



PUMPKIN PRODUCTION IN CALIFORNIA

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PRODUCTION AREAS AND SEASONS

Pumpkins (*Curcubita pepo* L. var. *pepo*) are grown in most counties of California. San Joaquin County produces the most by far (70% of California production in 2011), with Sacramento County as a distant second. Although most pumpkins are grown for jack-o-lanterns for the Halloween season, growers also raise other ornamental types. Even some types that can be used for cooking (e.g., Sugar Pie types and Fairytale pumpkins) are also grown and marketed as ornamentals. Planting dates depend on the variety's growth rate: most are planted in May or June for Halloween harvest, but some ornamental types may be planted in April. In Southern California's low desert, the buildup of whitefly populations during spring and summer increases damage and disease in pumpkins, melons, and other cucurbits to such a degree that they simply cannot be grown for fall harvest.

VARIETIES AND PLANTING TECHNIQUES

The principal Halloween pumpkins are the jack-o-lantern varieties and ornamental mini-pumpkins. In the past, the leading jack-o-lantern variety was Howden, a vining type. More recently, cultivars have been developed with special attention given

to improvements in color, yield, consistency, and size, including Aladdin, Gladiator, Magic Lantern, Magic Wand, and Spartan. These modern varieties have a more compact growth habit than the traditional vining types. Jack-o-lantern pumpkins tend to range from 10 to 20 pounds (4.5 to 9 kg), although size is to a great degree dependent on management. Characteristics of a high-quality jack-o-lantern include deep, rich orange color, upright shape, and a strong handle (stem).

Other ornamental varieties include Jack-Be-Little, Mini-Jack, Munchkin, Sugar Pie, and Sweetie Pie (orange mini-pumpkins); Lumina (a white jack-o-lantern pumpkin); and Baby Boo (a white mini-pumpkin). There are also numerous smaller jack-o-lantern or ornamental types that weigh from 1 to 10 pounds (0.45 to 4.5 kg), such as Apprentice, Cannon Ball, Field Trip, and Lil' Ironsides. Other, "mammoth" varieties have been bred specifically for exceptional size. These mammoth varieties are not true pumpkins (*Curcubita pepo* L. var. *pepo*) but *C. maxima*, and are more closely related to Hubbard squash.

Pumpkins typically require 90 to 120 days from emergence to maturity. Timing for planting is critical. Although varieties are rated according to their number of days to maturity, the actual growth time varies with average temperatures and solar radiation. More time is required to reach maturity in cooler, coastal areas. Excessively high temperatures may result in failure to set fruit. Halloween pumpkins should be mature and have a good color 1 to 4 weeks prior to Halloween. Because pumpkins store well under ambient conditions, there may be advantages to harvesting the crop early and storing it for a few weeks. Early crops may suffer less damage from insects and diseases and may require fewer sprayings. Jack-o-lantern or ornamental pumpkins that fail to mature before Halloween have little commercial value.

PUMPKIN ACREAGE AND VALUE

Year	Acreage	Average yield (tons/acre)	Gross value/acre
2011	5,900	14.5	\$3,393
2010	6,200	16.0	\$3,232
2009	5,100	14.5	\$4,031

Source: California Agricultural Statistics: 2011 Crop Year (Sacramento: USDA–National Agricultural Statistics Service)

CULTURE

Vining varieties such as Howden typically are planted in wide rows where the vines are allowed to run. Newer varieties that have a more compact, bushy growth habit are better suited to closer row spacings. Vining types need more space for optimum production, and as the planting density increases they produce fruit in greater numbers but of smaller size. The grower can manipulate the crop's variety, planting density, irrigation, and fertilization in order to produce the size he or she believes the buyer will want.

The modern, compact pumpkin varieties are grown on raised beds with rows 80 (or sometimes 90) inches apart. Small-fruited varieties are grown on similar beds but with double rows of plants on each bed. The larger, vining varieties usually are grown with wider spacings of 3 to 5 feet (0.9 to 1.5 m) between plants and 6 to 10 feet (1.8 to 3 m) between rows. Some small-scale growers hand-plant their pumpkins in hills with these same spacings and leave two plants per hill. In some areas, growers use 40-inch (100-cm) beds and plant every other bed. Approximately 2 to 3 pounds (0.9 to 1.4 kg) of seed is required to achieve a final stand of 3,000 to 4,000 plants per acre. Growers commonly plant excess seed and then thin the plants to the desired plant spacing after emergence.

SOILS

Pumpkins are grown on a wide range of soils. Growers with soil that has a high clay content may have more problems with root and stem diseases because of a wetter soil surface and higher humidity in the lower canopy. For this reason, growers typically use raised beds on such soils. Crop management on heavier soils is often complicated further by excessive moisture or poor irrigation management. Sandy soils also require close attention to water management (more frequent irrigation) to prevent moisture stress and the resulting interruption of foliage or fruit growth.

IRRIGATION

Water management is critical to the development of vigorous vines to support fruit growth and the maintenance of the foliage canopy to protect developing fruit from sunburn. Most pumpkins are grown with drip irrigation, although there are growers who use furrow irrigation. Excessive irrigation aggravates root and stem rot problems and increases humidity in the lower canopy, which contributes to foliage and fruit diseases. If you use furrow irrigation, your irrigation management should emphasize infrequent, deep watering to encourage

deep root development and allow time for the soil surface to dry between irrigations.

With drip irrigation, two lines of tape are typically used on beds with 80-inch centers. The tape usually is placed 10 to 12 inches deep and, ideally, the soil surface remains dry to prevent fruit rot and crown rot. Drip irrigation has the advantage of being able to provide smaller, more frequent irrigations, which minimizes water stress on the vines while avoiding the saturated soil conditions that promote disease.

FERTILIZATION

Phosphorus (P) and potassium (K) fertilizer application decisions can be based on soil analysis values. For soils with a pH value greater than 6.2, the soil P is measured with the bicarbonate extraction test. Soils with less than 15 ppm P definitely need to be fertilized with P, and the crop yield from soils with between 15 and 25 ppm P will also likely benefit from P fertilization. Soils with more than 25 ppm P have sufficient P for crop growth and crops will not respond to additional P fertilization. In situations where P fertilizer application is warranted, 40 to 80 pounds of P_2O_5 per acre (45 to 90 kg/ha) applied preplant or at planting will satisfy crop needs.

Soil K is measured by extracting the soil with ammonium acetate. Values of less than 80 ppm K indicate a need for K fertilization, soils with a K value between 80 and 120 ppm may have improved yields with K fertilization, and soils with more than 120 ppm K have sufficient K to satisfy crop needs. Typical K fertilization rates for deficient soils vary from 75 to 150 pounds of K_2O per acre (84 to 168 kg/ha).

Nitrogen (N) needs of pumpkin are moderate in comparison to those of other vegetable crops. Small quantities of N can be applied preplant, but the bulk of the crop's nitrogen needs should be addressed 30 to 40 days later when rapid growth begins. Nitrogen can be shanked into the soil with tractor-applied N or it can be applied through a drip irrigation system. Typical total N use by a pumpkin crop is 100 to 150 pounds per acre (112 to 168 kg/ha).

POLLINATION

Pumpkins require bee pollination for optimal yields. Smaller ornamental pumpkins require a much higher percentage of pollinated flowers for optimal yields than do larger pumpkins. Each flower is receptive for only one day, and multiple bee visits may be required for optimal pollination. Although many growers rely primarily on native bees for pollination, it is best to introduce one to two beehives per acre of pumpkins very early in the blooming period to ensure that adequate numbers of bees are present and that the bees can establish a pattern of visits to emerging flowers.

FRUIT DEFECTS

There is a low consumer tolerance for fruit defects in pumpkins. Even coloring and a symmetrical shape are very important to consumers. Poor pollination can result in misshapen fruit. High temperatures can result in thinner-walled pumpkins that do not hold up as well in shipping. Other fruit defects can be caused by the fungi and viruses discussed below. Shallow feeding damage from soil insects can result in warts that render the fruit unmarketable. The exception to this would be specific ornamental varieties that are prized for their warty appearance (e.g., Red Warty Thing).

INTEGRATED PEST MANAGEMENT

See the UC Integrated Pest Management Guidelines (online at www.ipm.ucdavis.edu) or your local county Farm Advisor for current pest management information (see *UC IPM Pest Management Guidelines*, UC Agriculture and Natural Resources Publication 3339).

Insect management. Seedcorn maggot (*Delia platura*) hollows out seeds or eats portions of seedlings. Damage is common in early plantings in cool soils, especially in fields with high organic matter content. If conditions are favorable for a maggot infestation, apply a registered insecticide as a broadcast spray that is then incorporated into the soil, as an injection into the seedline, or as a seed treatment at planting. Wireworms (*Limoniuss* spp. and others) can kill young plants and weaken older ones by feeding on the root system. Flea beetles such as the palestriped flea beetle (*Systema blanda*) and *Epitrix* spp. can attack seedlings, causing severe damage or death of plants. Flea beetles chew holes in cotyledons and young leaves. They can be controlled with foliar applications of a registered insecticide. *Epitrix* spp. occasionally feed on fruit late in the season if the plants are under foliar stress. Squash bugs (*Anasa tristis*), which have sucking mouthparts, kill pumpkin leaves and vines when populations are high. They lay reddish brown, barrel-shaped eggs in masses on the underside of leaves and the juveniles actively feed on the fruit and foliage.

In milder southern and coastal areas, the sweet-potato whitefly (*Bemisia tabaci* biotype B) and greenhouse whitefly (*Trialeurodes vaporariorum*) are not killed by winter temperatures and their populations rise gradually throughout the spring. This pest may build to serious levels and in that case may require treatment with a registered insecticide. Aphids also cause problems by weakening the plant through their feeding, and both whiteflies and aphids are vectors of viral diseases. Pumpkins in the low desert growing areas of Southern California require soil injection of a neonicotinoid insecticide at planting for whitefly con-

trol. Foliar sprays may be required after 30 to 45 days for continued whitefly management. Insecticides applied for whitefly control also prevent aphid problems. Pumpkins can only be grown in spring in the low desert due to several whitefly-transmitted virus diseases, including cucurbit yellow stunting disorder, squash leaf curl, and cucurbit leaf crumple.

Leafminers (*Liriomyza* sp.) may damage cotyledon leaves, but natural predators are usually able to control them as long as the predators are not eliminated by repeat applications of broad-spectrum insecticides. The western spotted cucumber beetle (*Diabrotica undecimpunctata*) and western striped cucumber beetle (*Acalymma trivittatum*) can attack in large numbers and feed on younger and older plants. The larvae feed on the roots and underground parts of the stem, and the adults feed in flowers (causing blossom drop) and on developing fruit. Cucumber beetles may be present in large numbers on young seedlings and they often require spraying with a registered insecticide for sufficient control and to avoid serious economic losses. The western striped cucumber beetle should not be confused with palestriped flea beetle, a much smaller insect.

The larvae of several species of armyworm (*Spodoptera* spp.) and looper (*Trichoplusia* spp.) larvae can also damage pumpkins. These larvae feed on foliage and may damage fruit. Scout the field to determine worm populations during periods when the fruit is most susceptible to damage, before the rind begins to turn orange. These worm pests can be controlled with registered insecticides (including *Bacillus thuringiensis* products) and biological control.

Disease management. Powdery mildew (*Podosphaera fuliginea* syn. *Sphaerotheca fuliginea*) is common in pumpkin fields throughout the growing season. This fungal disease can be a problem at any time in coastal growing areas and, in late summer and fall, in the inland valleys. Growers recognize it as a white powdery growth on upper and lower leaf surfaces. If not controlled, the disease will completely destroy the foliage, and any fruit that survives will be sunburned and discolored. The loss of productive vines also severely restricts fruit yield and size. Since 1998, many commercially grown varieties have had some level of resistance to powdery mildew. Powdery mildew resistant (PMR) pumpkin varieties vary in their susceptibility to powdery mildew, depending on the number of resistance alleles they possess. Varieties with two copies of the resistance allele (homozygous varieties) generally develop less powdery mildew than those with only a single copy (heterozygous varieties); the common commercial varieties are marketed as "intermediately resistant" to powdery mildew. Fields should be frequently and carefully

scouted for the disease and registered fungicides should be applied at the first sign of the disease.

Charcoal rot (*Macrophomina phaseoli*) affects pumpkins and other cucurbits. Leaves of the crown area turn yellow and wither. If the disease spreads, vines may wilt and die. The causal organism, a soil-borne fungus with a wide host range, is common on most soils in California's Central Valley. The fungus tolerates high temperatures and dry soil and the disease is favored by water-stressed plants and high temperatures.

Phytophthora crown and root rot (*Phytophthora capsici*) is a serious fungal disease of pumpkins and squash in places where soils are wet for extended periods. Phytophthora may cause root rot, crown or stem lesions, or foliar blight. Fruit may also be severely infested and may rot. Warm temperatures of 68° to 80°F (20° to 27°C) and poor drainage favor development of this disease. Phytophthora can move rapidly, and disease incidence may be higher in fields where pumpkins are planted following other host crops such as tomatoes or peppers.

Fusarium crown and foot rot, also called Fusarium fruit rot (*Fusarium solani* f. sp. *cucurbitae*) may affect the lower stem or crown area of the plant, causing plants to wilt and die. Fruit that are in contact with the soil may also be affected by dry lesions that have a concentric ring pattern and render the fruit unmarketable. The fungus survives on soil and seed and is most common on the central coast. Control of Fusarium depends on the long-term (four-year or longer) rotation of fields out of cucurbits and the use of clean seed.

As is true for many other cucurbits, some of the most serious diseases of pumpkins are caused by viruses. Of the viruses affecting pumpkins in California, the most important are transmitted by aphids, whiteflies, and beetles. Transmission of each virus is specific to particular insects. Viruses such as *Cucumber mosaic virus* (CMV), *Watermelon mosaic virus* (WMV), *Zucchini yellow mosaic virus* (ZYMV), and *Papaya ringspot virus* (PRSV-W) are transmitted by aphids in a nonpersistent manner—that is, the aphids need only spend a few seconds or minutes on the plant to probe the leaf surface and transmit the virus. Conversely, *Cucurbit aphid-borne yellows virus* (CABYV), which is common in the Southern California low desert, is transmitted only when the cotton melon aphid (*Aphis gossypii*) feeds on the plant phloem. *Squash mosaic virus* is transmitted by the spotted cucumber beetle and other related beetles, and may also be seedborne.

Many of these viruses are present in native vegetation, weeds, rangeland plants, or other crop plants, and many are readily transmitted to developing pumpkins as the insect vectors move into pumpkin

fields. If possible, avoid growing other cucurbits in the same area before you plant pumpkins so as to avoid providing an opportunity for virus to move from one crop to another. It is always desirable to plant succeeding crops of pumpkins or other cucurbits upwind rather than downwind of previously planted cucurbit crops. Other crops, such as peppers, may also harbor a number of viruses that can affect neighboring cucurbit crops.

Weed management. Weeds can reduce pumpkin yields if they are allowed to compete with the crop for nutrients and light. Pumpkins are grown during the warm time of year, and key troublesome weeds include summer grasses and broadleaf weeds such as barnyardgrass and common purslane. Infestations of perennial weeds such as field bindweed and nut-sedge are difficult to control, so fields infested with these weeds should be avoided. Weed control techniques for pumpkins include cultural, mechanical, and chemical control. A key preplant cultural control is the use of pre-irrigation to stimulate a flush of weed growth, followed by shallow cultivation. This technique can greatly reduce the quantity of early season weeds. Mechanical cultivation can control a large number of weeds early in the season before the vines begin to cover the bed top. Only a few herbicides are registered for use on pumpkins, but those include pre-emergent and selective post-emergent materials that can control a wide spectrum of weeds. Hand weeding is generally necessary in pumpkin fields to remove weeds that have escaped control by the methods just mentioned. However, good weed control practices early on can help to make subsequent hand weeding operations more efficient and less costly.

HARVESTING AND HANDLING

Pumpkin production across a broad range of environments has shown that the jack-o-lantern types typically yield 1,000 to 2,500 marketable fruit per acre, weighing a total of 10 to 25 tons (11 to 27.5 t). Smaller varieties will produce 2,000 to 6,000 marketable fruit per acre, weighing a total of 5 to 10 tons (5.5 to 11 t).

Pumpkins can be harvested when the outer skin is even-colored and hard. (The side touching the soil may be lighter in color.) Water generally is cut off between 7 and 10 days before harvest to promote drying of the vine. The fruit should be cut from the vine in a way that leaves 3 to 5 inches (7.5 to 12.5 cm) of stem, or some other length as dictated by the buyer. Harvesters should try to avoid handling fruit by the stem. Growers generally cut the fruit and then wait two to three days before handling them again so the cut stems will have time to cure. Pumpkins may be field-packed or may first be brought to a shed for washing. Smaller ornamental types are packed in a

shed where they are washed and receive a light wax coating.

Optimal storage conditions for pumpkins are 50° to 55°F (10° to 13°C) at 50 to 70 percent relative humidity. Pumpkins are sensitive to chilling injury at low temperatures. Many pumpkin producers in California find that pumpkins will hold for 3 to 6 weeks in early to mid-fall if you simply keep them on racks or in bins in a well-ventilated, shaded area. Pumpkins generally cannot be held beyond 60 days, even in ideal storage conditions.

MARKETING

Pumpkins sold wholesale are most often packed in sturdy, tri-wall fiberboard bulk bins either 24 or 36 inches tall. These bulk bins, printed with high-resolution logo graphics, have become a common way for retailers to display the pumpkins. California produces the most pumpkins for the fresh market

(187 million pounds in 2012) of any state, followed by Ohio, Pennsylvania, New York, Illinois, and Michigan. In California, almost all pumpkins are grown for the Halloween market, when they may be sold directly from the field or farm stand to the public. Agritourism operations, where customers visit the farm, are becoming an increasingly important source of income for some pumpkin operations. In a 2009 statewide survey of agritourism operations, pumpkin patches were reported as one of the most popular attractions, often offered in tandem with other on-farm activities such as corn mazes and pony rides. More than half of the survey respondents reported more than \$50,000 in annual revenues, and pumpkin patch/corn mazes were rated as the most profitable of a range of other agritourism offerings such as tours, events, and retail sales. A majority of operators (64%) also reported that they intend to expand their agritourism venues over the next five years.

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