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'Ice Cube', 'Blush', and 'Mini-Green': Miniature Crisphead Lettuce Cultivars

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More than 80% of the lettuce *(Lactuca sativa* L.) consumed in the United States is of the crisphead type (U.S. Dept. of Agriculture, 1992). Over the last 100 years, taste and texture preferences of crisphead lettuce in the United States have undergone minor changes. Head size and weight have steadily increased, such that cultivars presently grown in this country are large (i.e., 16 to 22 cm in diameter). 'Ice Cube', 'Blush', and 'Mini-Green' are miniature crisphead lettuces that closely resemble standard cultivars in appearance, but attain about one-half the diameter (8 to 12 cm). Because of their size, these cultivars can be consumed by a person in one meal. The commercialization of miniature lettuce may lead to increased lettuce consumption by people who choose not to purchase lettuce of normal size for fear it cannot be consumed before spoilage.

'Ice Cube' and 'Blush' are adapted for production in the western United States, especially under the optimum growing conditions found in California and Arizona. 'Mini-Green' tolerates higher temperatures during heading and may hold some promise for eastern production areas and for home-garden use.

Origin

These cultivars were developed by the U.S. Agricultural Research Station, Salinas, Calif., and were released in 1992 (Fig. 1). They were derived from a cross: 86-1024 (dwarf-1) × 'Salinas'. 'Salinas' is the standard commercial cultivar used in the coastal districts of California. A double mutant, 86-1024 [early flowering *(Ef)* and dwarf *(dwf)*], was developed in 1986 by W. Waycott and L. Taiz, Univ. of California, Santa Cruz, for studying gibberellin(GA) biosynthesis (Walcott, 1989). Line 86-1024 was isolated from an M_2 population of 81-1251-C-18-2, induced by germinating seeds in ethylmethane sulfonate (EMS) (Waycott, 1989). The M_2 population was developed by soaking seeds in aerated distilled water (≈ 20C for 24 h), then decanting and replacing the water with aerated 0.03% (v/v) EMS solution for 24 h. The seeds were then washed 30 min in aerated distilled water and sown in soil.

The F_3 breeding line, 81-1251-C-18-2, was derived from a cross between 'Vanguard 75' and an early flowering mutant '56779E' carrying *Ef-1 Ef-1.* Dwarf-1 carries the recessive allele *dwf-1* that we believe blocks GA biosynthesis. Dwarf-1 individuals contain ≈50% of the wild-type level of gibberellin A_1 (GA_1), the putative active GA in lettuce (Waycott et al., 1991). Although the miniature lettuce lines have not been tested, we believe them to be deficient in GA_1 as well, suggesting that their resultant phenotype is caused by reduced cell division and expansion (Sachs, 1965).

An F_2 population derived from 86-1024 × 'Salinas' was sown in the field in Salinas, Calif., during Spring 1988, from which 30 mini-lettuce selections were made. Individuals in this population were segregating red and green, and both types were selected. A sample of three F_3 families was grown in Huron, Calif., during the fall of the same year, and 12 single-plant selections were made from the three lines. During Spring and Summer 1989, 41 F_3 and F_4 families were grown in Salinas, and 62 single-plant selections were made from 20 families. Forty-two F_4 and F_5 families were grown the following year in the same location, and 79 single-plant selections were made from 18 families. In 1990, 62 F_5 and F_6 families were grown once in early spring and once in early summer in Salinas. From these plantings, 44 single-plant selections were made from 19 families. From these selections, the 10 best F_6 and F_7 families were bulked within families for observation in 1991. Based on the results of numerous trials in California, New York, and Pennsylvania, seven of the bulked families were increased in the greenhouse at the end of 1991. Three [91-1174M ('Mini-Green'), 91-1175M ('Blush'), and 91-1177M ('Ice Cube')] were chosen for release.

Description

Color. The three cultivars have dull, dark-green outer leaves that are slightly darker than those of the 'Salinas' parent. Green pigment extends quite close to the core, and the interior color is creamy-yellow. 'Blush' has a tinge of red on the outer leaves. Seeds (achenes) of all cultivars are black.

Size. The cultivars are firm to hard at maturity (Fig. 2). Size is equivalent to a mature Boston-type butterhead lettuce. Head is spherical to slightly flattened (transverse elliptical). The top of the head is well covered and may become spiraled during cold weather. The butt and the ribs are flat, while the core is small and the bases of the leaves overlap well.

Leaf type. The cultivars have mildly undulate leaf margins that are moderately dentate

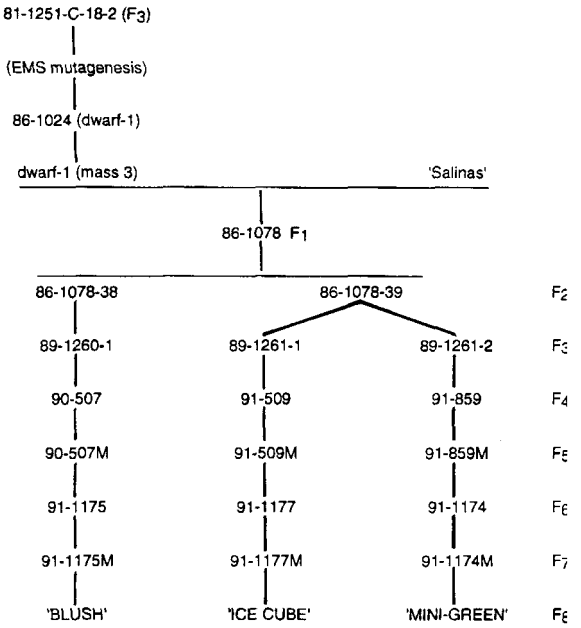

Fig. 1, Pedigrees of 'Ice Cube', 'Blush', and 'Mini-Green' miniature crisphead lettuce (EMS = ethylmethane sulfonate; M =mass).

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Fig. 2. Vertical cross sections of **(left)** 'Ice Cube' and **(right)** 'Salnas' lettuce. Note looser head of miniature type, indicating that it matures 5 to 10 days later than normal crispheads. Head diameters: 12.7 and 19.1

and strongly ruffled. Texture is relatively soft, slightly softer than that of 'Salinas'; the leaf surface is moderately blistered. Outer leaves are broader than long.

Disease reactions

'Ice Cube', 'Blush', and 'Mini-Green' are similar to 'Salinas' in disease reactions. They are susceptible to lettuce mosaic, cucumber mosaic, turnip mosaic, and big vein viruses. They are susceptible to corky root rot and sclerotinia *(Sclerotinia minor* Jagger), but are less prone to tipburn than 'Salinas' (Table 1). Although results are preliminary (unpublished), reaction to downy mildew *(Bremia lactucae* Regel) suggests this disease may not develop as rapidly on the miniature lettuces as on 'Salinas'. Preliminary data (unpublished) also suggest that these lines may be less preferred as a host by the green peach aphid *(Myzus persicae* Sulzer) than the 'Salinas' parent.

Performance and adaptation

'Ice Cube' (91-1177) and 'Blush' (91-1175) are virtually identical in appearance except that 'Blush' develops a red tinge on the exterior leaves. The F_3 generation of 'Mini-Green' (91-1174) was selected under higher temperature conditions (daytime as high as 37C, nighttime as low as 19C, in Huron, Calif.) and thus may have higher tolerance to heat than 'Ice Cube' or 'Blush'. Maturation time for these plant types is slightly later than 'Salinas', up to 10 days in cool weather and ≈5 days in warm weather (Fig. 2). Initiation of rapid stem elongation (bolting) is delayed, while total plant height is substantially reduced (Table 1). Despite these delays, the tendency to develop a head was stronger than in 'Salinas'. Field trials in New York and Pennsylvania demonstrated that the miniature cultivars can withstand daytime highs of 30 to 33C during the final weeks of growth in midsummer without a substantial loss in the ability to head.

Table 1. Mean tipburn incidence and stem lengths of 'Salinas' and 'Mini-Green' lettuce measured during mid-summer conditions (mid-July), at 60 and 68 days after sowing, in Davis, Calif. Average daily highs during head formation were 37C, and the daily mean was 25.8C.

	Stem ht (cm)		Tipburn (%)
Cultivar	60 days	68 days	at 60 days
Salinas	15.2 ± 1.7	43.3 ± 9.2	53.4 ± 9.5
Mini-Green	3.9 ± 0.7	11.7 ± 1.1	11.3 ± 3.6

Nutritional content

A composite sample from 12 separate heads of 'Salinas', 'Mini-Green', and 'Valmaine' (romaine type), grown under similar conditions in the field, were analyzed for major nutritional components (Table 2). 'Mini-Green' contained slightly higher amounts of most components analyzed than did 'Salinas'. However, 'Valmaine' was substantially higher than either crisphead cultivar for nearly all nutritional categories, especially vitamin A.

Seed production

The GA deficiency and delay in maturity cause these cultivars to flower later and set fewer seeds than 'Salinas'. Gibberellin A_3 (GA_3) can be applied as a spray (to the point of runoff) to plants at concentrations of 10.0 to 50.0 mM (3.0 to 10.0 ppm), two or three times during the vegetative stage, to produce plants that phenotypically resemble the 'Salinas' parent. Applications should be made 3, 6, and 9 weeks after sowing. Care should be taken not to apply GA_3 too close to the flowering period, as it will cause sterility and poor seed set.

Seed availability

'Ice Cube', 'Blush', and 'Mini-Green' have been released to seed companies and are available in commercial quantities. Small quantities of remnant seed are available for research purposes.

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Table 2. Nutritional content of 'Salinas', 'Mini-Green', and 'Valmaine' lettuce per 100 g tissue (fresh weight).

Assay[z]	Salinas	Mini-Green	Valmaine
Calories	21.0[y]	16.3	21.9
Protein (g)	0.8	1.2	1.5
Carbohydrates (g)	4.0	3.5	4.9
Fat (g)	0.2	0.3	0.3
Vitamin A (carotene) (IU[x])	100	130	2950
Thiamine HCl (mg)	0.05	0.07	0.09
Riboflavin (mg)	0.02	0.03	0.09
Niacin (mg)	0.2	0.28	0.38
Vitamin C, total (mg)	3.6	3.2	10.7
Calcium (mg)	10.3	13.2	27.4
Iron (mg)	0.229	0.315	0.898
Sodium (mg)	22.5	20.9	45.6
Potassium (mg)	121.0	147.0	210
Phosphorus (mg)	18.4	22.3	27.5
Magnesium (mg)	6.34	8.24	15.3
Zinc (mg)	0.15	0.166	0.236
Copper (mg)	0.0204	0.0201	0.0306
Total fiber (g)	1.0	1.2	1.6
Moisture (g)	94.6	94.6	92.6
Ash (g)	0.4	0.4	0.7

[z]Analysis made from a composite sample of 12 field-grown plants performed by Hazleton Laboratories, Madison, Wis.
[y]All figures have an accuracy of ±5%, except for vitamin A, which has an accuracy of ±10%.
[x]IU = international units.