MN 144, MN 313, and MN 314: Garden Pea Lines Resistant to Root Rot Caused by *Aphanomyces euteiches* Drechs.

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Root rot of peas (*Pisum sativum* L.), incited by *Aphanomyces euteiches*, is the major pest in many U.S. production areas and is a serious soilborne disease in most growing regions of the world (Davis and Shehata, 1985; Papavizas and Ayers, 1974; Pfender and Hagedorn, 1983). MN 144, MN 313, and MN 314 were developed in a long-term breeding program that employed the combination of moderately resistant genotypes followed by repeated selection and screening of progenies in a disease nursery (Southern Experiment Station, Waseca, Minn.) infested with *A. euteiches*. The *A. euteiches* resistance level of MN 144, MN 313, and MN 314 is significantly improved beyond that of previously released germplasm. MN 313 and MN 314 also carry resistance to *Fusarium oxysporum* Schlecht. emend. Snyder & Hans. f. sp. *pisi* (van Hall) Snyder & Hans. race 2, the causal agent of near-wilt disease.

Origin

MN 144, MN 313, and MN 314 were derived by pedigree selection (Fig. 1). Before the final cross, five generations of pedigree selection were conducted in the field nursery within a germplasm pool comprised of several sister lines that had been randomly intermated in a greenhouse in 1982. Minnesota 108, released in 1976, was one of the sister lines. No

record was kept of the number of intermatings made. The F₁ seed was bulked, and F₂ seed was produced for pedigree selection. Minnesota 108 and its sister lines also were developed by pedigree selection, but that program alternated between greenhouse and growth chamber environments. Screening within each generation alternated between an environment favorable to the pathogen (growth chamber) to one favorable to the host (greenhouse) (Davis et al., 1976; Shehata et al., 1976).

Seed of 36 F₆ lines was mechanically mixed and planted in the field in 1988 under the designation 88MF1231. In 1989, two selections from 88MF1231 served as the female parents in the final crosses (Fig. 1). These were 89MF24-5 and 89MF24-16. MN 144 was derived by pedigree selection following the cross 89MF24-5 × 792022, and is a bulked F₆ of six selections from the F₅. Line 792022 was released by the U.S. Dept. of Agriculture (USDA)

in 1981 as a selection from the cross PH-114-119 × Afila, the original *afila* (*af*) mutant (Kraft, 1981). Line 792022 is a semi-leafless (*afila*) type and has resistance to *A. euteiches*.

MN 313 and MN 314 were derived by pedigree selection following the cross of 89MF24-16 × (792022 × 'Green Sugar') F₆, a breeding line obtained from John Kraft, USDA/Agricultural Research Service. 'Green Sugar' was released by Crites–Moscow Growers, and is not known to have *A. euteiches* root rot resistance. MN 313 and MN 314 arose as different selections in the F₂ population. MN 313 is a bulk of 31 F₆ lines, and MN 314 is a bulk of 22 F₆ lines.

Performance

MN 144, MN 313, and MN 314 have averaged ≈1 to 3 on a 0 to 5 visual rating scale for disease severity expressed as foliage (haulm) symptoms in replicated plots at the disease screening nursery at Waseca, Minn., for the past several years. Disease severity was rated as 0 = no symptoms, 1 = 1% to 25%, 2 = 26% to 50%, 3 = 51% to 75%, 4 = 76% to 99% of the plants dead or showing foliar (shoot) symptoms, and 5 = all plants dead. Commercial cultivars in the disease nursery averaged between 4 and 5. In 1993, replicated disease field nursery tests of one or more of these three lines at Prosser, Wash.; Arlington, Wis.; and LeSueur, Minn., provided supporting results (Davis et al., 1994).

Subsequent to field testing, MN 144, MN 313, and MN 314 were compared in a replicated greenhouse test with several other root-rot-resistant pea breeding lines released in recent years (Table 1). Paired inoculated vs. noninoculated flats, each containing 22 plants, were arranged in a randomized block design with four replications. Based on three disease severity criteria (disease index and percent weight loss of roots and tops calculated by comparing the weight of inoculated and

*Random matings followed by five generations of pedigree selection

Fig. 1. Pedigree of *Aphanomyces euteiches*-resistant pea breeding lines MN 144, MN 313, and MN 314.

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Table 1. Greenhouse evaluation of MN 144, MN 313, and MN 314 pea breeding lines and several control lines and cultivars for *Aphanomyces euteiches* root rot resistance.

Line/cultivar ^z	Disease index ^y	Wt loss from disease (%)	
		Tops	Roots
MN 313	48.7	9.0	26.7
MN 144	49.2	22.7	53.2
MN 314	49.5	26.0	39.7
USDA 792022	65.5	32.2	55.2
WI 8901	85.5	56.2	69.2
WI 8903	87.5	56.7	67.2
Minnesota 108	90.1	60.5	72.0
Nunhems 8221	96.5	74.2	74.2
Little Marvel ^x	98.5	78.0	67.0
LSD _{0.05}	8.9	13.8	10.4

^zUSDA 792022, WI 8901, WI 8903, and Minnesota 108 were released previously as root rot resistant, while 'Nunhems 8221' and 'Little Marvel' are tolerant and susceptible cultivars, respectively.

^yDisease index = summation of disease ratings $\times$ 100/no. plants $\times$ 5. Disease ratings were based on a 0 to 5 visual rating of the root system of each plant, where 0 = healthy, with roots all white; 1 = few scattered, water-soaked, light-brown areas on roots; 2 = water-soaked, light-brown areas confluent and more extensive (tissue still firm), but not involving the entire root system; 3 = water-soaking and browning involving all roots, and epicotyl tissue soft but not collapsed or shriveled; 4 = water-soaking, browning, and decay involving all roots and epicotyl, cortex easily sloughed off, with epicotyl shriveled or rotted; and 5 = plant dead.

^x'Little Marvel' was included in only two replications and was not included in the analysis.

noninoculated plants), MN 144, MN 313, and MN 314 were more resistant than other entries tested. These data confirm field nursery observations.

Description

Plants of MN 144, MN 313, and MN 314 are determinate, white-flowered, and typically flower within 14 to 17, 15 to 16, and 14 to 15 nodes, respectively. The leaves of MN 144 and MN 314 express the recessive *afila* mutant, and thus the plants are semi-leafless, whereas MN 313 is of the normal (wild) type. While MN 144 and MN 314 produce one to two pods at each flowering node, MN 313 has a stronger tendency to produce two pods per

flowering node. MN 313 and MN 314 are of green, wrinkled seed type, while seed of MN 144 is green and smooth. Pods have blunt tips and contain five to seven seeds in MN 313 and MN 314, and four to six seeds in MN 144. Plant, pod, and seed character of MN 313 and MN 314 is of commercial type for processing, whereas MN 144 tends to be viney by comparison. These lines have not been evaluated for canned and frozen product quality.

Intended use

MN 144, MN 313, and MN 314 are intended for use as parental material in the development of cultivars having greater resistance to *A. euteiches*. MN 313 and MN 314

likely will be useful in the improvement of processing and home garden peas, while MN 144, having smooth, starchy seed, may be more appropriate for the improvement of field peas.

Availability

Seed samples of MN 144, MN 313, and MN 314 may be obtained from D.W.D.

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