2013 Gene List for Other Genera of Cucurbitaceae

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The Cucurbitaceae includes many important vegetables species, including cucumber, melon and watermelon. Those are major crop species originally from the Old World: cucumber from India; melon and watermelon from Africa (Wehner and Maynard, 2003). However, there are other important species originally from Africa such as gherkin (*Cucumis anguria*), African horned melon (*Cucumis metuliferus*), bottle gourd (*Lagenaria siceraria*); and species originally from India such as sponge gourd (*Luffa* spp.), Melothria (*Melothria maderaspatana*) and bitter melon (*Momordica charantia*). They have fruit that are used for food, decoration, containers, utensils or sponges. The exception is *Melothria*, which has medicinal uses (Iman *et al.*, 2006).

Gene List Update

The following list is the latest version of the gene list for the other genera of the Cucurbitaceae, those that are not covered in the CGC gene lists. The genes originally were organized and summarized by Robinson (1979, 1982). The list was subsequently updated by Taja and Wehner (2009). This current gene list provides an update of the known genes, with 27 total mutants grouped by species.

Researchers are encouraged to send reports of new genes, as well as seed samples of lines having the gene mutant to the gene curator (Mark G. Hutton), or the assistant curator (Thomas C. Andres). 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 gene curators for other genera 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 made editorial corrections, and added genes not previously described: *F1,2y* and *pia* (*Cucumis anguria*), *pm (Lagenaria siceraria*), *Rf-1* and *Rf-2* (*Luffa acutangula*), *Tlcy* and A^{dgn} (*Luffa aegyptiaca* or *L. cylindrica*).

Previous Gene Lists

Robinson, 1979: 13 genes added, 13 genes total
Robinson, 1982: 1 gene added, 14 genes total
Taja and Wehner, 2009: 6 genes added, 20 genes total
VandenLangenberg and Wehner, 2013: 7 genes added, 27 genes total

West Indian Gherkin (*Cucumis anguria*)

Six gene loci have been described so far for West Indian gherkin. A single dominant gene produces bitter fruit: *Bt* (Koch and Costa, 1991). Another dominant gene controls resistance to *Cucumber green mottle mosaic virus*: *Cgm* (den Nijs, 1982). Two loci control fruit spininess: *S and P* (Koch and Costa, 1991). A single dominant gene controls resistance to *Fusarium oxysporum* f. sp. *melonis* race 1,2y: *F1,2y* (Matsumoto and Miyagi, 2012). The resistant type line was PI 320052. A single recessive gene controls alleviation of pollen-pistil incongruity: *pia* (Matsumoto and Miyagi, 2012).

African Horned Melon (*Cucumis metuliferus*)

Watermelon mosaic virus resistance in African horned melon or kiwano is controlled by a single dominant gene *Wmv* (Provvidenti and Robinson, 1972). Another single dominant gene, *Prsv* controlled resistance to *Papaya ringspot virus* (Provvidenti and Gonsalves, 1982). The resistant type line was PI 292190, and the susceptible type line was Acc 2459.

Bottle Gourd (*Lagenaria siceraria*)

Red pumpkin beetle (*Aulacophora foveicollis*) resistance is controlled by a single dominant gene *Af* (Vashishta and Choudhury, 1972). Different genes affect shape and color of the fruit in bottle gourd. The genotype

bb produces bottle-shaped fruit, and *BB* produces disk-shaped fruit. The genotype *rr* produces round fruit shape that is also recessive to the genotype *RR*, with disk-shaped fruit. The gene *db* interacts with *b* to produce an F2 of 9 club: 3 round: 4 dumbbell-shaped fruit (Tyagi, 1976). Dark green fruit color is controlled by the genotype *GG* which is dominant to the genotype *gg* with light green fruit color (Tyagi, 1976). The genotype *lb lb* controls the light brown seed coat color, but it is recessive to the genotype *Lb Lb* with brown seed coat color (Tyagi, 1976).

Four normal-leaf parents (Pusa Naveen, PBOG 13, PBOG 22 and PBOG 61) were crossed with segmented-leaf parents (PBOG 54) of bottle gourd to study the inheritance of segmented leaf shape. Normal-leaf shape parents showed true breeding normal-leaf shape plants. However, the segmented-leaf parent (PBOG 54) surprisingly segregated in a ratio of 3 segmented: 1 normal-leaf plants. Moreover, F_1 also segregated in 1 segmented: 1 normal leaf shape suggesting that the parental cultivar PBOG 54 was heterozygous for the leaf shape gene and the segmented leaf was dominant over normal type. The segregation in the backcrosses of 1 segmented: 1 normal-leaf type confirmed that a single dominant gene *S* is responsible for the segmented leaf shape character in bottle gourd (Akhilesh and Ram, 2006).

Powdery mildew resistance was reported by Wang *et al*., (2011) as being under the control of a single recessive gene. We suggest the gene symbol *pm*, with the recessive type line J083 as the source of resistance.

Luffa Gourd (*Luffa* spp.)

Luffa species (also spelled loofah) include luffa sponge gourd or smooth luffa (*Luffa aegyptiaca or L. cylindrica*), luffa ridge gourd or angled luffa (*Luffa acutangula*). The gynoecious gene *g* (Choudhury and Thakur, 1965) interacts with andromonoecious gene *a* to produce the following phenotypes: monoecious or trimonoecious (*AA GG*), andromonoecious (*aa GG*), gynoecious (*AA gg*), or hermaphroditic (*aa gg*) plants. A single dominant gene, A^{dgn}, was reported by Singh *et al.,* (2012) to control the expression of androgynous inflorescence in *Luffa cylindrica*. The landrace Androgyn-K was used to create three inbreds, and subsequent crosses with monoecious line NDSG-5 resulted in androgynous monoecious F_1 offspring. The F_2 and BC_1 segregation data suggested inheritance was under the control of a single dominant gene (Singh *et al.,* 2012). Their report also indicated that A^{dgn} may control the number of organs produced on vine nodes. Further research should be conducted to determine the relationship of A^{dgn} to previously reported genes, including those that alter vine node organ number.

Two dominant genes restore male fertility in the presence of sterile cytoplasm in *Luffa acutangula*: *Rf-1* and *Rf-2* (Pradeepkumar *et al*., 2012).

A single dominant gene controls resistance to *Tomato leaf curl New Delhi virus* (ToLCNDV) in *Luffa cylindrica*. We suggest the gene symbol: *Tlcv*. Resistance sources include inbred lines DSG-6 and DSG-7 (Islam *et al*., 2010).

Melothria (*Melothria maderaspatana*)

Small seed size (3.0 mm) is controlled by the gene *s* (Sing, 1972) that is recessive to *SS* for large seed size (3.6 mm). White seed coat color is controlled by the gene *w.* Homozygous recessive *ww* produces a white seed coat, heterozygous *Ww* produces an ash-colored seed coat, and homozygous dominant *WW* produces a black seed coat (Sing, 1972).

Bitter Melon (*Momordica charantia*)

Light brown seeds *lbs* (Ram *et al*., 2006) is inherited as a single gene that is recessive to dark brown seeds *Lbs*. Large seed size is controlled by the gene *ls*, which is recessive to small seed size (Srivastava and Nath, 1972). White immature fruit skin is inherited as a single gene *w* for white epicarp that is recessive to *W* for green epicarp (Srivastava and Nath, 1972).

Ram *et al*. (2006) reported that gynoecism in Gy263B was controlled by a single recessive gene *gy-1*. The gynoecious plants of Gy263B had significantly longer (2000 mm) vine length than their monoecious counterparts (1275 mm).

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Table 1. The morphological and resistance genes of the miscellaneous genera and species of the Cucurbitaceae.

Symbol	Gene description and type lines	References
Cucumis anguria		
Bt	*Bitter fruit.* Fruit with bitter flavor due to a single dominant gene determined in the segregating populations of *Cucumis anguria* x *C. longipes*.	Koch and Costa, 1991
Cgm	*Cucumber green mottle resistance.*	den Nijs, 1982
F1,2y	*Fusarium oxysporum f. sp. melonis race 1,2y resistance*. Resistance controlled by a single dominant gene.	Matsumoto and Miyagi, 2012
P	*Spined fruit.* The fruit spininess is determined in the segregating populations of *Cucumis anguria* x *C. longipes* by two pairs of independent genes.	Koch and Costa, 1991
pia	*pollen-pistil incongruity alleviation*. Pollen-pistil incongruity alleviation is controlled by a single recessive gene.	Matsumoto and Miyagi, 2012
S	*Spined fruit*. The fruit spininess is determined in the segregating populations of *Cucumis anguria* x *C. longipes* by two pairs of independent genes.	Koch and Costa, 1991
Cucumis metuliferus		
Prsv	*Papaya ringspot virus resistance.* Resistance to *Papaya ringspot virus*; dominant to susceptibility.	Provvidenti and Gonsalves, 1982
Wmv	*Watermelon mosaic virus resistance.* Resistance to *Watermelon mosaic virus*; dominant to susceptibility.	Provvidenti and Robinson, 1972
Lagenaria siceraria		
Af	*Aulacophora foveicollis resistance.* Resistance dominant to susceptibility to the red pumpkin beetle.	Vashishta and Choudhury, 1972
b	*bottle.* Bottle-shaped fruit recessive to disk.	Tyagi, 1976
db	*dumbbell*. Interacts with b to produce F2 of 9 club: 3 round: 4 dumbbell-shaped fruit.	Tyagi, 1976
G	*Green.* Dark green fruit color; dominant to light green.	Tyagi, 1976
lb	*light brown seed*. Light brown seed coat color recessive to dark brown.	Tyagi, 1976
pm^z	*Powdery mildew resistance.* A single recessive gene controls resistance.	Wang *et al*., 2011
r	*round.* Round fruit; recessive to disk-shape fruit.	Tyagi, 1976
S	*Segmented leaves.* A single dominant gene which is responsible for segmented leaf shape in bottle gourd from PBOG 54 (heterozygous for segmented leaf shape).	Akhilesh and Ram, 2006

Luffa spp.		
A^{dgn}	*Androgynous*. A single dominant gene controls the expression of androgynous monoecious inflorescence.	Singh *et al*., 2012
g	*gynoecious.* Pistillate flowers only; interacts with *a* to produce monoecious or trimonoecious (*AA GG*), andromonoecious (*aa GG*), gynoecious (*AA gg*), or hermaphroditic (*aa gg*) plants.	Choudhury and Thakur, 1965
Rf-1	*Restorer of fertility 1*. One of two dominant genes having complimentary action govern fertility restoration.	Pradeepkumar *et al*., 2012
Rf-2	*Restorer of fertility 2*. One of two dominant genes having complimentary action govern fertility restoration.	Pradeepkumar *et al*., 2012
Tlcv[z]	*Tomato leaf curl New Delhi virus resistance.* A single dominant gene controls resistance to ToLCNDV.	Islam *et al*., 2010
Melothria maderaspatana		
s	*small seeds.* Small (3.0 mm) seeds recessive to large (3.6 mm) seeds.	Sing, 1972
w	*white seeds.* White seed coat if *ww*, ashy if *Ww*, and black if *WW.*	Sing, 1972
Momordica charantia		
gy-1	*gynoecious.* Recessive gene for a high degree of pistillate sex expression from Gy263B (100% gynoecious line).	Ram *et al*., 2006
lbs	*light brown seed.* Light brown seed coat color; recessive to dark brown.	Srivastava and Nath, 1972
ls	*large seed.* Large seed size; recessive to small seed size.	Srivastava and Nath, 1972
w	*white epicarp*. White immature fruit skin; recessive to green.	Srivastava and Nath, 1972

[z] Suggested gene name according to the rules of gene nomenclature for the Cucurbitaceae (Robinson *et al.,* 1976).