Release of Cornell 607-612: Common Bean Breeding Lines with Resistance to White Mold

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The New York State Agricultural Experiment Station announces the release of six dry bean (*Phaseolus vulgaris* L.) breeding lines with resistance to white mold [*Sclerotinia sclerotiorum* (Lib.) de Bary]. These breeding lines, ‘Cornell 607’ dark red kidney (DRK), ‘Cornell 608’ DRK, ‘Cornell 609’ black bean (BB), ‘Cornell 610’ BB, ‘Cornell 611’ light red kidney (LRK), and Cornell 612 LRK, represent germplasm with high levels of resistance to white mold developed through greenhouse selection and evaluation in multistate greenhouse and field comparisons through the W-2150 regional project.

White mold is an important disease of common bean worldwide reducing both yield and quality of seed harvested. Plant protection from white mold can be conferred through both plant architecture and physiological resistance (Kolkman and Kelly, 2003; Schwartz et al., 1978). Physiological resistance can be selected using several approaches for the selection of breeding lines (Hunter et al., 1981; Schwartz et al., 1987; Steadman et al., 1997). A technique known as the “straw test,” which shows a very high correlation with field resistance, was used in the selection of these materials (Petzoldt and Dickson, 1996; Singh and Teran, 2008; Teran and Singh, 2009). This test was used to develop the six breeding lines by inoculating two petioles on each plant in the populations as described previously (Griffiths et al., 2004; Teran et al., 2006).

Origin and Description

Lines ‘Cornell 607’, ‘Cornell 608’, ‘Cornell 609’, ‘Cornell 610’, ‘Cornell 611’, and ‘Cornell 612’ were selected from three lineages of recurrent selection using previously developed breeding lines as sources of resistance to white mold (Griffiths, 2009). ‘Cornell 607’ (DRK) and ‘Cornell 608’ (DRK) selections were developed from a cross between ‘Cornell 603’ (Griffiths, 2009) and the DRK cultivar Cabernet (Seminis Vegetable Seeds, Woodland,

CA). F₁ hybrid seeds generated from the six crosses were increased to generate segregating F₂ populations; 40 F₂ plants from each lineage were advanced to create 40 F₃ sister lines from each of the six populations from single F₂ plants. These were sown for inoculation and evaluation of five plants for each of the F₃ lines.

Greenhouse inoculations for the development of the white mold-resistant breeding lines were performed at Geneva, NY, with 2- to 3-d-old actively growing mycelia of white mold isolate #48 collected from a snap bean field in Murray, Orleans County, NY (Helene Dillard, NYSAES, Cornell Univ., Geneva, NY) grown on 2% potato dextrose agar (Difco, Sparks, MD). Plants were grown in 15 cm × 15-cm square pots in Cornell mix (Boodley and Sheldrake, 1982) in greenhouses at 25/22 °C day/night with a 14-h photoperiod under 1000-W metal halide lamps (300 μmol·m⁻²·s⁻¹) in preparation for the inoculation. Plants were inoculated using a modified technique that involved double inoculation of each plant with two 3-cm straws placed on petioles cut 5 cm from the nodes. Plants were evaluated for disease severity 14 d after inoculation, and selections of resistant plants were made based on aggressiveness and severity of the white mold growth. Ratings were made based on

a 1 to 5 scale, where 1 = no progression of symptoms beyond the first node, 2 = some progression of symptoms beyond the first node, 3 = progression of symptoms to the second node, 4 = progression of symptoms beyond the second node, and 5 = complete susceptibility and death of the plant.

Selection was undertaken for four generations (F₃ to F₇) using single seed selection to advance the most promising lines. The advanced lines were tested in replicated greenhouse screens at the F₈ generation, and the two lines showing the highest level of resistance to white mold within the DRK lineages based on their reactions to infection using the straw test approach were ‘Cornell 607’ and ‘Cornell 608’. The remaining breeding lines were developed using the same approach. BB lines ‘Cornell 609’ and ‘Cornell 610’ were developed as F₈ replicated trial selections from lineages selected through recurrent selection and single-seed descent from a cross between ‘Cornell 604’ (Griffiths, 2009) and BB cultivar T-39 (University of California Davis, Davis, CA). LRK lines ‘Cornell 611’ and ‘Cornell 612’ were also selected using this approach following the generation of breeding lineages from a cross between ‘Cornell 605’ (Griffiths, 2009) and ‘Wallace’ (Cornell University, Ithaca, NY).

The six dry bean (*Phaseolus vulgaris* L.) breeding lines being released represent three market classes, LRK and DRK in the Andean type, and BB in the Mesoamerican type (Fig. 1). The breeding lines have been evaluated for white mold resistance in replicated greenhouse trials with multistate entries for the 2010 W-2150 multistate regional project (Table 1). All six breeding lines performed well using the modified rating scale of 1 to 9 (Teran et al., 2006) scoring between 2.44 and 4.40 based on a mean of 20 inoculated plants for each entry and with scores in the same range or better than the resistant checks ‘G-122’ and ‘A-195’.

Field evaluations of the breeding lines were made in replicated trials in Livingston County, NY, and Tompkins County, NY, in

Fig. 1. Dry seed of ‘Cornell 607’, ‘Cornell 608’, ‘Cornell 609’, ‘Cornell 610’, ‘Cornell 611’, and ‘Cornell 612’ relative to commercial cultivars Montcalm, T-39, and Cabernet in similar market classes of common bean.

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Table 1. Greenhouse evaluation of 'Cornell 607', '608', '609', '610', '611', and '612' in 2010 greenhouse trials at Cornell University, NY.^z

Entry	No. of plants rated	Mean disease rating	Rank
Cornell 607	10	2.44 i ^y	1
Cornell 611	10	2.50 i	2
Cornell 605	10	3.00 hi	3
VCW54	10	3.10 g-i	4
Cornell 610	9	3.11 g-i	5
Cornell 612	9	3.22 f-i	6
G122	10	3.90 f-h	7
C08709	8	4.00 f-h	8
Cornell 609	10	4.10 f-h	9
Cornell 608	10	4.40 e-g	10
A195	10	4.50 ef	11
ND080547	10	5.60 de	12
NE2-09-16	10	5.80 d	13
P07751	10	6.20 cd	14
NE2-06-8	10	6.40 cd	15
NE2-09-4	10	7.20 bc	16
NE2-09-19	10	7.30 bc	17
P07863	10	7.30 bc	17
Beryl	10	7.90 ab	19
37-2	10	8.20 ab	20
NE2-09-1	10	8.30 ab	21
ND060514	10	8.40 ab	22
NE1-09-20	10	8.50 ab	23
NE2-09-6	10	8.50 ab	23
50-2	10	8.80 a	25
NE2-09-14	8	8.88 a	26
NE2-09-10	9	8.89 a	27
NE2-09-12	10	8.90 a	28
70-1	10	9.00 a	29
Ex-Rico (Bunsi)	10	9.00 a	29
Hystyle	10	9.00 a	29

^yTable represents relative ranking and means grouping differences when compared with the resistant control G-122 and susceptible checks Ex-Rico and Beryl. Results based on data submitted to W-2150 greenhouse trials (2011).

^zMeans separation according to Duncan's multiple range test ($P \leq 0.05$).

2010 (Tables 2 to 4). The DRK lines 'Cornell 607' and 'Cornell 608' yielded 3025.2 kg-ha⁻¹ and 2929.2 kg-ha⁻¹ in the Livingston County trial and 3903.2 kg-ha⁻¹ and 3412.8 kg-ha⁻¹ in the Tompkins County trial, respectively (Table 2). Both lines had seed sizes and maturities in line with commercial DRK cultivars being grown. The BB releases 'Cornell 609' and 'Cornell 610' yielded higher in the Livingston County trial generating 2508.1 kg-ha⁻¹ and 2423.3 kg-ha⁻¹, respectively; however, the performance for yield in the Tompkins County trial was low compared with commercial BB cultivars yielding only 2540.5 kg-ha⁻¹ and 2969.9 kg-ha⁻¹, respectively (Table 3). The LRK releases 'Cornell 611' and 'Cornell 612' yielded 3077.1 kg-ha⁻¹ and 3102.2 kg-ha⁻¹, respectively, in the Livingston County trial, and 3536.6 kg-ha⁻¹ and 4009.1 kg-ha⁻¹, respectively, in the Tompkins County trial (Table 4). The LRK lines show improvement for both seed size and maturity over 'Cornell 605' (Griffiths, 2009), which was the donor parent for white mold resistance in these selections. These new releases represent new germplasm that can be used for developing commercial cultivars of dry bean with enhanced resistance to white mold in the LRK, DRK, and BB market classes.

Table 2. Field-testing of dark red kidney breeding lines 'Cornell 607' and 'Cornell 608' in Livingston County, NY, and Tompkins County, NY, 2010.

Dark red kidney trial, Livingston County, NY, plant date 21 June					
Entry	Source	Yield (kg-ha ⁻¹)	Harvest index (%)	Seed size (seeds/lb)	Days to 90% dry pods
K06012	Mich. St.	3413.3 a ^z	50.8 a	1968.7 a	90.0 b
Cornell 607	Cornell	3025.2 ab	50.9 a	1840.8 bc	94.3 a
Cornell 608	Cornell	2929.9 a-c	45.3 ab	1863.5 b	96.0 a
Montcalm	Mich. St.	2880.2 a-c	43.6 ab	1745.4 c	98.0 a
Cornell 603	Cornell	2843.3 a-c	43.4 ab	1879.0 ab	95.3 a
GTS104	Gentec	2462.2 bc	40.4 b	1782.0 bc	96.7 a
Cabernet	Seminis	2108.0 c	41.0 b	1856.9 b	94.7 a

Dark red kidney trial, Tompkins County, NY, plant date 18 June					
Entry	Source	Yield (kg-ha ⁻¹)	Harvest index (%)	Seed size (seeds/lb)	Days to 90% dry pods
GTS 104	Gentec	4076.3 a	45.5 bc	1637.6 d	98.3 a
GTS 106	Gentec	3903.4 ab	46.5 bc	1686.5 cd	95.8 b
Cornell 607	Cornell	3903.2 ab	53.9 a	1753.8 bc	98.8 a
K08228	Mich. St.	3900.9 ab	44.7 c	1819.9 ab	93.5 c
Cabernet	Seminis	3779.9 ab	46.0 bc	1683.0 d	94.3 bc
K06012	Mich. St.	3719.3 a-c	47.4 b	1861.7 a	93.0 c
Montcalm	Mich. St.	3642.0 b-d	37.9 d	1604.9 d	99.0 a
Cornell 608	Cornell	3412.8 cd	45.2 c	1786.4 ab	99.0 a
Cornell 603	Cornell	3319.2 d	46.1 bc	1866.9 ab	93.3 c

^zMeans separation according to Duncan's multiple range test ($P \leq 0.05$).

Table 3. Field-testing of black bean breeding lines 'Cornell 609' and 'Cornell 610' in Livingston County, NY, and Tompkins County, NY, 2010.

Black bean trial, Livingston County, NY, plant date 21 June					
Entry	Source	Yield (kg-ha ⁻¹)	Harvest index (%)	Seed size (seeds/kg)	Days to 90% dry pods
GTS 1103	Gentec	3190.3 a ^z	48.7 a	4566.4 cd	93.3 d
Black Velvet	Seminis	3145.4 a	42.8 ab	4151.3 e	97.0 b
Zorro	Mich. St.	2823.4 ab	46.1 a	4639.1 b-d	93.3 d
Cornell 609	Cornell	2508.1 a-c	42.7 ab	3622.8 f	111.3 a
Cornell 610	Cornell	2423.3 a-c	44.0 ab	3552.9 f	110.3 a
Eclipse	Coop NRS	2338.1 a-c	38.8 ab	5137.4 a	90.0 e
T-39	ADM	2311.5 a-c	42.1 ab	4929.5 ab	95.7 b-d
Shania	ADM	2309.3 a-c	38.4 ab	5099.2 a	96.3 bc
Midnight	IBS	2254.6 a-c	38.8 ab	4981.7 b-d	95.0 cd
Jaguar	ADM	2254.4 a-c	38.9 ab	4979.3 ab	94.0 b-d
96-148	Cornell	2253.2 a-c	39.7 ab	4894.8 ab	95.0 cd
Condor	ADM	2202.0 a-c	41.1 ab	4475.3 d	96.0 b-d
Jet Black	Idaho BS	2133.3 a-c	39.0 ab	4813.3 a-d	95.0 b-d
Jolly Roger	Idaho BS	1765.0 bc	38.4 ab	4720.0 b-d	93.0 b-d

Black bean trial, Tompkins County, NY, plant date 18 June					
Entry	Source	Yield (kg-ha ⁻¹)	Harvest index (%)	Seed size (seeds/kg)	Days to 90% dry pods
Zorro	Mich. St.	4874.9 a	56.2 bc	4251.1 c-e	97.0 de
Jet Black	Idaho BS	4861.7 a	58.5 ab	4402.1 bc	96.8 de
COB 223-99	Gentec	4720.2 ab	57.8 b	4491.3 ab	92.5 h
GTS 1103	Gentec	4681.0 a-c	56.9 b	4359.6 b-d	92.8 gh
COB2159-00	Gentec	4679.5 a-c	60.3 a	4044.3 f	93.0 gh
Shania	ADM	4605.0 a-d	50.1 fg	4477.5 b	96.5 e
Midnight	Cornell	4602.2 a-d	48.7 hg	4520.5 ab	102.3 b
Condor	Mich. St.	4526.3 a-d	51.8 ef	4379.4 b-d	94.8 f
96-148	Cornell	4486.8 a-d	52.9 de	4097.9 ef	100.3 c
Jolly Roger	Idaho BS	4438.6 b-d	56.0 bc	4164.3 ef	95.8 ef
Eclipse	NDSU	4404.9 b-d	51.6 ef	4488.1 ab	94.3 fg
Black Velvet	Seminis	4370.0 b-d	43.4 i	4013.5 f	100.8 bc
Jaguar	Mich. St.	4357.3 b-d	54.3 cd	4647.3 a	91.8 h
T-39	UC Davis	4306.6 cd	50.5 fg	4236.8 de	98.3 d
Cornell 610	Cornell	2969.9 e	43.2 i	3337.8 h	105.8 a
Cornell 609	Cornell	2540.5 d	41.4 h	3730.8 ef	105.3 bc

^zMeans separation according to Duncan's multiple range test ($P \leq 0.05$).

Availability

Small amounts of seed are available from P.D. Griffiths, New York State Agricultural

Experiment Station, Cornell University, Department of Horticultural Sciences, 314 Hedrick Hall, Geneva, NY 14456 with a material transfer agreement.

Table 4. Field-testing of light red kidney breeding lines ‘Cornell 611’ and ‘Cornell 612’ in Livingston County, NY, and Tompkins County, NY, 2010.

Light red kidney trial, Livingston County, NY, plant date 21 June					
Entry	Source	Yield (kg·ha ⁻¹)	Harvest index (%)	Seed size (seeds/kg)	Days to 90% dry pods
NY105	Cornell	4143.0 a [*]	59.3 a	1547.0 ef	88.0 de
A-47	Cornell	3818.0 ab	54.4 bc	1462.3 f	88.7 c–e
CELRK	UC Davis	3556.5 a–c	56.5 ab	1538.8 ef	86.3 e
NY104	Cornell	3481.7 a–c	52.5 b–e	1592.4 d–f	88.3 de
Wallace	Cornell	3468.2 a–c	51.6 c–e	2232.6 a	89.7 c–e
A-36	Cornell	3442.1 b–d	53.8 b–d	1677.0 c–e	89.0 c–e
A-41	Cornell	3342.7 b–d	48.8 e–g	1948.2 b	91.0 c–e
Pink Panther	Seminis	3231.7 b–d	50.6 c–f	1544.8 ef	91.7 cd
Cornell 612	Cornell	3102.2 cd	46. fg	1650.6 c–e	93.3 c
Cornell 611	Cornell	3077.1 cd	49.7 d–g	1538.8 ef	92.0 cd
A-45	Cornell	3061.4 cd	45.7 g	1702.0 cd	92.7 cd
A-38	Cornell	2978.0 cd	46.3 fg	1887.1 b	92.7 cd
Cornell 605	Cornell	2922.8 cd	47. c–g	1737.9 c	102.0 b
RedKanner	Cornell	2745.0 d	46.0 fg	2011.3 b	106.3 a

Light red kidney, Tompkins County, NY, plant date 18 June					
Entry	Source	Yield (kg·ha ⁻¹)	Harvest index (%)	Seed size (seeds/kg)	Days to 90% dry pods
A-47	Cornell	4819.7 a	51.0 b	1374.6 i	100.0 ef
RedKanner	Cornell	4761.7 a	51.6 b	1735.0 c	107.0 a
NY105	Cornell	4666.4 ab	55.2 a	1475.5 gh	94.8 k
NY118	Cornell	4663.5 ab	47.3 cd	1613.8 d	104.5 b
A-36	Cornell	4553.2 a–c	51.4 b	1606.1 de	95.3 jk
Wallace	Cornell	4404.7 a–d	52.9 ab	2092.2 a	98.5 f–h
NY104	Cornell	4390.7 b–d	47.6 cd	1567.0 d–f	98.0 gh
COB1966-99	Gentec	4353.9 b–e	37.4 g	1416.0 hi	103.5 bc
CPB2092-99	Gentec	4325.4 b–f	40.9 f	1416.0 hi	102.8 bc
Pink Panther	Seminis	4242.4 c–f	42.1 ef	1478.8 gh	96.8 h–j
A-41	Cornell	4132.3 d–h	46.2 cd	1885.6 b	99.0 e–g
Cornell 612	Cornell	4009.1 e–h	44.9 c–e	1578.1 de	99.0 e–g
KO6619	Mich St.	3993.4 f–h	39.4 fg	1637.0 d	100.8 de
A-38	Cornell	3982.7 f–h	44.6 de	1642.4 d	95.8 i–k
Cornell 605	Cornell	3978.5 f–h	50.7 b	1623.7 d	103.3 bc
CELRK	UC Davis	3940.3 gh	47.8 c	1531.8 e–g	92.5 l
Chinook2000	Mich St.	3881.3 gh	40.0 f	1732.4 c	102.0 cd
A-45	Cornell	3858.4 hi	40.4 f	1571.9 d–f	97.3 g–i
1062-V98	Cornell	3798.0 hi	41.6 f	1610.5 d	100.8 de
Cornell 611	Cornell	3536.6 i	45.4 cd	1499.1 fg	97.8 gh

^{*}Means separation according to Duncan’s multiple range test ($P \leq 0.05$).

Literature Cited

- Boodley, J.W. and R. Sheldrake, Jr. 1982. Cornell peat-lite mixes for commercial plant growing. New York Agr. Exp. Sta. Agr. Info. Bul. 43.
- Griffiths, P.D. 2009. Release of Cornell 601-606: Common bean breeding lines with resistance to white mold. HortScience 44:463–465.
- Griffiths, P.D., M.M. Jahn, and M.H. Dickson. 2004. Cornell 501: A white mold tolerant snap bean breeding line. HortScience 39:1507–1508.
- Hunter, J.E., M.H. Dickson, and J.A. Cigna. 1981. Limited-term inoculation: A method to screen bean plants for partial resistance to white mold. Plant Dis. 65:414–417.
- Kolkman, J.M. and J.D. Kelly. 2003. QTL conferring resistance and avoidance to white mold in common bean. Crop Sci. 43:539–548.
- Petzoldt, R. and M.H. Dickson. 1996. Straw test for resistance to white mold in beans. Annu. Rep. Bean Improv. Coop. 39:142–143.
- Schwartz, H.F., D.H. Casciano, J.A. Asenga, and D.R. Wood. 1987. Field measurement of white mold effects upon dry beans with genetic resistance or upright architecture. Crop Sci. 27:699–702.
- Schwartz, H.F., J.R. Steadman, and D.P. Coyne. 1978. Influence of *Phaseolus vulgaris* blossoming characteristics and canopy structure upon reaction to *Sclerotinia sclerotiorum*. Phytopathology 68:465–470.
- Singh, S. and H. Teran. 2008. Evolution of screening methods for identification of physiological resistance to white mold in dry bean. Annu. Rep. Bean Improv. Coop. 51:40–41.
- Steadman, J.R., K. Powers, and B. Higgins. 1997. Screening common bean for white mold resistance using detached leaves. Annu. Rep. Bean Improv. Coop. 40:140–141.
- Teran, H., M. Lema, H.F. Schwartz, R. Duncan, R. Gilbertson, and S. Singh. 2006. Modified Pedzoldt and Dickson scale for white mold rating of common bean. Annu. Rep. Bean Improv. Coop. 49:115–116.
- Teran, H. and S.P. Singh. 2009. Efficacy of three greenhouse screening methods for the identification of physiological resistance to white mold in dry beans. Can. J. Plant Sci. 89:755–762.