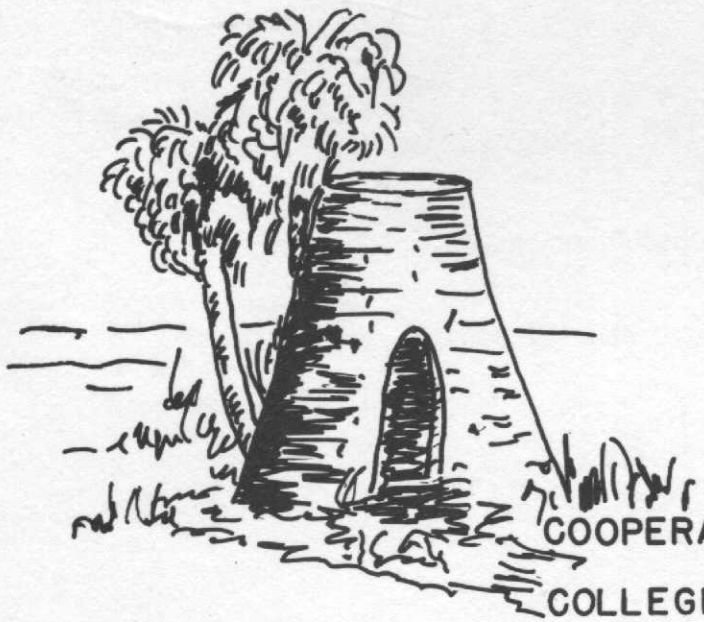
COMMERCIAL PESTICIDE APPLICATORS MANUAL :

AGRICULTURE - PLANT



COOPERATIVE EXTENSION SERVICE
COLLEGE OF THE VIRGIN ISLANDS

Developed in cooperation with the Virgin Islands Dept. of Agriculture

OCT 1982

COMMERCIAL PESTICIDES APPLICATOR MANUAL:

AGRICULTURE: PLANT

This manual was adapted for Virgin Island needs from materials furnished by the Training Branch, Operations Division, Office of Pesticide Programs, U.S. Environmental Protection Agency, Washington, D.C. It supplements the EPA/USDA publication: "APPLY PESTICIDES CORRECTLY - - A GUIDE FOR COMMERCIAL APPLICATORS." That publication should be read first.

The information herein provides a base to use in preparing for the certification examination in the category of AGRICULTURAL PLANT PEST CONTROL.

Reference to commercial products or trade names is made with the understanding no discrimination is intended and no endorsement is implied by the College of the Virgin Islands Cooperative Extension Service.

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December, 1975

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS
(Acts of May 8 and June 30, 1914)
Agricultural Extension Service, College of the Virgin Islands
and the United States Department of Agriculture, Cooperating
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TABLE OF CONTENTS

COMMERCIAL PESTICIDES APPLICATOR MANUAL:

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STANDARDS FOR CERTIFICATION

The U.S. Environmental Protection Agency has set these specific standards:

"Applicators must demonstrate practical knowledge of crops on which they may be using restricted use pesticides. The importance of such competency is amplified by the extensive areas involved, the quantities of pesticides needed, and the ultimate use of many commodities for food and feed. Practical knowledge is required concerning soil and water problems, preharvest intervals, reentry intervals, phytotoxicity, and potential for environmental contamination, non-target injury and community problems resulting from the use of restricted use pesticides in agricultural areas."

Applicators must demonstrate a practical knowledge of crops grown and the specific pests of these crops on which they may be using restricted use pesticides. You must:

- - accurately identify the pests
- - select the correct registered pesticides
- - apply the most effective, efficient and least environmentally disrupting control measures.

In order to minimize environmental problems you must recognize:

- - Soil and water problems, such as, leaching, residues, erosion, etc.
- - preharvest and reentry intervals
- - phytotoxicity and potential for environmental contamination
- - non-target injury
- - community problems, such as, nearby housing, schoolgrounds, waterways, etc. resulting from the use of restricted pesticides in agriculture.

Careless habits resulting in misuse and contamination of the environment are not only prohibited by law but may affect you, your family, your neighbors, and your Islands.

PROBLEMS WITH PESTICIDES USE

As a commercial applicator you are daily exposed to many pesticides ranging from low to high toxicity. You must consider their total effect on yourself. Your health and your business depends upon your knowledge and care in application to avoid the side effects of phytotoxicity, bee toxicity, drift damage, reentry, residues, tolerances, etc.. See Table 1 for relative hazards:

TABLE I. RELATIVE HAZARD OF SPRAY CHEMICALS TO SPRAYMEN

MOST DANGEROUS[1]	DANGEROUS	LESS DANGEROUS		LEAST DANGEROUS
carbofuran (Furadan) (C)	aldrin (CO)	naled (Dibrom) (OP)	Alar (M)	Moreston (M)
Di-Syston (OP) [2]	Carzol (C)	chlordane (CO)	aminotriazole (Amitrole) (M)	napthaleneacetic acid (NAA) (M)
methomyl (Lannate) (C)	dioxathion (Delnav) (OP)	dimethoate (Cygon) (OP)	calcium nitrate (M)	oil (M)
parathion (OP)	dieldrin (CO)	De-Fend (OP)	captan (M)	Omite (M)
Phosdrin (OP)	dinoseb (DNBP) (N)	Diazinon (OP)	dichlobenil (Casoron) (M)	Perthane (CP)
Schradan (OMPA) (OP)	endrin (CO)	ethion (OP)	copper sprays (M)	rotenone (M)
strychnine (M)	Methyl Parathion (OP)	Fundal (M)	dodine (Cyprex) (M)	carbaryl (Sevin) (C)
demeton (Systox) (OP)	nicotine (M)	Galecron (M)	dalapon (M)	simazine (M)
TEPP (OP)	paraquat (M)	Guthion (OP)	dichlone (M)	terbacil (Sinbar) (M)
thimet (Phorate) (OP)	Phosphamidon (OP)	Imidan (OP)	diuron (Karmex)(M)	sodium polysulfide (M)
Zinophos (OP)	carbophenothion (Trithion) OP)	Lead arsenate (M)	ethephon (Ethrel) (M)	Solubor (M)
	Zectran (C)	Lindane (CO)	ferbam (D)	sulfur (M)
	zinc phosphide (M)	Meta-Systox-R (OP)	Gardona (OP)	tetradifon (Tedion) (CO)
		binapacryl (Morocide) (N)	Glyodin (M)	2,4-D (CO)
		Plictran (M)	iron chelate (M)	2,4,5-T (CO)
		endosulfan (Thiodan) (CO)	Karathane (N)	2,4,5-TP (CC)
		toxaphene (CO)	Kelthane (CO)	urea (M)
		Zolone (OP)	lime-sulfur (M)	zinc sulfate (M)
			malathion (OP)	zineb (D)
			maneb (D)	ziram (D)
			methoxychlor (C))	

[1] These estimates are based on use experience as well as on observed acute dermal and oral toxicity of the compounds to experimental animals. The classification into hazard groups is both approximate and relative.

[2] The chemical class to which the pesticide belongs is designated as follows: C, carbamate; CO, chlorinated organic; D, dithiocarbamate; M, miscellaneous; N, nitro; and OP, organic phosphorus.

Your greatest hazard from pesticides is from absorption through the skin as is the case of 80% of agricultural poisoning cases. This hazard is increased by cuts, abrasions, scratches, scuffs, or other damage to the skin. However, absorption can occur even through healthy skin. Absorption is high and rapid in such sensitive areas as the:

- - scrotum
- - arm pit
- - ear canal
- - forehead
- - scalp

It is lower and slower in less sensitive areas as the

- - palm of the hand
- - ball of the foot

But even in these lower absorptive areas, penetration can be great and the rate will vary from material to material. Whether highly toxic or relatively safe, any pesticide spilled on the skin should be washed off immediately as pesticides can be absorbed within a few minutes. Waiting until a job is done before washing may be too late! Wash by rubbing the hands together or with a piece of cloth using detergent and water. Do not scrub with a brush as this may abrade the skin permitting more rapid absorption. Wear gloves when working spray machinery.

Eyes

The eyes are particularly sensitive to harm and should be protected with goggles or face shield. If a pesticide is splashed into the eye, immediately wash it with a gentle stream of clean running water while holding the eyelid open. Large amounts of water should be used and continued for 15 minutes or more. Do not use chemicals or drugs in wash water. A convenient plastic eye wash bottle and holder is now available and would be useful to carry in the field.

Lungs

Inhalation of pesticide droplets or dust is of next importance to skin contact as a cause of agricultural accidents. Vapors and extremely fine particles, 10 microns or less, are particularly hazardous because of the large absorptive surface in the lungs. Repirators should be worn as indicated on the label or under conditions you think protection is desirable. Daily use of even moderate pesticides greatly increase exposure dangers. It is also wise to wear a respirator when using moderately toxic pesticides like malathion during the same day you are using more highly toxic pesticides of the same group.

Respirators And Gas Masks

All respirators must be approved by the Mining Enforcement and Safety Administration (MESA) and the National Institute for Occupational Safety and Health (NIOSH) An approval number must appear on the box in which the respirator is packed and on the boxes in which replacement filters and cartridges are packed. These approval numbers will start with the letters "TC". Those bearing the letters "BM" should be discarded. A listing of approved respirators as of the date of this publication will be found in the Appendix. Please check for the latest information.

Reentry into Treated Fields

These standards were established

in 1974 and apply particularly to agricultural uses. You must follow these rules:

- - no unprotected person may be in the field you are treating with any pesticide.

- - no pesticide application shall be made that will expose any person to pesticides, directly or indirectly, through drift other than those involved in the application and wearing protective clothing.

- - the label restriction and directions must be followed.

Those pesticides presently restricted (you must keep aware of any changes) and requiring workers to wear protective clothing when entering treated fields within the following time periods are as follows:

24 hours

EPN	Guthion
ethion	phosalone

48 hours

Azodrin	endrin
Bidrin	ethyl parathion
carbophenothion	Meta-Systox-R
demeton	methyl parathion

It is recommended that you notify your client any time you apply one of the above materials to avoid misunderstanding, poor public relations, and possible litigation. Tell him the name of the material, time of application, and required reentry interval. If workers must enter the field prior to the expiration of the required interval, growers are obligated to notify the workers of the necessary reentry information and furnish them with protective clothing.

Fields treated with pesticides other than those listed above may be reentered without protected clothing after the spray has dried or the dust settled. New labels will indicate the necessary reentry information; old ones may not.

Days To Harvest Intervals

Don't confuse with reentry intervals. This is the time period that must pass between pesticide application and crop harvest to allow the pesticide residues in the crop to fall to the tolerance levels or below to protect the consumer. The same pesticide may have different intervals for different crops and conditions.

Hazards To Crops

The greatest hazard is usually an adverse reaction by the crop to the chemical. This "phytotoxicity" may be the result of direct application or drift on to the plant, runoff from a treated field, or from persistent soil residues. Injury to the plant may appear as poor germination, dead, burned or scorched spots on leaves, stunting, delayed development russeting or misshapen fruit, or death of the plant. Unfortunately, these signs usually do not appear until several days after application and then they may be confused with other problems. These clues will help you determine if the injury is due to chemicals:

- - location of injured plants or areas on a plant
- - nature of the injury
- - lack of signs of other causes of injury, such as, ooze or fungus
- - weather records
- - cropping history

- - location in relation to highways, industrial sites, cities, etc.

- - sharply defined injured areas
- - uniform color of injured area

The likelihood of plant injury resulting from the use of pesticides varies with the chemical, the formulation used, the concentration, method of application, growing condtions, and the stage or conditions of the plant.

- - Desicants, defoliants, and herbicides are particularly hazardous through drift to sensitive plants.
- - Organophophates, carbamates, and oils are more likely to cause injury when drying conditions are poor.
- - Chlorinated hydrocarbons are more injurious in hot, dry weather.
- - Emulsifiable concentrations are more hazardous than wettable powders because solvents may dissolve waxy protective covering on plant leaves.
- - Mixtures of pesticides are more likely to cause damage than materials applied individually.
- - Applications at high pressures may cause more damage than at lower pressures.
- - Row ends and field edges are more apt to be damaged because of maneuvering of spray rigs.
- - Growing conditions (shallow soils, wet spots, etc.) may make plants more susceptible to injury.
- - Differences in the sensitivity of varieties are not uncommon.
- - While these are all possible even following recommendations, severe injury is unlikely and is usually a sign of other problems.

Hazards to Bees

Honey and wild bees are necessary for pollination, thus potential loss of these insects must be reduced by:

- - not applying pesticides toxic to bees to crops that are in bloom
- - selecting pesticides least harmful to bees (see Table II)
- - using least harmful formulations (dusts more hazardous than sprays; ECs less residual than WPs; granular formulations have lowest hazards)
- - timing applications to reduce contact with bees (evening is better than morning but both are safer than daytime applications)
- - avoid treating near hives to reduce the possibility of drift
- - contact beekeeper before spraying and request he move his bees
- - mowing a cover crop in bloom just before treatment

Drift

Pesticides are not pollutants as long as they stay on target. Drift of pesticides from target areas is probably the most important and costly problem to commercial applicators because:

- - possible lawsuits resulting from off-target injury or unsalable crops
- - local public relations may prevent an effective program from continuing
- - loss of working time because of unfavorable conditions

Almost any application will result in some drift, but it can be minimized by:

- - working when there is little or no wind, if necessary in early morning or evening
- - when downwind crop calls for the same pesticides as the target crop
- - locating areas away from houses, streams, or similar situations
- - using good judgment to stop treatment when conditions are poor
- - selection of application equipment
- - selection of chemical and formu-

lation
- - adding adjuvants as thickeners or foaming agents to increase the particle size

In addition to actual physical drift, certain materials vaporize producing fumes which may cause damage for long distances downwind. Volatile compounds include esters of 2,4-D, 2,4,5-T and other phenoxy compounds, dinitros, and some carbamate herbicides. Spraying in the coolest part of the day decreases vaporization potential.

Contamination

Keep contamination of areas where pesticides are not wanted to a minimum by:

- - confining applications to the target area
- - considering drift, runoff, soil erosion, volatility of pesticide, persistence of pesticide, plant absorption, use of minimum dosages, etc.
- - choosing the best pesticide that will give effective control, persistent enough to do the job, and yet break down when no longer needed
- - check on grazing or feeding by livestock on treated areas
- - tying pesticides down in the back of the truck when transporting to prevent spills while carrying broom, shovel, and neutralizers (Clorox, lime, etc.) to take care of spills
- using a separate pump with check valves to prevent back siponage when filling from a well
- proper disposal of "empty" pesticide containers
- - wearing protective clothing when mixing and applying pesticides and cleaning equipment after application
- - keeping spray equipment in good repair to stop leaks and malfunctioning
- - keeping alert to the dangers and using good judgment is the best preventative of all

Specific Use Problems

Some categories of pesticides have special problems requiring your attention over and above the usual awareness.

Herbicides

The use of herbicides has grown so fast they now represent the largest single group of pesticides used in agriculture. Although as a group they are relatively not toxic to humans and wildlife, they are not without danger and some are highly toxic. Biggest problem is their phytotoxic effect on non-target plants through misapplication. This can occur as:

- - drift of spray, particles or vapor
- - soil contamination
- - excessive soil persistence
- - sprayer contamination

All must be avoided. While they produce readily seen effects, it is too late to remedy the cause by the time they are visible. The following herbicides, in particular, present a hazard to non-target plants through drift:

2,4-D	mecoprop
2,4-DB	MCPA
dicamba	MCPB
dichlorprop	paraguat
dinoseb	picloram
fenac	propanil

silvex 2,3,6-TBA
2,4,5-T

The above pesticides are also most likely to cause sprayer contamination. Decontamination is a problem as repeated flushings with water may not be a dependable method. Emulsifiable formulations are more difficult to remove than water soluble, metallic and amine salts. Attempt to decontaminate by adding 1 quart of household detergent to 25 gallons of warm water. Circulate through all parts of the sprayer. Let stand for several hours, drain, and flush with more water. Test on sensitive plants, such as, bean or tomato seedlings. Injury will usually appear in 2-7 days if the sprayer is still contaminated.

Soil persistence of herbicides is an important factor. You must consider the crops that are to follow. Soil persistence is dependent upon many factors including:

- - rate
- - formulation
- - type of application
- - soil type
- - microbial populations
- - soil temperature
- - moisture
- - tillage

In general herbicide breakdown is most rapid in warm moist soils with good microbial growth.

Growth Regulators

These pesticides are used to improve crops by stimulating more growth, flowering, fruiting or the opposite. They may upset the physiology of the flower or fruit when applied during or after bloom causing reduction in fruit and seed production. Or they may improve fruit set, prevent excessive fruit drop or control fruit maturity. Because of the sensitivity of plants to these chemicals, extra precautions must be made to insure that the right amounts are applied at the precise time. Calibration of equipment is vital. Application is usually made as a foliar spray, soil drench or bark injection.

Sprout inhibition is another form of growth regulation to prevent sprouting in storage. These should not be applied to onions intended for use as seed. Others break up dormancy of plants or parts. Fertilizers and plant nutrients are not included in this group.

Desiccants and Defoliants

Defoliant chemicals cause leaves to drop from a crop, such as, tomatoes, to make harvest easier without killing the plants. Desiccants speed up the drying of plant parts to aid in harvesting of some seed crops and nursery stock by killing the foliage. Frequently the terms are used interchangeably Their advantages include:

- - reduce disease or insect populations
- - kill weeds interfering with harvest
- - aid and simplify mechanical harvesting
- - improvement of quality
- - reduce moisture content of seed
- - reduce disease of stored crops
- - increase yields

Their disadvantages may be:

- - reduction in yield and quality
- - presence of toxic residues

Complications can result from the use of these materials due to various side effects and because treated crops cannot be generally used for grazing and many do not permit use of seed for

food, feed or oil purposes.

Soil Fumigants

The soil is the most complex medium you will treat for the control of pests. You must know the characteristics of the pesticide, the soil and the pest and their interrelationships to effectively use soil pesticides. The volatile pesticides or "fumigants" vary considerably in action and application. Dosage depends upon the concentration in the soil and the time the organism is exposed which in turn is influenced by soil conditions, such as, soil type, moisture level, etc. Recommended rates are selected to perform satisfactorily over a wide range of soil conditions. Dosage is also affected by temperature and stage of development of the organism. Soil structure and conditions also influence the effectiveness of fumigants. Aeration time (the time needed to allow the fumigant to leave the soil) is important to avoid injury to the crop. This will vary with the:

- - chemical
- - soil temperature
- - moisture
- - texture
- - crop to be planted

Non-Volatile Soil Pesticides

These vary from high to low water solubility, from non-systemic to systemic activity, and from short to long residual effectiveness. Systemics may translocate in the plant tissues. Other pesticides usually rely on movement to the organism through direct application, mixing with soil and/or water or depend upon the organism to seek it out usually in the root zone. Non-fumigant soil pesticides are usually more dependent upon soil moisture than the fumigants. Moisture is often needed to:

- - activate or release the pesticide
- - move or distribute it into or through the soil
- - aid absorption into the plants.

However, this need is quite variable as those with low water solubility, high evaporation rates, sensitivity to breakdown by sunlight, or high absorption rates on soil particles, usually require mechanical mixing into the soil regardless of rainfall or irrigation.

Combinations/Mixtures of Pesticides

The mixture of different pesticides to accomplish two or more objectives at the same time thus reducing labor costs in application is an old and widely used-method. Under present federal regulations, uses of pesticides inconsistent with (or not mentioned on) the labeling are a misuse and unlawful. The legislative history shows, however, that it was the intent of Congress that EPA be reasonable in interpreting and enforcing misuse provisions. Accordingly, EPA has set the policy until modified by further regulations that tank mixtures and serial applications are consistent with the label if:

- - the label specifies such uses,
- - there is state registration for such uses, or
- - such uses are recommended by state agencies or are common agricultural practice.

Even when pesticides are approved for use in a mixture, problems may still result. Formulations of a pesticide vary from product to product due to the different additives. Incompatibilities are expressed in many different ways, including:

- - crystalline precipitate or gela-

tinous masses are commonly formed
- - breaking the emulsion so that different ingredients separate out
- - lessened activity of the combination

Incompatability may be minimized by:

- - using formulation produced by same manufacturer
- - keeping equipment clean and well-drained
- - partially filling a tank before adding any pesticides
- - diluting concentrates before combining them
- - mixing wettable powders with water to form a slurry before they are added to the tank unless you have an inductor system
- - making certain that agitation is adequate to maintain the suspension
- - adding wettable powders to the tank before the emulsifiable concentrates.

Mixtures of Pesticides and Fertilizers

Many of the principles for using tank mixtures of pesticides also apply to fertilizer-pesticide mixtures. The most important thing to remember is that the resultant mixture is to be treated as a pesticide not a fertilizer. The total quantity of pesticide in the tank may be less than the accepted variation in fertilizer application. Timing, placement and distribution are frequently different for pesticides and fertilizers.

Serial Applications of Pesticides

These are applications in which the pesticides are applied individually but following one after another. Although the time is generally limited to a few days, it can be longer. Problems arising from incompatible serial applications may include:

- - plant injury
- - loss of effectiveness of one or both pesticides
- - excessive residues

Adjuvants or Spray Additives

Pesticides are formulated for general performance purposes under average conditions. For many jobs they perform satisfactorily but there are also many situations where they fall far short. The substances added to a spray mixture to aid or improve the performance of the main ingredient are called adjuvants. They may be added to a spray mixture to:

- - improve the wetting of the foliage or the pest
- - change the evaporation rate of the spray
- - improve the weathering ability of the spray deposit
- - improve the penetration absorption and translocation of the pesticide
- - adjust or buffer the pH of the spray solution increasing the effectiveness and longevity of the alkalaine sensitive particles
- - improve the uniformity and the amount of the deposit
- - improve the ease of mixing or compatibility of the spray mixture
- - increase the safety from spray injury to the crop
- - reduce the drift hazard to neighboring crops
- - improve physical properties of the mixture, such as, anti-foaming

agents.

Depending upon their intended use, adjuvants are called emulsifiers, wetting agents, stickers, spreaders, deposit builders, film formers, buffering agents, thickeners, penetrants, foaming agents, antifoaming agents, etc.

These are highly active materials. In most cases, a very small quantity will have great effect so use only the amount recommended. Regulations require spray adjuvants, for use with pesticides, to be exempt from the requirement of a tolerance or to have a tolerance established. Also they must be registered and carry an EPA number.

Accurate diagnosis of the pest and its damage is essential in deciding how to solve a pest problem.

IDENTIFICATION AND DIAGNOSIS

While identification of the pest and the damage it causes is essential, a knowledge of the crop and its growth characteristics is important in recognizing the damage.

INSECTS

Most insects injurious to agricultural crops have a life cycle in which either (1) the newly hatched insect looks like the adult except for size and possibly wing development and feeds in the same places or (2) the adults and young are not alike going through several different life forms generally from egg to larvae to pupa to adult with different habits for each stage. See Fig. 1.

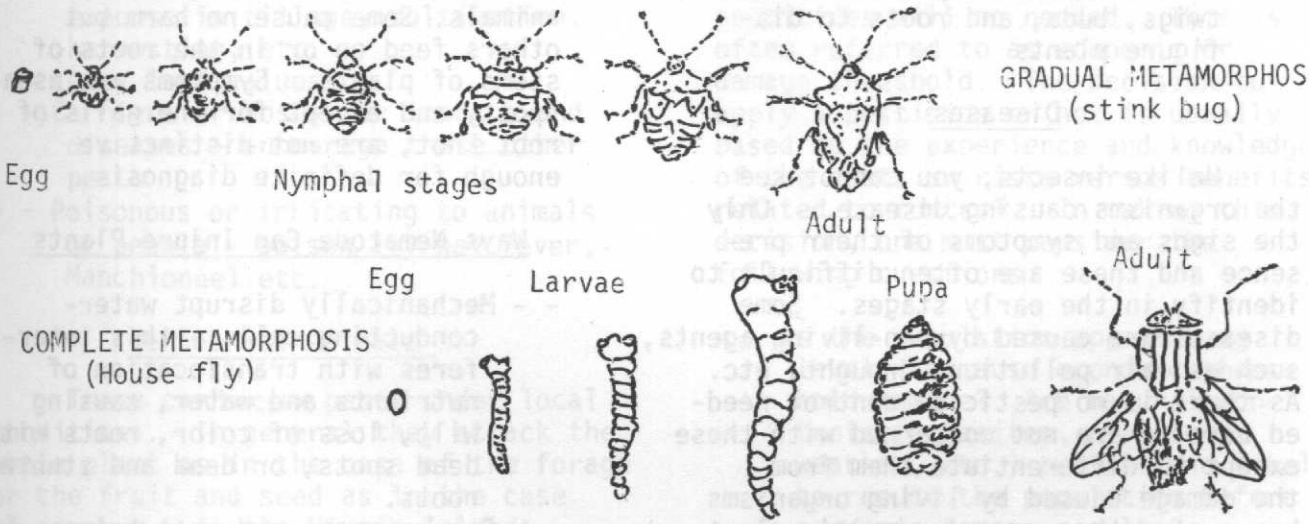

Fig. 1

Careful observation often reveals the cause. An insect may be eating plant roots but the first signs appear on the leaves. So until the roots are examined, the cause may not be correctly identified. With careful observation, knowledge of the plant's history, and a general knowledge of possible causes within the geographical area, plant ills can frequently be diagnosed. The following are some elementary aids to assist you in this diagnosis:

<u>Ways Insects Can Injure Plants</u>

- - chewing - usually leave obvious feeding wounds, such as, ragged leaves, holes in wood, wilted or dead plants, etc.
- - sucking - no obvious wounds as they suck out juices causing off-color scorch or hopper burn, wilted or misshapen foliage/fruit

- - oviposition scars- scars formed on woody part of plants or fruit caused by egg-laying
- - vectors - carry diseases on their bodies or inject them with their mouthparts while feeding from plant to plant resulting in wilt, dwarfing, off-color foliage, etc.
- - excretions - honey dew deposits secreted by some insects encourage growth of sooty mold interfering with plant functions
- - gall formation - irregular growths of scar tissue may form on leaves, twigs, buds, and roots to disfigure plants

Diseases

Unlike insects, you cannot see the organisms causing disease. Only the signs and symptoms of their presence and these are often difficult to identify in the early stages. Some diseases are caused by non-living agents, such as, air pollution, drought, etc. As there is no pesticide control needed here we are not concerned with these except to differentiate them from the damage caused by living organisms known as pathogens or parasitic plant diseases. Prevention or prevention of spread is the primary concern in disease control.

Ways Parasitic Diseases Injure Plants

- - Damage water-conducting cells- these plug the vascular system which carries food and water throughout the plant and results in wilting and dead branches.
- - Damage cells of leaves or fruit- these leave splotches or spots on the surface lowering marketability of fruit.
- - Damage roots and root hairs - these interfere with the plant's intake of nutrients and water causing wilting, yellowing, and stunting.
- - Damage to cells by overgrowths - these irregular growths occur on various parts of the plant interfering with normal growth processes.
- - Damage to flowers, fruit and seeds - rot and molds destroy the viability of these plant parts.
- - Damage or death of plant tissues from production of toxins.

Nematodes

Nematodes are small, worm-like animals. Some cause no harm but others feed on or in the roots of stems of plants. Symptoms are usually spotty and except for the galls of root knot, are not distinctive enough for definite diagnosis.

Ways Nematode Can Injure Plants

- - Mechanically disrupt water-conducting cells - this interferes with translocation of nutrients and water, causing wilt, loss of color, roots with dead spots, or dead and stunted roots.
- - Damage roots and root hairs - this interferes with absorptive capability of the plant causing the same symptoms as above.
- - Gall informations - these cause growths on the roots that may be confused with nitrogen-fixing nodules on legumes, bacterial, or fungal infections.

Weeds

Of our common pests, weeds are generally the easiest to see and recognize since a weed is a plant out of place. The effects of weeds are generally shown in reduced yields and small size or through contamination of the crop.

There are two major types of weeds:

narrowleaf and broadleaf. The narrowleaf weeds are the grasses and sedges. These are parallel veined. The broadleaf weeds include purslane, field bindweed and many others. The veins in this group are netlike.

Ways Weeds Injure Plants Or Crops

- - Reduce yields - compete for moisture, light and nutrients
- - Reduce crop quality - weed seeds, dockage, weeds in hay, etc.
- - Increase production costs - require additional labor and equipment expense in tillage, cultivation, harvesting, etc.
- - Lower land values.
- - Carriers or hosts for insects and diseases - encourage these other pests
- - Poisonous or irritating to animals or people - poison ivy hay fever, Manchioneel etc.

Vertebrate Animals

These can become pests under local conditions. In general they attack the whole plant as in the case of the forage or the fruit and seed as in the case of sorghum. In the Virgin Islands, rats and mice cause the biggest loss to stored materials. There is some loss to field crops by birds. As deer numbers are low, most damage to forage is done by domestic browsing animals not under control.

ECONOMIC CONTROLS

Economic injury levels depend on the amount of damage that can be tolerated rather than on pest population levels. In some instances the presence of even small numbers may result in too much damage, while other cases, heavy populations may not cause significant injury. Sometimes the pest is very conspicuous but may not affect crop yields or quality. The number of pests that can be tolerated varies widely even for the same species in different areas on the same crop and at different stages of crop maturity. In most agricultural situations, complete control or eradication of an insect is not practical or necessary.

When damage to quality or yield is threatened and other factor such as parasites, predators, pathogens, weather, etc. will not prevent it, pesticides will be needed. This is often referred to as economic or damage threshold. The decision to apply a pesticide or not is usually based on the experience and knowledge of the costs or risks versus benefits related to control. In making this decision, one must consider the following questions:

- - Is the population approaching levels to cause economic threshold damage? Are natural controls (parasites, predators, weather, etc.) present and likely to reduce the population before economic damage results?

- - Will costs of the pesticide and labor needed to apply it be less than the gains to be made?

- - What effect will the pesticides have on the environment and the beneficial forms including non-target species?

- - Can the crop be harvested before damage is serious?

The dollar return from control should be greater than the cost of the control. These figures change from season to season and within a season,

as the market price of the crop changes. There is no single or simple answer.

LIFE CYCLE

Thorough knowledge of the life cycle of the pest is important in making the decision as to whether or not to take control measures, and if so, when?

Most if not all pests, are most readily controlled at one particular stage in their development. The treatment for many must be applied before their damage is noticed. Most fungicides are protectants and must be on the leaves, stems, branches and/or fruit as a protective coating before the disease spore arrives. Most infection occurs under moist conditions. So, it is important to spray before the rain comes, not afterwards. Identification of the casual agent and a knowledge of the disease cycle is the key to proper application of preventative fungicides.

The procedure you follow may be influenced by the biology of the insect, disease, or weed. If the insect is held partially in check by parasites, you may use less pesticide for a lower degree of control to give the parasites a better chance of survival.

An understanding of the growth habits of weeds is also a requirement for making judgments of chemically treating with herbicides versus cultivation, rotation, or other such practices. The weed population in a given field may be controlled by ordinary cultivation or it may be one, such as, bindweed, that is sheltered within the rows and will later emerge to affect the crop.

OTHER METHODS OF CONTROL

You should not ignore supplemental cultural practices which you can suggest to your growers. One such practice is crop rotation. When a successful rotation program is followed, a pest specific to one crop will not carry over to the following crops.

Sanitation practices, such as, cleaning up cull piles and plowing down old stubble, are a definite help in eliminating off-season sources of some pests. The use of resistant varieties of food and feed crops should be encouraged to minimize the dependence on chemical controls.

Biological control is the practice of reducing the numbers of a pest by the use of natural agencies such as parasites, predators and diseases. The fundamental basis of such control is the fact that life in nature exist in a state of balance which is maintained by the competitive interaction of various forces. Cottony-Cushion scale is a serious pest of citrus and lady-bird beetle known as the vedalia is most effective in controlling the scale. The successful solution of the scale problem by the use of natural enemies has given biological methods of control great prominence. The other agricultural pests that have been brought under control by biological methods include sugarcane leaf hopper, sugar cane borer, cocoanut moth, cocoanut scale, black scale and more recently oriental fruit fly. The use of resistant varieties of food and feed crops should be encouraged to minimize the dependence on chemical controls.

Integrated pest management (the use of cultural practices, biological controls, resistant varieties, release of sterile pests, and other non-chemical methods <u>along with chemical pesticides</u>) is the direction agriculture must go in the future. Economics and

control effectiveness are going to depend on flexible approches to individual problems.

CROPS AND PESTS

It is not possible in a manual such as this to provide detailed information on all agricultural crops and pests associated with them. For more specific information and literature, you should contact the CVI Cooperative Extension Service.

On the Virgin Islands we are concerned with the following commodities:

Fruit and nut trees
Corn and sorghum
Grain legumes
Tropical root crops
Vegetables

FRUIT AND NUT CROPS

While the primary type of pesticide application equipment used in horticulture on the mainland is the air-blast sprayer, this type is not practical on the Islands. Application equipment consists solely of high (over 100 psi) or low (under 100 psi) pressure sprayers. Consequently the problem of drift and hazards to the applicator are not quite as extreme as with the air-blast sprayer. But as the material must be put up in the air these problems are still present to more of a degree than on ground crops.

Do not apply when strong winds are blowing. Be particularly careful on planting borders with other crops that may be more sensitive or have residue problems because of food or feed involvement. Avoid drifting pesticides on yourself as the applicator. Wear adequate clean protective clothing as needed. Put protective glove cuffs outside your sleeves when spraying directly upwards. Do not mix oil with highly toxic pesticides because oils evaporate slowly thus increasing the problem of drift and applicator exposure. Start your spray patterns so the applicator will be working upwind at all times.

Phytotoxicity or spray injury is also a problem needing your continuous attention. There is a great difference in response between varieties as well as between different fruits. Poor fruit finish is often the result of chemical injury. To avoid injury do not spray at temperatures of 90°F. or above and some materials. such as sulfur should not be applied above 85°F..

Avoid spraying trees in early bloom with insecticides whenever possible because of toxicity to bees and other pollinating insects. Avoid leaving puddles of spray material or contaminated water as this can be highly toxic to bees foraging for water.

If you apply any of the insecticides calling for either a 24 or 48 hour reentry period (see page 4) be sure your client knows the situation and is aware of the proper reentry intervals as well as the days to harvest limitations.

CORN AND SORGHUM

One of the most widely used pesticides is the herbicide atrazine. This is of little hazard to the applicator and is generally not considered a hazard to wildlife. However, it is persistent and may injure sensitive crops planted too soon on the same area after corn or sorghum is harvested. Read the label before planting a different crop. Be

careful not to leave puddles or permit drift to hay or pasture land. If livestock gets sick for any reason, atrazine will be suspected so your application technique must not be faulty. Atrazine plus oil is recommended in post-emergence treatments to provide a quicker kill of weeds. However, it is possible to cause severe damage to corn or sorghum if unsuitable oil or contaminated sprayers are used. Read the label.

Some of the newer carbamate insecticides used on corn are highly toxic and you should use care in their handling and application to protect yourself against toxic splashes or drift. In some areas runoff from cultivated fields is a problem. This can be reduced by leaving a sodded buffer strip between the corn or sorghum field and water. Also your client may wish to consider planting crops using safer pesticides near sensitive areas.

GRAIN LEGUMES

Runoff can be substantially decreased by keeping sod between the cultivated area and water. This, of course, is your client's responsibility, but you can suggest it to him. You can also suggest planting crops that do not require hazardous materials where runoff is a problem.

Operating your sprayer at excessive speeds will contribute to both drift and slopping of spray from the tank. If your client's fields are rough you may be able to get him to do a better job of leveling in the future. Excessive pump pressures also cause more drift because more fine droplets are formed as pressures are increased. Use the lowest pressure to still give good coverage and satisfactory control.

Bee kill is a problem. Bees are necessary pollinators as well as honey producers and should be protected. Spraying while bees are working on bloom in the fields should be avoided whenever possible. Spraying in early morning or evening will help and choosing pesticides of low residual activity (see Table II,) is desirable.

Some of the herbicides used on soybeans can result in phytotoxicity. When applied as preemergence treatments, chloramben (Amiben) may stunt soybeans if heavy rains concentrate the chemical near the seeds. Randox, Ramrod, and Lasso may cause leaf crinkling on seedlings. Other herbicides used on soybeans can cause post-emergence phytotoxicity.

Soybeans are treated with several insecticides including toxaphene which is deadly to fish in small quantities and is persistent in the bottom silt of ponds, lakes and streams. Avoid drift and runoff. Other insecticides include Lannate and methyl parathion. When using these highly toxic materials you must wear adequate protective clothing and equipment both when mixing and applying.

TROPICAL ROOT CROPS

Root crops commonly cultivated in the Virgin Islands include yam, sweet potato, cassava, and tannia. Root rot and leaf spots are most common fungus diseases. Black rot is a root disease caused by fungus, Rosellina spp.. No chemical soil treatment has so far been effective in controlling this condition. Rotation of crops and sanitation are the only control measures available.

VEGETABLES

As vegetables involve many different crops and pests, you will be working with

TABLE 2. POISONING HAZARD TO HONEY BEES OF INSECTICIDES AND MITICIDES ON BLOOMING CROPS

Use Rating	Residual Toxicity	Material
Hazardous to honey bees at any time	High, 1 day to 2 weeks	arsenicals, Azodrin, Baygon, Bidrin, carbaryl (Sevin), carbofuran (Furadan), chlorpyrifos (Dursban), Dasanit, dichlorvos (Vapona), dimethoate (Cygon), dinoseb, endothall, EPN, fention (Baytex), Guthion, heptachlor, Imidan, lindane and benzene hexachloride, malathion D, malathion ULV, Matacil, Methyl Parathion, Methyl Trithion, naled (Dibrom) D, parathion, Phosdrin, phosphamidon.
Not hazardous if applied in either evening or early morning when honey bees are not foraging, except during periods of high temperature in these times	Moderate, 3 hours to 1 day	Abate, carbophenothion (Trithion), Carzol, chlordane, demeton (Systox), dioxathion (Delnav), Di-Syston EC, endosulfan (Thiodan), endrin, ethion, heptachlor G, malathion EC, methomyl (Lannate SP), methoxychlor, Meta-Systox-R, Morocide, naled (Dibrom) EC, VC-13 Nemacide, Orthene, Perthane, phorate (Thimet) EC, G, Phostex, Phosvel, TEPP, Thanite, Torak, toxaphene, trichlorfon (Dylox), Zolone.
Not hazardous to bees at any time	Low, 1 hour to 1 day	Acaraben (chlorobenzilate), Acaralate (chloropropylate), allethrin, Baygon G, carbaryl (Sevin) G, carbofuran Furadan) G, Dasanit G, Dikar, Di-Syston G, Galecron and Fundal SP, Karathane, Kelthane, lime-sulfur, malathion G, Morestan, oil sprays (Superior), propargite (Omite), Pentac, Plictran, pyrethrum, rotenone, sulfur, Temik G, tetradifon (Tedion). Most herbicides and fungicides.

Abbreviations: EC - emulsifiable concentrate; D - dust; ULV - ultra low volume; WP - wettable powder; G - granular; SP - soluble powder

a variety of pesticides, several of which are highly toxic. Adequate clean protective clothing and equipment is necessary. High pressure equipment makes fine drift and increases your problem as does the use of dusts. As you turn the end of the row you frequently move back through the drift so protect yourself accordingly.

Many vegetable fields border sensitive areas - backyards with vegetable gardens, ornamentals, children and toys, pastures, other crops, barnyards, roads, etc.. Be sure not to drift hazardous pesticides onto them. Use equipment that is less likely to cause drift in sensitive situations or adjust it to minimize drift by lower pressures, larger droplets, etc.. You must be careful not to drift registered pesticides from one crop onto another for which it may not be registered. Similarly, the herbicide you use safely and legally on one vegetable crop may be deadly to a nearby vegetable. Check to be sure the crop following can be planted with no risk of damage from herbicide contaminated soil.

While it is the grower's responsibility to notify his workers, make him aware of the use of any pesticide having the special reentry period of 24 to 48 hours (see page 4). Be sure your client is familiar with the days to harvest limitations.

PESTS

It cannot be repeated too often that effective pest control is based on accurate recognition of the pest causing the damage so that the applicator can determine the most effective and selective means of controlling the damage. The following is a brief summary of nematode, insect and disease pests found in the Virgin Islands.

Nematodes

Nematodes are microscopic round worms that require special diagnostic examination to determine the species present. Symptoms of their injury are stunted or sickly-looking plants with no visible aboveground damage. The roots may show numerous knots or galls or may be distinctly enlarged or swollen.

Nearly all common vegetable crops are susceptible to nematodes and they may become a production problem in gardens planted in the same place each year, particularly on light, sandy soil. Problems can be extreme in soils low in organic matter, soil nutrients and moisture.

The most practical control measure is rotating crops with non-susceptible crops or converting to other uses for a year or two. However, grass rotations are needed to suppress weed growth as the latter are excellent alternate hosts to the nematodes. Turning over the soil several times at monthly intervals during the dry season will aid in reducing nematode populations. If they become excessively damaging, it may be necessary to treat the soil with a chemical nematicide before planting.

Diseases

A discussion of common, diseases will be found on pages 20-24.

Insects

A discussion of injurious insects will be found on pages 25-29.

DISEASES OF PLANTS IN THE VIRGIN ISLANDS - 1

Name of Disease	Plants Attacked: Types	Plants Attacked: Parts	Injury Diagnosis	Control Measures
Anthracnose	Banana Cucurbits Legumes Mango Papaya Tomatoes	Fruits Stems Leaves	Round sunken spots with pinkish-tan centers that later darken into elongated tan spots on stems. Whitish spots on onion leaves.	Chemical: Spray with fungicides Cultural: Rotate crops every 3 years; plant clean seed
Black leg	Cole crops	Stems Leaves	Grayish spots speckled with tiny black dots on stems near ground; stem girdling; wilted foliage	Chemical: Treat seeds with fungicides. Cultural: Rotate crops; plant resistant varieties.
Black rot (bacterial)	Cole crops Sweetpotato	Leaves	Black leaf veins; black ring near outside edge on crosscut stem.	Cultural: Rotate crops; plant resistant varieties.
Black rot (fungal)	Sweetpotato	Roots Tubers	Round black sunken spots on tubers; black cancers on underground parts of stems.	Cultural: Destroy diseased plants; rotate crops; plant clean seed pieces.
Black scurf (sooty mold)	Citrus	Leaves	Dark Velvety growth that interferes with photosynthesis thus weakening plant.	Chemical: Control of insects whose honeydew secretions encourage the mold.
Blight. Early	Celery Eggplants Tomatoes	Leaves Stalks Fruits	Small, circular yellow-brown spots becoming larger and grayer as they spread. Cankers sometimes girdle stems. Dark leathery spots on fruit stem end.	Chemical: Apply fungicide every 7-10 days.

DISEASES OF PLANTS IN THE VIRGIN ISLANDS - 2

Name of Disease	Plants Attacked: Types	Plants Attacked: Parts	Injury Diagnosis	Control Measures
Blight, Late	Celery Tomatoes Eggplants	Leaves Stems Fruits	Gray, water soaked spots at leaf margins. Hard, corky brown rot below surface of fruit.	Chemical: Apply fungicide every 7-10 days, midseason to harvest.
Blossom end rot	Tomatoes Watermelons	Fruits	Large, dark, sunken corky spots at blossom end. Prevalent where soil dried rapidly while plants were making vigorous growth.	Cultural: Physiological disorder. Provide calcium, especially during drought.
Damping-off	Many plants particularly those raised from slips.	Seeds Seedlings	Seed decayed; blackening of roots and stem at ground; water-soaked constriction of stem at ground line.	Chemical: Treatment of seed bed with fungicides or heat.
Fruit rot	Eggplants Peppers Tomatoes	Stems Leaves Fruits	Brown sunken stems at soil line; brown or gray leaf spots; large, ringed circular brownish spots on fruit.	Cultural: Plant resistant varieties.
Fusarium wilt	Eggplants Okra Pepper Tomatoes	Leaves Stems	Yellowing and wilting of foliage beginning with lower leaves; browning of woody tissue under green part of stem.	Cultural: Rotate crops but do not use other crops that are susceptible. Plant resistant varieties.
Internal cork	Sweetpotato	Tubers	Tough, corky tubers.	Cultural: Plant cork-free seed stock.

DISEASES OF PLANTS IN THE VIRGIN ISLANDS - 3

Name of Disease	Plants Attacked: Types	Plants Attacked: Parts	Injury Diagnosis	Control Measures
Leaf spot (bacterial)	Many plants	Leaves Stems Fruits	Variable leaf spotting with brown to yellow circular spots that spread. Found on older leaf margins and progress inward.	Chemical: Spray with fungicides. Cultural: Crop rotation; resistant varieties; good drainage; and clean seed.
Leaf spot (fungal)	Celery Many plants	Leaves	Spots vary from small to large, circular to irregular, light tan with darker borders but can also be black, gray, or brown. Followed by drying and defoliation. Difficult to tell from bacterial leaf spot.	Chemical: Spray with fungicides. Cultural: plant resistant varieties; crop rotation with unrelated plants.
Mildew, Downy	Cabbage Cucurbits Many plants	Leaves Roots	High humidity-temperature conditions. Underleaf surfaces have white to purple-black mold. Upper leaf surfaces turn yellow and curl. Brown, necrotic areas on roots.	Chemical: Treat with fungicides as soon as symptoms appear as it spreads rapidly.
Mildew, Powdery	Many plants	Leaves Stems	White powdery growth on upper leaf surfaces. Later infected areas become brown and dry. Appears in dry seasons.	Chemical: Spray with fungicides.
Mosiac	Many plants	Leaves Stems Fruits	Mottling of leaf surfaces; distorting of leaves; stems streaked or necrotic. Fruits develop knobby spots, loss of color, and spotting.	Chemical: Control of nearby weed reservoirs and insect vectors. Cultural: Resistant-varieties.

DISEASES OF PLANTS IN THE VIRGIN ISLANDS - 4

Name of Disease	Plants Attacked: Types	Plants Attacked: Parts	Injury Diagnosis	Control Measures
Panama Disease	Banana	Leaves Stems	Reddish discoloration and streaking in leaves, resulting in wilting and yellow discoloration starting at tips and along margins.	Cultural: Plant Resistant varieties.
Purple blotch	Onions	Leaves	Large purple spots intermixed with white spots on leaves.	Chemical: Spray with fungicides.
Rhizoctonia canker	Eggplants Tomatoes	Leaves Stems Fruits Roots	Hardy, shiny black bodies on roots; white water-soaked spots on fruits; brown cankers on sprouts and stolons; sprouts dying or developing numerous off-shoots. Lower leaves drooping but not dripping.	Cultural: Plant disease-free pieces in clean soil.
Root rot (bacterial)	Avocado Carrots	Roots	Decayed or soft roots.	Cultural: Good drainage, release plants; rotate crops.
Root rot (fungal)	Legumes	Roots Stems	Decayed roots and plant base.	Chemical: Treat seeds with fungicides. Cultural: Plow cover crops under 8 weeks before planting.
Rust	Legumes	Above	Rust pustules on all parts, but most common on underleaf surfaces. Dirty white when young, but reddish brown with age. Eventually kills foliage.	Chemical: Use of fungicides. Cultural: Rust resistant varieties.

Name of Disease	Plants Attacked: Types	Plants Attacked: Parts	Injury Diagnosis	Control Measures
Scab	Avocados Citrus Cucurbits	Leaves Stems Fruits	Sunken brown spots disfigure stem, twist leaves, discolor fruit. Gummy ooze exudes from spots.	Chemical: Spray with fungicides. Cultural: Destroy diseased fruit; rotate every 3 years.
Soft rot	Onions	Bulbs	Rotting of bulbs.	Cultural: Harvest bulbs promptly and store in dry, airy place. Plant resistant varieties.
Smut	Corn Sorghum	Stalks Ears	Large irregular galls that release black spores.	Cultural: Remove and destroy galls. Rotate crop.
Wilt (bacterial)	Corn Eggplants Peppers Tomatoes	Leaves	Stunted, wilted plants; yellow substance oozes from cut parts.	Cultural: Rotate crop; plant resistant varieties.
Wilt (fungal)	Cole crops	Leaves	Yellowish-green leaves starting on one side of plant, followed by leaf drop.	Cultural: Plant resistant varieties.
Wilt (virus)	Carrots	Leaves Roots	Yellow-green leaves in center spreading to roots or on side of plant followed by leaf drop.	Chemical: Control leafhopper Cultural: Plant resistant Varieties.

INSECT PESTS OF PLANTS IN THE VIRGIN ISLANDS - 1

Name of Insect	Plants Attacked: Types	Plants Attacked: Parts	Pest Recognition	Injury Diagnosis
Aphids	Beans Cole crops Cucurbits Papaya Sorghum Most plants	Leaves	Tiny, slow-moving, soft-bodied insects found densely congested on curled leaves.	Plant vitality weakened. Molds form on honeydew.
Armyworms	Beans Corn Sorghum Most vegetables	Leaves	Black to greenish caterpillars with light stripes up to 40mm long.	Holes eaten in leaves or entire leaves eaten.
Bean leaf beetles	Beans	Leaves	Larvae are oval, green to yellow, six-spined caterpillars. Adults are green, yellow or red beetles with black markings.	Regular-shaped holes eaten in leaves. Skeletonize undersurface.
Cabbage looper	Cole crops Soybeans	Leaves	Pale-green caterpillars with white stripe down both sides. Up to 40mm long. Crawls with a looping motion.	Ragged holes eaten in leaves.
Corn earworm	Beans Corn Cowpeas Okra Tomatoes	Pods Fruits	Light green to nearly black caterpillars with light and dark stripes. Red brown head.	Caterpillars bore into pods, fruits and stems. Eat kernels of corn down to cob particularly near tip. Brown, moist castings.

INSECT PESTS OF PLANTS IN THE VIRGIN ISLANDS - 2

Name of Insect	Plants Attacked: Types	Plants Attacked: Parts	Pest Recognition	Injury Diagnosis
Cornstalk borer Lesser	Corn Sorghum	Young plants	Small, greenish, soil inhabiting caterpillars.	Young plants tunneled and killed
Crickets, Field	Beans Cucurbits Tomatoes, etc.	Seedlings Fruit Pods	Short, dark-brown, jumping insects. Nocturnal.	Seedlings and fruit eaten.
Crickets, Mole	Cole crops Onions Peppers	Seedlings	Dark-brown, burrowing insects.	Seedlings uprooted by burrowing activities.
Cutworms	Cole crops Cucurbits Okra Many plants	Leaves Stems Roots	Medium sized (up to 50mm) caterpillars. Color varies with species.	Leaves or small plants cut off near ground by soil-inhabiting caterpillars. Leaves ragged. Stands spotty.
Diamondback moth	Cole crops	Leaves Buds	Small, green caterpillar. Small moth lays yellow eggs.	Small holes eaten in underside of leaves and buds.
Flea beetles	Beans Cole crops Cucurbits Tomatoes Many plants	Leaves Roots	Tiny, metallic hopping beetles. Slender, whitish worms up to 8mm long.	Small round holes eaten in foliage by adults. Larvae tunnel in roots and eat small rootlets.
Fruit fly	Mango	Fruit	White maggots, pointed at anterior end. 10mm long. Small fly with two white bands on yellowish abdomen.	Eggs and larvae in fruit pulp.

INSECT PESTS OF PLANTS IN THE VIRGIN ISLANDS - 3

Name of Insect	Plants Attacked: Types	Plants Attacked: Parts	Pest Recognition	Injury Diagnosis
Grasshoppers	Beans Cucurbits Tomatoes	Leaves	Gray to green, large, hopping insects.	Leaf feeding.
Hornworms	Peppers Tomatoes	Leaves Fruit	Large caterpillar, green to brown. Horn-like projection on posterior.	Large caterpillar feeding on leaves or fruit.
Leafhoppers	Beans Carrots Lettuce Okra	Leaves Stems	Small (3mm) wedge-shaped, hopping insects	Leaves yellowed or bronzed then wilting especially at tips. May transmit diseases also.
Leaf miners	Beans Cowpeas Cucurbits Okra Tomatoes Many plants	Leaves	Tiny worm burrowing between leaf surfaces.	Foliage tunneled by tiny maggots leaving lace-like appearance.
Lima bean pod borer	Beans	Pods	Small, pink caterpillars.	Bores into bean pods.
Melonworm	Cucurbits	Leaves	Pale-green, white-striped caterpillar.	Worms feeding on underside of leaves.
Midges	Sorghum Other grasses	Seeds	Pink to orange larvae. Adults are orange fragile, gnat-like insects.	Eggs deposited during pollination and larvae develop in seeds.

INSECT PESTS OF PLANTS IN THE VIRGIN ISLANDS - 4

Name of Insect	Plants Attacked: Types	Plants Attacked: Parts	Pest Recognition	Injury Diagnosis
Millipedes	Tomatoes	Seedlings Fruits	Hardshelled, many-legged worm-like	Cut off young shoots; chew tender plant parts
Mites, Spider	Beans Corn Eggplant Lettuce Tomatoes	Leaves Fruit	Microscopic, 8-legged, spider-like insects.	Leaves webbed and discolored by bronzing. Calyx ends of fruit are most susceptible to attack.
Scale	Many plants	Leaves Stems Fruits	1) protective coat of wax like a blister (armored scale) 2) no coat of wax and move about more (soft scale) 3) white, cottony appearance (mealybugs)	Distinctive clusters of these types of insects. Give off honeydew secretions which attact sooty mold.
Stink bugs	Cucurbits Okra Tomatoes, etc.	Leaves	Green or brown, shield-shaped sucking insects about 13mm long.	Wilting of leaves or buds
Slugs and snails	Lettuce	Leaves	Legless, shelled or shelless slimy animals.	Slimy tracks on vegetation. Very large holes or complete leaves eaten.
Striped cucumber beetle	Cucurbits	Stems Leaves	Black-yellow striped beetles.	Feed on leaves and tender shoots. Carry wilt and mosaic diseases.

INSECT PESTS OF PLANTS IN THE VIRGIN ISLANDS - 5

Name of Insects	Plants Attacked: Types	Plants Attacked: Parts	Pest Recognition	Injury Diagnosis
Thrips	Beans Lettuce Okra Onions Peppers	Leaves	Tiny, elongated insects, 1-3mm long. Wingless or 4 narrow, hairy wings.	White, silvery blotches on leaves
Webworms	Cole crops Cucurbits Sorghum Many plants	Leaves Heads	Spotted, coarsely-haired caterpillars, 6-18mm long. Silk-lined tunnels	Leaves webbed together and eaten.
Weevils	Beans Corn Peppers Spinach	Pods Fruit Buds Leaves	White or yellow fat grubs. Adult beetles have prominent snouts.	Bore into pods. Feed on foliage, buds or fruit.
White grubs	Sweetpotato	Roots	Cream to pink, robust, U-shaped grubs.	Large grubs feeding on roots.
Wireworms	Corn Lettuce	Roots Bulbs	Hard, shiny larvae.	Roots and bulbs tunneled by larvae.

PESTICIDE APPLICATION EQUIPMENT

The equipment used in applying agricultural pesticides varies with the crop, the type of application, the pest to be controlled, and the formulation used. There are several types - - granule spreaders, boom sprayers, soil fumigation machinery, dust pumps, etc. - - but they all have one requirement in common. They must apply the right amount of pesticide equally over the target area at the recommended rate.

Too little, uneven, or too much deposit are all inefficient uses of material resulting in insufficient control, spotty control, or excessive residue, respectively. Proper adjustment and calibration of the sprayer prevents needless waste of pesticides.

The total deposit laid down on a crop depends on:

- - the concentration of pesticide in the tank
- - the rate of discharge through the nozzles
- - the speed at which the sprayer travels

All of these factors must be controlled if the correct amount is to be applied.

BOOM SPRAYERS

Your core manual tells you about low pressure and high pressure field sprayers. While they differ somewhat in performance characteristics, both are used as agricultural boom sprayers. The methods of calibration apply to both types as well as boomless sprayers which have a central nozzle or nozzles that produce a wide swath similar to the others.

There are four variables that you can adjust to govern the amount of spray delivered by boom sprayers:

- - nozzle spacing on the boom
- - nozzle tip orifice size
- - pressure
- - ground speed of sprayer

Routine checks should be made to be sure the nozzles are not badly worn, have uniform output and spray pattern, and equal fan angle.

GRANULAR APPLICATORS

Granular pesticides must be applied with precision. Application of less than 90% of the rate may result in ineffective control. Applications greater than recommended are costly and may injure the crop. The amount of the granules applied depends on the size of the metered opening, speed of travel, field roughness, and the flow rate of the granules. Granules flow at different rates, depending upon size, density and type of granule, temperature and humidity. Therefore, it is necessary to recalibrate for each different formulation.

SOIL FUMIGATION APPLICATORS

Some of the principle methods used for soil treatment are:

1. Injection system (fumigants and other liquid soil pesticides)
   a. Chisel cultivators, blades, or shanks with non-volatiles.
   b. Sweep-type cultivator shovels
   c. Planter shoe
   d. Plow

e. Transplant water

2. Surface treatment soil incorporation. Use mostly for low and non-volatile materials. Mixing is usually shallow, 5 inches or less. The simplest method is to spray soil, turn it in with disks and compact with a drag, float, or culti-Packer. Rotary hoes or weeders are also used.

3. Drenching and flooding. Usually used prior to planting. May also be applied by irrigation water.

In all calibration measurements the pesticide amounts applied should be within 5 percent of the recommended dosages or you must recalibrate until they are.

APPENDIX: Suggested References

Maxwell, Lewis S.
1974. Florida Insects. Their Habits and Control. 119p Maxwell Publ. Co., Tampa, Florida

Metcalf, C.L. and W. P. Flint
1962. Destructive and Useful Insects. 1087p McGraw-Hill Book Co. New York

Naylor, A. G.
1974. Diseases of Plants in Jamaica. 129p Ministry of Agriculture, Kingston, Jamaica.

Winters, Harold F. & George W. Miskimen
1967. Vegetable Gardening in the Caribbean Area. 114p U.S. Dept. of Agriculture, Agricultural Handbook No. 323