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and

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**NOTICE OF RELEASE OF ROMAINE LETTUCE GERmplasm  
WITH RESISTANCE TO LETTUCE DROP DISEASE**

The Agricultural Research Service, United States Department of Agriculture and the University of California, Davis, announce the release of seven F6:8 breeding populations of romaine lettuce (*Lactuca sativa* L.). The breeding populations were selected from the Hearts Delight × Eruption cross and are being released as germplasm with improved resistance to lettuce drop compared to currently available romaine cultivars. These lines should be used as parents in crosses with elite romaine cultivars to develop lettuce drop resistant cultivars.

Introduction

Lettuce drop is a destructive disease of romaine lettuce in central coastal California that is predominantly caused by *Sclerotinia minor* (Subbarao, 1998). The fungus infects plant roots, crowns, and senescing leaves through eruptive germination of sclerotia resulting in complete decay of the crown tissue, wilting of leaves, and ultimately collapse of the plant before harvest. Large numbers of sclerotia form on infected plants and can survive in the soil for at least seven years. Complete control of the disease has not been achieved with existing cultural practices, and resistant cultivars are a potentially valuable tool for integrated pest management (Subbarao, 1998). Immunity to the disease is not known, but differences in the frequency of symptomatic plants at harvest maturity has been reported (Hayes et al., 2010). Most romaine cultivars are highly susceptible; though the commercial romaine cultivars Brave Heart and Green Forest are reported to be partially resistant. High-level resistance is known in the slow-bolting, small-statured, dark red Latin type cultivar Eruption (Mamo et al. 2019). Eruption was used as a parent to breed romaine germplasm with improved resistance to lettuce drop in central coastal California.

Pedigree and materials used in testing

The F6:8 (F6 derived F8) breeding lines being released are numbered RH16-0001, RH16-0002, RH16-0003, RH16-0004, RH16-0005, RH16-0007, RH16-0008 and were derived from the cross Eruption × Hearts Delight. Advanced testing was conducted using F6:7 seed lots. The germplasm for distribution is F6:8 seed resulting from massing seed produced by approximately 30 plants per line. Hearts Delight (PI

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606778) is a hearting type romaine developed by Enza Zaden from a cross between Green Towers and Bautista. Eruption (PI 613577) was developed by Enza Zaden but its parentage was not reported at the time of this germplasm release.

## Development

Lettuce plants grown in disease nurseries that are asymptomatic at harvest maturity may have slow-progressing or inconspicuous infections, and therefore may still die from *S. minor* before seed production. Because of this, a modified pedigree breeding method was used to develop the resistant germplasm by selecting plants for improved horticultural traits and seed production from non-infested fields. F<sub>2</sub> plants were field grown, selected for horticultural characters and allowed to self-pollinate in a greenhouse. Starting with the F<sub>3</sub> and repeating in each subsequent generation through the F<sub>6</sub>, disease resistance evaluations were conducted in a Spring-planted field experiment in an infested field site in order to identify families with a high level of resistance. In a parallel field experiment in a non-infested field site planted at approximately the same time, plants with superior horticultural characters were selected for seed production from only the resistant families identified in the infested field. A summer-planted field experiment in a disease infested field was conducted with the selected resistant families from the spring field experiment in order to confirm their resistance reactions; families susceptible in the summer test were discarded. This effort produced 48 F<sub>6</sub> plants, that were self-pollinated to generate 48 F<sub>6</sub>:7 lines. These inbred lines were then tested in two unreplicated, infested field experiments. Seven lines with less disease than Hearts Delight and with head weight and core length similar to Hearts Delight were selected for further evaluations. These selected lines were evaluated for disease resistance in three replicated, disease-infested, field experiments. A fourth infested field experiment included four lines only due to limited amounts of seed. Two non-infested replicated field experiments were planted to assess head weight, head height, and core length. Salad shelf-life and the frequency of the internal defect tip burn were evaluated in one of the field experiments. Seven F<sub>6</sub>:7 lines were identified for release. Approximately 30 plants per line were grown to seed and the seed massed to generate F<sub>6</sub>:8 lots for distribution. The released germplasm was derived from a single F<sub>3</sub>:4 family, coded RH09-0488.

## Lettuce Drop Resistance

Disease data were statistically analyzed on the arcsine scale and then back transformed, producing a value referred to as disease rating (DR). The DR ranges from zero to one and is proportional to percent mortality. Means were declared significantly different at  $P < 0.05$  using Dunnett's procedure. The breeding lines consistently produced a lower proportion of diseased plants compared with the susceptible commercial cultivar Hearts Delight (DR = 0.65). Mean DR values of partially resistant Green Forest and Brave Heart were 0.60 and 0.53, respectively, in three field experiments. The seven breeding lines had less disease than the cultivars in the three tests. Disease levels in RH16-0004 (DR = 0.43) and RH16-0007 (DR = 0.43) were significantly less than Hearts Delight; RH16-0008 (DR = 0.42) was significantly lower than Hearts Delight and Green Forest; RH16-0001 (DR = 0.28) and RH16-0002 (DR = 0.31) were significantly less disease than all three resistant cultivars. In the fourth field experiment with only four breeding lines, the DR values were lower in Hearts Delight (0.37), Green Forest (0.23) and Brave Heart (0.18) than in previous experiments. RH16-0007 (0.15) and RH16-0001 (0.09) were significantly less than Hearts Delight and Green Forest. RH16-0002 and RH16-0003 (both DR = 0.05) were significantly less affected than Hearts Delight, Green Forest, and Brave Heart.

When used as parents, the breeding lines are expected to produce families with better levels of resistance than commercially available romaine cultivars. Nineteen F<sub>3</sub> families from RH09-0488 × Green Towers with prior selection for horticultural characters had mean DRs in two field experiments ranging from 0.44 to 0.72 while Green Towers had a mean DR of 0.81. Five of the F<sub>3</sub> families had significantly lower DR

than Green Towers. The families expressed variation in head size, core length, and leaf color that should enable selection of commercially useable cultivars.

#### Horticultural and other characters

The released breeding lines are romaine type lettuce with light green, upright leaves. The top of the heads remains open to semi-closed at maturity. Seed color is white. In two field experiments, head weight and head height were similar to, or lower than Hearts Delight. Core length was similar to slightly longer than Hearts Delight. The breeding lines are as susceptible to tipburn as Hearts Delight and have similar shelf-life quality when processed into salad. In limited field testing in the Salinas Valley, the released germplasm demonstrated downy mildew and big-vein disease susceptibility similar to Hearts Delight.

#### Use and availability

RH16-0001, RH16-0002, RH16-0003, RH16-0004, RH16-0005, RH16-0007, RH16-0008 are being released as germplasm due to their improved resistance to lettuce drop compared with currently available romaine cultivars. The released lines should be used as parents for development of romaine cultivars with improved resistance to lettuce drop. Limited seed samples of these breeding lines are available for distribution to all interested parties for research purposes. The lines are being publicly released with no intellectual property protection for the development and commercialization of new cultivars by seed companies, universities, non-governmental organizations or other bona fide private or public research organizations. It is requested that appropriate recognition be made if these populations contribute to research or the development of new germplasm, breeding lines, or cultivars. Requests for seeds can be submitted via Germplasm Resources Information Network (GRIN) at <https://www.ars-grin.gov>.

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Signatures:

  
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7/10/2020  
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Date

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Date