
NATURAL PEST
AND DISEASE CONTROL

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Pests and diseases are part of the natural environmental system. In this system there is a balance between predators and pests. This is nature's way of controlling populations. The creatures that we call pests and the organisms that cause disease only become 'pest and diseases' when their activities start to damage crops and affect yields.
If the natural environmental system is imbalanced then one population can become dominant because it is not being preyed upon. The aim of natural control is to restore a balance between pest and predator and to keep pests and diseases down to an acceptable level. The aim is not to eradicate them altogether, as they also have a role to play in the natural system.
Once a pest or disease has started to attack a crop, the damage cannot be repaired and control becomes increasingly difficult. Where possible, use techniques to avoid or prevent pest and disease attack in the first place. These are the methods of pest and disease control described in this manual:

Why is natural control preferable to chemical control?

Pesticides do not solve the pest problem. In the past 50 years, insecticide use has increased tenfold, while crop losses from pest damage have doubled. Here are three important reasons why natural control is preferable to pesticide use.

Cost: Using natural pest and disease control is often cheaper than applying chemical pesticides because natural methods do not require buying expensive materials from the outside. Products and materials which are already in the home and around the farm are most often used.

Safety for people: There is much concern over the dangers of chemical products. They may be misused because the instructions are not written in the language spoken by the person using the product. There have been many reports of people suffering from severe skin rashes and headaches as a result of using chemical pesticides. There are an estimated one million cases of poisoning by pesticides each year around the world. Up to 20,000 of these result in death. Most of the deaths occur in developing countries where chemical pesticides, which are banned in Europe or the USA, are still available.

Safety for the environment: Pests are often controlled with man made chemicals which have many harmful effects, for example:

- Artificial chemicals kill useful insects which eat pests.
- Artificial chemicals can stay in the environment and in the bodies of animals causing problems for many years.
- Artificial products are very simple chemicals and insect pests can vary quickly, over a few breeding cycles, become resistant to them and can no longer be controlled.

Knowing the problem: Before taking action to control pests and diseases it is very important to make sure that the problem is correctly identified. Only then can you hope to succeed. Knowledge of pests and diseases will help you to decide whether the problem is caused by a pest, a disease, a mineral deficiency in the soil or an environmental factor. A good identification book may help with this.
Proper identification should be the first step in controlling the problem and, more importantly, in preventing it from happening again.
The following pages describe a general approach to natural pest and disease control and give some specific examples.

A healthy soil: A soil managed using organic methods will give plants a balanced food supply. Plants which are fed well, like people, will be much more resistant to pest and disease. So caring for the soil is important. It should be managed in ways that develop and protect its structure, its fertility and also the millions of creatures for which it is a home. Caring for the soil involves providing a regular input of organic residues in the form of animal manures and plant remains. The aim is to:

- Maintain levels of humus (organic material) that give structure to the soil
- Feed organisms which live in the soil
- Provide nutrients for crops

Whilst chemical fertilisers appear to improve plant growth, their use can also have negative effects. A plant may look healthy but because of the high content of nitrogen given by the chemical fertiliser, causing fast sappy growth, it becomes attractive to pests. It has been observed that aphids lay double the number of eggs on a plant grown with chemical fertilizers compared to organically grown plants.

A healthy crop: By giving plants the right growing conditions they will be more able to resist pests and diseases. Also, the right choice of crop will help to deter pests and disease. A crop growing in an area where it is not suited is more likely to be attacked. You should take into account of the soil type, climate, altitude, available nutrients and the amount of water needed when selecting your crops. Plants will only yield well and resist pests and diseases if they are grown under the most suitable conditions for that particular plant.
To help ensure a healthy crop, weeding should be done early and regularly to stop weeds from taking nutrients which should be going to the crop.

Resistant varieties and genetic diversity: Within a single crop there can be many differences between plants. Some may be tall and some may be able to resist particular diseases. There is more variety in the traditional crops grown by farmers. These have been grown and selected over many centuries to meet the requirements of the farmer. Although many of these are being replaced by modern varieties, seeds are often saved locally.
Crops which have been bred by modern breeding methods tend to be very similar and if one plant is susceptible to a disease, all the other plants are susceptible as well. Although some new modern varieties may be very resistant to specific pests and diseases they are often less suited to the local climate and soil conditions than traditional varieties. It can therefore be dangerous to rely too much on any one of them.

A wide variety or “genetic diversity” between the plants within a single crop is important. This helps the crop to resist pests and diseases and acts as an insurance against crop failure in unusual weather such as drought or flood. It is important to remember this when choosing which crops to grow.

Crop rotation: Growing the same crops in the same site year after year can encourage a build up of pests and diseases in the soil. These will transfer from one crop to the next. Crops should be moved to a different area of land each year, and not returned to the original site for several years. For vegetables a 3 to 4 year rotation is usually recommended as a minimum. Crop rotation also helps a variety of natural predators to survive on the farm. A typical 4-year rotation would include a cycle with maize and beans, a cereal and a root crop with either of the following;

1. Grass or bush fallow (a fallow period where no crops are grown).
2. A legume crop where a green manure, which is a plant grown mainly for the benefit of the soil, is grown.

With crops such as brassicas and onions which are usually grown in a vegetable garden the whole year round, the populations of certain pests and diseases can keep increasing because there is always a suitable host plant for them. Breaking the cycle can help to solve the problem. This can be done through rotation within the vegetable garden.

Good hygiene: If infected plant material, live or dead, is left lying around, pests and diseases can be passed on to future crops. Debris should be cleared up and disposed of. This can be done by composting the debris. The composting process will kill some pests and diseases and produce compost which is a good soil improver and fertiliser.

Soil tillage: Many pests spend part of their lives as larvae or pupae in the soil. Ploughing or digging when the soil is dry can reveal the pest and they will dry out and die in the sun, or they can be picked off the ground by hand or birds or other predators. Ploughing can also push the pest deep down into the ground where they will not be able to survive. Ploughing and disturbing the soil should be carefully considered against the harmful effects it may have such as destroying the structure of the soil and causing soil erosion.

Soil pH: The pH (acidity or alkalinity) of a soil can affect some diseases. Changing the pH can reduce the problem.

Timely sowing: It is often the young of many pests (larvae, caterpillar), rather than the adults, that cause damage to crops. Problems can be avoided by delaying sowing until the egg laying period of a pest is over, or by protecting the plants during this period. It is therefore important to know the life cycle of pests, so that timely sowing can be carried out.
In Ghana, for example, farmers in the forest zone only plant maize in the main rainy season. In the lesser rainy season, the maize is attacked by stem borers.

Companion planting: Companion planting means growing certain plants to protect other plants from pests or diseases. This may be because the pest is deterred by the companion plant, or because it is attracted to the companion plant rather than the crop.
For example onions planted either side of a row of carrots help to deter carrot flies. You need to sow 4 rows of onions for 1 row of carrots. This effect will only last as long as the onions are growing leaves. Many pests avoid garlic, so this can be used very effectively for companion planting with most crops.
In a similar way farmers in Zimbabwe have found that placing mint leaves near spinach plants will deter insect pests. By planting milkweed among vegetables, some African farmers have effectively reduced the number of aphids on their crops. This is because aphids are more attracted to the milkweed than to the vegetables.
Companion planting can also mean that one plant acts as a barrier for another. In Columbia, jassid infestation in beans is reduced when beans are sown 20 to 30 days after maize. The maize acts as a shelter for the beans.

Plants to attract predators and parasites: Similarly to companion planting, which seeks to deter pests from the main crop, attractant plants can be grown to attract predatory insects.

Areas of natural habitat: Bushes and trees are a home for many useful insects and birds. They provide resting areas, shelter and food. Areas of natural habitat can be left around the edges of fields where crops are grown. If these areas are destroyed then there is likely to be an imbalance between the populations of predator and pest.

Specific plants to attract beneficial insects: There are many plants that can be grown to attract natural predators and parasites which will help to keep down pests and diseases. Flowers such as marigolds (*Tagetes*), mint (*Mentha*), sunflower (*Helianthus annus*), sunhemp (*Crotalaria juncea*) as well as local legumes are useful attractant plants. Hoverflies, whose larvae feed on greenfly are attracted to the flowers of herbs and vegetables such as fennel, celery, dill, carrots and parsnips (*Umbelliferae* family). The nectar and pollen that these flowers provide will help to increase the number of eggs that these insects lay. *Umbellifers* will also provide food to various parasitic wasps whose young live on aphids and some caterpillars. Red hot pokers (*Kniphofia uvaria*) are used in parts of Africa to attract birds that eat aphids.

Barriers: Barriers are physical structures put in place to prevent a pest from reaching a plant. They keep pests away from a plant but do not kill them. Here are some examples that you can adapt, depending on the resources available to you:

Crawling insects: Cut the top off a transparent plastic bottle and place it firmly into the ground, over a young plant. This stops pests such as slugs from reaching the plant.

Climbing insects: To help protect trees from attack by insects, grease bands can be used. Wrap a piece of plastic or a long leaf around the trunk of the tree. Spread any kind of thick grease on top of this. Fold over the top of the foil or plastic to form an overhang to protect the grease from being washed away by rain. Check the grease every week to ensure that the grease is intact. This prevents crawling insects such as ants, fruit fly larvae, slugs, snails, beetles or caterpillars from damaging trees, especially fruit trees, or grain stores.

Termites: Digging a 70-100cm trench around buildings and nurseries can prevent attack from subterranean species of termites. This is a good method of control however it is hard work. Alternatively, barriers can be built. These should be partially above and below ground and should be made from material that is impenetrable to termites such as basalt, sand or crushed volcanic cinders. Particle size of the material is critical, they should not be too large for the termites to carry away, and not so small that termites can pack the particles to create a continuous passage through which they can move.
Bait traps: The use of baits and traps are traditional methods, which have become neglected because of the increasing use of chemical pesticides. Here are some examples:

Cutworms
Method one: Mix equal quantities of hardwood sawdust, bran, molasses and enough water to make the solution sticky. Spread around the base of the plants in the evenings. The molasses attract the cutworms and as they try to pass through it they get stuck. The substance dries out in the sun and the pest dies.
Method two: Mix 100 grams (g) of bran, 10g of sugar, 200g of water, 5g of pyrethrum powder. Spread around the base of the plants. The cutworms eat the substance and die.

Fruit fly: Traps need to be put in place before an attack is likely to start. For fruit fly, the traps should be baited 6 to 8 weeks before the fruit ripen.
Here are two examples of trap constructions which could be adapted:

Method one: Make a small hole in the bottom of a plastic bottle or container. Seal the top of the bottle with a lid or stopper. Fill one quarter of the bottle with the bait. Hang the bottle upside down from trees around fields or gardens. The flies are attracted to the bait through the small hole. They are then trapped and drown in the bait.
Method two: Cut the top of a plastic bottle off. Pour some bait in the bottom half of the bottle. Turn the top half of the bottle upside down and place in the bottom half. Again the flies are attracted into the bottle and drown in the bait. Here are two different baits for fruit fly that can be poured into the traps:

- Mix 1 litre of water, 250 millilitres (ml) of urine, a few drops of vanilla essence, 100g of sugar and 10g of pyrethrum powder.
- Mix 1 teaspoon of pyrethrum powder, 250g of honey, a few drops of vanilla essence, 250g of orange or cucumber peel or pulp and 10 litres of water.

Light traps: Light traps are set up at night and attract a variety of flying insects including moths, mosquitoes, chafer beetles, american bollworms, army worms, cutworms, brown rice plant hopper, green rice leaf hopper, rice black bugs, rice gall midges, rice stem borers and tomato hornworms.
Make a tripod construction from wooden poles or bamboo. Press the poles down firmly into the ground to secure it so that it cannot be blown over or knocked down by animals. Suspend a lantern from the top of the construction over a bowl of water with a little oil in it.
Fire risks must be kept in mind and the lamps must be hung so that the wood does not catch fire.
The best timing for placing light traps around a garden or field, depends on the life cycle of the insect and the development stage of the crop. The best time is just after the moths emerge but before they lay eggs, so it is important to know the life cycle of the pests.

Fly trap: Fly traps are large boards measuring about 30cm by 30cm which are painted bright yellow/orange and covered with an adhesive such as oil or glue. Different pests are attracted to different colours so you need to experiment. The flies are attracted to the bright colour of the board and fly onto it. They get stuck in the oil or glue and die. For example, leaf minors are attracted to yellow, so place several yellow boards 60cm off the ground (on a table or hung from a tree). The board will attract a huge number of insects, which means a considerable reduction of pests.

Pheromone traps: Pheromone is the sexual attractant produced by some female insects. If a trap is baited with this it will attract the male insects into the trap from which they cannot escape. Pheromone traps alone can reduce pest damage. Alternatively they give an indication of pest populations and therefore the best time to apply control methods. Pheromones traps are usually prepared by commercial companies and may be costly to the farmer. However, if you have a particularly severe pest problem it may be worth investing in one rather than using chemical pesticides.

Hand picking and squashing: In some cases it may be possible to pick pests directly off the crops. This can be done especially with caterpillars and other large insects in small plots of land. Smaller pests such as aphids can be squashed on the plant. Parts of plants that are diseased can be cut or broken off the plants to prevent the spread of the disease.

Biological control: Biological control means using one creature or organism to control a pest. This often involves introducing a creature or organism, which is known to be predatory, to an area with the aim that it will control the population of the pest.
Some widespread pest and disease problems have been dealt with in this way by government projects. For example, a variety of creatures have been introduced to control the cassava mealy bug in Kenya. Here are other examples of creatures or organisms which are known to control certain pests:

- Control of Cabbage caterpillars: *Bacillus thuringiensis* (Bt) is a bacteria which kills many types of caterpillar, but only when they eat it. This bacteria (which can be bought as a commercial product called "*Bactospeine*") is applied to brassicas (cauliflowers, cabbages) as a spray. A similar product called Dipel is available in Guyana.
- Control of Vine weevils: Nemasys H is a preparation containing parasitic nematodes which seek out and destroy vine weevil larvae. It is watered onto the soil.

Biological control does not have to involve buying commercial products.

It can be achieved on a small-scale by encouraging natural predators to live and breed in the area where pests are a problem. This can be achieved by having trees and hedges around the farm to provide a home for them. There are many insects and animals which should be encouraged because they feed on pests. Here are some examples: frogs, toads, hedgehogs, mice, moles, bats, birds, chamelions, lizards,spiders, ants, assasin bugs, black-kneed capsids, bees, branchid wasps, parasitic wasps, dung beetles, ground beetles, earthworms, hawk moths, dragon flies, hoverflies, lacewings and stick insects.

NATURAL PESTICIDES

If pest and diseases cannot be prevented or controlled by cultural and physical means, it may be necessary to use natural pesticides. Many growers have developed ways of making their own spray from plants such as neem, garlic, hot peppers, marigolds, etc. The potential crop protection uses of 50 local plant species have been described by Pluke *et al* (1999). A few examples are highlighted below:

NEEM (*Azadirachta indica*)

Neem is known to posses insectidal properties and has been shown to be effective against a number of inert species. The table below (Pluke *et al*, 1999) shows the range of neem's effect on insect pests.

Range of Neem's effetcs on Insects Pests

METHODS OF PREPARATION
(Pluke *et al* 1999)

For storage protection purposes, the neem seed oil is often used. The production of this is described below;

- **Neem seed oil:** The chemicals in neem oil break down in sunlight and so it is best to make the oil under shade. Collect the ripe seeds from the tree or the ground, where they have fallen. The pulp of the seed should be removed before drying. Drying should take a few days of good sun. Once dry, the seeds can be stored in the dark for a year without losing their effectiveness. To prevent mould developing, the seeds should be stored in containers that can let air through them .To extract the oil, dried seeds should be shelled by cracking the seed with a stone or by pounding in a mortar. The inner seed or kernel should be separated from the husk by winnowing. If the crushed seeds are very hard and brittle they should be moistened and left to stand for several hours until they can be pressed together by hand. Crushing the seeds in a mill or mortar produces a rough, sticky mixture out of which oil can be pressed by kneading. Repeated kneading and squeezing removes the oil. Adding a little water usually helps the extraction. The solid remaining after the oil has been extracted is called the neem or
seed cake. Using the method given above, 100-150ml of oil, (4-5 tablespoons) can be extracted from 1 kg of dried inner seed. This doesn't seem a lot but you only need a little to protect your grain – 6 tablespoons of oil can do 30 kg of the stored product. The beans or grain should be well mixed with the oil. Neem oil gives long lasting protection, (over a year), whereas leaves have to be replaced to give continued control. Neem oil is bitter, (but non-poisonous), for the first 3-4 weeks of treatment but then the taste starts to diminish. To remove the bitter taste before eating, the beans or rice should be covered with hot water for a few minutes and drained.

Neem can also be prepared as a crop spray. Below are two methods:

Method 1:Aqueous neem seed extract.

500g of dried seeds are crushed in a mill or mortar and then added to 10L of water, stirring vigorously. This mixture is then left overnight before being filtered, fine mosquito mesh is good for this. When needed, half a handful of soap powder is added to help the neem mixture stick to the plant. The mixture can be stored in the dark for 3-4 days before it loses its potency. This preparation has been used effectively against caterpillars, grasshoppers and certain beetles.

Method 2:

Aqueous neem leaf extract. 1 kg of leaves are bruised and crushed. Place these in a bowl of hot water for 15 minutes or overnight in cold water. After this time water is added to make the total volume up to 8 litres. This is then filtered and half a handful of soap powder added. Neem powder can also be applied to crops. Again there are two methods of preparation:

Neem seed powder: The dry seeds should be cracked and the inner seed or kernel separated from the husk. The kernel should then be partially crushed, dried (out of the sun), and then further pounded to produce the powder. This powder has mostly been used for the protection of stored products. It can also be used in the field, in a suspension with water or as a dust incorporated directly into the soil. In the soil it will protect seedlings from ground pests. In some cases it has shown systemic properties.

Neem leaf powder: The leaves are picked and dried in the shade. When the leaves have dried they are crushed with a mortar and pestle to produce the dust. The powder is used in protecting stored products. Reapplication of neem in the field is usually necessary; after 7 days of sunlight neem loses 50% of its effectiveness. In areas of vegetable cultivation, with large pest problems, weekly applications may be necessary.

MARIGOLD:

A solution can be made from marigold using soap and water. The liquid acts as a crop strengthener to help beans, tomatoes, etc. resist blight, mildew and other fungal diseases. It also repels aphids, caterpillars and flies.