



*WHY PAPAYA TREES
FAIL TO FRUIT*

W. B. STOREY

Cooperative Extension Service
University of Hawaii
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Hardly a week goes by without someone, usually a home gardener but occasionally a farmer, calling the Horticulture Department to find out why his papaya trees are not producing any fruit. Investigations of numerous inquiries have shown that failure of trees to fruit at all, cessation of fruiting on apparently healthy trees, and decline of trees which have been bearing may be due to any one of a number of causes.

The cause of unfruitfulness may be either something inherent in the trees themselves or unsuitable cultural conditions. The principal causes are discussed briefly below. The first three may be called hereditary causes, because they result from the nature of the trees themselves and not from anything which can be controlled by proper culture. The rest of them may be called environmental causes, because they result from lack of suitable culture.

1. TREE IS FEMALE. This has turned out to be the most common cause for complaint for trees which are healthy and vigorous and flowering profusely but fail to set a single fruit.

The female is a unisexual tree; that is, it produces flowers which have well-developed functional ovaries but no stamens. Consequently, they produce no pollen and are entirely dependent upon the presence of nearby male or bisexual trees for pollination and fruit setting. The female is easily recognized by the flowers, which are rather large, having a fairly large, roundish pistil, no stamens, and five petals that are entirely separate from each other. This kind of tree is shown in figure 1.

When the flowers have not been pollinated, the pistils fail to develop beyond the size of a walnut in the week or two after opening. Then they begin to turn from green to yellow, usually with the development of a characteristic broad, brown band around the equatorial portion, and soon fall from the tree.

As may be judged by relative sizes of the pistils and by the blank spaces at the bases of some of the leaves on the tree in figure 1, not all the flowers were pollinated. An occasional fruit is setting, because the flower was pollinated by wind or by insects with pollen from bisexual trees which were growing a short distance away.

One of every three trees of the Solo papaya is female, so the best solution to the problem is to plant two seedlings at each place where one is wanted. The females can be recognized by their flowers when the young trees begin to blossom and can then be eliminated, leaving only the bisexuals, which are productive because they are self-pollinating. The only other alternative, if one wishes to have females fruit when there are no male plants nearby, is to pollinate the flowers by hand with

pollen taken from opening flower buds from male or bisexual trees. Bisexual trees, even when growing nearby, are not very good pollinators of females.

2. **TREE IS MALE.** Male trees are comparatively rare and are becoming rarer all the time, but occasionally one does show up in a planting. The male has been bred out of Solo, and when one appears it usually has come from using seed from a fruit which was set by pollen from a nearby male tree.

The characteristics of the male tree (figure 2) are the opposite of those of the female. Its flowers have 10 functional stamens but no well-developed pistil. The pistil is present only as a little, rudimentary structure incapable of developing into a fruit. However, an exceptional male will occasionally produce a few flowers having functional pistils which develop into fruits, but most males do not.

The male is easily recognized by its long, pendant clusters of small, trumpet-shaped flowers. If a young tree at first flowering has flower clusters over 8 inches long, the chances are it is a male.

One need not have male trees in his planting if he secures seed from bisexual fruits grown on plantations or in back yards with no male trees nearby. If there are male trees fairly close by, one should bag mature buds on desirable bisexual trees and leave the bags in place for at least 3 weeks after flowering.

Male trees may be left in place to pollinate female trees, but if one wishes to keep his strain of Solo pure, he should take no seed from either females or open-pollinated bisexuals for further planting.



Figure 1. Female tree. Most young fruit shown will drop from lack of pollination.



Figure 2. Male tree showing long, pendulous flower clusters.

3. TREE IS A SUMMER-STERILE BISEXUAL. Some forms of bisexual trees characteristically go sterile during the warmer months, usually from July to December. At this time the pistils fail to develop and become functional, so the tree is essentially male. During the winter and spring months, the pistils develop normally. The result is alternating fruitfulness and barrenness (figure 3), with the trees ripening a crop in the summer and fall months and standing barren during the winter and spring months.

The best remedy for this sort of behavior is to obtain seed for planting only from trees known to be fruitful throughout the year.

4. INSUFFICIENT WATER. The papaya tree needs an adequate supply of moisture in the soil to keep it growing vigorously all the time. If the amount of rainfall or of water given in irrigations is insufficient, the tree may cease flowering altogether. All but the uppermost leaves usually fall, and the trunk grows thinner and thinner at the top (figure 4). In time it may lose all its leaves and stop growing entirely.

With inadequate soil moisture, the tree cannot absorb enough water and the mineral nutrients dissolved in it, for good growth. With prolonged dryness, much of the root system may die, carrying the rest of the tree with it. The preventive is to keep the tree amply supplied with water at all times.

The symptoms which characterize insufficient water are similar to those from other causes which affect the root system adversely.

5. LACK OF NUTRIENTS. If a tree is growing in an apparently suitable soil, is being given sufficient water, but still looks and behaves like the tree in figure 4, lack of a sufficient supply of available nutrients in the soil may be the answer. It may simply be starving to death.

Applications of a complete fertilizer at the rate of about $\frac{1}{2}$ pound every 3 or 4 months in the first year and $1\frac{1}{2}$ -2 pounds at the same intervals in the second year should prove helpful.

Fertilizer and water go together, as a tree needs sufficient water all the time to make efficient use of the fertilizer.

6. POOR SOIL AERATION. Some of the past work of the Station has indicated that the papaya grows well only in well-aerated soils. In a field terraced for soil conservation at Poamoho Experimental Farm, trees at the outer edge of a terrace grew well while those at the bottom of the terrace where much of the topsoil had been scraped away grew poorly. All trees were given the same amount of water and fertilizer, so the inference was drawn that the poor trees were on a poorly aerated subsoil.

The symptoms of poor aeration are somewhat like those of insufficient water. Usually, however, the trees start off with spindly growth and never improve.

The only recommendation that can be made at this time is to avoid heavy-textured poorly drained soils in planting. The use of the so-called soil conditioners like krilium, prior to planting, may offer a solution, but their possibilities have not as yet been explored with regard to papaya growing.

7. POOR DRAINAGE. This is a common cause of papaya trees dying out. The early symptoms are similar to those of other causes where the root system is damaged.

A papaya tree will not stand waterlogged soils very long. Water standing around a tree for no longer than 24 hours may be enough to kill it, possibly

through drowning of the roots from lack of sufficient air or possibly also from making them susceptible to attack by soil-fungus diseases.

Preferably, papayas should not be grown on heavy, poorly drained soils. If they are so grown, they should be watered only enough to keep them growing well, with no water standing around them very long.

8. DISEASES. ROOT DISEASES. The effect of root diseases is like that of other environmental factors. Additionally, the tree may rot at the base near or beneath the ground and is easily pushed over. Root diseases are usually serious only in heavy, poorly drained soils, or in areas of fairly heavy rainfall, especially in the winter season.

Little is known yet about the best methods of combatting root diseases. It is best to select as sunny a site as possible on the best-drained soil available and avoid overwatering.

STEM AND LEAF DISEASES. The principal stem and leaf diseases which cause papaya trees to decline are phytophthora rot and powdery mildew.

Phytophthora rot exhibits symptoms comparable to malnutrition. The disease may start as a dark, soft blotch anywhere on the trunk, but usually just at the surface of the ground. Fortunately, it is not usually encountered except at times of heavy rainfall or high humidity and generally only in cool, shady localities, as no satisfactory means of control is known. If an initial attack is fairly high on the trunk, the tree may be cut off well below the point of infection, and often healthy branches will arise so that the tree can be saved.



Figure 3. Summer-sterile hermaphrodite. Note abrupt cessation of fruit setting.



Figure 4. Hermaphrodite tree showing cessation of fruit setting because of poor cultural conditions.

Mildew usually causes yellowing and premature dropping of all but the uppermost leaves. It is readily detected by numerous mouldy patches and what looks like fine webbing on the undersides of the leaves. It is generally worst during rainy or humid weather.

Mildew can be effectively controlled with the use of wettable sulfur (about 4 tablespoons to a gallon of water or 5 pounds to 100 gallons). In these concentrations it does not injure the trees, so it is well to spray the trees periodically every 3 or 4 weeks. As will be noted later, sulfur is also effective in controlling mites, so periodic spraying does double duty.

Some of the copper fungicides are also effective in controlling mildew, but the effect of a number of them on the tree itself is still an unknown quantity. It is known that Bordeaux mixture injures papaya trees and, therefore, should not be used.

9. MITE AND INSECT DAMAGE. Mites and insects can cause papaya trees to decline as effectively as lack of water or nutrients, and the symptoms are somewhat similar. Often the leaves become yellow and fall prematurely and, in cases of severe infestation, may become distorted in appearance. If there is fruit on the tree, it may exude latex which collects in clumps on the surface, or become scarred or scaly in appearance.

The worst offenders are the privet mite, the broad mite, and the common red spider. The privet and broad mites can be controlled with the use of wettable sulfur at the concentration recommended for mildew. The red spider is not controlled by sulfur. It can be controlled, however, by spraying the trees with aramite at the rate of 1 pound of the 15 percent wettable powder to 100 gallons of water or 1 tablespoon to a gallon of water. This material may cause some burning of young leaves, so care should be taken to avoid overdosing. Mite infestations are usually worst in dry weather.

10. SETBACK BY CHEMICALS. It has been mentioned that oil sprays and Bordeaux mixture may injure papaya trees and, therefore, should not be used. They tend to produce the effect of burning the leaves and flowers which sets the trees back.

Some of the chemical weed killers which are not released for use in papaya orchards such as 2, 4-D, CMU, TCA, pentachlorophenol, and arsenicals affect growth adversely if they get on the trunk or leaves. Essentially, the papaya tree is nothing more than a giant herb and should be treated as such. Some materials such as 2, 4-D may be absorbed through the roots and cause damage to the tree even when used some distance away.

The symptoms of poisoning by 2, 4-D are a decrease in the size of the top of the trunk and serious distortion of the leaves. If the action of the chemical is not prolonged, the tree may recover, but the crop is usually lost during the period of distress. Prolonged action will in time kill the trees. Decline of trees from this cause is found fairly commonly in home garden plantings where herbicides containing 2, 4-D are used to control weeds.

The other chemical weed killers may cause slow to rapid death for no apparent reason. One can only be warned to exercise caution in the use of herbicides around papaya trees, avoiding particularly those containing 2, 4-D, CMU, and TCA.

11. OTHER CAUSES. In addition to the causes of unfruitfulness and decline of papaya trees discussed above, there are a number of lesser causes which occasionally

are encountered. Among these are the growing of trees in places too shady for good growth, infection by papaya mosaic and papaya ringspot virus diseases, and invasion of the roots by nematodes.

Plants growing in places which are too shady, such as among other plants, near high hedges, or close to a house, tend to grow tall and spindling and fail to flower until their heads have gotten up into the light. The papaya grows best out in full sunlight.

The symptoms of papaya mosaic are a rather rapid diminishing in size of the topmost leaves of the tree and reduction in size of the stem, usually with some bending of the top. The leaves become yellow and tend to bend downward. The leaf stalks have slightly raised streaks, or "oil spots," which have a water-soaked appearance.

Papaya mosaic is widespread on Oahu. Plants may be affected at any age, and the disease seems to move only upward from the point of initial infection. Young and old plants are best pulled out and replaced by new plants.

Papaya ringspot causes yellowing of the younger leaves, with a tendency for the areas between the veinlets of the blade to pucker upward. Mature green fruits show characteristic yellowish rings with green centers over the surface of the skin.

Papaya ringspot may affect the growth of a tree and cause noticeable reduction in fruit setting, especially if the tree became infected before maturity.

Papaya ringspot is known to be transmitted from tree to tree by insects, principally the green peach aphid as well as by mechanical means. It is not transmitted through seeds. Control by roguing is the best way to control spread of the disease. Seedling trees should not be taken from an area where the disease is known to be present for planting elsewhere.

Nematodes have been found to cause severe galling of papaya tree roots. They undoubtedly do some damage, but the effect upon growth and yield has not been evaluated.

It is perhaps worth remarking that unfruitfulness or decline of papaya trees may be due not to any single cause mentioned but to a combination of several of them. Papaya trees may be expected to perform at their best if the seedlings planted come from a bisexual strain known to be fruitful, are planted in a sunny location with suitable soil, are given adequate supplies of water and fertilizer at all times, and are sprayed against insects and diseases periodically as a preventive measure rather than after damage has become apparent.

If help or advice is needed, contact the county agent at the University of Hawaii Agricultural Extension Service office nearest you.

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