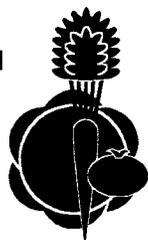


**VEGETABLE RESEARCH
AND
INFORMATION CENTER**

Vegetable Production
Series



ICEBERG LETTUCE PRODUCTION IN CALIFORNIA

Louise Jackson, Associate Professor/Cooperative Extension Specialist, Department of Vegetable Crops, University of California, Davis; *Keith Mayberry*, University of California Cooperative Extension Farm Advisor, Imperial County; *Frank Laemmlen*, University of California Cooperative Extension Farm Advisor, Santa Barbara County; *Steve Koike*, University of California Cooperative Extension Farm Advisor, Monterey County; *Kurt Schulbach*, University of California Cooperative Extension Farm Advisor, Monterey County; and *William Chaney*, University of California Cooperative Extension Farm Advisor, Monterey County

PRODUCTION AREAS AND SEASONS

The major production areas for iceberg (crisphead) lettuce (*Lactuca sativa*) in California are the central coast (Monterey, San Luis Obispo, San Benito, Contra Costa, and Santa Clara Counties), the southern coast (Santa Barbara and Ventura Counties), the Central Valley (Fresno, Kings, and Kern Counties), and the southern deserts (Imperial and Riverside Counties). Production is highest in Monterey County, followed by Imperial County.

Planting to harvest takes 70 to 80 days for midsummer plantings and as long as 130 days for late-fall plantings. In the southern deserts, iceberg lettuce is planted from mid-September to mid-November for harvest from early December to January and February. In the lettuce-growing areas of the central coast, where temperatures are fairly uniform year-round, lettuce is planted from late December to mid-August for harvest from early April to November. Southern coastal plantings are made from November to August for harvest from April to December. In the Central Valley, iceberg lettuce is planted from early August to early September for harvest from late October to mid-November. Spring plantings are made from early November to late December for harvest in April.

ICEBERG LETTUCE ACREAGE AND VALUE

Year	Acreage	Average yield (tons/acre)	Gross value/acre
1994	128,500	17	\$4,862
1993	141,000	18	\$5,940
1992	147,000	18	\$4,680

Source: *California Agricultural Statistics 1994* (Sacramento: California Department of Food and Agriculture, 1995).

CLIMATIC REQUIREMENTS

Lettuce is a cool-season crop with distinct temperature requirements. The optimal growing temperatures are 73°F (23°C) during the day and 45°F (7°C) at night. Most California growing regions have daytime temperatures from 63° to 83°F (17° to 28°C) and night temperatures from 37° to 53°F (3° to 12°C). At the high end of the temperature range, lettuce may bolt, causing bitterness and loose, fluffy heads, and tipburn is also common. At temperatures near freezing, young plants are not damaged, but growth is slow. Freezing can damage the outer leaves of mature lettuce, leading to decay in handling and storage.

VARIETIES AND PLANTING TECHNIQUES

Lettuce varieties are adapted to specific planting periods in the Southern California deserts. Planting a variety out of slot will result in nonheading, puffiness, or bolting. Moderately high temperatures can occur in early spring. As the season progresses, temperatures change from extremely hot days to cooler days and freezing nights. Varieties commonly planted in Southern California include Empire, Fall Green, Tres Equis, Niner, Gilaben, Trendsetter, Del Rey, Annie, Diplomat, Rico, Desert Storm, Merit, Desert Queen, Honcho II, Early Giant, New Dominion, Winterset, Mt. Signal, Shilo, Kofa, Barn Burner, Pybas 251, Palmetto, Yuma, Sedona, Cool Breeze, Vancrisp, Vanmax, MOR 109, Vanmor, Prime Time, Winterhaven, Winter Supreme, Domingos 43, Red Coach 74, Coolguard, and Vanguard 75.

In the central coast, resistance to downy mildew and corky root diseases are important considerations for variety selection. Current varieties are the Salinas types, El Dorado, Target, Bronco, Pybas 251, Marksman, Vista Verde, Magnum, Wrangler, Premier, Stinger, Top Gun,

Cowboy, Pybas 101, Pybas 102, Mustang, and Legacy. In the Central Valley, fall-planted varieties include Empire, Acacia, Desert Queen, Marvel, Raider, Fall Green, Gilaben, Diplomat, Maverick, Tres Equis, Redondo, Miner, Daybreak, Sundowner, and Fortuna. Tiber, a new USDA release, looks promising for tipburn resistance. Spring-planted varieties include Honcho II, Yuma, Coach Supreme, Westland, Winterset, Vanguard 75, and Vanmax. Late-spring plantings include Salinas, Titan, Vansal, Spector, Diamond, El Dorado, and Legacy.

Most iceberg lettuce is planted using pelleted seed and a precision planter; very little lettuce is transplanted in California. Seed are planted 2 to 3 inches (5–7.5 cm) apart in rows on 42-inch (105-cm) beds. At a 2-inch (5-cm) spacing there will be 157,000 seed per acre (388,000 seed/ha). The cost of seed varies with variety, coating, spacing, seed enhancement and priming (osmoconditioning) treatments. Nonprimed, natural lettuce seed may be susceptible to thermodormancy when ambient temperatures are above 90°F (32°C) for an extended period. Priming allows the seed to overcome thermodormancy and germinate at higher temperatures. Thermodormancy can also be broken by starting the initial irrigation in the late afternoon so the seed can imbibe water and germinate during the cooler hours of the night.

SOILS

Iceberg lettuce grows best in silt loams and sandy soils in the southern deserts. Lighter-textured soils provide better drainage during cold weather and warm up more readily. In the central coast and Central Valley, lettuce can be grown on heavy clay soils as long as there is good soil structure and adequate drainage. Lettuce has a moderately low degree of salt tolerance: excess salinity results in poor seed germination and small heads.

IRRIGATION

In the southern deserts, most growers use sprinklers for the first 5 to 7 days or until the seedlings emerge. The field is then furrow-irrigated for the remainder of the season. In the southern deserts 3 acre-feet (3,700 cu. m) of water per acre is typically used to grow a lettuce crop. The majority of the water is applied in the last 30 days before harvest. Care must be taken not to oversaturate the beds when growing early-season lettuce—excess moisture favors the development of bottom rot. Gated pipe is also used to deliver water, especially near harvest. Gated pipe allows uniform application of water down furrows and maintains a dry head basin so that harvest equipment can turn around on dry soil.

In the central coast, most fields are pre-irrigated with about 2 inches (5 cm) of water to soften the soil for seedbed preparation. Both seeded and transplanted let-

tuce are sprinkle-irrigated frequently until seedlings emerge or are established (usually 6 to 10 days). For direct-seeded lettuce, another sprinkler irrigation is applied about 2 to 3 weeks later to prepare the field for thinning. (Proper soil moisture makes it easier to thin the closely spaced seedlings.) After thinning, about two-thirds of the acreage is furrow-irrigated using gated pipe until harvest. Depending on soil type and terrain, some fields are sprinkled to maturity with hand-move, linear-move, or permanently buried sprinkler systems. In late summer or fall when corky root disease can be a problem, sprinkler irrigation is often used because the plants' root systems are degraded. Water application is typically 1.0 to 1.5 acre-feet (1,233–1,850 cu. m) per acre for a lettuce crop in the central coast. As the crop approaches maturity, excess water and fertilizer causes heads to become large and puffy, reducing their value.

A small but growing acreage of lettuce is drip-irrigated in the central coast. Both buried and surface drip tape are used. Water is applied with drip irrigation after the post-thinning cultivation. With buried drip systems, the tape is placed 7 to 12 inches (17.5–30 cm) deep in the center of the bed. Most growers use a manifold system so lines can be fed from either end of the field. This allows easy flushing of the system and prevents drought if there is a leak or blowout in the center of a row. Arizona/Sundance-style cultivation and field renovation equipment are used with buried drip systems. High iron content in water in some areas of the central coast create major plugging problems for subsurface drip users. Plugging by other precipitates, gopher damage, blowout, and cultivation and harvesting equipment damage are other common problems. Some microirrigation users prefer to lay surface drip tape down the center of the bed immediately after the post-thinning cultivation. The tape may be laid on the surface or buried 2 to 3 inches (5–7.5 cm) deep. Surface fabric pipe is used to deliver water to the tape. Lay-flat tape is often reeled in just before harvest; shallow-buried tape is reeled in after harvest has been completed.

FERTILIZATION

In the southern deserts, 500 pounds per acre (560 kg/ha) of 11-52-0 is usually broadcast prior to listing. Nitrogen (N) is sidedressed just after thinning and during later growth. Early, warm-season lettuce requires less N than a crop grown in January and February. About 150 pounds of N per acre (168 kg/ha) is used for early-season crops, while 200 to 250 pounds per acre (224–280 kg/ha) is applied during cold weather.

In the central coast, fertilization begins with applying 50 to 70 gallons per acre (468–655 l/ha) of 6-16-6, 3-10-10, or 9-9-9 into the bed at listing. An alternate practice is to apply about 300 pounds per acre (336 kg/ha) of 6-20-20 in the bed at listing. There are usually from two to

four sidedressings applied at and after thinning. At thinning, 300 pounds per acre (336 kg/ha) of 15-8-4 is sidedressed into the beds, or 35 to 40 gallons per acre (327–374 l/ha) of UAN-32 (urea–ammonium nitrate, 32-0-0) or 500 pounds per acre (560 kg/ha) of 16-20-0 is sidedressed. Two to three weeks later, 35 gallons per acre (327 l/ha) of UAN-32 or CAN-17 (calcium–ammonium nitrate, 17-0-0), or 40 to 45 gallons per acre (374–421 l/ha) of AN-20 (ammonium nitrate, 20-0-0) is applied to finish out the crop. A final application of 10 to 15 gallons per acre (94–140 l/ha) of AN-20 may be water-run if the grower feels the crop will run short of N prior to harvest. Typically, 200 to 220 pounds of N per acre (224–246 kg/ha) is applied to the early crops when the soil is cool, and 170 to 180 pounds per acre (190–202 kg/ha) of N is applied to the summer or fall crops. When corky root disease is high, growers increase application of N to compensate for the shallow, degraded root system. In some soils, lettuce will respond to applications of zinc.

Lettuce is very sensitive to overdoses of ammoniacal fertilizers. Seedling injury will be expressed by root burn, yellowing of the leaves, and dead plants. Fertilizer injury later in the season is expressed by wilting of the outer leaves and a rusty reddish discoloration in the middle of the plant root.

Manures and composts are rarely used in production of lettuce in the southern deserts. About two-thirds of the growers in the Salinas Valley, however, apply at least some manure to their lettuce. Manure is commonly applied at a rate of 4 tons per acre (9 t/ha) and is primarily applied to maintain good soil structure. In the Salinas Valley there is growing interest in using compost, which is applied at about the same rate as manure.

INTEGRATED PEST MANAGEMENT

Contact the UC Davis IPM World Wide Web site at <http://www.ipm.ucdavis.edu> or your local county Farm Advisor for current pest management information (*UC IPM Pest Management Guidelines*, DANR Communication Services Publication 3339).

Weed management. Several herbicides are used for lettuce weed control. Some herbicides have greater activity on specific weed problems. Consult your weed control Farm Advisor for more details as to the best ones to use. Herbicides used on lettuce may be disked into the soil before bedding or applied preplant, postplant, or by air, depending on the product.

Insect identification and control. The most important insect pests of lettuce in California are worms, aphids, leafminers, and whiteflies. These pests cause problems according to the geographical region and time of year. In coastal areas, the pea leafminer (*Liriomyza huidobrensis*) is the most important pest. This insect removes plant tissue and can contaminate the harvested crop. Control strategies should be aimed at the larvae,

not the more mobile, insecticide-resistant adults.

In Southern California, the silverleaf whitefly (*Bemisia argentifolii*) has caused slow growth and delayed maturity of the crop. Although this pest can be controlled with registered materials, it may become resistant if one chemical is used too heavily.

In all production areas, various worms, green peach aphids, and lettuce root aphids are always potential problems at various times of year and weather conditions. These should be managed by using selective materials to avoid making other problems more severe. Crops should be rotated to slow insecticide resistance.

Disease identification and management. In the southern deserts, the most serious diseases affecting iceberg lettuce are lettuce big vein virus, bottom rot, and lettuce drop. In coastal areas, young lettuce seedlings are rarely seriously affected by diseases, with the exception of downy mildew, which can cause damage during all phases of growth. Lettuce mosaic virus, corky root disease, and bacterial leaf spot can also be a problem in coastal areas. In the Central Valley, lettuce can be affected by *Fusarium* wilt and lettuce drop.

Lettuce mosaic (LMV), big vein (LBVa), beet western yellows (BWY), and turnip mosaic (TuMV) are viral diseases that affect lettuce. With the exception of LMV, these viruses are of moderate concern and control measures are rarely needed. LMV can be controlled by using mosaic-free seed (i.e., no virus in 30,000 seed). Other management steps include selecting resistant cultivars, controlling aphid vectors, removing weed hosts, and plowing down harvested fields that can harbor viruses. A lettuce-free period, which creates a break in the virus cycle during the winter, is mandated by county ordinance in some coastal areas.

Lettuce drop (*Sclerotinia minor* and *S. sclerotiorum*) is a serious soilborne fungal disease that can affect crops from rosette stage until harvest. Rotate crops and use protectant fungicides after thinning and before leaves get too large to provide some protection. Lettuce drop caused by *S. sclerotiorum*, rarely found in coastal areas, is common in the southern deserts.

Bottom rot (*Rhizoctonia solani*) can cause serious losses in the San Joaquin Valley and the southern desert areas; it is rarely seen elsewhere in the state. The disease is most prevalent on early-season lettuce that matures between the end of November and mid-January. Use fungicidal sprays to control this disease.

Downy mildew (*Bremia lactucae*) is managed by planting resistant cultivars and applying protectant fungicides. However, the genetic variability of this pathogen results in some strains that are not controlled by fungicides or resistant cultivars.

Bacterial leaf spot (*Xanthomonas campestris* pv. *vitiensis*), varnish spot (*Pseudomonas cichorii*), anthracnose (*Microdochium panattonianum*), and powdery mildew

(*Erysiphe cichoracearum* f. sp. *lactucae*) are foliar diseases that can affect developing lettuce. Favored by the wet, cool conditions of spring, bacterial leaf spot can be only partially controlled by copper fungicides; other control options are not yet available. Because the varnish spot bacterium is found in reservoir water, avoiding sprinkler irrigation usually eliminates this disease. Anthracnose is found only in fields where the resting fungal structure is present in soil during rainy spring weather. Application of protectant fungicides controls this pathogen; avoid planting lettuce in fields with a history of the disease. Powdery mildew is rarely a problem in commercial fields, and control options are not recommended.

Corky root is caused by the soilborne bacterium *Rhizomonas suberifaciens*. Rotate crops so that lettuce is not planted consecutively in the same fields and avoid over-fertilizing with N. However, for infected crops, growers may need to add supplemental fertilizer and water to achieve satisfactory crop yields. Some resistant cultivars are now available.

Fusarium wilt (*Fusarium* sp.) of lettuce is found only in the Central Valley. Because it is a new disease of lettuce, control options are limited. Growers should take precautions so that infested soil is not moved to clean fields.

Other pests and disorders. Freezing injury on mature lettuce is expressed as blistering and peeling of the epidermis followed by browning of the tissues. Normally freezing injury is confined to the cap and wrapper leaves. Tipburn is a physiological disorder caused by the lack of mobility of calcium in the heads during warm weather and rapid growing conditions. There is presently no control for lettuce tipburn.

HARVEST AND HANDLING

Iceberg lettuce is field-packed into cartons. About 60 percent of lettuce is harvested by ground packing (naked packed, as opposed to wrapped). In ground packing, crews of approximately 20 to 30 are split into units (trios) that consist of two cutters and a packer. Trio members often rotate jobs and are normally paid by the number of cartons packed. The solid lettuce heads are cut, trimmed to 4 to 5 wrapper leaves, and packed 24 per carton. A carton has a minimum gross weight of 50 pounds (22.7 kg). About 40 percent of lettuce is wrapped at harvest. Cut and trimmed heads (wrapper leaves removed) are stacked on a table, and workers then wrap and seal each head in film or a plastic bag. The wrapped heads are packed with either 24 or 30

heads per carton. Lettuce in cartons is vacuum cooled prior to storage in a cold room. Vacuum cooling removes field heat in roughly 15 minutes.

Some companies contract, grow, and handle bulk lettuce as their primary product. At harvest, all wrapper leaves are removed in the field. Heads are packed in bins approximately 1 cubic yard in volume for precooling and transport. At the processing plant, heads can be further trimmed, cored, cooled, washed, and precut into various types of retail packages for the food-service industry. The entire processing plant is maintained at 35° to 40°F (1.7° to 4.5°C) to help maintain crispness and freshness.

POSTHARVEST HANDLING

Lettuce is highly perishable and should be cooled as soon as possible after harvesting. Vacuum cooling reduces product temperature to 34°F (1°C); it should then be stored just above freezing at 98 percent relative humidity. Lettuce harvested at prime maturity with no major defects may be held for 2 to 3 weeks at 34°F. At 37°F (3°C), shelf life is reduced to 1 to 2 weeks. Russet spotting is a disorder caused by storing lettuce in containers or cold rooms where ethylene gas, which can be generated by ripening fruits and gasoline engines, is present. Brown stain is a storage disorder caused by high carbon dioxide levels in the cold room.

Iceberg lettuce is sold in many types of packages. Fifty-pound (22.7-kg) cartons containing 24 or 30 wrapped or naked-packed heads are common. Processed iceberg lettuce (chopped, cleaned, or cored) is shipped in 1,000-pound (454-kg) bins. Food-service packs include one 20-pound (9-kg), four 5-pound (2.25-kg), or two 10-pound (4.5-kg) cartons. There are also packages containing 6 heads that are cleaned and trimmed or cored and trimmed.

MARKETING

California produces iceberg lettuce year-round. Supplies peak in May and June and are lowest in December, January, and February. California's lower volume during the winter is due to large supplies coming from western Arizona; the overall national supply is nearly static. Most of California's iceberg lettuce is shipped by refrigerated truck to markets throughout the United States and Canada. Limited quantities are shipped by air, mostly to export markets in Europe. Iceberg lettuce products are used by fast-food outlets, restaurants, institutions, airlines, and schools.

The University of California, in accordance with applicable Federal and State law and University policy, does not discriminate on the basis of race, color, national origin, religion, sex, disability, age, medical condition (cancer-related), ancestry, marital status, citizenship, sexual orientation, or status as a Vietnam-era veteran or special disabled veteran. The University also prohibits sexual harassment. This publication is available in alternative media on request. Inquiries regarding the University's nondiscrimination policies may be directed to the Affirmative Action Director, University of California, Agriculture and Natural Resources, 300 Lakeside Drive, 6th Floor, Oakland, CA 94612-3560; (510) 987-0096.