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Pineapple Cultivation in Hawaii*

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Overview of Commercial Production Practices

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Pineapple is a perennial plant that requires a functional root system to produce multiple fruitings. Economic production of 'Smooth Cayenne', the dominant pineapple cultivar grown commercially in Hawaii, has been based on a two- or three-fruit crop cycle requiring approximately 32 or 46 months, respectively, for completion. A field newly planted with crowns requires approximately 18 months after planting before the first fruiting, referred to as the "plant crop," is harvested. Two subsequent fruitings, referred to as "ratoon crops," are produced from vegetative suckers (also called shoots) on the plant. Fruits are harvested year-round for fresh market and canning operations. Generally, production levels and fruit quality are highest during the summer.

During growth and flowering but before fruit development, fertilizers, herbicides, insecticides, nematicides, and fungicides may be applied to maintain crop growth and control weeds, pests, and diseases as needed to maintain a healthy crop, as follows:

- Fertilizers—preplant; postplant via drip irrigation, foliar broadcast sprays
- Herbicides and insecticides—preplant; postplant via broadcast or spot application
- Nematicides—preplant; postplant via drip irrigation, foliar application during plant development
- Fungicides—preplant via crown dips, postplant via foliar sprays

Common practice in the industry is to apply only the minimum amount of pesticide required to achieve control, to wait as long as possible between applications, and to minimize the number of applications. These practices reduce environmental and health risks while ensuring adequate control of pests and maximum economic benefit. Generally, pest-control chemicals are not applied during the 5–6-month fruit development period before harvest.

Field operations and equipment

Mulching

After field preparation, a machine lays a thin plastic mulch film marked with the plant spacing; beneath this mulch it also lays a plastic tube for drip irdrigation, injects a fumigant for nematode control, and applies fertilizer.

* This document combines two previous publications of the College of Tropical Agriculture and Human Resources.

The first section, "Overview of commercial production practices," is adapted from *Pineapple, the plant and its culture*, by Kenneth G. Rohrbach, published under the imprint of the Hawaii Agricultural Experiment Station, Hawaii Institute of Tropical Agriculture and Human Resources, University of Hawaii at Manoa (5 pp., no date [ca. 1990]). The brochure provided a snapshot of the pineapple crop cycle as then practiced by the major commercial plantation growers in Hawaii.

The second section, "Growing pineapple," was first published in 1988 under the title *Pineapple* as CTAHR Commodity Fact Sheet PIN-3(A). It was intended as a "how-to" guide providing information for someone wishing to cultivate a crop of pineapple.

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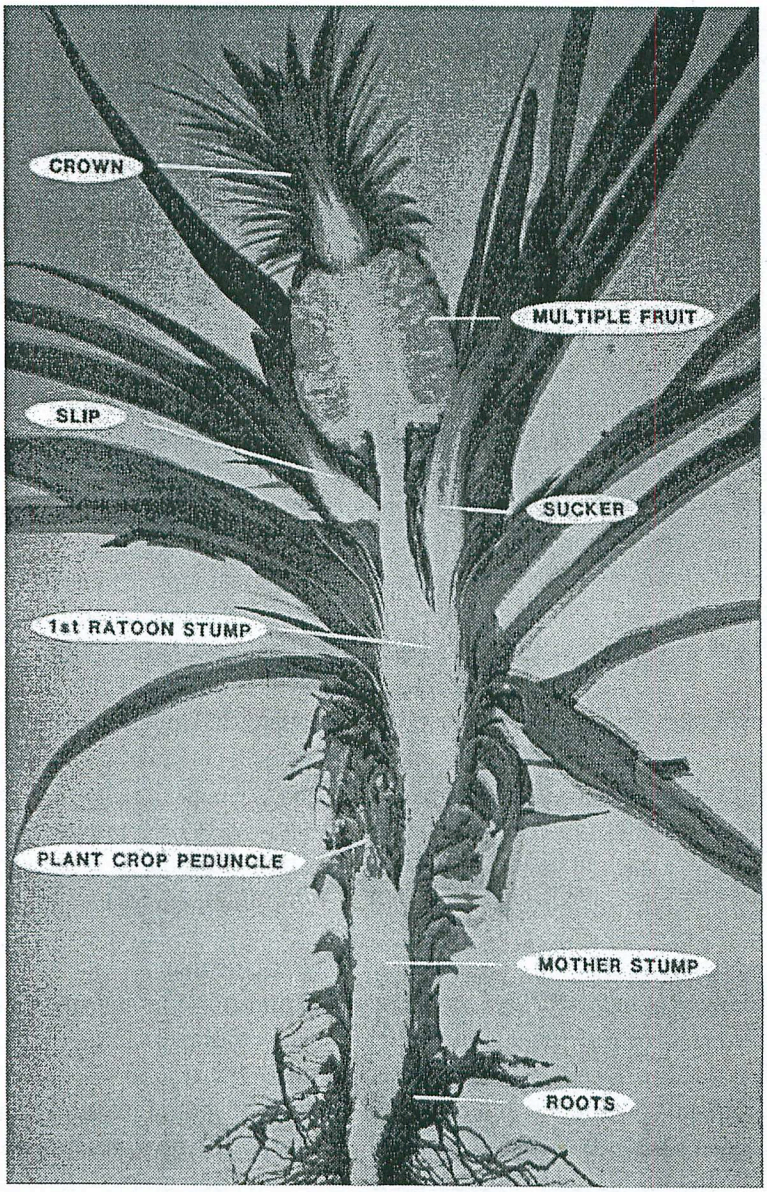
The parts of a pineapple plant
(cross-section of a first-ratoon plant)



Reproduced from *Pineapple, the plant and its culture*, by Kenneth G. Rohrbach, Hawaii Agricultural Experiment Station, Hawaii Institute of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, 5 pp., no date (ca. 1990); original photo courtesy of Dole Packaged Foods Co.

Evenly distributed rainfall of 60 cm per year is adequate for maximum growth.

Soil types

Acid soils are especially suited to pineapple. When soil pH is between 4.5 and 5.5, soil-borne diseases are reduced. Soil pH greater than 7.0 should be avoided. Good soil drainage is a necessity. Where rainfall is high or soils are not well drained, soil management techniques to improve drainage must be used. Pineapple tolerates low soil fertility, but best production is obtained with high fertility. High levels of soluble soil aluminum and manganese are tolerated. High soil organic matter and potassium status are desirable.

Propagation

Pineapple is propagated asexually from various plant parts. For production purposes, the parts used are crowns, slips, hapas, and suckers, with crowns and slips being most common. The number and proportion of slips, hapas, and suckers produced on the plant vary with clone and climate. Special techniques are used for rapid increase of strain selections.

Rapid increase methods

Tissue culture using meristem from axillary buds is possible if callus culture is avoided. Plants regenerated from callus tend to be variable. Growth regulators known as morphactins applied after forcing can cause production of up to 25 slips per plant. Two traditional methods are stump (stem) and crown sectioning. Plants obtained by sectioning develop slowly, and extra care in field preparation and irrigation is needed to promote rapid growth.

Stump sectioning. Stumps are harvested after the one-inch open heart flowering stage or after fruit harvest. Leaves are stripped off starting at the base, or they are cut off leaving the leaf bases attached to the stump. The stump is cut longitudinally into quarters or sixths, which are then cut into wedge-shaped sections weighing 15–20 g, each having at least one axillary bud. The sections are dipped in fungicide and planted bud upward 2.5 cm apart and 2 cm beneath the soil in a well-prepared, fumigated nursery bed. The bed may be lightly mulched with straw or compost. As many as 50 sections may be obtained per stump. A section will produce another stump in about two years.

Crown sectioning. Crowns are cut vertically into quarters or sixths, starting at the top and cutting toward the base. The vertical sections may be cut horizontally in half between the crown base and apex. After drying for one to two days, the sections are dipped in fungicide and sown 2.5 cm apart in nursery beds, with the leaves above ground. Plantlets from crown sections should reach the original crown size in less than one year. Under semisterile conditions, crowns have been microsectioned to produce up to 100 plants.

Crowns

Crowns are currently the preferred planting material in Hawaii. They are twisted from the fruit at the time of harvest. The wound is allowed to dry ("cure") for one to two weeks or, more commonly in Hawaii, the crowns are dipped in fungicide and planted soon after harvest. The chance of rot is reduced by trimming the crown butt to remove fruit tissue high in sugars. Crowns grow more slowly and are less drought resistant than slips but may have the potential to develop better root systems. Crowns should be graded by weight to minimize variability in the field.

Slips

A slip is a rudimentary fruit with an exaggerated crown. Slips develop from buds in the axils of leaves borne on the peduncle (fruit stalk). Because they must grow outward, then upward from under the fruit, slips are curved at the base. On slip-producing clones, the number of slips can vary from none, as is common in hot, equatorial zones, to as many as 10 or more, as is observed in the undesirable mutation known as "collar of slips." Some clones never produce slips.

Slips become visible on the peduncle when the fruit is about half developed. When intended for use as planting material, they are harvested two to five months after the plant crop harvest, that is, 10–13 months after slip growth starts. When not so used, they are removed from the plant to increase ratoon yield. Slips are broken from the peduncle, then cured or dipped in fungicide. Slips may be stored butt end up in a dry place for up to one year, but they should be planted within one month of harvest for best results.

Hapas and suckers

Hapas are intermediate in form between slips and suckers. They are produced in small numbers on plants grown

Irrigation

Irrigation by the drip system to supplement rainfall is becoming standard practice in Hawaii. The tubing is laid in the center of each bed beneath the plastic mulch. There should be one tubing orifice for every two plants. When rainfall is lacking, the irrigation system should provide 47,000–94,000 liters of water per hectare per week to the plants. Crowns usually are "set" after planting by one overhead irrigation during dry weather.

Drip irrigation may be helpful to alleviate effects of root damage due to nematode infestation. Pineapple plants irrigated by drip lines are less susceptible to moisture stress because irrigation water is delivered directly to the root zone.

Weed control

Weeds are controlled by black plastic mulch. To control weeds in bare soil areas between the mulch beds, registered preemergence herbicides cleared for pineapple may be used according to the instructions on the label. Some herbicide labels permit application of the herbicide as overtop sprays immediately after planting and at later stages during the crop cycle.

Forcing

The growth regulator most commonly used for forcing is ethephon, an ethylene-releasing compound that is widely used for field applications. Ethylene and acetylene are also used for forcing. In commercial agricultural plantings, plants are forced with a solution containing ethephon mixed with urea.

Forcing with growth regulators is most effective during cooler seasons; hot weather is inconducive to good floral induction. During hot seasons (night temperatures greater than 25°C), withholding nitrogen (N) fertilizer for 4–6 weeks before forcing can improve induction by increasing plant carbohydrate relative to N.

Fertilizer

Pineapple has high requirements for fertilizer N, potassium (K), and iron (Fe), and relatively low requirements for fertilizer phosphorus (P) and calcium (Ca). Less fertilizer is required during the first five months after planting; requirements increase sharply afterward and peak at two to four months before floral initiation. P and Ca are usually banded in the plant line during bed preparation. K is usually applied to the soil before planting and later may be sidedressed. Other nutrients-sometimes including K are applied as foliar sprays or through the drip irrigation system, or by both methods, during the plant growth cycle.

Preplant fertilizer. The need for fertilizer applications to the soil is best determined by soil tests. In Hawaii, Ca need not be applied if soil pH is greater than 4.6, because of the low plant Ca requirement. If soils are low in P, approximately 75 kg/ha P should be broadcast or banded beneath the plant rows. Applications of animal manures may reduce the need for supplemental applications of Fe and other micronutrients.

Postplant fertilizer. Postplant applications of fertilizers to the plant crop may provide 450 kg/ha N (400–500 kg/ha is common), 400 kg/ha K, 25 kg/ha magnesium (Mg), and 2 kg/ha zinc (Zn). Frequent foliar applications of Fe are usually necessary in Hawaii because pineapple is not able to extract soil iron efficiently from low-pH soils. If Fe is moderately unavailable, 5–10 kg/ha iron sulfate ($FeSO_4$) may suffice; where problems are more severe, as in Hawaii's pineapple soils, 6–24 kg/ha may be required.

Foliar fertilizer. The volume of fertilizer solution applied foliarly to pineapple varies with plant population, growth stage, and amount of fertilizer being applied. Concentrations of fertilizer applied in sprays must be carefully calculated to avoid solutions that burn the plants.

Low-volume sprays of 250–500 liters/ha are directed to the green portion of the leaves, allowing little or no rundown into leaf axils. Nutrient uptake is through green leaf tissue. Salt concentration may be as high as 20 percent by weight

Medium-volume sprays of 500–2500 liters/ha are directed to the green portion of the leaves, with rundown into leaf axils but with little or no runoff into the soil. Uptake is through green tissue, basal white tissue at leaf bases, and axillary roots near the base of the stem. Maximum salt concentration is 5 percent.

High-volume sprays greater than 2500 liters/ha are similar to medium-volume sprays except there is runoff of fertilizer solution into the soil at the base of the plant.

Urea is not phytotoxic at concentrations as high as 20 percent when applied to green leaf tissue only. The urea should contain less than 1 percent biuret. Fertilizer solution concentrations should not exceed 1 percent iron sulfate or 0.1 percent zinc sulfate.

Fertilizer regimes. Table 1 shows an example of a fertilizer regime for a plant crop cycle. Fertilizer is ap-