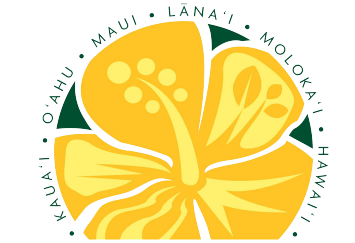

UNIVERSITY of HAWAI'I
MASTER GARDENER
College of Tropical Agriculture & Human Resources

This publication was written in 1943. Although the information on general planting and garden management provide relevant information for today's home gardeners in Hawai'i, ***recommendations on chemical fertilizers and chemical pesticides are outdated****. Research has provided much more information on chemical fertilizer and pesticide use for the home garden to protect yourself, your neighbors and your local and global environment.*

For current, relevant information about fertilizer and pesticide use for home gardeners in Hawaii, please see references below:

Testing Your Soil: Why and How to Take a Soil-Test Sample http://www.ctahr.hawaii.edu/oc/freepubs/pdf/SCM-9.pdf

Yard and Garden Nutrient Management
http://www.ctahr.hawaii.edu/oc/freepubs/pdf/HH-13.pdf

Integrated Pest Management for Home Gardens:
Insect Identification and Control
http://www.ctahr.hawaii.edu/oc/freepubs/pdf/IP-13.pdf

HOME GARDENING IN HAWAII

HAWAII AGRICULTURAL EXPERIMENT STATION BULLETIN No. 9

HAWAII AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF HAWAII

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Home Gardening in Hawaii

HAWAII AGRICULTURAL EXPERIMENT STATION
BULLETIN NUMBER 91

UNIVERSITY OF HAWAII HONOLULU, U. S. A. • 1943

HOME GARDENING IN HAWAII

W. A. FRAZIER

FOREWORD

HAWAII IS PLAYING a historic role in this war. Her people are bending every effort to hasten the final victory. To this end, thousands of families now grow in home gardens many of the vegetables required for their tables—food that would otherwise occupy valuable cargo space in vessels coming to the Islands. This home-gardening bulletin has been prepared for these enthusiastic and patriotic gardeners. It is hoped that in its pages they will find suggestions for more intelligent, productive gardening—gardening that will provide food for victory now and will help make the Islands more self-sufficient after the war.

J. H. BEAUMONT

April, 1943

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W. A. FRAZIER

April, 1943

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INTRODUCTION

No state or territory of the United States is climatically better situated than Hawaii for production of a year-round vegetable supply in home gardens.

For many years hundreds of successful gardens, containing a wide variety of vegetables, have been planted by home gardeners and by grammar- and high-school students at schools throughout the Territory. Various divisions of the University of Hawaii Agricultural Experiment Station have repeatedly produced successful crops of major vegetable types. A large part of the head cabbage, green beans, and leaf lettuce consumed in the Territory before the war was grown locally; most of our winter tomatoes in recent years were produced in the Territory. The nutrition division of the experiment station has demonstrated the high nutritive value of Hawaiian-grown vegetables.

There is no valid reason, from the standpoint of either production or nutrition, why, in this war or at any other time, Hawaii cannot or should not produce an abundant year-round home-garden vegetable supply.

During winter months, while northern mainland states experience temperatures too low for most vegetable crops, Hawaii's climate is ideal for production of many vegetables. During summer months, daytime temperatures in many southern mainland areas are often above 100° F., too high for best results with most vegetables. In the Hawaiian summer, crops grow day after day at 65° to 78° F., a temperature range that results in extremely rapid development of most vegetable crops, early maturity, several crops a year, and heavy yields. However, these year-round favorable temperatures promote the development and persistence of many insects and diseases that are a challenge to gardeners. Yet there are few desirable vegetables which should be eliminated in Hawaiian gardens simply because of insect or disease problems. To be sure, some crops are disastrously attacked, occasionally or regularly, but the problem is not peculiar to Hawaii. Wherever gardens are grown, there are insect and disease enemies that must be fought continuously.

Those who neglect the first principles of vegetable culture—varietal selection, and disease and insect control—may expect failures. Upon such neglect must be placed much of the blame for occasional

pessimism regarding vegetable production in Hawaii. Any garden endeavor will be only as good as the intelligent planning, work, energy, and enthusiasm which go into it.

SECTION

•1•

GENERAL GARDEN PLANNING

The Ideal Location

IF THE HOME GARDENER can choose his site, he should select one that—

(*a*) Is near the home.
(*b*) Is near a faucet for easy irrigation if in a dry area.
(*c*) Is distant from large trees, shrubs, and hedges, roots of which will rob garden plants of water and nutrients.
(*d*) Is distant from any appreciable shade. (Leafy crops such as lettuce, chard, spinach, and Chinese cabbage may be planted in any partially shaded area.)
(*e*) Is well-protected from strong winds.
(*f*) Is on a flat area, rather than a steep slope.
(*g*) Has well-drained soil.
(*h*) Has a loam soil, high in organic matter and essential plant food elements.

Most Gardens Need Windbreaks

The importance of protection from strong trade winds cannot be overemphasized. There are few locations in the Islands where one should even attempt to grow a garden without a windbreak.

Panax, pigeonpeas, and oleanders are some of the plants that make good windbreaks. If the garden is not too exposed, pole lima beans or pole cowpeas will serve. Sorghum or corn, planted thickly, makes rapid growth and provides protection for short periods of time. Palm leaves (see figure 7), gunny bags, or laths may be used where it is necessary to construct an artificial windbreak, and pole lima beans may be grown on them.

Tools the Gardener Needs

Dozens of types of miscellaneous small garden tools are manufactured. The small home gardener requires only a few of these, but they should be obtained before the garden is started. Simple tools

that reduce time and effort in preparing the garden and keeping the soil free of weeds will help to maintain the gardener's enthusiasm. Figures 4 and 5 show a good assortment.

It is poor economy to buy the cheapest tools. Good tools, well cared for from year to year, will prove to be a very minor cost to the gardener.

A Useful Classification of Crops

Crops suitable for gardens in Hawaii may be usefully grouped as follows:

SUN-LOVING CROPS

Tomatoes Eggplants Corn Bush green beans

RAPID-MATURING CROPS

Radishes Lettuce Bush green beans Leafy cabbage (Pak Choy)

CROPS USUALLY TRELLISED OR STAKED

Tomatoes	Pole lima beans	Bitter melons
Pole green beans	Yardlong beans	Chayotes

CROPS BEST USED FOR COMPANION CROPPING OR INTERPLANTING
(see Section 2)

Lettuce Radishes Onions

OTHER CROPS THAT DO NOT REQUIRE WIDE SPACING

Beets Carrots Mustard Spoon cabbages

CROPS WHOSE LEAVES OR EDIBLE PARTS MAY BE CUT REPEATEDLY

Chard	Broccoli	Mustard	Bunching onions
Parsley	Celery	New Zealand spinach	Tahitian taro

When chard, mustard, and Tahitian taro are wanted for the table, the outer leaves of each plant should be cut. The branches of New Zealand spinach should be cut near the tips. If only the center branches of broccoli are picked, the side branches will continue to sprout and produce edible heads. Parts of each bunch of bunching onions can be pulled, leaving one or two plants for further development. The outer leaf stalks of celery can be broken off.

What Crops to Plant

Decision as to what crops to plant depends upon several important factors:

(*a*) *Size of garden.* In a small garden it is best not to try to grow sweetpotato, Irish potato, taro, and corn. These starchy crops require more land than certain other crops, and their relative money values are low. In a large garden there may be room for them.

(*b*) *Likes and dislikes of family.* It is only reasonable to expect every gardener to plant the crops that he likes, but he should confine his planting to vegetables which have a good chance for success in Hawaii.

(*c*) *Crop production.* The vine crops such as cucumbers, pumpkins, and watermelons require too much space for the food value they provide. Moreover, in many districts of Hawaii, larvae of the melonfly destroy most of the fruits unless they are carefully protected by bags.

(*d*) *Adaptability to environment.* For the home gardener it is especially desirable to select crops adapted to our climate, and reasonably insect- and disease-free. This factor outweighs all others in the case of some vegetable crops (see figures 7 and 8).

As a rule, the most consistently good home-garden crops for Hawaii are carrots, beets, leaf lettuce, chard, Chinese green mustards (Tendergreen and other types), green onions, eggplants, green beans, and lima beans. Broccoli and the cabbages (head, spoon, and Chinese) are excellent garden crops at low elevations during winter, and at high elevations they thrive the year around. Okra and New Zealand spinach are good warm-season crops. Tomatoes, grown at low elevations, do best during cool seasons. (For further discussion of individual crops and their characteristics, read Section 10.)

(*e*) *Nutritive value.* Most home gardeners give little thought to the nutritive value of the crops they grow. More attention should be given to selecting a garden balanced from a nutritional standpoint. Fortunately there are, in each of the main vegetable groups, highly nutritious crops that are either very well or moderately well adapted to our climate.

All crops in the *greens group* are good or fair for furnishing vitamins and minerals. Lettuce, broccoli, parsley, and green mustard are best.

Within the *root-crop group,* the carrot is the outstanding vegetable for protective food value.

All of the *legumes* are excellent sources of vitamins and minerals. These include pole and bush beans of the green snap and lima type, as well as the bush and pole cowpeas and soybeans.

Of crops in the *starchy group,* deep yellow varieties of sweetpotatoes (yams) are highest in vitamins and minerals. However, corn, Irish potatoes, sweetpotatoes, and taro are all primarily energy foods. As has been pointed out, the required quantities of such vegetables cannot be grown unless the garden is large.

In the *miscellaneous-crops group,* tomatoes are much superior in vitamin values to the other vegetables adapted to Hawaiian conditions. (For more detailed information on vitamin and mineral values of vegetables, see list in appendix.)

What Time of Year to Plant

Many Island residents are well aware of temperature and rainfall variations between different localities, and between summer and winter. Although growth and behavior of all of the vegetable crops discussed in this bulletin have not been given sufficient study in these many local climates to permit detailed recommendations for crops or varieties, experience has shown that a rough classification as to adaptability of many of the crops is possible.

Table 1 shows a diagram of the preferred months for planting vegetable crops within three arbitrary elevation ranges.

At medium to low elevations, fairly desirable year-round performers are carrots, beets, chard, mustards, eggplant, green (bunch) onions, and all kinds of beans. At high elevations, cabbage, broccoli, and lettuce, in addition to carrot, beet, chard, and green onion, are good year-round crops. It is well for every gardener to become acquainted with the general temperature requirements of the most desirable crops.

A graph in the appendix compares local temperatures with temperature ranges preferred by each crop. The graph shows that, except for cool-season crops at low elevations in summer, the temperature ranges at most locations are favorable for growing a desirable variety of garden vegetables.

Rainfall and sunshine are other climatic factors that may limit production in certain localities, but it is difficult, on present evidence, to evaluate their local effects.

How Much of a Crop Should Be Planted?

The amount of any vegetable to be planted at one sowing depends in general upon the size of the garden, the size of the family, the likes or dislikes of the gardener, and the producing power or yield of the crop. If a garden is small, there is little likelihood of the gardener planting too much of any one vegetable; but the more he plants of one, the smaller the variety of the vegetables he can plant. Each gardener must learn from experience the amount to plant to satisfy his demands.

Every gardener knows that it is impossible to predict accurately the yields of various crops because of factors beyond human control,

TABLE 1.—Best months for planting seeds of various vegetable crops at different elevations in Hawaii[1]

(+) plus sign indicates months best for planting
(−) minus sign indicates months when crop can be planted with possibility of moderate success
( ) blank space indicates months least desirable for planting

CROP	LOW ELEVATIONS 0–1,000 feet						MEDIUM ELEVATIONS 1,000–2,000 feet						HIGH ELEVATIONS 2,000–3,500 feet					
	Jan., Feb.	Mar., Apr.	May, June	July, Aug.	Sept., Oct.	Nov., Dec.	Jan., Feb.	Mar., Apr.	May, June	July, Aug.	Sept., Oct.	Nov., Dec.	Jan., Feb.	Mar., Apr.	May, June	July, Aug.	Sept., Oct.	Nov., Dec.
Greens																		
Beet tops	+	+	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Broccoli	+	+			+	+	+	+	−	−	+	+	+	+	+	+	+	+
Cabbage, Chinese[2]	−				+	+	+	+	−	−	+	+	+	+	+	+	+	+
Cabbage, head	+	−			+	+	+	+	−	−	+	+	+	+	+	+	+	+
Cabbage, spoon	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Celery					+	+				+	+	+	+	+	+	+	+	+
Chard	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Lettuce, Mignonette	+	+	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Lettuce, Iceberg type	−					−	−				+	+	+	+	−	−	+	+
Mustard, Chinese	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Onion, green	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Parsley	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Spinach, New Zealand	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	−
Root crops																		
Beet roots	+	+	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Carrot	+	+	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Daikon	−	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Radish	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Turnip	+	+	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Fresh and green-shell legumes																		
Bean, bush green	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+		
Bean, pole green	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+		
Bean, bush lima	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+		
Bean, pole lima	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+		
Cowpea, bush	+	+	+	+	+	+	+	+	+	+	+	+		−	+	+		
Cowpea, pole	+	+	+	+	+	+	+	+	+	+	+	+		−	+	+		
Pea, Chinese[3]	−					+	+				+	+		−	+	+	−	−
Soybean[4]	+	+	+	−	−	−	+	+	−	−	−	−		+	−	−		
Starchy crops																		
Corn	+	+	−	−	+	+	+	+	+	+	+	+	−	+	+	+	−	
Potato, Irish[5]	+	−			−	+	+	+	−	−	+	+	−	+	+	+	−	−
Sweetpotato	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−		
Miscellaneous																		
Eggplant	+	+	+	+	+	+	−	+	+	+	−	−	−	+	+	−		
Okra	−	+	+	+	+	−	−	−	+	+	+	−		+	+	+	−	
Tomato[5]	+	+	−	−	+	+	+	+	−	+	+	+	−	+	+	+	−	−

[1] The climate of Hawaii is such that, except for highest areas where frost occurs, all vegetable crops will make an effort to grow. The important question is one of *desirability* of growth and the care required to make the plant perform satisfactorily.

[2] Will head well when planted from about September to December at low elevations.

[3] Chinese (edible-pod) peas are often difficult to grow because of diseases and insects, and they should have cool weather.

[4] Our present varieties of soybeans do best when planted in spring and early summer. See page 38 for varieties to plant during different seasons.

[5] At high elevations leaf diseases are serious on these crops, especially during cool, rainy, winter months.

yet it is possible, from observations and experience in gardens as well as information gained from many experiments conducted in recent years by the Hawaii Agricultural Experiment Station, to give a fair estimate of expected *ranges* of yields.

Table 2 presents estimates of yields for the various crops suggested for planting in Hawaii, and in addition gives estimates of consumption and amounts to plant for a family of four or five.

TABLE 2.—Estimated yields per linear foot, amount required per meal for a family of five, and linear feet suggested for each planting of a particular crop

CROP	Estimated average yield in pounds per linear foot of row[1]	Estimated pounds required to serve 5 persons for one meal[2]	Suggested linear feet to plan for one planting[3]
Greens			
Beet tops	½–1	1⅓	10–20
Broccoli	1–1½	1	10–20 (5 to 10 plants)
Cabbage, Chinese	1¼–2	1	10–20
Cabbage, head	1¼–2	1	10–20 (10 to 15 plants)
Cabbage, spoon	¾–1½	1	20–30
Celery	1¼–2½	?	15–20
Chard	2–3	1	5–10
Lettuce	½–¾	¼ (salad)	15–25
Mustard, green	1–1¾	1	15–20
Onion, green	1–1½	⅛ (flavoring)	10–20
Parsley	½–1¼	$\frac{1}{16}$	2–4 (3 or 4 plants)
Spinach, New Zealand[4]	1½–2½	No data	8–12 (5 or 6 plants)
Root crops			
Beet roots	¾–1¼	1	10–20
Carrot	¾–1¼	1	25–40
Daikon	¾–1¼	1	10–20
Radish	¼–1½	?	4–6
Turnip	¾–1¼	1	8–12
Fresh and green-shell legumes			
Bean, bush green	½–1	¾	20–35
Bean, pole green	¾–1½	¾	15–25
Bean, bush lima[5]	½–¾	1⅔	30–45
Bean, pole lima[5]	¾–1½	1⅔	25–40
Cowpea, bush	½–1	No data	20–25
Cowpea, pole	¾–1½	No data	15–20
Pea, Chinese	⅙–⅜	1	25–40
Soybean[6]	⅙–⅓	2	15–30

TABLE 2 (*Continued*).—Estimated yields per linear foot, amount required per meal for a family of five, and linear feet suggested for each planting of a particular crop

CROP	Estimated average yield in pounds per linear foot of row[1]	Estimated pounds required to serve 5 persons for one meal[2]	Suggested linear feet to plan for one planting[3]
Starchy crops			
Corn	1 ear per ft.	3⅓	50–75
Potato, Irish	¾–1¼	1⅓	[7]150–300
Sweetpotato	1¼–1¾	1⅓	[7]100–200
Miscellaneous vegetables			
Chayote	3½–5½	?	8–12 (2 or 3 plants)
Eggplant	3–4½	1	6–12 (3 to 6 plants)
Okra	1½–2	¾	6–12 (4 to 6 plants)
Tomato	2–3½	1¼	25–40 (10 to 20 staked plants)

[1] Yield ranges here are fairly conservative. A gardener can produce far below or above these figures, depending upon a multitude of factors such as variety, season, stands, irrigation, fertility, protection from insects, diseases, and wind.

[2] Information supplied by Helen Yonge Lind, formerly of the Home Economics Department, University of Hawaii.

[3] Suggested for a family of four or five. This refers to each crop in question and is *not* to be interpreted as meaning that *all* of the listed crops must be planted in the garden. Each gardener would alter these figures, depending upon his preferences for certain crops.

[4] Chinese spinach (amaranth), Tahitian taro, or Malabar nightshade could be grown instead of New Zealand spinach.

[5] Shelled.

[6] In the shell.

[7] To furnish a 2- or 3-month supply.

How Often Is It Necessary to Plant Each Crop?

Many soil, climatic, varietal, insect, and disease factors determine whether a gardener can have an approximately continuous supply of vegetables, if he follows a repeat planting schedule. Crops usually mature more slowly at the cool temperatures of winter months and high elevations. Some varieties of a given crop produce over longer periods than others.

In order to develop a long-range planting plan, gardeners must know the approximate period of time required for crops to mature, how long they can be harvested once maturity is reached, and the

total time that the various crops will occupy an area in the garden. Table 3 gives information on these questions. The estimates represent a range of average conditions. The lowest figures in the ranges apply at low elevations, in summer. Figures midway between minimums and maximums roughly apply to winter at low elevations and summer at high elevations. Maximum figures should be taken for high elevations in winter.

TABLE 3.—Number of days to first harvest, length of harvest period, and total growth period of vegetable crops in Hawaii

CROP	Approximate time from planting to first harvest[1]	Period during which crop can be harvested (from first to last harvest)	Approximate time crop will occupy the area	How often to plant to provide more or less continuous supply[2]
Greens	*Days*	*Days*	*Days*	*Weeks*
Beet tops	45–75	25–40	80–120	4–6
Broccoli	65–95	30–60	[3]100–150	8–12
Cabbage, Chinese	45–85	25–40	80–120	4–6
Cabbage, head	70–95	20–40	[3]90–130	2–6
Cabbage, spoon	35–65	20–40	55–100	2–6
Celery	110–150	40–60	[3]125–200	8–12
Chard	45–75	60–100	120–170	8–12
Lettuce	30–60	15–25	50–85	2–4
Mustard, Chinese	30–65	20–40	50–100	4–6
Onion, green	[4]65–90	30–60 or more	90–150	8–24
Parsley	50–80	Several months	Several months	12–24
Spinach, New Zealand	55–85	60–120	130–200	12–24
Root crops				
Beet roots	45–75	25–40	80–120	4–6
Carrot	50–80	40–90	90–150	4–12
Daikon	35–60	20–30	65–95	2–6
Radish	20–40	10–20	30–60	2–4
Turnip	50–80	25–40	70–110	4–6
Fresh and green-shell legumes				
Bean, bush green	45–60	15–25	65–90	2–6
Bean, pole green	55–70	30–45	80–115	4–8
Bean, bush lima	60–80	[5]60–90	120–160	8–12
Bean, pole lima	65–90	[5]60–120	150–250	8–16
Cowpea, bush	60–85	25–50	90–120	4–6
Cowpea, pole	65–95	[5]75–125	120–175	8–12
Pea, Chinese	55–85	20–40	90–125	4
Soybean	55–85	10–15	70–110	2–4

TABLE 3 (*Continued*).—Number of days to first harvest, length of harvest period, and total growth period of vegetable crops in Hawaii

CROP	Approximate time from planting to first harvest[1]	Period during which crop can be harvested (from first to last harvest)	Approximate time crop will occupy the area	How often to plant to provide more or less continuous supply[2]
Starchy crops	*Days*	*Days*	*Days*	*Weeks*
Corn	60–85	7–14	75–105	2–4
Potato, Irish	75–100	—	90	—
Sweetpotato	120–180	—	150	8–12
Miscellaneous vegetables				
Chayote	90–150	Several months	Many months	24–48
Eggplant	70–110	[5]120–200	[3]150–250	8–16
Okra	50–75	[5]60–100	110–175	8–12
Tomato	75–95	40–65	[3]115–150	4–12

[1] Figures are from time seeds are planted, both for crops that are usually transplanted and for those planted where they are to grow to maturity.

[2] These ranges are only approximate, and are determined by numerous crop, varietal, climatic, and soil factors. In general, cool weather permits longer periods of harvest of a given planting. For such crops as broccoli, beans, and tomatoes, high fertility of soil will aid in prolonging the harvest period. Different varieties of a given crop vary in length of producing period.

[3] These estimates apply from time of seeding to harvest. Since these crops are usually transplanted, approximately 25 to 40 days should be subtracted from the indicated days to get the number of days the crop will occupy the garden. The transplants would usually be grown outside the garden or in a small spot in some corner of the garden.

[4] From seed. From green transplants, time to first harvest is only 20 to 40 days.

[5] If mature lima bean pods are picked off constantly for green shell beans, the beans will continue to produce over long periods in Hawaii. There will be definite productive and unproductive periods, however. This is true for pole cowpeas, too, as for example, with the Yardlong variety. Do not permit old eggplant fruits to remain on the vine. Keep the okra pods constantly picked.

Adverse conditions may delay maturity far beyond the first day in the harvest ranges shown, and exceptionally favorable conditions may result in maturity earlier than indicated. In general, however, the grouping that follows will serve as a guide in planning garden utilization according to the time crops will occupy given areas. The term includes the full period from seeding to the last day on which there is any harvest. Because their terms may vary, onion, beet, daikon, potato, and bush lima are placed in two classifications.

SHORT-TERM CROPS (generally under 90 days)	MEDIUM-TERM CROPS (generally 90–120 days)	LONG-TERM CROPS (over 120 days)
Bean, bush green[1]	Bean, bush lima	Bean, bush lima
Beet	Bean, pole green	Bean, pole lima
Cabbage, head	Beet	Broccoli
Cabbage, spoon	Cabbage, Chinese	Celery
Daikon	Carrot	Chard
Lettuce[1]	Corn, sweet	Chayote
Mustard, Chinese	Cowpea, bush	Cowpea, pole
Potato, Irish	Daikon[2]	Eggplant
Radish[1]	Onion	Okra
Soybean	Peas, Chinese edible pod	Onion
	Potato, Irish	Parsley
	Turnip	Potato, sweet
		Tomato[3]
		Spinach, New Zealand

The length of time from first to last harvest determines the interval between plantings if a continuous supply of the crop is desired. The following classification of crops according to planting intervals represents normal expectations. The higher the temperature, the more often should plantings be made. Many of the plants, as indicated in the discussion of climatic effects, should *not* be planted the year around.

PLANT APPROXIMATELY EVERY 2 TO 4 WEEKS (preferably every 2 weeks)	PLANT APPROXIMATELY EVERY 4 TO 6 WEEKS	PLANT APPROXIMATELY EVERY 8 TO 12 WEEKS	PLANT ONLY AFTER 12 WEEKS OR MORE
Bean, bush green	Bean, bush green[4]	Bean, bush lima	Bean, pole lima[7]
Cabbage, head	Bean, pole green[5]	Bean, pole green[5]	Chayote
Cabbage, spoon	Beet	Bean, pole lima[7]	Eggplant[8]
Corn	Cabbage, Chinese	Broccoli	Parsley
Lettuce	Cabbage, head[4]	Carrot[5]	Spinach, New Zealand
Radish	Cabbage, spoon[4]	Celery	Onion, green[9]
Soybean	Carrot[5]	Chard	
	Corn[4]	Cowpea, pole	
	Cowpea, bush	Eggplant[8]	
	Daikon[4]	Okra	
	Mustard	Onion, green[9]	
	Pea, Chinese	Sweetpotato[10]	
	Soybean[4]	Tomato[6]	
	Tomato[6]		
	Turnip		

[1] Lettuce, radishes, and bush green beans mature very rapidly.
[2] The Chinese variety is a short-term crop.
[3] Tomatoes sometimes mature more rapidly than indicated here.

Other Suggestions on Planting

Plan plantings well ahead of time. (See Section 3.)

Plant crops with somewhat similar growth habits together—for example, carrots, beets, turnips, and onions.

Plant rather tall crops together—okra, eggplant, staked tomatoes, and pole beans (figure 8).

Plant rapid-maturing crops together, so that all of the area they occupy can be replanted at the same time. Such crops include radishes, lettuce, daikon, beets, mustard, cabbage (from transplants), and bush green beans.

Quickly replant those spaces left vacant by rapid-maturing crops, especially if the garden is small.

Make use of companion cropping or intercropping (see Section 2), especially with lettuce and radishes.

Use rather long rows whenever possible—rows 25 to 30 feet long are convenient for many garden plans.

As far as possible, keep tomatoes, eggplants, and beans out of the shade.

Avoid helter-skelter planting of miscellaneous crops all over the garden, unless forced into it by lack of space.

If the garden area is relatively flat, plant the rows in a direction that will permit the running of irrigation water in small furrows beside the rows. Furrow irrigation is *especially advisable after crops have become well-established.*

If the garden area is on a steep slope or on the banks of a bomb shelter, plant rows around the slope, not up and down it. Gardeners who have plots on slopes should consult their extension agents or agricultural teachers for methods of preventing soil erosion.

Provide a windbreak.

See Reminders, Section 12.

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[4] These crops often mature over a short period, and in such cases require planting at less than 4-week intervals.

[5] Very often harvested over a 6- to 8-week period, which is on the border line of the classification.

[6] A short-season variety of tomato, such as Bounty, may produce for only 4 to 6 weeks or less, while some of the longer-season types, especially of plum tomatoes, may ripen fruits for 8 to 12 weeks or longer.

[7] Pole lima beans tend to produce over long periods of time in Hawaii.

[8] Eggplants often tend to bear fruit over long periods in Hawaii, but young, vigorous plants are by far the most productive.

[9] Most of the green bunching onions can be harvested over long periods.

[10] Sweetpotato roots continue growing for many months, and unless ruined by insects or diseases can be harvested over longer periods than the 8 to 12 weeks indicated. As with the other crops, however, conservative ranges are listed in this classification.

SECTION

•2•

GENERAL GARDEN MANAGEMENT

Companion Cropping or Intercropping

THE GROWING of more than one crop in a given area at the same time is called companion cropping or intercropping. The small home gardener must make every effort to utilize the garden area effectively. Crops which mature very quickly—particularly radishes and lettuce—can be planted in the row or between the rows of slowly maturing crops such as eggplant, okra, and tomato.

For example, mignonette lettuce can be grown between transplanted tomatoes, eggplants, or even cabbage, for by the time these crops are beginning to cover the row, the lettuce will have been harvested. Radishes develop so quickly and have such small tops that there is seldom need to set aside special space for them. Radishes can also be planted between rows of crops such as carrots, beets, chard, and onions, if planted at the same time as these crops.

Succession Planting

Succession planting is the repeated planting of crops (preferably not the *same* crop) on a given area so that several crops are harvested during the year. In Hawaii, several crops of short-term vegetables can be grown on the same area during a 12-month period. When one crop has been harvested, another should be planted immediately. Sufficient time, of course, must be taken to see that the soil is again loosened and a satisfactory seedbed prepared.

The most efficient small home gardener will have a given area vacant in the garden for only a few days. However, if plenty of land is available, it is well to let part of the area lie idle for a few weeks at a time.

Rotation of Crops Advisable

As has been pointed out, in succession planting it is usually not wise to replant the crop that has just been harvested, although at

times it is necessary. The best practice is to plant some other type of vegetable in the area, thereby *rotating* the various families or groups of garden vegetables. In a small home garden, careful plans must be made well in advance to secure good rotations. Examples of good sequences follow:[1]

AFTER . . .	PLANT ONE OF THE FOLLOWING . . .
Beet or chard	Bean, tomato, eggplant, okra, cabbage, lettuce, or onion
Cabbage or broccoli (any type)	Chard, lettuce, onion, beet, carrot, bean, tomato, or eggplant
Lettuce	Bean, carrot, cabbage, beet, onion, radish, turnip, or tomato
Onion	Bean, radish, beet, cabbage, lettuce, carrot, or turnip
Carrot	Lettuce, broccoli, cabbage, bean, New Zealand spinach, or onion
Daikon or radish	Bean, chard, eggplant, tomato, okra, lettuce, or onion
Turnip	Chard, onion, New Zealand spinach, bean, eggplant, or tomato
Cowpea or bean	Beet, chard, broccoli, cabbage, lettuce, onion, tomato, eggplant, or carrot
Eggplant	Beet, chard, broccoli, cabbage, lettuce, onion, carrot, or daikon
Tomato	Broccoli, cabbage, chard, lettuce, onion, carrot, beet, radish, turnip, bean

The Importance of Irrigation

In most areas of the Territory the gardener should not attempt to grow vegetables without irrigation. Even when showers fall frequently, the total rainfall may be so light that garden crops will suffer for lack of water. Plants which do not have sufficient water will grow slowly, and edible quality may be poor.

It is extremely important that the soil surrounding seeds be kept moist until seedlings appear. In order to secure good germination of seeds, it may be necessary to irrigate some soils once or twice a day. When plants become well established, frequency of irrigation can be reduced. In many areas a good irrigation once a week is sufficient for plants that have been growing for a few weeks. However, so many soil and climatic variables in Hawaii may affect water requirements that no set rules can be given. The twice-a-day irrigation sometimes practiced is rarely necessary for established plants.

[1] The important thing is to avoid immediate planting of (1) root crop after root crop; (2) members of the cabbage family (broccoli, cabbage, Chinese cabbage, etc.) after each other; (3) eggplants after tomatoes or vice versa; (4) beans after beans, etc. In a small garden, the best that can be done is to rotate as much as possible; some poor rotation at times cannot be avoided.

Plants which show decided wilting during the early part of the day or very late afternoon usually need a good irrigation. Frequent heavy soaking of the soil is poor practice.

Overhead irrigation—that is, use of sprinklers of any type—is often advantageous in securing good germination of seeds. Such irrigation moistens the entire soil area and assures the gardener that soil around the seeds is wet. Furrow irrigation (irrigation by running water down small furrows alongside the seeded row) has decided advantages once plants are up and growing, because it does not wash off sprays or dusts—especially dusts—applied for insect and disease control. Overhead irrigation often washes off dusts and sprays before they have done their work. However, on steeply sloping land the small gardener should make use of overhead irrigation, for the difficulties of properly preparing furrows for irrigation are too great.

It is often convenient for the gardener to use a nozzle on the garden hose for overhead irrigation until plants get a good start; then shallow furrows can be made with a hoe, 3 or 4 inches away from the row, and water thereafter applied in the furrows (figure 10).

Frequent Cultivation Advisable

The garden should be hoed frequently if weeds continue to appear. *The time to kill weeds is when they are small.* Heavy soils may benefit from a cultivation after each good irrigation. However, to avoid puddling, heavy soil should not be hoed, dug up, cultivated, or walked on when distinctly wet.

After cultivation, soil is better aerated and will soak up water more easily. A shallow soil mulch should be formed by using a hoe or small hand cultivator of some type. Deep cultivation close to large vegetable plants will injure much of the root system.

Mulches and How to Use Them

Straw, leaves, lawn clippings, or cane trash may be placed on the soil surface around the bases of plants to conserve soil moisture, keep down weeds, and keep the soil cool. The covering should be 2 or 3 inches deep. A mulch of this type is especially helpful during dry, hot weather. A temporary mulch on the soil surface, applied immediately after planting such crops as lettuce, beets, and carrots, will aid in securing better stands in summer at low elevations. Burlap bags or old cloth of any type can be used (figure 12). The mulch must be removed from above the seeded row when plants come up,

but may be left on the surface between rows.

After cane trash, leaves, lawn clippings, and straw have served their purpose as a mulch, they may be spaded into the soil, thereby increasing its organic content. If crops tend to become yellow after incorporation of these organic materials into the soil, side dressings of ammonium sulfate or a nitrate fertilizer should be given.

SECTION

·3·

SUGGESTED PLANTING DIAGRAMS FOR MEDIUM, LARGE, AND SMALL HOME VEGETABLE GARDENS

ALTHOUGH GENERAL HINTS and suggestions on planning vegetable gardens have been given in Section 1, many gardeners—particularly those who are new at the game—appreciate more explicit recommendations on plans for home gardens. Every gardener must develop a plan especially suited to his conditions and desires. However, he may find it simpler to modify for his own needs one of the three garden diagrams presented hereafter than to develop an entirely new plan.

These diagrams take into consideration average yield or production, diversity of crop types, nutritive balance, and adaptability to Hawaii. The essential difference between the three gardens diagrammed is in the amount of space that they use.

In all of the diagrams, the desirability of transplanting certain crops has been recognized. Therefore it should be remembered that seeds of onion, cabbage, tomato, eggplant, and broccoli are to be planted in seedbeds or germination flats 3 to 6 weeks before the date indicated for planting (or transplanting) in the garden proper.

A Medium-Sized Garden (50 by 30 feet)

A medium-sized garden is presented first in considerable detail (figures 1 and 6). It is estimated that this garden, 50 by 30 feet, would provide most of the fresh vegetables (including fresh lima and green beans) for four or five persons. This estimate is based on the assumption that the garden will be carefully planned and that proper attention will be given to culture, disease control, and insect control. The garden was planned especially for medium to low elevations. However, the plan is also roughly satisfactory for high elevations, except that in such localities beans, okra, and eggplants should not be expected to do so well in winter as at other times

of the year. If the gardener wishes to produce part of his starchy foods (Irish potatoes, sweetpotatoes, or taro), he could do so on an area of this size only with more intense management than the diagrammed garden requires.

Preparatory to drawing up the planting diagram, the linear feet of plantings shown in table 4 were compiled. *Footnotes to table 4 should be studied closely.*

For approximately a year the University of Hawaii Agricultural Experiment Station has had on the campus a medium-sized home

TABLE 4.—Linear feet of rows to be planted to each crop in a 50- by 30-foot garden[1]

CROP	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Beans, bush green...	[2]30	[2]30	[2]30	[2]30	[2]30	[2]30	[2]30	[2]30	[2]30	[2]30	[2]30	[2]30
Beans, bush lima....			30			30			30			30
Beets	20		20		20		20		20		20	
Cabbage	[2]30	15	[2]30	15	[2]30	15	[2]30	15	[2]30	15	[2]30	15
Carrots	30		30		30		30		30		30	
Chard			10			10			10			10
Eggplant			10			10			10			10
Lettuce	[2]30	15	[2]30	15	[2]30	15	[2]30	15	[2]30	15	[2]30	15
Mustard, green[3]					10		10		10			
Okra			10			10			10			10
Onions, green bunching[4]			30						30			
Tomatoes[5]	30		30		30		30		30		30	
Turnips[3]	10		10								10	

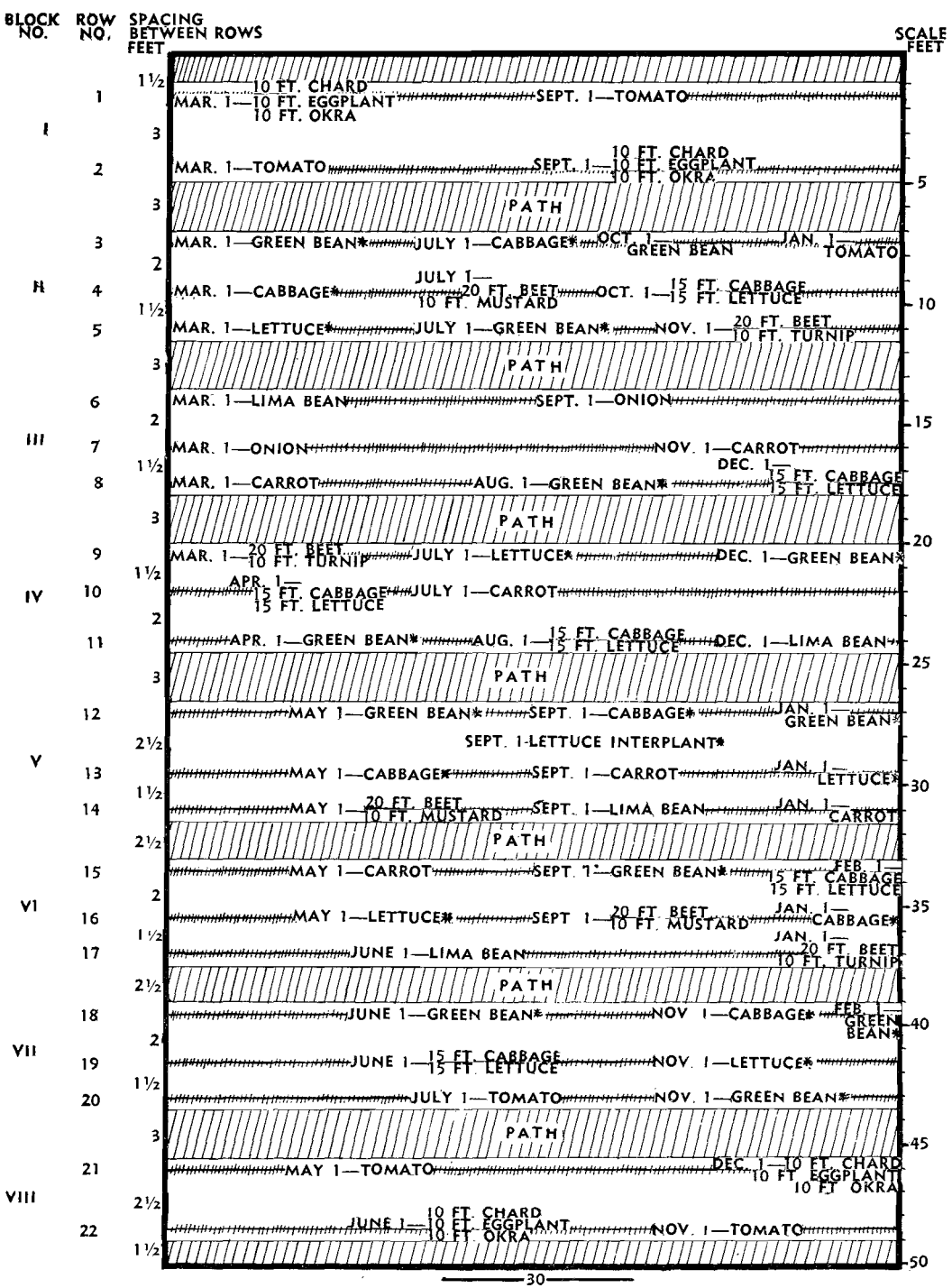
[1] These amounts would not conform to the desires of all gardeners. They are approximations which should be of general value and are not meant to distort individual initiative in crop selection and determination of amounts to plant.

[2] To be planted twice each month—15 feet the first of the month. and 15 feet about the middle of the month. For cabbage, Pak Choy or Shakushina white mustard (spoon) cabbage could be substituted. Such substitutions would be advisable at low elevations, especially in the summer. Broccoli could be substituted for a cabbage planting in October and perhaps again in February for low elevations. At high elevations broccoli could be substituted for head cabbage at any time. Chinese cabbage also could be planted at any time in place of head cabbage. Soybean could replace bush green bean plantings as desired, especially in spring and summer.

[3] Mustard and turnip are used as fill-in crops, depending upon season of year.

[4] Fresh green onions for the table, and for seasoning.

[5] Planting an early variety such as Bounty with a later one such as Break O'Day would spread the harvest period to better advantage. Fifteen feet of row planted each month would be better than 30 feet every two months. At low elevations, summer plantings should contain some plants of plum or cherry tomato, since they are more likely than other varieties to set fruit during warm weather. A supply of summer tomatoes is often difficult to maintain at low elevations.


BLOCK NO.
ROW NO.
SPACING BETWEEN ROWS FEET
SCALE FEET
I
II
III
IV
V
VI
VII
VIII
1½
1
10 FT. CHARD
MAR. 1—10 FT. EGGPLANT
10 FT. OKRA
SEPT. 1—TOMATO
3
2
MAR. 1—TOMATO
SEPT. 1—10 FT. CHARD 10 FT. EGGPLANT 10 FT. OKRA
3
PATH
3
MAR. 1—GREEN BEAN*
JULY 1—CABBAGE*
OCT. 1—GREEN BEAN
JAN. 1—TOMATO
2
4
JULY 1—
MAR. 1—CABBAGE*
20 FT. BEET 10 FT. MUSTARD
OCT. 1—15 FT. CABBAGE 15 FT. LETTUCE
1½
5
MAR. 1—LETTUCE*
JULY 1—GREEN BEAN*
NOV. 1—20 FT. BEET 10 FT. TURNIP
3
PATH
6
MAR. 1—LIMA BEAN
SEPT. 1—ONION
2
7
MAR. 1—ONION
NOV. 1—CARROT
1½
DEC. 1—
8
MAR. 1—CARROT
AUG. 1—GREEN BEAN*
15 FT. CABBAGE 15 FT. LETTUCE
3
PATH
9
MAR. 1—20 FT. BEET 10 FT. TURNIP
JULY 1—LETTUCE*
DEC. 1—GREEN BEAN*
1½
10
APR. 1—15 FT. CABBAGE 15 FT. LETTUCE
JULY 1—CARROT
2
11
APR. 1—GREEN BEAN*
AUG. 1—15 FT. CABBAGE 15 FT. LETTUCE
DEC. 1—LIMA BEAN
3
PATH
12
MAY 1—GREEN BEAN*
SEPT. 1—CABBAGE*
JAN. 1—GREEN BEAN*
2½
SEPT. 1-LETTUCE INTERPLANT*
13
MAY 1—CABBAGE*
SEPT. 1—CARROT
JAN. 1—LETTUCE*
1½
14
MAY 1—20 FT. BEET 10 FT. MUSTARD
SEPT. 1—LIMA BEAN
JAN. 1—CARROT
2½
PATH
15
MAY 1—CARROT
SEPT. 1—GREEN BEAN*
FEB. 1—15 FT. CABBAGE 15 FT. LETTUCE
2
16
MAY 1—LETTUCE*
SEPT 1—20 FT. BEET 10 FT. MUSTARD
JAN. 1—CABBAGE*
1½
17
JUNE 1—LIMA BEAN
JAN. 1—20 FT. BEET 10 FT. TURNIP
2½
PATH
18
JUNE 1—GREEN BEAN*
NOV 1—CABBAGE*
FEB. 1—GREEN BEAN*
2
19
JUNE 1—15 FT. CABBAGE 15 FT. LETTUCE
NOV. 1—LETTUCE*
1½
20
JULY 1—TOMATO
NOV. 1—GREEN BEAN*
3
PATH
21
MAY 1—TOMATO
DEC. 1—10 FT. CHARD 10 FT. EGGPLANT 10 FT. OKRA
2½
22
JUNE 1—10 FT. CHARD 10 FT. EGGPLANT 10 FT. OKRA
NOV. 1—TOMATO
1½
5
10
15
20
25
30
35
40
45
50
30

garden essentially like the one diagrammed. The University plantings have shown that crops such as beets, carrots, bush lima beans, and tomatoes should be planted more frequently than the diagram suggests if an ideal distribution of harvests is to be procured. However, it is hardly necessary that all the crops be available during every week of the year.

A home garden of the type outlined here requires almost daily attention and many hours of work weekly. It is well for inexperienced gardeners to start in a small way and expand to a larger area and a greater diversity of crops as interest and experience develop.

In preparing the diagram, the length (50 feet) was subdivided to indicate the exact block and row spacing. All plantings are full 30-foot rows unless otherwise indicated. March 1 has been arbitrarily selected as a starting date for this as well as the other two gardens.

Radishes could be interplanted in almost any area of the garden. New Zealand spinach could be substituted for one or two chard plantings. Footnote 2 of table 4 suggests other possible substitutions.

Many rows in this garden would be vacant for several weeks at a time. The soil should, in such an event, be dug up and left fallow. In an area to be kept in vegetables for several years, this period of rest would be of great value in maintaining good physical condition and productiveness. *The plan provides for blocks that can be treated roughly as rotation units, and that can be applied to either flat, raised, or bordered beds.*

Pole lima beans, pole green beans, or pole cowpeas (Yardlong beans) could be planted on the borders of the garden as a partial windbreak or could be grown against a fence. These would replace some of the bean plantings as diagrammed, thereby leaving room for other crops.

Succession plantings of many of the crops tend to build up *insect*

FIGURE 1.—Year-round plan for a medium-size home garden—30 by 50 feet. See table 4 for linear feet of rows to be planted to each crop and footnote 2, which suggests substitutes for cabbage plantings at low elevations, especially in summer. In the diagram, unless otherwise indicated, each planting of a given crop is a row 30 feet long. The asterisks (*) after cabbage, lettuce, and green beans mean that 15 feet should be planted the first of the month and 15 feet on the 15th of the month. The green bean and lima bean plantings indicated in this plan should be bush varieties. March 1 was arbitrarily chosen as a starting date.

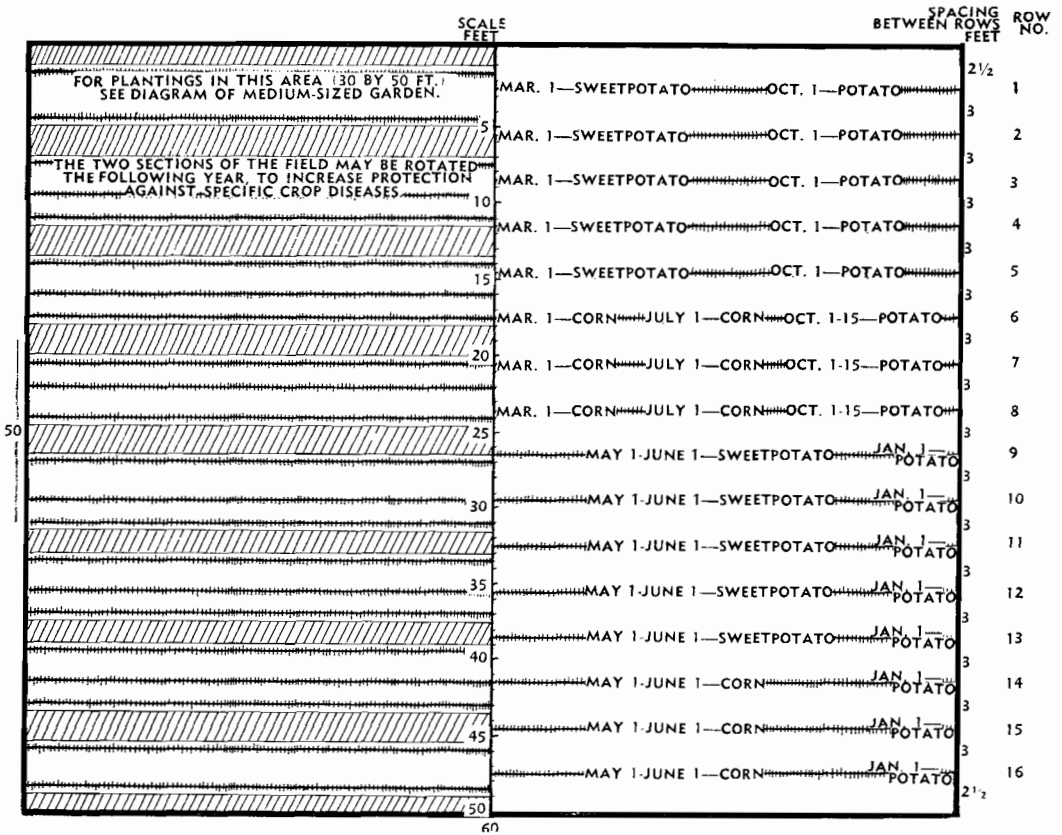
populations and diseases unless the gardener practices constant control.

A Large Home Vegetable Garden (60 by 50 feet)

Under good conditions, a garden 60 by 50 feet should supply most of the fresh and starchy vegetables for four or five persons (figure 2).

The plan contemplates that half the space (30 by 50 feet) be planted according to the diagram for the medium-sized garden, and that the other half be planted to Irish potatoes, sweetpotatoes, and sweet corn. However, the actual proportions of the crops and the planting dates shown will apply only to low to medium elevations in the Islands. At high elevations sweetpotatoes are not well adapted,

FIGURE 2.—Year-round plan for a large home garden—50 by 60 feet. See table 5 for linear feet of rows to be planted to starchy crops in half of this garden.



and Irish potatoes should be grown during the spring and summer rather than late fall and winter months.

The number of rows of Irish potatoes and sweetpotatoes is based on estimated annual requirements of around 1,000 pounds of the two starchy crops combined, with expected normal yields of just over 1 pound for each linear row of Irish and 1½ pounds for sweets. Because of the expected higher yield of sweetpotatoes, space is available during the summer months for growing corn.

The scheme for planting is shown in table 5.

TABLE 5.—Linear feet of rows to be planted to starchy crops in half of large garden

CROP	JAN.	FEB. MAR.	MAY JUNE	JULY	OCT.
Irish potatoes ...	[1]240				[2]240
Sweetpotatoes ...		150	150		
Corn		90	90	90	

[1] Harvest first 2 weeks in April; hold in *cool*, well-aerated place and use any cut or bruised tubers first.

[2] Harvest early in January; clean off and burn all dead vines and spade up area so that no diseases will be carried over to the January planting in adjacent area.

A Small Home Garden (30 by 15 feet)

A garden 30 by 15 feet should supply a considerable part of the green vegetables for two to four people, but *to do so, it must be cultivated intensively.* The diagram (figure 3) provides for rapid harvests and succession cropping, and would probably be practical only at relatively low elevations. At high elevations, in winter, slow crop growth would make it necessary to reduce the number of crops grown or arbitrarily eliminate a few plantings now and then. A serious difficulty in intensive cultivation of so small an area is the necessity of preparing seedbeds for new plantings scattered throughout the area.

The monthly planting scheme for the small home-garden diagram is shown in table 6.

Pole lima beans planted around the garden, to grow on a fence or artificial windbreak, would add to the garden's productivity. The detailed plans for a medium-sized garden gives further suggestions of crops that may be substituted for those listed. At low elevations in summer, substitutes for head cabbage should be considered (table 4, footnote 2).

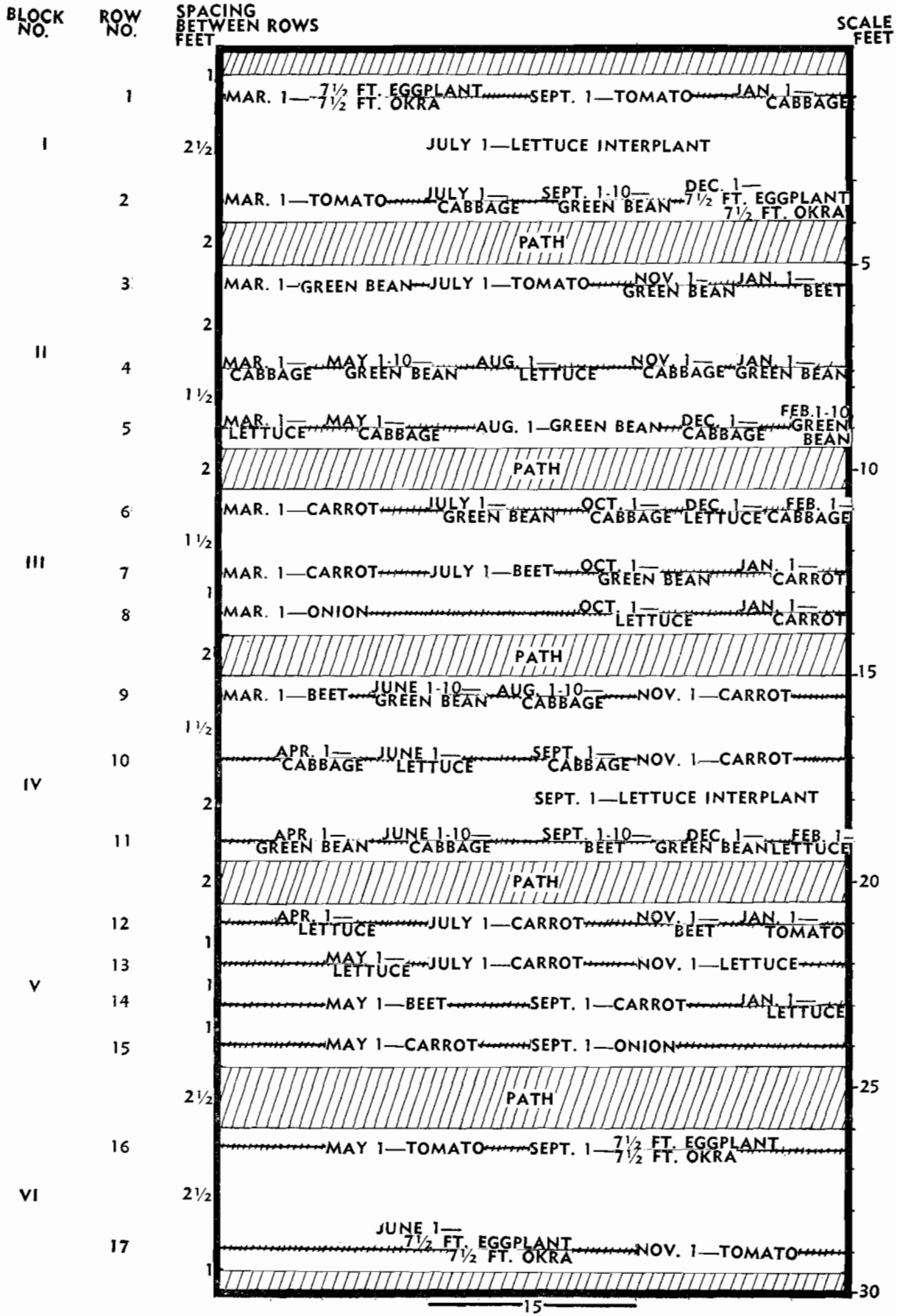

BLOCK NO.
ROW NO.
SPACING BETWEEN ROWS FEET
SCALE FEET
I
II
III
IV
V
VI
1
MAR. 1—7½ FT. EGGPLANT 7½ FT. OKRA—SEPT. 1—TOMATO—JAN. 1—CABBAGE
2½
JULY 1—LETTUCE INTERPLANT
2
MAR. 1—TOMATO—JULY 1—CABBAGE—SEPT. 1-10—GREEN BEAN—DEC. 1—7½ FT. EGGPLANT 7½ FT. OKRA
2
PATH
5
3
MAR. 1—GREEN BEAN—JULY 1—TOMATO—NOV. 1—GREEN BEAN—JAN. 1—BEET
2
4
MAR. 1—CABBAGE—MAY 1-10—GREEN BEAN—AUG. 1—LETTUCE—NOV. 1—CABBAGE—JAN. 1—GREEN BEAN
1½
5
MAR. 1—LETTUCE—MAY 1—CABBAGE—AUG. 1—GREEN BEAN—DEC. 1—CABBAGE—FEB. 1-10—GREEN BEAN
2
PATH
10
6
MAR. 1—CARROT—JULY 1—GREEN BEAN—OCT. 1—CABBAGE—DEC. 1—LETTUCE—FEB. 1—CABBAGE
1½
7
MAR. 1—CARROT—JULY 1—BEET—OCT. 1—GREEN BEAN—JAN. 1—CARROT
1
8
MAR. 1—ONION—OCT. 1—LETTUCE—JAN. 1—CARROT
2
PATH
15
9
MAR. 1—BEET—JUNE 1-10—GREEN BEAN—AUG. 1-10—CABBAGE—NOV. 1—CARROT
1½
10
APR. 1—CABBAGE—JUNE 1—LETTUCE—SEPT. 1—CABBAGE—NOV. 1—CARROT
2
SEPT. 1—LETTUCE INTERPLANT
11
APR. 1—GREEN BEAN—JUNE 1-10—CABBAGE—SEPT. 1-10—BEET—DEC. 1—GREEN BEAN—FEB. 1—LETTUCE
2
PATH
20
12
APR. 1—LETTUCE—JULY 1—CARROT—NOV. 1—BEET—JAN. 1—TOMATO
1
13
MAY 1—LETTUCE—JULY 1—CARROT—NOV. 1—LETTUCE
1
14
MAY 1—BEET—SEPT. 1—CARROT—JAN. 1—LETTUCE
1
15
MAY 1—CARROT—SEPT. 1—ONION
2½
PATH
25
16
MAY 1—TOMATO—SEPT. 1—7½ FT. EGGPLANT 7½ FT. OKRA
2½
17
JUNE 1—7½ FT. EGGPLANT 7½ FT. OKRA—NOV. 1—TOMATO
1
30
15

TABLE 6.—Linear feet of rows to be planted to each crop in a 30- by 15-foot garden

CROP	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Beans, bush green...	15	15	15	15	15	15	15	15	15	15	15	15
Beets	15		15		15		15		15		15	
Cabbage[1]	15	15	15	15	15	15	15	15	15	15	15	15
Carrots	30		30		15		30		15		30	
Eggplant[2]			7½			7½			7½			7½
Lettuce	15	15	15	15	15	15	15	15	15	15	15	15
Onions, green bunching			15						15			
Tomatoes[3]	15		15		15		15		15		15	
Okra			7½			7½			7½			7½

[1] About twelve plants needed for each planting.
[2] Two or three plants required each time.
[3] About six to eight plants required each time.

FIGURE 3.—Year-round plan for a small home garden—15 by 30 feet. See table 6 for linear feet of rows to be planted to each crop. Also see footnote 2 to table 4 suggesting substitutes for cabbage plantings at low elevations, especially in summer. In the diagram, unless otherwise indicated, each planting of a given crop is a row 15 feet long. The green bean plantings indicated in this plan should be bush varieties. March 1 was arbitrarily chosen as a starting date.

SECTION

•4•

GARDEN SOILS, MANURES, AND FERTILIZERS[1]

Improvement of Soil

IT IS STANDARD PRACTICE for agriculturists to state that vegetables should have rich, sandy loam soils for good growth. True, such soils are to be preferred, but ideal soils are rarely available in small gardens in Hawaii and we must make the best use of what we have. Through skillful handling, many seemingly unpromising soils can be made to produce vegetable crops. The improvement may be brought about by one or a combination of the following practices.

(*a*) Applying relatively large amounts of organic matter (manures or composts).

(*b*) Using black sand (volcanic ashes from the mountains) or beach sand, in addition to manure, for heavy, tight soils.

(*c*) Applying commercial fertilizers and possibly lime.

(*d*) Irrigating carefully—particularly avoiding continued overirrigation.

(*e*) Improving drainage.

(*f*) Cultivating carefully—particularly by avoiding cultivating and walking in the garden when the soil is wet.

Attempts to grow crops on steep hillsides all of whose topsoil has been washed away or in low areas whose water table is near the soil surface may prove foolhardy—even with the judicious use of commercial fertilizer. However, satisfactory gardens are sometimes maintained in poor drainage areas by digging drainage ditches and by planting the crops on high beds.

If the gardener is doubtful about the practicability of using certain soil for growing vegetables, he should consult a competent agriculturist before he expends time, money, and energy on a garden doomed to be a disappointment.

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[1] This section was reviewed by Lyman A. Dean, Associate Chemist, Hawaii Agricultural Experiment Station.

Manures and How to Use Them

Value of barnyard manure depends to a great extent upon the animal producing it, the nature of his feed, the age of the manure, and the care with which it has been preserved. In general, poultry manure has more plant nutrients than horse manure, and cow manure ranks below both. The high nitrogen content of poultry manure makes it especially beneficial for leafy crops such as lettuce, chard, cabbage, mustard, and spinach. Pig manure varies greatly in fertilizer value, but in no case is there good reason for discarding pig manure as unfit for use. Rabbit manure may be composted or added to the garden in the fresh state in small quantities from time to time; commercial fertilizer should be used with it. The following thoughts should be kept in mind in regard to barnyard manures:

(*a*) Manure may be used when it is fresh, either before or after crops are planted, but if it is used in the fresh state on a growing crop it should not be allowed to touch the plants. This is especially important for chicken manure.

(*b*) Applications of horse, cow, or pig manure at the rate of 1 pound per square foot of soil are considered as moderately heavy.

(*c*) In general, poultry manure should be used at about one-half the rate of other manures.

(*d*) It is generally best for home gardeners using fresh chicken manure to apply small amounts to the garden, frequently, rather than to leave the manure in a pile to rot for several months.

(*e*) If manure is placed in piles for storage or composting, it is well to add superphosphate at the rate of 5 to 10 pounds per 100 pounds of manure. The superphosphate will help preserve nutrients in the manure and will add to its fertilizer value. The compost heap should be kept moderately moist. Heavy rains or heavy amounts of water applied to a manure heap leach out the nutrients. In heavy rainfall areas, a cover over the manure is desirable.

(*f*) If manures from different sources are available, as from cows, poultry, or pigs, it is generally best to mix them rather than to keep and use each separately.

(*g*) Although the value of manure for vegetable gardens is generally recognized, it should be realized that there are certain possible disadvantages in its employment. Weed seeds and nut grass may be introduced; the cost is high; and, if the manure contains much straw, it may actually depress plant growth for the first few weeks after application to the soil.

Mud Press and Sawdust

The mud press from sugar mills is an excellent material for improving soil *if given sufficient time to decompose.* Mud press for a vegetable garden should preferably be composted before it is applied (see discussion of Composts). Several months may be required for thorough decomposition. Use of fresh mud press, especially in large amounts, on a garden area may result in serious yellowing of crop foliage. Mud press should be free of nut grass when applied to gardens.

Sawdust, too, should first be composted unless amounts used are relatively small or unless plenty of nitrogen is given to the garden crops to prevent yellowing. If mixed with chicken manure, there is less need for addition of nitrogen.

Composts, Artificial Manures

Manure or compost helps improve the physical condition and helps prevent baking and poor aeration of heavy, tight, "run together" soils. Plant roots grow best in a well-aerated soil.

When manure is not available, as is so often the case for home gardeners, partially decomposed leaves or lawn clippings will help. An artificial manure or compost of considerable value can be made by throwing leaves, lawn clippings, and tender hedge clippings into a compost pit or pile, *preferably adding a thin layer of manure and soil,* about 10 pounds of superphosphate, and 5 pounds of ammonium sulfate to each 100 pounds of organic matter. (A pit is preferred in dry areas, and a pile on top of the ground in wet areas.) Diseased plants from the garden should not be used in the compost heap.

A 6- to 8-inch layer of leaves or trash should be followed by a sprinkling of the fertilizers and soil. This can be repeated until the pile is 30 to 40 inches deep. The pile should then be covered by a layer of soil. If superphosphate and ammonium sulfate are not readily available, a complete fertilizer such as 6–9–5 (six, nine, five), 8–12½–6, 5–10–10, or 4–12–8 may be used. A better balanced fertilizer for making this artificial manure,[2] especially prepared for use in composting rough organic matter, may be obtained from certain fertilizer dealers. In using such commercial fertilizers the dealers' directions should be followed.

The compost heap should be kept moderately moist *all of the time,*

[2] *Artificial manure* is a name that has been applied to the product obtained when rough organic materials are decomposed in the presence of certain added commercial fertilizers.

and should be turned over and mixed rather well after 3 or 4 weeks. At intervals of about 3 weeks the heap should have one or two more mixings. After 3 months or more it may be ready for use. Heavy soakings with water should never be given; the heap should have just enough each time to keep it moist.

Commercial Fertilizers

The value of manure in vegetable gardens has been discussed. But manure alone *is not a well-balanced fertilizer for vegetables.* It is too low, especially in phosphate, for most Hawaiian soils. Also, if the manure is strawy and coarse, a fertilizer relatively high in nitrogen is needed.

Three major elements required by plants and often deficient in soils are supplied by the usual commercial fertilizers. They are nitrogen, phosphorus, and potassium. If the gardener goes to a fertilizer dealer and buys a 100-pound bag of 4–12–8, he will be purchasing 4 pounds of nitrogen, 12 pounds of phosphate, and 8 pounds of potash—or 24 pounds of plant food—plus 76 pounds of other chemicals or materials employed as carriers and fillers. Kinds of fertilizers and their uses are discussed later in this section.

Lime Usually Unnecessary[3]

Liming is not necessary for most of Hawaii's gardens. Areas which sometimes benefit from applications of lime are old pineapple lands and localities where rainfall is heavy. If the gardener is not sure about the need for lime, he should apply it over a small area and observe the crop growth as compared to growth in the unlimed part of the garden. Rate of application should be from 10 to 20 pounds of hydrated (slaked) lime per 100 square feet of area, depending upon the acidity of the soil. It should be broadcast on the surface, then spaded to a depth of 4 to 6 inches, preferably a few weeks before planting seed.

Soil Preparation

The procedure outlined here for preparing a new soil area for a garden is nearly ideal, and the gardener who follows it will increase his chances of having a successful garden.

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[3] For a more comprehensive discussion of liming Hawaiian soils, read: Dean, L. A., Fertilizers, Their Purpose, Nature, Purchase, and Use. Hawaii Univ. Agr. Ext. Serv. Bul. 37: 33–36. 1940.

For those who can obtain manure, the following procedure is recommended:

(*a*) At least 3 or 4 weeks before planting time, apply manure to the area at the rate of 1 pound per square foot.

(*b*) Before the manure is spaded in, broadcast an application of 8–12½–6, 4–12–8, 6–9–5, or 11–48 ammonium phosphate fertilizer at the rate of about 2 pounds per 100 square feet (800 to 1,000 pounds per acre). The inorganic material will expedite the breakdown of the manure, aid in maintaining the organic matter of the soil, and provide the total soil mass with a moderate supply of nutrients. (See discussion of fertilizer application at time of planting.)

(*c*) Spade in the manure and commercial fertilizer to a depth of 6 to 8 inches.

(*d*) Give an immediate irrigation sufficient to moisten to an 8-inch depth, and keep the soil moderately moist to this depth until time to prepare the beds for planting.

(*e*) If weeds come up after the irrigations, hoe them out at about 7- to 10-day intervals. By far the best time to germinate the weed seeds and kill the young weeds is *before* the garden is started. This is extremely important in any new garden area where weeds have been allowed to grow for months or years.

(*f*) On the day before or the day of planting, rake over the area. Do not work in the area if soil is wet enough to pack wherever one stands. Level the surface with a rake; remove any rough debris and stones that may still be present on the surface; make sure that the soil is not in a cloddy condition and that it has not packed down and become hard. If it has become packed, it should again be dug to at least a 6-inch depth. Where a large amount of manure has been applied, the chances are that no packing will have occurred. Large clods must be broken up or the seedbed will not be satisfactory for sowing small seeds.

This procedure is predicated on the application of both manure and commercial fertilizer, and is most practical when an entire garden area is being prepared for the first time. When subsequent plantings are made, most of the garden area will be occupied and only small spaces will be prepared at any one time. Whenever a crop is harvested several weeks or a month before the subsequent planting is scheduled and manure is available, it is wise to replenish the plant nutrients in the soil.

Gardeners who are unable to obtain manure for improving the soil may have to depend upon other organic matter or sand or good

top soil hauled to the garden area. Regardless of whether manure or other organic matter is used, commercial fertilizers usually should be applied, and in some cases their use alone is all that is required to make a productive area out of a soil low in fertility.

Garden plots which have been in sod and are being cultivated for the first time in years may be found in too perfect a physical condition. They may be so open that considerable difficulty is encountered in keeping them moist, especially in the top inch or two. With a soil in this condition, newly planted seedbeds—particularly those planted to small seeds of carrots, lettuce, etc.—require frequent irrigation. Barnyard manure will improve this condition.

Types of Beds: Raised, Flat, Bordered

When the soil has been prepared, the gardener must determine the type of seedbed best suited to the land he has available.

The *raised bed,* 4 or 5 feet wide and varying in length, is common in Hawaii (figure 11). Paths are usually 18 to 24 inches wide, and the height of the bed may vary from 6 to 18 inches. These raised beds are most valuable for low areas where the water table is high, or in high-rainfall areas where good drainage and rapid drying are important. *It is not necessary for the gardener in a dry area, with a well-drained soil, to use raised beds.* If he does, he must give more attention to irrigation because the soil in raised beds dries out rapidly. However, raised beds are convenient to work with, and the loose soil thrown up in making them automatically insures a good seedbed for the first planting. Since the gardener usually walks between the high beds, there is less trampling and packing of soil near the plants—an important factor with soils that pack easily.

In low-rainfall areas, with well-drained soils, planting the garden on *flat beds* is a satisfactory practice. No furrows are required if irrigation water is applied by means of a sprinkler. It is often desirable in flat seedbeds to irrigate by sprinkling until plants are up and then make small furrows beside the rows (within 3 to 4 inches of the seedlings) for the irrigation water.

Many small backyard gardens in the Territory have *bordered beds* —beds bordered with boards or rocks (figure 9). One- by six-inch lumber is often used to hold the soil in place. These boards are held by small stakes driven into the ground on either side. Bed widths are usually 4 feet. Lengths vary, depending upon the shape of the yard area and slope of the land. Walks between beds should be 18 to 24 inches. Where lumber is available, these wooden borders often

repay the gardener for initial work of installation. They are neat in appearance, help keep grass from encroaching on the garden area, prevent erosion of soil during rains, and eliminate the necessity of spading up pathways that have been trampled upon. It is doubtful whether their use is practical for large garden areas.

For discussion of planting of seed, see Section 6.

Application of Commercial Fertilizer

Even though the soil has been improved with manure or some type of compost, it is usually advisable to apply a commercial fertilizer. As has been pointed out, use of the commercial fertilizer only will be sufficient in some soils.

Under most soil and climatic conditions, the ideal method of applying commercial fertilizer for many vegetables is to place it, at time of planting, in two bands, one on each side of the plant row, 2 inches laterally from the seed and 3 inches deep. However, satisfactory results will be obtained by placing the fertilizer in a single band 1 or 2 inches to one side of the seed row, and to a depth of 3 or 4 inches. A furrow 3 or 4 inches deep can be made with a hoe, and the fertilizer band can be applied in the furrow bottom (figure 13). Soil should then be moved back into the furrow to level off the surface of the bed. A shallow furrow for the seed is then made.

If a line has been stretched between two stakes to mark the row, both fertilizer furrow and seed furrow can be made without moving the line.

An excellent practice for home gardens in the Territory is to apply a complete fertilizer at time of planting, and to use ammonium sulfate as a side dressing after plants are well established. If ammonium sulfate is not available, a side dressing with the complete fertilizer would be satisfactory.

The most economical method of purchasing fertilizers is for two or three gardeners to get together and buy a 100-pound bag. Study the statement on page 33 on various fertilizers for home gardens and their suggested employment in Hawaii.

Leafy crops, such as lettuce and cabbage, may turn yellow more rapidly than root crops or legumes because they need relatively more nitrogen, but it is unwise for home gardeners to adhere too strictly to the statement often made that "for leafy crops, use nitrogen; for root crops, use potash; and for crops grown for fruit or seeds, use phosphate." Garden soils should be well supplied with all of these

APPROXIMATE ANALYSIS OF FERTILIZERS (nitrogen-phosphate-potassium)	COMMENTS ON THEIR USE[4]
6–9–5 (six-nine-five; also called KK) or 8–12½–6 (also called B)[4]	One of these two fertilizers would be an excellent choice for home gardens. Best employment is in bands at time of planting.
4–12–8[4]	Satisfactory in many gardens for use in bands just before seed is sown; especially desirable for root crops such as carrots, beets, turnips. May often be too low in nitrogen, especially for leafy crops requiring ammonium-sulfate side dressing later on.
5–10–10 and 10–10–5[4]	May be used in place of 4–12–8 in the way indicated above. The 5–10–10 and 10–10–5 are popular in the Hilo and Volcano areas of the Island of Hawaii. They are used at planting time, and side dressings of ammonium sulfate are applied later, as plants develop.
11–48–0 (ammonium phosphate A)[5]	Excellent for use in bands at planting time or as side dressings[6] if applied 2 or 3 inches deep and 2 or 3 inches to the side of the plants. Should not be used if potassium is needed. An excellent tomato fertilizer for many Hawaiian soils. It furnishes a high quantity of phosphate.
16–20–0 (ammonium phosphate B)[5]	Excellent as a side dressing. Should be placed in soil to a depth of 2 or 3 inches rather than on soil surface, so that phosphate is in the root zone.
21–0–0 (sulfate of ammonia)[7]	This fertilizer carries *only* nitrogen. It is valuable to home gardeners for side dressings, especially for leafy crops or when plants become yellow. *Yellowing* is often a sign of nitrogen deficiency. If it is applied too close to plants or in too heavy amounts it will cause severe burning.
0–20–0 (superphosphate)	This fertilizer carries *only* phosphate. A few home gardeners might find it worth while to use this material if considerable manure is used, or if nitrogen in the soil is high. It is valuable for adding to manure in composts.

[4] Any home gardener will do well to select *one* of the four first-mentioned fertilizers. Other generally satisfactory fertilizers, varying slightly from these ratios, may be found on the market.

[5] The 11–48 and 16–20 ammonium phosphates and the sulfate of ammonia may not be available to gardeners during the war.

[6] By side dressing is meant application after the plants are up and growing.

[7] Calcium nitrate or sodium nitrate (each about 16-percent nitrogen) can be used instead of sulfate of ammonia. All of these may be scarce during the war.

nutrients. Phosphate and nitrogen are more often the limiting elements in Hawaiian soils.

For specific fertilizer needs of certain individual crops, refer to the general discussions of these crops in Section 10.

Fertilizer should not be applied nearer than 2 or 3 inches to the seeds—never *with* the seeds or directly *above* the seeds. Such placement might injure the seeds or the future young plants.

Side dressings of nitrogen (ammonium sulfate most commonly) are often placed on the soil surface about 3 inches from the base of plants (figure 17). Because nitrogen will move downward rather easily to reach the root zone, it need not be buried. Potassium and phosphate, particularly the latter, do not move downward so easily, and that is why it is usually best to apply complete fertilizers, such as 4–12–8, 6–9–5, and 8–12½–6, well down into the soil both at time of planting and when used as side dressings. There are exceptions to these rules. In some of the coarse, sandy soils near the ocean and in the coarse soils of the Volcano District on the Island of Hawaii, application of a complete fertilizer to the soil surface is feasible. In the Volcano District, fertilizers commonly used for this purpose are 5–10–10 and 10–10–5. In these soils, application of two or three side-dressings of a complete fertilizer, rather than nitrogen alone, is a common practice. Note figure 14 on method of applying fertilizers containing nutrients *in addition to nitrogen* for side dressings of growing crops. For plants *closely spaced* in the row, a continuous band, as shown, is desirable. For *widely spaced* plants, such as cabbage, tomatoes, and eggplants, the fertilizer side dressings can be applied in a discontinuous band, so that most of the fertilizer will be near the root system of each plant (figure 15).

Amount of Fertilizer to Apply

Table 7 shows amounts of fertilizer in pounds to apply to each 25 linear feet of rows spaced 12 to 48 inches apart. Since it is often inconvenient to weigh the fertilizer, the following rough suggestions are made for applying fertilizer in a band:

(*a*) When placing such fertilizers as 4–12–8, 8–12½–6, 5–10–10, and 6–9–5 at time of planting, use 1 to 1½ level tablespoons per linear foot of row, or one medium handful (3 to 4 tablespoons) to about 3 feet of row. This is roughly a rate of 700 to 1,000 pounds an acre, for rows 18 inches apart. The amounts to apply per linear foot should not vary greatly for rows slightly closer or farther apart. (A medium handful may be regarded, roughly, as the quantity in a

moderately closed hand, held upright.)

(*b*) When placing a high-analysis fertilizer such as 11–48 ammonium phosphate at time of planting, use slightly less than indicated for low-analysis fertilizers in (*a*).

(*c*) For side dressings with ammonium sulfate, calcium nitrate, sodium nitrate, or 16–20 ammonium phosphate, use ½ tablespoon or slightly less per linear foot of row, or one medium handful to about 6 feet of row. This is roughly a heavy side dressing of 300 to 400 pounds per acre for rows 18 inches apart. Care must be taken to keep these fertilizers at least 2 inches from the base of plants; otherwise severe injury may result.

See figure 16 for discussion of application of fertilizer in liquid form.

TABLE 7.—Amounts of fertilizer to apply per 25 linear feet of row at various spacings between rows and various rates of application

DISTANCE BETWEEN ROWS	APPROXIMATE AMOUNTS[1] OF FERTILIZER PER 25 FEET OF ROW ON THE BASIS OF . . .					
	200 pounds per acre	400 pounds per acre	600 pounds per acre	800 pounds per acre	1,000 pounds per acre	1,200 pounds per acre
Inches	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
12	0.12	0.25	0.35	0.50	0.60	0.75
18	0.18	0.37	0.55	0.75	0.90	1.10
24	0.25	0.50	0.75	1.00	1.25	1.50
30	0.30	0.62	0.90	1.25	1.50	1.80
36	0.37	0.75	1.10	1.50	1.80	2.20
42	0.43	0.85	1.25	1.75	2.10	2.50
48	0.50	1.00	1.50	2.00	2.40	3.00

[1] Roughly, six to nine medium handfuls of fertilizer will weigh one pound. This will vary, of course, depending upon the individual's hand size and weights of different fertilizers.

SECTION

•5•

SEEDS FOR HOME GARDENS

Purchase and Storage

ACTUAL COST of seeds is a small item, but purchase of seeds which germinate poorly or of seeds of inferior varieties can be a costly mistake. The gardener should buy enough seeds for two or three sowings, but it is essential that he store the seeds properly.

Gardeners in Hawaii often find it difficult to secure good stands because of low seed viability. The basic reason is that our high humidity, coupled with temperatures ranging from 65° to 78° F. throughout much of the year, promote rapid deterioration of vegetable seeds.

In a few months "new" seeds of many vegetables, stored at room temperature in Hawaii, lose their viability or become so weakened that inferior seedlings result. Seedsmen should make every effort to store their seeds at low temperatures and to run germination tests on seed lots at frequent intervals. Gardeners should store their left-over seeds in the refrigerator—not in the tool box or dresser drawer. There is no danger of injury to vegetable seeds in temperatures at or near freezing. Seeds can be stored in an airtight container at room temperature if the humidity is held down by calcium chloride or calcium oxide (quicklime) placed in the bottom of the container but not in contact with the seeds.

Desirable Varieties

It is suggested that gardeners study the varieties recommended in table 8, which lists many but not all of the desirable varieties. Seedsmen may carry varieties very similar in growth habits to some of those listed, yet under different names. Moreover, improved strains and varieties are constantly being introduced; consequently, lists of recommendations become obsolete within a relatively short time.

Seed distributors should not package seeds without giving correct varietal names on the packets, nor should gardeners buy seeds unless varietal names are given. Small gardeners are advised not to experiment to any extent with new varieties. It is best to use those of

known productivity and let the experiment stations test new ones. For several crops, a more complete discussion of varieties is given in Section 10.

TABLE 8.—Vegetable varieties recommended for Hawaii

CROP	VARIETIES	REMARKS
Greens		
Beet tops	Detroit Dark Red, Asgrow Wonder, Crosbys Egyptian, Green Top Bunching	First two listed are best for large tops; many other varieties may be satisfactory
Broccoli	Calabrese, Propageno, Italian green sprouting	
Cabbage, Chinese	Wong Bok, Chiefoo, Chihili, Pe Tsai	
Cabbage, head	Golden Acre, Copenhagen Market, Marion Market, Green Acre, Fordhook Forcing, Baby Ballhead	Last two mentioned have very small heads; Marion Market is the largest and latest variety listed here
Cabbage, spoon	Shakushina	This is the true spoon-leaf type
Cabbage, spoon	Pak Choy	This is nonheading but does not have distinct spoon-shaped leaves
Celery	Utah	Utah is the dark green type. See Section 10 for other varieties
Chard	Fordhook Giant, Lucullus, Rhubarb Chard (red stalk), Large Ribbed White	
Lettuce	Manoa, Mignonette	Both small; not iceberg type. See Section 10 for other varieties
Mustard, Chinese	Kai Choy (large green leaves), Tendergreen, Chinese Broadleaf, Chinese Smoothleaf	
Onion, green	Chinese bunching, Nebuka (Japanese bunching)	Green sets are usually available and should be used
Parsley	Moss Curled	
Spinach, New Zealand	New Zealand	
Spinach, Chinese	(Amaranth)	
Root crops		
Beet roots	Detroit Dark Red, Asgrow Wonder, Crosbys Egyptian, Green Top Bunching	Many other varieties may be satisfactory
Carrots	Red Cored Chantenay, Danvers Half Long, Imperator, Oxheart, Morse Bunching, Nantes	Many other varieties may be satisfactory
Daikon	Japanese (Kokonoka), Chinese	

TABLE 8 (*Continued*).—Vegetable varieties recommended for Hawaii

CROP	VARIETIES	REMARKS
Greens (Cont.)		
Radishes	Scarlet Globe, White Icicle, and many others	Scarlet Globe is early, White Icicle slightly later. Many other varieties may be satisfactory
Turnips	Purple Top White Globe, Shogoin	
Fresh and green-shell legumes		
Beans, bush wax	Pencil Pod Black Wax, Prolific Black Wax	Both excellent; resistant to rust disease
Beans, bush green	Bountiful, Plentiful, Giant Stringless Green Pod, Burpees Stringless Green Pod	All excellent and highly resistant to rust disease
Beans, pole green	Kentucky Wonder Brown-Seeded Rust Resistant	See Section 10
Beans, bush lima	Fordhook Bush, Henderson Bush, Baby Potato Bush	Fordhook is the large lima type; other two are small podded
Beans, pole lima	Fordhook Pole, King of the Garden, Carolina Sieva	First two are large podded; Carolina Sieva is small
Cowpeas, bush	Blackeye, Cream Lady, Brown Crowder	Blackeye is earliest and easiest to shell
Cowpeas, pole	Yardlong (various types)	
Peas, Chinese	Mammoth Melting Sugar	Often difficult to grow; plant only in cool season
Soybeans	*Spring and summer:* Hahto, Sac, Imperial, Bansei. *Winter:* Seminole	
Starchy vegetables		
Corn	USDA 34	Best not to try other varieties
Potatoes, Irish	Bliss Triumph (Hawaiian Rose) for red potato; British Queen, Katahdin for white	Plant in fall, winter, early spring, at low elevations; in spring and summer at high elevations
Sweetpotatoes	Tantalus, No. 35.9, No. 35.5, Native Red (New Era Red), Kaneohe	See discussion of sweetpotato varieties in Section 10
Miscellaneous crops		
Chayotes	Any available	
Eggplants	Black Beauty, Half Long, Florida highbush	
Okra	Perkins Mammoth (Long Green), Dwarf Prolific	Other varieties may be satisfactory
Tomatoes	*Large fruits:* Break O' Day, Valiant, Bounty, Stokesdale, Pritchard, Marglobe, Rutgers. *Small fruits:* Plum (many strains), Cherry (many strains), and Pear (many strains)	See discussion of tomato varieties in Section 10

Growing Seed Supplies

As long as seed supplies of well-adapted varieties are obtainable in the Territory, it would be best for most gardeners to make no attempt to save their own seeds. Valuable space in small gardens is taken up by permitting crops to remain until seeds are produced.

Crops from which seeds can, if necessary, be saved in Hawaii, are broccoli, lettuce, daikon, beans of various types, cowpeas, soybeans, Chinese bunching onions, green and white mustards, Chinese spinach (amaranth), corn, eggplant, okra, and tomatoes. Crops which go to seed only after special handling or which in most areas of the Islands present difficult problems in seed production are beets, head cabbage, celery, chard, bulb onions, carrots, and Chinese cabbage.

A Simple Germination Test

When in doubt about viability of seeds, the gardener should run a simple germination test. Place a few seeds between folds of cloth or absorbent paper and lay them in the bottom of a dinner plate. Pour sufficient water over the cloth or paper to moisten it well, then place an inverted plate or other convenient cover over the germinator to hold in the moisture. Sufficient water should be added, as needed, to keep the cloth or paper *constantly* moist, but flooding (immersion) of seeds must be avoided. The test should be run in a shady place. Most vegetable seeds germinate within 4 to 8 days. To prevent damage from molds during germination, it is best to immerse cloth and dishes in boiling water for a few minutes before using them. They must be cool, however, when seeds are placed in them for the test. When the seeds have germinated, they should be counted. In general, *at least* 50-percent germination is desirable.

Seed Fumigation

Some seeds, such as beans and corn, if stored at room temperatures, may be attacked by weevils. These insects can be controlled by fumigating the seeds in a closed container with about 1½ teaspoonfuls of carbon disulfide to 1 gallon *of space.* The carbon disulfide should be placed in an open receptacle or poured on cloth or blotting paper *on top of the seeds* and the top of the gallon container tightly closed. Fumigation time should be approximately 24 hours. Heating in an oven for two hours at 130° to 140° F. is another method of control that has been recommended. Higher temperatures or longer periods of heating must be avoided.

For a discussion of seed treatment to control damping-off disease, see Section 7.

SECTION

·6·

PLANTING THE SEED, SEED REQUIREMENTS, AND THINNING

How to Make Furrows

AFTER THE SOIL has been pulverized and leveled off in preparation for planting, a cord should be stretched between two stakes where the row is to be planted; then fertilizer should be applied in a furrow made parallel to and 2 or 3 inches away from the cord, as described in Section 4.

When the soil has been leveled over the fertilizer furrow, a shallow furrow for seeds should be made directly under the cord. For making the furrow, the handle end of a hoe or end of a stake can be used. Drawing a stake 3 or 4 inches wide through the soil will make a *broad furrow,* which is best for planting carrots, beets, radishes, lettuce, and mustard. A corner of the hoe can be used for making deeper furrows for beans and corn.

Depth to Plant

Seeds of radish, lettuce, turnip, mustard, Chinese cabbage, spoon cabbage, carrot, and vegetables of similar size should usually be planted about ½ inch deep (figure 19). Slightly deeper planting may be satisfactory on coarse, open soils that dry out quickly, while slightly shallower planting may be better for fine soils that hold moisture well and from which seedlings emerge with more difficulty. Beans and corn should be planted 1 to 1½ inches deep. It is safe and best to sow all kinds of seeds shallower than has been indicated above *if special care is taken to maintain sufficient moisture in the seeded zone* (figure 18).

Quantity of Seeds to Sow

The quantity of seeds required to plant a given length of row is often difficult to ascertain. Although table 9 gives approximate amounts required, it must be understood that the estimates are very rough.

Small-seeded crops, such as carrots and lettuce, are most difficult to gauge, but it is wise to plant three or four times the quantity required for a perfect stand (figure 22); otherwise cutworms, damping-off, weak seedlings, or poor germination may cause erratic stands. On the other hand, there is no need for literally pouring seeds into the soil so that valuable seeds are wasted and tedious work is required for thinning. Also, damping-off may be more destructive when stands are extremely heavy.

Seedlings of beans, corn, and peas are large and relatively hardy so that it is well to plant only a very few more or no more than are actually needed for the desired stands.

Beets and chard need not be planted so thickly as lettuce, since each so-called seed is capable of producing two or more plants. Chard requires relatively wide spacing.

If the shallow furrow made to receive the seeds is rather wide and the seeds are scattered *laterally* over the 3 or 4 inches of furrow, there is more room for young plants to grow, more plants per linear foot of row can be left standing, and thinning will be facilitated.

Thinning and Spacing

When thinning is necessary, it should not be delayed until plants become badly crowded. For most crops, the three- or four-leaf stage is a convenient time for thinning. Young plants of carrots and beets are relatively delicate, and if they are thinned too early poor stands may result (figure 21).

Spacings of plants between rows vary according to crop, variety, soil fertility, and the type of irrigation practice. As a rule, the better the conditions for growth, the closer plants may be planted. That is, good fertility and plentiful moisture permit close planting. There is, of course, an unknown optimum planting distance for every individual garden and for each season. The gardener should do some simple experimenting to find how close he can plant and yet secure good crop growth (figure 20). Spacings shown in table 9 give conservative ranges for hand-cultivated gardens. Close spacing generally tends to delay maturity, particularly with root crops such as carrots and beets. At the same time, a longer *harvest range* may often be expected when the plants of root crops stand rather thickly in the row.

TABLE 9.—Depths to plant, spacings, and seed requirements for vegetables in Hawaii

VEGETABLE CROP	DEPTH TO PLANT SEED	SPACINGS		QUANTITY OF SEEDS OR PLANTS REQUIRED FOR PLANTING	
		In the row[1]	Between rows[2]	Number per foot of row[3]	Quantity per 25 linear feet of row[4]
Greens	*Inches*	*Inches*	*Inches*		
Beet tops	½–1	1½–2½	12–18	12–15	1 oz. or less
Broccoli	½	18–24	18–30	—	12 to 15 plants
Cabbage, Chinese	½	8–16	15–24	8–10	1 packet or less
Cabbage, head	½	12–20	18–30	—	20–25 plants
Cabbage, spoon	½	4–8	12–18	10–12	1 packet or less
Celery	⅛–¼	6–10	12–24	—	40 to 50 plants
Chard	¾–1	8–12	15–24	—	1 packet
Lettuce (small)	½	4–8	8–12	12–20	1 packet or less
Mustard, Chinese	½	4–8	12–20	12–20	1 packet or less
Onion, green	Seed ½–1	2–4	8–12	20–30	1 packet or less
Parsley	⅛–¼	4–6	12–18	12–15	1 packet or less
Spinach, New Zealand	¾–1	12–18	18–30	6–12	2 oz.
Root crops					
Beet roots	½–1	1½–2½	12–18	12–15	1 oz. or less
Carrot	½	1–2	12–18	30–40	⅛ to ¼ oz.
Daikon	½	2–3	12–18	15–25	½ oz. or less
Radish	½	½–1	12–18	30–40	½ oz. or less
Turnip	½	2–3	12–18	25–30	1 packet
Fresh and green-shell legumes					
Bean, bush green	¾–1¼	3–6	15–24	4–6	2 to 4 oz.
Bean, pole green	¾–1¼	12–24	24–36	3–4	2 oz.
Bean, bush lima	¾–1¼	6–8	15–24	3–4	2 oz.
Bean, pole lima	¾–1¼	12–24	24–36	2–3	2 oz.
Cowpea, bush	¾–1¼	6–12	18–30	3–4	2 oz.
Cowpea, pole	¾–1¼	12–24	24–36	2–3	2 oz.
Pea, Chinese	¾–1¼	1–3	12–18	10–12	2 to 4 oz.
Soybean	¾–1¼	3–6	12–18	4–6	2 to 4 oz.
Starchy vegetables					
Corn	1½–2	10–15	24–36	2–3	1 oz. or less
Potato, Irish	3–4	10–18	30–40	1 seedpiece	3 to 4 lbs.[5]
Sweetpotato	Plants 3–5	10–18	40–60	—	20 to 30 cuttings
Miscellaneous crops					
Chayote	Barely cover	40–60	60–72	—	5 or 6 fruits
Eggplant	½	24–36	30–40	—	12 to 15 plants
Okra	½–1	18–24	30–40	4–6	½ oz. or less
Tomato	½	18–30	24–36	—	12 to 15 plants

[1] If good *lateral spread* of 3 to 4 inches in the row is obtained for such crops as carrots, beets, radishes, turnips, and mustard, spacings closer than those indicated are possible.

[2] These spacings apply to a hand-cultivated garden. Wider spacings are advisable on large gardens where mechanical equipment is used.

[3] Provides for moderate safety margin in most cases. With excellent germination, some crops will need slight thinning out. If germination is known to be low, thicker planting than indicated may be desirable.

[4] Very rough approximations, except for plants required; for crops seeded in place in the garden, it will be best to use the column on seeds to sow per linear foot as a gauge for amounts to use when planting.

[5] Desirable to have each seedpiece weigh 2 or 3 ounces.

SECTION

•7•

GROWING PLANTS FOR TRANSPLANTING

Crops to Transplant

SEEDLINGS ARE GROWN for transplanting in order to conserve garden space for a few weeks, to facilitate irrigation, and to simplify control of insects or diseases that may attack the young seedlings.

Of the group of vegetable crops listed as being best adapted for Hawaii's gardens, the following should often be grown in small seedbeds, flats, cups, or pots, and transplanted to rows in the garden:

Broccoli	Lettuce	Eggplant
Head cabbage	New Zealand spinach	Tomato
Celery		

Many gardeners find it best to seed lettuce directly in the garden rather than to transplant.

Close attention must be given to young plants in early seedling stages. The small gardener should obtain plants of good varieties ready to transplant if he can get them at a reasonable cost.

Methods of Starting Young Plants

If the gardener is careful to provide rather fertile, nematode-free soil (see Root Knot, Section 8) and repeatedly inspects the young plants for insects and diseases, it matters not whether the transplants are grown in a flat, in a small seedbed in the garden, in individual paper cups, or in clay pots.

For sterilizing small quantities of soil, the following methods have been recommended: (1) Place soil in *shallow* pans and bake in an oven for 2 hours at 180° F.; (2) Pour boiling water over soil in a shallow container, using 1 gallon of boiling water to one-half gallon of soil. A disadvantage of the first method is the disagreeable odor which will result if soil is baked in the kitchen oven.

Plants grown in cups and pots are disturbed less and "grow off" more quickly when transplanted to the garden, but they usually require closer attention, especially as to irrigation, than plants grown in an open bed. Plants taken from an open seedbed, with

very little or no soil attached to the roots, can be easily and successfully transplanted if the soil around the plants is kept moist for a few days after transplanting.

A rich, open soil that holds water well should be provided for growing transplants. An ideal mixture consists of one part good soil, one part well-rotted compost or manure, and one part sand. For a rather sandy soil, about one part compost or manure can be used to two parts soil.

Any one of the following methods is commonly used in growing broccoli, cabbage, celery, lettuce, New Zealand spinach, eggplant, and tomato plants:

(*a*) Seeds are sown in a small bed in the garden. Seeding rate should be about 50 seeds per square foot. Seeds should be well scattered and spaced. Plants are allowed to grow until large enough for transplanting. Some thinning may be needed. Seeds of the crops named should be planted about ½-inch deep or slightly shallower. The soil *must* be kept moist until seeds have germinated. (See discussion of treating seeds for damping-off.)

(*b*) Seeds are sown in a bed in the garden as described in (*a*), but when the seedlings have three or four leaves they are transplanted to a seedling bed in the garden to give them more room. This procedure is hardly necessary for a good gardener. However, celery responds well to this extra transplanting.

(*c*) Seeds are sown in a flat or box filled with soil, at the rate of 50 to 100 seeds per square foot, and to a depth of ¼ to ½ inch. Seeds may be broadcast, then covered by sprinkling with soil to the desired depth; or shallow furrows can be made 2 inches apart and ¼ to ½ inch deep and seeds sown, then covered by carefully brushing soil back into the small furrows. After the seeds are sown, the flat should be irrigated well.

If a burlap bag or sheets of paper are placed over the flat, moisture will be held well and several subsequent irrigations can be avoided. However, the soil should be examined each day to determine whether irrigation is needed. A light, coarse soil may dry out quickly. In such a soil, planting at the ½-inch depth is desirable, whereas in a heavier soil a ¼-inch depth is sufficient if the flats are covered with cloth or paper. As soon as seedlings appear, the burlap or paper should be removed and the flat placed in partial shade for one day; thereafter the flat should be given full sunlight or shaded only lightly. When the plants have three or four leaves, they should be thinned to stand about 2 to 3 inches apart each way.

(*d*) Seeds are sown in a flat, but when the seedlings have three or four leaves they are transplanted to other flats and carefully spaced about 2 by 2, 2 by 3, or 2 by 4 inches apart (figure 23). When the small plants are removed from the flat they should not be pulled; they should be *lifted,* with as much soil attached as possible. The more room given to each plant, the stockier it will usually be. The carefully spaced plants can be "blocked out" after this first transplanting by cutting the soil with a knife when they are to be transplanted to the garden (figures 25, 26); if the soil is wet—as it should be—the plants can be removed with soil and root system intact. The shock of transplanting will thereby be reduced.

(*e*) Seeds are sown in a flat, but the individual seedlings are transplanted to paper cups or clay pots instead of to another flat. Use of these small containers is better insurance against disturbing the root systems when transplanting to the field. When the plants are large enough to be transplanted to the garden, a good irrigation should be given the soil in the cup. If paper cups are used, the paper should be removed and discarded just before the plant is placed in the ground.

(*f*) Seeds are sown *directly in paper cups or pots* (figure 24). The cups or pots are filled up to within ½ inch of the top, and three to six seeds are pushed into the dry soil to a depth of ¼ to ½ inch. The soil is then irrigated well, and it is kept moist until seeds are up. Care must be taken that all of the cups receive adequate moisture. When seedlings have three or four leaves, they should be thinned to one plant per cup and allowed to grow until ready for transplanting to the garden. Often the gardener fails to irrigate some of the cups or pots adequately. Seeds consequently fail to germinate or young plants suffer for lack of water.

Home-made paper cups, used for growing transplants, are popular in Hawaii (figure 24). They can be prepared in the following simple manner: Cut newspaper strips 6 inches wide entirely across a single sheet. Place a pint milk can or milk bottle near one edge of the paper strip and roll the paper up with the bottle or can; leave 2 or 3 inches of the strip below the bottom of the container. Fold this paper tightly against the bottom of the container, thus making a cup the size of the bottle or can.

Fertilizing Seedlings

Rapid growth of seedlings means earlier transplanting to the field and a shorter total time from planting of seed to first harvest. To

keep seedlings growing rapidly, it may be necessary to apply commercial fertilizer. The simplest means is to measure out the fertilizer into a sprinkling can and apply in water (figure 16). Dilute solutions thus prepared can be sprinkled around the base of plants without causing injury. For use on these small plants, 2 *level* tablespoons per gallon of water of "Root Stimulant," a commercial fertilizer, or a similar amount of 11–48 ammonium phosphate is desirable. If these are not available, 3 or 4 level tablespoons of a complete fertilizer, such as 4–12–8, 6–9–5, 5–10–10, and 8–12½–6, can be used. The plants should receive a thorough irrigation with the solution. It can be applied once a week. Use of 3 or 4 level tablespoons per gallon of one of these materials is also excellent at time of transplanting plants to the field. About ½ to 1 pint should be poured around the roots of each plant when it is set out.

Controlling Damping-off Disease

Damping-off is a term applied to failure of plant seedlings to develop as a result of attack from microorganisms present in the soil and at the soil surface. The attack may come before the seedlings emerge (pre-emergence damping-off) or after the seedlings emerge (post-emergence damping-off). Often poor germination is blamed on seeds when actually the trouble is pre-emergence damping-off. Every gardener should learn the symptoms of damping-off of seedlings *after* they have emerged. An unmistakable sign is the constriction (small diameter) of the plant stem near the surface of the soil (figure 41). In the early stage of damping-off the constriction may not be marked, but plants may have toppled over and a water-soaked appearance of the stem near the soil surface may be noted. This toppling over of seedlings is not an uncommon sight in Hawaii. Gardeners may become enthusiastic over an excellent stand of plants only to find, in a few hours or days, that the plants have vanished. This disappearance is almost certain to be the result of damping-off or of cutworms. (See Broccoli, Section 10, for discussion of cutworm control.)

Two materials, Semesan and copper oxide,[1] can be used in treating seeds for damping-off before seedlings emerge. One of the two chemicals can also be sprinkled over the plants and soil when plants begin to damp-off *after* emergence. The present recommendations

[1] Yellow Cuprocide, a trade name, is at present the common copper oxide available in the Territory.

of the experiment station as to the material for control of damping-off of specific crops follow:[2]

(*a*) Use copper oxide only on celery, lettuce, and tomato.

(*b*) Use Semesan on broccoli, cabbage, okra, radish, and turnip.

(*c*) Use either copper oxide or Semesan on beet, carrot, chard, eggplant, green bean, kohlrabi, and pepper.

The method of seed treatment is simple. The seeds are placed in a small vial or other container, a small amount of Semesan or copper oxide on the tip of a knife or spoon is added, the container is covered, and the seeds are shaken thoroughly for 1 or 2 minutes. The seeds should be coated with the fine powder. Any excess of the chemical can be poured back into the container. Seeds are ready to plant immediately after treatment. It is not recommended that every gardener treat all of the seeds that he plants. From experience with his soil and weather conditions, the gardener must learn whether seeds or plants are usually affected by damping-off, and then take the necessary steps to prevent it. (See discussion of Irrigating the Seedbed and Young Plants.)

Use of the chemicals in water for sprinkling *after* plants have emerged is necessary at times. A sprinkling can with fine perforations in the nozzle is best for applying either material to soil and seedlings. Usual concentrations are:

Semesan. 1 tablespoon per gallon of water. Irrigate the plants with 1 to 1½ quarts per 10 square feet of area. Do not apply more.

Yellow Cuprocide. 1½ teaspoons per gallon of water. Give the seedlings and soil surface a thorough drenching.

Irrigating the Seedbed and Young Plants

Daily inspections should be given the seedbed and young plants. The seedbed must not be kept soaking wet, yet soil must not dry out below the level of the planted seeds. It is unwise to attempt to irrigate a seedbed or young plants by dashing water on them from the open end of a garden hose. A nozzle with fine holes should be attached to the hose and the bed given a gentle, not a splashing, irrigation. Overirrigation before seeds are up may cause severe rotting, and if the soil surface around young plants is continually wet, damping-off diseases *can be expected* (see discussion of Controlling Damping-Off Disease). The best time to irrigate young plants is in

[2] For further details the gardener should read: Matsuura, M., Damping-Off and Its Control by Seed Treatment. Hawaii Agr. Expt. Sta. Prog. Notes 19. [Mimeo.] 1941.

early morning so that the surface will dry off during the day and will not be wet throughout the night. In an open, loose soil, especially during sunny, hot, windy weather, an irrigation each morning or even twice a day may be needed until plants are up. Under conditions where moisture is lost less rapidly or showers fall, an irrigation every 2 or 3 or more days may suffice. As plants become older, less frequent irrigations are needed, but when water is applied a good irrigation should be given—not just a token sprinkling.

Insects and Diseases of Seedlings

Damping-off, the most common seedling disease, has already been discussed. The gardener must also be continually on the lookout for insects, which can destroy tiny plants almost overnight. Since only small quantities of dust or spray are required, it is the best insurance to spray or dust at the least sign of disease or insect trouble.

Flea beetles and cabbage webworms are common and serious on young seedlings. Cutworms and grasshoppers can also be troublesome. For control methods, see discussion of insects on individual crops, Section 10.

Transplanting to the Garden

See table 10 for size of plants for transplanting. Plants of broccoli, cabbage, lettuce, eggplant, and celery should (*unless they are tall and leggy*) be planted to a depth only slightly deeper than that of the seedling in the seedbed (figure 27), but tomato plants should be planted deeply, with only 3 or 4 inches of plant remaining above ground. Plants are a small item in the cost of gardening, and it is sometimes wise to transplant two plants, within a few inches of each other, where only one is ultimately needed. After plants are growing well, one plant should be removed unless one of the two has previously been eliminated by cutworms, webworms, or diseases.

The soil should be pressed only lightly around the roots when transplanting. Moderate firming of soil around the roots will prevent the formation of air pockets, but the roots should not be crammed or doubled up in the hole made to receive the plant. A trowel is handy for making holes for the plants. In gardens of rather low fertility, it is desirable to use a commercial fertilizer in solution at the rate of ½ to 1 pint around each plant as the soil is pushed in around the roots. (See discussion of Fertilizing Seedlings.) A good irrigation should be given *immediately* after transplanting.

There is a tendency for gardeners to transplant seedlings when

TABLE 10.—Time from planting seed until plants are up, and time required for plants to reach transplant size

CROP	Time from planting until seeds should be up[1]	Time from seeding until plants should be ready for transplanting to garden	Size of transplant desirable
Greens	*Days*	*Weeks*	
Broccoli	6–12	3–6	5 or 6 leaves well expanded
Cabbage, Chinese	5–10	2–4	Best to plant "in place" in garden and not transplant
Cabbage, head	5–10	3–6	5 or 6 leaves well expanded
Cabbage, spoon	5–8	2–4	Plant "in place," if possible
Celery	12–20	6–10	6 or 8 leaves
Chard	7–12	3–4	Can be transplanted, but not desirable
Lettuce	5–10	2–4	Often best to plant "in place"
Mustard, Chinese green	5–10	——	Plant "in place"
Onions, green	6–12	6–10	Stems diameter of a pencil or larger
Parsley	8–16	4–8	4 to 6 leaves
Spinach, New Zealand	[2]10–20	4–8	4 to 6 leaves. Best to plant "in place"
Root crops			
Beets	6–12	——	Plant "in place"
Carrots	6–10	——	Plant "in place"
Daikon	5–9	——	Plant "in place"
Radishes	5–9	——	Plant "in place"
Turnips	5–9	——	Plant "in place"
Legumes			
Beans, bush or pole green	6–12	——	Plant "in place"
Beans, bush or pole lima	7–14	——	Plant "in place"
Cowpeas, bush or pole	5–10	——	Plant "in place"
Peas, Chinese	6–12	——	Plant "in place"
Soybeans	6–12	——	Plant "in place"
Starchy vegetables			
Corn	6–12	——	Plant "in place"
Potatoes, Irish	[3]7–21	——	Plant "in place"
Sweetpotatoes	——	——	Tip cuttings 12 to 15 inches long
Miscellaneous vegetables			
Chayote	——	——	Fruits or slips used
Eggplants	10–16	6–8	At least 5 or 6 leaves
Okra	[2]10–14	——	Plant "in place"
Tomatoes	6–12	3–6	6 to 10 inches high. Stocky plants best

[1] Temperature, soil moisture, age of seed, and other factors influence rate of germination.

[2] Seeds can be soaked in water 24 hours before planting.

[3] Nondormant seed showing active sprouts will come up in a short time. Dormant seed may lie in the soil many weeks. Use a mother seedpiece at least 2 ounces in weight (size of a hen's egg).

they are small and tender. This practice increases the danger of losing the plants. Since transplants grown in Hawaii are usually tender, it is well, *in hot sunny weather,* to provide a shade or partial shade for the transplanted seedlings for 2 or 3 days.

The best time to transplant is in late afternoon. If, after transplanting, the plants are given a good irrigation, they will usually be found upright and of good appearance the next morning. They will probably wilt during the day, but the dark, cool night hours will have aided in giving them an early start.

In the following list, vegetables are classified as to ease or difficulty of transplanting:

TRANSPLANT RATHER EASILY	IF CAREFULLY HANDLED, CAN BE SUCCESSFULLY TRANSPLANTED	GENERALLY UNLIKELY TO TRANSPLANT WELL[4]
Broccoli	Beets	Beans
Cabbage, head	Cabbage, Chinese	Carrots
Celery	Cabbage, spoon	Corn
Eggplants	Chard	Cowpeas
Lettuce	Chayote[3]	Daikon
Onion	Spinach, New Zealand	Mustard, Chinese
Parsley		Okra
Sweetpotatoes		Peas, Chinese
Tomatoes		Potatoes, Irish
		Radishes
		Soybeans
		Turnips

[3] If care is used in taking transplants (young, short shoots) from mother plant, the chayote can be transplanted. Best way to propagate is to plant fruits.

[4] With extreme care, *any* crop can be transplanted.

SECTION

·8·

DISEASE CONTROL IN THE GARDEN[1]

General Control Measures

LOSSES FROM DISEASE can often be prevented or checked by the following precautionary measures:

(*a*) Keep the garden free of weeds.
(*b*) Do not permit old, nonuseful vegetable plants to remain in the garden and harbor diseases.
(*c*) Fertilize and irrigate well so that plants grow rapidly.
(*d*) Do not permit plants to remain overcrowded—give such plants as tomatoes and eggplants room for free circulation of air.
(*e*) Rotate the crops as much as possible.
(*f*) Do not work around the plants when they are wet.
(*g*) Control insects, for some of them carry plant diseases.
(*h*) Use disease-resistant varieties when possible.
(*i*) Provide good drainage.
(*j*) Irrigate in the morning, rather than afternoon, if damping-off is common.

In preparing sprays containing insecticides and fungicides it is best for the home gardener to mix only enough for the day's operations. When kept several days, some such solutions undergo changes or losses that render them less useful or even harmful to plants.

It is best to prepare the spray solution in a separate container—not in the sprayer—using ½ to ⅔ of the total volume of water required. Then a cloth should be placed over the mouth of the empty sprayer so that the solution can be poured through it, thereby straining out any particles that might later cause the nozzle to become clogged. Sufficient water should then be added to bring the spray solution up to the proper volume. This procedure is particularly desirable when the gardener is preparing a spray from dry fungi-

[1] This section was reviewed by G. K. Parris, Plant Pathologist, Hawaii Agricultural Experiment Station.

cides and insecticides, and when two or more materials are being used in the spray at the same time.

Since some materials, such as copper oxide, tend to settle unless agitated, it is wise, while spraying, to shake the small sprayer frequently and thoroughly.

Types of Diseases

Diseases of vegetables may be roughly classed into two groups:

(*a*) Those caused by use of the wrong fertilizer, too much or too little fertilizer, improperly placed fertilizer, too much or too little irrigation, or poor cultural practices. A good example of this type of disease is blossom-end rot of tomato (figure 44), a dark decay that appears on the blossom ends of tomato fruits, due to lack of a plentiful and constant moisture supply.

(*b*) Those developing from definite causal agents such as fungi, bacteria, and viruses.

Virus Diseases

Virus diseases result from obscure causal agents, not visible under the ordinary microscope but now believed to be complex proteins, capable of multiplying themselves in the plant tissues. They cause a wide variety of symptoms on plants, but the most characteristic and noticeable to Hawaiian gardeners is the mosaic or light- and dark-green pattern on leaves often seen on tomatoes, green mustard, spoon cabbages (white mustards), and lettuce.

Several viruses attack tomatoes in Hawaii. One causes rapid dying back of growing points, so that it often appears as if the top of the plant had been burned (spotted wilt). Another causes tomato leaves to become extremely narrow, assuming a fern-leaf or shoestring appearance (cucumber mosaic). The latter virus can be carried to tomatoes from cucumbers. Virus diseases are carried by insects or by mechanical means, as when leaves or stems of affected plants are bruised and minute amounts of the sap are transferred by means of hands, cultivating equipment, or clothes. Since virus diseases multiply *inside* plant cells, spraying is of value only in an indirect way by helping to control insects, especially aphids. The general control measures recommended at the beginning of this section will be of some benefit in preventing virus injury.

Blights and Leaf Spots

Blights and leaf spots caused by *fungi* and *bacteria* are common garden diseases to which potatoes, tomatoes, beets, carrots, celery,

and eggplants are susceptible. These diseases can often be kept in check by early and timely spraying or dusting with copper oxide or Bordeaux mixture. Copper oxide dust or spray, which has been mentioned for controlling damping-off of seedlings, is more convenient for use by home gardeners than home-made Bordeaux mixture.[2] Ready-to-mix Bordeaux or ready-to-use copper or copper-lime *dusts* can be purchased, and instructions of the manufacturers should be carefully followed in using them.

Copper oxide can be mixed with most common insecticides for spraying if the gardener wishes to apply a poison for insects in the same operation. In combining the copper oxide with insecticidal materials, it is best to make a paste of the copper oxide in a very small amount of water before adding it to the main portion of water; then the required quantities of insecticides are measured into the water and the mixture is stirred well.

A copper-oxide nicotine-sulfate combination is often useful. It contains 1½ teaspoons Yellow Cuprocide[3] and 1½ to 2 teaspoons nicotine sulfate (Black Leaf 40) per gallon of water. Enough soap to make the water sudsy will help in spreading and sticking the spray.

Sulfur is sometimes used as a dust or spray for certain fungus diseases, particularly the rusts and powdery mildews. However, it does not have so great general value for disease control in home gardens as copper oxides or Bordeaux. If sulfur is to be used as a spray, *wettable* sulfur should be obtained. Three tablespoons of wettable sulfur per gallon of spray is the usual concentration. The sulfur should be made into a paste before it is added to the water diluent. The suspension should be stirred well while the additional water is being poured in. Sulfur should not be used on melons, cucumbers, or pumpkins because of danger of leaf burn. In hot weather, sulfur sometimes causes burning of other vegetables.

The secret of control of fungus diseases is to note their appearance *early* and to apply control measures immediately; or, better still, to

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[2] If home-made 4–4–50 Bordeaux mixture must be used, prepare it in the following manner: For 1 gallon, (1) dissolve 3 tablespoons powdered bluestone (instant or snow copper sulfate) in 1 quart water; (2) in another quart of water dissolve 8 or 9 tablespoons hydrated lime; (3) when both have been thoroughly dissolved, pour the two together, stir thoroughly, and then add 2 quarts of clear water. For the copper sulfate use a glass, wooden, or enamel container—not metal. Use Bordeaux the same day it is prepared.

[3] Yellow Cuprocide is the trade name of the most common copper oxide available in the Territory. It is listed as a convenience to gardeners—not as an endorsement over other copper oxides.

apply control measures before the disease appears. (See Section 12.) Such diligence is necessary and practical in areas where blights and leaf spots are commonly expected. Where the disease has struck, severely affected plant parts should be removed and destroyed before the fungicide is applied. For effective control, application of dusts or sprays *may* be needed at 7- to 10-day intervals—in some cases even more frequently.

Cause and Control of Wilts

Sudden unexplainable wilting of plants in spite of plentiful soil moisture is commonly caused by either *fungi* or *bacteria*. The causal organisms usually enter the plant through underground portions and spread through the plant internally. Consequently, a spray on exterior leaf or stem surfaces is of no avail. Potatoes, tomatoes, okra, peppers, and eggplants are often affected by wilts in Hawaii.

Control measures consist of rotation of crops and use of resistant varieties (see Section 10 for disease-resistant tomato varieties).

Root Knot or Galls

Abnormal increases in the root size of most vegetable crops are usually caused by nematodes—worms too small to see with the naked eye. Nematodes live in the soil and penetrate roots of plants. Those that cause the root swelling (root knot or galls, figure 42) interfere with normal root functions. They may cause plants to develop slowly and to produce slight vegetative growth and small crops. Nematodes are extremely difficult to eradicate. In large gardens, once soil has become badly infected, it may be practical and of some help to permit a portion of the area to lie dry and spaded up for several months. Remove all old roots as far as possible, and keep the plot moist for at least 2 weeks to hasten decomposition of the remaining roots.

Corn is highly resistant to nematode attack. Other plants that have been regarded as generally less subject to damage by nematodes are cabbage, Chinese cabbage, broccoli, onion, daikon, sweetpotato, and turnip. However, nematodes will attack these crops, and eradication of the worms cannot be expected simply by including these less susceptible plants in the rotation.

Nematodes can be killed by chloropicrin fumigation, but cost of the material is high. Use of this chemical requires special care, and a trained agriculturist should be consulted about it.

In Hawaii, care should be taken that transplants for the garden

are grown in nematode-free soil. This precaution is especially important for such crops as tomatoes, eggplants, and celery. (For sterilizing small quantities of soil, refer to Section 7, Methods of Starting Young Plants.)

SECTION

9

INSECT CONTROL IN THE GARDEN[1]

SOME HOME GARDENERS, planting small gardens for the first time, may be fortunate enough to escape insect troubles for a few months, but sooner or later they will need a working knowledge of common garden insects and the materials needed to control them.

General Grouping of Insects

Most garden insects that cause serious trouble may be classified into two groups: chewing insects and sucking insects. *Chewing insects,* such as caterpillars or worms, beetles, and grasshoppers, bite off and eat the plant parts. *Sucking insects,* such as aphids and leafhoppers, insert a tube (proboscis) into the plant leaf or stem and draw out the sap.

Chewing insects are usually controlled by applying *stomach* poisons to the leaf surfaces and other plant parts, either as sprays or dusts, so that the insect swallows the poison along with the leaf or stem parts. Sucking insects do not eat the plant surfaces on which poisons may be applied. They must be killed by *contact* or *respiratory* poisons.

Classification of Insecticides

Insecticides are materials used to kill insects. A simple grouping of the most common insecticides, based on their killing action, follows:

Stomach poisons: Calcium arsenate, lead arsenate, Paris green, cryolite (Kryocide is one trade name), tartar emetic, and rotenone. Rotenone is a chemical killing agent which may come from derris, cubé, or timbo roots. It is the only stomach poison listed here that is nontoxic to man when used as ordinarily directed.

Contact and/or respiratory poisons: Nicotine sulfate (Black Leaf 40 is a common trade name), pyrethrum, sulfur, oil emulsions, soaps,

[1] This section was reviewed by F. G. Holdaway, Entomologist, Hawaii Agricultural Experiment Station.

and rotenone. *Rotenone* is the only common insecticide which can be used both as a stomach poison and contact poison. However, it is not adequately effective on all insects. In the concentrations recommended for insect control, these contact poisons are not poisonous to man.

Dusting to Control Garden Insects

Most home gardeners find dusting more convenient than spraying. The care required in measuring materials and in keeping the sprayer clean often makes spraying troublesome. Purchase of a small duster is recommended. If none is available, a small cloth bag may be used. Dust is placed in the bag and applied by shaking the bag above the plant surfaces. However, for such insects as aphids, mites, and leafhoppers *it is essential that dust be applied to the under surfaces of the leaves* (figure 34), and this is difficult to do with a bag. If necessary, the plant stem must be carefully bent over or leaves turned up so that the dust can be applied to under surfaces. Essential facts about the most useful dusts for insect control in the garden follow:[2]

Rotenone dust.[3] Not toxic to man. Prepared dusts available in Hawaii, ready for use, include Botano R and Rotenone 75. Rotenone dust is the most useful insecticidal material for gardeners. (See following description of combination dusts.)

Sulfur dust. Not toxic to man. Ready for use as purchased. The gardener should ask for dusting sulfur. Along with rotenone dust, it makes a very desirable combination to have on hand at all times. It is especially useful for red spider (mite) control.

Nicotine dust. Not toxic to man after remaining on plants several hours. Especially effective for aphids. May be purchased ready-mixed as "Nico-dust." For home-made dust, add 3 tablespoons nicotine sulfate to 1 quart hydrated lime, and *mix thoroughly in a tight container.* This makes approximately a 4-percent dust. After mixing, pass through a fine screen to break up any lumps. If all the dust is not used, keep in an airtight container, for it deteriorates. It is best to apply nicotine dusts during the hottest part of the day. When mixing or applying nicotine dusts or sprays avoid breathing the fumes.

Cryolite dust. Poisonous to man. A ready-to-use dust may be purchased, or a dust can be made by thoroughly mixing 6 pounds of

[2] For use on specific insects, refer to Section 10.

[3] Rotenone and pyrethrum dusts may be found on the market under various trade names.

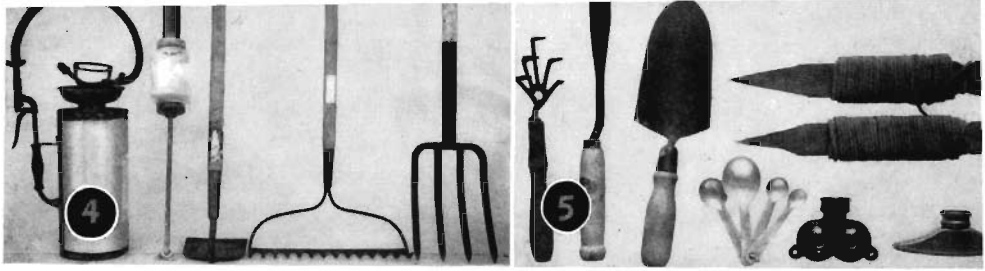
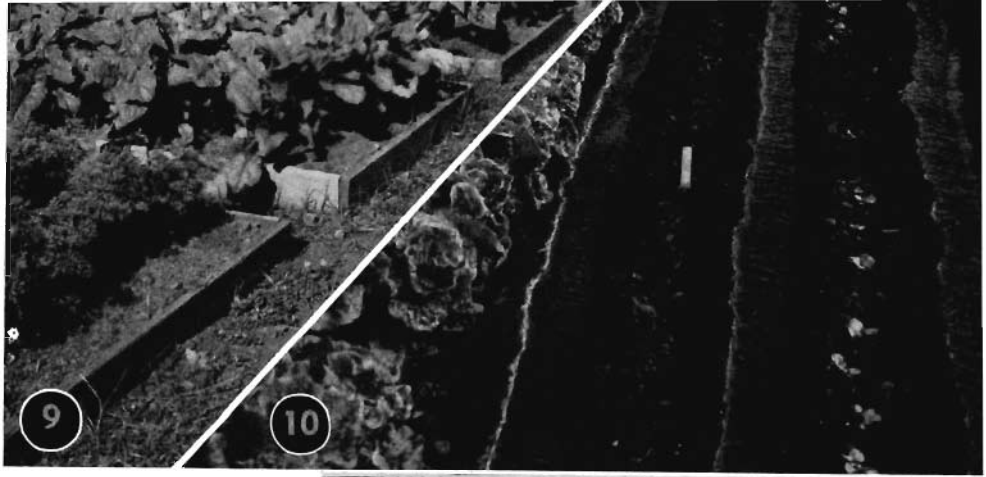


FIGURE 4. Large garden tools, left to right: This *sprayer,* of approximately 1½-gallon capacity, is fine for large gardens. For small gardens a 1- or 2-quart hand sprayer, costing not more than $2 to $3, should suffice. Sprayers are most valuable in areas of high rainfall. A gardener should always clean a sprayer thoroughly after using it; otherwise it will soon clog and become unusable. A *duster* is handier and more useful to most gardeners than a sprayer. Dusters of approximately 1-quart size as shown here usually can be purchased for $1 to $3. A *hoe* is the number one implement of the garden. The end of the hoe handle can be drawn through the soil for making shallow furrows for planting small seeds like those of carrots and lettuce. One corner of the hoe can be used for making deeper furrows for beans. For weeding, the hoe should be kept sharp. A *steel rake* with curved teeth is the best kind for gardeners. It should be used to smooth the surface of the soil and to remove any large rocks or debris that interfere with the making of a good seedbed. It also aids in breaking up clods. Although a *spading fork* is not needed so often as some other tools, it is the most useful tool for turning over soil. Deep spading of most soils, previous to planting, is needed for good plant growth. Neighbors may chip in to buy a fork, thereby reducing the cost to individuals. A *sprinkling can* is a useful addition to the tool list. In addition to being used for irrigating plants, it may be used to apply fertilizer in solution as shown in figure 16. • FIGURE 5. Small garden tools, left to right: The *claw weeder* is handy for working near garden plants, removing small weeds, and loosening the soil to a shallow depth. A knife type of hand weeder (not pictured here) is also very useful and is preferred to the claw weeder by many gardeners. This *asparagus-type knife* is useful in removing deep-rooted weeds such as nut grass. A *trowel* is useful for removing plants from seedbeds and setting them in the garden. It will save wear and tear on the hands (see figure 27). *Measuring spoons* should be kept handy. They are often needed to measure insecticides, fungicides, and fertilizers. A teaspoon and a tablespoon confiscated from the kitchen are satisfactory. This *sprinkler* is a low-cost type that performs well. There are several such sprinklers on the market—most of them excellent. This *irrigating nozzle* screws on the garden hose. It is handy for irrigating while holding the hose. Perforations in the nozzle should be small so that seeds or young plants will not be washed out of the soil or injured. It is particularly useful for irrigating the garden just after seeds have been planted. After plants have become well established, the gardener may wish to furrow irrigate (see figure 10). A *garden line,* with each end tied to a sharpened stake, is very useful for laying out a garden and for making straight rows (see figure 13). The line should preferably be as long as the rows in the garden. Crooked rows are a sign of careless gardening and are an indication that no garden line was used at planting time. • FIGURE 6. This University of Hawaii garden, photographed March 1, was planted according to the plans shown for a garden 30 by 50 feet (see figure 1). However, the garden pictured was started October 1 whereas the plan detailed in figure 1 for a medium-size garden calls for starting March 1. Pigeon peas were used for a windbreak. A garden of this size, if well cared for and kept in continuous operation, can produce the green vegetables required for at least four or five people. However, inexperienced gardeners might do well to start with a small garden and expand as interest and knowledge grow. A few days of neglect, in any garden, may mean the death of young plants and the waste of seed, fertilizer, and other materials that should be conserved, especially in wartime.

FIGURE 7. This garden 25 by 50 feet was provided with a palm leaf windbreak on the north and east sides. A windbreak is a necessity in most areas of the Islands. The Fordhook variety of pole lima beans was planted inside the garden near the windbreak, and the vines covered the palms. This variety should not be confused with Fordhook Bush. Pole limas bear over long periods in Hawaii and are one of the best garden crops. Chard, beets, lettuce, onions, head cabbage, bush green beans, carrots, tomatoes, eggplants, and okra, in addition to the pole limas, were growing in the garden when it was photographed. This list of crops represents an excellent selection for Hawaiian home gardens, especially for low elevations during the cool months. In the summer, at low elevations, leafy cabbages, such as Pak Choy, can be substituted for head cabbage. Tomatoes grow better in winter at low elevations than they do in summer. At high elevations, beans, eggplants, and okra may not grow well in winter. Broccoli is a good addition to the list for planting during winter at low elevations and throughout the year at high elevations. Crops on the right-hand side of the garden were planted early, those in the center later. At the left a third area, unplanted, was being held for another succession planting. For estimates as to the amounts to plant and how often to plant, see Section 1. •

FIGURE 8. In this garden the tallest crops were planted on one side so as to avoid shading the low-growing crops. The stair-step arrangement shows a row of young beans in the foreground and the following rows farther back, in the order named: Lettuce; full-grown bush green beans; eggplants and okra in the same row; pole lima beans. Many gardeners prefer to plant the individual crops in square or rectangular blocks, rather than in long, adjacent rows, thus reducing the likelihood of shading. However, the long rows may utilize garden space to better advantage.



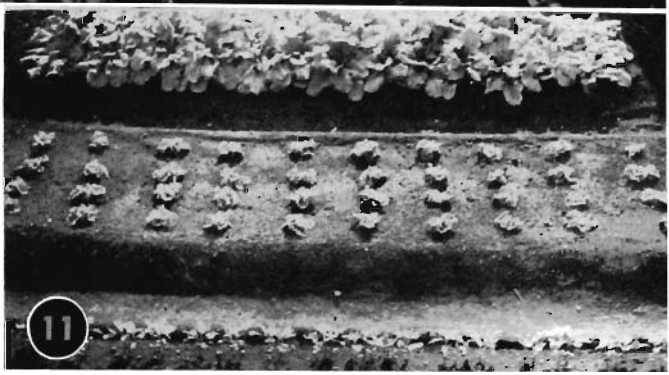
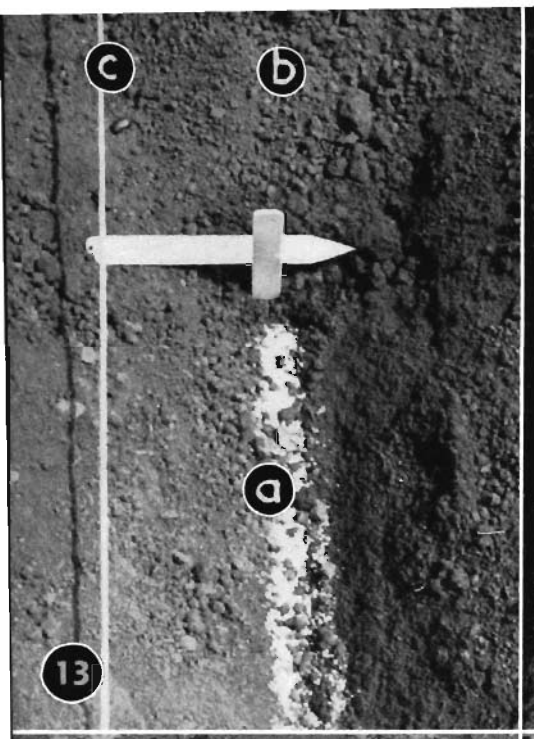
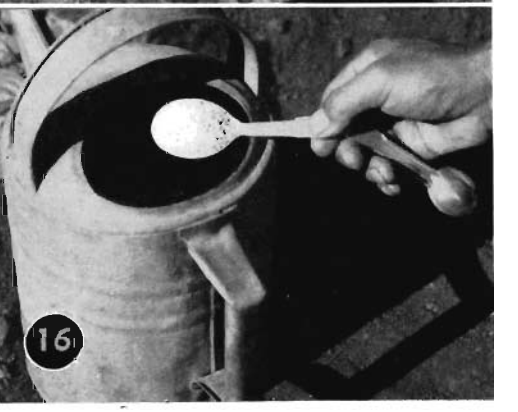


FIGURE 9. Boards used for holding soil in individual beds leave neat walkways between beds, help keep out grass, and prevent erosion. • FIGURE 10. In some gardens, on rather flat land, once crops are up and growing, furrow irrigation is advantageous because, unlike overhead irrigation, it does not wash off dusts or sprays applied for disease and insect control. • FIGURE 11. Raised beds are popular in Hawaii. The edges of such beds are ridged to prevent water from running down the sides during irrigation. • FIGURE 12. For mulches, many kinds of materials may be used. They may be placed over soil until seeds begin coming up. To conserve moisture and keep soil cool, they may be placed between rows of growing crops, especially in hot weather. They keep down weeds. Left, burlap bags; right, straw mulch.





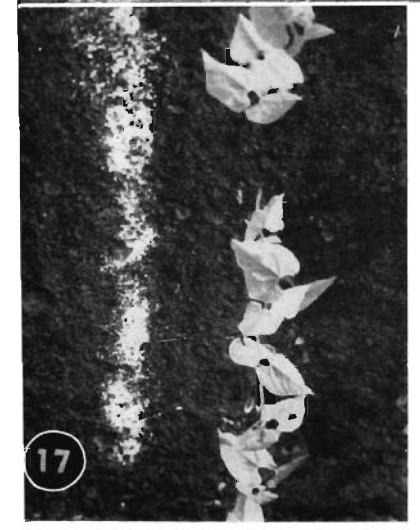
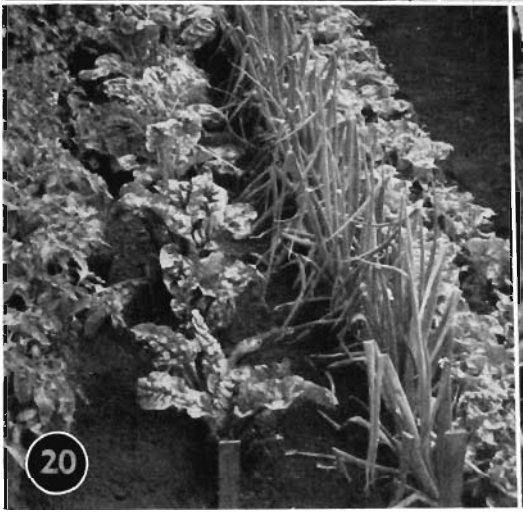


FIGURE 13. Apply a complete fertilizer in a band before seeds are planted. Stretch a string where row is to be planted. With one corner of a hoe, dig a furrow 3 inches deep 2 inches to one side of and parallel to the string. Place fertilizer in the furrow bottom (*a*). Pull soil over fertilizer and level the surface (*b*). Make a shallow furrow to receive seed underneath the string (*c*). Note bean seeds. • FIGURE 14. As a side dressing for growing crops, apply a *complete* fertilizer in furrows 3 inches deep and 3 to 4 inches on each side (or one side) of the row. Then level the soil. • FIGURE 15. For plants widely spaced, such as tomatoes and eggplants, fertilizer can be applied in a band 6 inches long for each plant. Place it 3 inches deep and 3 or 4 inches from the plant base, preferably on the furrow side if furrow irrigation is used. • FIGURE 16. Two to 3 *level* tablespoons of fertilizer per gallon of water should be used when placing transplants in the garden, for irrigating young seedlings in flats or pots, and for sprinkling near the bases of plants as a light nitrogen side dressing. • FIGURE 17. A side dressing containing *only* nitrogen may be placed on the soil surface 3 inches from bases of plants. Follow with an irrigation. If irrigation furrows are used, place side dressing in the furrows.



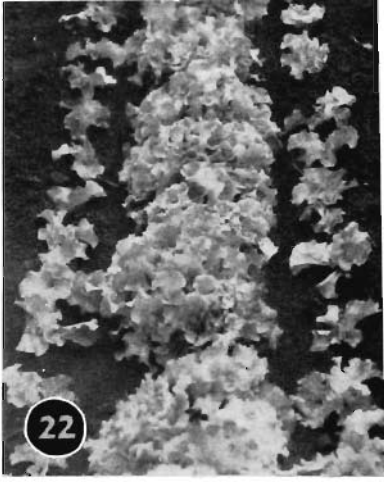


FIGURE 18. The V-shaped covering of light cloth on left was used to shade transplanted cabbage for 2 days; that on right was placed over lettuce just after seeds were planted. Such protection conserves moisture and keeps soil cool, insuring better stands, especially in summer. If left 4 or 5 days after plants are up, the cloth may reduce insect damage to beets, chard, and carrots. However, damping-off may develop. See page 47 for damping-off control. • FIGURE 19. A convenient way of planting small seeds like those of carrots and lettuce. Tear one corner off the seed packet. While moving the packet along the furrow, gently tap it with the index finger to make seeds drop at the desired rate. • FIGURE 20. Proper spacing between and within rows is important. Tomatoes on left are 24 inches from chard (center); chard is 18 inches from onions; lettuce (leaf) is only 6 inches from onions, and the two lettuce rows on the right are 6 inches apart. • FIGURE 21. Carrot plants should be spaced 1 or 2 inches apart in the row. If planted in a row 3 or 4 inches wide, as shown, plants can be staggered when thinned. • FIGURE 22. When lettuce grows thickly from seed sown in the garden, some plants can be transplanted to rows 6 inches away. Such transplants usually mature later than the other plants, thus extending the harvest.

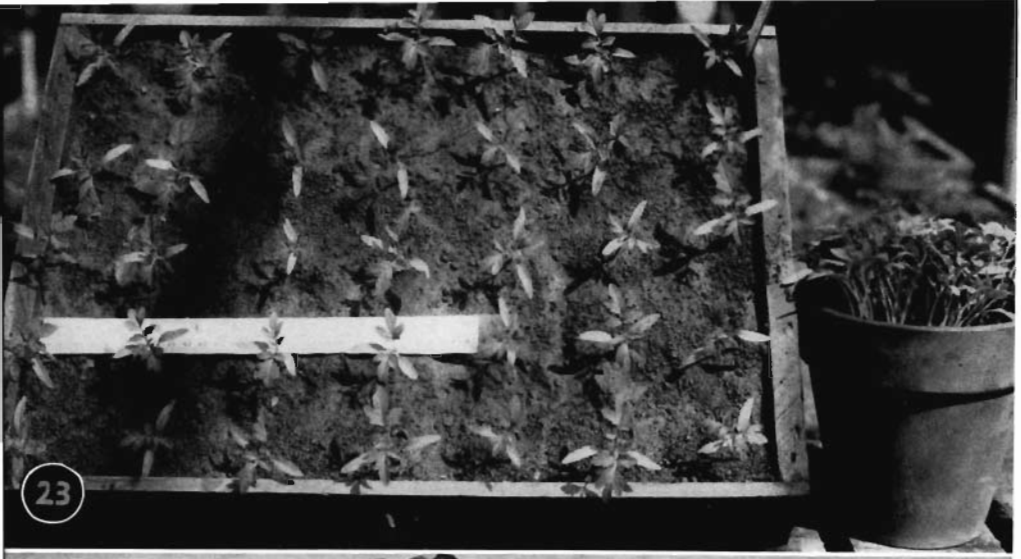


FIGURE 23. Young tomato plants, in the four-leaf stage, were transplanted from the pot on right to the flat. They were spaced 3 inches by 3 inches so that they would grow into stocky plants and could be "blocked out," with soil attached to the roots, for transplanting to the garden. Tomatoes and cabbage usually are ready to transplant to the garden 4 or 5 weeks from the time of planting seed. Eggplants are usually ready in 5 or 6 weeks. Celery may require 6 to 8 weeks. • FIGURE 24. A celery, a cabbage, a pepper, and an eggplant plant, all of good size for transplanting. Plants may be grown in clay pots, tin cans with perforated bottoms, or paper cups made from newspapers. If soil around roots is not disturbed during transplanting, the plants will receive little or no check in growth and none should die. This is the best method of growing plants for gardens that do not have irrigation water available for transplanting. Late afternoon usually is the best time to transplant. If the weather is rainy or cloudy and cool, the plants can be set out at any time during the day. • FIGURE 25. Husky tomato plant of desirable size for transplanting to the garden. Soil was wet, permitting "blocking out" of plant so that roots were not disturbed. (Picture from U.S.D.A. Farmers Bul. 1338.) • FIGURE 26. "Leggy" tomato plants. They were not thinned to the proper spacing. If transplanted to the garden they will not "grow off" as quickly as the husky plant at left.

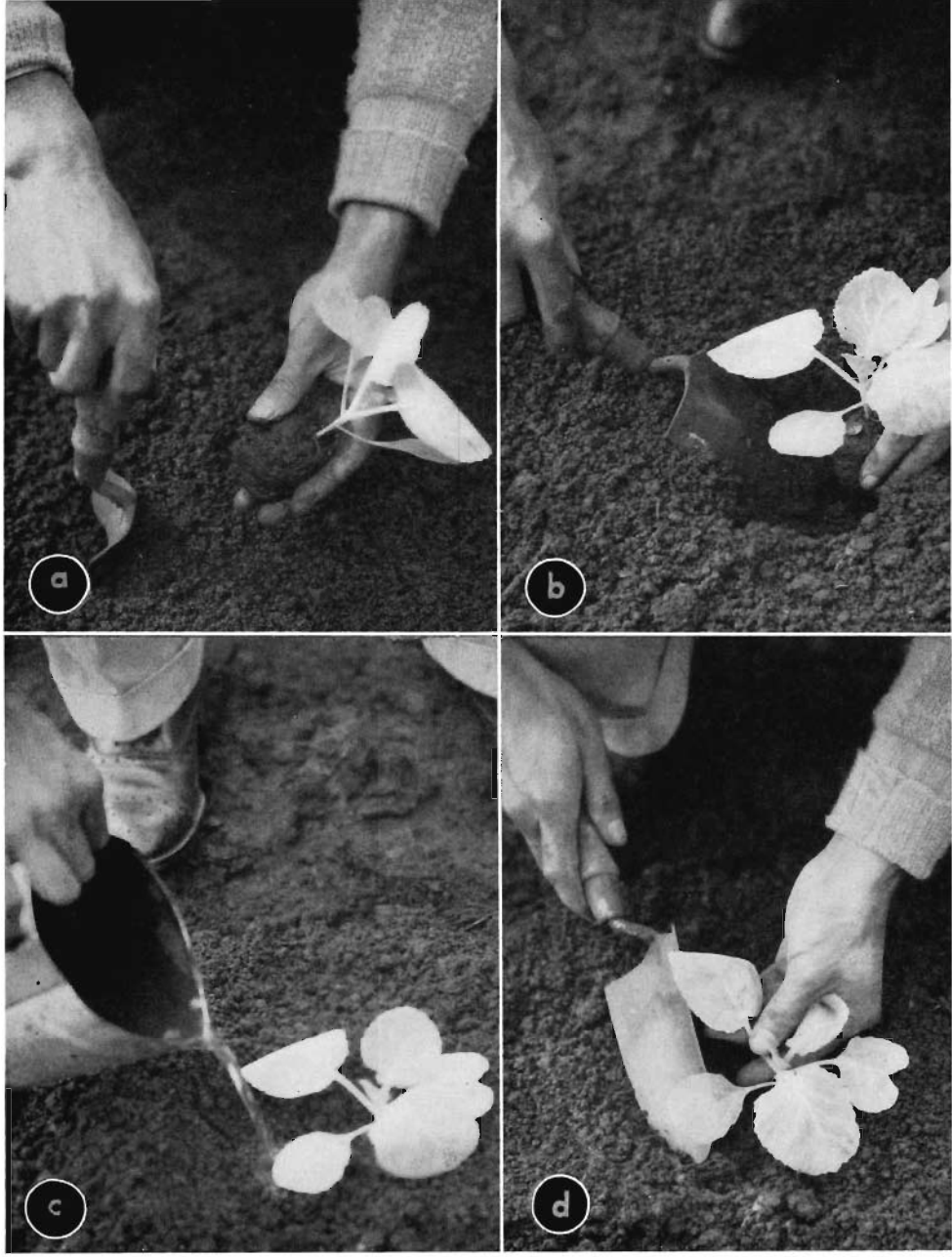


FIGURE 27. Transplanting. (*a*) A trowel can be used to make a hole for transplants. A stick, a dibble, or the bare hand is a good substitute. The hole must be made as wide and deep as necessary to easily receive the roots and soil. Otherwise there will be a "doubling up" of roots that is harmful, and there will also be a tendency to set the plant too shallow. (*b*) Cabbage, broccoli, celery, and lettuce should be set only slightly deeper than the original level of the plant in the seedbed. Tomatoes and eggplants can be set to a depth within an inch or two of the growing tip. It is particularly advantageous to set leggy tomato plants deeply, if they are to be staked, so that the root systems will be deep and so that the first clusters will not be high from the ground. (*c*) After part of the soil has been moved back into the hole and the soil around the plant has been slightly firmed, pour about a pint of water into the depression. It is a good plan to place a small amount of fertilizer in the water (figure 16). (*d*) Finally, the remaining soil should be pulled around the plant.

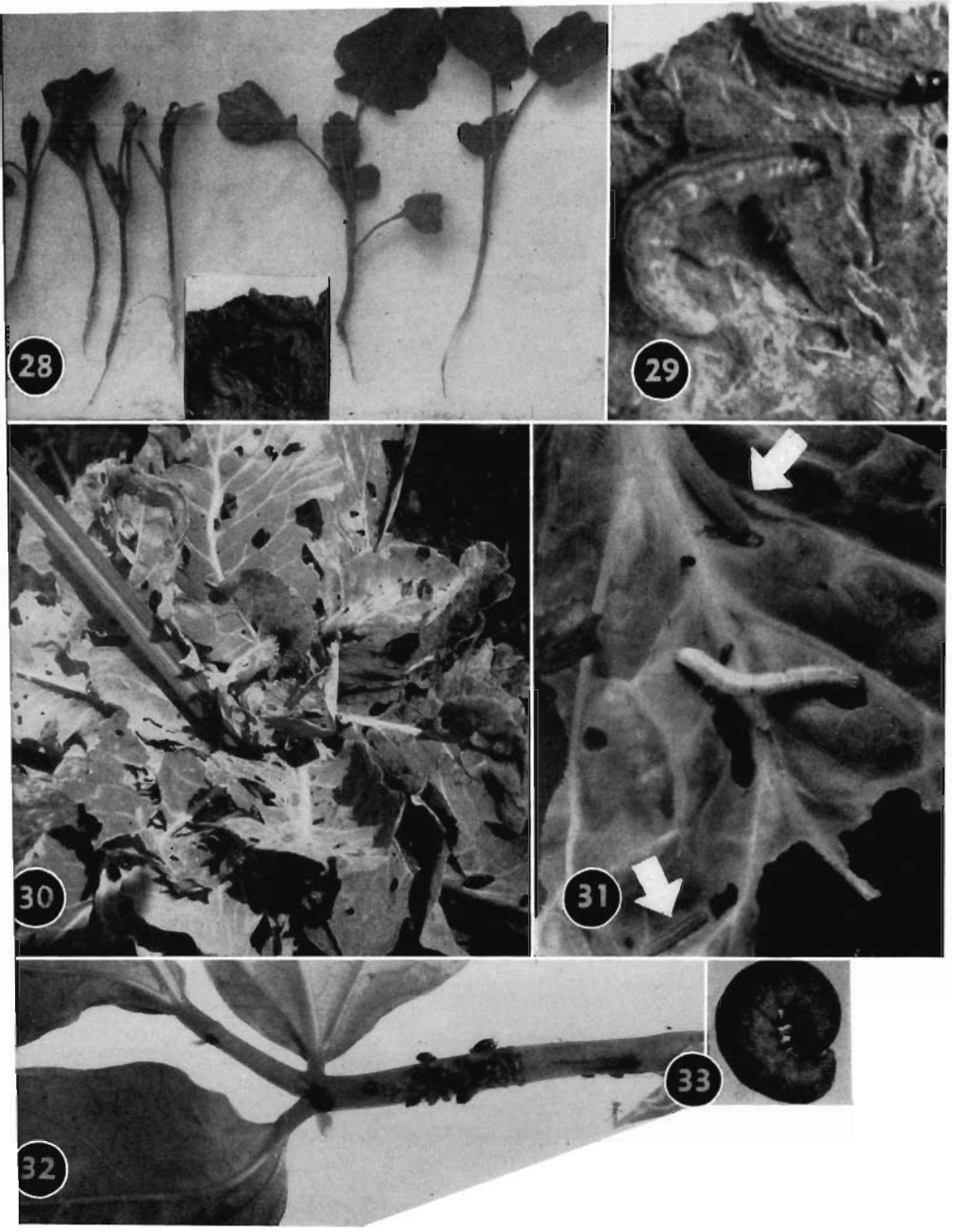
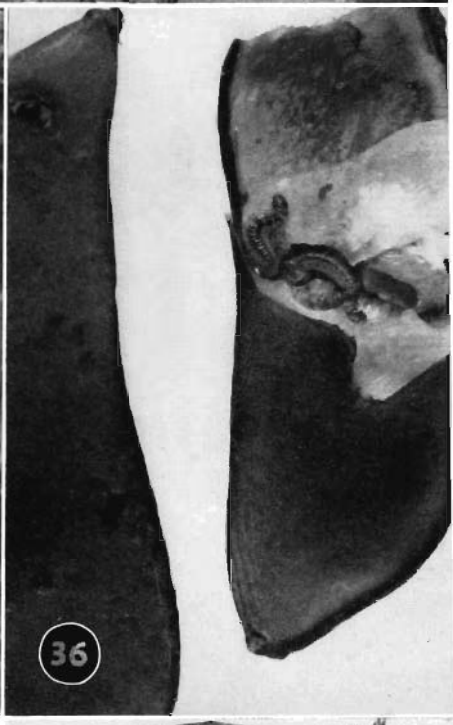


FIGURE 28. The small, black-headed worms in inset are full-grown cabbage webworms, natural size. As the young worms are tiny, the folded leaves around the growing tips must be examined carefully if the worms are to be found. They are very destructive in the small growing points (hearts) of head cabbage, spoon cabbage, Chinese cabbage, broccoli, turnips, mustard, daikon, and radishes. The cabbage on the left shows injury to young plants. Those on the right were not attacked. • FIGURE 29. This is an enlarged picture of the cabbage webworms in figure 28. • FIGURE 30. The raggedness of this cabbage plant resulted from attacks of cabbage worms and loopers. • FIGURE 31. The striped light green worm in the center of this cabbage leaf is a looper. The velvety green worms above and below are imported cabbage worms. About two-thirds of natural size. For control, see Section 10, Broccoli. • FIGURE 32. Aphids, among the most common of garden insects, are shown here in natural size on a bean leaf petiole. They are often found on the under sides of leaves. • FIGURE 33. Full-grown cutworm. See pp. 61, 64.



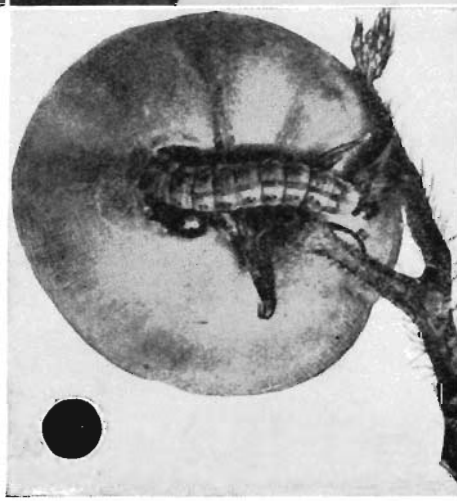
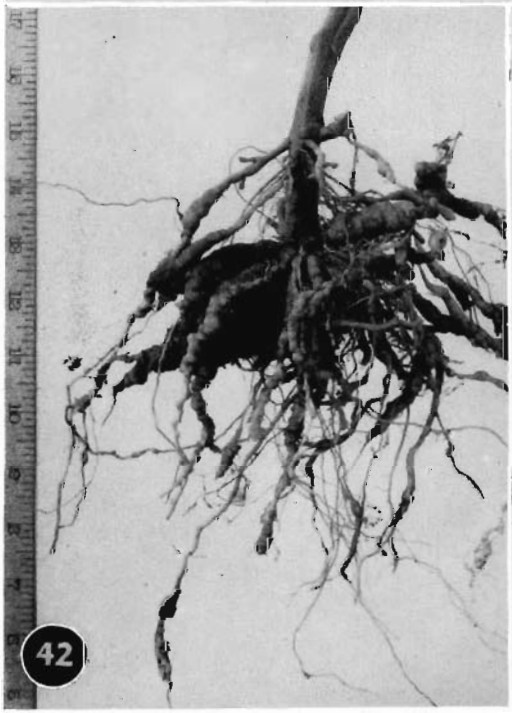


FIGURE 34. A small hand duster is convenient for use in controlling insects and diseases. Note that a deflector was used on the outlet of this duster so that sulfur dust could be applied easily to the under sides of the chard leaves to control mites. • FIGURE 35. Caterpillars on a lettuce leaf. Caterpillars may attack many other garden crops, such as beets, okra, chard, onions, cabbage, and broccoli. • FIGURE 36. Bean pod borers work inside the pods. The pod on right is split open to reveal borers, natural size. The pod on the left shows a hole in the upper part, indicating that a pod borer is possibly working inside. • FIGURE 37. Typical work of a tomato fruitworm (corn earworm). These worms begin eating when very small. The worm pictured is full-grown. (Quaintance and Brues.)

FIGURE 38. Beet webworms and the damage they do to beet leaves. Similar damage may occur on chard and spinach. The worms are light colored, almost transparent. Usually they are found on under sides of leaves. Control measures should be taken as soon as they are discovered. See Section 10, Insects of Chard. • FIGURE 39. Rose beetles on a bean leaf and the damage they cause. These insects work at night. During the day they lie burrowed into soil near the bases of plants. About 1⅓ times natural size. • FIGURE 40. Rose beetle injury to eggplant. If given good cultural care, eggplants will withstand moderate attacks of rose beetles. If injury is severe, see the methods of control described in Section 10, Insects and Diseases of Eggplants.



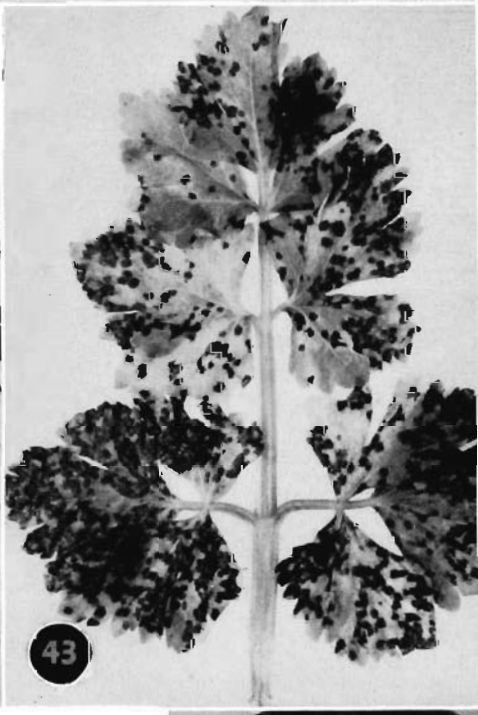


FIGURE 41. Damping-off disease. Note constriction of stems of these young chard plants at *a*. This pinched effect occurs near the surface of the soil, causing plants to topple over and die. See discussion and control of damping-off in Section 7. Many kinds of young vegetable crops may be attacked by this disease. Daily inspection of young plants should be made and, if plants show symptoms of damping-off, control measures should be taken. • FIGURE 42. Root knot of tomato, caused by nematodes—tiny worms living in the soil. Most garden vegetables in Hawaii are subject to attack by nematodes. For a discussion of nematodes and their control, see Section 8. (From U.S.D.A. Farmers Bul. 1338.) • FIGURE 43. Late blight disease on celery leaf. Leaf diseases of celery are common in Hawaii. (Florida Agr. Expt. Sta. Bul. 173.) • FIGURE 44. Blossom-end rot of tomato fruit. See discussion of tomato diseases in text, Section 10.

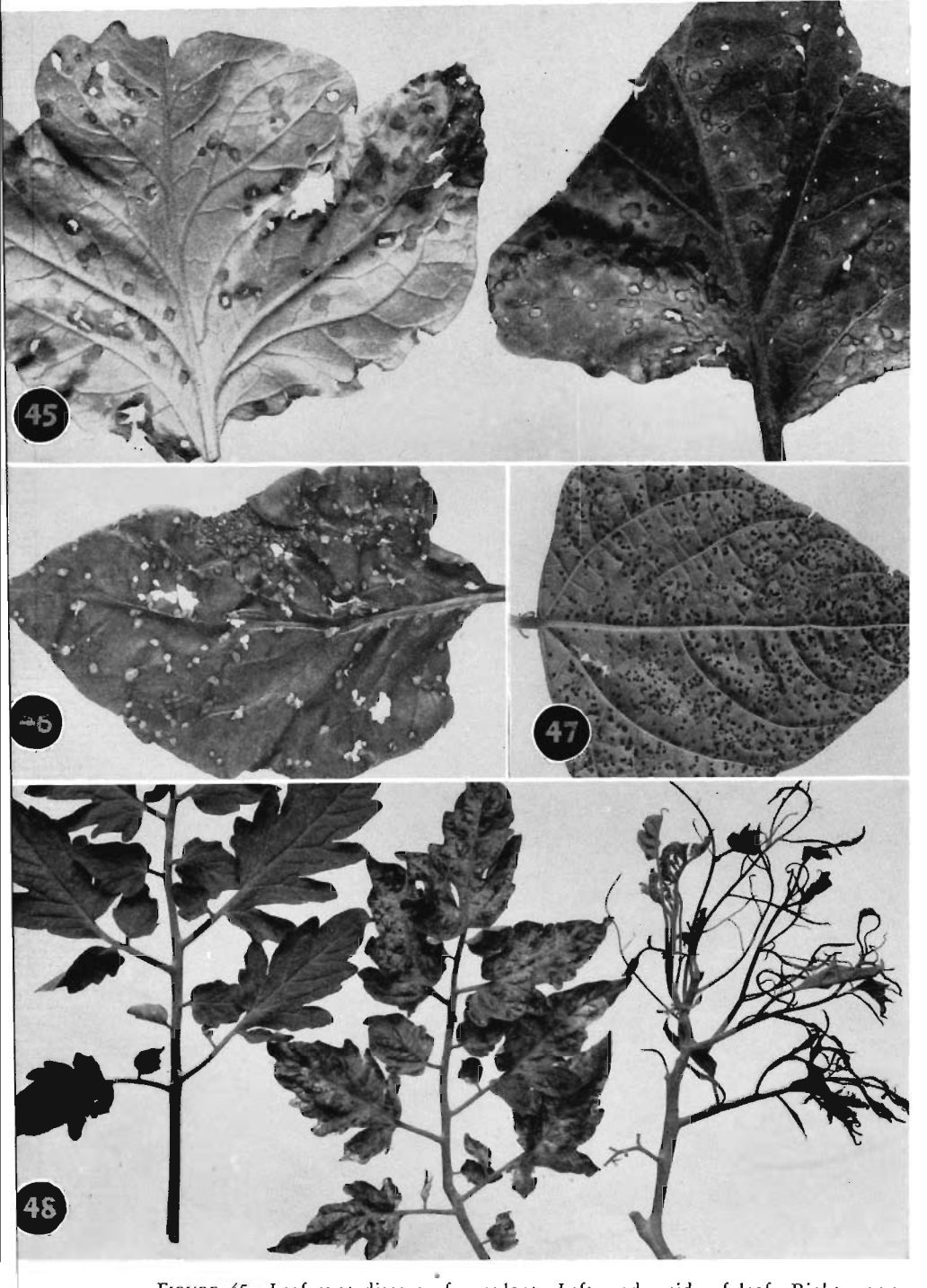


FIGURE 45. Leaf spot disease of eggplant. Left, under side of leaf. Right, upper surface of leaf. • FIGURE 46. Leaf spot disease of beet. This disease may also attack chard. Unless the leaves are severely injured, control measures may not be necessary. (Hawaii Ext. Bul. 33.) • FIGURE 47. Bean rust on under side of pole green bean leaf. Resistant, or partially resistant, varieties should be used when the disease is troublesome. See discussion of bean varieties in Section 10. (Courtesy G. K. Parris.) • FIGURE 48. Left, healthy tomato leaf. Middle, leaf showing tomato mosaic, a virus disease; note light- and dark-green pattern. Right, fern leaf, another virus disease; note narrow leaflets. Causal agent for these diseases is *inside* the plant tissue, and fungicide sprays or dusts are useless.

FIGURE 49. Chinese cabbage grows well in Hawaii during winter months at low elevations and year-round at high elevations. Pictured here is the Chihili variety. Wong Bok and Chiefoo have thicker and sborter heads. • FIGURE 50. Eggplants are a good crop for warm weather. • FIGURE 51. Broccoli is a good crop for home gardens during cool weather. After the main flowering head is harvested, side branches will develop and form heads as shown in this picture. • FIGURE 52. When grown during summer at low elevations, Chinese cabbage plants (Wong Bok) should be used as greens in this early, nonheading stage. They will form heads best and are less susceptible to rotting during cool months. • FIGURE 53. Left, Shakushina spoon cabbage or white mustard; right, Pak Choy white mustard. These members of the cabbage family prefer cool weather but are good substitutes for head cabbage during summer months. Their greatest enemy is the cabbage webworm. • FIGURE 54. Okra grows well at low elevations in summer.

FIGURE 55. Six leafy greens adapted to Hawaii. Upper row, left to right: Pak Choy (white mustard), chard, beet; lower row, Shakushina (spoon cabbage or white mustard), Chinese Smooth Leaf mustard (Kai Choy type), and Tendergreen mustard. Of this group of greens, chard is the one that can be harvested over the longest period of time. Usually, webworms are the most serious problem in growing the mustards. These leafy crops should be given plenty of fertilizer and water so that they make rapid growth. • FIGURE 56. Green onions are best propagated in Hawaii by transplanting individuals separated from clumps. Clumps purchased in stores are satisfactory for transplants. Roots and tops can be cut back as shown here for convenience in transplanting. If set to a depth of 2 or 3 inches, they will multiply in a few weeks so that several stems will be present in each clump. If one or two are left each time they are harvested, the gardener will have a fairly continuous supply. The Japanese bunching onion is a large, vigorous type, while Chinese bunching is medium in size, and Hawaiian bunching is still smaller. Green onions are one of the easiest crops to grow in the garden. • FIGURE 57. Beets are often ready for harvest in Hawaii within 50 days from planting. They are a dual-purpose crop, since the tops, as well as roots, may be eaten. The tops are high in vitamin value.

FIGURE 58. The chayote should be allowed to grow over a rock pile, air-raid shelter, or trellis. At low elevations it seems to do best during winter months. However, once plants are well established, they will produce a large number of fruits over most of the year. Though melonflies attack the chayote, they do little damage to it. • FIGURE 59. Remarkably heavy sets of pods are common on lima beans in Hawaii. For high table quality, pods should be picked before beans turn white. If overmature pods are left on the vines, yields will be reduced. • FIGURE 60. Bush green beans are one of the best garden crops. From an early age, they need plenty of water and fertilizer. During warm weather they mature within 45 to 50 days. • FIGURE 61. Belembe (Tahitian taro).

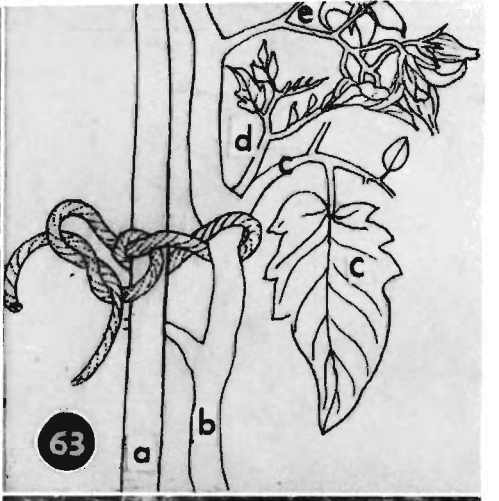


FIGURE 62. Tomato plant pruned to two stems and tied to stake. If bags to protect fruit from melonflies are placed over young flower clusters, flowers will set fruit inside bag—if they are going to set at all. Bags were off lower clusters only while picture was taken. Only indeterminate varieties should be staked. See Section 10, Tomatoes. • FIGURE 63. How to tie and prune tomatoes. Cross cord between plant and stake (*a*). Break off laterals (*d*), which arise at each leaf axil, before they are an inch long. Care must be taken that main or central growing tip (*b*), leaf and leaf petiole (*c*), and blossom cluster (*e*) are not broken off. On indeterminate varieties, blossom clusters usually occur after every third leaf. (Drawing by K. Kikuta.) • FIGURE 64. Tomatoes of determinate variety trailing over low framework made of koa haole. This type tomato should not be pruned or staked. • FIGURE 65. Plum tomatoes grow best on low framework. These small tomatoes often fruit abundantly.

cryolite with 5 or 6 pounds of talc (never with hydrated lime). Use on edible plant parts only when they are young. Especially useful on tomato fruitworm (corn earworm), cabbage worms, and cabbage webworms. Can be used on tomatoes until fruits are half-grown, and on cabbage until heading begins.

Calcium-arsenate dust. Poisonous to man. If a prepared dust is not available, one can be made by mixing equal parts of calcium arsenate and hydrated lime.

Pyrethrum dust.[3] Not toxic to man. Especially effective on beet webworms. Botano Py 20 is a commercial form available in Hawaii.

Combination dusts.[3] Ready-to-use dusts containing rotenone and sulfur or rotenone and pyrethrum (Sulrote, Rotenocide 75, and others) are excellent combinations and are sometimes available. They are not toxic to man. A cryolite-sulfur combination is excellent, but must be cautiously used, since cryolite is toxic to man.

Spraying to Control Garden Insects

For general instructions on preparing spray solutions, see Section 8, General Control Measures.

The two most useful materials to have on hand for spraying to control garden insects are (1) rotenone or rotenone-pyrethrum, and (2) sulfur. Rotenone may at times become difficult to obtain during the war, and gardeners may be forced to use some of the other insecticides. Nicotine sulfate is often useful, especially for aphids, and, if necessary, for small caterpillars. Cryolite and other materials toxic to man also have special uses, as shown in the discussions in Section 10. The common insecticides used in sprays, the amounts to use per gallon of water, and compatibility with other insecticides and fungicides are given in table 11.

In preparing sprays, home gardeners usually work only with quarts or gallons. Simple conversions for preparing sprays follow:

CONVERSIONS

1 tablespoon	=	3 teaspoons
2 tablespoons	=	1 fluid ounce
16 fluid ounces	=	1 pint
1 tablespoon	=	15 cc. (approximate)
1 pint	=	32 tablespoons (fluid)
1 gallon water	=	8 pounds (approximate)
1 pound	=	454 grams (approximate)
1 liter (1000 cc.)	=	1 quart (approximate)
1 cubic foot	=	7.5 gallons (approximate)

[3] Rotenone and pyrethrum dusts may be found on the market under various trade names.

TABLE 11.—Common insecticides used in sprays, amounts to use per gallon of water, and compatibility[1]

MATERIAL	AMOUNTS PER GALLON OF WATER (level teaspoons or tablespoons)	MATERIALS THEY CAN BE USED WITH[2]
Nicotine sulfate (Black Leaf 40). Leaves no poisonous residue if plant parts are not used until several hours after treatment	1½ to 2 *teaspoons* plus, preferably, 1 cu. in. soap, *or* 2 *tablespoons* soap flakes	With most of the common insecticides and fungicides
Cryolite. *Poisonous* to man	2 to 2½ tablespoons	Nicotine sulfate, copper oxide, rotenone, sulfur, soluble fish oil, but *not* with most soaps, hydrated lime, or Bordeaux
Calcium arsenate. *Poisonous* to man	2 to 3 tablespoons	Copper oxide, sulfur, rotenone, and most of the other common insecticides and fungicides
Soap (laundry soap or flakes). Not poisonous to man	1 to 2 cu. in. per gallon or 2 to 4 tablespoons per gallon	Soap alone may be used for sucking insects only if more desirable insecticides are unobtainable
Lead arsenate. *Poisonous* to man	2 to 2½ tablespoons	Nicotine sulfate, copper oxide, rotenone, sulfur, hydrated lime
Wettable type sulfur. Not poisonous to man	3 to 4 tablespoons	Nicotine sulfate, calcium arsenate, lead arsenate, cryolite, copper oxide, rotenone, hydrated lime
Rotenone or rotenone-pyrethrum materials such as (trade names): Foliafume, Pyrote, DX, and Extrax.[4] Not poisonous to man	Follow manufacturers' instructions carefully[3]	Most materials except hydrated lime and Bordeaux
Prepared oil emulsion such as (trade names): Volck, Summer Mulsion, and Nico-Mulsion.[4] Not poisonous to man	Follow manufacturers' instructions carefully	All common insecticides and fungicides except sulfur compounds. Useful for most chewing and sucking insects in their early stages of development. In general, gardeners should purchase and use when other more useful garden insecticides are unobtainable

[1] For use on specific crops and insects refer to Section 10.

[2] Sometimes more than one type of insect—or insects plus diseases—occur on one plant, and it is desirable to use more than one insecticide or fungicide (or both) at the same time. Some materials cannot be mixed together, or are termed noncompatible. Copper oxide is the simplest material for home gardeners to use for many diseases, and it will be noted that it can be used in combination with any of the listed insecticides.

[3] Content of rotenone and pyrethrum varies, depending upon the manufacturer, and instructions on the container should therefore be followed.

[4] Preparations with trade names other than those listed may be on the market, and they may be just as satisfactory.

Table 12 states dilution factors for preparing sprays.

TABLE 12.—Dilution factors for preparing sprays

DILUTION DESIRED	AMOUNT OF LIQUID INSECTICIDE OR FUNGICIDE PER GALLON OF WATER	AMOUNT OF LIQUID INSECTICIDE OR FUNGICIDE PER QUART OF WATER
	Teaspoons	*Teaspoons*
1:600	1½	⅓
1:400	2	½
1:200	4	1
1:100	8	2

Poison Bait for Cutworms, Snails, and Slugs

Damage from snails and slugs may be suspected if the tops of small plants disappear overnight or if irregular holes are found in plant stems. Cutworms usually cut plants off just above the soil surface, leaving the wilted tops undisturbed and the stubs of the plants emerging from the soil.

These pests are usually best controlled by means of poison baits, rather than by dusts or by sprays. However, calcium-arsenate dust or even rotenone dust, generously applied to small seedlings, especially near the soil surface around the plant stems, will often give satisfactory control. Snails, slugs, and cutworms work mostly at night. A poison bait can be prepared by the gardener as follows:

1 pound bran
2 tablespoons lead arsenate *or* calcium arsenate *or* Paris Green
2 or 3 tablespoons molasses
Enough water (about ¾ cup) to moisten well, but not enough to make soggy. Mix thoroughly

The moist bait should be scattered lightly along plant rows near the base of plants, preferably in late afternoon.

Various commercial poison-bait materials may be secured, which, in general, are satisfactory (Bug-Geta, etc.). They should be used according to the manufacturers' directions.

Repeated application of poison bait at 4- to 10-day intervals may be required until damage becomes negligible. (See other control measures for cutworms under Broccoli, Section 10.)

Care must be taken that poison baits are kept out of the reach of children and domestic pets.

SECTION

•10•

INDIVIDUAL CROPS, THEIR CULTURE, THEIR INSECTS, AND THEIR DISEASES

THIS SECTION discusses individual crops adapted to Hawaiian conditions, special measures recommended for the culture of each, and specific insect and disease problems most often encountered. *Where insecticides or fungicides are recommended, the gardener should consult formulas and methods of preparation in the two preceding sections.*

GREENS GROUP

Certain of the vegetables listed in the greens group in this bulletin are not usually included in such a classification, but, from the standpoints of nutrition and of organization of this bulletin, it has been convenient so to classify them.

Broccoli

Except during midsummer months at low elevations, sprouting broccoli can be grown in Hawaiian gardens throughout the year. It is an excellent home-garden vegetable, much better adapted to our climate than its close relative, cauliflower, and it bears highly nutritious, flowering heads over a period of several weeks.

Since the crop occupies space in the garden for many weeks, it should often be given a fertilizer side dressing after the first harvest. Ammonium sulfate or ammonium phosphate 16–20 are good side-dressing materials. If these are not available, a complete fertilizer can be used.

After the first large, central cluster of flower buds is harvested, lateral shoots develop from leaf axils and smaller clusters of flower buds are produced (figure 51). The bud clusters should be harvested, with *8 to 10 inches of stem,* before any flowers open. The stem below the cluster is usually very tender and should be cooked with the buds. Rotting of the main stem after harvest is common when overhead irrigation is practiced or showers fall. A small, water-resistant

cap of paper or other material placed over the cut surface will reduce some of the rotting. Cutting the stem at an angle may also help.

Propageno and Calabrese are good strains of Italian green sprouting broccoli. Heading or cauliflower broccoli is a distinct type of plant, and is not as satisfactory for the home garden as the Italian green sprouting strains.

Diseases and Insects. Broccoli is relatively free of serious diseases in Hawaii, but see diseases of head cabbage. Table 13 gives facts on insects that damage broccoli.

Head Cabbage

Like sprouting broccoli, head cabbage prefers cool regions (mean temperatures below 70° F.), but it will grow and head in the Islands throughout the year. At low elevations during summer months, heads are often very small, growth is slow, and insect problems are usually serious. In our climate the plant from which a cabbage head is harvested will send out secondary shoots, and these laterals will form small heads. However, it is not generally worth while to leave cabbage in the garden for the purpose of securing a second harvest in this manner.

Cabbage requires relatively high nitrogen in the soil, and if plants appear to be heading up while small or show yellowing, side dressings of nitrogen fertilizer are needed. Ammonium sulfate may be used for side dressing. About 1 tablespoon (⅓ handful) should be applied 2 or 3 inches from the base of the plant. It can be placed on the soil surface and irrigated in. At time of transplanting, a fertilizer such as 8–12–6, 6–9–5, or 5–10–10 containing phosphate and possibly potash, in addition to nitrogen, is desirable. A small handful should be applied for each plant, about 3 inches from the plant stem and 3 inches deep.

The varieties Golden Acre and Green Acre are excellent for gardens because their heads are relatively small and they mature early. For still smaller heads, of very dark green color, Baby Ballhead and Fordhook Forcing are recommended. Copenhagen Market is usually larger and slightly later than Golden Acre. Marion Market is still larger and later. In a combination planting of Golden Acre and Marion Market varieties, the harvest period would be extended. A medium-large variety such as Marion Market should be given more space than Golden Acre. Relatively close spacing (12 inches, for example, instead of 18) will reduce head size. Soil fertility, irrigation, and many other factors also affect size of heads.

If weather is warm and dry, cabbage transplants may benefit from shading during their first few days in the garden. Figure 18 shows a light cloth covering draped over a cord stretched along the row, 6 to 8 inches above the plants. Such shading helps to keep the soil cool and moist. Figure 27 illustrates the transplanting of cabbage.

TABLE 13.—Insects of broccoli and their control

INSECTS	DESCRIPTION AND REMARKS	CONTROL	
		Spray	Dust
Aphid or plant louse	Soft-bodied sucking insect, only ⅛ inch or less long, slow-moving. Often in large clusters. One of most common of all garden insects. Causes leaf curling and malformation. Be sure to spray or dust under sides of leaves. (See figure 32)	Nicotine sulfate is preferred. Rotenone - pyrethrum may be used if necessary	Nicotine is preferred. Rotenone-pyrethrum may be used if necessary
Imported cabbage worm (a caterpillar)	A velvety, green worm up to 1¼ inches long. Eats holes in leaves. Dusts are generally preferable to sprays on broccoli and cabbage. (See figures 30, 31)	Use rotenone or rotenone - pyrethrum, *especially* after small heads form. On young plants use lead arsenate, cryolite, or Paris Green	Use rotenone or rotenone - pyrethrum, especially after small heads begin to form. On plants early in development, calcium arsenate or cryolite may be used
Looper	This caterpillar moves with a looping motion. Length up to 1 inch (see figures 30, 31). Damages plants by eating holes in leaves	Same as for imported cabbage worm	Same as for imported cabbage worm
Cabbage webworm	Finely striped worm with black head; only ½ to ¾ inch long when full-grown. Eats the tiny growing tips (hearts) of the plants, causing severe damage. May be extremely serious on small seedlings. (See figures 28, 29)	Cryolite, lead arsenate, calcium arsenate, rotenone, or rotenone - pyrethrum	Cryolite, lead arsenate, calcium arsenate, or rotenone. Dusts preferred to sprays. Use only rotenone on large, bearing plants. Cryolite very effective on small plants
Cutworm	Dark caterpillar which cuts plants off at soil surface overnight. During day usually hides in soil near base of plant. To keep them from plants, paper collars extending 3 inches above soil surface and about 1 inch beneath surface can be placed around plants. Or cans with both ends removed may be used for collars until the plants are well established. Cans should be pushed into soil 1 or 2 inches deep, leaving 2 or 3 inches above the soil. (See figure 33)	Poison bait may be used. Bait should be scattered on soil surface, near base of plants, in late afternoon. See Section 9 on preparing poison bait for cutworms, etc.	Very young plants can be thoroughly dusted with calcium arsenate
Snails and slugs	Stay under rocks, soil, or debris during day; eat stems and foliage of plants at night	Poison bait as for cutworms	

Diseases and Insects. Head cabbage is attacked by the same insects as broccoli. Diseases to which it is subject are described in table 14.

TABLE 14.—Diseases of head cabbage and their control

DISEASES	DESCRIPTION AND REMARKS	CONTROL
Downy mildew	A fluffy, white mold that appears on under sides of leaves. Sometimes *especially* serious in cool, cloudy areas, in *seedbeds*. A fungus disease	*Spray* or *dust* with copper oxide or home-made or prepared Bordeaux,[1] especially in seedbeds
Blackleg	A fungus disease causing brownish, sunken cankers on stems of plants near soil level. Circular brown spots on leaves may occur	Rotate members of the cabbage group with other crops
Black rot	A bacterial disease that dwarfs plants and makes leaves brown or yellow and veins of leaves black. Entire head may decay, becoming sour mass	Rotate the plantings. Use disease-free soil for growing seedlings. Remove and destroy diseased plants
Wire-stem	A fungus disease that stunts plants and may make them grow long-stemmed. Stem portions in contact with top inch of soil darkened	Do not use transplants which show discolored stems. Use Bordeaux or copper sprays or dusts in seedbed

[1] Prepared Bordeaux in this publication refers to the commercial, ready-to-use product.

Chinese Cabbage

Chinese cabbage thrives best in cool weather. Many gardeners grow the plant in warm weather, when heads seldom form, and use it for cooked greens. It is often harvested as soon as it reaches a spread of 8 to 10 inches (figure 52). During cool months the Chiefoo and Wong Bok varieties form rather short, thick heads, while Chihili (figure 49) forms a tall, tapering head, with very dark green wrapper leaves. Off-type, nonheading plants are common. Chinese cabbage is generally well adapted in Hawaii, and should be planted at times to replace head cabbage, in whole or in part. At low elevations hard heads will form only during cool months.

Seeds should preferably be planted in place in the garden, although transplants can be used, as with head cabbage. Fertilization should be similar to that discussed for head cabbage. It is important that the crop be kept growing rapidly.

For a discussion of Chinese-cabbage insects and diseases, see Broccoli, Head Cabbage, and Spoon Cabbage. In warm, rainy weather,

as plants near maturity, Chinese cabbage is very susceptible to rotting. Plants should be harvested young under such conditions.

Spoon Cabbage

We refer to any of the *nonheading* oriental cabbages as spoon cabbages. Some of these have long, white, upright leaf stalks (Shakushina), while others are more spreading, with shorter, broader stalks and with leaves less spoon-shaped (Pak Choy) (figure 53). They are sometimes called white mustards. There are many forms of these cabbages; most seed stocks show considerable variation among plants. If protected from insects, especially webworms, these cabbages will thrive better than head cabbage during warm weather, and they can be harvested in early stages of maturity. It is best to plant the seeds in place, although seedlings can be transplanted. The spoon cabbages should be kept well fertilized, preferably with a complete fertilizer such as 8–12½–6, or 6–9–5, or with 16–20 ammonium phosphate at planting time and a side dressing of ammonium sulfate 2 or 3 weeks after plants come up.

Diseases and Insects. For insects and diseases of spoon cabbages, see Broccoli and Head Cabbage. In addition, two diseases listed in table 15 may occur.

TABLE 15.—Some diseases of spoon cabbages

DISEASES	DESCRIPTION	CONTROL
Mosaic	A virus disease causing mottling and sometimes stunting of leaves	Rotation. Keep all weeds down. Keep aphids controlled
White rust	A fungus disease causing white pustules on leaves, which, when broken, emit a chalky powder. Does not render leaves unfit for table usage	Use furrow irrigation when possible. Keep weeds down. Copper oxide or Bordeaux spray or dust may aid in partial control

Celery

Celery grows best within a temperature range of 60° to 70° F. Therefore, at low elevations, even winter months are slightly too warm for most rapid growth of the plant and attainment of highest quality. However, home gardeners who give celery close attention will find that satisfactory plants *can* be grown during midwinter at low elevations. Some home gardeners grow a few plants during summer, at low elevations, and break off occasional leaf stalks to be

used in soups or as other flavoring. These plants are often small, but they serve their purpose.

Celery requires a rather long time to develop. At low elevations seeds planted in September and October usually will produce large plants in January or February. Although 4 or 5 months may be required for full maturity, plants can be harvested any time after they are half grown.

No vegetable crop requires closer attention than celery. The soil should be rich, preferably heavily supplied with manure; heavy applications of commercial fertilizers should also be used, before and after planting. A complete fertilizer relatively high in nitrogen, such as 8–12½–6 or 6–9–5, can be applied at time of transplanting. A handful to each 2 or 3 feet of row is a good application. The application should be repeated from 4 to 6 weeks after plants are set out, and should be followed by an ammonium sulfate side dressing in 2 or 3 weeks (one handful to about 6 feet of row).

Spraying to control blight (figure 43) is often, although not always, required at about 7-day intervals. The young seedlings are very delicate for several days following germination, and they often require partial shade. Plants should be transplanted at least once before being set out in the garden. Seed must be covered with only a slight amount of soil, and special care is required to see that soil does not dry out. Seeds are slow to germinate. They can be placed between moistened folds of cloth and left for 24 to 48 hours before planting. It is wise to use a burlap bag or other cloth over the planted seed to keep the soil from drying too rapidly. Celery plants require abundant soil moisture and should be irrigated at frequent intervals. Furrow (surface) irrigation is preferred. Spacings of 6 to 8 inches between plants in the row and of 1½ to 2 feet between rows are satisfactory. Close spacing may reduce plant size but aids in blanching.

Special Utah (Utah Green or Utah), a green stalk variety of good vigor, is among the best for Hawaii. This variety can be blanched by wrapping each plant with heavy paper about 10 days before harvesting. A few inches of top leaves should be left exposed. Because of our moderate temperatures, rotting of plants during blanching is common in Hawaii. Many gardeners prefer to eat the green stalks, and nutritionists highly recommend the use of green rather than blanched celery.

Some celery varieties produce cream-colored leaf stalks. These are known as self-blanching. Golden Self-Blanching is an old variety of

this type. Cornell No. 6 and Cornell No. 19 are new self-blanching varieties superior in tenderness and thickness of stalks.

Diseases and Insects. The diseases and insects to which celery is subject are described in table 16.

TABLE 16.—Insects and diseases of celery

NAME	DESCRIPTION AND REMARKS	CONTROL	
		Spray	Dust
Insects			
Aphid, looper, and caterpillar	See Broccoli	See Broccoli	See Broccoli
Mite (sometimes called red spider)	Very tiny mites, difficult to see with naked eye. Cause curling, purpling, and dwarfing of leaves	Wettable sulfur. Be sure to apply to under sides of leaves	Dusting sulfur. Be sure to apply to under sides of leaves
Diseases			
Late blight	A fungus disease causing circular yellow spots on leaves. Spots later turning brown, with tiny black specks. Use furrow irrigation if possible	Copper oxide, prepared Bordeaux, or wettable sulfur. at 7- to 10-day intervals	Copper oxide or Bordeaux (or sulfur if other materials not available)
Early blight	Small yellow to grayish spots, without black specks. Use furrow irrigation if possible	Same as for late blight	Same as for late blight
Blackheart	Brownish to black discoloration of leaf margins and veins of young leaves of the heart	Neither dusting nor spraying will be of help. This is a physiological disease, more common in warm wet weather. Uniform soil moisture should be maintained. Avoid overirrigation	

Chard

Swiss chard, one of the best vegetables for greens in Hawaiian gardens, can be grown throughout the year. Once well-established, plants are vigorous and high-yielding. When the older, outside leaves are picked for use, new ones develop in the center. Many pickings can be secured from one planting. Leaves can be cooked like spinach. The large leafstalks and midribs can be cooked like asparagus.

Chard is essentially a foliage beet, but the size of its leaves necessitates spacings of 6 to 12 inches in the row, as compared to much closer spacings for beets.

Chard should be given plenty of fertilizer and water so that plants will make rapid growth. A complete fertilizer should be used at planting time, and side dressings of ammonium sulfate may be required at 2- or 3-week intervals after plants begin production.

Young chard seedlings may benefit from shading such as that illustrated in figure 18. However, if such shading is employed, care must be taken that damping-off disease does not develop. Figure 41 shows the effects of damping-off disease on young chard plants. Figure 55 shows a good chard leaf.

Diseases and Insects. The diseases and insects to which chard is subject are described in table 17.

Lettuce

Lettuce of the Mignonette type should be planted in all home gardens in Hawaii. Although even Mignonette may tip-burn and develop bitterness quickly in summer, it can be harvested at an early age to escape, in part, serious losses in edible quality. Part of the injury from tip-burn in warm weather may be prevented by irrigating the plants, as they approach maturity, in furrows rather than by overhead sprinklers.

TABLE 17.—Insects and diseases of chard

NAME	DESCRIPTION AND REMARKS	CONTROL	
		Spray	Dust
Insects			
Looper and caterpillar	See Broccoli	See Broccoli	See Broccoli
Beet webworm	Greenish worm which feeds on under sides of leaves, spinning web over itself. Be sure to apply spray or dust to under sides of leaves (figure 38)	Pyrethrum (preferred) or rotenone-pyrethrum	Pyrethrum,[1] rotenone - pyrethrum, or strong nicotine
Leafhopper	Small greenish insect about ⅛ inch long, found only on under sides of leaves. Adult flies. Young moves sidewise on the leaf. Leaves become curled, stunted	Wettable sulfur, rotenone or rotenone - pyrethrum, or Bordeaux (copper is toxic to leafhoppers)	Sulfur, rotenone, or pyrethrum
Mite	See Celery	Wettable sulfur. Sulfur burn may occur in warm weather	Sulfur. Sulfur burn may occur in warm weather
Snails	See discussion under Poison Bait for Cutworms, etc., Section 9		
Diseases			
Leaf spot	Small circular brown spots with purple to red borders (figure 46). It is well to give the plants plenty of room. Irrigate by furrows, if possible	Copper oxide or Bordeaux, if disease becomes serious. Repeat at weekly intervals	Copper oxide, Bordeaux, or copper-lime
Damping-off	For symptoms and control see Section 7. Also see figure 41		

[1] Preferred for control, as indicated by unpublished data of F. G. Holdaway.

Large head lettuce of the New York (Iceberg) varietal type, such as Imperial 44 and Imperial 847, cannot be relied upon to grow well at low elevations in Hawaii. Fairly satisfactory heads can be produced in winter and early spring, but gardeners at low elevations should generally plant the Mignonette (purple-tinge) or Manoa (Green Mignonette) varieties.

Lettuce can be transplanted to the garden or planted in place. If planted in place, it may be thinned out slowly, and the thinnings may be used for greens even though no heads have been formed. Thinned plants can also be used for transplants. Mignonette or Manoa may be planted closely, and double rows 6 to 8 inches apart should be used when space is at a premium.

Lettuce is a good crop to interplant among other crops. It is small and will withstand considerable shading. Indeed, it is an advantage to have lettuce shaded during the hottest hours of summer days. A partial shade of laths or light cheesecloth can be used for summer plantings.

Quick growth of lettuce results in crisp, sweet foliage; therefore, good fertility and plenty of water are important during all stages of growth. A commercial fertilizer such as 6–9–5, 8–12½–6, 16–20 ammonium phosphate, or 11–48 ammonium phosphate can be used at planting time. It should be followed by ammonium sulfate as a side dressing 2 or 3 weeks after plants are up.

Diseases and Insects. The diseases and insects that may affect lettuce are described in table 18.

Mustard

Several types of green mustard exist (figure 55). Kai Choy is the Chinese name for a local type of mustard. Chinese Broad Leaf and Chinese Smooth Leaf varieties are sold by some mainland seedsmen. A green mustard with very large leaves and fair quality which is adapted to our conditions is Tendergreen (synonymous with the varietal names Japanese Mustard and Mustard Spinach). It is available from seedsmen in Hawaii as well as from mainland sources. Like the other green mustards, it is of oriental origin.

All mustards should be given plenty of fertilizer and water so that they will grow rapidly. One or two side dressings of ammonium sulfate may be desirable. Unless leaves are harvested before they are full-grown they may be distinctly tough.

Diseases and Insects. For insects and diseases to which mustards are subject, refer to Turnip, Daikon, and Radish.

TABLE 18.—Insects and diseases of lettuce

NAME	DESCRIPTION AND REMARKS	CONTROL
Insects		
Caterpillar (looper and other worms)	See Broccoli and also figure 35	See Broccoli
Cutworm	See Broccoli	See Broccoli
Leafhopper	See Chard	See Chard
Thrips	Very small insect that feeds on leaf surfaces, leaving a whitish appearance. Difficult to see	*Spray* with rotenone, rotenone-pyrethrum, or strong nicotine sulfate. Or *dust* with rotenone, rotenone-pyrethrum, or nicotine sulfate
Diseases		
Bottom rot	Causes darkened, slightly sunken areas on leaves. Plant may quickly rot into black mass	Keep soil surface dry as possible. Give plants more room. Rotate the garden crops
Bacterial rot	A bacterial disease. Rapid wilting may occur. If leafstalks are cut across, they may show brownish streaks, or streaks may be seen from surface of leaf	Avoid splashing water over the plants. Keep dry as possible. Remove diseased plants. Rotate
Mosaic	Light- and dark-green mosaic pattern on leaves. A virus disease	Keep insects controlled. Do not save seed from diseased plants

Onions, Green Bunch and Bulb

Green bunch onions grow well the year around in all sections of Hawaii.

Bulb onions will make the largest bulbs if seeds are planted from September to January. During the short winter days they form large "base" plants that are capable of bulbing to a good size when hours of daylight increase in March, April, and May. In Hawaii, bulb onions must usually be produced from true onion seeds. It is best to sow the seeds thickly in a small seedbed in the garden in October, November, or December and transplant when the stem diameter is at least the size of a pencil. Transplants should be spaced about 4 inches apart in the row, and rows should be 12 to 18 inches apart. The bulbs can be harvested for immediate use before they are fully mature, but if they are to be kept for a few weeks they should be mature when harvested. When tops become weak near the neck of the bulb and fall over, the plants should be pulled and permitted to dry 2 or 3 days. Then the stem should be cut off

about 2 inches above the bulb. As bulbs approach maturity, the tops should be pushed over or broken down to aid in more uniform maturation of the bulbs. Stored bulbs must be kept well-aerated. Refrigeration will prolong the storage life of onions.

Yellow Bermuda, White Bermuda, Red Creole, Babosa (Grano), and Red Bermuda (Lord Howe Island) are by far the best bulb varieties for Hawaii. Red Creole is a small-bulb type but the *only good storage onion adapted to our climate.* If kept well-aerated, it can be stored for many weeks at common temperatures.

Most home gardeners are content with the bunching onions. Japanese bunching (Nebuka), Chinese bunching, and Hawaiian bunching are well adapted throughout the year. They are most easily propagated by transplanting green plants separated from clumps that have been growing for some time. For convenience in planting, the tops can be cut back halfway and the roots clipped to within ½ inch of the base of the plant (figure 56). The plants should be set to a depth of about 1½ inches. From one to three plants can be planted together. Close spacing of plants in the row (2 to 4 inches) and between rows (6 to 12 inches) facilitates maximum use of the area devoted to onions. Bunch onion seeds can be planted, but the small plants are delicate and require several weeks to develop for transplanting. Small bulbs (called sets) are used on the Mainland for planting early green onions. They are seldom available in Hawaii, and are not needed because of the ever-present supply of green plants.

Diseases and Insects. Green onions are generally free of serious diseases. Bulb onions, when they reach maturity, are extremely susceptible to soft rot, which may be caused by various bacteria. Bulbs should be harvested as soon as they are mature, and they should be cured in a dry, well-aerated place. Two insects that attack onions are described in table 19.

Parsley

A few parsley plants, in some out-of-the-way spot in the garden, will produce greens or garnishing material for many months. The large, outer leaves should be harvested as needed. Moss Curled is an excellent variety.

Seeds should be planted about ¼ inch deep, and soil should be kept covered until plants begin coming up. Overnight soaking of seeds will hasten germination. A complete fertilizer should be applied before seeds are sown. Side dressings of a nitrogen fertilizer

TABLE 19.—Insects of onions

INSECTS	DESCRIPTION AND REMARKS	CONTROL
Thrip	Very small, yellow to brown insect, difficult to see. Most abundant in folds of leaves in center of onion plants. Causes leaves to appear etched with small white spots. More serious on bulb onions than on bunching types	*Spray* with 1½ teaspoons tartar emetic plus 5 teaspoons brown sugar per gallon of water. (*Poisonous* to humans, and of most use on bulb onions); *or* nicotine sulfate (for fair results only). Or *dust* with nicotine sulfate (for fair control only)
Caterpillar	Worm that eats holes in leaves or works on *insides* of leaves, skeletonizing them	Once worms have entered the inside of the leaf, only hand picking is effective. Stomach poisons on outside surfaces would render the green leaves unfit for human food

such as ammonium sulfate, applied at intervals of 3 or 4 weeks, will aid in keeping the plants growing rapidly.

Diseases and Insects. Parsley is generally free of disease attacks. For insects, see Celery.

New Zealand Spinach

Although it is not a true spinach, New Zealand spinach is an excellent greens crop for home gardens in Hawaii. It thrives during warm weather and continues to produce greens for several weeks.

Only a few plants are necessary for the average family. If seeds are soaked in water for a few hours before planting, germination will be speeded. Occasional side dressings of a complete fertilizer or ammonium sulfate should keep the plants in a thrifty condition and prolong the harvest period. In harvesting, tips of the individual branches should be cut back to about 3 inches. Side shoots form, and in a few days further cuttings can be made.

Diseases and Insects. The plant is generally free of disease troubles but at times may be attacked by insects. For information on these insects, see Chard.

ROOT-CROP GROUP

Beets

Monthly mean temperatures in Hawaii, especially at low elevations in summer, exceed the 70° F. usually considered as a maximum above which beet growth, color, and texture are unfavorably affected. However, beets of satisfactory quality can be grown throughout the

year, and, since both roots and tops are edible, the crop is a most desirable one for gardens (figure 57).

Best growth of tops for greens will be secured by using manure or commercial fertilizer high in nitrogen. Beets will not thrive in distinctly acid soil. Detroit Dark Red and Asgrow Wonder often have larger tops under our conditions than such varieties as Green Top Bunching and Crosbys Egyptian. The latter two varieties are slightly earlier in maturity.

Individual "seeds" of beets often produce more than one plant, and the resultant clumps of plants may require thinning. However, if soil fertility is good, the foliage may be permitted to develop so that the clumps can be thinned for greens; or the first edible-sized roots may be pulled, leaving the smaller plants to develop later. Harvesting should begin as soon as roots are large enough to use. Overmature beets are tough and woody.

In general, it is best to plant beet seeds in place. If beets are transplanted, care must be taken that the central roots are set in place straight down. The four- or five-leaf stage is satisfactory for transplanting.

Diseases and Insects. Beet webworm is a common and serious pest (figure 38). It is usually most troublesome during summer months. (For control of webworm and other beet pests, see Chard.)

Beets, like chard, may be attacked in the young-seedling stage by damping-off organisms. For control, see discussion of damping-off in Section 7. Good drainage should be provided as a precaution against rotting of the edible-sized roots. Leaf spot attacks beets as well as chard (figure 46).

Carrots

Carrots can be grown in Hawaii's gardens every month of the year, but they grow best in temperatures of 60° to 70° F. High temperatures and heavy irrigation cause poor coloration.

Because young carrot seedlings are very delicate, they should have care in irrigation and protection from winds. Three or four times as many seeds should be sown as are required for a perfect stand, thereby allowing for the usual nongerminating seeds, weak seedlings, cutworm damage, and damping-off. A 2- to 4-inch *lateral* spread of the seed along the row will eliminate the necessity for laborious thinning, unless the rate of seeding is unnecessarily heavy. The plants may stand two or three abreast in the row. In rich soils, the roots will develop even though they closely crowd each other.

If spaced closely, the first roots to reach edible size should be harvested immediately, and the smaller roots left to mature later. Thus carrots can be harvested over a period of many weeks. Young carrots less than 1 inch in diameter at the shoulder are usually the most tender. Quality will be reduced if carrots are left in the ground too long before harvesting—as they often are in Hawaii. Vitamin value of carrots, both young and old, is very high.

Red Cored Chantenay, Nantes, and Danvers Half Long are excellent varieties, as are also the longer-rooted Imperator and Morse Bunching. Oxheart, a very short carrot, is also satisfactory.

Diseases and Insects. Carrots are relatively free of insects and diseases. Aphids sometimes attack carrots, first becoming noticeable around the crowns, at the leaf bases. For methods of control, see Broccoli. For mites, see Celery. Vegetable weevils, which attack foliage of the carrot, can be controlled by arsenate sprays or dusts. An arsenate or cryolite dust is very effective on cutworms on small plants such as carrots, lettuce, and beets (see Broccoli).

Leaf spot is a disease of common occurrence on carrots, especially in areas of high rainfall. It is caused by a fungus which produces brownish spots on the leaves. Plants may often be attacked without serious effects. Copper-oxide or Bordeaux spray or dust applied at intervals of approximately 10 days will curtail severe damage. Furrow irrigation is preferable when plants are diseased with leaf spot.

Root rot or soft rot of carrots may cause collapse of the edible-sized roots. Good drainage, use of raised beds in wet areas, relatively wide spacing of plants, and rotation are preventive measures.

Daikon (Winter Radish)

Oriental types of winter radishes, in Hawaii called daikon (a Japanese name), are well-adapted to Hawaii. The large roots are eaten raw or pickled. Their food value is comparatively low.

Seeds from the Orient of Chinese daikon (a blunt, medium-length type) and of Japanese daikon (a large, long root, most often used for pickling) may not be available. However, daikon produces good seed crops here, and locally grown seeds are often obtainable. Mainland varieties of winter radish, such as Celestial and California Mammoth White, are being substituted to some extent for oriental daikon.

Diseases and Insects. Aphids and webworms are two of the most common insects on daikon (see Broccoli). If the leaves of daikon

are not used for greens, cryolite can be used on the old plants for webworm control.

For information on white rust that affects daikon, see Spoon Cabbages.

Radishes

All of the small varieties (red, scarlet-tipped, and white-icicle) and the long red varieties do well in Hawaii's gardens. They usually mature in 3 or 4 weeks, and length of harvest is for only 2 or 3 weeks. There is no need for planting more than 5 or 6 linear feet of row to radishes at any one time. In small gardens, where space is at a premium, radishes should always be intercropped.

Diseases and Insects. See Daikon.

Turnips

Turnip roots do not compare favorably with carrots in food value, and their tops are usually less popular than beet tops for greens, but the crop can be planted now and then to add variety to the garden.

The best time of the year to grow turnips at low elevations is from fall to late spring, for they prefer relatively cool weather. The varieties Shogoin (Japanese foliage turnip) and Purple Top White Globe are best adapted to our climate because they withstand warm temperatures better than most other types. Tops of Shogoin are preferred for greens. Purple Top White Globe is generally preferred for roots. Rutabagas, at high elevations especially, may be substituted for turnips (see Section 11).

Diseases and Insects. Aphids and webworms may be destructive to turnips. For control measures, see Broccoli. For diseases of turnips, see Spoon Cabbages. Rotting of roots near the crown is very common in Hawaii at low elevations during warm, wet weather. Wide spacing of plants in the row, use of furrow irrigation, and copper spray or dust around the crown of the plant may effect partial control.

LEGUMES GROUP

Green Beans

Except during winter at high elevations, the climate of Hawaii is in general ideal for growth and pod setting of beans (figures 59, 60). Remarkable sets of pods of both green and lima beans are common throughout the Islands. Plants often shed some of their pods because they are unable to furnish nutrients for normal maturation of all of them.

Beans respond well to liberal applications of barnyard manures and complete fertilizers such as 8–12½–6 and 6–9–5. One of the secrets of obtaining heavy yields from bush beans—green or lima—is to promote rapid growth in early stages of development so that a large base plant is obtained before flowering and pod setting begin.

Bush green beans should be spaced about 4 inches apart in the row, while pole varieties should be spaced 12 to 18 inches apart. Overnight soaking of seeds hastens germination.

Of the bush green beans, Bountiful, Plentiful, Giant Stringless Green Pod, Burpees Stringless Green Pod, and Asgrow Stringless Green Pod are all well-adapted varieties. Pencil Pod Black Wax is a fine wax (yellow-pod) variety. These bush varieties are highly resistant to the rust disease. Of the pole green beans, Kentucky Wonder Rust Resistant is generally safest for gardeners. In dry areas, during summer, Lualualei may give higher yields, but it may be disastrously attacked by rust, particularly during moist weather. Although Kentucky Wonder Rust Resistant is apparently more susceptible to rust than formerly, it is still far more resistant than Lualualei. Kabuto, a local variety, has considerable rust resistance at the present time.

Bush and pole green beans should be harvested as soon as they reach edible size. Pickings should be made at 3- or 4-day intervals. Overmature beans are tough and they drain the vine of nutrients. A side dressing of ammonium sulfate applied when first pods are setting will help fatten pods and will prolong the length of the harvest. Harvested green beans should be placed in the refrigerator immediately, for they lose quality rapidly at room temperatures. Pods should be harvested while they are smooth. Bulges in the pods are an indication of overmaturity.

Bush green beans normally will bear over a period of 2 to 3 weeks. Properly grown pole beans should bear 3 to 5 weeks or longer. Bush varieties begin maturing several days earlier than pole types. The rose beetle often interferes seriously with green beans as they reach late stages of vine growth. Frequent irrigation should be given green beans, especially during the harvest period.

Bush varieties are more convenient for most home gardeners, because no support is required. However, the greater frequency of planting required of bush varieties must be kept in mind.

Diseases and Insects. Table 20 describes insects and diseases to which green beans are subject.

TABLE 20.—Insects and diseases of green beans

NAME	DESCRIPTION AND REMARKS	CONTROL
Insects		
Capsid	Adult—about $\frac{3}{16}$ inch long, dark with some light markings; young—wingless, light green in color. Under sides of foliage show black specks of excrement. Young and old feed on under sides of leaves	*Spray* or *dust* with nicotine sulfate,[1] pyrethrum, or rotenone-pyrethrum
Leafhopper	See description under Chard. Causes curling of bean leaves. In serious attacks, leaves turn yellow and fall off	*Spray* with pyrethrum, sulfur, rotenone-pyrethrum, Bordeaux. *Dust* with pyrethrum, sulfur, rotenone
Mite	See Celery	See Celery
Aphid	See Broccoli	See Broccoli
Rose beetle	Mottled brown beetle almost ½ inch long. Eats holes in foliage during night, leaving a lacy appearance. Usually hides in soil near base of plants during day (figure 39)	Difficult to control. Use lead arsenate[1] (*poisonous*) spray or dust on old, abandoned bean plants to kill as many beetles as possible. Also use lead arsenate on other nonedible plants being attacked
Caterpillar	See Broccoli	See Broccoli
Bean pod borer	See Lima Beans	Cryolite dust or spray (*poisonous*) may be safely used on lima beans as pods mature, but on green beans *only up to* earliest stages of pod growth
Diseases		
Anthracnose	Fungus disease causing veins of leaves to appear blackened. Pods and stems may show brownish, sunken cankers. Seeds inside pod may be affected	Do not pick or cultivate beans when foliage is wet. Do not save seed from affected plants
Rust	Fungus disease, causing raised reddish dots on stems, leaves, and sometimes on pods (figure 47)	Bush green beans are usually resistant. *Dusting* or *spraying* with sulfur, if begun early in growth of plants, is of some value. Read discussion on pole green bean varieties in the text
Mosaic	Virus disease causing crinkling, puckering, and mottling of leaves	Do not save seed from diseased plants. Remove and destroy diseased plants

[1] Preferred for control, as indicated by unpublished data of F. G. Holdaway.

Lima Beans

Lima beans are a good year-round crop for home gardens in Hawaii. Like green beans, they should be well fertilized early in growth. Large-podded varieties, such as Fordhook Bush, Fordhook

Pole, and King of the Garden, are easiest to shell by hand. Henderson, Baby Potato, and Hopi are small-podded bush varieties that thrive well in Hawaii.

All limas can be harvested over longer periods than green beans. Pole limas, such as Fordhook Pole and King of the Garden, will grow well on garden walls and fences. Being large-podded, these two varieties are in general preferable to small-podded types for home gardeners. Small-podded pole varieties are Sieva and Florida Speckled. Stakes for pole beans should be 6 to 8 feet long.

Lima beans are most tender and of best flavor before seeds reach the white stage. Only by experience can the gardener learn to pick pods at the desired stages of maturity.

Diseases and Insects. The pod borer (figure 36), a caterpillar that bores holes in the pods, can be kept in check by cryolite dust or spray. Small-podded limas are generally less severely attacked than large-podded varieties. Rose beetle is less serious as a rule on limas than on green beans. Aphids often attack limas. (See Insects of Broccoli.) Nicotine is the most effective material against aphids.

For other insects and for diseases, see Green Beans.

Cowpeas

Southern Blackeyed pea (Blackeyed bean) is a common variety of edible cowpea. Pods may be used in early stages in the same way as snap green beans, or the enlarged green seeds can be shelled from pods and cooked like green lima beans or they can be dried and then cooked.

Blackeye is one of the best bush types. As the vines are larger than those of green bush beans, more space is required. Brown Crowder and Cream Lady also are good bush varieties, but the green seeds are not so easily shelled as those of the Blackeye. Yardlong beans are pole cowpeas with very long pods. Pods of Yardlong types are often superior to bush cowpeas for use as "green snaps." Like green beans, they should be placed in the refrigerator soon after harvest.

Insects. Aphids and leafhoppers commonly attack cowpeas. Leafhoppers *can be extremely serious* and appear to be most destructive during the summer months. They prefer to attack cowpeas rather than green or lima beans. For further information, see Green Beans.

Chinese Peas

Chinese peas are often referred to as edible-pod peas. Although they are better adapted to the Island climate than northern garden

(English) peas, they are *definitely a cool season crop* and thrive best in winter or at high elevations in summer. They are, as a whole, not so desirable a home-garden legume as green or lima beans, or soybeans. A variety of excellent vigor is Mammoth Melting Sugar. It should have stakes for support.

Diseases and Insects. Dust or spray with rotenone for caterpillar and leafminer. Leafminer is a tiny caterpillar that burrows between upper and lower layers of cells of leaves. Arsenicals or cryolite can be used before pods form.

For control of leafhoppers, see Green Beans.

For control of aphids, see Broccoli.

Powdery mildew, a fungus disease that causes talcum-like appearance of leaves, is difficult to control, but dusting or spraying with sulfur, Bordeaux, or copper oxide may be of some help.

Soybean[1]

The soybean, long a staple edible legume of the Orient, is steadily increasing in popularity in the United States. Its nutritive value is extremely high. The crop has often not given satisfactory yields when planted between September and February, because under the stimulus of short winter days flowering begins when the plants are still very small. This objection can be largely overcome by a proper selection of varieties for planting during the different months.

The three most important considerations in soybean culture in the home garden are:

(*a*) Proper selection of varieties of the edible types. The varieties Hahto, Sac, Bansei, and Seaweed are excellent for planting from March through July, and the variety Seminole from August through February.

(*b*) Fertilization with nitrogen and phosphate or a complete fertilizer, such as 8–12½–6 or 6–9–5, in the seed furrow below the seed, but not in contact with it.

(*c*) Ample irrigation during the first 40 days of growth.

The varieties mentioned are all small-plant types if planted during the months indicated. They can be planted in rows 18 to 24 inches apart and spaced 3 to 5 inches in the row. Repeat plantings should be made every 2 to 4 weeks.

Diseases and Insects. Chinese rose beetle is a serious pest of soybeans, although the early-maturing varieties listed, when given good

[1] Much of this information has been made available through courtesy of Colin G. Lennox of the Hawaiian Sugar Planters' Association.

cultural care, will usually produce a crop in spite of the beetles. Serious diseases are uncommon.

STARCHY GROUP

Sweet Corn

Sweet corn is a satisfactory crop for large gardens but takes up too much room in small home gardens. At low elevations it will grow satisfactorily during all months; at high elevations it grows unsatisfactorily during the cold, rainy weather of midwinter.

None of the true sweet corns commonly grown on the Mainland should be planted in Hawaii because of their generally poor growth and extreme susceptibility to corn mosaic. By far the best variety for Hawaiian gardens at this time is U.S.D.A. 34, a sweet corn of fair quality that is rather highly resistant to corn mosaic. Seeds grown locally can usually be obtained.

A fair crop should produce an average of about one good roasting ear per plant. When the ears near maturity, they should be carefully watched, as a few days' overmaturity means poor edible quality. To test for proper maturity, open the tip of the husks slightly so that a few kernels are exposed, and press one or two good-sized kernels with the thumb nail. If the test indicates that the kernels are in a milk or soft-dough stage the ear should be harvested. If no milk or soft dough is present, the ear is overmature. A good indication of maturity is a dry, brown silk, and a firm, plump "feel" to the ear. Corn should be placed in the refrigerator as soon as harvested to prevent the rapid conversion of sugars to starch, and consequent low quality.

Diseases and Insects. The corn earworm, which commonly attacks roasting ears, is the same insect as the tomato fruitworm. In general, more trouble with tomato fruitworms will be experienced if corn is grown in the garden. Corn will act temporarily as a "trap crop"; then when it is taken out of the garden, the tomatoes will be severely attacked. The corn earworm is a green to light brown worm that may grow up to 1½ inches in length; it eats the kernels, most often near the tip of the ear. For fair control, inject ⅓ to ⅙ teaspoon of white mineral oil into the ear tip after all silks have started to shrivel.[2]

For leafhopper control, see Chard. Use nicotine or rotenone-pyrethrum dust only if insect population becomes extremely heavy.

[2] Preferred method of control as indicated by unpublished data of F. G. Holdaway and William C. Look.

For aphid control, see Broccoli.

Mosaic disease of corn has been discussed in connection with varieties. No control other than use of resistant varieties is practicable. Mosaic causes dwarfed, misshapen plants and striped leaves.

Potatoes (Irish)

Where plenty of space is available, Irish potatoes are a good crop for fall and winter plantings at low elevations, and for spring and summer plantings at high elevations. In small gardens it is usually best to utilize the space for other vegetables.

The potato prefers cool temperatures. That is one of the reasons why higher yields are secured in certain mainland regions than in Hawaii. However, experience has shown that the red-skinned Bliss Triumph (Hawaiian Rose) will produce satisfactory crops at low to medium elevations from October through March. British Queen is one of the best adapted of the white-skinned varieties; Katahdin is another.

Good seed stock is a major item in successful potato growing. On the whole, it is not wise for home gardeners to buy mainland-grown potatoes from a local grocery store to use as seeds. Whenever possible, certified seeds should be secured from seed stores. Nor is the use of locally grown potatoes for seedpieces a good general practice year after year, because in warm climates seed-borne diseases and other types of degeneration contribute to unsatisfactory performance.

Tubers at least as large as hens' eggs (2 oz. each) should be planted. It is a waste of effort and garden space to cut and plant the eyes, with only a tiny piece of tuber attached. The seedpieces should be planted 3 or 4 inches deep, at least 1 foot apart in rows 3 feet apart. When plants are several inches high, they should be "hilled up" by working soil to the bases to a depth of 3 or 4 inches. Potatoes respond well to plentiful irrigation. Fertilizers rather high in phosphate are generally best. A 12–30–6 is the most common fertilizer used for the commercial crop on the Island of Oahu. A 4–12–8, commonly obtained by home gardeners, can be used, but should be applied in heavy amounts. Other complete fertilizers previously mentioned (Section 4) can be expected to give satisfactory results. Fertilizer should be applied in bands 2 or 3 inches to the side of and on a level with the seedpiece. It should never be placed in contact with the seedpiece.

Plants are usually mature within 90 days. They should be dug

when tops have died down, although a few hills can be harvested earlier if desired. Irish potatoes will keep best in a cool place. For long storage they should be kept at 32° to 40° F. Under ordinary room temperature it is best to *keep them well-aerated.*

Diseases and Insects. Potatoes may be commonly attacked by the diseases and insects listed in table 21.

TABLE 21.—Insects and diseases of Irish potatoes

NAME	DESCRIPTION AND REMARKS	CONTROL
Insects		
Aphid	See Broccoli	See Broccoli
Caterpillar	See Broccoli	*Spray* with lead arsenate or calcium arsenate
Cutworm	See Broccoli	See Broccoli
Mite (red spider)	See Celery	See Celery
Tuber moth	Whitish worm with dark head which tunnels into tubers	It is best for home gardeners to prevent damage by hilling up potatoes well and irrigating around base of plants so that soil is not open or cracked. Spraying with lead arsenate may be helpful, but may not be necessary
Diseases		
Late blight	Large water-soaked areas develop on leaf margins. Lower leaf surface has white, mildew-like appearance. The water-soaked areas may dry out rapidly. Develops rapidly in cool, moist weather	*Spray* with copper oxide or prepared Bordeaux. Or *dust* with copper oxide or copper-lime
Early blight	Another fungus disease, differing from late blight in characteristic brownish, round spots which develop concentric rings. Develops rapidly in wet weather	Same as for late blight
Mosaic	Various virus diseases may attack the plant, causing such symptoms as leaf mottling, rolling of leaves, yellowing of plant	Neither sprays nor dusts can be used to control the virus. Use certified seed. Keep aphids controlled
Fusarium wilt	See Tomato	Rotate. Do not use tomato or pepper in the rotation. Neither sprays nor dusts will help

Sweetpotatoes

The sweetpotato is admirably adapted to Hawaii's climate, and should be grown in gardens large enough for production of starchy food.

It is best, as a general rule, not to use manures in production of sweetpotatoes, as the crop may develop too much vine and too few edible roots. Heavy irrigation or commercial fertilizers that are high in nitrogen will cause similar undesirable growth. Many soils do not require any fertilization for good growth of sweetpotatoes, and superphosphate alone would generally be preferable to fertilizers containing nitrogen. Light, well-drained soils are best for sweetpotatoes.

Large-vined varieties, such as Tantalus, New Era Red, and 35.9[3] are generally best adapted to light soils and relatively dry areas. Varieties 35.5 and Kaneohe will also grow well in these areas. Nancy Hall, a popular mainland variety, is usually a low yielder here but is grown in some districts. Yellow Yam has dark salmon flesh, variety 35.5, light, starchy flesh; and the other varieties mentioned are intermediate between the yam (moist, dark flesh) and starchy (white, dry flesh) types.

Tips of runners 12 to 15 inches long should be used for transplants. They should be planted 4 to 8 inches deep, basal end down. An irrigation at planting time should be followed by frequent irrigations for a few days until roots are formed. Planting distances should be 12 to 18 inches in the row, and rows should be 3, 4, or 5 feet apart.

When vines are not available for making cuttings, edible sweetpotatoes may be "bedded down" by planting 3 or 4 inches deep. They will form sprouts, which in 4 to 6 weeks should be 10 to 12 inches high. These sprouts (slips) can then be pulled out with roots attached and used for transplants.

During warm weather, sweetpotatoes may be ready for harvest in 3 or 4 months. If heavy yields are desired it is better to let the plants grow for about 5 months. Sweetpotatoes do not mature and cease growth as do Irish potatoes. In our climate, unless insects or diseases destroy the edible roots, they will continue to enlarge for many months. Severe pruning of vines will reduce yields.

In high-rainfall districts and in low areas where the water table is near the surface, sweetpotatoes should be planted on ridges, so that they receive the best possible drainage and aeration; otherwise, long, thin, stringy roots will be produced.

After harvest, the edible roots should be held in a *warm, dry, well-aerated place for 2 or 3 weeks or more* if highest quality is desired. Because of their extreme susceptibility to rotting, bruising during

[3] Numbered varieties listed here refer to those developed by the agronomy division of the Hawaii Agricultural Experiment Station.

harvest *must be avoided* if sweetpotatoes are to be stored. During this period, much of the starch will change to sugar, giving the potatoes a sweeter taste. If weevils are present, only a few days of storage may be practicable, as these insects will tunnel through the roots and make them unfit for consumption in a very short time. For further discussion of sweetpotato insects, see table 22.

TABLE 22.—Insects of sweetpotatoes

INSECTS	DESCRIPTION AND REMARKS	CONTROL
Leaf miner	A tiny worm which tunnels in leaves, producing a skeletonized and spider-weblike appearance	*Spray* with nicotine sulfate, 1½ teaspoons, plus oil emulsion 3 tablespoons per gallon. Or *dust* with cryolite (fair results only)
Stem borer	A worm up to ¾ inch long which bores in stems; often in main stem near crown of plant, leaving pile of excrement. Worm bores downward into edible roots	*Spray* with cryolite two or three times at intervals of 3 or 4 weeks, beginning about end of third month after planting. Or *dust* with cryolite, timed as indicated for sprays
Sweetpotato weevil	A fat, white grub that tunnels in edible roots, giving them bitter taste	For control, see treatment for stem borer
Red spider	See Celery	See Celery
Aphid	See Broccoli	See Broccoli
Leafhopper	See Chard	See Chard

Diseases. Few diseases of sweetpotatoes are serious in Hawaii. Black rot, a fungus which attacks underground parts of the plant, causes large, circular, brown to black spots on edible roots. No control is possible once the disease is established. If possible, home gardeners should use tip cuttings from growing vines for planting material.

MISCELLANEOUS GROUP

Chayote

The chayote is a large-vined plant belonging to the cucurbit (melon and squash) family. The fruits are somewhat flattened, pear-shaped, and yellow to green in color (figure 58). Fruits usually weigh from ½ to 1 pound each, but may be larger. Most types are rather wrinkled and corrugated. The fruits are cooked like squash.

The vine is vigorous and hardy, and should have a fence or trellis upon which to grow. It responds well to heavy manuring and applications of commercial fertilizer. One or two vines properly cared

for are often capable of producing large quantities of fruit and may be sufficient for an average family.

The chayote is the only edible member of the cucurbit family introduced into Hawaii that appears to be rather tolerant of melonfly attack.

For propagation the entire fruit is used. It should be planted with the large end in the soil, sloping downward, and with the small end slightly exposed. A more difficult method is to remove young shoots from the plant base to a small propagation bed, where they can be carefully irrigated and tended until roots form.

Insects. Insects that attack chayote are aphids (see Broccoli), leafhoppers (see Chard), bean capsid (see Green Beans), and mites (see Celery).

Eggplant

The eggplant thrives best during warm weather. It is a relatively easy crop to grow in home gardens in Hawaii, once the plants have become well established (figure 50).

Many people prefer the fruit quality of the long types, but the round-fruited varieties, such as Black Beauty, are generally easier to grow. Three or four thriving plants should suffice for the average family. Plants should not be neglected by leaving overmature fruits on them. Fruits of round types are ready for harvest when they reach 3 or 4 inches in diameter.

Seeds of eggplant are often slow in germinating, and the young seedlings are delicate. Flea beetles usually attack the young seedlings and may kill them unless dusts or sprays are applied. Young plants should be kept growing steadily. When serious setbacks in growth occur, eggplants produce hardened, woody stems, and the transplants fail to develop into thriving, heavy-bearing plants.

In the detailed planting plans presented in this bulletin, four plantings of eggplants per year are indicated. Under good conditions, the plants may continue to thrive and produce fruits for a year or longer. Repeat plantings may therefore not be a necessity, yet young, vigorous plants will produce more fruits than old ones. Occasional side dressings of a complete fertilizer should be given plants that are kept in production several months.

See table 23 for information on eggplant diseases and insects.

Okra

Okra is a warm-season plant (figure 54). In Hawaii it thrives better in summer than in the cool, short days of winter. If pods are

TABLE 23.—Insects and diseases of eggplants

NAME	DESCRIPTION AND REMARKS	CONTROL
Insects		
Flea beetle	A small, dark, beetle which jumps when disturbed. Eats small round holes in leaves	*Spray* with cryolite, rotenone, or Bordeaux (as repellent). Or *dust* with cryolite, rotenone, or calcium arsenate
Mite	See Celery	See Celery
Rose beetle	Refer to figure 40 for picture and see Green Beans for description	*Spray* with lead arsenate[1]
Pepper weevil	The small white larvae feed inside the fruits	*Spray* with cryolite or lead arsenate. Or *dust* with cryolite or calcium arsenate
Aphid	See Broccoli	See Broccoli
Diseases		
Cercospora leaf spot	Yellow to brownish spots on leaves with concentric rings typical (figure 45)	*Spray* with Bordeaux or copper oxide. Or *dust* with copper-lime or copper oxide
Septoria leaf spot	See Tomato	See Tomato
Wilt	Plants wilt in spite of plentiful soil moisture. Stems near soil may be darkened on inside	Do not replant eggplant in same area. Do not save seeds from affected plants. Tomato, potato, and okra may also be attacked. Sprays and dusts are of no value

[1] Preferred for control as indicated by unpublished data of F. G. Holdaway.

picked every 3 to 5 days, the plants continue to bear over many weeks. Leaving old pods on the plants lessens the yields. Only a few well-tended plants are needed in a garden. The pods are not fit for human food unless they are young and tender. Rather large pods may be tender if they have developed rapidly.

The seeds should be soaked in water about 24 hours before planting. Seeds which fail to swell should not be planted.

Okra is often used in soups. It may be boiled plain, or cut in thin slices, rolled in flour, and fried in fat. The last-named method eliminates the sliminess of this vegetable.

The plants, varying with varieties, grow rather tall, especially in summer, and should be given plenty of room. The tall, vigorous varieties, such as Perkins Mammoth and White Lightning, are potentially the heaviest yielders, and they bear over the longest periods of time. More gardeners should learn to like okra and plant it in the summer garden.

Diseases and Insects. For aphid and caterpillar control, see Broccoli; for leafhopper control, see Chard; for wilt, see Eggplant.

Tomatoes

From a nutritional standpoint and for general utility in cooking and preparing meals, the tomato is one of the most desirable home-garden vegetables. The climate at low elevations in the Islands is excellent during the winter for growth and fruit setting, but summer temperatures are usually above the optimum, especially for large-fruited varieties. Insects and diseases are also generally more serious during summer at low elevations. In cold, heavy-rainfall districts of high elevations, blight diseases are serious during the winter. A cool, dry climate with plenty of sunshine is ideal for tomato growing.

Fertilizers for tomatoes should be relatively low in nitrogen, at least until a desirable fruit set has been obtained. After fruits are set, side dressings of nitrogen may aid greatly in increasing the size of fruits. At the time plants are transplanted to the garden, a fertilizer *high in phosphate,* such as 4–12–8 or 11–48 ammonium phosphate, should be used. Fertilizer applied at time of transplanting or as side dressings should be placed 3 or 4 inches from the base of the plant and to a depth of 3 or 4 inches. Roughly, two level tablespoons of fertilizer applied in a band 6 to 12 inches long supply a rather heavy application.

No one tomato variety will be best for all home gardeners. Local variations in climate and soils may have important effects on varietal response. It is only possible, therefore, to *group* the varieties into the following general classifications, which may be of some value to gardeners:

(*a*) Varieties with large fruits whose individual stems end in flower clusters. Such growth is called determinate, as contrasted with indeterminate growth (see *b*). Vines of determinate types are short and compact (figure 64); those of indeterminate growth are usually long and sprawling. Under adverse conditions, determinate varieties tend to set fruit slightly better than indeterminate varieties, but usually do not set so well as those of the plum, pear, and cherry group. The determinate group includes Pritchard, Bounty, and Pearson. Bounty appears to be the best large-fruited tomato for summer planting at low elevations. It is small-vined, very early, and matures the crop over a short period of time. Plantings of Bounty alone should therefore be made oftener than would be the

case if only longer-bearing varieties were planted. These determinate varieties are *not* well adapted to pruning and staking. This is especially true of Bounty. A low framework for the vines to trail over helps to keep them off the ground.

(*b*) Varieties with large fruits and indeterminate vines, adapted to all elevations during the cool seasons of the year and to high elevations during summer. Those that are good for staking and pruning are Break O' Day (similar to Grothens Red Globe), Valiant, Stokesdale, Rutgers, and Marglobe.

(*c*) Small-fruited group: The pear, plum, and cherry (round) varieties of tomatoes generally are able to set fruits when many large types fail (figure 65). The percentage of fruits attacked by melonflies is also generally less in these types. A good plan is to have at least a few small-fruited plants in the garden, particularly in summer. Numerous varieties exist in this group, and generally the home gardener can obtain a few seeds from local sources.

Staking and pruning of the large-fruited, large-vined varieties is advisable, especially in high-rainfall districts (figures 62, 63). This practice conserves space, tends to aid in fruit setting, reduces losses from "soil" rots, and makes it easier to spray or dust the fruits and later to pick them. Fruits on staked plants are more susceptible to blossom-end rot, a disease resulting from poor irrigation practice. A uniform water supply should be maintained, but over-irrigation is harmful. Certain virus diseases are likely to be spread during pruning. Staked plants should be pruned to one or two main stems, and all side branches (laterals arising at leaf axils) should be broken out when they are only an inch or two long—usually every 3 or 4 days. Plants for staking can be spaced 18 to 24 inches in the row; unstaked plants should be 3 or 4 feet apart.

In districts where melonflies sting the fruits, the blossom clusters should be covered with small cloth bags 8 or 10 inches long and 6 or 8 inches in diameter. A drawstring attached to the open end of the bag can be used to tie the bag somewhat loosely to the main stem of the plant. As soon as a tiny fruit appears on the cluster, the entire cluster should be bagged. The unopened flowers will develop and open inside the bag, and, as they are self-pollinating, will set fruits if conditions are favorable. Fruits will grow, mature, and develop red color while inside the bags. Mature green or pink fruits of the tomato can be harvested, if necessary, and placed in a cool place in the house to develop red color.

Diseases and Insects. Table 24 describes insects and diseases to which tomatoes are subject.

TABLE 24.—Insects and diseases of tomato

NAME	DESCRIPTION AND REMARKS	CONTROL
Insects		
Aphid	See Broccoli	See Broccoli
Melonfly	Adult is a light yellow fly with dark markings. Produces small white maggots which eat on inside of fruit. Fruit soon collapses. Gardeners should continually pick infected fruits and immerse them in water for 72 hours to kill the maggots	See discussion in the text on bagging of tomato clusters, and see figure 42
Corn earworm (tomato fruitworm)	(For description, see Corn.) Eats large holes in tomato fruits (figure 37)	*Spray* with cryolite. Or *dust* with cryolite or calcium arsenate
Mite (red spider)	See Celery	See Celery
Pinworm	Tiny grayish worm up to ¼ inch long; burrows into fruit around stem attachment, leaving small hole. Not so destructive as melonfly maggots	*Spray* with cryolite. Or *dust* with cryolite or calcium arsenate
Diseases		
Virus diseases (only a few of the viruses that may attack tomato plants in Hawaii are listed)	*Mosaic*—causes mottling of leaves (light- and dark-green spotting, sometimes puckering). *Fern leaf*—leaves become narrowed, almost to threads in severe cases. *Spotted wilt*—upper leaf surfaces become bronzed, possibly followed by round, dead spots; growing point of plant may suddenly wilt, turn dark, and die back. See figure 48 for mosaic and fern leaf	Keep insects well controlled. Keep weeds killed. Remove plants severely affected early in growth. Do not touch healthy plants after handling diseased ones until hands have been thoroughly washed. Rotate tomatoes in the garden. If possible, keep tomatoes away from potatoes. German Sugar variety (a plum type) appears resistant to spotted wilt. Sprays and dusts are useless, except in an indirect way in controlling insects
Fusarium wilt	A fungus which attacks plants through roots. Causes wilting and progressive collapse of plant. Stems near surface darkened on inside	Some seed stocks of Marglobe, Pritchard, Break O' Day, and Rutgers are somewhat resistant. Pan America is highly resistant. Rotation is important. Spray or dust is useless because organism is in soil and attacks within the root tissue

TABLE 24 (*Continued*).—Insects and diseases of tomato

NAME	DESCRIPTION AND REMARKS	CONTROL
Bacterial wilt	Plants wilt, especially in heat of day; may recover at night. Wilting becomes progressively more severe from day to day	Since the organism attacks through the roots, sprays or dusts are useless. Good soil drainage and rotation must be practiced. Peppers, eggplants, and potatoes must be kept out of the rotation, since they also may be attacked
Septoria leaf spot	Small, round, brownish spots on leaves. Centers gray, with tiny black dots. Develops most rapidly during rainy weather, or on leaves near moist soil surface	*Spray* with copper oxide or Bordeaux. Or *dust* with copper oxide or copper-lime
Early blight (alternaria)	See Potato	See Potato
Late blight	See Potato	See Potato
Blossom-end rot	Small, medium, or large, slightly sunken, blackened areas on blossom end of fruit. A physiological disease (figure 44)	Provide a uniform moisture supply. Neither sprays nor dusts help
Nematodes	See Section 8	It is especially important that seedlings be grown in nematode-free soil, as neither sprays nor dusts help

SECTION

•11•

CROPS LESS WELL-ADAPTED TO OR LESS COMMON IN HAWAIIAN GARDENS

FEW GARDENERS are content, month after month, to confine their plantings to crops that are easy to grow. Variety adds spice, in gardens as elsewhere, and all of the crops discussed in this section *can* be grown in Hawaii. It is not uncommon to see some of these less well-adapted plants thriving where the gardener's experience or favorable local conditions promote successful growth of the crop. However, these crops often require more work and energy than the crops previously discussed, and the quality and yields may be too low to justify the effort.

Asparagus requires about 2 years to reach good production. The crop will grow in Hawaii, but the plants lose vigor in a few years because the climate does not give them adequate rest periods. In very dry locations, the crowns may be given an artificial rest period by withholding water from the plants for 8 to 12 weeks each year just before harvest. For winter asparagus, the dry period should be timed from September to November. Since asparagus is a perennial, it should be placed at one side of the garden, where it will not interfere with other garden operations. Harvests can be started the second year after planting, and should preferably extend for 3 to 6 weeks at any one time. After the harvest period, tops should be allowed to develop for a few months to store food in the fleshy roots.

Artichoke (*globe*) prefers a cooler climate than prevails in most areas in Hawaii. If given good care, it will grow fairly well at our high elevations. High temperatures open the edible buds rapidly and make them leathery.

Belembe (locally called *Tahitian taro*). This plant grows well in Hawaii and produces edible leaves over long periods (figure 61). Propagation is by means of offshoots from old plants.

Brussels sprouts, to be of good quality, should have low temperatures. The small heads produced in leaf axils are open and of poor quality when the crop grows at temperatures above 70° F.

Cauliflower can be grown at low elevations during cool months, but crops are not of the best quality. Gardeners at high elevations have a better chance of success. In general, however, the crop is not a good home-garden vegetable in Hawaii.

Celtuce, a new, lettuce-like plant of oriental origin, is grown both for the fresh green leaves and for the single stem which may be peeled and used like celery. It prefers cool weather.

Collards, popular as greens in the southern United States, are nonheading plants with leaves that resemble those of cabbage. The crop is generally more resistant to hot weather than kale, but best quality is attained only under cool-temperature conditions.

Cucumber vines often thrive in Hawaii, but fruits are likely to be attacked by melonflies and vines are susceptible to mildew. Because of these two problems, the low food value of cucumbers, their short bearing period, and the room they require in the garden, most gardeners leave cucumbers out of planting plans.

Endive is essentially a cool-season crop. The most satisfactory growth and the most tender, crisp leaves are obtained under cool conditions. Gardeners at low elevations should generally confine their endive plantings to cool months. Inside leaves can be blanched by tying all leaves together near the tips. From 1 to 2 weeks are required for blanching. When plants are blanched under our conditions, frequent inspection should be made to determine whether the inner leaves are rotting. Endive can be used in the same manner as lettuce. It may be transplanted from seedbeds, but it is generally best to plant the seed in place and thin the seedlings to 6 to 12 inches apart in the row. It requires fertilization similar to that for lettuce.

Herbs. In this group may be listed mint, sage, dill, chives, basil, and thyme. As a rule, these kitchen herbs require abundant sunshine, rich soil, and uniform water supply. Relatively few insects or diseases attack the plants. Most of them can be grown in borders of the yard or garden.

Kale. Many types of kale exist; all are nonheading plants, the leaves of which are pulled off and eaten for greens. The plant prefers cooler temperatures than prevail at low elevations in the Islands.

Kohlrabi can be planted, preferably during cool months, to substitute for cabbage or broccoli. It grows well the year around at high elevations. The enlarged, round, edible stem portion tastes somewhat like turnip. White Vienna is a preferred variety. The rounded stem should be harvested when it reaches 1½ to 2½ inches in diameter; otherwise it rapidly becomes tough and fibrous. For a

continuous supply, the crop should be planted every 2 or 3 weeks. For insects and diseases, see Broccoli.

Muskmelon and **Watermelon.** These crops take much room in the garden, are low in food value, and extremely susceptible to melonfly and aphid attacks. In most localities fruits should be bagged to prevent loss from melonflies.

Pumpkin and **Squash.** In most home gardens, aphids, mildews, and melonflies are serious on these crops. Melonflies are especially destructive at low elevations. The large vines of pumpkins and winter-type squash require wide spacing.

Parsnip. To attain good quality, this crop requires lower temperatures than generally prevail in Hawaii. It matures slowly.

Pea (*garden*). The common, northern, sweet (English) pea requires cool temperatures and seldom produces good crops at low elevations in Hawaii. It is very susceptible to mildew attack. For our climatic conditions, Creole is one of the most satisfactory varieties.

Pepper. Peppers planted in fall, winter, or early spring often grow well. The California Wonder variety is well adapted. Growth and fertilization of plants should be similar to practices recommended for tomato. Weevils, larvae of which eat into the buds and fruits, are serious pests of peppers which many home gardeners find difficult to combat. However, with proper insect control, the crop can be a valuable addition to the garden. (Note pepper-weevil control under Eggplant, Section 10.)

Rhubarb. This plant grows best at high elevations. In warm areas, most satisfactory growth is probably obtained by keeping the plants as dry as possible during summer and then forcing them with plentiful fertilization and irrigation during cool months. In cold climates, where rhubarb is best adapted, plants are dormant during winter months.

Rutabagas (*Swede turnips*) are in general less well adapted than turnips. However, rutabagas of large size have been produced at low elevations during cool months, and at high elevations they can be substituted for turnips. They keep better than turnips, and are higher in food value.

Salsify (*vegetable oyster*) is a root crop that can be cooked and used similarly to carrots. It prefers cool weather but will grow fairly well in warm months.

Spinach. Common spinach should preferably be planted during cool months. It will respond well to ample fertilization with manures and commercial fertilizers.

Spinach (*Ceylon* or *Malabar Nightshade*). This glossy-leaved herb is grown by several gardeners in the Hilo area. Once established, it grows rapidly. Young leaves and growing tips are cooked in the same manner as New Zealand spinach. It is a good substitute for New Zealand spinach, and tends to be less "slick" when cooked. It may be propagated either by cuttings or seeds. Cuttings root best if given partial shade and plenty of water.

Spinach (*Chinese*). This amaranth thrives in summer and can be planted throughout the year. There is considerable variation in amaranth seed stocks. Some are leafier and more desirable than others. The plant grows rapidly and is often ready for harvest in 3 weeks. If leaves or tips are harvested, the plant will continue growth. High soil fertility, especially in winter, is desirable.

Tahitian taro. (See Belembe.)

SECTION

•12•

REMINDERS

POSSIBLE PITFALLS for gardeners have been discussed in previous sections, but it may be desirable to summarize them here and to give additional hints on the over-all planning and care of the garden.

General Admonitions

Plant a garden only if you have a reasonably desirable piece of land and the time and genuine interest to care for the crops until they mature. Time, seeds, fertilizers, and spraying and dusting materials are not to be wasted during war.

Make a planting plan of your garden for several months in advance. Secure the seeds, fertilizers, and insecticides that will be needed. Plan ahead in all operations. One good scheme is to plan for plantings on a certain date each month or at least as near to a certain date as possible—say the first of each month. Only a few crops need be planted more often than once in 30 days. (See Sections 1 and 3.)

Provide a windbreak if your garden is exposed. The heavy trade winds can cause immense damage to most vegetables, and especially to the tall-growing crops, by bruising, twisting, and otherwise mechanically injuring tender growing tissues. (See Section 1.)

Spade the soil to a depth of at least 6 inches, preferably 10 to 12 inches, before planting.

Plant only as large an area as you can care for with the help available. A small, well-kept garden is best in the long run—for the crops, for the appearance of the garden, and for your morale.

Unless you are an experienced gardener and have plenty of space, confine your planting to a relatively few crops. From 8 to 12 kinds will usually be enough. Study the discussion of crops easiest to grow in Hawaii (Section 1).

Study the seasonal adaptation of vegetable crops. Don't think that because you have success with a certain crop at one season of the year, the same crop will grow well the year around. (See Section 1.)

If your garden is rather small, keep all space occupied as well as possible. As soon as you harvest a crop, replant the area, preferably to a different crop.

Study the charts on approximate time required for different vegetables to reach maturity and the length of time that they will remain in the garden and still be of good edible quality. This will aid greatly in preparing your future planting plans. (See Section 1.)

Have on hand the tools you are going to need.

Unless the area is very small, plant only a part of your garden at one time. If you plant it all at once, you will have too many vegetables for a while and then a slack period during which you have nothing. (See Sections 1 and 3.)

Choose a location near enough your residence for convenience.

If your area slopes, lay out rows to run around, not up and down.

Lettuce, chard, New Zealand spinach, and mustard may be planted in partial shade, *but no vegetable crop will thrive well under heavy shade.* Tomato plants, in particular, should have as much sunlight as possible.

Remember that many vegetable plants cannot be transplanted easily. (See lists in Section 7.)

You cannot have a successful garden if you have a flock of chickens that you permit to run free. Either fence the garden or confine the chickens. Watch out for the children and the dogs.

All of the seed in the packet need not be planted at one time. On the other hand, don't waste space by stretching the seed too far. See Section 6. With small seeds, especially, it is best to plant a little heavily and plan on thinning the seedlings.

Thin plants when they show signs of being crowded. Do it when they are small.

Tall crops should not be planted so they shade low-growing ones.

Remember that a good gardener never permits more than 2 days to pass without inspecting the garden to answer such questions as these: Are the plants wilting? Is the leaf color normal? Is this crop ready for harvest? Is a bug eating the cabbage?

Let all members of the family share responsibility for maintenance of the garden. If all members help, no one will be overburdened and all will have the pleasure of seeing crops develop from tiny seedlings to full maturity.

Remember that suggestions in mainland publications relative to selection of crops, time to plant, diseases and insects are often not applicable to Hawaii.

Seed

Study the charts of recommended varieties and ask your seedsman for seeds *by varietal names.* Before you plant new varieties ask your county agent, agricultural teacher, or seedsman about them.

Save your own seeds only if it is a case of necessity, or if you have a real interest in doing so.

Discard seeds from packets that have been stored at room temperatures for several months. Seeds deteriorate very rapidly in Hawaii. Buy fresh seeds, or keep your seeds in the refrigerator. Many gardeners successfully store seeds in the refrigerator for years.

Be sure not to plant too deep the small seeds of radish, lettuce, turnip, onion, carrot, cabbage, tomato, and eggplant. One-half inch is about right in most soils. A quarter inch is even better for carrot and lettuce, if plenty of moisture is provided. The larger seeds of bean, corn, and cowpea should be planted about 1 to 1½ inches deep.

Fertilizers

In general, Hawaiian soils need fertilizers to provide nutrients for vegetables. *You may make a sad mistake if you fail to use commercial fertilizer.*

Manure plus commercial fertilizer, especially phosphate, will usually give far better results than manure alone or commercial fertilizer alone.

Learn enough about fertilizers so that you can buy and use them intelligently. Do not buy just *any* commercial fertilizer.

If you apply commercial fertilizers in direct contact with planted seed or directly on any part of a growing plant, you will most likely cause severe injury to the seed or plant. Read Section 4 on methods of applying fertilizers.

If, in preparing ground for a garden, a heavy growth of weeds is spaded into the soil, it should be given at least 3 or 4 weeks, *under moist conditions,* to decompose.

Irrigation

After planting seeds, make a *daily* inspection until seedlings are up to determine whether irrigation is necessary. Sometimes the "bad" (nongerminating) seeds we hear about are bad only in that they are subjected to bad irrigation practice. The small seeds in particular must be watched carefully. An open, loose soil can easily dry out to a depth of ½ inch in 24 hours. Such soil should be irrigated each day, preferably in the morning, and in some cases twice

each day. However, don't overirrigate the planted seedbed. If the soil *at the level of the seed* looks and feels definitely moist, the seeds will germinate.

Once plants are well started, they do not need such frequent irrigation.

Irrigate immediately plants which have been transplanted. Watch them carefully for a few days, possibly providing a shade for each plant for the first 3 or 4 days. They should be kept moist.

Avoid walking or working in the garden when soil is very wet unless you have permanent pathways or unless it is absolutely necessary. Such a practice will result in a "puddled," hardened soil that will bake and crack upon drying and will add to the job of spading when you prepare for the next crop.

Occasionally a gardener turns on the sprinkler and for hours at a time forgets to move it or turn it off. Such neglect injures the plants by overirrigation and leaches out nutrients needed for plant growth. A good irrigation should wet the soil to a depth of from 6 to 12 inches.

Harvesting

If you have a fair-sized garden, start harvesting at an early age such crops as carrots, beets, chard, radishes, turnips, celery, New Zealand spinach, lettuce, parsley, Chinese cabbage, spoon cabbage, and onions. These crops can be called mature when they reach a reasonably edible size. By beginning the harvest early, you can enjoy fresh, tender vegetables over a long period.

If you must hold vegetables for several hours after harvest, the refrigerator is the place to put them to preserve the best edible qualities. This is especially true for green beans, sweet corn, and the leafy vegetables.

Old and neglected plants in the garden harbor insects and diseases. If you can't use all of the vegetables when they are in a good edible stage, give them to your neighbor.

Be sure to harvest beans, okra, and eggplants before they pass their best edible stage. Otherwise, yields will be reduced and table quality will be poor.

Insects and Diseases

Provide materials and equipment (simple though they may be) for control of insects and diseases. It is as essential that you secure these as it is that you buy seeds.

Some gardeners make the mistake of believing that once they have planted the seeds, all they need to do is wait for harvest time. Watch carefully for the appearance of insects and diseases, become familiar with the most common ones, and learn how they damage crops and how to control them.

Keep weeds out of all parts of the garden, even though some areas may not be used. Weeds harbor insects and diseases. If you neglect insect and disease control, your garden will become a reservoir for infestation of your neighbor's garden.

Plants grown in fertile, well-irrigated, and well-cultivated soil often have a good chance to "grow out of" or "away from" insect and disease attacks.

For insects as well as diseases, spray or dust *under* sides of leaves. It is very important to spray or dust under sides of leaves for most fungus diseases and for sucking insects such as aphids, red spiders, and leafhoppers.

Apply measures of control when insect or disease troubles first appear. When experience indicates that certain diseases are likely to attack the crop, apply dust or spray as a protection *before the disease appears.* For insects, it is usually most practical to wait until they appear, but not to wait until they have caused serious damage.

Prepare only as much spray as is needed.

A single application of dust or spray will not permanently insure the crop against disease or insect attack. Observations must continue to determine the need for further applications. For many insects and diseases, applications must be repeated at 5- to 10-day intervals.

Literally burying a plant in dust is wasteful, because more materials are ordinarily used for dusting than for spraying. A *thin film* is usually sufficient.

Rotation of crops will help to avoid certain disease troubles.

Poisons should be placed where children cannot reach them. Keep them on high shelves or in locked cabinets.

Handpicking of caterpillars from such crops as lettuce, cabbage, beet, onion, chard, okra, and broccoli is practicable if one has the time or the help to examine upper and lower leaf surfaces carefully every few days.

Remember that dusts:

(*a*) Are often much simpler and more convenient to use than sprays.

(*b*) Can be returned to the container, whereas unused sprays should be discarded.

(*c*) Usually require less time than sprays.

(*d*) Often are less likely to burn tender foliage.

(*e*) Are usually ready to use, as purchased, and require no careful measuring or mixing.

(*f*) Are most practical in dry districts.

(*g*) Should not be applied during heavy winds unless a good windbreak is present.

(*h*) Should, if they contain stomach poisons for chewing insects, preferably be applied early in the morning. Morning dew on the plants will help the dust to stick to the foliage.

(*i*) Should, if they contain nicotine (Black Leaf 40) or pyrethrum for sucking insects, preferably be applied during the *hottest part of the day,* when their contact with the insects and the effect on their respiratory action is most effective.

(*j*) Are at a disadvantage in high-rainfall districts because they may be washed off by rain; when heavy showers are frequent, dusts might have to be applied every 3 or 4 days until desired results are obtained.

(*k*) Should *not* be applied *just before* an overhead irrigation of the garden.

Dusters for home gardens need not be costly. Small dusters of about one-quart capacity are large enough. A deflector attachment on the end of the delivery tube is desirable, so that dust can be deflected to the under sides of leaves.

Rinse and clean out the sprayer each time after using. Otherwise it will soon become clogged and unfit for a thorough spraying job.

When spraying, cover thoroughly all parts of the plant, for a poor job will necessitate another application. It is not necessary to drench the plant—a mist-like spray is preferred.

The sprayer should be equipped with an angle pipe or movable nozzle that will permit spraying the under sides of leaves. Spraying the upper surfaces of leaves may have little or no effect on insects attached to the under surfaces.

In preparing a spray from powder, one should first make a paste of a small amount of water and the powder, and then add this paste to the water in the spray.

Gardeners can learn much by going to qualified individuals to discuss methods of culture, and insect, disease, and other miscellaneous problems. Such persons include experienced gardeners, representa-

tives of fertilizer and seed firms, vocational agricultural teachers, county agricultural agents, and members of the University of Hawaii Cooperative Extension Service in Agriculture and Home Economics, the University of Hawaii Agricultural Experiment Station, and other agricultural research stations.

APPENDIX

Vitamin and Mineral Values of Vegetables

The table below[1] presents, in simple form, a list of the crops either well- or moderately well-suited to Hawaii, and their relative vitamin and mineral values. The gardener would do well to plant those vegetables that are high in food value and at the same time are those he prefers to eat.

Comparative vitamin and mineral contents of well- and moderately well-adapted vegetables. Values based on data obtained locally for some vegetables, others from Sherman, Chemistry of Food and Nutrition, 6th ed., 1941

Crop	Vitamins	Minerals
Greens		
** Beet tops	Good A, poor B and C	Good iron
*** Broccoli	Good A and C, fair B	Good calcium, fair iron
** Cabbage, Chinese (mature Wong Bok)	Poor A, B, and C	Fair calcium and iron
** Cabbage, head	Poor A unless green, fair B and C	Fair calcium, poor iron
** Cabbage, spoon (white mustard)	Good A, poor B	Good calcium, fair iron
** Celery (green)	Poor A, B, and C	Good calcium, fair iron
** Chard	Good A, poor B and C	Poor calcium, fair iron
*** Lettuce	Good A, poor B and C	Fair calcium and iron (if green)
*** Mustard, Chinese green	Good A, fair B, fair C	Good calcium, fair iron
** Onions, green	Good A, poor B, fair C	No analysis available
*** Parsley (good for minerals and vitamins, but usually very small quantities are eaten)	Good A	Good calcium and iron
** Spinach, New Zealand	Not known	Not known
Root crops		
* Beet roots	Poor A, B, and C	Poor calcium and iron
*** Carrots	Good A, fair B, poor C	Fair calcium and iron
* Daikon	Poor A, B, and C	Poor calcium and iron
* Radishes	Poor A, B, and C	Poor calcium and iron
* Turnips (roots, white)	Poor A, B, and C	Poor calcium and iron

[1] Prepared by Prof. Carey D. Miller, Nutritionist, Hawaii Agricultural Experiment Station.

Crop	Vitamins	Minerals
Legumes		
*** Beans, green	Good A, fair B, poor C	Good calcium, fair iron
*** Beans, lima	Fair A, good B, poor C	Good calcium and iron
*** Cowpeas (whole pods with beans)	Good A, fair B, poor C	Fair calcium and iron
** Peas, Chinese	Not known	Good calcium; (iron unknown)
*** Soybeans	Good A and B, poor C	Good calcium and iron
Starchy vegetables		
** Corn, sweet	Fair A in yellow, none in white; poor B and C	Poor calcium and iron
** Potatoes, Irish	Poor A, good B; fair C if young and new, poor if old, stored	Fair calcium, fair iron
*** Sweetpotatoes	Good A if deep yellow; good B, poor C	Fair calcium and iron
Miscellaneous vegetables		
* Chayote	Not known	Unknown
** Eggplants	Poor A, fair B, no C	Poor calcium and iron
* Okra	Poor A and C, fair B	Good calcium, fair iron
*** Tomatoes	Good A and C, good B	Poor calcium and iron

*** "Star" vegetables for Hawaii gardens from standpoint of vitamin and mineral value.
** Of moderate vitamin and mineral value.
* Of low nutritive value.

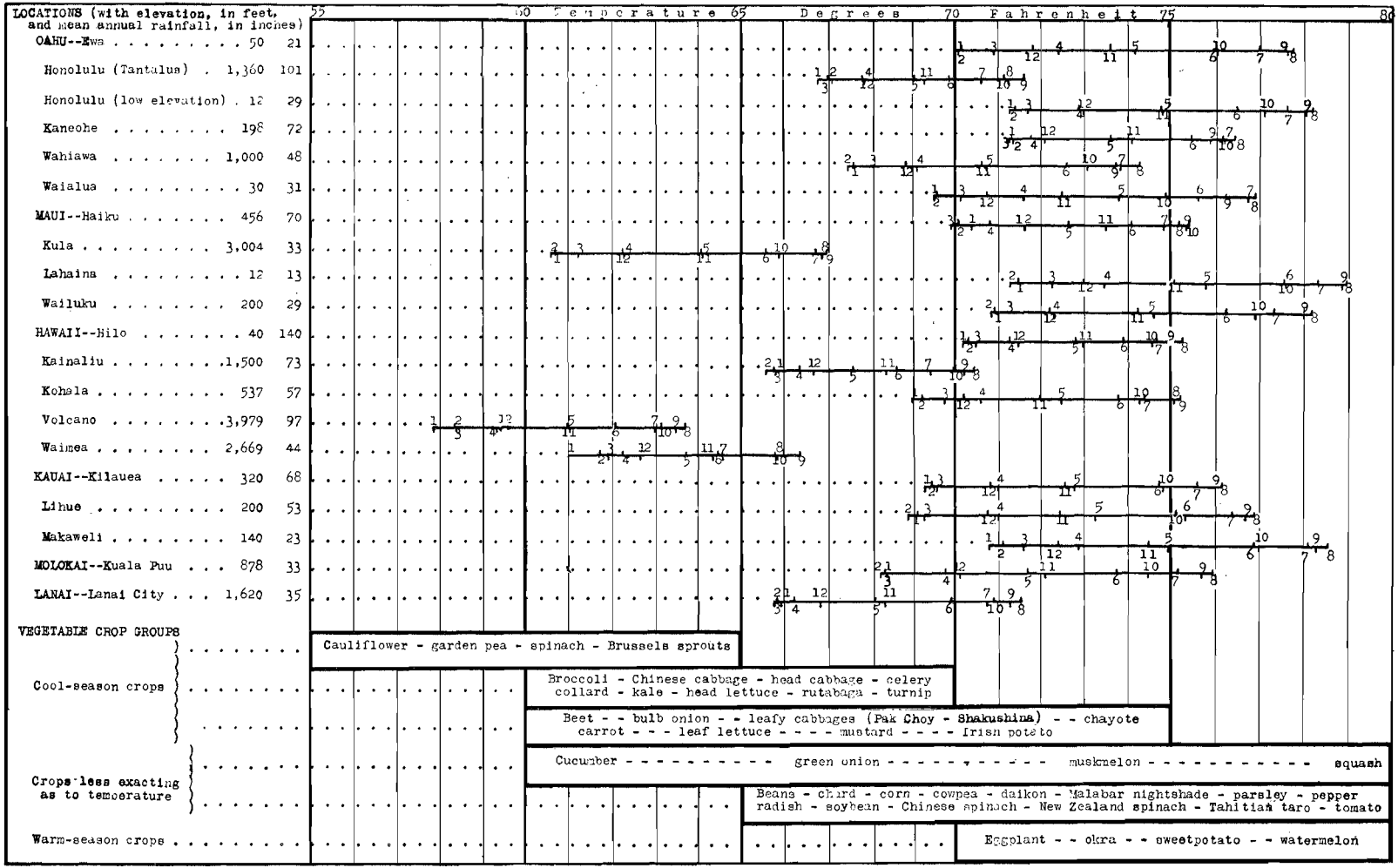
Mean Temperatures in Hawaii and Best Temperatures for Growing Vegetables

Many of Hawaii's home gardeners have irrigation water available to irrigate vegetables during dry weather. But gardeners can do little to control another important climatic factor affecting vegetable growth—temperature.

Because different temperature levels exert profound effects on vegetable crop growth, the accompanying graph was prepared to show the temperature ranges preferred by certain vegetable crops and mean temperatures at several Island locations throughout the year. The graph was not prepared with the thought that it would serve as a monthly planting calendar, but with the hope that it would indicate, particularly to gardeners at low elevations, that midsummer temperatures are definitely high for some crops and that other crops can be expected to grow best at these high temperatures.

In studying the graph, the reader should not infer that the various crops will not grow at all above or below the temperature ranges they are stated as preferring. Yet careful research and common experience have demonstrated that the best growth and quality can be expected within the temperature limits shown. For some crops, optimum ranges are known to be rather narrow; on others information is meager. For practical purposes, it has been necessary to group several crops together, although not all crops in each group have the same optimums.

Mean temperatures in Hawaii and best temperatures for growing vegetables. See explanation in Appendix.



The difference in temperature between summer and winter months in Hawaii is very small in comparison with such differences in mainland areas, but this small difference is of considerable importance from the standpoint of plant behavior.

The numbers 1 to 12 along the narrow horizontal bars in the upper portion of the graph are symbols for months, as follows:

1 January	5 May	9 September
2 February	6 June	10 October
3 March	7 July	11 November
4 April	8 August	12 December

Their positions on the bars indicate the mean monthly temperatures for twenty meteorological stations in Hawaii. Examples: For Ewa, numbers 1 and 2 fall near the 70° F. line, indicating that for January (number 1) and February (2) the monthly means are approximately 70° F.; the March (3) mean is approximately 71° F.; the June (6) and October (10) means are approximately 76° F. The short vertical strokes above and below the horizontal bars show more exactly for each meteorological station the mean temperature for each month.

The elevation, rainfall, and temperature data were made available through the courtesy of the United States Weather Bureau, Honolulu. In most cases, the records are averages for many years.

The Bureau gives the following additional information on location of the twenty weather stations: Honolulu (low elevation) = downtown Honolulu; Kaneohe = mauka (hospital area); Wahiawa = Wheeler Field; Kula = Sanatorium; Lahaina = Kaanapali; Kainaliu = University of Hawaii Agricultural Experiment Station branch station; Kohala = mission; Volcano = observatory; Kuala Puu = Molokai Ranch.

In connection with and as an adjunct to the graph, the following general observations may be made:

1. In most localities June, July, August, September, and October are the warmest months, and December, January, February, March, and April are the coolest. In general, May and November are intermediate between the cool and warm seasons.

2. At low elevations plantings made in May and June grow and mature in increasingly warm weather, and plantings made in October and November develop in cooler weather. Therefore, best results can be expected from cool-season crops if they are planted in October and November, and roughly, through March or April.

3. At low elevations, a wider diversity of crops can be grown in winter months than in summer months.

4. At medium to high elevations, temperatures are within a range favorable for growth of a large number of vegetable crops throughout the year. Many insects and diseases are less serious at the cooler temperatures of these high elevations.

5. Several vegetables listed in the graph are not considered desirable home garden crops in Hawaii. They were included simply to make the list more comprehensive. For detailed information on each crop, see Section 10.

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