

PA-559, a Root-knot Nematode-resistant, Red-fruited, Habanero-type Pepper

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PA-559 is a new Habanero-type pepper [*Capsicum chinense* Jacq.] released 18 Sept. 2008 by the Agricultural Research Service of the U.S. Department of Agriculture (USDA). PA-559 is a red-fruited, advanced breeding line that is homozygous for a dominant gene conditioning a high level of resistance to the southern root-knot nematode [*Meloidogyne incognita* (Chitwood) Kofoid and White], the peanut root-knot nematode [*M. arenaria* (Neal) Chitwood], and the tropical root-knot nematode [*M. javanica* (Treub) Chitwood]. The release of PA-559 will provide pepper breeders interested in developing both open-pollinated and F1 hybrid cultivars access to a near-cultivar quality parental line that is homozygous for the root-knot nematode resistance gene.

Origin

In 1995, a recurrent backcross breeding procedure was initiated to transfer the dominant root-knot nematode resistance gene from a Scotch Bonnet accession into a classical Habanero-type background (Fig. 1). The donor parent was PA-426 and the recurrent parent was PA-350. PA-426 is a root-knot nematode-resistant, Scotch Bonnet-type germplasm line that was released by the USDA in 1997 (Fery and Thies, 1997, 1998b; Thies and Fery, 2001). PA-350, susceptible to root-knot nematodes, is a Habanero-type cultigen obtained from an heirloom collector. In 2002, a total of 63 BC4F3 populations were evaluated in a greenhouse test for reaction to *M. incognita* and in a replicated field test for horticultural characteristics. Although superior, root-knot nematode-resistant, orange-fruited BC4F3 populations were identified in these 2002 tests, no resistant, red-fruited BC4F3 populations were found. However, one of the susceptible red-fruited BC4F3 popula-

tions (02-535-3) did exhibit superior horticultural characteristics, and a single plant from this population was subsequently crossed with a single plant from one of the resistant, orange-fruited BC4F3 populations (02-530-2) to initiate a pedigree breeding procedure to develop a root-knot nematode-resistant, red-fruited, Habanero-type line. PA-559 was derived from a single F3 (BC4F3 × BC4F3) plant grown in 2005. Both of the parental lines used in the last cross are sister lines of the orange-fruited, root-knot nematode-resistant cultivar Tiger-Paw-NR that was released by the USDA in 2006 (Fery and Thies, 2007).

Description

PA-559 has a compact plant habit (height = 47 cm; width = 80 cm) and produces lantern-shaped, red-colored fruit (Fig. 2). The period from transplanting to first harvest of mature fruit ranges from 78 to 97 d at Charleston, SC. There are usually two pedicels per axil and the pedicel position at anthesis is intermediate. Flower color is white and the stamens have white filaments and purple anthers. At full anthesis, the length of the style is slightly longer than the stamen. The leaves are large and have a lanceolate shape. The stems and leaves are glabrous. There is no visible presence of anthocyanin on the pedicels, a very slight presence of visible anthocyanin on the stems and branches, and an intermediate presence of visible anthocyanin on the petioles. The fruits are attached to the pedicel in a pendant manner (typically two fruit per cluster); the calyx margin shape is dentate; the annular constriction at the junction of the calyx and pedicel is absent; and the pedicels are short, curved, and slender.

Observations of field plantings conducted at Charleston, SC, in 2006 through 2008 indicate that the fruit characteristics of PA-559 are comparable to those of currently available Habanero-type cultivars (Fig. 3). A typical fruit weighs 7.8 to 8.3 g and is campanulate or lantern-shaped (2.3 to 2.7 cm wide × 4.2 to 4.6 cm long). The shape of the pedicel attachment end of the fruit is truncate, the neck at the base of the fruit is absent, and the shape at the blossom end of the fruit is blunt. The fruit cross-section is slightly corrugated. The fruit wall is thin (2.0 to 2.1 mm). The color of immature fruit is green; the color of harvest-stage fruits is a bright red (Munsell

color rating: 6.4 R 3.7/9.4). The fruits are extremely pungent (256,433 Scoville heat units), and a typical fruit has three locules (average number of locules: 3.1 to 3.2).

PA-559 is homozygous for a dominant gene that conditions resistance to the southern root-knot nematode (Fery and Thies, 1998a). This *C. chinense* resistance gene is allelic to the dominant gene that conditions much of the southern root-knot nematode resistance in the *C. annuum* cv. Carolina Cayenne (Fery and Thies, 1998a). ‘Carolina Cayenne’ is a highly resistant cultivar whose resistance is derived from the *C. annuum* cayenne-type cultivar Carolina Hot (Fery et al., 1986). Fery and Dukes (1996) reported that the resistance in ‘Carolina Hot’ is conditioned by two genes, one dominant and one recessive; they demonstrated that the dominant gene in ‘Carolina Hot’ is allelic to the single dominant gene (*N*) that conditions the *M. incognita* resistance in the *C. annuum* cv. Mississippi Nemaheart. Thies and Fery (2000) used two isogenic sets of bell pepper lines (differing at the *N* locus) to characterize the impact of the *N* gene on resistance to the peanut root-knot nematode, the tropical root-knot nematode, and the northern root-knot nematode (*M. hapla* Chitwood). Although they noted that the *N* gene did not condition resistance to the northern root-knot nematode, they did demonstrate that the gene conditions a high level of resistance to both the peanut and tropical root-knot nematodes.

The *N* root-knot nematode resistance gene was first described in 1957 (Hare, 1957). It needs to be noted that the *N* gene-mediated root-knot nematode resistance trait exhibited by both ‘Carolina Hot’ and ‘Mississippi Nemaheart’ has remained effective for decades; ‘Carolina Hot’ was released in the late 1950s (Martin and Crawford, 1958) and ‘Mississippi Nemaheart’ was released in the mid-1960s (Hare, 1966).

PA-559 exhibited a high level of resistance to the southern root-knot nematode in all greenhouse tests; the numbers of galls and egg masses on the roots have always been minimal. The results of a six-replicate test conducted in greenhouse soil benches infested with *M. incognita* race 3 showed that PA-559 roots yielded 97.6% fewer *M. incognita* eggs per gram fresh root than did roots of the susceptible recurrent parent

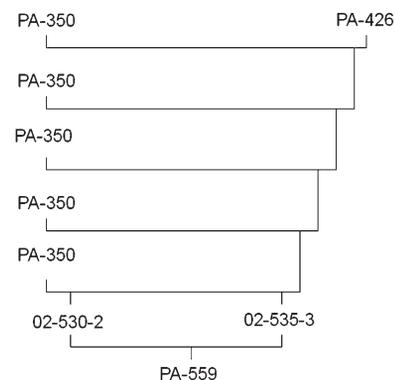


Fig. 1. Pedigree of PA-559 pepper.

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Fig. 2. A typical fruiting plant of the root-knot nematode-resistant Habanero-type pepper PA-559.



Fig. 3. Freshly harvested fruit of the red-fruited PA-559 (left) and the orange-fruited commercial cultivar Habanero (right).

Table 1. Average root-gall index, average egg mass index, and average number of eggs per g fresh root tissue for PA-559, PA-350 (susceptible Habanero-type recurrent parent), PA-426 (resistant Scotch Bonnet-type donor parent), and PA-136 (susceptible *Capsicum annuum* control) plants grown in soil infested with the southern root-knot nematode, *Meloidogyne incognita* race 3 (greenhouse experiment).^z

Pepper accession	Gall index ^y	Egg mass index ^x	No. eggs/g fresh root tissue
PA-559	1.07 b ^w	1.07 b ^w	604 b ^v
PA-350	4.65 a	4.70 a	25,278 a
PA-426	1.00 b	1.00 b	1,064 b
PA-136	4.97 a	4.97 a	55,319 a

^zRandomized complete-block experiment with six replications (five plants per plot; seeds planted on 14 Feb. 2008; seedlings transplanted into a steam-pasteurized mixture of soil, sand, and peat on 3 Mar. 2008; soil surrounding roots of each seedling was infested with 3,000 *M. incognita* race 3 eggs on 10 Mar. 2008; and roots of all plants removed from the growth media on 27 May 2008 for evaluation for galling and egg masses). The NaOCl procedure described by Hussey and Barker (1973) was used to extract *M. incognita* eggs from a fibrous root sample taken from each plot.

^yRated on a scale of 1 to 5: 1 = no galls; 2 = light galling, 1% to 25% of root system galled; 3 = moderate galling, 26% to 50% of root system galled; 4 = heavy galling, 51% to 80% of root system galled; and 5 = severe galling, 81% to 100% of root system galled.

^xRated on a scale of 1 to 5: 1 = no egg masses evident, 2 = scattered egg masses covering 1% to 25% of root system, 3 = moderate number of egg masses covering 26% to 50% of root system, 4 = numerous egg masses covering 51% to 80% of root system, and 5 = extremely large number of egg masses covering 81% to 100% of root system.

^wMean separation within columns by Student-Newman-Keuls multiple range test ($P \leq 0.05$).

^vNematode egg data were transformed by $\log_{10}(x + 1)$ to normalize the data before analysis. Nontransformed data are shown. Values followed by the same letter are not significantly different according to Fisher's least significant difference ($P \leq 0.05$).

PA-350 (Table 1). The resistance exhibited by PA-559 is equal to that exhibited by the donor of the resistant gene, PA-426.

The root-knot nematode-resistant PA-559 is recommended for use as a parental line by pepper breeders interested in developing

root-knot nematode-resistant cultivars of Habanero-type peppers. The dominant nature of the gene conditioning the root-knot nematode resistance trait would make PA-559 useful as an inbred parent for development of root-knot nematode-resistant F1 hybrids. PA-559 is a well-adapted, Habanero-type pepper and is potentially useful in commercial production without further development.

Availability

Small trial samples of PA-559 breeder's seed are available from the senior author for distribution to all interested research personnel. Genetic material of this release will be deposited in the National Plant Germplasm System where it 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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