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Controlling Biting Insects – Mosquitoes, Black Flies, No-See-Ums, Punkies, Sand Flies,
Horse Flies, Deer Flies

Michigan State University

Cooperative Extension Service

Home and Family Series

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CONTROLLING BITING INSECTS



MOSQUITOES
BLACK FLIES
NO-SEE-UMS
PUNKIES
SAND FLIES
HORSE FLIES
DEER FLIES

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MOSQUITOES

SINCE some 140 species of mosquitoes occur over a wide variety of North American water habitats, very few places are free of these insects. Only the females feed—on the blood of all warm-blooded animals. Many species are carriers of human diseases, but such diseases, including malaria and yellow-fever, are rare in Michigan.

All Michigan mosquitoes spend their lives in water as larvae (wigglers, wrigglers). Hence, water is required for their development. Adults have wings and do not live in water. Mosquitoes pass the winter either as eggs, wigglers, or adults. Over-wintering adults hide in washrooms, cellars, out-buildings, hollow trees, and other sheltered places. Wigglers remain frozen or in a dormant condition on the bottom of streams, ponds, and lakes. Eggs are laid in the fall singly or in rafts on the water surface of quiet ponds or on fairly dry soil. Some eggs may hatch in the fall, but most hatch the following spring or summer. Eggs laid on dry soil must have moisture (usually in the form of rain) to hatch.

For successful control, something should be known about adult mosquito habits, life cycles, breeding habits, and hibernating places. The life habits of the three most prevalent mosquitoes in Michigan are given as examples:

1. The common malarial mosquito (*Anopheles quadrimaculatus*) has four dark spots on its wings. Wigglers, or larvae, are found almost entirely in still,

clean water. They do not like bright sunlight or dark shade, preferring some sunlight but living mostly in light shadows. An ideal breeding place is a recently impounded body of water with some underbrush and a few trees to produce the necessary shading of the water surface.

2. The northern house mosquito (*Culex pipens*) has no spots on the wings. It is light brown with whitish bands across its barrel-shaped abdomen. When feeding, its body remains parallel with the surface upon which it is standing. This mosquito breeds in still, stagnant water such as that in tin cans, cisterns, cess-pool drains, plugged eavetroughs, rain barrels, tubs, flat roofs, hollow stumps, sewer ditches, sluggish drains, and roadside pits. The northern house mosquito breeds continuously throughout the summer.

3. The woodland-pool mosquito breeds in woodland pools, although it may choose less-shaded places.

USING THIS BULLETIN

This bulletin has a dual purpose: (1) To give instructions for controlling mosquitoes and other biting dipterous insects by individual property owners and in large-scale operations; and (2) To suggest insecticides that have little or no danger to wildlife, and a minimal chance of contaminating milk and food-stuffs. See further notes on insecticides, p. 2; storage and container disposal, p. 3; and chlorinated hydrocarbons, p. 7.

It overwinters as an egg and hatches as early as February. The wiggler escapes freezing by burying in the mud. Egg hatching continues into May. This species has a large spring brood, but becomes less annoying as the summer progresses.

The adult mosquito is about one-fourth inch long. It does not have black spots on its wings. Its back is black and the thorax brown without bands. The last segment of the legs is white, while the next few segments are white at each end and dark in the middle. It is not a strong flyer. The woodland pool mosquitoes were of little importance in Michigan until homes were built in suburban areas near the breeding places.

CONTROL MEASURES

Mosquito control involves four main approaches:

1. Individual Properties:

This program is made up of four parts: (a) Eliminating standing water. These areas involve stagnant pools, swamps, rain gutters, flat roofs, bird baths and other containers for pets, holes in trees, auto tires, and other similar situations where stagnant water can be held for periods of time. (b) Keeping tightly covered all cisterns, rain barrels, tubs, cesspools, septic tanks, and other somewhat permanent containers of water. (c) Mowing the lawn once a week, destroying weeds; this keeps adult mosquitoes from using the lawn and weed areas as a hiding place. (d) Insecticide treating of shrubs, flowers, trees, and other areas where adult female mosquitoes hide and rest.

2. Community Programs:

Mosquito control on a community basis implies a

Modern insecticides divide into three main groups for mosquito control: (1) **Chlorinated hydrocarbons** such as DDT, aldrin, dieldrin, chlordane, methoxychlor, and others. (2) **Phosphates** such as parathion, malathion, Guthion, naled, and others. (3) **Botanicals** such as rotenone and pyrethrum.

As a group, the **chlorinated hydrocarbons** present more difficulties in use, primarily because of their adverse effect upon wildlife and the chance of residue concentrations in food, IF THEY ARE USED IMPROPERLY. **Phosphates** are safer around wildlife and foods, IF USED STRICTLY ACCORDING TO DIRECTIONS. However, some are dangerous to the person who applies them. This literature indicates those which are dangerous to use. The **botanicals** are quite safe to use, except possibly for those with asthma.

program over the total area. It attempts the elimination of the water-breeding areas (mainly by draining), control of larvae, chemical treating of sewer traps (as an example of what needs to be done), and the control of adult mosquitoes. Individual property owners can help community mosquito control by eliminating their own mosquito breeding areas.

3. Airplane Control of Mosquitoes:

This mosquito control method employs primarily an insecticide applied from the air over a wide area, usually at a carefully selected time. The program is for the most part a function of city government. Careful drainage of standing water can be a real help to airplane control of mosquitoes.

4. When needed, a combination of these methods may be beneficial to the whole mosquito control program.

The community or wide-area approach generally gives the best control. Treating an individual property may give poor results, especially when breeding areas are nearby, or adult mosquitoes are carried into the area on prevailing winds.

Wiggler Control

Mosquitoes are controlled either as adults or wigglers (larvae), or both. The following information for mosquito control contains instructions for treating large areas on an acre basis, or smaller areas usually in terms of 1,000 square feet.

WIGGLER CONTROL

Insecticide	Amount per Acre of Standing Water
Malathion, 57 percent Emulsifiable concentrate	1 pint to 3 gallons of water*. ($\frac{1}{2}$ fluid ounce in $\frac{1}{2}$ pint of water per 1,000 square feet.)
Pyrethrum, 0.007 percent Oil solution	20 gallons of the formulation. ($\frac{1}{2}$ gallon per 1,000 square feet.)
Fenthion (Baytex), 46 percent Spray concentrate	1 $\frac{1}{2}$ fluid ounces to 1 $\frac{1}{2}$ gallons of water or fuel oil* ($\frac{1}{4}$ pint of the above mixture per 1,000 square feet.) Apply a light, uniform spray to the surface of the water. Repeat as needed.
Abate, 43 percent Emulsifiable concentrate	$\frac{1}{2}$ to 1 $\frac{1}{2}$ fluid ounces to 3 gallons of water. (use $\frac{1}{4}$ pint of the above mixture to 1000 square feet.)
Oil (kerosene, fuel oil, or diesel oil)	115 gallons. (2 $\frac{3}{4}$ pints per 1,000 square feet.)

*If good coverage depends on increasing or decreasing the amount of water or fuel oil used, do so. DO NOT, HOWEVER, ALTER THE AMOUNT OF INSECTICIDE APPLIED.

†If the area to be treated is partially covered with plants, double the dosage. When water is heavily covered with plants, oil is usually not effective for mosquito larvae.

Apply a light, uniform spray to the surface of the water, using a compressed-air sprayer or other suitable larger equipment. Repeat as needed. The efficiency of the treatment depends on its timeliness. Hence, treat only when wigglers are present. Mosquito larvae live near the water surface, projecting a tube out of the water to breathe air. Consequently, they can be killed by a thin film of insecticide entering or sealing the tube.

Warnings

1. Do not exceed the dosage of pyrethrum, or fish kill may result. Use the other insecticides with care where fish and wildlife may be endangered.
2. Apply larvicide only to water areas. Avoid treating vegetation or drifting any material where cattle graze, or on the forage of cattle.
3. Fenthion should be used by trained operators only.
4. Always read the label for additional precautions.

Adult Mosquito Control

During the day, mosquitoes hide in tall grass, shrubbery, trees, and other shady places. They move in the morning, on cloudy days, and in evenings to areas visited by people. Hence, keep your lawns mowed, grass and weeds cut, shrubbery properly pruned, and low hanging branches on trees trimmed.

Winds blow mosquitoes into cities and towns from outside areas. While prevailing winds may be most important, shifting winds from other directions could be responsible for considerable adult mosquito deposition. A study of wind direction is necessary for a complete adult mosquito control program.

Storage and Container Disposal

Store all pesticide chemicals away from the reach of children (preferably locked up). A separate storage area (well marked with an appropriate sign) away from the home, barn, or tool shed is recommended. This protects firemen and other individuals in case of fire, for pesticide chemicals can create a smoke-fume hazard.

Carefully dispose of empty containers. The label for each pesticide can be a source of directions for proper and safe disposal of pesticide chemicals. Your county agricultural agent also has literature concerning this problem. For still further information, get United States Department of Agriculture's publication entitled "Safe Disposal of Empty Pesticides Containers and Surplus Pesticides."

Culex mosquito

Female



Chemical control of adult mosquitoes is better accomplished over a large area. The larger the treated area, the greater will be the control of adults within this area. Following are materials and methods for adult mosquitoes:

Sprays

These treatments may be considered residual in nature. That is, they should last for a considerable length of time. But weather conditions including rain and high temperatures may alter how long they last. Whatever their fault, sprays offer the best means of controlling mosquitoes on individual properties.

Apply the spray to shrubs, flowers, trees, outbuildings, door steps, porches, and other places where the adults find hiding places. If the lawn is kept cut, mosquitoes normally do not hide here and present no special problem. Tall grass and weeds harbor the adults and should be eliminated, kept cut, or sprayed. Suggested insecticides for sprays are:

SPRAYS FOR ADULT MOSQUITOES

Material	Amount of Insecticide per Acre
Malathion, 57 percent Emulsifiable concentrate	3 pints to 100 gallons of water. (1½ fluid ounces to 2½ gallons of water per 1,000 square feet.)
Malathion, 57 percent Emulsifiable concentrate plus	1½ pints malathion plus 1½ pints methoxychlor to 100 gallons of water.
Methoxychlor, 25 percent Emulsifiable concentrate	¾ fluid ounce methoxychlor to 2½ gallons of water per 1,000 square feet.)
Fenthion (Baytex), 46 percent Spray concentrate	2 pints to 100 gallons of water. (1 fluid ounce to 3 gallons of water per 1,000 square feet.)

SPECIAL WARNINGS

ABOUT FENTHION:

FOR USE BY PEST CONTROL OPERATORS AND COMMERCIAL NURSERYMEN ONLY.

1. Avoid excessive wetting of plants.
2. Avoid treating plants in direct sunlight or when temperatures are above 90° F.
3. Because of possible plant injury, do not apply to hawthorn, sugar maple, American linden, or the rose variety, Delight.
4. Spray when air is still to avoid drift onto food crops and forage for livestock.
5. If a wettable powder is available, use it instead of a spray concentrate.

Compressed air and other small type equipment can be used to apply spray treatments. See instructions for mixing 2½ gallons of insecticide and water. Apply a uniform spray to plants and other areas treated, but avoid runoff and heavy treating of tender buds of plants, especially with malathion. Repeat as needed. The efficiency of this treatment depends on thorough coverage with sufficient insecticide and water to give as much lasting residue as possible.

Warnings

1. Although malathion and methoxychlor (malathion, especially) produce small effects on birds and land animals, use them carefully where wildlife may be endangered by excessive treating.

2. Because methoxychlor is quite poisonous to fish, its use should be avoided where fish can be injured.

3. Avoid treating vegetation where cattle graze. For treating forage crops, get other instructions.

4. Always read the label for additional precautions. Protect your children by keeping them out of spray drift and away from concentrated formulations.

Fogs

This method of treatment uses heat to burn the oil and produce a smoke-type fog which does not destroy the insecticide.

FOGS FOR ADULT MOSQUITOES

Insecticide	How to Make the Finished Fog Solution*
Malathion, 50 percent Oil concentrate plus Thioprase, plus Fuel oil	5-1/5 gallons 1 pint 95 gallons
Note: 90 percent malathion can be used without Thioprase, providing No. 2 fuel oil is used as the carrier.	
DDE, 0.5 percent fuel oil solution	Buy DDE fuel oil solution already mixed. DDE is not especially damaging to birds and other wildlife as a fog. Do not use it for any other type of treatment.

Dichlorvos (Vapona), 90 percent concentrated solution.

1 pint to 16 gallons of fuel oil (diesel oil).
Warning: Only trained personnel should apply or direct the use of dichlorvos. Do not use it or drift it onto food or feed crops.

Fenthion (Baytex), 46 percent Spray concentrate.

3 pints to 25 gallons of kerosene, fuel oil, or diesel oil. This amount is 6 fluid ounces of formulation in 3 gallons of kerosene-type oil.
Warning: Only mosquito abatement districts, public health officials, and other responsible personnel should apply or direct the use of fenthion.

At this speed and with a 350-foot swath, 1/5 gallon of any one of the mixtures is applied per acre, giving an average dosage rate. If a 200-foot swath is treated at the given speed and dosage rate, ½ gallon of one of the mixtures is used per acre, which is a very satisfactory dosage rate. Thermal fogs do not build up appreciable residues. Hence, the least amount of material that gives immediate satisfactory results is the correct dosage.

Note: When a machine is calibrated to deliver 40 gallons of liquid per hour at 5 miles per hour speed, it applies the same amount of any spray mixture. That is, 40 gallons are applied while traveling 5 miles (26,400 feet). The dosage rate in gallons per acre will differ according to the depth of the spray swath. That is, distance traveled in feet times depth of spray swath in feet divided by 43,560 square feet in an acre equals acres treated. Divide the acres treated into the gallons of spray mixture applied per hour to get how much treatment is being applied per acre.

Warnings

1. Children and others should not play in the fog drift.

2. Driving cars through the fog can be dangerous.

3. Spitting of car finish can occur if prolonged exposure is allowed. If accidents occur, wash cars immediately.

4. Always read the label for additional precautions.

Mist Application

This method is similar to a spray treatment, but with a mist treatment the spray mixture is more concentrated and less gallons of water are used per acre. Mist blowers are used to apply mist sprays. Hydraulic sprayers are used for residual (longer-lasting) sprays.

MIST SPRAYS FOR ADULT MOSQUITOES

Insecticide	Amount of Insecticide per Acre*
Malathion, 57 percent Emulsifiable concentrate	¼ to ½ pound actual chemical per acre. (That is, 2/5 to 4/5 pint of the formulation.)
Fenthion (Baytex), 46 percent Spray concentration	1/10 pound actual chemical per acre. (That is, 1/5 pint of the formulation.)
Naled (Dibrom), 60 percent Emulsion concentrate	1/10 to ¼ pound actual chemical per acre. (That is, 1/10 pint (1.6 fluid ounce) to ¼ pint of the formulation.)

*At least 3 gallons of water per acre are needed when using a mist-blower for adult mosquitoes. Mix, for example, 2/5 pints of 57 percent emulsifiable malathion concentrate in each 3 gallons of water in the spray tank. Always use the specified amount of insecticide per acre. As needed for better coverage or penetration, increase the amount of water used per acre, never the amount of chemical, unless label instructions say it is all right.

*Calibrate standard fogging machines to deliver 40 gallons per hour of the fogging solution at 5 miles per hour speed. A swath of 200 to 350 feet can be covered.

Warnings

1. Avoid contamination of food, feed and drinking water.
2. Avoid breathing and getting into mist drift; keep children out of it.
3. Use only as herein directed, unless other directions are obtained.
4. Always read the label for additional precautions and instructions of use.

Aircraft (Mainly for adult mosquitoes)

Malathion is the only insecticide currently suggested for mosquito control by air application. For oil carriers do the following to make 100 gallons of finished malathion oil spray:

Malathion 95 percent,	2 gallons
Thiosperse,	1 pint (to 1 quart)
Fuel oil,	98 gallons
Finished spray,	100 gallons (approximately).

This mixture contains 4 ounces of actual malathion per gallon of finished spray. To areas with light vegetation or considerable open areas, apply 2 to 3 quarts of the mixture per acre. Use 4 quarts of the mixture per acre over dense vegetation.

Note: 90 percent malathion can be used without Thiosperse, providing number 2 fuel oil is used as the carrier.

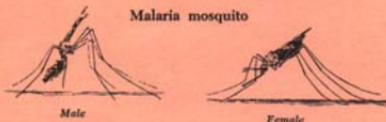
When water is used as the carrier, mix:

Malathion, 57 percent Emulsifiable Concentrate	5 gallons
Water	95 gallons
Finished spray	100 gallons

This mixture contains 4 ounces ($\frac{1}{4}$ pound) of malathion per gallon. Apply 1 gallon of the mixture per acre. If mosquitoes are bad, use 2 gallons of the above mixture per acre; also, the amount of malathion in the mixture can be doubled by using 10 gallons of the concentrate to 90 gallons of water. However, do not increase the amount of the stronger mixture applied per acre; that is, use only 1 gallon per acre.

Warnings:

1. Use the treatment carefully around water areas.
2. Oil applied by air may cover cars, often creating washing problems. If this happens, wash the car immediately.



NO-SEE-UM PUNKIE and SAND FLY

1/25 to 1/15 inch long



No-see-ums, punkies, and sand flies are bloodsucking midges. They are quite small, two-winged flies about 1/25 to 1/15 inch long. Breeding places for the larvae (worms) include water, decaying leaves and other plant parts, ponds, and moist rot-holes in trees. Unlike mosquitoes, the larvae vary as to their location in the habitat—some live in the mud of ponds and swamps, some at the surface of the water, others in tubes they form from leaves.

These insects are very annoying to vacationers and home owners in infested areas. They usually bite in early morning and early evening. They are attracted to lights and may become a nuisance in buildings. These insects are at their worst during spring and mid-summer. Some two brood species may occur in late summer and fall.

CONTROL MEASURES

1. Clean up the leaves and weeds that drift in along the lake-shore and edges of lakes and ponds. Remove leaves from eaves troughs and other locations around buildings. If possible, drain puddles and soggy ground near camps or buildings. Treat rot-holes in trees with 5 percent dust of either DDT or chlordane. The sprays suggested for adult mosquito control would also suffice.

2. To other breeding areas, use malathion, pyrethrum, or fenthion as suggested for mosquito control. These insecticides will be adequate for infested leaves, mud areas, and shallow ponds but have only limited value for open-type ponds and lakes. Oil surface treating of water has little value for control of the larvae of no-see-ums, punkies, and sand fly maggots, except for those few species that live close to the water surface. An oil film will kill the pupae of these few species that float on the water surface, or adults as they emerge out of the water through the oil. But this, for the most part, has not been too practical.

3. Paint window and door screens with 5 percent DDT or methoxychlor in refined kerosene; for more permanent control, either reduce the size of the screen openings by applying aluminum paint or install small meshed screens. This will help keep these small midges out of buildings. NOTE: Sixty-mesh screen or silk bolting cloth is needed to exclude the smallest of these pests. This type of screening will limit airflow and may not be so desirable from this standpoint.

4. Repellents give some protection against the bites of these midges. Use such repellents as dimethyl phtha-

late, indalone, Repellent 612, diethyl toluamide, or prepared mixtures of these materials.

HORSE FLY and DEER FLY

Up to 1 inch long



Horse flies and deer flies are closely related. Some horse flies measure 1 inch in length and do not have dark bands on the wings. The body color of these flies is usually black or brown. The smaller horse fly species may have banded wings. Deer flies belong to this latter group.

The larvae (worms) of horse and deer flies live on the bottom of ponds, marshes and wet meadows and the adults are usually nearby. They are most plentiful near woods in hot weather. The adult horse and deer flies pierce the skin of animals and man with their sharp mouthparts. Drops of blood may ooze from these wounds.

CONTROL MEASURES

1. Draining ponds, wet meadows and other water areas will help control these insects. However, since the adults can fly in from other areas, drainage measures may not be too effective unless done on a large scale.

2. Spraying horses, cows, and other animals with a water mixture of 2/10ths of 1 percent pyrethrum plus 2 percent piperonyl butoxide will help reduce the problem. Note: A few other insecticides are available for use on animals. Get specific instructions for their use.

3. Humans may get some relief from these insects by using such repellents as dimethyl phthalate, indalone, Repellent 612, diethyl toluamide, or commercial mixtures of these materials. Avoiding woods and infested animals, especially on hot, bright days, will reduce materially the possibility of being bitten by these insects.

BLACK FLY

1/25 to 1/5 inch long



Black flies are small, chunky and hump-backed. They are about one twenty-fifth to one-fifth inch long, depending on the species. Contrary to their name, they are not all black in color.

Adult black flies bit all warm-blooded animals. They hover about various parts of the body (including nostrils, eyes, ears, and mouth) without making much sound. Their bites may cause irritation, swelling, or itching for several days.

These insects are common in nearly all parts of the United States and Canada; they are especially annoying in northern Michigan. The black fly larvae (immature forms) live in water and are usually found in our cold, fast-flowing streams, especially with rock or gravel bottoms. The larvae attach themselves to weeds, stones, or plants in the stream. They usually appear as adults in the spring, although some species may occur later in the season.

CONTROL MEASURES

It is most difficult to control black flies. Larval control in streams has not been practical, especially on a small scale. In some respects, adult control has been no better, due to widespread migration of them. Residual and space treatments similar to those suggested for adult mosquitoes have value, especially if applied during the warmer part of the day. Black flies are active during the hot, bright periods of the day, while mosquitoes are about on cloudy days, evenings or early mornings. However, treatments for black flies and mosquitoes can be applied at the same time with reasonably good results.

The most positive way to protect yourself from these pests is by wearing boots, head veils, and gloves. Chemical repellents will also protect up to five hours. Some of the better ones contain either dimethyl phthalate, indalone, Repellent 612, diethyl-toluamide or mixtures of these materials. Apply repellents before exposure to the insects. Not everyone will get the same amount of protection from repellents. You may have to try several different ones.

INSECTICIDES

For good insect control, learn how to use insecticides (chemicals) effectively. Most are available in several formulations, each with its own use for control in and around houses and other buildings.

Those discussed are the more common formulations. For others, read the label on the container for instructions on use.

EMULSIONS

Emulsions are liquids. They must be *mixed with water*, turning it milky. These materials are used in long-lasting water applied sprays, or shorter lasting mists. Also used in mosquito wiggler control for water surface treatment. They are generally not used inside buildings. Apply them outdoors to grass, shrubs, trees, other plants, foundations, over or on water areas where applicable. Be careful when applying to tender

flowers and shrubs. They may injure these plants or the fish in the water. In concentrate form, emulsions are dangerous if spilled on clothing and skin. Change clothing and wash skin immediately with soap and water. Use masks and protective clothing while spraying, especially when using dangerous materials or if you are applying them over a long time.

SOLUTIONS

Solutions are also liquids. They differ from emulsions in that they are used as bought and *are not mixed with water*. They are made with refined (deodorized) kerosene or similar materials, plus an insecticide. These materials are used for water surface treatments for mosquito wigglers and in fogging equipment. Do not apply to plants since they cause severe injury. Like emulsions, solutions are dangerous if spilled on clothing and skin. Immediately wash off with soap and water. Change clothing. Use masks and protective clothing, particularly when using dangerous materials or if you are applying them over a long time.

WETTABLE POWDERS

These are similar to dusts (see below). They contain a higher percentage of chemical, however. For some purposes they are used as bought in place of dusts. However, wettable powders are usually mixed with water and applied as sprays. The spray is seldom used indoors, but is useful when applied outdoors, especially for long-lasting (residual) sprays. Avoid breathing or getting powder (or spray) on the skin. Use masks and protective clothing, especially when using dangerous materials or if you are applying them over a long time.

DUSTS

Dusts are dry powders which normally contain a lower percentage (often much lower) of insecticide than wettable powders. The carrying agents (fillers)

Chlorinated Hydrocarbons

This bulletin does not contain suggestions for use of chlorinated hydrocarbon insecticides for control of mosquitoes, black flies, no-see-ums, punkies, sand flies, horse flies and deer flies, unless there is little or no danger to wildlife and a minimal chance of contaminating milk and food stuffs. The materials suggested herein may not be as effective as DDT or other insecticides used in the past, BUT THEY DO ELIMINATE MANY OF THE UNDESIRABLE CHARACTERISTICS OF THE CHLORINATED HYDROCARBONS. The cost of the insecticides also may exceed that of the earlier materials, but the overall safety of use warrants this additional cost.

for the insecticide are usually clays or talcs. They are used as bought and *are not mixed with water*. Use them outdoors where effective, usually as substitutes for long-lasting (residual) sprays.

AEROSOLS

Aerosols are liquids held under pressure in a container. When released, usually by pressing a button, some kinds form a gas, others a spray. Gas producing types are for control of flying insects (such as flies), liquid for those that crawl or run on floors (such as ants). Choose to fit your needs, but the gas-forming types have little value for mosquitoes and biting flies except in buildings for temporary control.

EQUIPMENT

The hand compressed air sprayer, the small power sprayer, the lawn mower mounted fogging machine, the aerosol, and the paintbrush are probably the best kinds of equipment for the home owner to use for mosquitoes and other biting insects. Large power equipment, such as sprayers, mist blowers, and oil and steam type "fogging" machines are best suited for community control of mosquitoes and other biting flies. The airplane is an important part of mosquito control, but has good use for only large operations.

Each type of equipment has good features and disadvantages. Careful study of your insect control jobs will help you buy and use it effectively.

COMPRESSED AIR SPRAYER

The water capacity of a hand-compressed air sprayer is usually 1 to 4 gallons. Air is pumped into the tank, forcing the spray out when the nozzle is opened. It is ideal for outdoor application of wettable powders and emulsions. Its use indoors is limited if a lot of water is applied with the insecticide. Shake the sprayer when you use wettable powder.

THE POWER SPRAYER

The power sprayer works on the same principle as the compressed air sprayer, except it has a larger tank capacity and is power driven. Whether this type of equipment is needed will depend largely on the size of the area to be treated, and how often.

THE MIST BLOWER

This equipment is normally power driven, and for the most part it is large type. Consequently, community or area programs are where it is most often used. This machine uses two or more times the concentrations of insecticide in the same amount of water as does the power sprayer. Because of this, the mist blower uses less water per acre to apply the same amount of insecticide as the power sprayer. An air

blast or air stream is used to discharge the water and insecticide from the mist blower.

THE FOGGING MACHINE

Three main principles are involved in the use of the fogging machine:

1. Heat is used to burn the oil carrier of the insecticide. This does not destroy the insecticide. In fog-type (smoke) applications of insecticides, water is never used as the carrier. **NOTE:** Steam also will disperse an insecticide. In this case, water is heated until it produces steam.

2. The second important part of fog or steam application of insecticide is air movement. There must be enough of this to carry fog or steam through all types of vegetation. Too much wind, of course, will carry them too far, resulting normally in poor control.

3. Fog or steam application of insecticides for mosquitoes does not leave a lasting residue. Hence, for the most part, they only have temporary value.

QUART-SIZED SPRAYER

The quart-sized sprayer is also a compressed air type, but air must be pumped into it continuously while in use. It can be used satisfactorily with emulsions or solutions but not wettable powders. Use it both indoors and outdoors for treating small areas. **NOTE:** Where higher pressure is needed for good application, it has limited use.

AEROSOL

Aerosols, discussed earlier, can usually be bought to fit your need, either gas producing for flying insects, or liquid types for crawling pests. Aerosol refers to a liquid held in a container under pressure, usually released by pressing a button.

PAINTBRUSH

Use an inexpensive paintbrush to apply insecticide solutions to screens. A light film is usually sufficient.

GENERAL WARNINGS

1. Avoid using any material in this bulletin around food or where children can get into it. When large areas are treated outdoors, keep children away until 72 hours after application.

2. Avoid breathing sprays or dusts. A handkerchief fitted to the face will help prevent excessive breathing of these materials. However, if there is a chance of breathing highly poisonous materials, special masks should be used. Some insecticides, such as pyrethrum or rotenone, may be harmful to persons with asthma, although the chemicals are generally quite safe otherwise.

3. If emulsions, solutions or concentrated wettable powders are spilled on the skin, wash immediately with soap and water.

4. Do not use insecticides in oil (kerosene) around open flames, electrical wiring, or on asphalt floor coverings. Avoid the use of insecticides which may stain or spot fabrics.

5. Avoid heavy applications of insecticides to tender flowers and shrubs, especially emulsion type sprays. Read labels to avoid using any material specified as damaging to certain plants.

6. Do not apply an insecticide listed in this folder to vegetables, fruits, and livestock, or to garden soils unless the label or up-to-date Michigan State University Cooperative Extension Service literature says you can safely do so.

7. Avoid careless use of *any* material, regardless of how poisonous it is.

8. *Read the label for each insecticide used. Follow directions.*