?
ms-2		*male sterile* with high seed productivity; *ms-2* from 'Kamyzyakskii'; *Ms-2* from cultivars like 'Allsweet'.	Dyutin, and Sokolov, 1990	-	?
nl	-	*nonlobed leaves*; leaves lack the typical lobing; incomplete dominance; (named nonlobed by Robinson*); *nl* from spontaneous mutation of 'Black Diamond'.	Mohr, 1953	Robinson et al., 1976*	C
O	-	*Elongate fruit*; incompletely dominant to spherical, so that *Oo* is oval; *O* from 'Long Iowa Belle'; *o* from 'Round Iowa Belle', 'China 23', 'Japan 4', and 'Japan 6'.	Weetman, 1937	Poole and Grimball, 1945	?
p	-	*pencilled lines on skin*; inconspicuous stripes; greenish-white mottling* (called pencilled by Robinson**); recessive to netted fruit; *p* from 'Long Iowa Belle' and *P* from 'Japan 6'.	Weetman, 1937*	Poole and Grimball, 1945; Robinson et al., 1976**	?
Pgd-1	*6 Pgdh -1*	*6-Phosphogluconate dehydrogenase-1;* one of three codominant alleles, each regulating one plastid band; found in *C. lanatus.*	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
$Pgd\text{-}1^1$	*6 Pgdh* -1^1	*6-Phosphogluconate dehydrogenase-*1^1; one of three codominant alleles, each regulating one plastid band; found in *Praecitrullus fistulosus.*	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
$Pgd\text{-}1^2$	*6 Pgdh* -1^2	*6-Phosphogluconate dehydrogenase-*1^2; one of three codominant alleles, each regulating one plastid band; found in *Acanthosicyos naudinianus.*	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Pgd-2	*6 Pgdh -2*	*6-Phosphogluconate dehydrogenase-2*; one of five codominant alleles, each regulating one cytosolic band; found in *C. lanatus*.	Navot and Zamir, 1986; Zamir et al., 1984	-	M
$Pgd\text{-}2^1$	*6 Pgdh* -2^1	*6-Phosphogluconate dehydrogenase-*2^1*;* one of five codominant alleles, each regulating one cytosolic band; found in *C. ecirrhosus*.	Navot and Zamir, 1987; Zamir et al., 1984	-	M
$Pgd\text{-}2^2$	*6 Pgdh*	*6-Phosphogluconate dehydrogenase-*2^2; one of five codominant alleles, each	Navot and Zamir, 1987; Zamir et al.,	-	M

	-2^{2}	regulating one cytosolic band; found in *Praecitrullus fistulosus*.	1984		
Pgd-2^{3}	*6 Pgdh -2*^{3}	*6-Phosphogluconate dehydrogenase-2*^{3}; one of five codominant alleles, each regulating one cytosolic band; found in *C. colocynthis*.	Navot and Zamir, 1987; Zamir et al., 1984	-	M
Pgd-2^{4}	*6 Pgdh -2*^{4}	*6-Phosphogluconate dehydrogenase-2*^{4}; one of five codominant alleles, each regulating one cytosolic band; found in *Acanthosicyos naudinianus*.	Navot and Zamir, 1987; Zamir et al., 1984	-	M
Pgi-1	-	*Phosphoglucoisomerase-1*; one of three codominant alleles, each regulating one plastid band; found in *C. lanatus*	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Pgi-1^{1}	-	*Phosphoglucoisomerase-1*^{1}; one of three codominant alleles, each regulating one plastid band; found in *C. colocynthis*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Pgi-1^{2}	-	*Phosphoglucoisomerase-1*^{2}; one of three codominant alleles, each regulating one plastid band; found in *Acanthosicyos naudinianus.*	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Pgi-2	-	*Phosphoglucoisomerase-2;* one of six codominant alleles, each regulating one cytosolic band; found in *C. lanatus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Pgi-2^{1}	-	*Phosphoglucoisomerase-2*^{1}*;* one of six codominant alleles, each regulating one cytosolic band; found in *C. lanatus and C. colocynthis.*	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Pgi-2^{2}	-	*Phosphoglucoisomerase-2*^{2}*;* one of six codominant alleles, each regulating one cytosolic band; found in *C. ecirrhosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Pgi-2^{3}	-	*Phosphoglucoisomerase-2*^{3}; one of six codominant alleles, each regulating one cytosolic band; found in *Praecitrullus fistulosus.*	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Pgi-2^{4}	-	*Phosphoglucoisomerase-2*^{4}; one of six codominant alleles, each regulating one cytosolic band; found in *C. lanatus* var. *citroides*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Pgi-2^{5}	-	*Phosphoglucoisomerase-2*^{5}*;* one of six codominant alleles, each regulating one cytosolic band; found in *Acanthosicyos naudinianus.*	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Pgm-1	-	*Phosphoglucomutase-1*; one of four codominant alleles, each regulating one plastid band; found in *C. lanatus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Pgm-1^{1}	-	*Phosphoglucomutase-1*^{1}*;* one of four codominant alleles, each regulating one plastid band; found in *C. colocynthis.*	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M

Pgm-1²	-	*Phosphoglucomutase-1²*; one of four codominant alleles, each regulating one plastid band; found in *Acanthosicyos naudinianus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Pgm-1³	-	*Phosphoglucomutase-1³*; one of four codominant alleles, each regulating one plastid band; found in *Praecitrullus fistulosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Pgm-2	-	*Phosphoglucomutase-2*; one of four codominant alleles, each regulating one cytosolic band; found in C. *lanatus*.	Navot and Zamir, 1987; Zamir et al., 1984	-	M
Pgm-2¹	-	*Phosphoglucomutase-2¹*; one of four codominant alleles, each regulating one cytosolic band; found in *Acanthosicyos naudinianus*.	Navot and Zamir, 1987; Zamir et al., 1984	-	M
Pgm-2²	-	*Phosphoglucomutase-2²*; one of four codominant alleles, each regulating one cytosolic band; found in *C. lanatus*.	Navot and Zamir, 1987; Zamir et al., 1984	-	M
Pgm-2³	-	*Phosphoglucomutase-2³*; one of four codominant alleles, each regulating one cytosolic band; found in *Praecitrullus fistulosus*.	Navot and Zamir, 1987; Zamir et al., 1984	-	M
pm	-	*powdery mildew susceptibility*; susceptibility to *Sphaerotheca fuliginea* is recessive; *pm* from PI 269677; *Pm* from 'Sugar Baby' and most cultivars.	Robinson et al., 1975	-	P
Prx-1	-	*Peroxidase-1*; one of seven codominant alleles, each regulating one band; found in *C. lanatus.*	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Prx-1¹	-	*Peroxidase-1¹*; one of seven codominant alleles, each regulating one band; found in *C. colocynthis*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Prx-1²	-	*Peroxidase-1²*; one of seven codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Prx-1³	-	*Peroxidase-1³*; one of seven codominant alleles, each regulating one band; found in *C. lanatus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Prx-1⁴	-	*Peroxidase-1⁴*; one of seven codominant alleles, each regulating one band; found in *C. ecirrhosus.*	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Prx-1⁵	-	*Peroxidase-1⁵*; one of seven codominant alleles, each regulating one band; found in *C. lanatus and C. colocynthis*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Prx-1⁶	-	*Peroxidase-1⁶*; one of seven codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Prx-2	-	*Peroxidase-2.*	Navot and Zamir, 1987	-	M
Prx-3	-	*Peroxidase-3*.	Navot and Zamir, 1987	-	M

r	-	*red seed coat*; genes *r*, *t* and *w* interact to produce seeds of different colors; black from 'Klondike' (*RR TT WW*); clump from 'Sun Moon and Stars' (*RR TT ww*); tan from 'Baby Delight' (*RR tt WW*); white with tan tip from 'Pride of Muscatine' (*RR tt ww*); red from citron (rr tt WW); white with pink tip from 'Peerless' (*rr tt ww*).	Poole et al., 1941	-	?
s	-	*short (or small) seeds;* epistatic to *l*; long recessive to medium or short; *LL SS* for medium, *ll SS* for long, and *LL ss* or *ll ss* for short seed; *ll SS* from 'Peerless'; *LL SS* from 'Klondike'; *LL ss* from 'Baby Delight'.	Poole et al., 1941	-	?
Sat	-	*Serine acetyltransferase*; catalyzes the formation of O-acetylserine from serine and acetyl-CoA.	Saito et al., 1997	-	M
Skdh-1	-	*Shikimic acid dehydrogenase-1.*	Zamir et al., 1984	-	M
Skdh-2	-	*Shikimic acid dehydrogenase-2;* one of six codominant alleles, each regulating one band.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Skdh-2^1	-	*Shikimic acid dehydrogenase-2*^{1}; one of six codominant alleles, each regulating one band; found in *C. colocynthis*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Skdh-2^2	-	*Shikimic acid dehydrogenase-2*^{2}; one of six codominant alleles, each regulating one band; found in *C. colocynthis*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Skdh-2^3	-	*Shikimic acid dehydrogenase-2*^{3}; one of six codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Skdh-2^4	-	*Shikimic acid dehydrogenase-2*^{4}; one of six codominant alleles, each regulating one band; found in *C. ecirrhosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Skdh-2^5	-	*Shikimic acid dehydrogenase-2*^{5}*;* one of six codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
slv	-	*seedling leaf variegation;* conferred by a single recessive gene in PI 482261; linked or pleiotropic with a dominant allele for resistance to cool temperature injury (20°C for greenhouse-grown plants); *slv* from PI 482261 (resistant to ZYMV-FL); *Slv* from 'New Hampshire Midget'.	Provvidenti, 1994	-	P
Sod-1	-	*Superoxide dismutase-1;* one of three codominant alleles, each regulating one band; found in *C. lanatus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M

Sod-1^{1}	-	*Superoxide dismutase-1*^{1}; one of three codominant alleles, each regulating one band; found in *C. colocynthis*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Sod-1^{2}	-	*Superoxide dismutase-1*^{2}; one of three codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987; Zamir et al., 1984	-	M
Sod-2	-	*Superoxide dismutase-2*; one of two codominant alleles, each regulating one band; found in *C. lanatus*.	Navot and Zamir, 1987	-	M
Sod-2^{1}	-	*Superoxide dismutase-2*^{1}*;* one of two codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot and Zamir, 1987	-	M
Sod-3	-	*Superoxide dismutase-3*; one of two codominant alleles, each regulating one band; found in *C. lanatus*.	Navot and Zamir, 1987	-	M
Sod-3^{1}	-	*Superoxide dismutase-3*^{1}*;* one of two codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot and Zamir, 1987	-	M
Sp	-	*Spotted cotyledons, leaves and fruit*; dominant to uniform foliage and fruit color; *Sp* from 'Sun, Moon and Stars'* and 'Moon and Stars'**; *sp* from 'Allsweet'.	Poole, 1944*	Rhodes, 1986**	C
Spr-1	-	*Seed protein-1.*	Navot and Zamir, 1986	-	M
Spr-2	-	*Seed protein-2.*	Navot and Zamir, 1986	-	M
Spr-3	-	*Seed protein-3.*	Navot and Zamir, 1986	-	M
Spr-4	*Sp-4*	*Seed protein-4.*	Navot et al., 1990; Navot and Zamir, 1986	-	M
Spr-5	*Sp-5*	*Seed protein-5.*	Navot et al., 1990; Navot and Zamir, 1986	-	M
su	*Bi, su*^{Bi}	*suppressor of bitterness*; (*su* named by Robinson*); non-bitter fruit; *su* from 'Hawkesbury'; *Su* from bitter-fruited mutant of 'Hawkesbury'; bitterness in *C. colocynthis* is due to *Su Su* genotype.	Chambliss et al., 1968	Robinson et al., 1976*	?
t	*b*^{t}	*tan seed coat*; genes *r*, *t* and *w* interact to produce seeds of different colors; black from 'Klondike' (*RR TT WW*); clump from 'Sun Moon and Stars' (*RR TT ww*); tan from 'Baby Delight' (*RR tt WW*); white with tan tip from 'Pride of Muscatine' (*RR tt ww*); red from citron (rr tt WW); white with pink tip from 'Peerless' (*rr tt ww*).	McKay, 1936	Poole et al., 1941	?

Ti	-	*Tiny seed;* dominant over medium seed (*ti*); *Ti* from 'Sweet Princess'; *ti* from 'Fujihikari'.	Tanaka et al., 1995	-	?
tl	*bl*	*tendrilless* (formerly called *branchless**), after 4th or 5th node, vegetative axillary buds are transformed into flower buds and leaf shape is altered; *tl* from 'Early Branchless'; *Tl* from breeding lines 'G17AB', 'ASS-1', 'YF91-1-2', and S173 breeding line.	Rhodes, Zhang, Baird and Knapp, 1999; Zhang, Rhodes, Baird and Skorupska, 1996a	Lin, Tong, Wang, Zhang and Rhodes, 1992*	?
Tpi-	-	*Triosephosphatase isomerase-1*. one of four codominant alleles, each regulating one band; found in *C. lanatus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Tpi-1^1	-	*Triosephosphatase isomerase-1*^{1}; one of four codominant alleles, each regulating one band; found in *C. colocynthis*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Tpi-1^2	-	*Triosephosphatase isomerase-1*^{2}; one of four codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Tpi-1^3	-	*Triosephosphatase isomerase-1*^{3}; one of four codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot et al., 1990; Navot and Zamir, 1986, 1987	-	M
Tpi-2	-	*Triosephosphatase isomerase-2*; one of three codominant alleles, each regulating one band; found in *C. lanatus*.	Navot and Zamir, 1987	-	M
Tpi-2^1	-	*Triosephosphatase isomerase-2*^{1}; one of three codominant alleles, each regulating one band; found in *Acanthosicyos naudinianus*.	Navot and Zamir, 1987	-	M
Tpi-2^2	-	*Triosephosphatase isomerase-2*^{2}; one of three codominant alleles, each regulating one band; found in *Praecitrullus fistulosus*.	Navot and Zamir, 1987	-	M
ts	*tss*	*tomato seed*; seeds smaller than short (*LLss* or *llss*), almost the size of a tomato seed; *ts* from tomato seed Sugar Baby mutant; *Ts* from 'Gn-1'.	Zhang et al., 1994a	Zhang, 1996	C
Ure-1	-	*Ureaase-1*.	Navot and Zamir, 1987	-	M
w	-	*white seed coat*; genes *r*, *t* and *w* interact to produce seeds of different colors; black from 'Klondike' (*RR TT WW*); clump from 'Sun Moon and Stars' (*RR TT ww*); tan from 'Baby Delight' (*RR tt WW*); white with tan tip from 'Pride of Muscatine' (*RR tt ww*); red from citron (rr tt WW); white with pink tip from 'Peerless' (*rr tt ww*).	Poole et al., 1941	-	?
Wf	*W*	*White flesh*; (named white flesh by Robinson*); *Wf* is epistatic to *B* (*Y* renamed *B* by Henderson)*; WfWf BB* or	Shimotsuma, 1963	Robinson et al., 1976*	?

		WfWf bb white fleshed; *wfwf BB* yellow fleshed; *wfwf bb* red fleshed; *B* from breeding line V.No.3 and *b* from V.No.1; flesh color segregated into 12 white, 3 yellow and 1 red in the F2.			
y	*rd*	*yellow flesh*; recessive to red flesh; *y* from 'Golden Honey'; *Y* from 'Angeleno' (black seeded).	Porter, 1937	Poole, 1944; Henderson, 1989; Henderson et al., 1998;	C
y^o	-	*orange flesh*; allelic to *y*; *Y* (red flesh) is dominant to y^0 (orange flesh) and *y* (salmon yellow flesh); y^o (orange flesh) is dominant to *y* (yellow flesh); *cc* y^oy^o *I-C I-C* from 'Tendersweet Orange Flesh'; *cc yy I-C I-C* from 'Golden Honey'; *cc YY i-C i-C* from 'Sweet Princess'.	Henderson, 1989; Henderson et al., 1998	Poole, 1944; Porter, 1937	C
Yl	-	*Yellow leaf;* incompletely dominant to green leaf (*yl*); *Yl* from 'Yellow Skin'.	Warid and Abd-El-Hafez, 1976	-	?
zym-FL	*zym*	*Resistance to zucchini yellow mosaic virus (ZYMV-FL);* resistance is specific to the Florida strain; zym-FL from PI 482322, PI 482299, PI 482261, and PI 482308.	Provvidenti, 1991	-	P

z Asterisks on cultigens and associated references indicate the source of information for each.

y C = Mutant available from Cucurbit Genetics Cooperative watermelon gene curator; M = molecular marker or isozyme; P = mutants are available as standard cultivars or accessions from the plant introduction collection; ? = availability not known; L = mutant has been lost.

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