

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

**NOTICE OF RELEASE OF ICEBERG, ROMAINE, AND LEAF LETTUCE BREEDING
LINES WITH IMPROVED DISEASE RESISTANCE**

Executive Summary

The Agricultural Research Service, U.S. Department of Agriculture announces the release of sixteen breeding lines of lettuce (*Lactuca sativa* L.). Five (SM13-I1, SM13-I2, SM13-I3, SM13-I4, and SM13-I5) of the six iceberg breeding lines can be used for whole head or salad blend production; the sixth iceberg line (RH08-0111) does not form heads that meet the modern iceberg standard. This breeding line, however, can be used in breeding programs because it combines high level resistances to downy mildew, bacterial leaf spot, *Verticillium* wilt race 1, and lettuce dieback. Two (SM13-R2, SM13-R3) of the four romaine breeding lines are suitable for whole head, salad blend, and spring mix production, one breeding line (SM13-R1) is suitable for the whole head production only. The fourth romaine line (RH08-0464) can be used in breeding programs due to its good resistance to downy mildew. SM13-R1, SM13-R2, and SM13-R3 are resistant to dieback. Five leaf breeding lines (SM13-L1, SM13-L2, SM13-L3, SM13-L4, and SM13-L5) have very high levels of polygenic resistance to downy mildew and can be used for spring mix and salad blend production. The sixth leaf breeding line (SM13-L6) has resistance to *Verticillium* wilt race 1 and is suitable for whole head, spring mix, and salad blend production. The leaf breeding lines are resistant to dieback with the exception of SM13-L1.

Introduction

Lettuce (*Lactuca sativa* L.) is the most popular, commercially produced, leafy vegetable in the U.S. Lettuce cultivars are divided into horticultural types based on the shape and size of the head, the shape, size and texture of leaves, stem length, and seed size. Three prevalent types of lettuce used in U.S. cultivation are crisphead (which includes the sub-types iceberg and Batavia), romaine, and leaf. Crisphead cultivars form a spherical head; the iceberg sub-type has a large, dense head, while the Batavia sub-type has a smaller and less dense head. Romaine cultivars form an elongated head that may or may not close on the top. Leaf type cultivars are highly variable in terms of leaf color, shape, size, texture, leaf margin, and blistering. Leaf type lettuces generally have leaves that are shorter than romaine and heads that do not close to cover younger leaves. The USDA lettuce breeding program in Salinas, California is focused mostly on development of improved iceberg, romaine, and leaf lettuce inbred lines through introgression of desirable traits from wild species, heirloom material, and unadapted germplasm. The new lines are then released into the public domain and used by private or public breeding programs directly for seed increase and sales, or for development of new cultivars through additional rounds of selection or mating.

This release notice describes development and performance of iceberg (six), romaine (four), and leaf (six) breeding lines. These inbred lines were evaluated for economically important traits in field and laboratory experiments.

Development and pedigree of breeding lines

Lettuce is a diploid ($2n=2x=18$), naturally self-pollinating species, and cultivars are inbred lines. Artificial cross-pollinations were made between selected parental lines to produce the F1 generation. The subsequent generations were produced by growing plants in the greenhouse or field, and allowing each plant to naturally self-pollinate. Seed from each plant was kept separate. Field selections for desirable traits were performed starting with F2 generations.

Line	Type	Pedigree
RH08-0111	iceberg	F8: Salinas × La Brillante
SM13-I1	iceberg	F6: [(Salinas × Iceberg) × (Iceberg × Calmar)] × Glacier
SM13-I2	iceberg	F6: [(Salinas × Iceberg) × (Iceberg × Calmar)] × Glacier
SM13-I3	iceberg	F6: [(Salinas × Iceberg) × (Iceberg × Calmar)] × Glacier
SM13-I4	iceberg	F6: [(Salinas × Iceberg) × (Iceberg × Calmar)] × Glacier
SM13-I5	iceberg	F8: (Iceberg × Salinas) × (Iceberg × Salinas)
RH08-0464	romaine	F6: Balady Banha × Darkland
SM13-R1	romaine	F7: PI 491224 × Parris Island Cos
SM13-R2	romaine	F8: PI 491224 × Parris Island Cos
SM13-R3	romaine	F8: Darkland × PI 491214
SM13-L1	leaf	F7: Grand Rapids × Iceberg
SM13-L2	leaf	F7: Grand Rapids × Iceberg
SM13-L3	leaf	F7: Grand Rapids × Iceberg
SM13-L4	leaf	F7: Grand Rapids × Iceberg
SM13-L5	leaf	F7: Grand Rapids × Iceberg
SM13-L6	leaf	F7: Lolla Rossa × PI 491224

Evaluation of breeding lines

Eight field experiments were conducted in Salinas, Calif. in 2012 and 2013 using a randomized complete block design with three replications. Experiments included sixteen tested inbred lines, parents (or more distant ancestors) of the breeding lines, and control cultivars. Additional material, such as unreleased breeding lines, plant introductions, and cultivars, were tested in the same experiments. All germplasm was evaluated for horticultural traits (head weight, height, diameter, closure, firmness, and savoy and core length), yield, and resistances to tipburn, downy mildew (*Bremia lactucae*), lettuce drop (*Sclerotinia minor*), Verticillium wilt (*Verticillium dahliae*) and leaf miner (*Liriomyza* sp). Post-harvest quality was evaluated using whole heads and fresh-cut salad. Resistance to bacterial leaf spot (*Xanthomonas campestris* pv. *vitians*) was evaluated in greenhouse tests; resistance to lettuce dieback (Tomato bushy stunt virus and Lettuce necrotic stunt virus) was assessed with molecular markers.

Performance of breeding lines

The sixteen breeding lines can be used for different markets or breeding programs based on their performance. Five out of six iceberg lines (SM13-I1, SM13-I2, SM13-I3, SM13-I4, and SM13-I5) are suitable for salad blend and whole head markets. Though SM13-I2 and SM13-I3 exhibited more rapid decay of whole heads than the overall average, their rates of decay are expected to be acceptable for commercial production. RH08-0111 is not acceptable for commercial production of whole heads because of its small, soft heads that do not conform to the standard for modern iceberg cultivars. However, the line can be used in iceberg breeding programs as a donor of alleles for resistance to downy mildew, bacterial leaf spot, and Verticillium wilt race 1.

Two romaine breeding lines (SM13-R2 and SM13-R3) are suitable for salad blend, spring mix, and the whole head production. Romaine breeding line SM13-R1 cannot be used for fresh-cut products, because it decays rapidly after processing, but it is suitable for whole head market. An important trait of these three breeding lines is their resistance to dieback, because most of the currently grown romaine cultivars are susceptible to this disease. Romaine breeding line RH08-0464 has improved field resistance to downy mildew inherited from cv. Balady Banha. RH08-0464 can be used in breeding programs, but is not suitable for commercial production.

All six leaf-lettuce breeding lines are acceptable for commercial production of salad blend, and spring mix. SM13-L1, SM13-L2, and SM13-L6 could also be used for whole head production. SM13-L1 to SM13-L5 demonstrated very high field resistance to downy mildew, with resistance alleles inherited from cvs. Iceberg and Grand Rapids. Five of the leaf-lettuce breeding lines (SM13-L1 being an exception) have alleles for dieback resistance, a disease that may substantially limit lettuce production in California and Arizona. SM13-L1 is earlier bolting than other breeding lines. SM13-L6 has resistance to Verticillium wilt race 1.

Availability of breeding lines

Limited samples of seeds are available for distribution to all interested parties for research or commercial purposes. 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 should be sent to Dr. Ivan Simko, USDA-ARS, 1636 E. Alisal St., Salinas, CA 93905 or to Ivan.Simko@ars.usda.gov.

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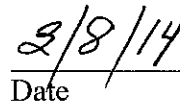
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