

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
Washington, D.C.

and

UNIVERSITY OF CALIFORNIA
Davis, CA

**NOTICE OF RELEASE OF PI 673090, 673091, 673092, 673093, 673094, 673095, 673096,
673097, LETTUCE**

Release of eight iceberg lettuce breeding lines with resistance to *Verticillium* wilt caused by race 1 isolates of *Verticillium dahliae*

Executive Summary

The Agricultural Research Service, United States Department of Agriculture and the University of California, Davis, announce the release of eight inbred breeding lines of lettuce (*Lactuca sativa* L.). The lines are iceberg type lettuce with resistance to race 1 of *Verticillium* wilt caused by *V. dahliae*. They were selected from the cross Tiber × (Tiber × (La Brillante × Pacific). Resistance is derived from La Brillante, a Batavia type lettuce cultivar with resistance to *V. dahliae*. The eight lines are suitable for commercial production in *V. dahliae*-infested and non-infested fields. They are being released for commercialization of *Verticillium* wilt-resistant iceberg cultivars and for use as parents in further breeding of resistant cultivars. They have been deposited in the National Plant Germplasm System as PI 673090 through PI 673097.

Introduction

Verticillium wilt, caused by the soil borne fungus *Verticillium dahliae* Kleb., is a serious disease that affects lettuce and a broad range of economically important crops grown in the Salinas Valley of California (Atallah et al., 2011). While all types of lettuce are susceptible, *Verticillium* wilt is most damaging to iceberg type cultivars, often resulting in complete loss of the crop in afflicted fields. Host resistance is the best long-term control method, since current cultural control methods are cost prohibitive, potentially damaging to the environment, or of limited feasibility (Atallah et al., 2011). Two pathogenic races (race 1 and race 2) of *Verticillium dahliae* on lettuce are known (Hayes et al., 2007). The heirloom cultivar La Brillante expresses complete resistance to race 1 isolates and is currently effective at preventing disease in Salinas Valley commercial fields. We are reporting the release of eight iceberg breeding lines possessing resistance to race 1 isolates of *V. dahliae* inherited from 'La Brillante'.

Origin and Development

The breeding lines being released are numbered RH12-3194, RH12-3195, RH12-3196, RH12-3197, RH12-3198, RH12-3199, RH12-3200, and RH12-3201 with the pedigree Tiber × (Tiber ×

(La Brillante × Pacific). ‘La Brillante’ is a yellow-green Batavia type cultivar of unknown origin and is not used for commercial production in California. ‘Tiber’ and ‘Pacific’ are modern iceberg type cultivars bred by the USDA for improved resistance to big-vein disease (Ryder and Robinson, 1991) and the physiological defect tipburn (Ryder and Waycott, 1998), respectively. ‘Pacific’ and ‘Tiber’ are susceptible to *Verticillium* wilt (Hayes et al. 2007).

Families or inbred lines were selected for *Verticillium* wilt resistance in a field site at the USDA research station in Salinas, CA that was artificially infested with *V. dahliae* race 1 isolate VdLs16. Evaluations were conducted by uprooting 10 randomly selected plants from each family or line, vertically sectioning the root and crown, and assessing the plant for root discoloration and foliar symptoms typical of *Verticillium* wilt. In a subsequent field experiment at a site that does not have *V. dahliae*, single plant selections with industry-acceptable iceberg type head characteristics were taken from only the families previously deemed resistant (typically < 10 percent disease incidence). These selected plants were dug-up, repotted in a greenhouse, and allowed to self-pollinate to create seed of the next generation. This selection procedure was conducted in the F3, F4, and F5 generations. Evaluation of yield, adaptation, and disease resistance in replicated, multi-location experiments were conducted using F6 seed and F7 seed massed from multiple plants.

Description

Verticillium wilt resistance. The F6 and F7 generation of the breeding lines were assessed for resistance to *Verticillium* wilt in four Salinas, CA, field experiments. This included two replicated, race 1 field experiments at the USDA research station, one replicated field experiment at an infested grower site, and one unreplicated field experiment at an infested grower site. The breeding lines were highly resistant to *Verticillium* wilt, each having a median disease incidence (expressed as percent symptomatic plants) of zero for all experiments, except for RH12-3195 and RH12-3197, which had median disease incidences of 10% in one experiment. The median disease incidence on ‘Salinas’ in these experiments ranged from 70 percent to 90 percent, and the amount of disease observed on each breeding line was significantly less ($P < 0.05$) than ‘Salinas’ in all replicated experiments. ‘Tiber’ was evaluated in only the grower field experiments and had a median disease incidence of 70 percent for both experiments. All breeding lines but RH12-3197 had significantly less disease incidence ($P < 0.05$) than ‘Tiber’.

Horticultural performance and yield. The breeding lines are suitable for packing into cartons or processing into salad. The horticultural characteristics, range of adaptation, and harvest dates of the breeding lines were most similar to ‘Tiber’ (http://www.ars-grin.gov/cgi-bin/npgs/html/dno_eval_acc.pl?80025+495544+8) based on evaluations of 15 to 20 foot plots of each breeding line or check cultivar in six replicated Salinas Valley field experiments harvested between May and September. Core height, head size, head weight, and shelf-life of salad or whole heads were generally not significantly different from ‘Tiber’ or ‘Salinas’. Yields of the breeding lines and check cultivars varied widely between experiments, ranging from 117 cartons per acre (‘Salinas’ in a *Verticillium* wilt infested site) to 1128 cartons per acre (RH12-3199 in a non-infested site). Expressed as a percentage, mean yields of breeding lines from all non-infested field experiments ranged from 53 percent (RH12-3200) to 98 percent (RH12-3195) of ‘Tiber’, while yields from all *V. dahliae*-infested field sites ranged from 80 percent (RH12-3199)

to 156% (RH12-3196) of 'Tiber'. In some environments the breeding lines produced flatter heads than 'Tiber', which appeared to lead to an increased occurrence of bottom rot. Incidence of the physiological defect tipburn was recorded in three field experiments, and the percentage of plants with tipburn for RH12-3195 (26 percent tipburn) and RH12-3196 (19 percent tipburn) was significantly ($P < 0.05$) greater than 'Tiber' (4 percent tipburn). The percentage of plants with tipburn in the remaining breeding lines ranged from 9 percent to 14 percent, and were not significantly different from 'Tiber' or 'Salinas' (10 percent tipburn).

Yields in Salinas, CA grower trials. Four breeding lines were grown and harvested using commercial methods and equipment in large-scale, two-acre experimental blocks, that had a history of *Verticillium* wilt. The breeding lines were grown on 40 inch beds, two seed lines per bed, and 10 inches between plants within each seed line. The crop was harvested as 24 count cartons of wrapped lettuce, which has a theoretical maximum yield of approximately 1300 cartons per acre at this plant density. In a September 3, 2013 harvest, RH12-3196 yielded 1091 cartons per acre and RH12-3201 yielded 1133 cartons per acre. No *Verticillium* wilt was observed in the breeding lines. In an October 6, 2014 harvest, RH12-3194 yielded 803 cartons per acre and RH12-3195 yielded 693 cartons per acre. The primary cause of yield loss of the breeding lines was bottom rot. No *Verticillium* wilt was observed in the breeding lines while a neighboring planting of 'Tiber' had approximately 5 percent incidence of *Verticillium* wilt. The planting of 'Tiber' was harvested as bulk, pre-cored lettuce for salad processing and yielded 40,000 pounds per acre. This converts to approximately 800 cartons per acre.

Availability

Limited seed samples of these breeding lines are available for distribution to all interested parties for research purposes. These lines are being publically released with no IP protection for the development of new cultivars by seed companies, Universities, NGOs or other bona fide private or public research organizations. Samples are available through the National Plant Germplasm System as PI 673090 through PI 673097. It is requested that appropriate recognition be made if the breeding lines contribute to research or the development of new germplasm, breeding lines, or cultivars. Written requests for seed can also be sent to Dr. Ryan Hayes, USDA-ARS, 1636 E. Alisal St., Salinas, CA 93905 or sent through email (Ryan.Hayes@ars.usda.gov).

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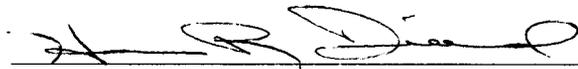
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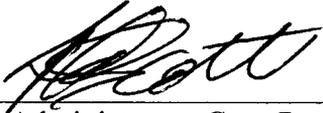
Signatures:



Dean, College of Agricultural and Environmental Sciences
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6/4/2015

Date



Deputy Administrator, Crop Production and Protection
Agricultural Research Service, U.S. Department of Agriculture

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Date