Handbook of Tropical and Sub-Tropical Horticulture

by: Ernest Mortensen and Ervin T. Bullard

Published by:
Agency for International Development
Department of State
Washington, D.C. 20523 USA

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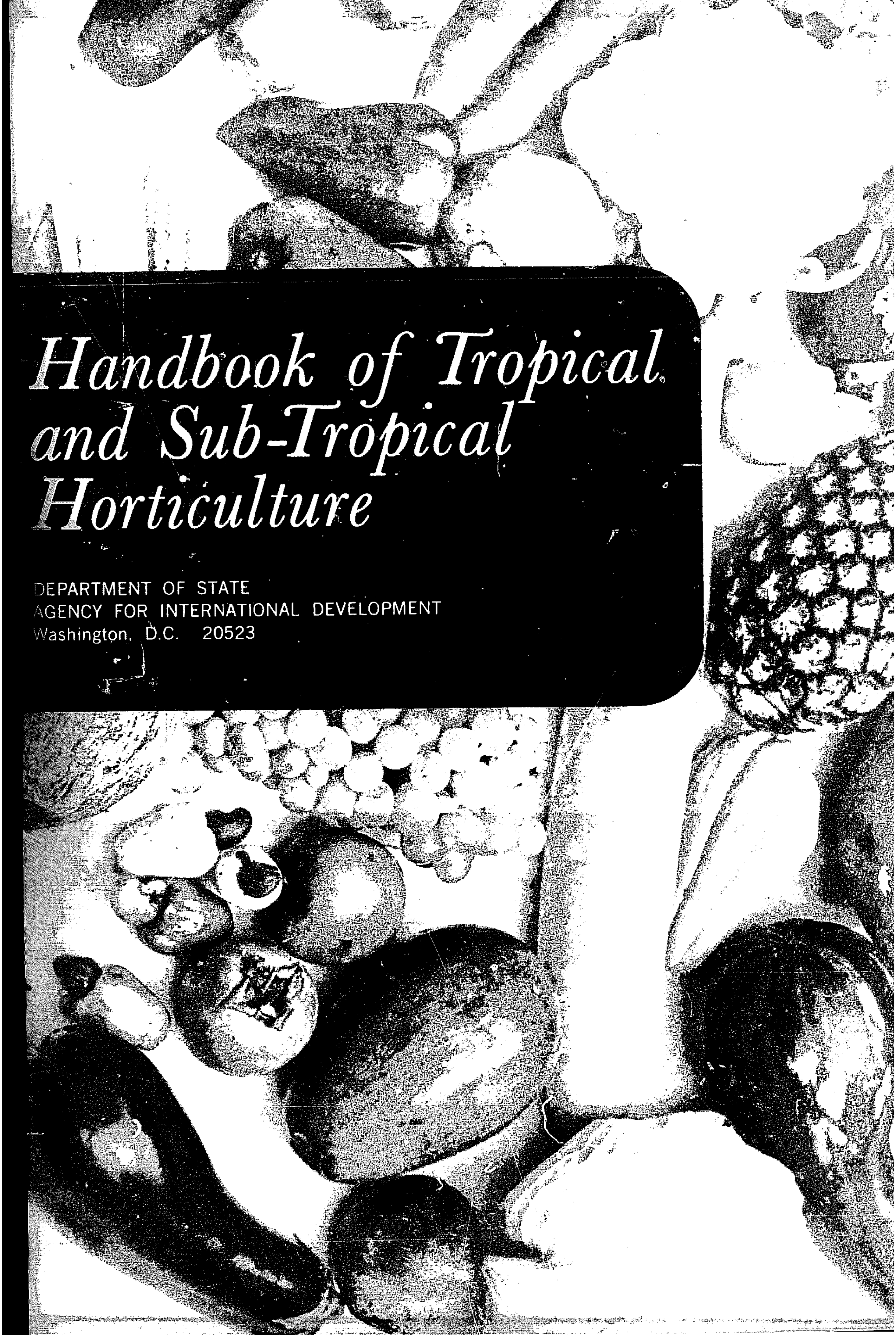

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DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
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Ernest Mortensen and Ervin T. Bullard

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For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $3.90
Stock Number 044-001-00022-5
Cat. No. S18.8:H78/970

Agriculture Technical Services Desk
Agriculture and Rural Development Service
Office of War on Hunger
Agency for International Development

Printed May 1964
Reprint November 1964
Reprint April 1966
Revised April 1968
Revised June 1970

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PREFACE

U.S. agencies having responsibility in foreign assistance programs long have recognized the need for a handbook on horticultural crops in the Tropics. Information on the subject may be found in various scientific textbooks, treatises and papers. It is to fill the need for consolidated information in ready reference form that this "Handbook on Tropical and Subtropical Horticulture" is issued by the Agency for International Development in consultation with the U. S. Department of Agriculture.

Based upon an extensive survey of available literature, this manual is designed for the use of U.S. A.I.D. technicians and contract personnel, and for Peace Corps volunteers engaged in rural development. It is written in layman's language so that it may be understood by the non-specialist who yet is called upon to work with farm families in solving their agricultural problems. Nevertheless, research workers and students also will find it of value because of its up to date and extensive bibliography. It also serves as reference and guide for teaching courses.

In addition to U.S. A.I.D. and Peace Corps personnel, there are two other groups to whom this Handbook can be of great help. The one group is composed of missionaries living with rural people and concerned with agricultural education in the Tropics. Often lacking an agricultural background, they must search for practical information on tropical crops to help local farmers increase agricultural productivity. In the other group are employees of large agricultural companies. Some of these are foreign, others are local technicians. Perhaps their first aim is to promote the use of a specific agricultural chemical, for example, but since they have close contact with farmers, they are called upon often to answer questions pertaining to other phases of agriculture.

There has been a dearth of agricultural research people in the Tropics and a shortage of funds for basic and applied research. In general the quality of research work has been good, but quantity and coverage are limited. The Handbook indicates in the first chapter those fields of endeavor where work is needed immediately. Major fruit, nut and tree crops are discussed in the second chapter with emphasis on such important points as spacing, pruning, fertilizing, budding, and disease and insect control. A few Temperate Zone fruits are included to stress that they can be grown only at higher elevations in the Tropics, due to chilling requirements. Crops are listed alphabetically and scientific names are given for reference purposes.

The Handbook continues with a description of all major vegetable crops. Information is presented on seed storage, vegetable varieties, fertilizer recommendations, plant spacings, temperature requirements, soil and cultivation. Major diseases with their control are presented in a table for easy reference.

Herbicides are being used extensively in temperate regions for weed control. They will come into more use in the Tropics in the future, especially if labor costs continue to increase. Accordingly, a table lists recommended herbicides for each crop. Likewise, a table is presented to indicate major insects and how they can be controlled. Pictures are included for identification purposes.

Source of plant material is provided, as well as sources of equipment and materials used in the production of horticultural crops. Conversion factors are included for converting the imperial system of weights and measurements to the metric system, which is used in most of the tropical countries. A conversion table is presented for converting temperature from Fahrenheit to centigrade. Included also is a table to determine the number of plants or trees per hectare at the most common spacings.

In summary, the main function of the Handbook is to give A.I.D. agricultural technicians, Peace Corps personnel, and other workers concise methods of economically producing horticultural crops in the Tropics. It is to assist them in helping the farmer produce food crops more efficiently and improve his standard of living. As this Handbook is translated into different languages, it is used directly by local extension personnel, village-level workers, and the better-trained farmers who are natural leaders in their communities. This publication has been translated into French by A.I.D.'s Centre Regional d'Editions Techniques (C.R.E.T) in Paris, France. It also has been translated into Spanish by A.I.D.'s Regional Technical Aids Center (R.T.A.C.) in Mexico City, Mexico. Finally, the references on the different crops lead the student's way to the more detailed information which is beyond the scope of the Handbook.

notes from which the original Handbook and this revision evolved.

Appreciation also is expressed to the staff of the Haitian Division of Research for research assistance, and in particular to Jacques Jolicoeur,

for plant pathogens; J. M. Good for nematodes; B. S. Crandall and J. R. McGrew for plant diseases; L. L. Danielson for weed control.

University of Hawaii, Honolulu: J. C. Gilbert, H. Y. Nakasone, R. R. Romanowski and I. W.

Table 17. SUGGESTED INSECT CONTROL FOR FRUITS (Continued)

CROP	INSECT NAME		DAMAGE	CONTROL[1]	REFERENCES
	COMMON	SCIENTIFIC			
Grape	Leafhopper	*Empoasca decipiens* etc.	Suck juices causing leaves to turn gray.	Malathion or DDT spray soon after grape bloom.	
	Berry moth	*Paralobesia viteana*	Destroys young fruit in cluster.	Carbaryl spray at petal fall and later.	
	Phylloxera	*Phylloxera* sp.	Attack roots causing decline and death of vines.	Resistant rootstocks.	
	Wasps	*Polistes* spp. etc.	Feed on ripe fruit.	See Date.	7
Grapefruit	See Citrus.				
Guava	Aphids	See Apple.			
	Fruit flies	*Anastrepha striata,* *Dacus* spp.	Maggots attack fruit.	Malathion bait spray.	21
	Green Scale	*Coccus viridis*	Occur on branches.	Malathion spray.	1
Lemon	See Citrus.				
Lime	See Citrus.				
Lychee	Fruit flies	*Ceratitis capitata* etc.	Maggots attack fruits causing decay.	Malathion bait spray.	21
Mandarin	See Citrus.				
Mango	Fruit flies	*Anastrepha* spp. etc.	Maggots feed on ripe or nearly ripe fruits.	Malathion bait spray. Clean up and bury infested fruit.	21
	Treehopper	*Aconophora pugionata*	Feed on leaves.	Carbaryl spray.	1
	Scale	*Aulacaspis tubercularis*	Occurs on branches esp. in India.	Malathion spray.	1
Olive	Fruit fly	*Dacus oleae*	Very destructive to fruits.	Malathion bait spray.	21
	Scale	*Parlatoria* spp.	Occurs on branches.	Carbaryl spray.	
Orange	See Citrus.				
Papaya	Green peach aphid	*Myzus persicae*	Carries mosaic virus.	Malathion spray. Do not plant cucumbers or melons near papaya.	14
	Fruit flies	*Toxotrypana curvicauda*	Larvae feed in interior.	Destroy or bury all dropped fruits. Malathion bait spray.	1
	Scale	Various	Leaves and young fruit.	Malathion spray.	1
	Whiteflies	*Trialeurodes* spp.	Feed on leaves.	Carbaryl spray.	22
Passion fruit	Aphids	See Papaya.			16
	Fruit flies	See Papaya.			16
	Mites	Several	Feed on foliage.	Dicofol.	16

Table 17. SUGGESTED INSECT CONTROL FOR FRUITS (Continued)

CROP	INSECT NAME COMMON	 SCIENTIFIC	DAMAGE	CONTROL[1]	REFERENCES
Peach	Oriental fruit moth	*Grapholitha molesta*	Larvae feed in fruits.	Carbaryl or DDT spray.	20
	San Jose scale	*Aspidiotus perniciosus*	Gray scale covers branches.	Malathion spray.	20
	Leafhopper	*Homalodisca insolita*	Transmits phony peach disease.	Malathion or Carbaryl sprays.	20
	Peach tree borer	*Sanninoidea exitiosa*	Larvae bore in trunk near soil level.	Spray trunk with DDT 4 times at 4 week intervals. Begin Aug. 1 in northern hemisphere.	20
Pineapple	Mealybug	*Dysmicoccus brevipes*	Feeds at base of fruit; transmits wilt.	Malathion spray.	1
	Scale	*Diaspis bromeliae*	Feeds on leaves.	Malathion spray.	2
Plums	Plum curculio	*Conotrachelus nenuphar*	Grubs bore into fruits causing them to drop.	Dieldrin every 10 days. Begin at petal fall.	
	Mites	*Tetranychus* spp.	Suck juice from leaves and cause them to fall.	Dicofol spray.	
Pomegranate	Fruitworm	*Euzophera punicaella*	Larvae enter young fruit and cause rotting.	Suggest early spray with Carbaryl.	10
Sapodilla	Fruit flies	*Anastrepha serpentina* etc.	Maggots feed in fruits and cause decay.	Malathion bait spray.	21
Strawberry	Mites	Various	Suck juice from leaves. Form light webbing.	Dicofol spray.	3
	White grubs	*Phyllophaga* spp.	Grubs feed on roots and cause plants to wilt..	Dieldrin, 3 lbs. per acre active ingredient on soil before planting. Work in well.	3,8
Tangelo	See Citrus.				
Tangerine	See Citrus.				
Tea	Mites	See Strawberry			18

[1] See Table 13 for formulas.

Table 18. SUGGESTED INSECT CONTROL FOR VEGETABLES[1]

CROP	INSECT	DESCRIPTION	CONTROL	CAUTION
Asparagus	Asparagus beetle *See Photo Fig. 90.*	Adult: metallic blue to black, orange to yellow markings 1/4" long.	Spray with 57% Malathion.	Do not apply within 1 day before harvest.
	Cutworm	See Peas.	Bait—3% toxaphene.	
Beans	Bean aphid	Adult and young. Tiny black insect like cabbage aphid. Bean aphids cluster on stems and under leaves.	Malathion spray	Do not apply within 1 day before harvest.
	Bean leaf beetle *See Photo Fig. 91.*	Adult: Reddish to yellowish, black spots on back 1/4" long.	50% wettable DDT	Do not apply within 7 days before harvest for DDT.

Table 18. SUGGESTED INSECT CONTROL FOR VEGETABLES (Continued)

CROP	INSECT	DESCRIPTION	CONTROL	CAUTION
Beans (Continued)	Corn earworm *See Photo Fig. 101.*	Green, brown or pink, light stripes along sides and on back, 1 3/4″ long.	50% wettable Methoxychlor or 50% WP Sevin	Do not apply within 3 days before harvest.
	Leafhoppers	Adult: Green wedge shaped, 1/8″ long. They fly quickly when disturbed.	Spray with Malathion. Spray with Sevin.	Do not apply within 1 day before harvest.
	Lima bean pod borer *See Photo Fig. 108.*	Pink, pale yellow head, 5/8″ long, wriggles violently when disturbed.	Same as for bean leaf beetle.	
	Mexican bean beetle	Adult: copper colored, oval, 1/4″ long, 16 black spots on back. Larva: orange to yellow, spiny, 1/3″ long.	Spray with Malathion. Spray with 5 lb. of active Carbaryl per acre.	Do not apply within 1 day before harvest.
	Spotted cucumber beetle *See Photo Fig. 121.*	Yellowish green, 12 black spots on back, 1/4″ long.	Same as for bean leaf beetle.	Do not apply within 7 days before harvest.
Beet	Beet webworm *See Photo Fig. 92.*	Yellow to green, a black stripe and numerous black spots on back, 1-1/4″ long.	50% Wettable DDT or Carbaryl.	Do not eat beet tops if sprayed with DDT.
	Blister beetle *See Photo Fig. 93.*	Gray, black or striped, slender 1/2 to 3/4″ long.	Same as for beet webworm.	
	Cutworms	See Peas.		
Cabbage Broccoli and Cauliflower	Cabbage, aphid *See Photo Fig. 94.*	Adult and young: tiny green, blue soft bodied covered with a fine whitish wax. Aphids cluster on leaves.	Remove and destroy heavily damaged plants early in the season. Apply Malathion spray.	Do not apply Malathion within 1 day of harvest.
	Cabbage looper *See Photo Fig. 95.*	Pale-green measuring worm, light stripes down back 1-1/2″ long. Doubles up when it crawls.	Early application: 40% Wettable powder Toxaphene. Late application: Malathion.	Toxaphene should be used before formation of parts of plants to be eaten; after this stage Malathion should be used.
	Cabbage webworm	Dull grayish yellow, fat, 5 brownish-purple stripes down back, 1/2″ long.	Apply Malathion spray.	Do not apply within 1 day before harvest.
	Diamond back moth	Larva: light green slender, 1/3″ long. It wriggles rapidly when disturbed and often drops from the plant and hangs by a silken thread.	Same as for Cabbage looper.	
	Harlequin bug *See Photo Fig. 105.*	Adult and young: Black brilliantly colored with red and yellow, shield shaped, 3/4″ long.	Early application: DDT spray.	Do not apply DDT after formation of the part to be eaten.
Cabbage	Imported cabbageworm	Velvety green, 1 1/4″ long.	Same as for cabbage looper.	Do not apply within 1 day before harvest.

Table 18. SUGGESTED INSECT CONTROL FOR VEGETABLES (Continued)

CROP	INSECT	DESCRIPTION	CONTROL	CAUTION
Cabbage (Continued)	Root maggots	Yellowish white, legless 1/4″ to 1/3″ long.	Apply Chlordane spray when first two leaves appear. Repeat after thinning or transplanting. Add 2 level tsp. of 40% chlordane to each gal. of transplanting water. Use 3/4 cup per plant.	Do not apply Chlordane to plants past seedling stage.
Carrot	Celeryworm	Green, banded with black and yellow markings, 2″ long.	Remove caterpillars by hand.	
	Carrot rust fly *See Photo Fig. 96.*	Larva: yellowish, white, legless, 1/3″ long.	Apply Chlordane to soil surface and work in thoroughly before planting.	
	Aster leafhopper	Adult and young: Light greenish yellow, slender, wedge shaped, very active, several pairs of tiny black dots on face, 1/8″ long.	Apply 50% wettable DDT as spray or Carbaryl.	Do not use treated tops for feed or food.
Celery	Celery leaf tier *See Photo Fig. 97.*	Greenish, up to 3/4″ long.	Apply 50% wettable DDT as spray.	Do not apply DDT after the bunch begins to form or the stalk is half grown, whichever is earlier.
Cucumber	Aphids	See Muskmelon.		
	Pickleworm	Yellowish white, brownish head, 3/4″ long. Dark spots on young worm.	Apply Carbaryl (Sevin).	Do not apply within 1 day before harvest.
	Beetles (*Diabrotica* spp.) *See Photo Fig. 121*	Several species; all feed on leaves and young seedlings.	Carbaryl or Methoxychlor.	Do not apply insecticides within one day before harvest.
Eggplant	Aphids	Adults and young are tiny, green to black and soft bodied, cluster on underside of leaves.	Apply Malathion spray.	Do not apply Malathion to eggplant within 3 days before harvest.
	Colorado potato beetle *See Photo Fig. 98.*	Adult: yellow, black-striped 3/8″ long. Larva: brick-red humpbacked, 3/5″ long.	Apply 50% Wettable DDT spray.	Do not apply DDT to eggplant within 5 days before harvest.
	Eggplant lace bug *See Photo Fig. 102.*	Adult: Grayish to light brown; flat, lacelike wings, 1/16″ long. Nymph: yellowish, louselike, spiny, up to 1/10″ long.	Apply Malathion spray.	Do not apply Malathion to eggplant within 3 days before harvest.
	Flea beetles *See Photo Fig. 114.*	Black, brown or striped jumping beetles, about 1/16″ long.	Apply DDT spray early in season and Methoxychlor later.	Apply DDT before formation of the fruits and after formation of the fruits. Use Methoxychlor.
	Hornworm *See Photo Fig. 106.*	Green, diagonal lines on sides, horn on rear end, up to 4″ long.	Handpick worms. Apply 50% TDE wettable powder as a spray.	Do not apply TDE to eggplant within 1 day before harvest.
	Whitefly	Small white flies on leaves.	Use Malathion spray.	See Aphids.

Table 18. SUGGESTED INSECT CONTROL FOR VEGETABLES (Continued)

CROP	INSECT	DESCRIPTION	CONTROL	CAUTION
Lettuce	Aphids	See Muskmelon.		
	Wireworms *See Photo Fig. 130.*	Yellow to white; dark heads and tails; 1/2—1-1/2 in. long.	Apply 3/4 cup of 40% Chlordane in 2-1/2 gal. of water to 1,000 sq. ft. of soil. Work in soil to 6" or 8".	Do not apply within 1 year before planting carrots or parsnips.
	Cabbage looper *See Photo Fig. 95.*	Pale-green measuring worm, light strips down back, 1-1/2" long, doubles up when it crawls.	Spray with 40% Toxaphene before thinning and with Malathion after thinning.	Same as for aphids.
	Cutworms	See Peas.		
	Fall armyworm *See Photo Fig. 104.*	Light green to black, striped white inverted Y on front of head, 1/3" long.	Apply 50% wettable DDT to grasses and weeds near garden.	
	Aster leafhopper	Adult and young. Light greenish yellow, slender wedge shaped, very active, up to 1/8" long.	Apply Malathion sprays when plants are 1/2" hign and repeat every week.	Same as for aphids.
Muskmelon and Cantaloupe	Aphids	Feed on underside and curl the leaf.	Spray with Malathion.	Do not treat within 1 day before harvest.
	Pickleworm	Yellowish white, brownish head, 3/4" long.	Spray with Carbaryl at weekly intervals.	Do not treat within 1 day before harvest.
	Spider mite *See Photo Fig. 120.*	Adult and young. Tiny (barely visible to naked eye), red or greenish red. On underside of leaves.	Spray with Malathion or Dicofol.	Do not treat within 2 days before harvest.
	Striped cucumber beetle *See Photo Fig. 125.*	Adult: yellow to black, 3 black stripes down back 1/5" long. Larva: white, slender, brownish at ends, 1/3" long.	Spray with Malathion or use Methoxychlor.	Same as for Pickleworm.
Okra	Aphids	See Eggplant.		
	Corn earworm *See Photo Fig. 101.*	Green, brown or pink. 1-3/4" long.	Apply Carbaryl dust or spray.	Do not apply Carbaryl within 1 day of harvest.
	Bollworms	Spiny small gray caterpillar in pods.	Carbaryl.	See Earworm.
	Stink bug *See Photo Fig. 119.*	Adult: brown, green or black, with or without markings, shield shaped 5/8" long and 1/3" wide. Stink bugs discharge a foul odor.	2 lbs. active Carbaryl per acre.	See Earworm.
Onion	Onion maggot	White root maggot, legless 1/3" long. Found in bulbs.	Apply Malathion spray.	Do not apply Malathion within 3 days before harvest.
	Cutworms	See Peas.		
	Onion thrips *See Photo Fig. 111.*	Adult: yellow or brownish, winged, active, 1/25" long. Larva; white, wingless.	Same as for Onion maggot.	Same as for Onion maggot.

Table 18. SUGGESTED INSECT CONTROL FOR VEGETABLES (Continued)

CROP	INSECT	DESCRIPTION	CONTROL	CAUTION
Pea (Blackeye) cowpea	Cowpea curculio *See Photo Fig. 99.*	Adult: Black humpbacked snout beetle, 1/4" long.	Spray with Toxaphene.	Do not apply Toxaphene within 7 days before harvest.
	Stink bug *See Photo Fig. 119.*	Suck pods and cause dark seed.	See Okra.	See Okra.
Peas (Garden)	Aphids	See Eggplant.		
	Cutworms *See Photo Fig. 100.*	Cutworms are dull gray, brown or black and may be striped or spotted. They are stout, soft bodied and smooth, 1-1/4" long.	Apply Toxaphene dust or spray to soil surface in the late afternoon.	Do not apply Toxaphene to foliage of peas.
	Lima-bean pod borer	See Beans.		
	Pea weevil *See Photo Fig. 112.*	Adult: Brownish, white black and grayish markings, 1/5" long.	Apply Malathion spray while adults are within the blossoms.	
	Root maggots	Several species (including seed corn and cabbage maggots) yellowish white, legless 1/4 to 1/3" long.	See Onion maggot.	
Pepper	Aphids	See Eggplant.		
	Cutworms	See Peas.		
	Flea beetles	See Eggplant.		
	Hornworms *See Photo Fig. 106.*	Green, diagonal lines on sides, prominent horn on rear end. 4" long.	Handpick worms. Spray with 50% wettable TDE powder.	Not not apply TDE within 1 day before harvest.
	Pepper weevil *See Photo Fig. 113.*	Adult: Black snout beetle, gray or yellow markings 1/8" long. Snout is half the length of the body.	Apply Toxaphene or DDT every week to 10 days.	Do not apply DDT within 5 days before harvest.
Potato	Aphids	See Eggplant.		
	Colorado potato beetle *See Photo Fig. 98*	Adult: yellow, black striped, 3/8" long. Larva: brick red, humpbacked, 3/5" long.	Spray with 50% wettable Carbaryl.	
	Flea beetles *See Photo Fig. 114.*	See Eggplant.	1 lb. active Carbaryl per acre.	
	Leafhoppers *See Photo Fig. 115.*	Adult: Green, wedge shaped, up to 1/8" long. They fly quickly when disturbed.	Spray with DDT or Methoxychlor or Malathion.	
	Millipedes *See Photo Fig. 109.*	Brown or grayish, wormlike, hard-shelled, many pairs of legs, 1 to 1 1/4" long.	Spray with DDT.	Do not apply on tubers.
	Mole cricket *See Photo Fig. 110.*	Adults and nymphs: Light brown, large, beady eyes, short, 1 1/2" long.	Spray 3/4 cup of 40% wettable Chlordane on 1,000 sq. ft. of soil and mix in upper 6" or apply ready mixed 3% Chlordane bait. Use 1 lb. of bait for 1,000 sq. ft. Apply in late afternoon after a rain.	

Table 18. SUGGESTED INSECT CONTROL FOR VEGETABLES (Continued)

CROP	INSECT	DESCRIPTION	CONTROL	CAUTION
Potato (Cont.)	Potato tuberworm *See Photo Fig. 116.*	Pinkish-white, brown head, up to 1/2" long.	Spray with DDT. Keep out weeds.	Do not expose tubers to infested foilage after digging.
	Sowbugs	Dark-gray, oval, flattened body, 7 pairs of legs, 1/2" long.	Spray soil with 50% wettable DDT.	Do not apply on tubers.
	White-fringed beetles *See Photo Fig. 128.*	Adult: Dark gray snout beetles, light band along sides of body 1/2" long.	Apply 1/4 lb. of DDT or 1/8 lb. of Chlordane per 1,000 sq. ft. of soil surface before planting. Work into top 3" of soil. Mix 1/2 lb. of 50% DDT or 1/4 lb. of 50% Chlordane in 2 1/2 gal. of water.	
Potato	White grubs *See Photo Fig. 129.*	White or light yellow, hard brown heads, curved 1/2 to 1 1/2" long.	Treat surface of soil with 1/4 lb. of Chlordane per 1,000 sq. ft. Mix 1/2 lb. of 50% Chlordane in 2 1/2 gal. of water.	Do not apply excessive amounts of Chlordane to the soil.
	Wireworms	See Lettuce.		
Radish	Root maggots	Yellowish white, legless 1/4 to 1/3" long.	Spray with Chlordane when first leaves appear and repeat shortly after thinning.	Do not apply to plants past the seedling stage.
Squash and Pumpkin	Aphids	See Eggplant.		
	Cutworms	See Peas.		
	Pickleworm	See Cucumber.		
	Spider mites	See Muskmelon.		
	Squash bug *See Photo Fig. 122.*	Adult: brownish, flatback stink bug, 5/8" long.	Handpick adults and eggs. Trap bugs under boards placed on soil. Try Malathion or Carbaryl spray.	
	Squash vine borer *See Photo Fig. 123.*	Larva: white, up to 1" long.	Partial control with Carbaryl spray. Start application when runners develop, repeat once a week.	
	Cucumber beetles *See Photo Figs. 121, 125.*	See Cucumbers.		
Sweet Corn	Corn earworm *See Photo Fig. 101.*	Green brown or pink, light stripes along sides and on back, 1-3/4" long.	Spray with DDT early in the season. Use 2 tsp. of 25% DDT emulsifiable concentrate in 1 gal. of water. Spray whole plant. Later spray silk every 2 days. Carbaryl can be used.	Do not feed DDT treated foliage to animals

Table 18. SUGGESTED INSECT CONTROL FOR VEGETABLES (Continued)

CROP	INSECT	DESCRIPTION	CONTROL	CAUTION
Sweet Corn (Cont.)	Corn sap beetles	Adults: Usually black, 3/16" long. Larva: white or cream colored. 1/4" long.	Apply Malathion spray after silks appear and repeat 10 days later.	
	Cutworms	See Peas.		
	Leafhopper (*Dalbulus maidis*)	Transmits corn stunt.	Carbaryl (Sevin).	
	Lesser cornstalk borer *See Photo's Fig. 104 and 124.*	Enters young stalks soon after emergence and causes them to wilt and die.	Rotate crops; avoid weedy areas. Spray or dust with Dieldrin on soil when beans have 2 true leaves.	
	Root maggots	See Radish.		
	White grubs	See Potatoes.		
	Wireworms	See Lettuce.		
Sweet Potato	Flea beetles	See Eggplant.		
	Sweet potato weevil *See Photo Fig. 126.*	Adult: Reddish snout beetle, shiny, ant-like, slender-bodied, bluish black head, 1/4" long.	Apply 2 to 2-1/2% Dieldrin dust along the row in a strip 6 to 8" wide. Apply soon as roots begin to enlarge and repeat 2 weeks later.	Do not apply Dieldrin within 21 days before harvest.
	Wireworms	See Lettuce.		
Tomato	Aphids	See Eggplant.		
	Blister beetles	Gray, black or striped, slender, 1/2 to 3/4" long.	Spray with Methoxychlor.	Do not apply within 1 day before harvest.
	Colorado potato beetle	See Potato.	Apply DDT spray.	Do not apply within 5 days before harvest.
	Cutworms	See Peas.		
	Flea beetles	See Eggplant.		
	Hornworms *See Photo Fig. 106.*	Green, diagonal lines on sides, prominent horn on rear end, 4" long.	Handpick worms. Spray with Toxaphene.	Do not apply Toxaphene within 3 days before harvest.
	Spider mites	See Muskmelons.		
	Stalk borer *See Photo Fig. 124.*	Slender, 1 1/4" long, young borer; creamy white, dark purple band around body. Several brown or purple stripes running lengthwise down the body.	Remove and destroy weeds. Avoid planting in weedy or sod areas.	
	Stink bugs	See Okra.		
	Tomato fruitworm	Green, brown or pink, light stripes along sides and on back, 1 3/4" long.	Apply 50% wettable DDT or Carbaryl spray.	Do not apply DDT 5 days before harvest.
	Tomato russet mite	Can be seen with a 20 X magnification hand lens. White and pear shaped.	Spray with 40% wettable sulfur when fruits set and repeat every 2 weeks.	Use 3 tablespoons per gallon of water. High concentrations may injure plants.

Table 18. SUGGESTED INSECT CONTROL FOR VEGETABLES (Continued)

CROP	INSECT	DESCRIPTION	CONTROL	CAUTION
Watermelon	Cucumber beetles *See Photo Fig. 121, 125.*	See Cucumber.		
	Aphids	Causes leaves to curl and deform.	Spot spray with Malathion. Destroy infested plants.	
	Cutworms	See Peas.		
	Pickleworms	See Cucumber.		

[1] Part of the information in this table was obtained from U.S.D.A. Farmers' Bul. 46. "Insects and Diseases of Vegetables in the Home Garden (1963" and Agriculture Handbook No. 120, "Insecticide Recommendations of the Entomology Research Division for the Control of Insects attacking Crops and Livestock for 1963." Insect control recommendations always are changing due to research work and changing regulations of the Federal Food, Drug and Cosmetic Act. The above mentioned publications usually are revised each year and the most up-to-date publications should be requested from the United States Department of Agriculture.

PRECAUTIONS

Insecticides used improperly can be injurious to man and animals. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the labels.

Keep insecticides in closed, well-labeled containers in a dry place. Store them where they will not contaminate food or feed, and where children and animals cannot reach them. Promptly dispose of empty insecticide containers; do not use for any other purpose.

When handling an insecticide, wear clean, dry clothing.

Avoid repeated or prolonged contact of insecticide with your skin.

Wear protective clothing and equipment if specified on the container label. Avoid prolonged inhalation of insecticide dusts or mists.

Avoid spilling an insecticide concentrate on your mouth. If you spill any on your skin or clothing, remove contaminated clothing immediately and wash the skin thoroughly with soap and water. Launder the clothing before wearing it again.

After handling an insecticide, do not eat, drink, or smoke until you have washed your hands and face. Wash any exposed skin immediately after applying an insecticide.

Avoid drift of insecticide to nearby wildlife habitats, bee yards, crops, or livestock. Do not apply insecticides under conditions favoring drift from the area to be treated.

Many insecticides are highly toxic to fish and aquatic animals. Keep insecticides out of all water sources such as ponds, streams, and wells. Do not clean spraying equipment or dump excess spray material near such water.

Do not apply insecticides to plants during hours when honey bees and other pollinating insects are visiting them.

Have empty insecticide containers buried at a sanitary land-fill dump, or crush and bury them at least 18 inches deep in a level, isolated place where they will not contaminate water supplies. If you have trash-collection service, thoroughly wrap small containers in several layers of newspaper and place them in the trash can.

Excellent references to have available are "Agriculture Handbook No. 321, 1967" and "Safe Use of Agricultural and Household Pesticides" available from Agricultural Research Service, U.S. Department of Agriculture.

GENERAL (Mixing rates and fruit and vegetable controls)

Mixing rates given on the commercial packages seldom include the amounts to mix small quantities. In Table 14 will be found the amounts calculated from the rate per 100 gallons usually given. Table 15 gives factors for conversion to stated percentages. For example, if the percent of active ingredient is one, 2 lbs. of a 50% wettable powder will be needed or 4 lbs. of a 25% wettable powder concentrate. Table 16 gives a guide for measuring small amounts in level tablespoons.

Table 17 is a suggested list of controls for fruit insects. This is not complete but an attempt has been made to include the common insects that might be encountered. The species that occur in the United States have been checked with Department of Agriculture specialists while those from tropical areas are taken from available foreign publications.

The list of controls for vegetable insects (Table 18) is more complete since many of these crops are planted also in temperate climates. Two excellent references for those that occur in the United States are "Home and Garden Bulletin 46" authored by L. R. Reed and S. P. Doolittle, 1963; and "Insects and Diseases of Vegetables in the Home Garden" U.S. Dept. Agr. 48 pp.

References for Fruit Insect Table

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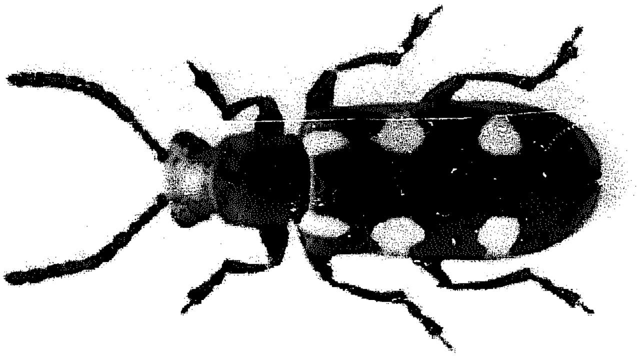

Figure 90. Asparagus Beetle.

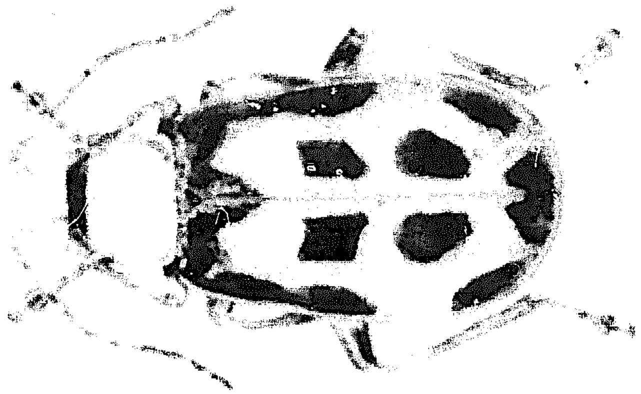

Figure 91. Bean Leaf Beetle.

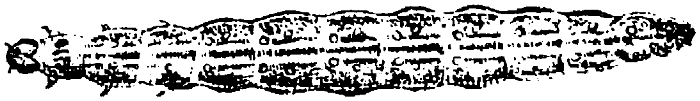

Figure 92. Beet Webworm.

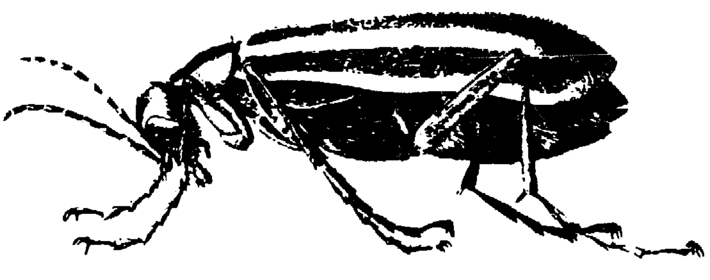

Figure 93. Blister Beetle.

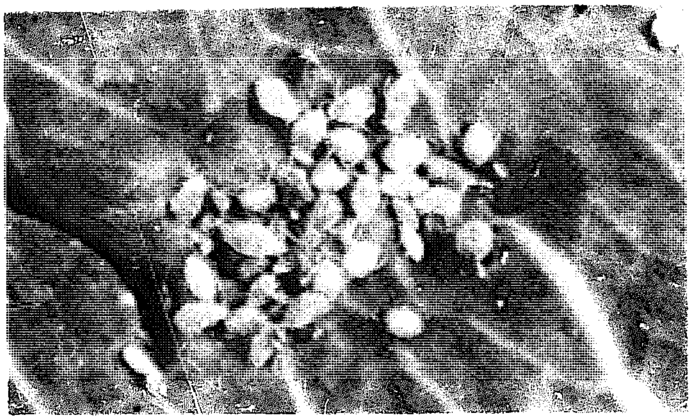

Figure 94. Cabbage Aphids.

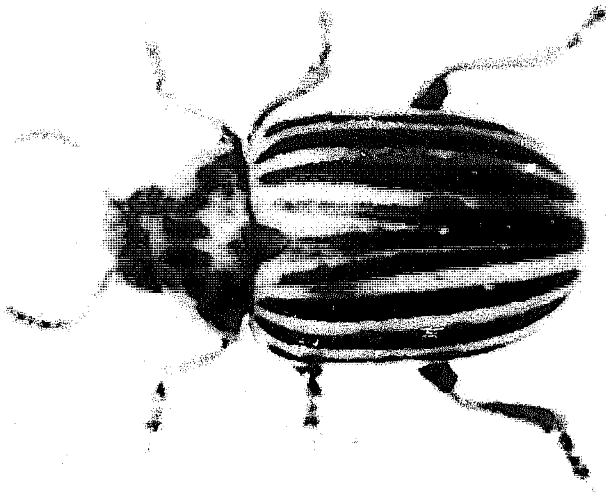

Figure 98. Colorado Potato Beetle.

Figure 95. Cabbage Looper.

Figure 96. Carrot Rust Fly Larva.

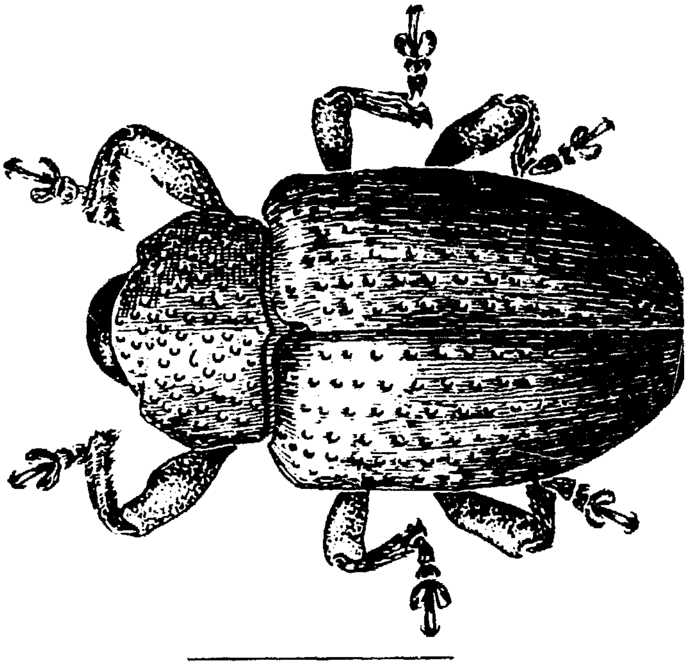

Figure 99. Cowpea Curculio Adult

Figure 97. Celery Leaf Tier.

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Figure 100. Cutworm.

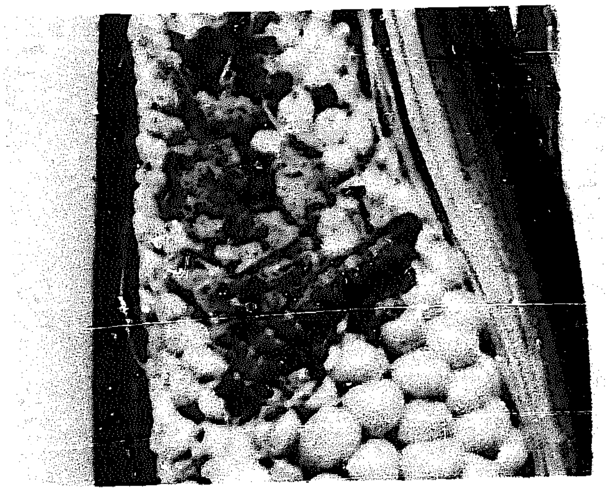

Figure 101. Corn Earworm.

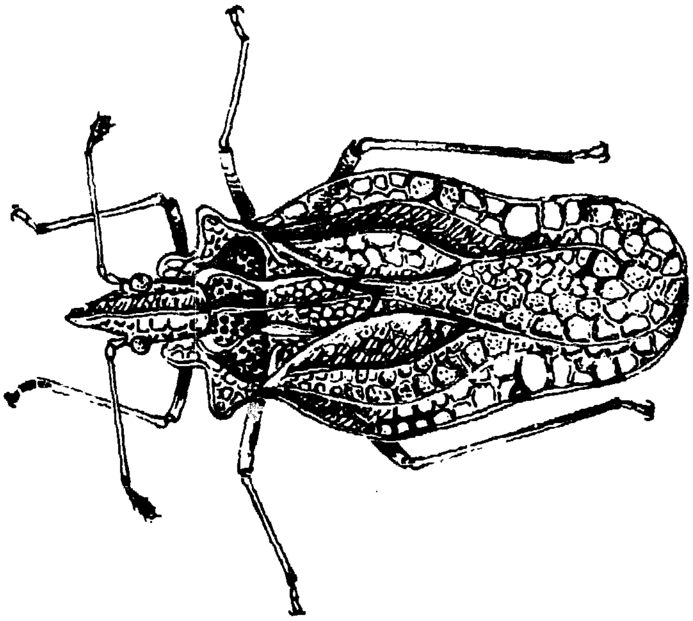

Figure 102. Eggplant Lace Bug.

Figure 103. European Corn Borer.

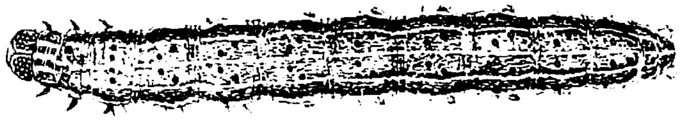

Figure 104. Fall Armyworm.

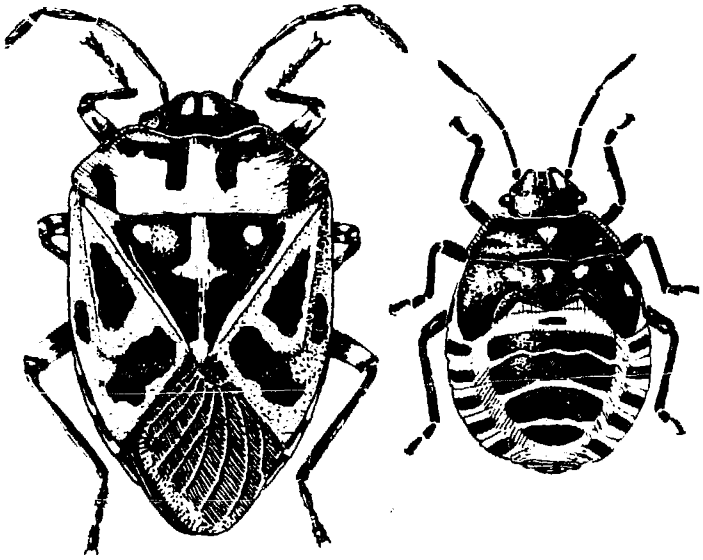

Figure 105. Harlequin Bug.

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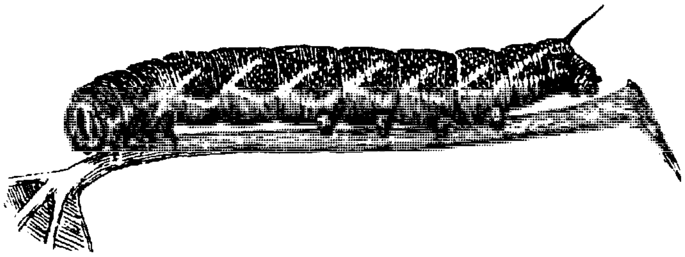

Figure 106. Hornworm.

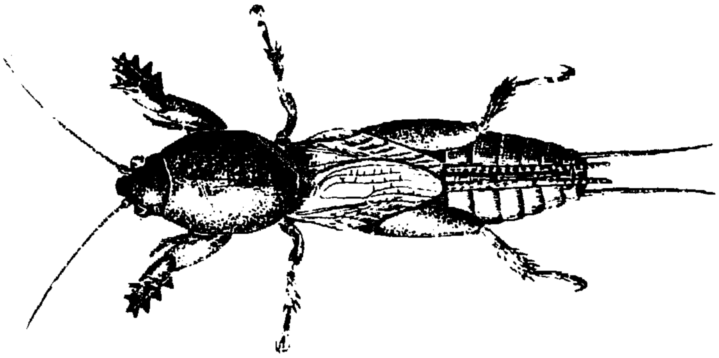

Figure 110. Mole Cricket.

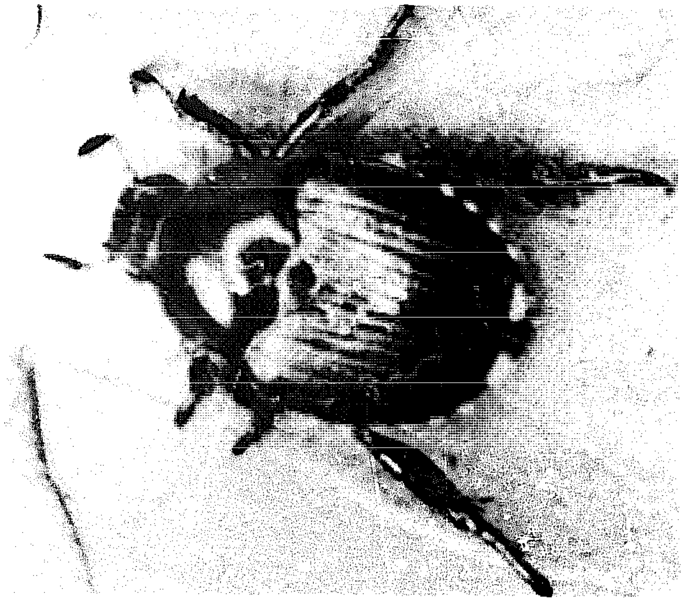

Figure 107. Japanese Beetle.

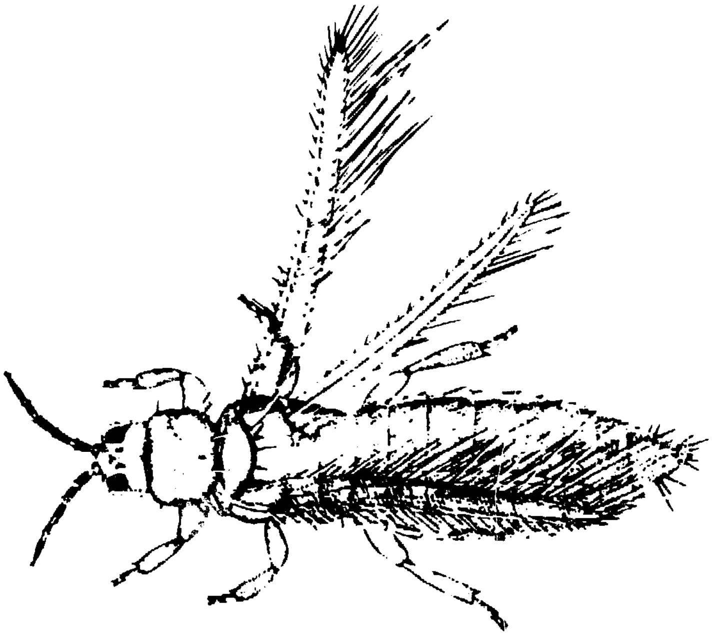

Figure 111. Onion Thrips.

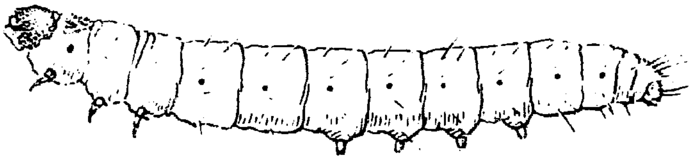

Figure 108. Lima-bean Pod Borer.

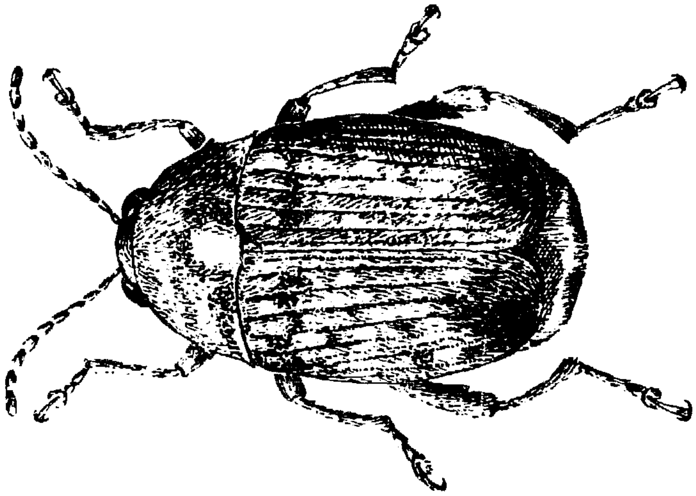

Figure 109. Millipede.

Figure 112. Pea Weevil Adult.

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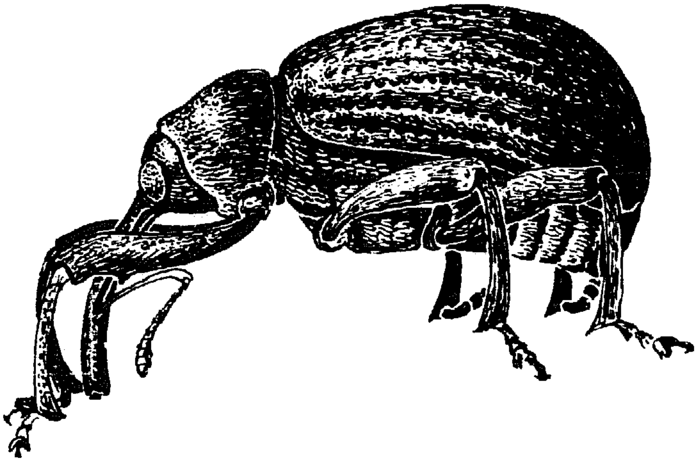

Figure 113. Pepper Weevil.

Figure 116. Potato Tuberworm Larva.

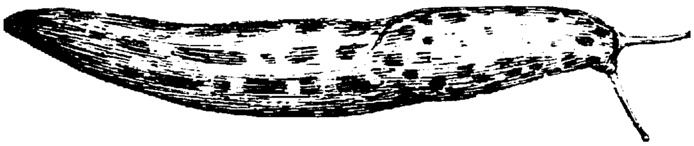

Figure 117. Slugs.

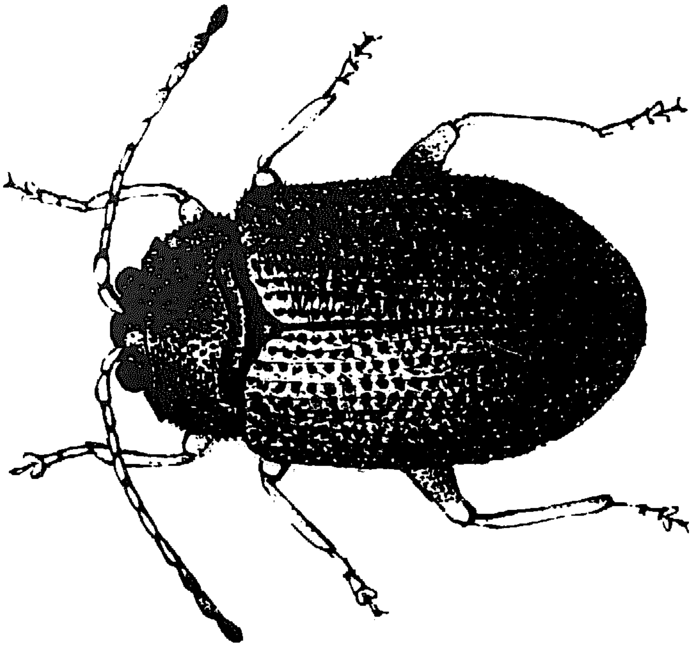

Figure 114. Potato Flea Beetle.

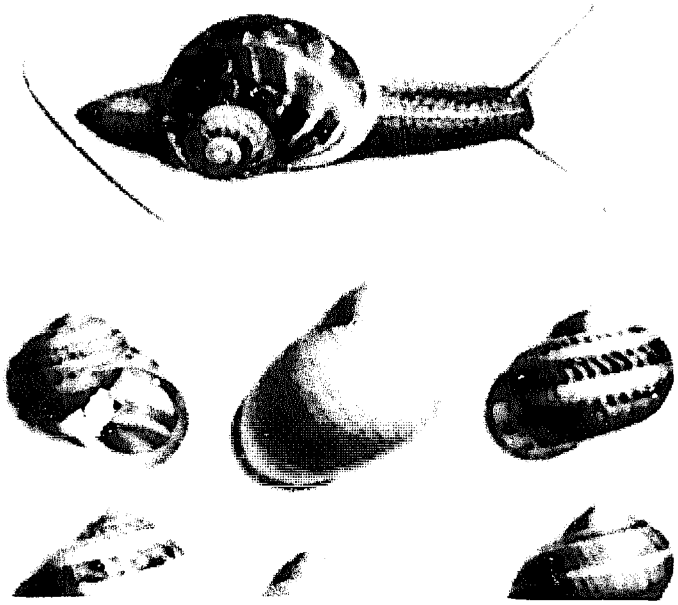

Figure 118. Snail.

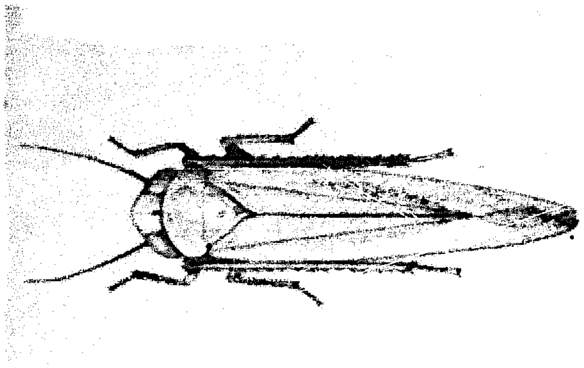

Figure 115. Potato Leafhopper.

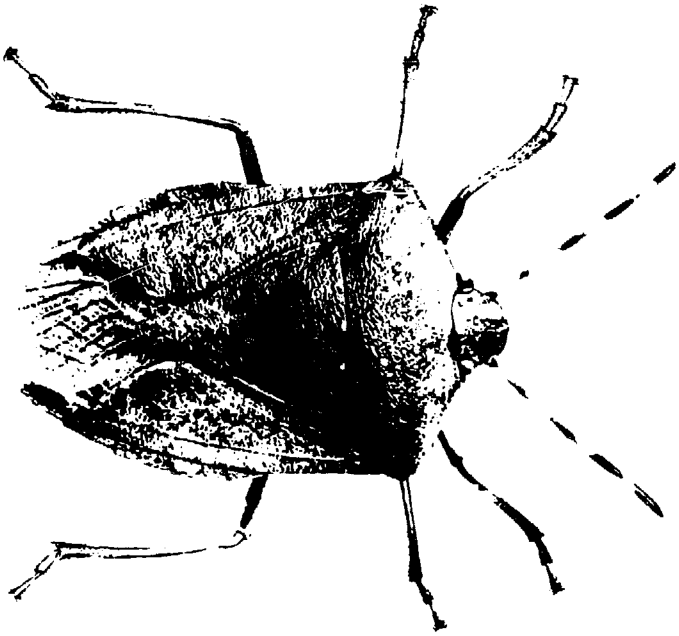

Figure 119. Southern Green Stink Bug.

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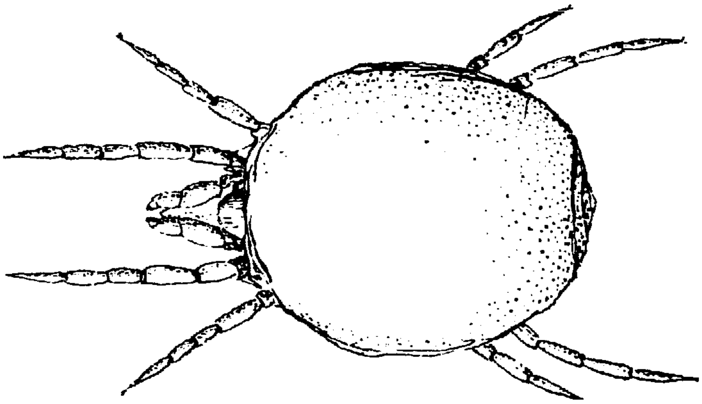

Figure 120. Spider Mite.

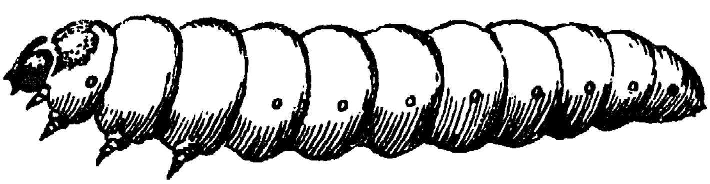

Figure 123. Squash Vine Borer.

Figure 124. Stalk Borer.

Figure 121. Spotted Cucumber Beetle.

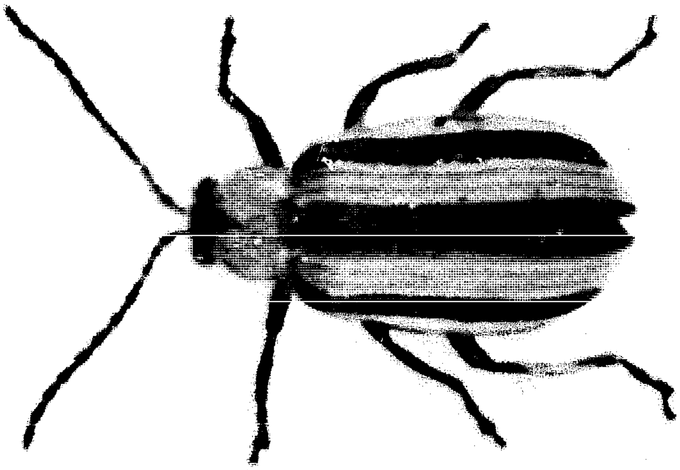

Figure 125. Striped Cucumber Beetle.

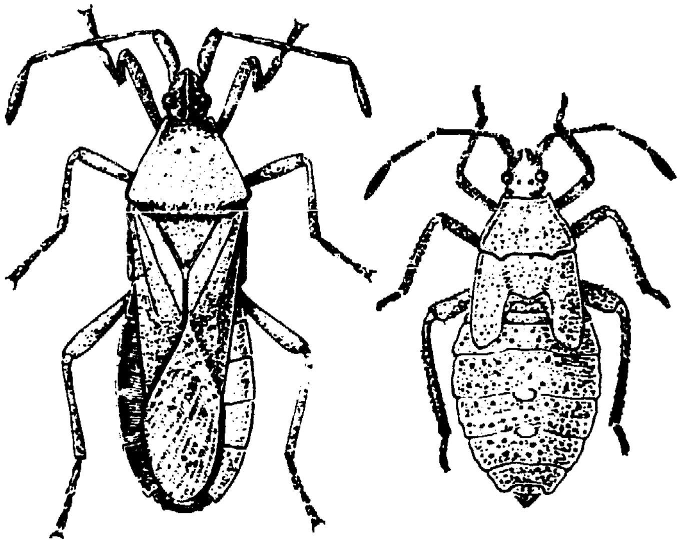

Figure 122. Squash Bug.

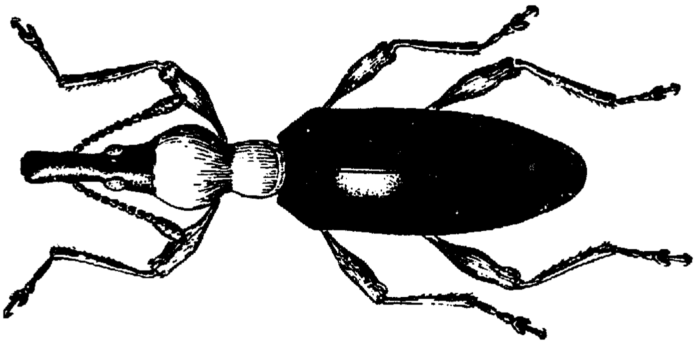

Figure 126. Sweet Potato Weevil.

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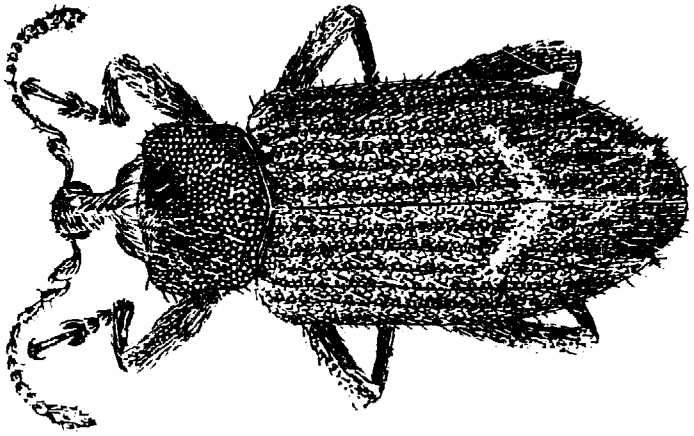

Figure 127. Vegetable Weevil.

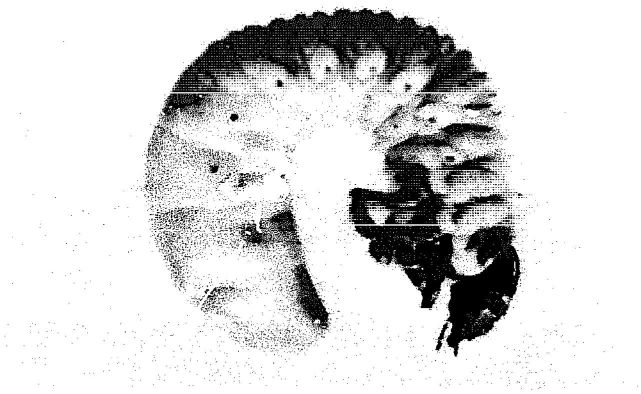

Figure 129. White Grub Larva.

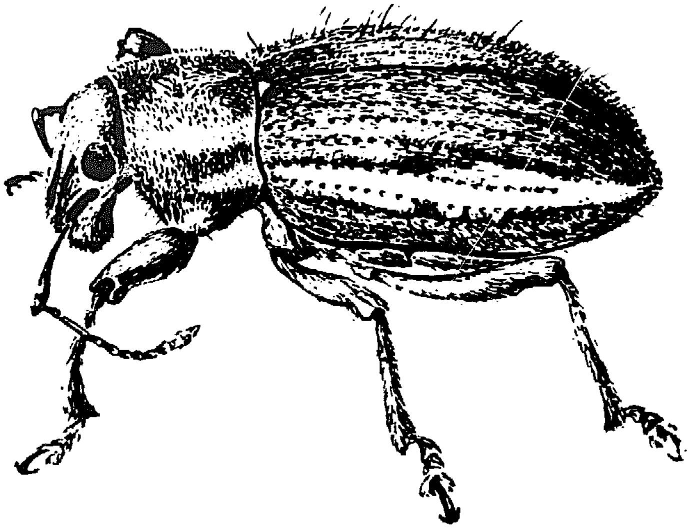

Figure 128. White-fringed Beetle.

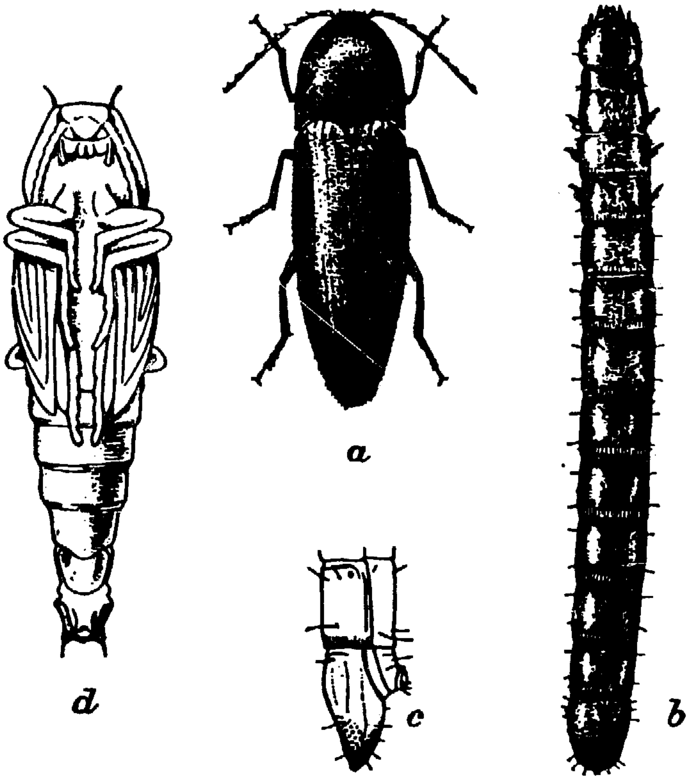

Figure 130. Wireworm.

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Chapter 7

PLANT MATERIAL

The introduction of new varieties for the tropical areas is very important. In areas where variety trials have not been conducted, the first step would be to start variety trials. In order to conduct variety trials, it is important to know where to obtain experimental plant material.

Since it is not easy to select varieties without some kind of trial, the best method will be to select varieties with the characters desired. For example, disease resistance, earliness, etc. could be used to make your selections. Length of day also will be a factor. Varieties adapted to the same latitude should be selected.

The list of seed sources is by no means complete. It includes some wholesale seedsmen as well as retailers. Plant breeders have been omitted because their supplies are insufficient for general distribution. Therefore, seeds should be ordered from private companies.

VEGETABLE SEED SOURCES[1]

Commercial

NAME	ADDRESS	CROPS
Arthur Yates & Co.	Sydney, Australia	All Crops
Asgrow Export Corporation	Milford, Conn.	All Crops
W. Atlee Burpee Co.	Hunting Park Ave. at 18th St. Philadelphia 32, Pa.	All Crops
Corneli Seed Co.	101 Choteau Ave., St. Louis 2, Mo.	All Crops
Dessert Seed Co.	P.O. Box 181, El Centro, Calif.	Onions, etc.
Ferry-Morse Seed Co.	Box 100, Mountain View, Calif.	All Seeds
Glecklers	Metamora, Ohio	Tomato
Joseph Harris Seed Co.	Rochester 11, New York	Tomato, beans, etc.
Northrup King & Co.	1500 Jackson St. N.E. Minneapolis 13, Minn.	All Crops
J. E. Ohlsen's ENKE	Linnesgade 14, Copenhagen, Denmark	All Crops
Pieters, Wheeler Seed Co.	Gilroy, Calif.	All Crops
Peto Seed Co.	Box 138, Saticoy, Calif.	Tomato
Reuter Seed Co.	320 N. Carrolton Ave., New Orleans 9, La.	All Crops
Rogers Bros. Co.	P.O. Box 2188, Idaho Falls, Idaho	Beans, Peas
Seed Research Specialists	Modesto, Calif.	All Crops
Simpson Nursery Co.	Monticello, Fla.	Watermelons
Stokes Seeds Ltd.	Ste. Catherine Ontario, Canada	All Crops
Takii and Co., Ltd.	180 Umekoji-Imokuma Kyoto, Japan	All Crops esp. hybrids
Twilley, O. S.	Salisbury, Md.	Cucurbits, tomato
Vaughan's Seed Co.	601 W. Jackson Blvd., Chicago 6, Ill.	All Crops
Vilmorin, Andrieux & Co.	Paris, France	All Crops
Willhite Melon Seed Farms	Weatherford, Texas	Watermelons

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[1] This is by no means a complete list of seed companies and the authors do not recommend these seed companies but are merely suggesting a few possible sources of vegetable seeds. There are many other seed companies that are just as reliable as the ones listed.

Chapter 8

EQUIPMENT, SUPPLIES AND MATERIALS

Introduction

One of the main problems that confronts a horticulturist working overseas for the first time is that of obtaining equipment, supplies and materials. A horticulturist working in the United States can look in the classified section of a telephone directory and have the information he wants in a few minutes and receive his supplies and materials in a matter of days.

This situation does not exist in many of the areas overseas where a horticulturist might be working. It usually is not possible to take all the reference material overseas that one would like.

If one does not know a ready source of supplies he must write to someone else to determine a source of supplies and then write to the company for prices and other information before requisitioning the supplies and equipment. This type of operation may delay a project from one to six months before the materials and supplies are available for use.

A partial list of equipment, materials and supplies is presented here to give the horticulturist an idea where some of the important items can be located. There are many sources for most of the items listed but only one or two are indicated for each item to save space.

The authors do not endorse or recommend any of the companies listed in this book since many other companies may supply these items. The list is presented only as a possible source of the items.

SOURCE OF EQUIPMENT, MATERIALS AND SUPPLIES

ITEMS	REMARKS	SOURCE
1. Applicators	For use on 1 lb. cans for Dowfume MC-2	Arrow Products Co. 447 Lincoln St. Carlstadt, N. J.
2. Bags-polyethylene	For planting trees	Dobeckman Co. 1700 - 5th St. Berkley 10, Calif.
3. Calculator	For statistical analysis	Friden, Inc. San Leandro, Calif.
		Monroe Calculating Machine 555 Mitchell St. Orange, N. J.
4. Dusters		D. B. Smith Export Co. Smith Bldg. Main St. Utica 2, N. Y.
5. Embossers	For labelling trees	Dymo Industries, Inc. 525 Bridge St. Duryea, Pa.
6. Fertilizers	Chelates of Iron, Manganese and Zinc	Division of Geigy Chemical Corp. P. O. Box 430 Yonkers, N. Y.
	Diammonium phosphate	Olin Mathieson Chemical Corp. Mathieson Bldg. Baltimore, Maryland
	General	Esso Chemical Co. 15 West 51st St. New York 19, N. Y.
7. Fungicides	Phygon XL	U. S. Rubber Co. Naugatuck Chemical Div. Naugatuck, Conn.
7. Fungicides	Tri-Basic copper sulphate	Tennessee Corporation 614 Grant Building Atlanta, Ga.
	Manzate, Parzate Spreader-Sticker Delsan A-D Arasan SF-M	E. I. du Pont de Nemours & Co. Wilmington, Delaware
	Captan Orthocide 50W	California Chemical Ortho Division P. O. Box 7067 Orlando, Florida

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3. Calculator	For statistical analysis	Friden, Inc. San Leandro, Calif.
		Monroe Calculating Machine 555 Mitchell St. Orange, N. J.
4. Dusters		D. B. Smith Export Co. Smith Bldg. Main St. Utica 2, N. Y.
5. Embossers	For labelling trees	Dymo Industries, Inc. 525 Bridge St. Duryea, Pa.
6. Fertilizers	Chelates of Iron, Manganese and Zinc	Division of Geigy Chemical Corp. P. O. Box 430 Yonkers, N. Y.
	Diammonium phosphate	Olin Mathieson Chemical Corp. Mathieson Bldg. Baltimore, Maryland
	General	Esso Chemical Co. 15 West 51st St. New York 19, N. Y.
7. Fungicides	Phygon XL	U. S. Rubber Co. Naugatuck Chemical Div. Naugatuck, Conn.
7. Fungicides	Tri-Basic copper sulphate	Tennessee Corporation 614 Grant Building Atlanta, Ga.
	Manzate, Parzate Spreader-Sticker Delsan A-D Arasan SF-M	E. I. du Pont de Nemours & Co. Wilmington, Delaware
	Captan Orthocide 50W	California Chemical Ortho Division P. O. Box 7067 Orlando, Florida

SOURCE OF EQUIPMENT, (Continued)

ITEMS	REMARKS	SOURCE
8. General Agricultural Equipment		National Agricultural Supply Co. Fort Atkinson, Wis.
		Seed Trade Buyers Guide 327 So. La Salle St. Chicago 4, Ill.
9. Glue	Cement for repairing burlap bags	Val - A Company 700 - 710 W. Roog St. Chicago 9, Ill.
10. Herbicides	Alanap 3	Naugatuck Chemical International 1230 Avenue of Americas New York 20, N. Y.
	Dowpon (Dalapon) Premerge Dowfume MC-2 Dowcide G (Pentachlorophenate)	Dow Chemical Co. Midland, Michigan
	Sinox P.E.	F. M. C. International 161 East 42nd St. New York 17, N. Y.
	Chlore IPC Emulsifiable Concentrate	Pittsburgh Plate Glass International Geneva, Switzerland
	Eptam 6 EC Tillam 6 EC	Stauffer Chemical Co. 380 Madison Ave. New York 17, N. Y. Union Carbide
	Mylone Crag Sesone	Inter-America, Inc. 270 Park Avenue New York 17, N. Y.
	Lorox	E. I. du Pont de Nemours & Co. Wilmington, Delaware
	Amiben	Amchem Products, Inc. Ambler, Pa.
	Stoddard Solvent	Esso Research and Engineering Co. P. O. Box 51 Linden, N. J.
	Simazin Atrazin	J. R. Geigy S. A. Basel, Switzerland
11. Insecticides	Diazinon 25% WP Diazinon 60% E Diazinon 40% M	Division of Geigy Chemical Co. P. O. Box 430 Yonkers, N. Y.
11. (Cont.)	Sevin 50 W	Union Carbide International Co. 270 Park Avenue New York 17, N. Y.
	DDT 50% W (Deenate) Marlate 50 Methoxychlor	E. I. du Pont de Nemours & Co. Wilmington, Delaware
	Dieldrin 50% W	Miller Products Co. 7737 N. E. Killingsworth Portland, Ore.
	Aldrin	Stauffer Chemical Co. 380 Madison Ave. New York 17, N. Y.
12. Labels	Plastic for marking trees and shrubs	Economy Label Sales Co. P. O. Box 350 Daytona Beach, Fla.
13. Markers	Plastic for marking plots and seed bed	Life Markers P. O. Box 216 Clyde, Michigan
14. Measuring equipment		Keuffel and Esser Co. Adams and Third St. Hoboken, N. J.
15. Meteorological equipment		The Bendix Corp. Bendix International Division 205 East 42nd St. New York 17, N. Y.
16. Mist Propagator		Al Saffer and Co. 130 West 28th St. New York 1, N. Y.
17. Nursery Equipment		A. M. Leonard & Sons, Inc. Piqua, Ohio
18. Office Equipment		General Services Administration Federal Supply Service 50 Seventh St. N. E. Atlanta 23, Ga.
		Chas. J. Lane Corp. 105 Chambers St. New York 7, N. Y.
		Art Steel Co. Inc. 170 West 23rd St. New York 63, N. Y.
19. Pencils	Waterproof for labelling markers	Yoho and Hooker Youngstown, Ohio
20. Photographic Equipment	Negative files Files for Kodachrome slides	The Mega-File Co. Box 405 Doylestown, Pa.
		Eastman Kodak Co. Rochester, N. Y.

ITEMS	REMARKS	SOURCE
21. Plastic film	For covering nursery beds	Gering Plastics Division of Studebaker Packard Corp. Kenilworth, N. J.
22. Pollinating Supplies	Tassel & Silk Bags	Corn States Hybrid Service 803 Kee Way Des Moines 14, Iowa
22. Pollinating Supplies	Plastic vials for cacao or tomatoes (3/8" diameter x 1" long)	Lusterioid Container Co. Inc. 10 West Parker Ave. Maplewood, N. J.
23. Radio Equipment		O. O. Mallegg Inc. Daily News Building 400 West Madison Chicago, Ill.
24. Scientific Equipment		Arthur H. Thomas Co. P. O. Box 779 Philadelphia 5, Pa.
		Fisher Scientific Co. 635 Greenwich St. New York, N. Y.
25. Seed Packet		Disbrow Manufacturing Co. 181 South 18th St. East Orange, N. J.
26. Soil Analysis	Plant tissue analysis	Thorton Laboratories P. O. Box 2880 Tampa, Fla.
27. Soil Testing Equipment	Soil moisture meter for Bouyoucos blocks	Industrial Instruments 89 Commerce Road Cedar Grove, N. J.
	Bouyoucos Soil Moisture Blocks	Irrigation Development Corp. 260 Madison Ave. New York 16, N. Y.
	Soil Samplers, etc.	Soiltest Incorporated 4711 West North Ave. Chicago 39, Ill.
28. Sprayers		D. B. Smith Export Co. Smith Building Main Street Utica 2, N. Y.
29. Tags	White tags to identify seed sacks	Dennison Company Framingham, Mass.

Chapter 9

CONVERSION FACTORS

There are many types of measurements used in the Tropics. The metric system is used in most of the tropical countries but there are a few countries that use the Imperial system of measurements. The metric system has the advantage that it is based on tenths which facilitates easy calculations. In some countries, terms such as tarea, carreau, cuerda, manzana and faddan are used for land measurement. A tarea at one time was considered the amount of land a man could plow in a day with a team of oxen and is about 1/16 of a hectare.

Many different terms are used for measurements and only a few of the more important terms are included in the following tables. A uniform method of presenting scientific data is needed throughout the world so that the data will be understood by all people. The metric system probably will be adapted universally some day, but until it is, conversion tables are needed to convert one system to another readily.

AREA

Metric			
1 square centimeter	=	0.155	sq. in.
	=	100	sq. millimeters
1 square meter	=	1,550	sq. inches
	=	10.764	sq. feet
	=	1.196	sq. yards
	=	10,000	sq. centimeters
1 square kilometer	=	0.3861	sq. mile
	=	254.427	cuerdas
	=	1,000	sq. meters
1 are	=	100	sq. meters
	=	0.01	hectare
	=	0.0247	acre
1 hectare	=	2.471	acres
	=	0.775	carreau
	=	10,000	sq. meters
		100	ares
Imperial			
1 square inch	=	6.452	sq. centimeters
	=	1/144	sq. foot
	=	1/1296	sq. yard
1 square foot	=	929.088	sq. cm.
	=	0.0929	sq. meter
1 square link	=	62.7264	sq. in.
1 square yard	=	8,361.3	sq. cm.
	=	0.8361	sq. meter
	=	1,296	sq. inches
	=	9	sq. feet
1 square rod	=	25.292	sq. meters
	=	272.25	sq. feet
	=	30.25	sq. yards
1 square mile	=	2.59	sq. km.
	=	102,400	sq. rods
	=	658.98	cuerdas
	=	640	acres
1 acre	=	0.4047	hectare
	=	0.3135	carreau
	=	43,560	sq. feet
	=	4,840	sq. yards
	=	4,046.87	sq. meters
	=	160	sq. rods
	=	.579	manzana
	=	615	tareas
1 caballeria	=	64.58	manzanas
	=	43.15	hectares
	=	111.5	acres
1 carreau (Haiti)	=	3.18	acres
	=	1.29	hectares
1 cuerda (Puerto Rico)	=	625	sq. varas
	=	42,306	sq. feet
	=	3,930	sq. meters
1 dunum	=	100	sq. meters
1 manzana	=	10,000	sq. varas
1 tarea (Dominican Republic)	=	1/6.44	acre
	=	1/16	hectare
	=	629	sq. meters
1 faddan	=	4,200	sq. meters

IRRIGATION

1 acre foot	=	325,851	gallons
1 second-foot	=	448.8	gallons per minute
	=	3,600	cubic ft. per hour
1 horse power	=	550	foot pounds per second
1 acre inch	=	3,630	cubic feet
	=	27,154	gallons
Velocity	=	$0.75\sqrt{2gh}$	
		gravity	
g	=	32.2	
h	=	head in feet and tenths	

IRRIGATION (Continued)

Area = $D^2 \times .7854$
D = Diameter of pipe in feet and tenths
Problem 1 foot head 24" pipe
Volume = $0.75 \sqrt{2 g h}$
= $0.75 \sqrt{64.4 \times 1'}$
= $0.75 \sqrt{64.4}$
= $0.75 \times 8.02 = 6.02$
A = Area = $D^2 \times 0.7854$
= $2^2 \times 0.7854$
= $4 \times 0.7854 = 3.1416$
Quantity = AV
Q = quantity in second feet
Q = 3.14×6.02
Q = 18.9
10 - 20 sec. ft. good for 160 acres

LENGTH

Metric

1 millimicron	=	0.001	micron
1 micron	=	0.001	millimeter
1 millimeter	=	0.001	meter
	=	0.0394	inch
1 centimeter	=	10	millimeters
	=	0.3937	inch
	=	0.01	meter
1 meter	=	39.37	inches
	=	3.281	feet
	=	1,000	millimeters
	=	100	centimeters
	=	1.2	varas
1 hectometer	=	100	meters
	=	109.36111	yards
	=	328.0833	feet
1 kilometer	=	3,281	feet
	=	1,094	yards
	=	0.621	mile
	=	1,000	meters

Imperial

1 mil	=	1/1000	inch
	=	0.0254	millimeter
1 inch	=	25.4	millimeters
	=	2.54	centimeters
1 hand	=	4	inches
	=	10.16	centimeters
1 link	=	1/100	chain
	=	7.92	inches
	=	0.22	yard
	=	0.201	meter
1 foot	=	30.48	centimeters
	=	0.3048	meter
	=	12	inches
1 yard	=	0.9144	meter
	=	91.44	centimeters
	=	3	feet
	=	4.525	links
1 brasa	=	6	feet
	=	1.83	meters
1 vara	=	32.71	inches
	=	83.29	centimeters
1 rod	=	25	links
	=	5.025	meters
	=	198	inches
	=	16.5	feet
	=	5.5	yards
1 chain	=	4	rods
	=	22	yards
	=	66	feet
	=	100	links
	=	20.116	meters
1 mile	=	1,609.347	meters
	=	1.609	kilometers
	=	5,280	feet
	=	1,760	yards
	=	320	rods

PRESSURE

Metric

1 atmosphere	=	14.696	pounds per sq. in.
	=	760	mm. of mercury at 0° C.
	=	1,036	cm. of water
1 gm. per square centimeter	=	0.4912	lb. per sq. in.
1 kilogram per sq. meter	=	0.20482	lb. per sq. ft.
	=	0.0014223	lb. per sq. ft.

Imperial

1 pound per sq. in.	=	70.307	grams per sq. cm.
1 pound per sq. ft.	=	0.48824	grams per sq. cm.
	=	4.8824	kilograms per. sq. m.

VARIOUS

1 foot per second	=	0.68	miles per hour
1 degree of latitude	=	68.7	miles
1 degree of longitude	=	69.17	miles

VOLUME

Metric

1 cubic millimeter	=	0.000,000,001	cu. meter
1 milliliter	=	0.03382	fluid ounce
	=	0.001	liter
1 centiliter	=	0.01	liter
	=	0.61	cubic inch

VOLUME (Continued)

1 liter	=	33.82	fluid ounces
	=	2.113	U.S. pints liquid
	=	1.057	U.S. quarts liquid
	=	0.9081	quart, dry
	=	0.2642	U.S. gallon
	=	0.11351	U.S. peck
	=	0.221	Imperial gallon
	=	1,000	milliliters or cc.
	=	0.0353	cubic foot
	=	61.02	cubic inches
	=	0.001	cubic meter
1 cubic centimeter	=	0.061	cubic inch
	=	1,000	cubic millimeters
1 decalitre	=	10	liters
	=	18.162	dry pints
	=	9.081	dry quarts
	=	1.135	pecks
	=	0.283	bushel
1 hectoliter	=	100	liters
	=	2.8378	bushels
1 cubic meter	=	61,023.38	cubic inches
	=	35.314	cubic feet
	=	1.308	cubic yards
	=	264.17	U.S. gallons
	=	1,000	liters
	=	28.38	U.S. bushels
	=	1,000,000	cu. centimeters
	=	1,000,000,000	cu. millimeters
1 cubic kilometer	=	1,307,942,000	cu. yards
Imperial			
1 teaspoon (level)	=	0.17	fluid ounce
	=	6	cubic centimeters
1 tablespoon (level)	=	0.5	fluid ounce
	=	3	teaspoons (level)
	=	18	cu. centimeters
1 fluid ounce	=	1/128	gallon
	=	29.57	cubic centimeters
	=	2	tablespoons (level)
	=	29.562	milliliters
	=	1.805	cubic inches
	=	0.0625	U.S. pint (liquid)
1 gill	=	1/32	gallon
	=	1/4	liquid pint
	=	7.21875	cubic inches
	=	0.118	liter
1 cup	=	0.5	pint
	=	8	fluid ounces
1 U.S. pint (liquid)	=	473.2	milliliters
	=	2	cups
	=	0.5	quart
	=	0.4732	liter
	=	28.875	cubic inches
	=	16	fluid ounces
	=	1/8	gallon

1 pint (dry)	=	0.550	liter
	=	33.60	cubic inches
	=	0.5	quart (dry)
	=	0.0625	peck
	=	1/64	bushel
1 U.S. quart liquid	=	946.3	milliliters
	=	57.75	cubic inches
	=	32	fluid ounces
	=	4	cups
	=	1/4	gallon
	=	2	U.S. pints (liquid)
	=	0.946	liter
1 quart dry	=	1.1012	liters
	=	67.20	cubic inches
	=	2	pints (dry)
	=	0.125	peck
	=	1/32	bushel
1 cubic inch	=	16.387	cubic centimeters
1 cubic foot	=	28,317	cubic centimeters
	=	0.0283	cubic meter
	=	28.316	liters
	=	7.481	U.S. gallons
	=	1,728	cubic inches
1 U.S. gallon	=	16	cups
	=	3.785	liters or cc.
	=	231	cubic inches
	=	4	U.S. quarts
	=	8	U.S. pints
	=	8.3453	pounds of water
	=	128	fluid ounces
	=	0.8327	British Imperial gallon
1 British Imperial gallon	=	4.546	liters
	=	1.201	U.S. gallons
	=	277.42	cubic inches
1 boardfoot	=	144	cubic inches
	=	1/12	cubic foot
	=	2,359	cubic centimeters
1 cubic yard	=	0.7646	cubic meter
	=	46,656	cubic inches
	=	27	cubic feet
1 cord	=	128	cubic feet
	=	3.624	cubic meters
1 peck	=	8.809	liters
	=	537.605	cubic inches
	=	16	pints (dry)
	=	8	quarts (dry)
	=	0.25	bushel
1 U.S. bushel	=	35.24	liters
	=	0.3524	hectoliter
	=	2,150.42	cubic inches
	=	1.2444	cubic feet
	=	0.03524	cubic meter
	=	4	pecks
	=	32	quarts
	=	64	pints
1 barrel	=	7,056	cubic inches
	=	105	dry quarts
	=	115.626	liters

1 U.K. bushel = 2,219.36 cubic inches
= 36.37 liters

Other
1 almud = 0.98 cubic foot
= 27.75 liters
1 fanega = 2 almudes

WEIGHT

Metric
1 milligram = 0.001 gram
= 0.0154 grain
1 centigram = 0.01 gram
= 0.1543 grain
1 gram = 0.0353 avoirdupois ounce
= 15.4324 grains
1 decagram = 10 grams
= 154.324 grains
1 hectogram = 100 grams
= 3.53 avoirdupois ounces
= 1,543.24 grains
1 kilogram = 1,000 grams
= 353 avoirdupois ounces
= 2.2046 avoirdupois pounds
= 10 hectograms
1 quintal (metric) = 100 kilograms
= 220.46 pounds
1 metric ton = 1,000 kilograms
= 2,204.6 pounds
= 1.102 short tons
= 0.984 long ton

Imperial
1 dram (avoirdupois) = 1/256 avoirdupois pound
= 27.34 grains
= 1.772 grams
1 dram (apothecaries) = 1/96 apoth. pound
= 1/8 apoth. ounce
= 60 grains
= 3.8879 grams
1 grain = 1/7000 avoirdupois pound
= 0.064799 gram
1 ounce (avoirdupois) = 28.3496 grams
= 437.5 grains
= 1/16 pound
1 pound (avoirdupois) = 453.593 grams
= 0.45369 kilograms
= 16 ounces
1 stone = 14 pounds
= 6.350 kilograms
1 hundredweight (cwt) = 45.36 kilograms
= 100 avoirdupois pounds
1 quintal = 100 pounds

1 short ton = 907.184 kilograms
= 0.9072 metric ton
= 2,000 pounds
= 20 quintals

Other
1 arroba (Puerto Rico) = 25.36 pounds
1 arroba (Brazil) = 33.00 pounds
= 15 kilograms

YIELD

Metric
1 kilogram per hectare = 0.89 pound per acre
1 hectoliter per hectare = 68.88 pounds per acre
= 1.148 bushels (60 pounds) per acre

1 quintal per hectare = 89.214 pounds per acre
= 1.4869 bushels (60 pounds) per acre
= 100 kilograms per hectare
= 0.446 ton (2,000 lb.) per acre

Imperial
1 pound per acre = 1.121 kilograms per hectare

1 bushel (60 pounds) per acre = 0.871 hectoliter per hectare
= 67.26 kilograms per hectare

1 ton (2,000 lb.) per acre = 2.242 metric tons per hectare

Table 19. CENTIGRADE—FAHRENHEIT CONVERSION TABLE

On the centigrade scale, the temperature of melting ice is 0° and that of boiling water is 100° at normal atmospheric pressure. In the Fahrenheit scale, these two equivalent temperatures appear at 32° and 212°, respectively. The formula for converting Fahrenheit to centigrade is $C=5/9\ (F-32)$ and the formula for converting centigrade to Fahrenheit is $F=9/5\ C+32$.

C	C or F	F	C	C or F	F
—73.33	—100	—148.0	— 5.00	23	73.4
—70.56	— 95	—139.0	— 4.44	24	75.2
—67.78	— 90	—130.0	— 3.89	25	77.0
—65.00	— 85	—121.0	— 3.33	26	78.8

Table 19. CENTIGRADE—FAHRENHEIT CONVERSION TABLE (Continued)

C	C or F	F	C	C or F	F
—62.22	— 80	—112.0	— 2.78	27	80.6
—59.45	— 75	—103.0	— 2.22	28	82.4
—56.67	— 70	— 94.0	— 1.67	29	84.2
—53.89	— 65	— 85.0	— 1.11	30	86.0
—51.11	— 60	— 76.0	— 0.56	31	87.8
—48.34	— 55	— 67.0	0	32	89.6
—45.56	— 50	— 58.0	0.56	33	91.4
—42.78	— 45	— 49.0	1.11	34	93.2
—40.0	— 40	— 40.0	1.67	35	95.0
—37.23	— 35	— 31.0	2.22	36	96.8
—34.44	— 30	— 22.0	2.78	37	98.6
—31.67	— 25	— 13.0	3.33	38	100.4
—28.89	— 20	— 4.0	3.89	39	102.2
—26.12	— 15	5.0	4.44	40	104.0
—23.33	— 10	14.0	5.00	41	105.8
—20.56	— 5	23.0	5.56	42	107.6
—17.8	0	32.0	6.11	43	109.4
—17.2	1	33.8	6.67	44	111.2
—16.7	2	35.6	7.22	45	113.0
—16.1	3	37.4	7.78	46	114.8
—15.6	4	39.2	8.33	47	116.6
—15.0	5	41.0	8.89	48	118.4
—14.4	6	42.8	9.44	49	120.2
—13.9	7	44.6	10.0	50	122.0
—13.3	8	46.4	10.6	51	123.8
—12.8	9	48.2	11.1	52	125.6
—12.2	10	50.0	11.7	53	127.4
—11.7	11	51.8	12.2	54	129.2
—11.1	12	53.6	12.8	55	131.0
—10.6	13	55.4	13.3	56	132.8
—10.0	14	57.2	13.9	57	134.6
— 9.44	15	59.0	14.4	58	136.4
— 8.89	16	60.8	15.0	59	138.2
— 8.33	17	62.6	15.6	60	140.0
— 7.78	18	64.4	16.1	61	141.8
— 7.22	19	66.2	16.7	62	143.6
— 6.67	20	68.0	17.2	63	145.4
— 6.11	21	69.8	17.8	64	147.2
— 5.56	22	71.6	18.3	65	149.0
18.9	66	150.8	60	140	284
19.4	67	152.6	66	150	302
20.0	68	154.4	71	160	320
20.6	69	156.2	77	170	338
21.1	70	158.0	82	180	356
21.7	71	159.8	88	190	374
22.2	72	161.6	93	200	392
22.8	73	163.4	99	210	410
23.3	74	165.2	100	212	413
23.9	75	167.0	104	220	428
24.4	76	168.8	110	230	446
25.0	77	170.6	116	240	464
25.6	78	172.4	121	250	482
26.1	79	174.2	127	260	500
26.7	80	176.0	132	270	518
27.2	81	177.8	138	280	536
27.8	82	179.6	143	290	554
28.3	83	181.4	149	300	572
28.9	84	183.2	154	310	590
29.4	85	185.0	160	320	608
30.0	86	186.8	166	330	626
30.6	87	188.6	171	340	644
31.1	88	190.4	177	350	662
31.7	89	192.2	182	360	680
32.2	90	194.0	188	370	698
32.8	91	195.8	193	380	716
33.3	92	197.6	199	390	734
33.9	93	199.4	204	400	752
34.4	94	201.2	210	410	770
35.0	95	203.0	216	420	788
35.6	96	204.8	221	430	806
36.1	97	206.6	227	440	824
36.7	98	208.4	232	450	842
37.2	99	210.2	238	460	860
37.8	100	212.0	243	470	878
43	110	230	249	480	896
49	120	248	254	490	914
54	130	266	260	500	932

The numbers in the "C" or "F" column refer to temperatures in either centigrade or Fahrenheit degrees. If used to represent centigrade degrees, the equivalent temperature in Fahrenheit is listed in the "F" column. If used to represent Fahrenheit the equivalent is listed in the "C" column.

Table 20. CONVERSION OF OUNCES TO FRACTIONS OF A POUND

Ounce	Per cent of a Pound	
1	0.0625	or 0.06
2	0.125	or 0.13
3	0.1875	or 0.19
4	0.250	or 0.25
5	0.3125	or 0.31
6	0.375	or 0.38
7	0.4375	or 0.44
8	0.500	or 0.50
9	0.5625	or 0.56
10	0.625	or 0.63
11	0.6875	or 0.69
12	0.750	or 0.75
13	0.8125	or 0.81
14	0.875	or 0.88
15	0.9375	or 0.94

Table 21. NUMBER OF PLANTS PER ACRE AT GIVEN SPACINGS

Inches	No. of Plants	Inches	No. of Plants	Inches	No. of Plants
12 x 1	522,720	20 x 3	104,544	30 x 15	13,939
12 x 3	174,240	20 x 4	78,408	30 x 18	11,616
12 x 4	130,680	20 x 6	52,272	30 x 24	8,712

Table 21. NUMBER OF PLANTS PER ACRE AT GIVEN SPACINGS (Continued)

Inches	No. of Plants	Inches	No. of Plants	Inches	No. of Plants
12 x 6	87,120	20 x 9	34,848	30 x 30	6,969
12 x 9	58,080	20 x 12	26,136		
12 x 12	43,560	20 x 15	20,909	36 x 3	58,080
		20 x 18	17,426	36 x 4	43,560
15 x 1	418,176			36 x 6	29,040
15 x 3	139,382	24 x 3	87,120	36 x 9	19,360
15 x 4	104,544	24 x 4	65,340	36 x 12	14,520
15 x 6	69,696	24 x 6	43,560	36 x 15	11,616
15 x 9	48,484	24 x 9	29,040	36 x 18	9,680
15 x 12	34,848	24 x 12	21,780	36 x 24	7,260
		24 x 15	17,424	36 x 30	5,808
18 x 1	348,390	24 x 18	14,520	36 x 36	4,840
18 x 3	116,160	24 x 24	10,890		
18 x 4	87,120			40 x 3	52,272
18 x 6	58,080	30 x 3	69,696	40 x 6	26,136
18 x 9	38,720	30 x 4	52,272	40 x 12	13,068
18 x 12	29,040	30 x 6	34,848	40 x 18	8,709
18 x 15	23,232	30 x 9	23,232	40 x 24	6,534
18 x 18	19,360	30 x 12	17,424	40 x 30	5,227
				40 x 36	4,356
42 x 3	49,782	48 x 12	10,890	60 x 12	8,712
42 x 6	24,891	48 x 18	7,260	60 x 18	5,808
42 x 12	12,445	48 x 24	5,445	60 x 24	4,356
42 x 18	8,297	48 x 30	4,356	60 x 30	3,484
42 x 24	6,223	48 x 36	3,630	60 x 36	2,904
42 x 30	4,978	48 x 42	3,111	60 x 42	2,489
42 x 36	4,148	48 x 48	2,722	60 x 48	2,178
				60 x 54	1,936
48 x 3	43,560	60 x 3	34,848	60 x 60	1,742
48 x 6	21,780	60 x 6	17,424		

Table 22. NUMBER OF PLANTS PER HECTARE AT GIVEN SPACINGS

Centimeters	No. of Plants	Centimeters	No. of Plants	Centimeters	No. of Plants
25 x 2	2,000,000	75 x 50	26,666	125 x 60	13,333
25 x 5	800,000	75 x 60	22,222	125 x 75	10,400
25 x 10	400,000	75 x 75	17,777	125 x 80	10,000
25 x 15	266,666	100 x 2	500,000	125 x 90	8,888
25 x 20	200,000	100 x 5	200,000	125 x 100	8,000
25 x 25	160,000	100 x 10	100,000	125 x 125	6,400
50 x 2	1,000,000	100 x 15	66,666	150 x 5	133,333
50 x 5	400,000	100 x 20	50,000	150 x 10	66,666
50 x 10	200,000	100 x 25	40,000	150 x 25	26,666
50 x 15	133,333	100 x 30	33,333	150 x 50	13,333
50 x 20	100,000	100 x 40	25,000	150 x 75	8,888
50 x 25	80,000	100 x 50	20,000	150 x 100	6,666
50 x 30	66,666	100 x 60	16,666	150 x 125	5,200
50 x 35	57,142	100 x 75	13,333	150 x 150	4,444
50 x 40	50,000	100 x 80	12,500	175 x 5	114,280
50 x 45	44,444	100 x 90	11,111	175 x 10	57,140
50 x 50	40,000	100 x 100	10,000	175 x 25	22,856
75 x 2	666,666	125 x 2	400,000	175 x 50	11,428
75 x 5	266,666	125 x 5	160,000	175 x 75	7,618
75 x 10	133,333	125 x 10	80,000	175 x 100	5,714
75 x 15	88,888	125 x 20	40,000	175 x 125	4,571
75 x 20	66,666	125 x 25	32,000	175 x 150	3,809
75 x 25	53,333	125 x 30	26,666	175 x 175	3,265
75 x 30	44,444	125 x 40	20,000		
75 x 40	33,330	125 x 50	16,000		

Table 23. NUMBER OF TREES PER ACRE AT GIVEN SPACINGS

Feet	No. of Plants	Feet	No. of Plants	Feet	No. of Plants
6 x 1	7,260	10 x 1	4,356	18 x 4	605
6 x 2	3,630	10 x 2	2,178	18 x 6	404
6 x 3	2,420	10 x 3	1,452	18 x 8	303
6 x 4	1,815	10 x 4	1,089	18 x 10	242
6 x 5	1,452	10 x 5	871	18 x 12	202
6 x 6	1,210	10 x 6	726	18 x 14	173
		10 x 7	622	18 x 16	152
7 x 1	6,223	10 x 8	544	18 x 18	132
7 x 2	3,111	10 x 9	484		
7 x 3	2,074	10 x 10	435		
7 x 4	1,556			20 x 8	272
7 x 5	1,244	12 x 2	1,815	20 x 10	218
7 x 6	1,037	12 x 4	907	20 x 12	184
7 x 7	889	12 x 6	605	20 x 14	156
		12 x 7	454	20 x 16	136
8 x 1	5,445	12 x 10	363	20 x 18	121
8 x 2	2,722	12 x 12	302	20 x 20	109
8 x 3	1,815				
8 x 4	1,361	14 x 2	1,556		
8 x 5	1,089	14 x 4	778	24 x 12	151
8 x 6	907	14 x 6	518	24 x 16	114
8 x 7	778	14 x 8	389	24 x 20	92
8 x 8	680	14 x 10	311	24 x 24	76
		14 x 12	259		
9 x 1	4,840	14 x 14	222		
9 x 2	2,420			30 x 20	72
9 x 3	1,613	16 x 2	1,361	30 x 30	48
9 x 4	1,210	16 x 4	680	30 x 40	36
9 x 5	968	16 x 6	454		
9 x 6	807	16 x 8	340		
9 x 7	691	16 x 10	272	40 x 40	27
9 x 8	605	16 x 12	227		
9 x 9	528	16 x 14	194		
		16 x 16	170		

In order to obtain the number of plants per acre, divide 43,560 by the product of the spacing in the rows expressed in feet.

Table 24. NUMBER OF TREES PER HECTARE AT GIVEN SPACINGS

Meters	No. of Plants	Meters	No. of Plants	Meters	No. of Plants
2 x 0.25	20,000	5 x 1.0	2,000	8 x 1	1,250
2 x 0.50	10,000	5 x 1.5	1,333	8 x 2	555
2 x 0.75	6,666	5 x 2.0	1,000	8 x 3	416
2 x 1.0	5,000	5 x 2.5	800	8 x 4	312
2 x 1.25	4,000	5 x 3.0	666	8 x 5	250
2 x 1.50	3,333	5 x 3.5	571	8 x 6	208
2 x 1.75	2,857	5 x 4.0	500	8 x 7	178
2 x 2.0	2,500	5 x 4.5	444	8 x 8	156
		5 x 5.0	400		
3 x 0.5	6,666				
3 x 1.0	3,333	6 x 1	1,666	9 x 1	1,111
3 x 1.5	2,222	6 x 2	833	9 x 2	555
3 x 2.0	1,666	6 x 3	555	9 x 3	370
2 x 2.5	1,333	6 x 4	416	9 x 4	277
3 x 3.0	1,111	6 x 5	333	9 x 5	222
		6 x 6	277	9 x 6	185
4 x 0.5	5,000			9 x 7	158

Table 24. NUMBER OF TREES PER HECTARE AT GIVEN SPACINGS (Continued)

Meters	No. of Plants	Meters	No. of Plants	Meters	No. of Plants
4 x 1.0	2,500	7 x 1	1,428	9 x 8	138
4 x 1.5	1,666	7 x 2	714	9 x 9	123
4 x 2.0	1,250	7 x 3	476	9 x 10	111
4 x 2.5	1,000	7 x 4	357		
4 x 3.0	833	7 x 5	285		
4 x 3.5	714	7 x 6	238	10 x 10	100
4 x 4.0	625	7 x 7	204		

In order to obtain the number of plants per hectare, divide 10,000 by the product of the spacing in the rows expressed in meters.

Table 25. RANDOM NUMBERS: 1 TO 10

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
6	10	8	4	8	4	2	3	1	8	6	1	1	4
5	4	10	10	4	1	4	2	9	9	3	8	9	3
2	9	3	3	3	7	5	10	8	3	2	6	6	1
7	1	2	8	7	5	7	4	6	10	1	7	4	5
8	5	9	2	10	3	1	7	5	5	8	10	10	9
3	8	4	7	2	6	3	6	10	4	9	2	8	10
9	3	6	9	9	2	9	5	3	2	7	9	2	6
4	7	1	5	5	8	10	8	4	1	5	3	7	7
1	2	7	1	6	9	6	9	2	6	10	5	3	8
10	6	5	6	1	10	8	1	7	7	4	4	5	2

XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV
3	10	4	6	4	8	9	4	1	8
5	4	8	4	8	5	2	5	6	6
1	1	1	10	5	4	8	7	3	1
9	3	2	2	3	10	7	3	9	9
2	8	10	7	7	6	4	10	5	4
6	6	5	3	10	2	5	9	8	2
8	5	7	5	2	9	6	1	7	7
10	7	6	1	4	7	10	2	4	3
7	9	9	9	1	1	3	6	2	10
4	2	3	8	9	3	1	8	10	5

Table 26. RANDOM ARRANGEMENT OF NUMBERS FROM 1 TO 30

Taken from Table VI in Field Plot Technique by Leonard and Clark

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX
29	12	15	20	6	13	16	23	1	10	2	20	15	29	4	18	8	7	6	14
27	1	26	7	22	26	15	9	20	15	29	6	25	26	2	15	13	30	3	22
5	23	23	15	26	22	19	28	4	7	12	5	12	28	5	16	4	14	7	19
20	3	24	30	1	21	22	4	3	13	6	7	16	3	16	21	39	6	14	3
10	25	9	27	25	3	8	14	7	5	30	1	23	23	13	25	20	4	20	2
21	16	12	4	2	23	26	5	24	21	26	3	5	11	17	12	1	15	24	27
11	13	1	13	9	28	20	2	29	29	13	24	26	21	9	22	11	22	11	29
7	19	28	2	8	16	30	18	22	11	19	30	21	6	7	30	21	23	25	1
14	29	19	12	3	1	17	24	16	4	20	13	4	7	1	10	23	27	28	12
25	5	8	23	27	4	12	25	6	12	8	25	13	16	30	5	14	1	18	23
2	21	17	26	20	5	7	8	23	6	28	2	6	15	26	19	22	19	1	26
18	26	11	9	21	18	24	1	12	25	4	17	1	18	6	14	12	24	21	4
4	9	2	21	29	8	5	22	5	18	27	27	10	4	11	4	26	17	10	18

Table 26. RANDOM ARRANGEMENT OF NUMBERS FROM 1 TO 30 (Continued)

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX
23	17	30	18	18	10	23	26	17	1	24	18	18	12	27	13	18	18	13	13
30	10	21	16	10	29	4	19	8	26	5	15	22	10	20	7	2	26	16	9
8	27	25	1	5	30	21	29	11	23	7	14	2	27	12	8	16	8	9	5
17	6	16	8	17	17	27	12	30	20	11	11	27	1	14	29	3	2	27	16
13	30	3	14	30	11	9	30	13	2	21	26	3	14	22	9	19	12	29	8
26	14	10	29	11	15	28	16	27	27	3	23	17	19	10	2	28	13	22	20
22	11	5	19	7	9	13	3	21	30	16	9	28	5	25	23	7	25	17	21
24	28	7	11	4	25	6	10	14	8	15	10	11	13	15	17	17	5	26	11
9	2	6	25	12	7	2	11	10	14	23	4	8	22	18	11	25	21	8	25
28	24	29	3	28	6	3	15	13	3	9	19	7	8	8	3	6	11	5	6
15	8	13	5	24	2	14	17	2	19	22	12	30	2	21	6	10	10	19	17
16	22	20	17	14	14	11	27	26	24	14	16	14	20	28	24	30	3	2	28
12	7	22	6	15	12	10	6	25	16	10	8	19	9	29	20	27	9	4	30
6	20	4	22	23	24	29	20	28	28	1	21	9	30	23	28	15	16	15	24
3	4	18	10	16	19	25	13	19	9	17	22	29	17	19	26	24	20	23	7
1	15	27	28	13	27	18	7	9	22	25	28	20	24	24	1	9	29	12	15
19	18	14	24	19	20	1	21	18	17	18	29	24	25	3	27	5	28	30	10

Chapter 10

BOOKS AND GENERAL REFERENCES

There are many publications dealing with various phases of tropical horticulture. It is obviously impossible to include all, and often publications from other countries are not generally available. The selected list below is given for the convenience of the horticultural worker when he has no local library available. Prices have been omitted since they are changing from year to year.

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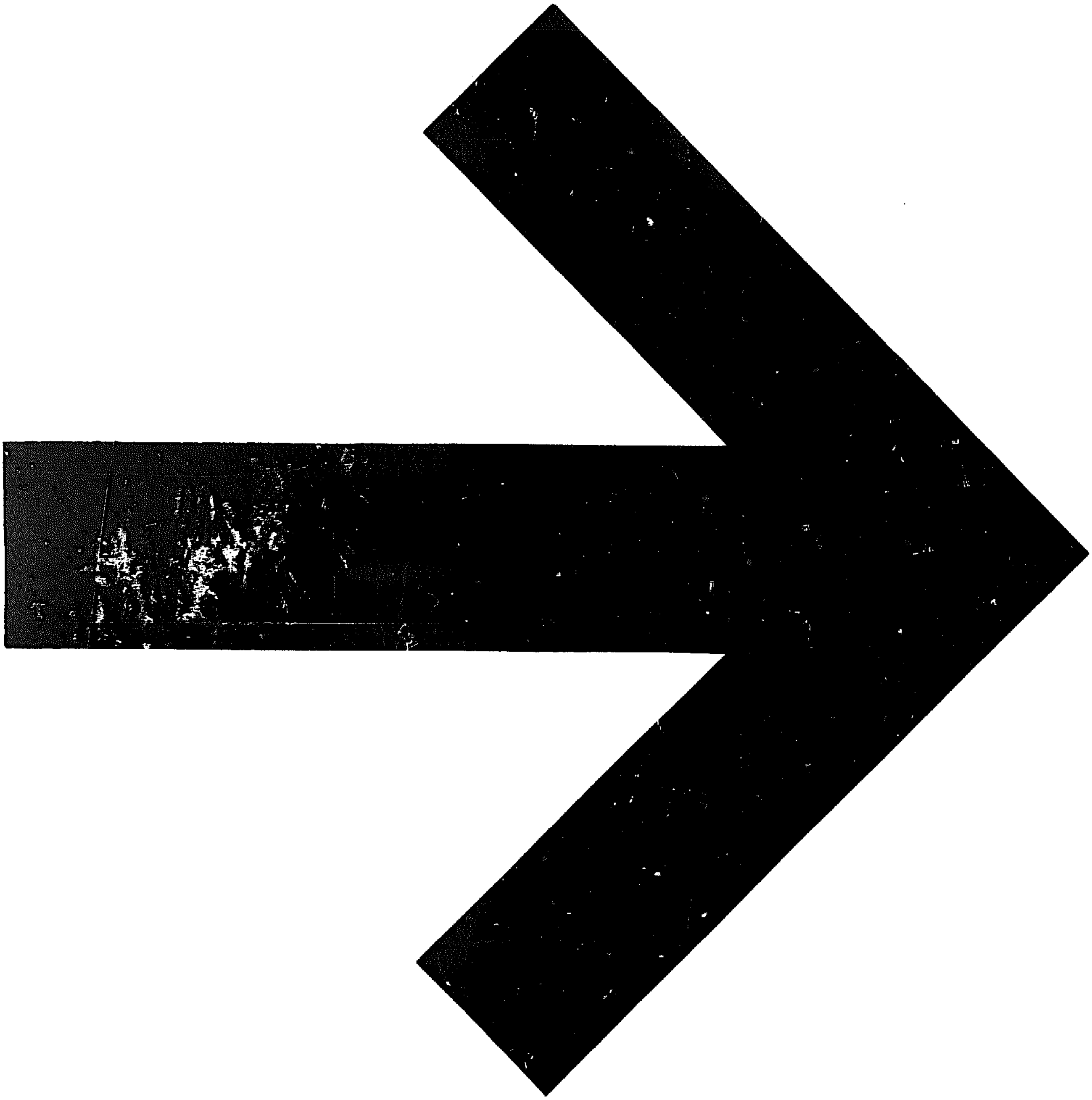

APPENDIX A

Insects Alphabetically by Common Name

Common Name	*Scientific Name*
aphids	*Aphis* spp.
aphids	Aphididae, spp of
asparagus beetle	*Crioceris asparagi* (L.)
aster leafhopper	*Macrosteles fascifrons* (Stål)
banana root borer	*Cosmopolites sordidus* (Germar)
bean aphid	*Aphis fabae* Scopoli
bean leaf beetle	*Cerotoma trifurcata* (Forster)
beetles or cucumber beetles	*Diabrotica* spp.
beetle	*Strategus* spp.
beet webworm	*Loxostege sticticalis* (L.)
black citrus aphid	*Toxoptera aurantii* (Fonscolombe)
blister beetles	*Epicauta* spp.
bollworm	*Earias* sp.
borer	*Xyleborus* sp.
cabbage aphid	*Brevicoryne brassicae* (L.)
cabbage maggot	*Hylemya brassicae* (Bouché)
cabbage webworm	*Hellula rogatalis* (Hulst)
cabbageworm	*Pieris* spp.
California red scale	*Aonidiella aurantii* (Maskell)
carpenter bee	*Xylocopa sonorina* Smith
carrot caterpillar	*Papilio* sp.
carrot rust fly	*Psila rosae* (F.)
celery leaf tier	*Udea rubigalis* (Guenée)
coconut scale	*Aspidiotus destructor* Signoret
coconut weevil	*Rhynchophorus palmarum* (L.)
codling moth	*Laspeyresia pomonella* (L.)
coffee bean borer	*Hypothenemus (Stephanoderes) hampei* (Ferrari)
coffee leaf miner	*Leucoptera coffeella* (Guérin-Méneville)
Colorado potato beetle	*Leptinotarsa decemlineata* (Say)
corn earworm, tomato fruitworm	*Heliothis zea* (Boddie)
corn sap beetles	*Carpophilus dimidiatus* (F.)
cowpea curculio	*Chalcodermus aeneus* Boheman
cowpea weevil	*Callosobruchus maculatus* (F.)
cutworms	Noctuidae, spp. of
diamondback moth	*Plutella xylostella* (L.)
eggplant lace bug	*Gargaphia solani* Heidemann
European corn borer	*Ostrinia nubilalis* (Hübner)
grape berry moth	*Paralobesia viteana* (Clemens)
fall armyworm	*Spodoptera frugiperda* (J. E. Smith)
flea beetles	Chrysomelidae, spp. of
fruit beetle	*Cotinis mutabilis* Gory & Percheron
fruit flies	*Anastrepha* spp.
fruit fly	*Anastrepha serpentina* (Wiedemann)
fruit fly	*Anastrepha striata* Schiner
fruit flies	*Dacus* spp.
fruit flies	Tephritidae, spp. of
fruit & shoot borer	*Leucinodes orbonalis* Guenée
fruitworm	*Euzophera punicaella* Moore
green peach aphid	*Myzus persicae* (Sulzer)
green scale	*Coccus viridis* (Green)
green shield scale	*Pulvinaria psidii* Maskell
harlequin bug	*Murgantia histrionica* (Hahn)
honey bee	*Apis mellifera* L.
hornworm	*Manduca* spp.
imported cabbageworm	*Pieris rapae* (L.)
Japanese beetle	*Popillia japonica* Newman
katydids or longhorn grasshoppers	*Sexava coriacea* (L.)
katydids or longhorn grasshoppers	*Sexava nubila* Stål
katydids or longhorn grasshoppers	*Sexava karnyi* Leefmans
katydids or longhorn grasshoppers	*Sexava novaeguineae* Brancsik
leaf-cutting ants	*Atta* spp.
leafhopper	*Dalbulus maidis* (Delong & Wolcott)
leafhoppers	*Empoasca* spp.
leafhopper	*Empoasca decipiens* Paoli
leafhopper	*Homalodisca insolita* (Walker)
lesser cornstalk borer	*Elasmopalpus lignosellus* (Zeller)
lima-bean pod borer	*Etiella zinckenella* (Treitschke)
loopers (cabbage looper)	*Trichoplusia ni* (Hübner)
mealybugs	*Planococcoides njalensis* (Laing)
Mediterranean fruit fly	*Ceratitis capitata* (Wiedemann)
melon fly	*Dacus cucurbitae* Coquillett
melonworm	*Diaphania hyalinata* (L.)

Common Name	*Scientific Name*
Mexican bean beetle	*Epilachna varivestis* Mulsant
Mexican fruit fly	*Anastrepha ludens* (Loew)
millipedes	Diplopoda, spp. of
mining scale	*Howardia biclavis* (Comstock)
mites	Acarina, spp. of
mites	*Oligonychus* sp.
mole cricket	*Gryllotalpidae*, spp. of
moth	*Artona catoxantha* (Hampson)
moth	*Eucosmophora* sp.
moth	*Hidari irava* (Moore)
olive scale	*Parlatoria oleae* (Colvée)
olive fruit fly	*Dacus oleae* (Gmelin)
onion maggot	*Hylemya antiqua* (Meigen)
onion thrips	*Thrips tabaci* Lindeman
orange dog	*Papilio* spp.
oriental fruit fly	*Dacus dorsalis* Hendel
oriental fruit moth	*Grapholitha molesta* (Busck)
palm weevil	*Rhynchophorus* spp.
papaya fruit fly	*Toxotrypana curvicauda* Gerstaecker
pea weevil	*Bruchus pisorum* (L.)
peach tree borer	*Sanninoidea exitiosa* (Say)
peach twig borer	*Anarsia lineatella* Zeller
pear leaf blister mite	*Eriophyes pyri* (Pagenstecher)
pear thrips	*Taeniothrips inconsequens* (Uzel)
pepper weevil	*Anthonomus eugenii* Cano
phylloxera	*Phylloxera* sp.
pickleworm	*Diaphania nitidalis* (Stoll)
pineapple mealbug (scale)	*Dysmicoccus brevipes* (Cockerell)
pineapple scale	*Diaspis bromeliae* (Kerner
plum curculio	*Conotrachelus nenuphar* (Herbst)
pod borer	*Acrocercops cramerella* (Snellen)
potato flea beetle	*Epitrix cucumeris* (Harris)
potato leafhopper	*Empoasca fabae* (Harris)
potato tuberworm	*Phthorimaea operculella* (Zeller)
pustule scale	*Asterolecanium pustulans* (Cockerell)
Quetta borer	*Aeolesthes sarta* (Solsky)
red-banded thrips	*Selenothrips rubrocinctus* (Giard)
red spiders or spider mites	Tetranychidae, spp. of
rhinoceros beetle	*Oryctes rhinoceros* L.
San Jose scale	*Aspidiotus perniciosus* Comstock
scab moth	*Nacoleia octasema* (Meyrick)
scale	*Aulacaspis tubercularis* Newstead
scale	Coccoidea, spp. of
scale	*Melanaspis aliena* (Newstead)
scale	*Parlatoria* spp.
seed-corn maggot	*Hylemya platura* (Meigen)
seed weevil	*Conotrachelus perseae* Barber
silky cane weevil	*Metamasius hemipterus sericeus* (Olivier)
southern green stink bug	*Nezara viridula* (L.)
sowbugs	Isopoda, spp. of
spider mite	*Tetranychus* spp.
spotted cucumber beetle	*Diabrotica undecimpunctata howardi* Barber
squash bug	*Anasa tristis* (De Geer)
squash vine borer	*Melittia cucurbitae* (Harris)
stalk borer	*Papaipema nebris* (Guenée)
stink bug	Pentatomidae, spp. of
striped cucumber beetle	*Acalymma vittatum* (F.)
sweetpotato weevil	*Cylas formicarius elegantulus* (Summers)
sweetpotato whitefly	*Bemisia tabaci* (Gennadius)
thrips	*Frankliniella* spp.
tomato russet mite	*Aculus lycopersici* (Massee)
treehopper	*Aconophora pugionata* (Germar)
vegetable weevil	*Listroderes costirostris obliquus* (Klug)
wasps	*Polistes* spp.
weevil	*Anthonomus unipustulatus* (Champion)
whiteflies	*Trialeurodes* spp.
white grubs	*Phyllophaga* spp.
white-fringed beetles	*Graphognathus* spp.
wireworms	Elateridae, spp. of

APPENDIX B

Insects Alphabetically by Scientific Names

Scientific Name	*Common Name*
Acalymma vittatum (F.)	striped cucumber beetle
Acarina, spp. of	mites
Aconophora pugionata (Germar)	treehopper
Acrocercops cramerella (Snellen)	pod borer
Aculus lycopersici (Massee)	tomato russet mite
Aeolesthes sarta (Solsky)	Quetta borer
Anarsia lineatella Zeller	peach twig borer
Anasa tristis (De Geer)	squash bug
Anastrepha spp.	fruit flies
Anastrepha ludens (Loew)	Mexican fruit fly
Anastrepha serpentina (Wiedemann)	fruit fly
Anastrepha striata Schiner	fruit fly
Anthonomus eugenii Cano	pepper weevil
Anthonomus unipustulatus (Champion)	weevil
Aonidiella aurantii (Maskell)	California red scale
Aphididae, spp. of	aphids or plant lice
Aphia spp.	aphids
Aphis fabae Scopoli	bean aphid
Apis mellifera L.	honey bee
Artona catoxantha (Hampson)	moth
Aspidiotus destructor Signoret	coconut scale
Aspidiotus perniciosus Comstock	San Jose scale
Asterolecanium pustulans (Cockerell)	pustule scale
Atta spp.	leaf-cutting ants
Aulacaspis tubercularis Newstead	scale
Bemisia tabaci (Gennadius)	sweetpotato whitefly (on eggplant)
Brevicoryne brassicae (L.)	cabbage aphid
Bruchus pisorum (L.)	pea weevil
Callosobruchus maculatus (F.)	cowpea weevil
Carpophilus dimidiatus (F.)	corn sap beetles
Ceratitis capitata (Wiedemann)	Mediterranean fruit fly
Cerotoma trifurcata (Forster)	bean leaf beetle
Chalcodermus aeneus Boheman	cowpea weevil
Chrysomelidae, spp. of	flea beetles
Coccoidea, spp. of	scale
Coccus viridis (Green)	green scale
Conotrachelus nenuphar (Herbst)	plum curculio
Conotrachelus perseae Barber	seed weevil
Cosmopolites sordidus (Germar)	banana root borer
Cotinis mutabilis Gory & Percheron	fruit beetle
Crioceris asparagi (L.)	asparagus
Cylas formicarius elegantulus (Summers)	sweetpotato weevil
Dacus spp.	fruit flies
Dacus cucurbitae Coquillett	melon fly
Dacus dorsalis Hendel	oriental fruit fly
Dacus oleae (Gmelin)	olive fruit fly
Dalbulus maidis (Delong & Wolcott)	leafhopper
Diabrotica spp.	beetles or cucumber beetles
Diabrotica undecimpunctata howardi	Barber spotted cucumber beetle
Diaphania hyalinata (L.)	melonworm
Diaphania nitidalis (Stoll)	pickleworm
Diaspis bromeliae (Kerner)	pineapple scale
Diplopoda, spp. of	millipedes
Dysmicoccus brevipes (Cockerell)	pineapple mealbug (scale)
Earias sp.	bollworm
Elasmopalpus lignosellus (Zeller)	lesser cornstalk borer
Elateridae, spp. of	wireworms
Empoasca spp.	leafhoppers
Empoasca decipiens Paoli	leafhoppers
Empoasca fabae (Harris)	potato leafhopper
Epicauta spp.	blister beetles
Epilachna varivestis Mulsant	Mexican bean beetle
Epitrix cucumeris (Harris)	potato flea beetle
Eriophyes pyri (Pagenstecher)	pear leaf blister mite
Etiella zinckenella (Treischke)	lima-bean pod borer
Eucosmophora sp.	moth
Euzophera punicaella Moore	eggplant lace bug
Frankliniella spp.	thrips
Gargaphia solani Heidemann	fruitworm
Graphognathus spp.	white-fringed beetles
Grapholitha molesta (Busck)	oriental fruit moth
Gryllotalpidae, spp. of	mole cricket

Scientific Name	Common Name
Heliothis zea (Boddie)	corn earworm, tomato fruitworm
Hellula rogatalis (Hulst)	cabbage webworm
Hidari irava (Moore)	moth
Homalodisca insolita (Walker)	leafhopper
Howardia biclavis (Comstock)	mining scale
Hylemya antiqua (Meigen)	onion maggot
Hylemya brassicae (Bouché)	cabbage maggot
Hylemya platura (Meigen)	seed-corn maggot
Hypothenemus (*Stephanoderes*) *hampei* (Ferrari)	coffee bean borer
Isopoda, spp. of	sowbugs
Laspeyresia pomonella (L.)	codling moth
Leptinotarsa decemlineata (Say)	Colorado potato beetle
Leucinodes orbanalis Guenée	fruit & shoot borer
Leucoptera coffeella (Guérin-Méneville)	coffee leaf miner
Listroderes costirostris obliquus (Klug)	vegetable weevil
Loxostege sticticalis (L.)	beet webworm
Macrosteles fascifrons (Stål)	aster leafhopper
Manduca spp.	hornworm
Melanaspis aliena (Newstead)	scale
Melittia cucurbitae (Harris)	squash vine borer
Metamasius hemipterus sericeus (Olivier)	silky cane weevil
Murgantia histrionica (Hahn)	harlequin bug
Myzus persicae (Sulzer)	green peach aphid
Nacoleia octasema (Meyrick)	scab moth
Nezara viridula (L.)	southern green stink bug
Noctuidae, spp. of	cutworms
Oligonychus sp.	mites
Oryctes rhinoceros (L.)	rhinoceros beetle
Ostrinia nubilalis (Hübner)	European corn borer
Papaipema nebris (Guenée)	stalk borer
Papilio spp.	orange dog
Papilio sp.	carrot caterpillar
Paralobesia viteana (Clemens)	grape berry moth
Parlatoria spp.	scale
Parlatoria oleae (Colvée)	olive scale
Pentatomidae, spp. of	stink bugs
Phthorimaea operculela (Zeller)	potato tuberworm
Phyllophaga spp.	white grubs
Phylloxera sp.	phylloxera
Pieris spp.	cabbageworm
Pieris rapae (L.)	imported cabbageworm
Planococcoides njalensis (Laing)	mealybugs
Plutella xylostella (L.)	diamondback moth
Polistes spp.	wasps
Popillia japonica Newman	Japanese beetle
Psila rosae (F.)	carrot rust fly
Pulvinaria psidii Maskell	green shield scale
Rhynchophorus spp.	palm weevil
Rhynchophorus palmarum (L.)	coconut weevil
Sanninoidea exitiosa (Say)	peach tree borer
Selenothrips rubrocinctus (Giard)	red-banded thrips
Sexava coriacea (L.)	katydid, longhorn grasshopper
Saxava nubila Stål	katydid, longhorn grasshopper
Sexava karnyi Leefmans	katydid, longhorn grasshopper
Sexava novaeguineae Brancsik	katydid, longhorn grasshopper
Spodoptera frugiperda (J. E. Smith)	fall armyworm
Strategus spp.	beetle
Taeniothrips inconsequens (Uzel)	pear thrips
Tephritidae, spp. of	fruit flies
Tetranychidae, spp. of	red spiders, spider mites
Tetranychus spp.	spider mite
Thrips tabaci Lindeman	onion thrips
Toxoptera aurantii (Fonscolombe)	black citrus aphid
Toxotrypana curvicauda Gerstacker	papaya fruit fly
Trialeurodes spp.	whiteflies
Trichoplusia ni (Hübner)	cabbage looper
Udea rubigalis (Guenée)	celery leaf tier
Xyleborus sp.	borer
Xylocopa sonorina Smith	carpenter bee

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