

# White Navy Bean 'Bolt'



Developed by University of Guelph Dry Bean Breeding Program  
Breeders: Tom Smith & K. Peter Pauls

'Bolt' is an early season maturity navy bean with good yield, excellent harvestability and resistance to anthracnose race 73

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## Performance Data\*

Variety	Market Class	Yield <sup>a</sup> (lbs/ac)	Maturity <sup>b</sup> (DAP)	Suitability for Direct Harvest <sup>c</sup>
<b>Bolt</b>	<b>Navy</b>	<b>2826.4</b>	<b>101.3</b>	<b>1.5</b>
Vigilant	Navy	3071.6	103.9	1.4
Lightning	Navy	2934.1	104.3	1.8
Thunder	Navy	2975.4	104.3	2.3
Fathom	Navy	3127.9	106.5	2.0
Mean		2987.1	104.0	1.8
LSD (0.05) <sup>d</sup>		92.8		

<sup>a</sup> 2013-2015 OPCC Performance data, 14 location years

<sup>b</sup> Days to maturity after planting

<sup>c</sup> Suitability for direct harvest (harvestability) is based on a scale of 1-5, where 1 = upright plant type, standing erect with good bottom pod height and 5 = more prostrate plant type that are not erect, with poor bottom pod height\*

<sup>d</sup> LSD (0.05) – the LSD is a measure of variability within a trial. There is a ninety five percent probability that yields that differ by an amount greater than the LSD are different. Yields that differ by an amount less or equal to the LSD should be considered the same.

\* Adapted from GoBeans.ca Infosheets



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# Disease Reaction <sup>a</sup>

Variety	BCMV		Anthracnose <sup>b</sup>			Common Bacterial Blight <sup>c</sup>
	Race 1	Race 15	Race 17	Race 23	Race 73	
<b>Bolt</b>	<b>R</b>	<b>R</b>	<b>S</b>	<b>S</b>	<b>R</b>	<b>S</b>
Vigilant	R	S	S	S	S	na
Lightning	R	R	S	S	S	S
Thunder	R	R	S	S	S	S
Fathom	R	R	na	na	R	R

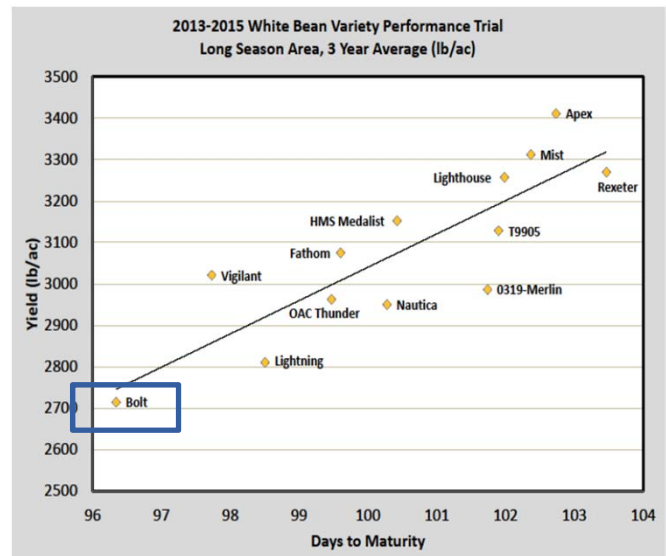
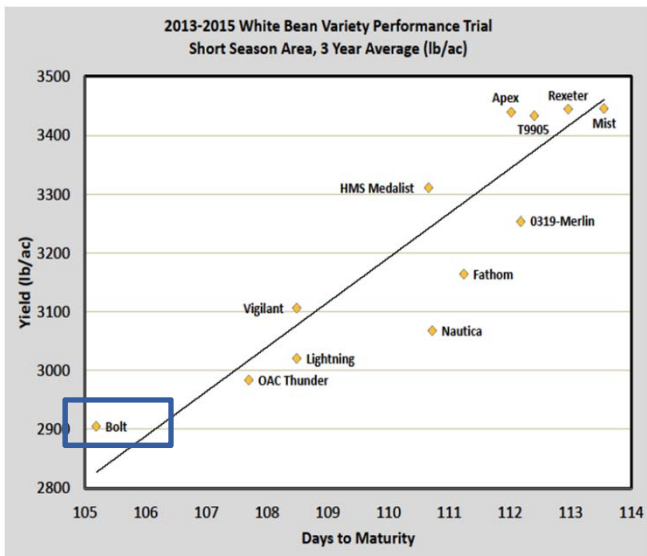
<sup>a</sup> R = Resistant, S = Susceptible, NA = Not Available.

<sup>b</sup> Anthracnose ratings, the predominant race found in Ontario is Race 73. Race 17 (binary system) is equivalent to the Alpha race, Race 23 (binary system) is equivalent to the Delta race.

<sup>c</sup> Resistance gene for common bacterial blight (*Xanthomonas campestris pv. phaseoli*).

## Yield and Maturity

### 2013, 2014 & 2015 Ontario Navy Bean Registration and Performance Trials.



Data from 2013-2015 OPCC Performance Trials, 7 location years

\* Adapted from GoBeans.ca Infosheets

Data from 2013-2015 OPCC Performance Trials, 11 location years

\* Adapted from GoBeans.ca Infosheets

**Pedigreed seed available at:**  
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## Bolt common bean

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**Abstract:** The breeding line ACUG10-1 named as Bolt (CFIA registration no. 7366) of common bean (*Phaseolus vulgaris* L.) is resistant to anthracnose [caused by *Colletotrichum lindemuthianum* (Sacc. & Magnus)] with an upright plant architecture, suitable for direct harvest and high yield potential. Bolt is recommended for the dry bean growing areas in southwestern Ontario.

**Key words:** *Phaseolus vulgaris* L., navy bean, anthracnose resistance.

**Résumé :** La lignée généalogique ACUG10-1 du haricot (*Phaseolus vulgaris* L.), connue sous l'appellation Bolt (numéro d'homologation 7366 de l'ACIA), résiste à anthracnose [causée par *Colletotrichum lindemuthianum* (Sacc. & Magnus)]. La variété se caractérise par un port droit et se prête à la récolte directe, avec un rendement potentiel élevé. Bolt est bien adaptée aux régions arides du sud-ouest de l'Ontario où l'on cultive le haricot. [Traduit par la Rédaction]

**Mots-clés :** *Phaseolus vulgaris* L., haricot, résistance à l'anthracnose.

### Introduction

Bolt is an upright navy bean (*Phaseolus vulgaris* L.) cultivar with high yield, early-season maturity and improved resistance to anthracnose. Bolt was developed by the University of Guelph, bean breeding program, Guelph, ON, Canada. The line was tested in the Ontario White Bean Registration and Performance Trials in 2010 and 2011. Bolt was registered by the Variety Registration Office, Canadian Food Inspection Agency, Ottawa, ON, on 24 April 2013 (Registration no. 7366).

### Pedigree and Breeding Methods

Bolt, tested as ACUG10-1, was developed from a single plant selection from an F<sub>5</sub> population with the pedigree OAC Rex/A98083//AC Compass/B98143///RESW2138/B981045//B98213/Kippen. The cross, made in the growth room facilities of the Department of Plant Agriculture, University of Guelph in 2002, was designed to improve resistance to anthracnose and agronomic traits including an upright growth habit. A conical crossing design (Bai et al. 1998; Bett 1993) was used to combine resistance

genes and agronomic characters. OAC Rex, which was derived from the cross HR20-728/MBE 7, was used to provide upright architecture with high podding, a narrow canopy and resistance to common bacterial blight (CBB) (Michaels et al. 2006). MBE7 has ICA Pijao in its pedigree, which has an indeterminate upright growth habit (Type II), purple flowers, resistance to Bean Common Mosaic Virus (BCMV) and tolerance to Bean Golden Mosaic Virus (Singh et al. 2013). AC Compass (Park and Rupert 2000), with the pedigree W1285c-42603/OAC Laser, is a high-yielding and erect plant type navy bean cultivar from the Greenhouse and Processing Crop Research Center (GPCRC), Harrow, ON. OAC Laser was derived from the cross between Midland, a black variety, with Seafarer (Park and Rupert 2007). B98143, B981045, and B98213 were head rows selected in 1998 and used in the cross as sources of upright architecture and yield. Kippen (Park et al. 2007) is a navy bean cultivar, derived from a cross between the HR40-1285 and HR45-1445, which has XAN159 in its pedigree. XAN159 often used as a source of common bacterial blight resistance with upright character (Park and Dhanvantari 1994).

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**Table 1.** Yield, days to maturity, seed weight, and lodging resistance of Bolt navy bean compared with AC Compass and Lightning tested in the Ontario White Bean Registration and Performance Trials during 2010–2011.

Cultivar	Yield (kg ha <sup>-1</sup> )		Days to maturity		100-Seed weight (g)		lodging resistance (1–5) <sup>a</sup>	
	2010	2011	2010	2011	2010	2011	2010	2011
AC compass	3122	2618	90.5	96	20	23	2.3	2.9
Lightning	3237	2796	93.7	99.9	21.9	21.9	1.3	2.6
Bolt	3179	2770	89.9	98.7	23.1	25.1	1.1	2.1
LSD ( $P < 0.05$ )	154	184	1.2	1.1	0.5	0.6	0.3	0.3

<sup>a</sup>Lodging resistance is determined at maturity using a 1–5 scale, from 1 = upright plants, 3 = partially upright plants to 5 = plants lodged due to weak stem.

**Note:** Test locations were Brussels, Elora, Granton, St Thomas, Kippen, and Woodstock in 2010 and Brussels, Elora, Highbury, St. Thomas, Woodstock and Kippen in 2011.

The population was advanced to the F<sub>5</sub> generation at the Elora Research Station, ON using a bulk population advancement approach, where the population was harvested by combine and bulked to plant the next generation. The F<sub>5</sub> bulk population was planted in the summer of 2004 at the Elora Research Station, ON. Single plant selection was performed in the F<sub>5</sub> generation and the resulting F<sub>5:6</sub> plant-rows were grown at the Elora Research Station in 2005. The main selection criteria for single plants and plant-rows were resistance to anthracnose, high yield potential, and desirable plant type with upright architecture. Seed of the selected single plants and plant-rows were examined for seed size, shape and colour, and for visual conformity with the standards of the navy bean market class. The lines were further tested and selected in replicated preliminary yield trials at the Elora Research Station, ON in 2006. Selected lines were entered into advanced yield trials at Elora Research Station and St. Thomas, ON in 2007 and 2008. Bolt was again tested in advanced yield trials in 2009 at Elora Research Station and St. Thomas, ON and was selected for entry into the registration and performance trial.

### Performance

Bolt was entered into the Ontario White Bean Registration and Performance Trials as ACUG 10-1 and was evaluated in multi-location yield-trials across Ontario in 2010 and 2011. These tests are performed under the guidelines set by the Ontario Pulse Crop Committee ([www.gobeans.ca](http://www.gobeans.ca)). Tests are conducted annually at various locations across the main bean growing areas in Ontario with four replications per location. Test locations with a coefficient of variation lower than 15% are considered valid tests. Agronomic data i.e., yield (adjusted to 18% moisture after combine harvesting), days to maturity, and 100-seed weight were collected for each plot in each location. Each year's data were subjected to an analysis of variance to estimate the least

square means and least significant difference ( $P = 0.05$ ) for each genotype.

### Agronomy

Across 12 location–years in the Ontario White Bean Registration and Performance Trials, during 2010 and 2011, Bolt navy bean yielded (on average) 2975 kg ha<sup>-1</sup>, which was 31 kg greater than the mean yield for the check cultivars, AC Compass and Lightning (Table 1). However, the yield advantage was not statistically significant ( $P = 0.05$ ). Bolt was rated as an early-season maturity cultivar with days to maturity two days earlier than the check mean in 2010 and similar to check mean in 2011. Bolt had significantly larger seed weight than both check cultivars, with a seed mass ranging between 23.1 and 25.1 g 100 seed<sup>-1</sup>. Bolt had a significantly higher lodging resistance than the check, AC Compass, in both years (Table 1).

### Quality

A composite seed sample from three locations was formed by mixing approximately 200 g of seed from each replicate of each entry (2400 g total) to estimate the hydration coefficient, washed-drained solids, and texture of the canned beans. The texture was assessed by measuring texture plateau force and texture firmness using wire extrusion cells by the Instron texture measurement system Model 441 (Instron Corporation, Canton, MA) for firmness and plateau force (Voisey 1971). A detailed methodology for canning quality measurement is available in Navabi et al. (2013). The hydration coefficient of Bolt was 2.33, which was not significantly different from the check cultivars in 2011. Bolt had degree of packing score similar to check cultivars in 2010 but a significantly higher score in 2011. Its washed drained weight was similar to the checks. In texture measurements, Bolt had significantly lower scores for texture measurement (plateau force and texture

**Table 2.** Canning quality of Bolt compared with commercial cultivars grown in the Ontario White Bean Registration and Performance Trials in 2010 and 2011.

Cultivar	Hydration coefficient <sup>a</sup>		Degree of packing (1–5) <sup>b</sup>		Washed drained wt. (%) <sup>c</sup>		Texture measurement <sup>d</sup>			
	2010	2011	2010	2011	2010	2011	Plateau force (N)		Firmness (N mm <sup>-1</sup> )	
AC compass	NA	2.27	3	1	58.78	56.44	254.9	196.3	18.34	10.72
Lightning	NA	2.3	3	1	59.1	57.78	269.5	169.9	20.36	11.35
Bolt	NA	2.33	3.33	2.33	59.99	56.61	186.9	150.4	13.48	9.49
LSD	NA	0.08	0.34	0.98	1.06	1.74	39.2	79.5	2.63	>3.37

<sup>a</sup>Soaked wt. (blanched in 88 °C water for 45 min) divided by dry weight (determined for 500 g of beans).

<sup>b</sup>Scored visually; 1: no clumping and 5: over half clumped.

<sup>c</sup>Weight of beans after washed and drained on a screen, presented as percentage of unwashed-undrained weight.

<sup>d</sup>Texture of canned beans was measured on Instron Texture measurement system using wire extrusion cells.

**Table 3.** Response of Bolt to anthracnose, bean common mosaic virus (BCMV), and common bacterial blight (CBB) compared with commercial cultivars.

Cultivar	Anthracnose <sup>a</sup>		BCMV <sup>b</sup>		Common bacterial blight <sup>c</sup>
	Race 23	Race 73	Race 1	Race 15	
OAC thunder	S	S	R	R	S
OAC rex	S	S	R	R	R
Lightning	S	S	R	R	S
Bolt	S	R	R	R	S

<sup>a</sup>Reactions against Anthracnose race 17, 23, and 73 were assessed after artificial inoculation under controlled conditions.

<sup>b</sup>Reactions against bean common mosaic virus race 1 and 15 were assessed after artificial inoculation under controlled conditions.

<sup>c</sup>Common bacterial blight score (0–5) was recorded in replicated trials in the artificially inoculated common bacterial blight nursery in the field.

firmness) in 2010 (Table 2), indicating that its seed was softer than those of check cultivars.

### Diseases Evaluation

Disease reactions with *Colletotrichum lindemuthianum*, (races 17, 23, and 73) causing anthracnose (Sacc. & Magnus), and the bean common mosaic virus (BCMV) (races 1 and 15), were tested under controlled conditions in separate growth chambers after inoculation of 10–15 plants at GPCRC, Harrow, ON. Anthracnose inoculation was done according to the method of Balardin et al. (1997) by brushing both the upper and lower surfaces of fully expanded primary leaves of 7–10 day-old seedlings with *C. lindemuthianum* spores (10<sup>6</sup> spores mL<sup>-1</sup>) cultured in Mathur's medium. Inoculated plants were placed in a mist chamber, 100% humidity at 23 °C for 48 h, and then

transferred to a growth cabinet at 23/18 °C day/night temperature with a 14 h photoperiod. Disease rating was done 5 days after inoculation using a visual score of 1–9, with 9 being the most susceptible and was repeated 3 days later (Corrales and Schoonhoven 1987). For BCMV inoculation, three to five BCMV infected leaves were ground using mortar and pestle in a 0.01 molar phosphate buffer (pH = 7.0) with addition of carborundum powder (Fisher Scientific, Pittsburgh, PA). The upper surfaces of the 10-day-old plant leaves were covered with ground infected leaves. Once the surfaces dried the plants were misted with water and maintained at 23/18 °C (day/night temperature) with a 14 h photoperiod. Beginning 10 days after inoculation, seedlings showing clear signs of mosaic or systemic necrosis are counted and removed and scored as susceptible. Beginning 20 days after inoculation, plants clearly not affected by necrosis or counted and removed and scored as resistant (Johnson et al. 1997). Common bacterial blight severity was rated visually on a scale of 0–5, based on the percentage of inoculated leaf surface with disease symptoms (Yu et al. 2000) in an artificially inoculated disease nursery in GPCRC, Harrow, ON, in 2013.

Bolt is resistant to race 73 of anthracnose (Table 3) and carries the resistance allele *Co-1<sup>2</sup>* on Pv01 (Vazinet al. unpublished data). It is also resistant to races 1 and 15 of BCMV and possesses the SCAR marker SW13 (Melotto et al. 1996) known to be linked to the hypersensitive response *I* gene on chromosome Pv02, but it is susceptible to CBB.

Bolt has an indeterminate growth habit with erect branching (Type II<sup>a</sup>) (Singh 1982) with a short vine and high podding nodes and good lodging resistance. It has green hypocotyls and white flowers and its leaves have a medium green colour. The pods are light tan when ripe, and covered with short pubescence. Pods have slight to no curvature with a short straight beak. Seeds

are white with dull seed coat lustre and white hilum. Bolt is adapted to and recommended for bean growing areas in Ontario with 2700 CHU or more.

### Maintenance and Distribution

Bolt was planted in isolation plots in Elora Research Station for purification and multiplication of seed in 2010. It was planted in isolated plots in Idaho, USA in 2011 for breeder seed production. University of Guelph will maintain the breeder seed. Pedigreed seed will be distributed by Hensall District Co-operative (HDC), 1 Davidson Drive, P.O. Box 219, Hensall ON, N0M 1X0 Canada, Phone: 519-262-3002, Fax: 519-262-2317.

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