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PA-593: A Root-knot Nematode-resistant Sweet Cherry-type Pepper

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PA-593 is a new sweet cherry-type pepper line containing the ***N*** gene, providing resistance to the most prevalent root-knot nematodes (RKN) in the southern United States. PA-593 has shown comparable growth, fruit, and yield characteristics to commercially available cultivars of sweet cherry-type peppers. PA-593 will provide breeders with a useful resource for incorporating RKN resistance into their breeding programs to produce commercial sweet cherry-type pepper varieties. This RKN-resistant pepper line was developed by the Agricultural Research Service, U.S. Department of Agriculture.

Origin

PA-593 was developed using a recurrent backcross breeding procedure. The resistant *N* gene donor parent was 'Charleston Belle'; the recurrent parent was 'Sweet Cherry'. 'Charleston Belle' is an RKN-resistant bell-type pepper released by the U.S. Department of Agriculture (Fery et al., 1998). The RKN-susceptible 'Sweet Cherry' accession used as the recurrent parent was obtained from D.V. Burrell Seed Growers Company (Rocky Ford, CO) (Fig. 1). PA-593 was derived from a single BC_3F_4 plant grown in 2014, and is homozygous for the dominant *N* nematode resistance gene. The *N* gene conditions a high level of resistance against several RKNs, including the most predominant and damaging species on pepper in the southern United States: *Meloidogyne incognita*, *M. javanica*, and *M. arenaria* (Thies and Fery, 2000).

Description

In both greenhouse and field trials, PA-593 displayed a high level of resistance to the southern RKN *M. incognita,* with less than 1% of its root system exhibiting galling compared with 30% to 45% root system galling observed on roots of the commercial parent 'Sweet Cherry' (Table 1). The resistance exhibited by PA-593 is equal to that exhibited by the donor parent, the RKN-resistant bell-type cultivar Charleston Belle.

PA-593 is similar in appearance and maturity to 'Sweet Cherry'. It has a compact growth habit. Stems and leaves are glabrous, and anthocyanin production is visible around the nodes. Leaves display a 3:1 length-to-width ratio, with an intermediate to dark-green color. Pedicel position is pendant at anthesis, with one pedicel per axil. The flowers have solid white corollas with blue anthers and white filaments. Stigmas protrude past anthers at full anthesis. There is an annular constriction at the junction of the calyx and peduncle. The fruits are persistent, with both pedicel and calyx usually remaining with the fruit at harvest, and the fruit is positioned in a declining to intermediate angle at harvest. The mean peduncle length for PA-593 was 25.6 ± 2.7 mm (SD), which

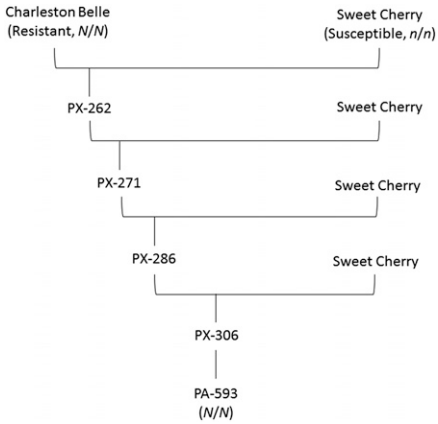

Fig. 1. Pedigree of the cherry-type pepper line PA-593 with the *N* gene for resistance to root knot.

Table 1. Mean root-galling and egg counts for *M. incognita* infecting PA-593 compared with its parental cultivars Sweet Cherry (susceptible) and Charleston Belle (resistant) in both a greenhouse and a field trial (Charleston, SC; Spring 2016).

Trial/pepper accession	Mean percent galling[z]	No. of eggs/g fresh root[y]
Greenhouse trial[x]		
PA-593	0.5 a[w]	16.7 a
Sweet Cherry[v]	30.8 b	310.5 b
Charleston Bell	0.8 a	55.6 a
Field trial[u]		
PA-593	1.1 a	53.2 a
Sweet Cherry	32.3 b	1525.8 b

[z]Pepper roots were scored visually for percent galling on a 0 to 100 scale.
[y]Fresh root tissue from individual plants was weighed, and then total *M. incognita* eggs were extracted using the 1% sodium hypochlorite method (Hussey and Barker, 1973) and counted using a dissecting microscope.
[x]The greenhouse experiment was conducted using a randomized complete block design with eight replicates (five plants from each line).
[w]Significant differences were assessed using two-way analysis of variance. Confidence intervals were calculated using Tukey's honest significant difference method ($P < 0.05$).
[v]D.V. Burrell Seed Growers Company (Rocky Ford, CO).
[u]The field experiment was conducted using a randomized complete block design with four replicates (five plants per plot). Seedlings were transplanted into a field infected heavily with *M. incognita*.

Fig. 2. Freshly harvested fruit from the root-knot nematode-resistant sweet cherry-type pepper PA-593.

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Table 2. Fruit morphology measurements obtained from the root-knot nematode-resistant sweet cherry-type pepper PA-593 compared with its susceptible parental cultivar Sweet Cherry. Data were collected from three independent field trials.[z]

Trial/Pepper accession	Width (mm)	Length (mm)	Wall thickness (mm)	Locules (no.)	Peduncle length (mm)
Trial I					
PA-593	32.7 a[y]	27.6 a	3.7 a	2.8 a	29.7 a
Sweet Cherry[x]	32.1 a	26.9 a	3.6 a	2.7 a	29.1 a
Trial II					
PA-593	30.1 a	24.4 a	3.7 a	2.5 a	28.3 a
Sweet Cherry	32.1 b	28.1 b	3.5 a	2.6 a	30.2 a
Trial III					
PA-593	31.6 a	26.2 a	3.5 a	2.4 a	21.9 a
Sweet Cherry	32.8 a	27.1 a	3.3 a	2.5 a	25.9 b

[z]The experimental design of each trial was a randomized complete block with six (trial I), eight (trial II), or seven (trial III) replications. Single-row plots were used for all trials (10 plants/plot, 30 cm between plants, and 102 cm between rows). All trials were established using transplants; trial I was planted on 28 Apr. 28 2015, trial II was planted on 18 Aug. 2015, and trial III was planted on 9 May 2016.
[y]All fruit means were generated from measurements of 30 (trials I and II) or 42 (trial III) fruit from each line. Significant differences were assessed using two-way analysis of variance. Confidence intervals were calculated using Tukey's honest significant difference method ($P < 0.05$).
[x]D.V. Burrell Seed Growers Company (Rocky Ford, CO).

Table 3. Mean fruit yield measurements from the *M. incognita*-resistant sweet cherry-type pepper PA-593 compared with its susceptible parental cultivar Sweet Cherry. Data were collected from three independent field trials.[z]

Trial/pepper accession	Fruit per plant (g)	Fruit per plant (no.)
Trial I		
PA-593	208.1 a[y]	24.1 a
Sweet Cherry[x]	200.0 a	22.5 a
Trial II		
PA-593	197.7 a	16.3 a
Sweet Cherry	267.1 a	21.7 a
Trial III		
PA-593	225.8 a	22.9 a
Sweet Cherry	236.5 a	22.4 a

[z]The experimental design of each trial was a randomized complete block with six (trial I), eight (trial II), or seven (trial III) replications. Single-row plots were used for all trials (10 plants/plot, 30 cm between plants, and 102 cm between rows). All trials were established using transplants. trial I was planted on 28 Apr. 2015, trial II was planted on 18 Aug. 2015, and trial III was planted on 9 May 2016. Four (trials I and II) or six (trial III) select plants from each plot were harvested two times for trial I (14–24 July 2015), and trials II and III were each harvested three times (21 Oct.–16 Nov. 2015 and 28 June–20 July 2016, respectively).
[y]Significant differences were assessed using two-way analysis of variance. Confidence intervals were calculated using Tukey's honest significant difference method ($P < 0.05$).
[x]D.V. Burrell Seed Growers Company (Rocky Ford, CO).

was comparable to the recurrent parent. The period from transplant to first harvest of mature fruit is about 65 d in Charleston, SC.

The fruit characteristics and yields of PA-593 are similar to those exhibited by the commercial cultivar Sweet Cherry. Immature fruits are green, progressing to a deep red at maturity (mean CIELAB color coordinate readings, L* = 36.92, a* = 37.21, b* = 18.18), which is consistent with the commercial 'Sweet Cherry'. The fruit is round, with a truncated shape where the peduncle attaches, and a blunt shape at the blossom end. Cross-sections of fruit are smooth and without corrugation (Fig. 2). In three replicated field trials conducted in Charleston, SC, in 2015 and 2016, mean fruit length was 26.1 ± 3.2 mm (SD), mean fruit width was 31.5 ± 2.3 mm (SD), and mean wall thickness was 3.6 ± 0.5 mm (SD) (Table 2). PA-593 produced an average fruit yield ranging from 197.7 to 225.5 g/plant, which is comparable to the recurrent parent 'Sweet Cherry' (200.0–267.1 g/plant) in the same trials (Table 3).

The RKN-resistant PA-593 is recommended for use as a parental line by pepper breeders interested in developing RKN-resistant cultivars of cherry-type sweet peppers. The dominant nature of the gene conditioning the RKN resistance would make PA-593 useful as an inbred parent for development of RKN-resistant F_1 hybrids.

Availability

Small amounts (about 25) of seed of PA-593 produced in a controlled greenhouse environment are available for distribution to interested research personnel and plant breeders. Address all requests to William Rutter, U.S. Vegetable Laboratory, USDA-ARS, 2700 Savannah Highway, Charleston, SC 29414 (e-mail: william.rutter@ars.usda.gov). Seeds of PA-593 will also be submitted to the National Plant Germplasm System, where they will be available for research purposes, including the development and commercialization of new cultivars. It is requested that appropriate recognition of the source be given when this germplasm contributes to research or development of a new breeding line or cultivar.

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