VEGETABLE RESEARCH AND INFORMATION CENTER

Vegetable Production Series

FRESH-MARKET BULB ONION PRODUCTION IN CALIFORNIA

RONALD E. VOSS, Cooperative Extension Vegetable Specialist, University of California, Davis; KEITH S. MAYBERRY, University of California Cooperative Extension Farm Advisor, Imperial County

PRODUCTION AREAS AND SEASONS

Fresh-market bulb onions (*Allium cepa* L.) are produced throughout California. The main production areas are the low desert (Imperial and Riverside Counties), the San Joaquin Valley (Kern, Fresno, and San Joaquin Counties), the southern and central Coast (San Benito, Ventura, Santa Clara, and Monterey Counties), the high desert (eastern Los Angeles County), and the northern mountain valleys (Shasta, Lassen, Siskiyou, and Modoc Counties). Bulb onions are planted from September through May. Harvest begins in April or May and is usually completed in September. Fresh bulb and lightly processed bulbs (fresh onion ring, whole-peeled, etc.) make up approximately 45 percent of the total bulb onion acreage in California, which ranks among the top fresh bulb producing states in the United States. Approximately 20 percent of California's fresh-market onions are stored for 3 to 6 months.

FRESH-MARKET BULB ACREAGE AND VALUE

Year	Acreage	Average yield (*tons/acre*)	Gross value / acre
1997	20,100	21.8	$5,140
1996	21,000	20.2	$3,830
1995	19,800	22.3	$5,560

SOURCE: *County Agricultural Commissioner's Annual Report Data* (Sacramento: California Department of Food and Agriculture, 1995–1997); individual county agricultural commissioner reports.

CLIMATIC REQUIREMENTS

Onions are cool-season, biennial plants (requiring two seasons to complete the cycle from seed to seed) that are commercially grown as an annual crop. Bulbing is highly dependent on day length. Varieties adapted to California will initiate bulbing at day lengths of approximately 12 to 15 hours. Dozens of varieties are grown in California due to the great difference in latitude between the Mexican border (32°N) and the Oregon border (42°N), and because several market classes are needed.

Short-day onions are planted in the fall and bulb with 12 to 14 hours of daylight. They are adapted to the desert regions of Southern California. Using transplants, these varieties can be grown in the lower San Joaquin Valley and southern Central Coast, with maximum latitude of approximately 36°N. Intermediate-day varieties are also planted in the fall. They are grown throughout the San Joaquin and Central Coast valleys and can be grown in the lower Sacramento Valley and central Sierra foothills. Day length requirements are approximately 13 to 15 hours, with optimal adaptation in latitudes of 35° to 38°N. As with the short-day types, varieties with a continuum of varying day-lengths have been developed.

Onion growth is very dependent on temperature. The minimum temperature for emergence is higher than for most other cool-season vegetables at 55°F (12.8°C) for 70 percent emergence in up to two weeks. In addition, early growth rate is slow compared to other cool-season crops. Optimal leaf growth rate occurs at 68° to 77°F (20° to 25°C). However, total plant growth rate is dependent on the amount of light intercepted. Maximum light interception occurs with a leaf area index of approximately 8 or higher.

Bolting is primarily driven by temperature when plants with a leaf base greater than approximately ⅜ inch (9.5 mm) in diameter are subjected to temperatures of 45° to 50°F (7.2° to 10°C). A combination of factors, including planting date, variety, plant size, temperature, as well as timing and duration of temperature, determine if and when bolting occurs.

VARIETIES

Few public onion breeding programs exist in the United States (none in California), but a large number of private seed companies are involved in onion variety development. Because of this, a large number of varieties is available for any given area, and development emphasizes hybrid and not open-pollinated varieties.

Onion varieties are generally classified according to day length (short, intermediate, and long), market use (green, fresh bulb, dehydrator bulb), and bulb color (within the fresh market class: yellow, brown, red, and white). A continuum of day length varieties has been developed, making the distinction between the different day length classes sometimes difficult. Adjustments can also be achieved with varying planting dates and the use of transplants instead of direct seeding.

Short-day, fresh-market bulbs are usually Granex,

Grano, or combination Granex-Grano types. Granex varieties are flat to thick-flat in shape; Grano types are large globe or top-shaped. Some varieties that are grown include yellow types such as Henry's Special, Mr. Max, Rio Hondo, Ringer, Texas Early Grano 502, Rio Enrique, Linda Vista, Monsoon, Colossal, Chula Vista, and Rio Bravo. Red varieties include Rio Raji, Red Grano, and Rojo. White varieties include Contessa, Diamante, Early Supreme, and Rio Redondo. Most fresh-market, short-day varieties are relatively low in soluble solids (5–7%) and pyruvic acid (2–6 moles / kg), with a relatively high sugar:pyruvate ratio. This makes them sweeter than other varieties. Other factors, such as sulfur content in the soil and temperature, influence the level of sweetness, as well.

Short-day onions are usually preferred by the onion ring industry because varieties have been developed with a single center (growing point) and numerous, thick fleshy rings. Short-day varieties are considered to be a non-storage or short-storage crop because they are soft, easily bruised or cut, and have thick necks and thin outer scales. They are harvested slightly immature to meet market demands. When allowed to mature fully, and if harvested carefully, short-day varieties maintain good quality for several weeks, and even months.

Intermediate-day varieties are frequently selections or derivatives from Sweet Spanish types (which may also be long-day). These are usually globe-shaped but may be flattened, and must have some resistance to bolting since they grow through winter. They include Stockton Yellow Globe, Stockton Red Globe, CalRed, Fresno Red, Vega, Yula, San Joaquin, Early Harvest, Cardinal, Early Red Burger, Rio Corona, Dakota, Rio Seco, Cimarron, Utopia, and many others. Intermediate-day varieties are also intermediate in solids, pyruvic acid (pungency), and storability.

Few long-day varieties are produced for the fresh market in California. This is because onion growers in the northern region of the United States can produce and store fresh bulbs at a much lower cost. The acreage of long-day storage varieties grown in the San Joaquin Valley has increased in recent years, and the acreage in the Antelope Valley (in the higher elevations of Los Angeles County) has remained steady. The potential for production and storage in the northern mountain valleys of California has not been fully developed. Numerous Sweet Spanish and Fiesta types (Sweet Spanish by Yellow Globe cross) have been adapted for California production between 37°N and 42°N latitude. Color types of red, white, and yellow are grown. Some long-day bulb varieties with intermediate to good storage periods are Fiesta, Blanco Duro, Maya, Copra, Cache, Cheyenne, Dakota, Zuni, Tamara, Norstar, Valiant, Armada, Fuego, Tesoro, Vaquero, and Condor. Long-day varieties are harvested in late summer and early fall. Because half of all onions in the United States are harvested during this same period, long-day varieties must withstand some storage in order to be marketable. In general, successful varieties have very firm bulbs, more and tighter outer scales, thinner necks, solids content of 8 to 12 percent, and pyruvic acid levels of 10 to 20 moles / kg.

PLANTING

Most commercial acreage is direct seeded, but transplants are used in some fall planted fields for an earlier harvest of short-day (particularly in regions north of the southern deserts) and intermediate-day varieties, and to achieve uniform, jumbo-size bulbs.

Onions are most commonly grown in multiple rows on raised beds 40 to 42 inches (102–107 cm) wide, but some production systems use 36-inch (91-cm) beds or wide beds of 60 to 80 inches (152–203 cm). Distribution of rows across the bed varies depending on the irrigation method and planter. With drip or sprinkler irrigation, rows are spaced equidistant across the bed at approximately 4-inch (10-cm) intervals. When furrow irrigation is used, the center of the bed is left empty for salt accumulation, with 2 or 3 rows planted on either side (bed shoulder). Most seeding is done with precision air planters, although some mechanical plate planters are used, especially in the southern desert.

Hybrid seed is expensive, and thinning is both costly and damages the plant stand. Uniform spacing of 2 to 3 inches (5–7.5 cm) between plants in a row is important to avoid small or deformed (doubles or flattened) bulbs and skips (no plants) that lower yield and promote weed growth. Both pelleted and raw seed are used. The shallow planting of onion seed—at approximately ½ inch (12.5 mm)—requires a soil surface that is well prepared and must be kept moist until germination. More shallow plantings may increase the tendency for flatter bulbs, and deeper planting may result in lower germination and rates of emergence, as well as deeper-shaped bulbs.

Onion seed is susceptible to loss of vigor from high temperature and humidity; germination tests are critical. The storage life of opened seed containers can be shortened very rapidly if not immediately placed in an environment low in temperature and humidity. Seeding rates should be adjusted for lower germination. Fresh-market onion seed is planted 2 to 3 pounds per acre (2.4–3.6 kg / ha).

SOILS

Onions will grow in a wide range of soil types: sand, loam, clay, and organic / peat. Onions are shallow-rooted and need a friable soil that retains moisture well. Excessively dense clay soils interfere with root growth

and frequently result in a serious clod problem at harvest. Sandy soils require very frequent irrigation. Seed germination and seedling establishment require a seedbed that is uniform, clod-free, firm, and several inches deep. Compared to planting on the flat or small ridges, raised beds provide better drainage and an area for salt accumulation away from the root zone.

Onions are sensitive or moderately sensitive to salinity, primarily at the stages of germination and emergence. Once plants are established, higher levels of salinity are tolerated. Yield reductions of 50 percent may occur at electrical conductivity levels of 4 to 5 mmho/cm (dS/m). Onions are more sensitive to salinity, sodium, and boron than are lettuce, cauliflower, broccoli, and cabbage.

IRRIGATION

Onion seed must not dry out, and the soil surface must not be allowed to crust over during the postplanting, pre-emergent state (which can last 10 to 20 days following initial irrigation). Sprinkler irrigation is the best management practice for stand establishment.

Onions require frequent irrigation throughout the season for several reasons. The root system is shallow, so very little water is extracted from a soil depth of more than 24 inches (61 cm), and most is from the top 12 inches (30 cm). Onion roots are mostly non-branching, and all roots originate at the stem, or basal plate, of the plant. This means that upper soil areas must be kept moist to stimulate root growth. Rates of transpiration, photosynthesis, and growth are lowered by even mild water stress. Onion plants show little capacity for reducing leaf water potential by osmotic adjustment to compensate for reduced water availability at the root, whether caused by salinity or dry soil. Stressed plants will be stunted, may result in doubles and splitting, and are usually higher in pungency.

The amount and frequency of irrigation depend on the method, soil type and conditions, and temperature. For optimal plant growth, irrigate when 25 percent of the available moisture in the top 24 inches (61 cm) of soil is depleted. An onion crop typically uses 24 to 30 inches (61–76 cm) of water. With 70 to 80 percent water use efficiency, applications of 30 to 36 inches (76–91 cm) of water should be sufficient. If more water is used, the frequency and length of irrigation should be examined or a different method of irrigation should be considered (drip, surge, sprinkler).

FERTILIZATION

Because onions are shallow rooted and usually planted in cool soils, they are responsive to fertilization. Soil analyses are the best indicators for phosphorus (P), potassium (K), and micronutrient needs. Tissue analyses, combined with soil and cropping history, are the best indicators for nitrogen (N) needs. Typically, no more than ⅓ of the nitrogen should be available at planting, ⅓ at early season (3–4 leaf stage), and ⅓ at midseason. Too much late season nitrogen availability can delay maturity, decrease storability, and contribute to bulb splitting. Because onions are sensitive to ammonia, fertilizers that contain high amounts of it should be avoided. Total supplemental nitrogen needs may vary from 100 to 400 pounds per acre (112–448 kg/ha) of nitrogen, depending on soil and cropping history and irrigation efficiency. High rates of phosphorus (200 lb/acre; 224 kg/ha) may be needed if soils are low or deficient. Onions are not responsive to potassium in most California soils. Zinc and other micronutrients may be needed in many soils. To meet planting and early season nitrogen and other nutrient needs, 5 to 10 tons per acre (11–22 metric tons/ha) of composted manure is sometimes used. Soil tests, tissue analyses, and preliminary quick tests on tissues (for nitrogen) are available.

INTEGRATED PEST MANAGEMENT

UC IPM Pest Management Guidelines for onions have been updated (including photographs) and are available for weed, insect, disease, and nematode pests. Sanitation, crop rotation, resistant varieties, and frequent monitoring are essential in the prevention and control of onion pests. Visit the UC IPM Website at http://www.ipm.ucdavis.edu or see *UC IPM Pest Management Guidelines,* ANR Communication Services Publication 3339.

Weed management. Onions compete poorly with weeds because it takes a long time for them to achieve ground cover, and the long growing season allows for successive flushes of winter and summer weeds. Hand weeding can be very destructive to the root system of onion. Therefore, a good pre-emergent herbicide program is common for fresh-market onions.

Insect identification and management. Thrips and onion maggots are the most frequent serious insect problems for onions, but mites, seed corn maggot, leafminers, and armyworms can also be serious pests.

Disease identification and management. Downy mildew *(Peronospora destructor)* and purple blotch *(Stemphylium vesicarium*, most common in California; and *Alternaria porri)* are the most serious foliar diseases. Bacterial rots (*Pseudomonas* and *Erwinia* spp.) start as foliar diseases before spreading to the bulb. They are a particular threat to plants grown under sprinkler irrigation throughout the season. Bacterial contamination is intolerable in processing plants and should be kept to a minimum. Pink root *(Phoma terrestris)*, white rot *(Sclerotium cepivorum* Berk.), Fusarium basal rot *(F. oxysporum* f.sp. *cepae)*, and bacterial rots (*Pseudomonas* and *Erwinia* spp.) are common diseases during production. Black mold *(Aspergillus niger)*, neck rot *(Botrytis allii)*, and blue mold *(Penicillium hirsutum)* are the most common harvest and postharvest diseases.

Nematode identification and management. Stem and bulb nematode *(Ditylenchus dipsaci)* and root-knot nematodes (*Meloidogyne* spp.) can be a problem in California onion production, but this does not occur frequently.

HARVESTING AND HANDLING

Fresh market bulbs are harvested by hand. Onion plants provide clear signals of maturity: the necks weaken and the tops fall over. Bulbs destined for storage must be mature before undercutting and harvest. Marketing considerations of short- and intermediate-day onions frequently result in harvest when only 20 to 50 percent of the bulbs are mature. These bulbs must be marketed immediately as immature bulbs will regrow tops.

Irrigation management before harvest is critical. Water use demand remains high until maturity begins, then decreases rapidly. Careful evaluation must be made for the last irrigation. Stopping irrigation too soon will reduce yield. Irrigating too late, or applying too much water late in the season, can cause splitting, delay maturity, and increase the incidence of decay. The last irrigation is best applied when 10 to 50 percent of the tops are over.

Before hand harvesting, the tops of onion plants are rolled to enhance maturity, and undercutting is done with a rod weeder (counterclockwise rotating bar). Then harvesting starts immediately to avoid sunburn. Large crews pull and hand clip the bulbs into buckets; the bulbs are placed in burlap sacks and left in the field to cure for 3 days to 2 weeks. This process allows onions to dry and form a protective outer covering on the bulbs. Then the onions are either dumped into bulk trailers for transport to packing sheds, 1,000-pound bulk bins for storage, or field-packed. Packing involves sorting into groups according to bulb diameter: Colossal (>4 in; 10 cm), Jumbo (3–4 in; 7.5–10 cm), Medium (2–3 in; 5–7.5 cm), Repacks (1.5–2 in; 4–5 cm), and Boilers (<1.5 in; 4 cm). Packing for market is primarily accomplished in 50-pound mesh bags or 50-pound cardboard boxes.

POSTHARVEST HANDLING AND STORAGE

Bulbs that are marketed directly from the field during spring and summer are stacked on pallets in the shade in a manner that allows air movement through the stacks. Shelf life of bulbs harvested before maturity is only 4 to 6 weeks. Mature bulbs can be stored for a considerably longer period at ambient temperatures.

Optimal storage temperature and relative humidity for onions is near 32°F (0°C) and 60 to 70 percent. Respiration increases logarithmically above 32°F (0°C), as does growth of most disease organisms. Roots sprout and mold growth increases at high humidity. Air movement is essential to maintain uniform temperature and humidity conditions. Skin color and retention are improved at higher humidity, but levels should not be raised above 70 percent.

Black mold *(Aspergillus niger)* is a common postharvest disease that is usually triggered by moisture, such as a light rain shower or dew at or near harvest. The disease appears several days later. *A. niger* does not grow at temperatures below 55° to 60°F (12.8° to 15.6°C). Gray mold (*Botrytis* spp.) can start in the neck when bulbs are incompletely dried and cured. Then it can engulf the entire bulb, originating in the interior or exterior. Blue mold (*Penicillium* spp.) is a cool-temperature enhanced disease. Prevention is the only effective management scheme against these diseases. Sanitation in and around storage facilities, proper curing, low temperature and humidity, and adequate air movement are essential.

MARKETING

Harvest begins in the south and moves northward. Market prices are highly dependent on the supply and quality of product from the preceding harvested areas, including harvests in Georgia and earlier spring harvests in southern Texas.

Transplanted short- or intermediate-day varieties are harvested in the San Joaquin Valley in late May and June. Direct seeded fields are harvested in July, August, and September. In July and August, early harvest begins in the northern United States. Very few fresh-market bulbs are produced in northern California because production costs are higher and markets and transportation systems have not been developed.

The largest acreage of fresh onions is found in Imperial, Fresno, and San Joaquin Counties. In recent years, increasing amounts of summer harvested bulbs from the San Joaquin Valley are stored in refrigeration for marketing through the fall and early winter. Red, yellow, and white varieties are produced and marketed this way.

A relatively new market for fresh bulbs is the whole-peeled market. Ventura County is the current center of this production and light processing. The varieties are primarily intermediate, mild types with most buyers from the institutional and food service industries. The majority of the demand for fresh onion rings continues to be for whole, unpeeled bulbs with single centers.

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