



Avocado Tree Care on Guam

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Contents

Preface	i
Introduction	1
Description	2
Avocado races	2
West Indian race	2
Guatemalan race	2
Mexican race	3
Roots	3
Leaves	3
Flowers	4
Fruit	6
Soil	7
Spacing	7
Windbreaks	7
Multi-purpose windbreaks	7
Federal programs that help establish multi-wurpose windbreaks.....	7
Watering	8
Flower and fruit production	8
Propagating avocado	8
Sexual production	9
Planting a Seed	9
Asexual propagation	9
Grafting	9
Planting a tree	11
Mulching	12
Pruning	12
Common pests of avocado	13
Disease pests	13
Insects and insect-like pests	13
Pollinators	14
Fertilizers	14
Fertilizer application	15
Flower and fruit froblems	18
Reasons for poor or no flowering	18
Reasons for poor fruit production	18
Harvesting, ripening, and storage	19
For more information	19
References	20

Preface

This avocado tree care guide on Guam is a compilation of books and publications that include *Useful Plants of Guam* (1905), *All About Citrus & Subtropical Fruits* (1985), *Fruits of Warm Climates* (1987), *Mango* (1993), *Local Avocado Varieties Mix It Up* (1995), *Compendium of Tropical Fruit Diseases* (1998), *Integrated Pest Management for Avocados* (2003), *Florida's Best Fruiting Plants* (2006), *Growing Tasty Tropical Plants in Any Home, Anywhere* (2010), *Tropical Fruits Volume 1* (2011), *Avocado Production in California* (2012), *Growing Avocados in Ventura County* (2016), and *Avocado Information* (2016).

This first edition guide is tailored for Guam's climate and offers suggestions on choosing what type of avocado(s) you want to grow, the right location to plant the tree, preparing the site for planting and managing the avocado tree for excellent fruit production, and much more. Thanks to James R. Hollyer, Dr. Thomas Marler, and Dr. George C. Wall for their helpful suggestions on this publication. The formatting was done by Emily Shipp and Luke Fernandez, March 2018.

Avocado: *Persea americana* Mill., aguacate, alageta

Size: 30 to 80 ft.

Flowering and fruit production: Flowering (Dec. to Apr.) fruit mature (Apr. to Sept.)

Light: Full sunlight year-round

Soil: Well-drained soil

Spacing: Home landscape: 25 to 30 ft. / Commercially: 20 to 40 ft.

Windbreak: 15 to 20 ft.

Watering: Soil around the tree should be moist, but not wet.

Fertilizing: Trees may require applications of complete fertilizer.

Pruning: Height and width of 10 to 15 ft.

Mulching: Maintain 4 to 6 in. layer of organic mulch placed 2 to 4 in. away from the trunk extending to the edge of the leaf canopy.

Disease pests: Root rot, anthracnose, stem-end rot, scab, fruit rot, and algal leaf spot

Insects and insect-like pests: Mites, thrips, whiteflies, mealybugs, and scales

Introduction

Avocado, known scientifically as *Persea americana* Mill., is native to Mesoamerica and it can be found from the central highlands of Mexico to the rain forests of northwest Colombia. Mesoamerican tribes began gathering and eating wild avocados at least 10,000 years ago and humans have actively cultivated it for 5,000 years. The Spanish probably introduced avocado to the sub-tropical United States of America, Europe, West Indies, and the Pacific from its native range since they were the first Europeans to eat and describe it.

The original Aztec name for the avocado is “ahuacatl”. This name is still used in parts of Mexico where the Aztec language has not been entirely replaced by Spanish who called it “aguacate.” Other common names include midshipman’s butter, vegetable butter, butter pear, and agovago pear. On Guam, it is known as “alageta” in Chamorro which is probably derived from the once common name of “alligator pear” used in the early 1900s.

William E. Safford introduced avocados to Guam in 1899. He was a botanist for the United States Department of Agriculture and served as the Assistant Governor of Guam from 1899 to 1900. Safford wrote the book, *Useful Plants of Guam*, that was published in 1905 and re-published in 2009. The avocado fruit is now highly prized and the tree is found in many home gardens and farms throughout the island.

This avocado tree care guide provides information and steps to grow and maintain a healthy, fruit-producing tree. The first and most crucial step is planning before planting. The planning stage involves determining what type of avocado(s) to grow, choosing the right location to plant the tree, preparing the site for planting, and most importantly, managing the avocado tree after planting. The tree will require proper watering, fertilizing, pruning, and pest management after planting and throughout its entire life. All these practices are essential for the success of the tree during its lifetime.

Description

Avocados are cultivated in tropical and subtropical areas of the world. They have many branches and are long-lived tropical evergreens. Depending on the cultivar, avocados can grow more than 6 feet (ft.) per year and attain heights of 30 to 80 ft. under ideal conditions. On Guam, however, they rarely reach this size because of typhoons and tropical storms.

Avocado races

The avocado, *P. americana*, is subdivided into three botanical races. The races: West Indian, Guatemalan, and Mexican, were domesticated in separate geographic regions of Mesoamerica each having distinguishing characteristics. Because the three races readily cross-pollinate, there are thousands of cultivars and hybrids worldwide and hundreds are propagated in commercial nurseries. A “cultivar” is a plant that is selected and cultivated by humans for its desirable characteristics. A “hybrid” is a plant created from two distinct parent lines that are cross-pollinated by hand to produce offspring with specific characteristics.

West Indian race

The West Indian race is native to the tropical lowlands of Central America, thrives in tropical climates from sea level to 3,300 ft. in altitude, and generally produces flowers from February to March. The skin of the fruit is thin to medium in thickness, shiny, leathery, non-granular or smooth textured, and are usually pear-shaped or oblong. Their fruit generally has a low (2 to 5%) oil content, is higher in sugar content than the other races, and has somewhat of a watery taste. It weighs between 1.0 to 5.0 pound (lbs.), and takes 5 to 8 months to mature.

Guatemalan race

The Guatemalan race of avocado is native to the tropical highlands of Central America, thrives in subtropical climates from 3,300 ft. to 6,600 ft., and generally produces flowers from March to April. The skin can be thin or thick, usually gritty or granular, and breaks easily when peeled by hand. Fruit from this race is usually round, and has a medium to high (9 to 30%) oil content. It has a rich nutty taste, weighs between 0.5 to 5.0 lbs., and takes 10 to 15 months to mature.

Mexican race

The Mexican race of avocado is native to the highlands of Central America and thrives in semi-tropical climates from 4,900 ft. to 9,850 ft., and generally produces flowers from January to February. The skin is thin, delicate, papery-smooth, tears easily during shipping or handling, and the color varies from dark green to deep purple. Fruit from this race generally has a medium to high oil content (9 to 30%). It has a rich nutty taste, weighs less than 1 lb., and takes 6 to 8 months to mature.

Roots

Avocado trees have a very aggressive shallow root system with 60% of its roots located in the upper 3 inches (in.) of soil and can raise pavement if planted too close to a paved area. Their fibrous feeder roots that develop near the surface of the soil absorb water, food, and air. Healthy roots usually extend beyond the leaf canopy of the tree, offer support, anchorage, and provide nutrients for proper growth.

Leaves

The new set (flush) of leaves can be reddish colored when young, but as they mature become dark green (Fig. 1). The leaves are 3 to 16 in. in length and can vary in shape. Mexican, and most Mexican hybrids, have a characteristic anise smell leaf scent when crushed; whereas, West Indian and Guatemalan races do not.



Figure 1. New avocado leaves.

Flowers

All races of avocados generally bloom from December to April on Guam. The flowers grow on loose branching clusters called a panicle (Fig. 2). They produce complete flowers that are made up of functional male stamens (Fig. 3) and female stigma parts (Fig. 4) in the one flower.



Figure 2. Avocado panicle.



Figure 3. Male flower found on a panicle.



Figure 4. Female flower found on a panicle.

Avocados are classified into A and B types according to the time of day when the female and male flower parts become reproductively functional (Fig. 5). The A-type opens as a female in the morning of the first day, closes in the afternoon and stays closed until the next afternoon when it





Flower Cycle	
MORNING	AFTERNOON
<p>A Type Female</p> 	<p>A Type Male</p> 
<p>B Type Male</p> 	<p>B Type Female</p> 

Figure 5. Avocado flower cycle.

opens as a male. In contrast, the B-type opens as a female in the afternoon of the first day, closes in the late afternoon and stays closed until the next morning when it opens as a male (Fig. 5). Cross-pollination between A and B types of avocados, which is not always necessary, enhances pollination and ensures good fruit set.

Fruit

An avocado fruit is a berry, consisting of a single large seed that is surrounded by bright green to rich-yellow colored flesh. The flesh texture is smooth and the flavor can be creamy, buttery, watery, or bland, with a nutlike flavor and smell. The skin is variable in thickness and texture, and typical mature fruit skin colors include yellow-green, deep-green, dark-green, reddish- purple, and a dark-purple almost appearing black, depending on its variety. Fruit shape ranges from round to pear-shaped, and the fruit weight varies from a few ounces (oz.) to 5 lbs. Even though the color, odor, and shape of a particular variety may be nearly identical, some characteristics such as thickness of the peel, size of the seed, diameter of the fruit flesh, overall size of the fruit, and taste may vary (Fig. 6).



Figure 6. Avocado fruit from different cultivars.

Soil

Avocado plants tolerate and produce satisfactory yields in a variety of soil types that drain well. Healthy roots require a lot of air or oxygen, and do not like flooding or poorly drained soils. Avocados grown in soil that is wet and soggy for long periods of time often have decreased growth, nutrient deficiencies, dieback, root rot, and even tree death. Avocado trees are also very sensitive to sodium and chloride salt accumulations caused by excess fertilizer applications in the soil. The tips and margins of leaves burn and leaves may drop off under these conditions.

Spacing

In a home landscape, plant a seedling or tree at least 25 to 30 ft. away from buildings, concrete sidewalks, power lines, near overhead or underground utilities or other trees. Commercially, tree spacing may be 20 to 40 ft. between trees but may vary depending on variety and soil conditions. For windbreak purposes space trees 15 to 20 ft.

Windbreaks

Windbreaks are barriers that reduce or redirect wind that enter a specific area. They usually consist of rows or multiple rows of trees, shrubs, or grasses that are strategically planted to form vegetative filters to slow damaging winds. The barriers create sheltered zones that improve crop and livestock production and soil and water conservation.

Multi-purpose windbreaks

Traditional windbreak plants are chosen for their fast, flexible, long-lived, upright growth habits, and adaptability to the growing conditions of the site. Multi-purpose windbreaks are also chosen for the qualities listed above, as well as providing an alternative product and income from the fruit, timber, and nut trees. Avocado trees are ideal multi-purpose windbreaks for commercial farms because they grow tall relatively fast, perform well in Guam's soils, and generate a crop of avocado fruit.

Federal programs that help establish multi-purpose windbreaks

WindbreaksThe United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) currently offers the Environmental Quality Incentive Program (EQIP) that may help to reimburse agriculture producers the cost of implementing approved conservation practices, such

as propagating fruit plants and planting labor. Avocado, breadfruit, mango, and soursop trees are a few of the many fruit trees approved for multi-purpose windbreaks under EQIP. For more information on multi-purpose windbreak species please see url http://cnas-re.uog.edu/wp-content/uploads/2017/11/Windbreaks_6_21_2017-1.pdf and contact the Guam NRCS office at (671) 300-8591 for EQIP <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/>.

Watering

Newly planted avocado trees should be watered at planting, every other day for the first week, and two times a week until rainfall is sufficient. Small trees need about 0.5 in. of rain every 3 to 4 days. If no rain has fallen during that period, the tree will need to be watered. Established juvenile plants need infrequent, deep watering during dry periods. For established mature trees, supplemental irrigation is recommended from flowering, throughout fruit development, and during extended dry periods.

Flower and fruit production

Avocados bloom from December to April on Guam, which is generally the driest and coolest time of the year. The dry cool weather helps with good flower and fruit “set” and decreases the amount of fungal disease during development.

A mature avocado tree has the ability to produce up to 1 million flowers when in bloom, but only 100 to 200 flowers on average set fruit and mature to harvest. The fruit yield from a tree depends on its variety, spacing, age of the tree, soil fertility, and weather. In some parts of the world avocados can produce 200 to 500 fruits/tree. However, on a good year in Guam each avocado tree bears an average of 100 to 200 fruits.

Propagating avocados

Avocados are propagated sexually (by seed) or asexually (grafting). Starting a plant from seed is much easier than grafting but the seedling will most likely not be exactly like the mother plant because of the pollination and fertilization process. Seedlings may also take 10 years to bear fruit with some trees never bearing fruit at all. A plant propagated asexually, however, will bear fruit in 3 to 5 years and the plant will be true-to-type, or a “clone” of the mother plant.

Sexual production

Planting avocado from seed is very common on Guam. The disadvantage, however, is that seeds are not true-to-type. The new plant produced from seed is usually a combination of traits contributed from two different trees. The effects are not seen until the seeds eventually become mature plants and produce fruits.

Planting a seed

After eating the flesh of an avocado, remove the seed, peel off the thin brown seed coat that surrounds it, and rinse the exposed seed. It is highly recommended that an avocado seed is planted in a potting mix and container that drain well. Using a 2 to 3 gallon pot will prevent the plant from becoming root bound. When planting, the seed should be oriented with the broad side (flat end) facing down and the sharp side (pointed end) facing up. The pointed end should be planted so that 25% to 50% of the seed is exposed to ensure proper germination. Fresh avocado seeds usually take 3 to 5 weeks to germinate.

Asexual propagation

When propagating avocados asexually, the identical variety as the mother plant will be produced. The most common way to asexually propagate avocados is grafting.

Grafting

Grafting involves the union of a detached healthy bud or shoot (scion) from the branch of a desired mature plant with a healthy seedling (rootstock) or a trunk of a mature tree (top working). Generally, the upper portion of the rootstock is removed completely and is replaced with the scion. Seedlings that are grafted can produce avocado fruits in as little as 3 to 5 years. Two of the easiest ways to graft avocado are wedge grafting (Fig. 7) and side approach grafting (Fig. 8). When grafting, a very sharp knife should be used to make clean cuts of the scion and rootstock.

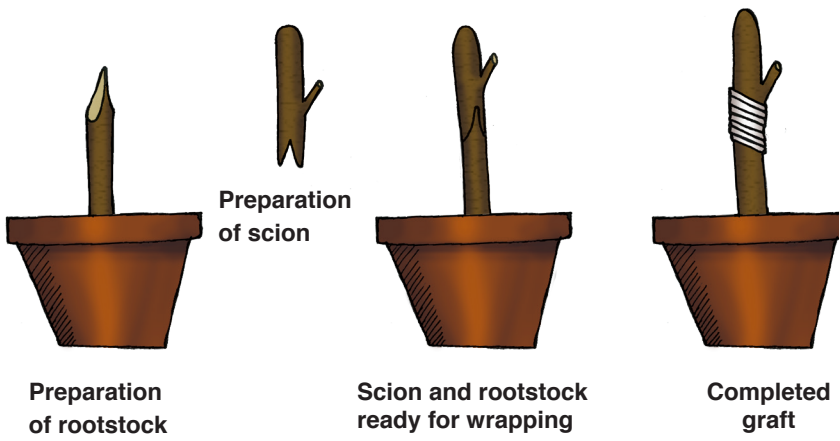


Figure 7. Wedge graft.



Figure 8. Side approach graft.

Planting a tree

Planting a young avocado tree properly will provide the tree with what it needs to grow rapidly and establish a strong canopy. It is highly recommended that avocado seeds are initially planted in a pot rather than directly into the soil. After the plant has reached a height of 2 to 4 ft., it should be transplanted into the soil in an area where the plant will receive full sunlight. The planting hole should be at least twice the diameter of the pot (Fig. 9). The depth of the hole should be no deeper than the size of the rootball. It is not necessary to add fertilizer before the plant is placed in the hole. After transplanting, fill the hole with excavated soil until the top of the rootball is even with the existing soil line and lightly tamp down to remove air pockets in the soil (Fig. 9). Water the plant thoroughly after

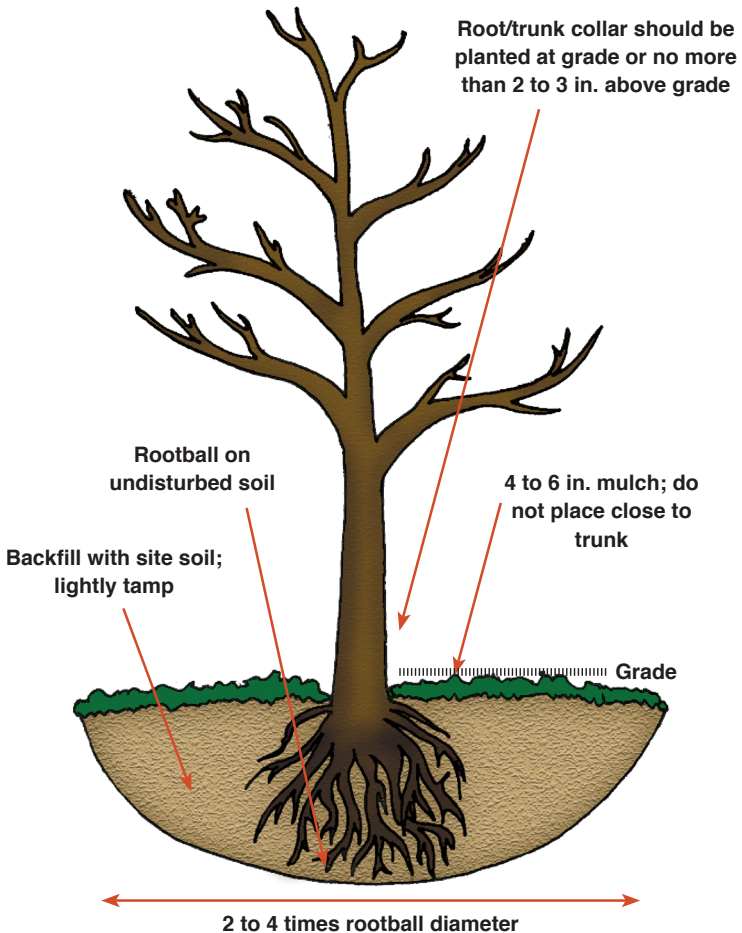


Figure 9. Planting an avocado tree.

transplanting. Preferably, the transplant should be planted at the beginning or during Guam's rainy season (July through November) to take advantage of the abundant rainfall.

Avoid planting in low lying areas so the tree will not be growing in standing water. If there is a potential for excessively wet or flooded soil conditions plant on a large hill or mound made up of native soil, 2 to 4 ft. high by 4 to 10 ft. in diameter. Follow the same directions as above for planting in the mound.

Mulching

Mulch is used to conserve soil moisture, suppress weed growth, and reduce or stop plant damage caused by lawn equipment. It also can reduce soilborne pathogens causing plant diseases that can splash on leaves during watering or rain.

Organic mulch occurs naturally in undisturbed jungles and forests when leaves, twigs, and branches drop onto the soil. In addition to the benefits listed above, organic mulch slowly releases nutrients as it decomposes, increases beneficial soil micro-organism interactions, prevents soil compaction, and improves the physical characteristics of the soil as it breaks down. Organic material such as grass clippings and small leaves should be replaced every few months while wood chips and palm fronds can last up to a year when used in landscapes and orchards.

Avocados are shallow rooting plants, so maintaining organic mulch around trees is beneficial. The roots function and develop best when protected by a 4 to 6 in. layer of undisturbed mulch kept 2 to 4 in. away from the trunk extending to the circumference of the edge of the leaf canopy.

Pruning

An avocado tree is usually not pruned when growing. However, selective pruning or training of limbs at a young age will help develop a strong manageable canopy height and width for avocado trees grown in a home landscape or orchard. Yearly pruning maintenance after fruit harvest will also improve avocado tree health by allowing air and sunlight to penetrate into the canopy, reduce pest and disease problems, and allow for easier fruit harvesting. In some cases, it is best to keep trees low and compact to reduce wind damage since their branches are easily broken by strong winds

or heavy crop loads. Severe pruning is sometimes necessary to maintain an ideal tree height of 10 to 15 ft. Avocado trees usually respond well to canopy reduction, but the setback is the loss of flower and fruit production for one to several seasons. (See the CNAS publication “*Pruning of Trees and Shrubs on Guam*” in the Reference Section.)

Common pests of avocado

There are numerous pests of avocado but only a few cause significant damage. Pests such as insects and diseases that cause significant damage are called “economic” pests. If the damage caused by a pest reduces a plant’s potential production by an amount greater than the cost of treatment it is considered an “economic” pest. In this section, only those diseases and insect pests of avocado having economic significance are discussed.

Disease pests

University of Guam’s College of Natural & Applied Sciences (CNAS) plant pathologists have reported many different diseases of avocado on island. The fungal disease called avocado root rot known scientifically as *Phytophthora cinnamomi* is by far the most economically important disease affecting avocados on Guam. Root rot affects avocados at all stages of growth and thrives in areas of excess soil moisture and poor drainage, thus it is best not to plant in low-lying areas. It can easily be spread by contaminated plants, equipment, shoes, and soil. Anthracnose, stem-end rot, scab, *Phytophthora* fruit rot and algal leaf spot/lichens infect avocado plants but are not economic pests to date.

Insects and insect-like pests

Many insect pests of avocado have been reported on island by CNAS entomologists. Some insects cause relatively minor damage; whereas, others can severely reduce yield. Many insects that attack avocado can be found attacking other plants, as well. Insects and insect-like pests that cause significant damage to avocado include aphids, mealybugs, mites, scales, thrips, and whiteflies.

Pollinator

During flowering time (December to April), flies (Fig. 10), bees and other insects visit avocado flowers and help with pollination, which is necessary for fruit production. If certain insecticides are sprayed on the tree, these beneficial pollinators may die and fruit production can be decreased. Therefore, use pesticides thoughtfully and only as needed.



Figure 10. Fly pollinator.

Fertilizers

Most fruit trees can survive in Guam's soil types and terrain without additional fertilization. However, avocado trees, as well as some other plants, generally need a complete fertilizer to maintain or improve the health of the tree, enhance growth, increase yields, and reduce pest problems.

The application of fertilizer varies with the age of the tree and the type and condition of the soil. Young non-bearing and fruit-bearing trees require some type of complete fertilizer, such as 16-16-16, 10-20-20, or 10-30-10 on a regular basis. A "complete" fertilizer is one that has all three primary elements nitrogen (N), phosphorus (P), and potassium (K).

The numbers on the fertilizer bag represent the content of the primary nutrients: % nitrogen, % P_2O_5 (available phosphate), and % K_2O (soluble potash), respectively on a percentage basis. All are needed for healthy, productive avocado trees. For example, a 30 lbs bag of a 10-20-20 complete fertilizer contains 3 lbs N (10% x 30 lbs), 6 lbs P_2O_5 (20% x 30 lbs), and 6 lbs K_2O (20% x 30 lbs) (Fig. 11). The remaining contents are generally inert materials and sometimes include other secondary and trace elements used by plants.



Figure 11. Bag of a complete fertilizer.

Do not use a complete fertilizer that has a *higher* percentage of nitrogen than phosphorus and potassium for fruit trees because nitrogen encourages leaf growth at the expense of fruit and root production. Fertilizers high in N are generally recommended for use on leafy crops, such as leafy greens and green herbs.

Fertilizer application

Table 1 shows how much complete fertilizer to apply to young, non-bearing avocado trees and Table 2 shows how much complete fertilizer to apply to avocado trees that are bearing fruit.

Table 1. Fertilizer program for a young avocado tree.

Year	Times/ Year	Amount per Tree Application (lbs) 10-20-20	Amount per Tree Application (lbs) 16-16-16
1	6	0.50 lbs 3.0 lbs/year	0.25 lbs 1.5 lbs/year
2	6	1.0 lbs 6.0 lbs/year	0.50 lbs 3.0 lbs/year
3	6	1.50 lbs 9.0 lbs/year	0.75 lbs 4.5 lbs/year
4	4	2.5 lbs 10 lbs/year	1.25 lbs 5.0 lbs/year
5	4	3.0 lbs 12.0 lbs/year	1.50 lbs 6.0 lbs/year
6	4	3.5 lbs 14.0 lbs/year	1.75 lbs 7.0 lbs/year

Table 2. Fertilizer program for bearing avocado trees. Apply 1/2 pound of (10-20-20) or 1/4 pound of (16-16-16) complete fertilizer per foot of tree canopy diameter per year.

Time of Application	Amount per 20' Tree Canopy 10-20-20	Amount per 20' Tree Canopy 16-16-16	Amount per 30' Tree Canopy 10-20-20	Amount per 30' Tree Canopy 16-16-16	Amount per 40' Tree Canopy 10-20-20	Amount per 40' Tree Canopy 16-16-16
After harvesting all fruit apply 1/2 the amount of fertilizer for the year	5.0 lbs	2.5 lbs	7.5 lbs	3.8 lbs	10.0 lbs	5.0 lbs
Apply 1/4 of the amount of fertilizer two months later	2.5 lbs	1.25 lbs	3.8 lbs	1.9 lbs	5.0 lbs	2.5 lbs
Apply 1/4 of the amount of fertilizer two months later	2.5 lbs	1.25 lbs	3.8 lbs	1.9 lbs	5.0 lbs	2.5 lbs
Total	10.0 lbs yearly	5.0 lbs yearly	15.1 lbs yearly	7.6 lbs yearly	20.0 lbs yearly	10.0 lbs yearly

Application of fertilizer for existing avocado trees may be done either topically or as in-ground spot applications. Topical applications involve the even distribution of fertilizer on the soil surface under the tree canopy and away from the main tree trunk. Preferably, concentrate the application of fertilizer within the circumference of the edge of the leaf canopy or “dripline” (Fig. 12).

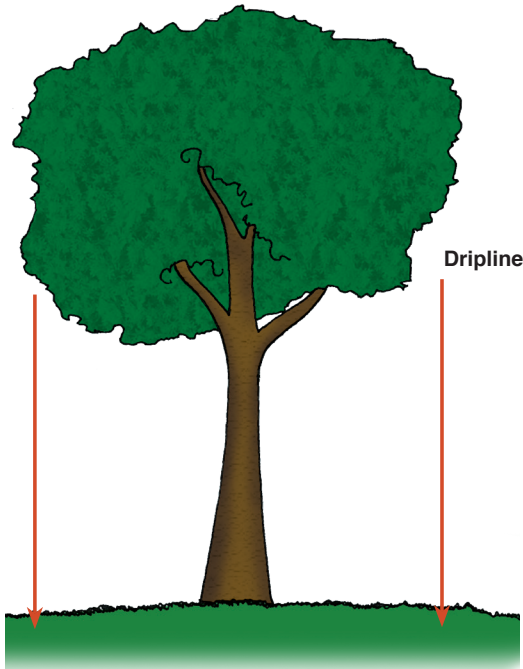


Figure 12. Tree dripline.

It is advisable to water fertilizer in thoroughly after it is applied to get the nutrients into the soil as soon as possible so they are not lost into the atmosphere or allowed to run off in a heavy rain. For medium to large size avocado trees apply the fertilizer 1 ft. toward the tree trunk from the dripline in a circular (band) fashion.

In-ground spot applications of fertilizer involves digging numerous holes 2 to 3 ft. apart along the dripline. Deposit about 1 to 2 tablespoons of fertilizer per hole, cover with soil and water moderately. Spot application, while it requires more work, makes more efficient use of the fertilizer. In-ground spot applications have less chance of fertilizer loss, especially nitrogen. The fertilizer should be covered up with soil promptly and watered in.

Flower and fruit problems

The production of flowers on an avocado tree is necessary for consistent fruit production. Reasons for poor flowering and fruit production are listed below.

Reasons for poor or no flowering

1. The tree may be too young to flower. Trees grown from seed may take 10 to 12 years before they have the ability to flower; whereas, grafted trees usually take 3 to 5 years to flower under normal conditions.
2. The tree may be out of season. Avocado trees flower from December to April on Guam.
3. The variety may be poorly adapted to Guam. Many avocado varieties have specific requirements for flowering naturally.
4. The flowers on the tree may need to be pollinated. Having both A and B type avocado trees may enhance pollination.
5. The tree may have had excessive vegetative growth prior to the flowering season. This can be caused by too much nitrogen from fertilizing, new organic matter added to the soil, typhoon damage, and excessive pruning of the tree canopy.

Reasons for poor fruit production

1. Poor flowering.
2. Poor fruit set from poor pollination or other reasons.
3. Disease or insect damage.
4. Poor nutrition of the tree.
5. Drought stress.

6. Unfavorable weather such as heavy rain, high winds or a typhoon at the time of flowering and when the fruits are small, will cause poor fruit production.
7. Biennial (flowers every other year) or erratic bearing. Avocado trees are prone to erratic or biennial bearing if they are not fertilized and watered properly.
8. Too much shade. Avocado trees require full sun for optimum fruit production.

Harvest, ripening, and storage

Depending on the variety, it takes 5 to 15 months for the fruit to mature after flowering. The fruits are considered mature for harvest when they reach a specified calendar date, color, weight, and size.

Avocado fruits do not ripen on the tree, they must be picked. When mature, avocados may be harvested at anytime. The easiest way to determine if the avocados are ready to harvest is to pick one large fruit and place it on the kitchen counter top or in a paper bag or box. A mature fruit ripens in 3 to 8 days after it is picked. If the fruit starts to shrivel, becomes rubbery or begins to rot before ripening properly, select another large fruit and start the observation again.

Because avocado fruit does not ripen until it is picked, leave the fruit on the tree and pick fruit when ready to eat it, remembering that it takes 3 to 8 days to ripen after harvest. But as the season progresses the fruit will eventually fall due to weather conditions. After fruit ripen they may be stored in the refrigerator for a few days before eating.

For more information

For more information regarding avocados contact the College of Natural & Applied Sciences, Cooperative Extension & Outreach at the University of Guam at 735-2080.

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