

HAWAII COOPERATIVE EXTENSION SERVICE

Hawaii Institute of Tropical Agriculture and Human Resources

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COMMODITY FACT SHEET PA-3(A)

FRUIT



PAPAYA

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Family: Caricaceae

Scientific Name: *Carica papaya*

Origin: American tropical lowlands

Description

Papaya is a short-lived perennial growing to 30 ft (9.14 m) high. Its hollow, herbaceous stem is usually unbranched. The deeply lobed, palmate leaves are borne on long, hollow petioles emerging from the stem apex. Flowers occur in leaf axils. Older leaves die and fall as the tree grows.

Papaya flowers are fragrant and have five cream-white to yellow-orange petals 1 to 2 in (2.5 to 5.1 cm) long. The stigmatic surfaces are pale green, and the stamens are bright yellow.

Papaya fruits are smooth skinned. They vary widely in size and shape, depending on variety and type of plant. Hermaphrodite plants of commercial 'Solo' varieties in Hawaii usually produce fruits that are pear shaped and weigh approximately 12 to 30 oz (340 to 851 g). Female plants of 'Solo' varieties produce round fruits. Other papaya varieties produce variously shaped fruits, which may weigh up to 20 lb (9.1 kg).

The fruits usually contain many seeds surrounded by a smooth yellow to orange-red flesh that is sweet in good varieties. Fruits are usually consumed fresh as a breakfast or dessert fruit. They also may be pureed for use in beverages, or dried. Fruits contain the protein-hydrolyzing enzyme papain, which is used in the brewing industry and in meat tenderizers; it is believed to aid digestion.

Flower type. Flower type is determined by the presence or absence of functional stamens (male parts) and stigma and ovary (female parts). Within varieties, flower type is usually identified by flower size and shape.

Female flowers are relatively large and rounded at the base. They have a stigma but lack

stamens. They generally must receive pollen in order to set fruit. Pollen can be carried by wind or by insects.

Male flowers are thin and tubular. They have perfect structure (i.e., they contain both male and female organs), but the small, vestigial ovary is nonfunctional. Male flowers are usually borne on a long flower stalk (peduncle).

Hermaphrodite flowers are intermediate between female and male flowers in size and shape. They are less bulbous than female flowers, but not as thin as male flowers. They have perfect structure with functional stigma and stamens and usually are self-pollinating.

Plant type. Three types of plants are recognized based on flower type: female, hermaphrodite, and male.

Female plants always produce female flowers. If no male or hermaphrodite plants are nearby to provide pollen, female plants usually fail to set fruit. Unpollinated female plants occasionally set parthenocarpic fruits, lacking seeds.

Male plants are distinguished by their long flower stalks bearing many flowers. Usually they do not produce fruit, but on rare occasions there is female expression in the flowers, and they may set fruits.

Hermaphrodite plants may have male flowers, hermaphrodite flowers, or both, depending on environmental conditions and the time of year. Hot, dry weather may cause suppression of the ovary and the production of female-sterile (i.e., male) flowers. This accounts for occasional seasonal failure of hermaphrodite plants to set fruit. Male flowers on hermaphrodite plants are borne on short peduncles.

Hermaphrodite plants tend to produce self-pollinated seeds, which result in relatively uniform progenies. Seeds from hermaphrodite

plants of 'Solo' varieties characteristically produce one-third female and two-thirds hermaphrodite plants, but no male plants are produced.

Although hermaphrodite and female plants have similar fruit texture and quality, female plants may be less productive, and the round female fruits are marketed only in small quantities in Hawaii as direct sales from growers to consumers. Female plants are removed from commercial orchards as soon as they can be distinguished at flowering. In home gardens, female plants may be kept if hermaphrodite or male plants are nearby to serve as a pollen source.

Varieties

The 'Solo' variety is valued for its productivity, uniform fruit shape and size, and excellent fruit quality. 'Solo' strains are predominantly self-pollinated and thus are highly inbred and uniform.

Three 'Solo'-type varieties are grown commercially in Hawaii. The most important is 'Kapoho', which has yellow-orange flesh and fruits that weigh 12 to 22 oz, considered an ideal size for export. 'Kapoho' is adapted to the Puna district of the island of Hawaii, where approximately 90 percent of the state's papayas are grown. The 'Sunrise' variety, commercially grown primarily on Kauai, has reddish-orange flesh and larger fruit than 'Kapoho'. 'Sunrise' is grown and marketed on a large scale overseas, but in Hawaii its production and export are small compared to those of 'Kapoho'. The 'Waimanalo' variety, which has yellow-orange flesh and somewhat larger fruit than other 'Solo' papayas, is grown and marketed almost entirely on Oahu.

Production

Papaya trees bear fruit throughout the year. "Skips" in the fruit column caused by temporary sterility may occur during hot, dry summer periods and may cause fruit shortages in winter.

The plants will continue to bear for many years, but yields usually decline as the trees age, and picking becomes difficult. In commercial production, fields are usually replanted or abandoned after three years.

Papayas marketed in or exported from Hawaii are regulated by a Federal Marketing Order that sets fruit size and quality requirements.

Location

Papaya grows best in warm areas below 500 ft (152 m) elevation. Fruit production and quality decline at higher elevations, where cooler temperatures cause flower drop and cat-faced (carpellidic) fruits. (Carpelloidy is the abnormal development of stamens into fleshy structures.)

Papaya can tolerate moderate winds if well rooted. Forty to 60 in (102 to 152 cm) of rainfall evenly distributed throughout the year is adequate for growth. With higher rainfall, soils should be porous and well drained. Planting on slopes or on raised hills helps to prevent waterlogging.

Soils

Papaya grows well on many types of soil, but they must be adequately drained. Restricted soil drainage promotes root diseases. Most commercial production in Hawaii is on porous aa lava. Production on other soil types is limited to low-rainfall areas where restricted drainage is less likely to cause problems. Heavy clay and pahoehoe lava soils should be avoided. Soil pH near neutral (pH 6.0 to 7.0) is preferred.

Soil categories used for commercial production vary from island to island. On Hawaii, both aa lava and soils are used. On aa lava lands, additional soil is usually brought in and placed in the planting hole. The soils used for papaya on the island of Hawaii have a high preplant phosphorus fertilizer requirement. These soils, as well as the organic soils derived from lava, are usually acidic, and liming may be necessary. On Kauai the soils used for papaya usually require liming and high levels of phosphorus fertilization. On Oahu the soils on which papaya is grown are often poorly drained.

Propagation

Papaya is grown from seed. Dry seed may be stored for a year or more in airtight refrigerated containers. Fresh seeds will usually germinate in 10 to 14 days. Germination can be improved by removing the gelatinous outer seed coat (sarcotesta) before drying.

Seeds are sown either in containers or directly in the ground. Transplanting container-grown plants is usually limited to areas where there is dependable rainfall or supplemental irrigation. When direct-sowing, 10 to 15 seeds are sown 1/4 to 1/2 in (63 to 127 mm) deep in each planting hole. To ensure adequate stands in lava lands, approximately 0.5 ft³ (14.16 dm³) of soil should be placed

in each planting hole. The soil helps to retain fertilizer nutrients and moisture.

Cultural Practices

Seedlings are thinned to five or six plants per hole six weeks after planting. Six weeks later, three vigorous seedlings per hole are selected, and the others are removed by cutting them off at ground level. When flower buds appear five to seven months after planting, the female plants can be distinguished and removed, keeping one hermaphroditic plant per hole. Tree spacing varies from 5 to 7 ft (1.52 to 2.13 m) between plants in rows 8 to 11 ft (2.44 to 3.35 m) apart.

Fertilizer schedules vary with soil type, climate, and season. The general suggestions for fertilizer applications given here are based on commercial practices but can be used by the home gardener. In commercial plantings, fertilizers are either broadcast onto the soil surface within the leaf drip zone or applied through drip irrigation lines. In home gardens, fertilizers are usually broadcast on the soil surface. Organic matter mixed with the soil before planting and applied afterward to the soil surface as mulch helps to ensure good rooting conditions and a supply of micronutrients.

Preplant fertilizer applications. On acid soils with a pH of less than 5.5, a preplant lime application is usually recommended to raise the pH and provide calcium. Dolomite, which provides both calcium and magnesium, may be substituted for part of the lime requirement. These soil amendments should be thoroughly mixed with the soil in the rooting zone before planting.

Phosphorus applied before planting should be thoroughly mixed with the soil or placed in a band away from the seeds. Application rates depend on soil type. For soils that do not have a high phosphorus requirement, a preplant application of 4 oz (113 g) of 0-46-0 per planting hole is recommended.

Preplant applications of complete fertilizers are usually not necessary when planting papaya, because the developing seedlings can initially use nutrients stored in the seeds. Soluble fertilizers placed in the planting hole may burn the roots and make them susceptible to root rots. Slow-release fertilizers generally do not burn roots when mixed with the soil, and in commercial practice they are applied on the soil surface when the seeds are planted.

Postplant fertilizer applications. Moderate applications of slow-release fertilizers are recom-

mended during the first few months of growth. Commercial growers apply 0.5 oz (14 g) of slow-release fertilizer per hole at planting and again six weeks later. Postplant fertilizer applications usually begin three months after planting with rates increasing with plant size. Maximum rates are applied at five- to eight-week intervals after the plants begin to flower. A typical application schedule with a fertilizer such as 14-14-14 begins with 4 oz (113 g) per plant per month during the third through fifth months after planting. This rate increases to 6 oz (170 g) every five weeks after the sixth month.

During winter months, when growth and fruit production are slower, quantities of fertilizer applied should be reduced. In the absence of rain or irrigation, repeated fertilizer applications can lead to buildup of undissolved fertilizers, which may release high concentrations of nutrients into the root zone with the next rainfall. Excessive N will cause excessive vegetative growth and is also believed to contribute to soft-fruit problems.

Papayas planted in replant fields often succumb to diseases caused by accumulation of soil-borne pathogens. A fallow period of three to five years may help to avoid the replant problem. Preplant soil fumigation is an alternative to the fallow period. On lava soils, the "virgin soil" technique can be used. Soil is collected from land where papayas have never been grown, and approximately 0.5 ft³ (14.16 dm³) of soil is placed in holes that are at least 1 ft (30.5 cm) in diameter and 4 to 6 in (10.2 to 15.2 cm) deep.

For best growth of young plants and good yields of bearing plants, papayas should be irrigated as necessary to supplement rainfall. When rainfall is limited, commercial growers may apply up to 10 gal (37.85 l) of water per tree per day to bearing trees. Yields can also be increased by good weed control practices.

Harvest

Papaya fruit should be harvested after color break—when some yellow shows on the fruit—but before fully yellow. Fruit for home consumption is best harvested when half yellow. If left to ripen on the tree, the fruit is often damaged by fruit flies and birds.

To be certified for shipment, fruit for export must be harvested and packed in strict compliance with quarantine regulations.

Harvested fruit is ripened at room temperature and refrigerated when fully ripe. When ready to eat, fruit is usually partially to fully yellow and

slightly soft; refrigeration can extend its storage life for several days. In commercial situations, the storage life of partially ripe fruit can be extended for up to two weeks by holding it at about 50°F (10°C), but lower temperatures may interrupt the ripening processes and cause injury; the optimal storage temperature for fully ripe fruit is about 36°F (2.2°C).

Diseases of Papaya

Anthraxnose and chocolate spot, *Colletotrichum gloeosporioides* (fruits, petioles)
Phytophthora, *Phytophthora palmivora* (fruit, stem, roots)
Powdery mildew, *Oidium caricae* (leaves)
Black spot, *Cercospora papayae* (fruit)
Damping off, *Pythium*, *Phytophthora*, *Rhizoctonia* (seedlings)
Wet rot, *Phomopsis* sp. (fruit)
Dry rot, *Mycosphaerella* sp. (fruit)
Watery fruit rot, *Rhizopus stolonifer*
Stem-end rot, *Botryodiplodia theobromae*,
Mycosphaerella sp., *Rhizopus stolonifer*,
Phomopsis sp. (mature fruit)
Papaya ring spot virus (formerly referred to as papaya mosaic)

Reniform nematodes, *Rotylenchulus reniformis*
Root-knot nematodes, *Meloidogyne* spp.

Insect Pests of Papaya

Green peach aphid, *Myzus persicae*
Onion thrips, *Thrips tabaci*
Stevens leafhopper, *Empoasca stevenci*
Mediterranean fruit fly, *Ceratitis capitata*
Melon fly, *Dacus cucurbitae*
Oriental fruit fly, *D. dorsalis*

Mite Pests of Papaya

Broad mite, *Polyphagotarsonemus latus* (seedlings, young plants, lower surface of young leaves)
Red and black flat mite, *Brevipalpus phoenicis* (fruit)
Tuckerellid mites, *Tuckerella ornata*, *T. pavoniformis* (trunks of old plants)
Carmine spider mite, *Tetranychus cinnabarinus* (lower surface of mature leaves)
Citrus red mite, *Panonychus citri* (upper surface of mature leaves)
Texas citrus mite, *Eutetranychus banksi* (upper surface of mature leaves)