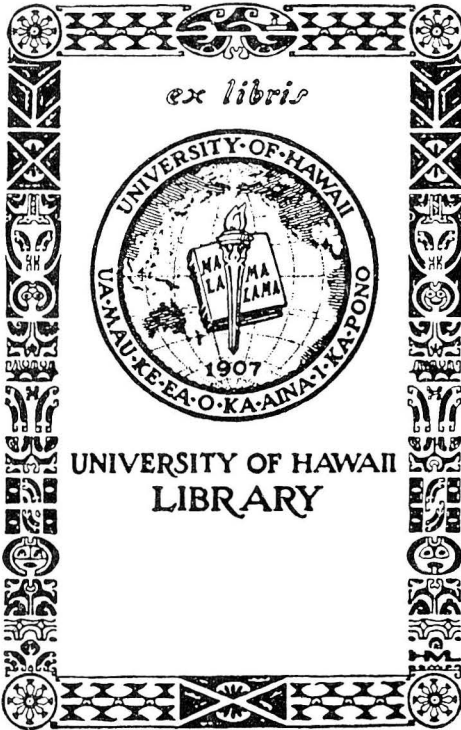


PLUM  
CULTURE  
IN HAWAII

Warren Yee  
and  
Daniel Shigeta

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## ACKNOWLEDGMENTS

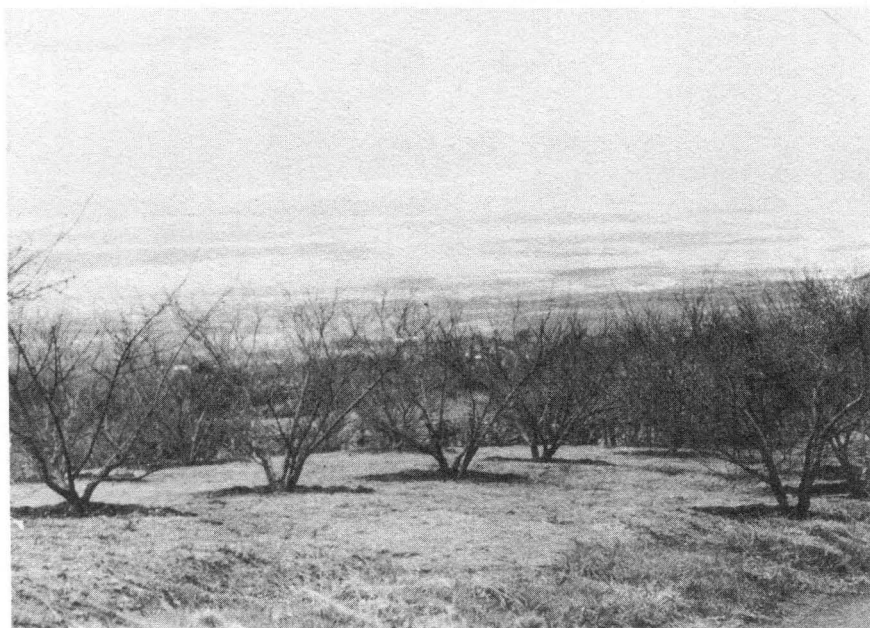
*The authors wish to express their deepest appreciation to L. W. Bryan for his numerous comments on plum introductions and his suggestions based on his experience with them in Hawaii. Thanks are due to N. Ambrose, Kazuo Maruyama, John Hashimoto, and James Yokoyama for going over the material and adding their suggestions to the circular. The assistance of George Aoki of the Cooperative Extension Service and Richard A. Hamilton, Toshio Murashige, Robert Raabe, and Frank Haramoto of the Hawaii Agricultural Experiment Station, and others of the College of Tropical Agriculture is appreciated. The information on plums from Claran O. Hesse and A. D. Rizzi of the University of California was very helpful in evaluating the varieties in Hawaii.*

# PLUM CULTURE IN HAWAII

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*Fig. 1. A plum orchard in Kula, Maui, at a 2,700-foot elevation. Photograph taken in February.*

### **PLUM CULTURE IN HAWAII**

The cultivation of temperate or deciduous fruit trees in Hawaii is of minor importance. Production is limited to the higher elevations of the islands. Areas with temperate fruit plantings include Kokee on Kauai; Kula and Polipoli Springs on Maui; and the Volcano, Kona, and Keana-kolu areas on Hawaii. These areas are all above 2,700 feet in elevation. The plum is grown under a wide range of rainfall varying from about 32 inches in Kula, Maui, to more than 90 inches in the Volcano district, Hawaii.

Plums, apples, peaches, and persimmons are the more important temperate fruits produced in the State. Of these, the plum is the most widely cultivated. The plum and the persimmon are the only locally produced deciduous fruits sold through regular marketing channels. However, the quantity marketed is small. An estimated 300 acres is in plums, mostly in government orchards and backyard plantings (*Fig. 1*).



Fig. 2a. A typical plum tree of the Methley variety, the most widely grown in the State.

### Varieties

Plums grown successfully in Hawaii are known as Japanese plums, *Prunus salicina* (*p. triflora*), or hybrids of this species. *P. salicina* is indigenous to China but came into the United States via Japan. The Japanese varieties normally have leaves with a glossy upper surface and a smooth and dull lower surface. The fruit is usually red or yellow.

The most widely known plum in Hawaii is the Methley plum (*P. salicina* x *P. cerasifera*) of South African origin. It is often mistakenly called the Sugar Plum, which is a European variety. It was introduced in 1926 when Dr. Harold Lyon received 5 different varieties grafted on Indian Blood peach stocks from the U. S. Department of Agriculture's Bureau of Plant Industry in Chico, California. Among them was the Methley, as well as Alpha and Sharps Early. All the introduced varieties were planted on June 13, 1926, at the Hawaiian Sugar Planters' Association station in Nauhi Gulch on the slopes of Mauna Kea at a 5,100-foot elevation.



*Fig. 2b. Methley plum flowers in late February. It is usually the first variety to flower.*

Many plum varieties came to Hawaii from California. Some of these have not grown and fruited well. The lack of cold temperatures and inadequate chilling periods in the islands have limited the number of varieties that can be grown successfully. Eldorado, Elephant Heart, and Duarte are the Japanese varieties that have not done well under the climatic conditions of areas where they were grown. On the other hand, Hollywood, Becky Smith, Beauty, Mariposa, Satsuma, Santa Rosa, Kelsey, Burmosa, and Sierra have performed better at elevations of 2,700 to 3,500 feet. Of these, the Kelsey plum has been most widely accepted. Santa Rosa is also grown extensively but has not performed as well as the Kelsey. Sierra is the newest of the introductions that show promise. At Keanakolu, Hawaii, at an elevation of 5,000 feet, the varieties Early Gold Shiro, Flaming Delicious, Great Yellow, Indian Blood, June Blood, Late Goose, and Sharps Early have borne crops.



*Fig. 3a. Variety Santa Rosa. Note incomplete defoliation of tree, although it was the month of February in Kula.*

***Methley (P. salician x P. cerasifera) (Fig. 2)***

The Methley variety comes into production earliest. It grows at sea level, but good fruit production occurs only at 2,700-foot or higher elevations. The tree is exceptionally vigorous and hardy. It is a heavy producer. The fruit is usually small, anywhere from 10 to 14 making up a pound. The flesh is red and the skin is purplish crimson. The variety is considered a poor shipper and keeper. It may set fruit when self pollinated. It is most popular in home plantings.

***Santa Rosa (Fig. 3)***

Santa Rosa is a mid-season variety. It comes into production in July when many California plums are already in the Honolulu markets. The tree is moderately vigorous. It is a temperamental bearer under Hawaiian conditions. The fruit is medium-sized, 5 to 7 making up a pound. It is dark purplish-red. The flesh is reddish near the skin and yellowish toward the center. It is a good shipper and keeper. It may set fruit when self pollinated; however, pollinating varieties are suggested for planting in the orchard.





*Fig. 3b. Santa Rosa variety fruit spurs. Photograph taken at the Volcano farm area in February.*

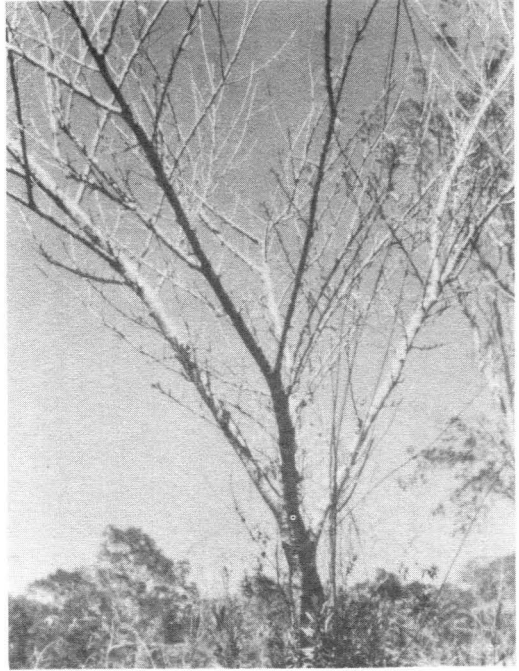
#### ***Mariposa (Fig. 4)***

The Mariposa is a mid-season variety that comes into production in late July. The tree is moderately vigorous in Kula. It is a fairly good bearer. The fruit is medium-sized, 6 to 8 making up a pound. It is purplish red with numerous, light-colored dots. The flesh is blood red and very sweet. Cross pollination is necessary.

#### ***Kelsey (Fig. 5)***

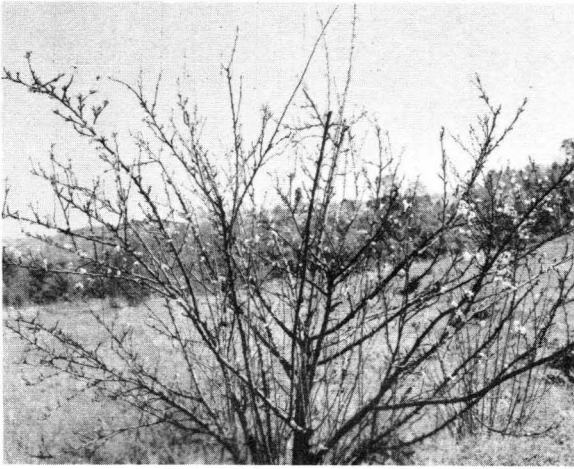
The Kelsey was introduced to the United States from Japan in 1870 and named after John Kelsey of Berkeley, who propagated it. It is a late maturing variety that comes into production in August and September. The tree is moderately vigorous. It is the most consistent and heaviest bearer in Kula. The fruit is medium-sized, 5 to 7 making up a pound. The base color of the fruit is yellowish green; the exposed side may be slightly purplish red. The flesh is yellow and firm. It is a good shipper and keeper. Cross pollination is necessary.

*Fig. 4a. Variety Mariposa showing complete defoliation in the month of February.*



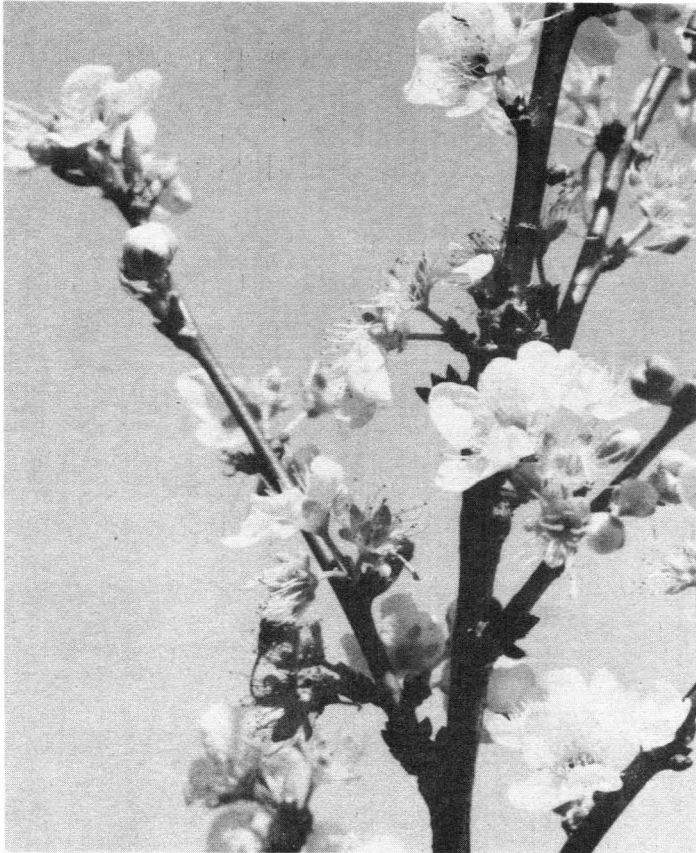
*Fig. 4b. Fruit spurs of this 5-year-old Mariposa tree are still dormant in February.*

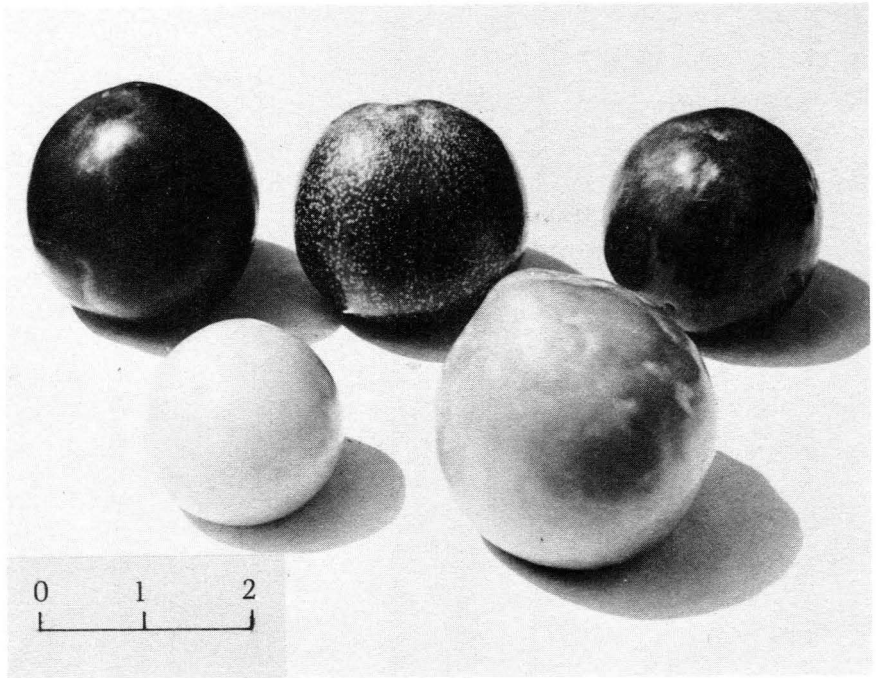




*Fig. 5a. Variety Kelsey. Note complete defoliation and the development of flowers. Photograph was taken in February.*

*Fig. 5b. Kelsey flowers in February. Photograph taken at Kula, Maui, at a 2,700-foot elevation.*





*Fig. 6. Fruit varieties.*

### **Pollination**

Many Japanese plums require cross pollination. Fortunately, in most instances, they are intercompatible. It is felt that self-pollinating varieties benefit from cross pollination (*e.g.*, Methley, Santa Rosa, and Beauty). Therefore, it is desirable to avoid solid plantings of one variety. Varieties planted for pollination purposes are most effective when their blossoming occurs about the same time as the principally grown varieties. Pollinators suggested for Santa Rosa are Beauty, Mariposa, Sierra, and Satsuma. Pollinators that can be used with Kelsey include Mariposa and Formosa.

One pollinating tree to 8 trees of the main variety has been recommended as an effective ratio to use in determining the number of pollinating trees needed in an orchard. Another approach suggested is to plant the pollinating tree within a 50-foot distance of the principal variety. Grafting a pollinating variety to the branches of the principal variety has not facilitated pollination too well in large plantings, but it may be practiced in the backyard.

Insects are the primary pollen-carrying agents. The honey bee is probably the most common insect found during the blossoming season.

Wind has also been mentioned as a pollen-carrying agent, but it has a negligible effect compared with insects.

### **Planting**

The planting distance varies with the plum variety. The Methley is usually spaced 25 to 30 feet apart because of its vigorous growing habit. The Kelsey and Santa Rosa are normally spaced 20 feet apart.

The time of planting is usually the late fall or winter months since there is little danger from cold injury in Hawaii. It is the time of year when rains are most frequent.

One- or two-year-old grafted trees are most suitable for field plantings. The planting hole should be dug large and deep enough so that the roots can spread out naturally. Mix about 1 pound of superphosphate with the soil at the bottom of the hole. Set the tree slightly deeper than it was in the nursery so that upon settling, the roots remain well covered. Spread a handful or two of fertilizer on the surface of the soil around the tree after the roots have been covered with soil. Trees should be well watered after planting.

### **Irrigation**

In the Volcano, Kona, and Keanakolu areas on Hawaii, adequate rainfall throughout the year usually makes supplementary irrigation unnecessary. In other areas, supplementary irrigation is necessary. During the growing and fruiting season before the fruits have reached mature size, a lack of sufficient soil moisture may result in a great number of undersized fruits. For this reason, maintaining adequate moisture in the soil is important.

Frequency of irrigation depends on prevailing weather conditions. During spring and summer, irrigate about once every 2 or 3 weeks to keep the tree vigorous. In late fall or winter when the trees are dormant, irrigate only two or three times during the entire period to prevent drying out and to maintain soil moisture.

### **Fertilization**

Some authorities say that the plum tree does not respond to fertilizer applications as fast as other deciduous fruit trees, such as the peach. Adequate fertilizer practices, however, do have a beneficial effect. Because of the low soil fertility of most Hawaiian soils, a fertilizer containing the three principal elements—nitrogen, phosphorus, and potash—is usually recommended. Examples of such fertilizers are 8-20-5, 14-14-14, and 10-10-10. The figures represent the pounds of nitrogen, phosphorus, and potassium, respectively, in a 100-pound bag of fertilizer.

How much fertilizer is applied depends on the age of the tree, size of crop, soil fertility, and other factors. A rule of the thumb is to apply a minimum of 1 pound of fertilizer a year for each inch of trunk diameter. For example, a tree with a 4-inch trunk diameter would receive in a year 4 pounds of fertilizer containing 8 per cent nitrogen, 20 per cent phosphoric acid, and 5 per cent potash (8-20-5). Sometimes this amount is inadequate and more is added. The County Extension Agent should be contacted for specific fertilizer recommendations.

The time to apply fertilizer is usually in March-April before the trees begin to flush or show new growth. The fertilizer is broadcast or spread within the dripline area of the tree. In an orchard where there is ground cover, remove the ground cover or grasses under the tree before fertilizing.

Soil tests of most plum-growing areas show extreme phosphorus deficiency. This deficiency can be partially corrected by broadcasting about 3,750 pounds of raw rock phosphate per acre at the time the soil is being prepared for planting.

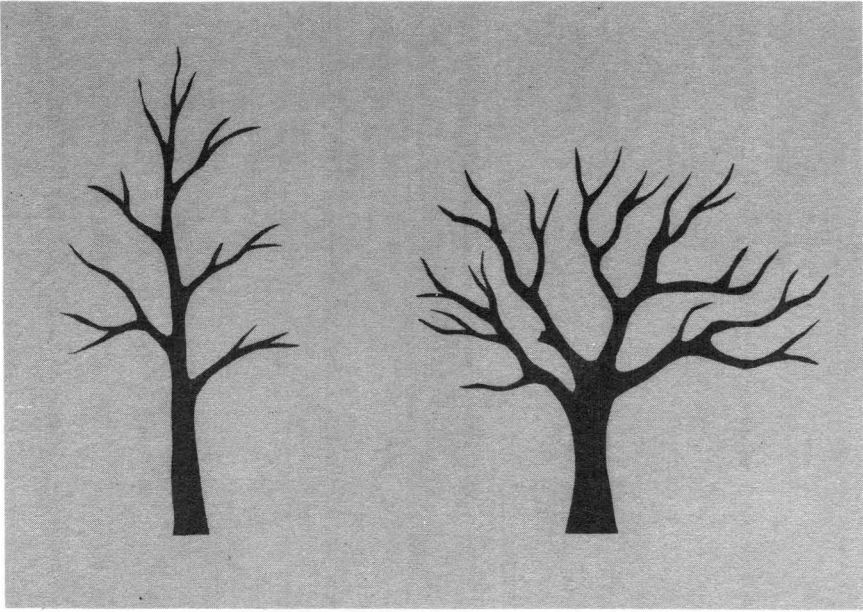
The soils of the Volcano district on Hawaii may be strongly acid, ranging from a pH of 4.5 to 5.3. To correct this acidity, apply 5,000 pounds of coral sand or ground coral rock, or 3,500 pounds of hydrated lime per acre. Broadcast the coral sand or hydrated lime the same time as the raw rock phosphate. Where feasible, disk the material into the soil.

### **Pruning**

A well-pruned tree is well-balanced, capable of supporting a good crop of high-quality fruits. Definite objectives are necessary for successful pruning. Some of these objectives are:

1. To develop a strong tree so that branches do not split from strong winds or too heavy a crop of fruit.
2. To facilitate harvesting so that fruits are easily reached.
3. To increase fruit size and reduce the cost of thinning.
4. To facilitate spraying for diseases and insects.
5. To develop and maintain healthy spurs.

Plum varieties and species vary in growth habit (see *Fig. 5*). Variations are more obvious in different species than in varieties. Varieties that grow upright should be made to spread more. Varieties that spread should be pruned to grow more upright. The technique of pruning, then, depends partly on growth characteristics. In general, pruning a branch of the tree stimulates growth near the branch but total growth of the tree is depressed. If a tree is severely pruned, its yield is also reduced.



*Fig. 7a. Modified leader.*

*Fig. 7b. Open center.*

### **Young trees**

Young, unbranched or whip trees that are set out are cut back at planting time to the desired 24-inch height. If a tree is vigorous, soon after new growth occurs, select and save 3 or 4 shoots spaced about 6 inches apart at different levels and different sides. These shoots form the permanent framework of the tree. All other growth is pinched back as often as necessary. This method of developing the tree is called the modified leader system.

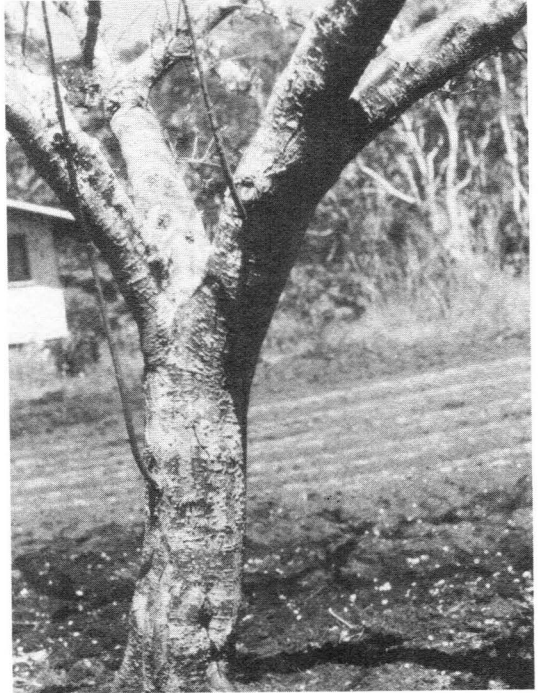
If older, branched trees are planted, select 3 to 5 well-spaced branches and head them back to a 16- to 20-inch length. Remove all other growth.

In the modified leader system, the highest branch is longer than the lower ones and the center trunk is longer than any other branch. (*Fig. 7-a*). In the open center system, also known as the vase-form or open-head system, the center is kept open by pruning (*Fig. 7-b*). All the main scaffold branches are allowed to grow at the same rate.

The open center and the modified leader system of training are both used in the islands.



*Fig. 8a. Open center system of training Methley plums is popular in Hawaii.*



*Fig. 8b. A close-up shows the wide-angled crotch developed in the open-center system.*



### ***Bearing trees***

Little or only moderate pruning is recommended for Kelsey or Santa Rosa trees that are bearing. These varieties grow rather slowly. On the other hand, the Methley grows very vigorously, sending out numerous branches. Heavy pruning is necessary to keep the Methley from getting out of control and to make harvesting easy. As the trees grow older, the open-center system is developed. The principal leaders are cut back to secondary branches to maintain a bearing tree that is low (*Fig. 8*). Pruning is done any time during the dormant period. Generally, growers prune during February or even as late as March.

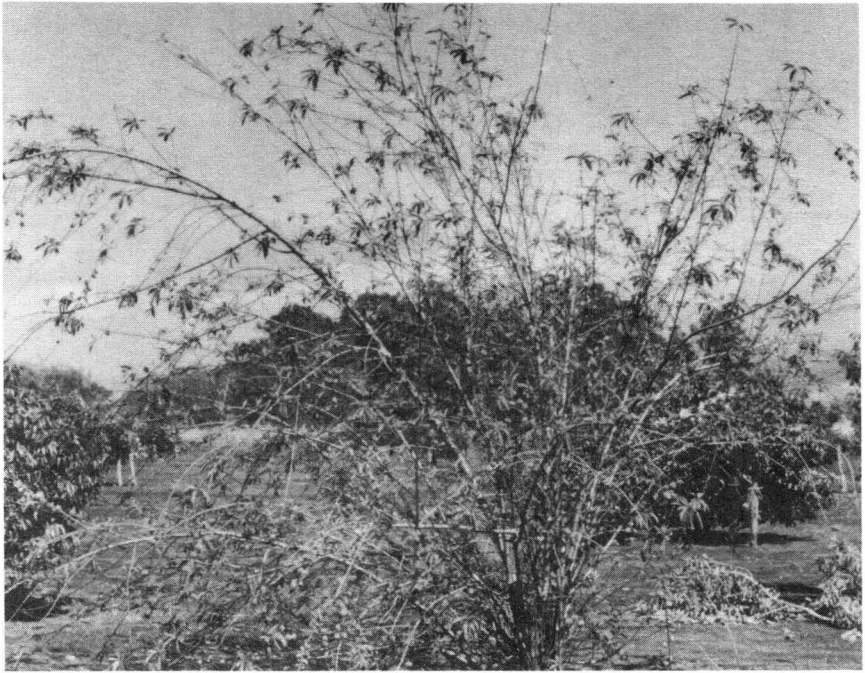
### **Thinning of Fruit**

Varieties like Kelsey and Methley tend to overbear during certain years and fruits must be hand-thinned to maintain fruit size. Fruit develop on young, 1-year-old growth as well as on the older wood. Thinning usually increases the fruit size, but the total weight of the crop is reduced. Thinning is done as early as practicable, before fruits reach the size of a cherry. This is considered necessary to thin effectively. In Queensland, Australia, the recommendation is to thin immediately after the fruit naturally sheds. The distance between fruits should be 3 to 4 inches, or at least equal to their diameter when fully grown.

Hand thinning can be tedious and costly, so the use of chemicals has been suggested. There is little information available on chemical thinning of plums, but the use of chemicals to thin other deciduous tree fruits, such as apples and peaches, has received considerable attention of research workers.

Chemicals that have been used on apples include NAA (naphthaleneacetic acid), Amid-Thin (naphthaleneacetamide), Sevin 1-naphthyl N-methyl-carbamate), and DNOC (dinitro-ortho-cresol). The effectiveness of the chemical sprays is influenced by the age and vigor of the tree, variety, pollinating conditions, and climate. The chemicals are applied on the assumption that fruit set will be heavy. Experience has shown that the weak and the young trees must be sprayed with caution, if at all. Some reasons for using chemicals are: (1) to reduce the amount of hand labor required for thinning, (2) to break the biennial bearing cycle of some fruit trees, and (3) to improve the size and color of the fruit.

In California prune plums have been successfully thinned with sodium dinitrocresylate at the rate of 1 quart to 100 gallons water. The most effective time to apply was when 90 per cent of the blossoms were open.



*Fig. 9a and b. Peach rootstock *Prunus persica*. It is commonly known as the Hawaiian peach and is the principal rootstock of plums in Kula, Maui.*

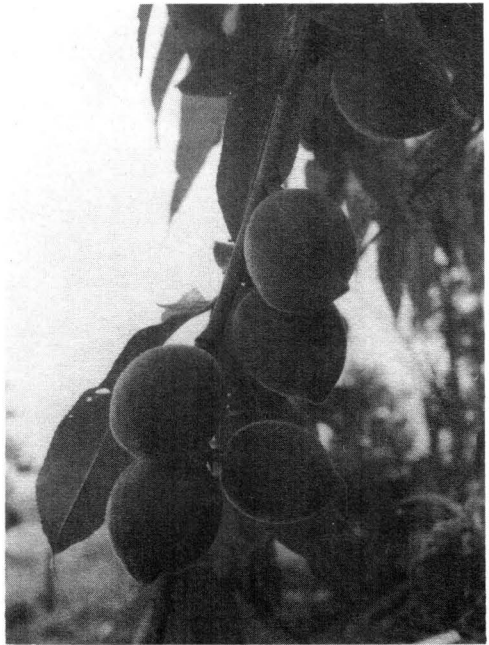




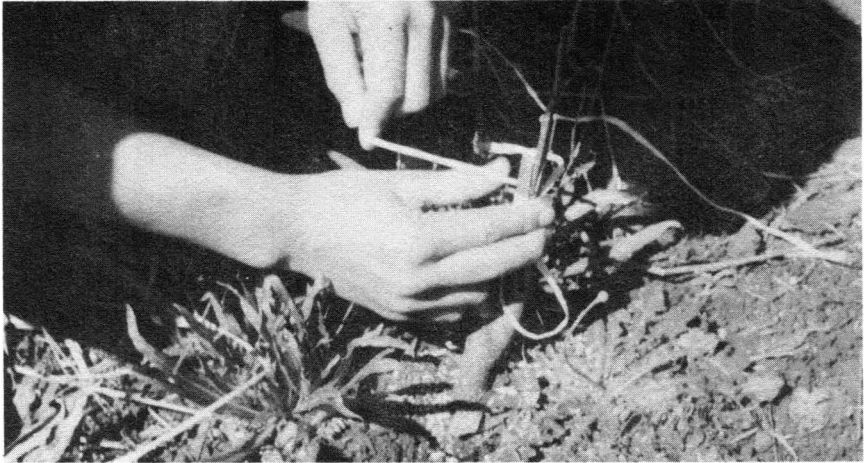
Fig. 10. Top working an old Methley plum tree to a Santa Rosa variety by the stump-bark technique.

## Propagation

### Rootstocks

The common wild Hawaiian peach (*Prunus persica*) is one of the principal rootstocks for plums (Fig. 9). It was brought to Hawaii from California in about 1813. This peach is thought to be of ancient Persian origin, but its home before establishing in Hawaii is said to be South China. As a rootstock, this "native" peach is well adapted to areas with good drainage and relatively low rainfall. In wet, poorly drained areas, it has not performed as well, so its popularity is restricted to such areas as Kula, Maui. In East Africa, it is said to be susceptible to crown gall, a bacterial disease.

The Methley plum is also used as a rootstock to propagate other plums and peaches. It is the standard rootstock of the high rainfall and humid areas, such as the Volcano district on Hawaii, because it is more adapted to these climatic conditions than the Hawaiian peach rootstock. It has also been used as a rootstock in the low rainfall areas, but its performance in these climatic areas, compared with the peach rootstock, has not been evaluated.



*Fig. 11. Stump-bark grafting of plums on peach seedlings is the usual practice in Kula.*

The selected plum variety is grafted to either the peach or Methley rootstock by using the stump-bark technique (see *Fig. 10*). To do the stump-bark graft, cut off two-thirds of the top of the rootstock. Then make a pointed cut of about 2 inches parallel to the rootstock, through the bark and into the wood. Slip the 3- to 4-inch scion or shoot of the variety desired under the bark. Tie the scion to the rootstock firmly and wax or cover with plastic to keep the scion or slip from drying before growth takes place. On either the peach or Methley rootstock the grafted trees begin producing in 3 years.

The nursery stock imported from California is usually grafted to Mariana or Myrobolan rootstocks, which are resistant to nematodes and some diseases such as oak root fungus. Limited observations in the Volcano and Waimea districts on Hawaii and the Kula district on Maui indicate that further research is needed to determine the adaptability of these stocks.

### **Cuttings**

Many plums are started from cuttings. An outstanding example is the Methley plum (*Fig. 11*). Cuttings anywhere from 12 to 15 inches long and  $\frac{1}{4}$ - to  $\frac{1}{2}$ -inch thick are used. However, it is not unusual to see a 3-foot long, 1-inch diameter branch used as a cutting. Generally, the cuttings are taken in February and  $\frac{1}{3}$  to  $\frac{1}{2}$  of their length is inserted into the media.

Planting cuttings has been tried at sea level and at high elevations. These experiences indicate that cuttings root better at the higher elevations, such as Keanakolu, than at sea level. Evidently, the cool temperature has some effect on the rooting process.

## Climate

In the fall, buds of plums and other deciduous trees go through a dormancy or rest period. The flowers or leafy shoots do not expand until they are exposed to a period of cold weather. Australian horticulturists say that an average temperature of 48° F. or less for 2 months or more is necessary. The cold temperature breaks this rest period and then flowering and normal growth can proceed.

Temperate fruits can be grown in subtropical Hawaii because of the mountains on the islands. The higher up the slopes of these mountains, the cooler the climate. It is because of the cold winter temperatures at higher elevations that it is possible to produce plums and other temperate climate fruits. Many backyard growers have orchards at elevations lower than is considered optimum for plums.

When the cold-period temperatures are inadequate to break the rest period, blossom buds fall or abscise before opening and new growth does not take place normally. This is a common occurrence in Hawaii. It is one of the limiting factors of plum production in the islands. Oil spray used in insect control has been suggested as an aid to overcome winters that are too warm. Dinitro-*o*-cyclohexyl phenol, known as DNO, at the rate of 0.96 per cent in water has been found effective on some temperate fruit trees under mainland conditions. The use of dinitro-cresol in combination with mineral oil has also been suggested.

In the interior valleys of Central California, which includes the Sacramento and San Joaquin Valleys where many plums are produced, winter temperatures range between 40° and 50° F. In Kula, where most local plums are grown, the lowest temperature in the last 5 winters was 41° F. in 1959. The average winter temperature was much higher (see Table 1).

Heavy rains during the flowering period deter good fruit setting. It is one of the major reasons why plum production has not expanded in the Volcano district. Rains prevent the proper functioning of pollen and restrict the insect activity necessary for pollination. Strong winds also decrease the amount of fruit setting.

Table 1. Temperature of the Kula Sanatorium Station on Kula, Maui.

YEAR	DECEMBER		JANUARY		FEBRUARY		MARCH	
	<i>Av.</i>	<i>Lowest</i>	<i>Av.</i>	<i>Lowest</i>	<i>Av.</i>	<i>Lowest</i>	<i>Av.</i>	<i>Lowest</i>
1963-64	63.8	51	62.9	52	59.9	50	62.2	51
1962-63	64.4	52	63.4	53	63.9	54	64.0	50
1961-62	62.2	49	61.6	48	59.4	44	61.5	50
1960-61	63.0	50	61.6	48	62.3	52	62.1	50
1959-60	61.0	49	60.7	47	60.6	45	62.2	47
1958-59	59.3	43	60.3	43	58.5	41	59.8	46
1957-58	61.1	45	57.8	44	59.7	42	58.4	42
1956-57	60.1	48	60.0	45	57.1	43	57.7	43

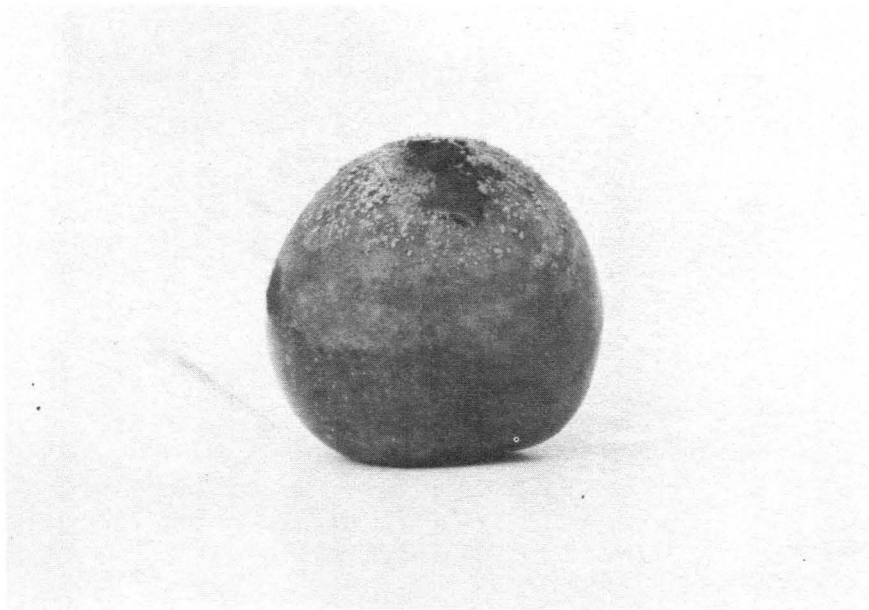


Fig. 12. Brown rot, *Sclerotinia laxa*, is the principal disease of plums in Hawaii. It occurs in the field or may develop in storage.

### Diseases and Pests

Brown rot caused by *Sclerotinia laxa* is the principal plum disease in the islands (Fig. 12). The fungus mainly attacks the blossoms, but it is a parasite on green as well as ripe fruit. For control, a spray with 2 pounds of 50 per cent Captan per 100 gallons of water is applied at the popcorn and the full bloom period. About 5 weeks before harvest, 4 pounds of wettable sulfur per 100 gallons of water is recommended as a spray. Thereafter, if it rains frequently, weekly spraying of wettable sulfur are suggested.

Blighted blossom and mummified fruit and twigs are important signs of brown rot infection. Orchard sanitation and a regular spray program to control insects and diseases are necessary to minimize this infection.

"Shot hole" refers to a disease in which small spots on the leaves fall out, leaving a shot-hole effect (Fig. 13). These spots are actually injuries resulting from attacks by bacteria, fungi, viruses, or insects, or mechanical and chemical injuries. A layer of cork cells forms around the injury, walling off the injured area. The cells eventually fall out, producing the typical shot hole. Even poor nutrition may result in a shot hole effect.

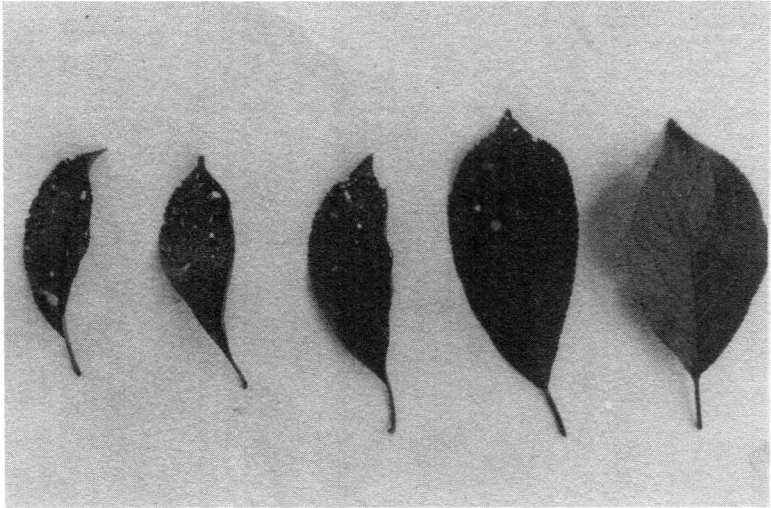


Fig. 13. Shot-hole disease (right: normal leaf). Other leaves may have been afflicted with bacteria, fungi, or other causes which result in a shot-hole appearance.

Lichens are a major problem of plums grown in very wet areas (Fig. 14 a and b). The lichens are found on stems and branches. Chemical control is possible by spraying some form of fixed copper, such as tribasic copper sulfate or copper A. Since these copper compounds may cause russetting of the fruits, the material is sprayed before flowering or after the fruiting period is finished.

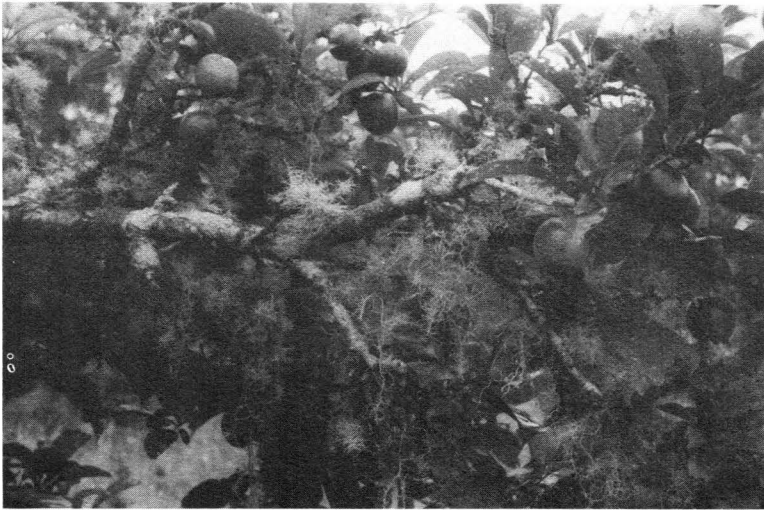
The "bracket" fungus (*Polyporus versicolor*) produces a heart rot (Fig. 15). It is not a virulent pathogen, but it will enter the tree through dead wood and wounds produced by mechanical injury. After it enters the tree, the fungus moves into the heart wood and though not actually killing the tree, it weakens the tree. The best means of control is to remove the dead wood and to treat all cut surfaces with a wound dressing.

Very limited information is available on pests of plums in Hawaii. The two-spotted spider mite, *Tetranychus telarius* (L); the broad mite, *Hemitarsonemus latus* (Banks); the Chinese rose beetle, *Adoretus sinicus* (Burm.) (Fig. 16); and the Mediterranean fruit fly, *Ceratitidis capitata* (Wied); are some of the insects reported to attack the plum. None of these pests is considered of major importance. Scales and thrips have also been seen on plums, but the species have not been identified. A general insecticide used to control these pests is Diazinon. Two pounds of 25 per cent Diazinon (wetable) in 100 gallons of water is suggested. For specific information on chemical control, consult the County Extension Agent.





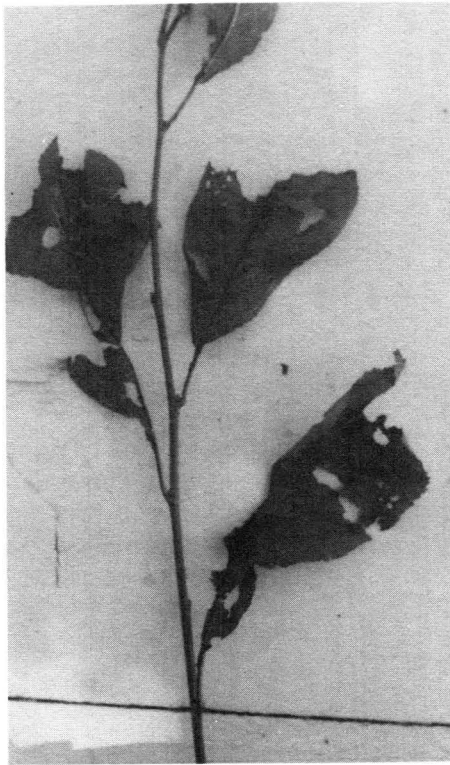
Fig. 14a and b. Lichens on plums usually occur in high-moisture areas.



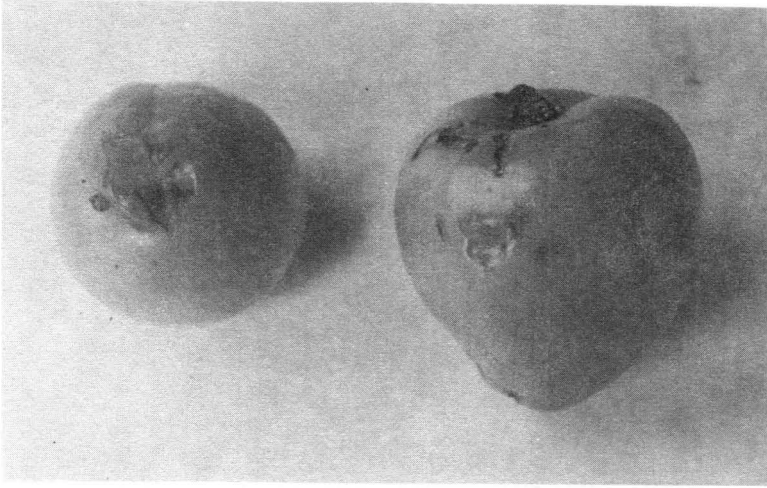
Birds are also a pest of plums (Fig. 17). Ripe fruits are frequently attacked by the white eye or Mejiro (*Zosterops palpebrosus japonicus*). Attempts have been made to scare the birds by using mechanical noise-makers. These have not been very successful.



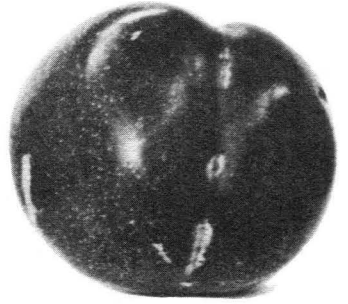
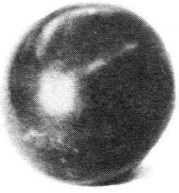
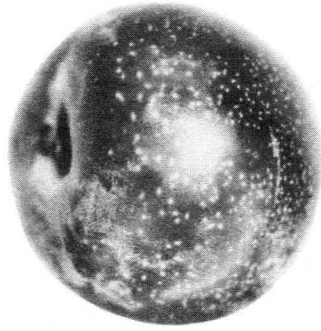
*Fig. 15. The bracket fungus (*Polyporus versicolor*) produces heart rot.*



*Fig. 16. The Chinese rose beetle (*Adoretus sinicus*) may eat leaves of plum trees.*



*Fig. 17. Damage by birds such as the Mejiro occurs wherever plums are grown.*



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