NATURAL PEST AND DISEASE CONTROL HANDBOOK

1. INTRODUCTION

Plant pests and diseases are significant to farmers because they can cause damage to plants and plant products. It is estimated that the home gardener can lose up to 25% of his crop if pests and diseases are left uncontrolled. In some cases this figure might be 100%.

There are a number of methods available for controlling pests and diseases. The general belief amongst farmers and extension workers is that synthetic chemicals (fungicides, bactericides and insecticides) are the only way to manage pests and diseases in crops. These sprays give very impressive results in an instant, but could result in serious problems in the longer term. Non target interactions, pollution and resistance are common issues, as is the fact that many pesticides are extremely poisonous and can be harmful to human beings, animals and the environment.

It is however possible to produce high-quality vegetables with sufficiently high yields, without using these chemicals. At the same time, soil fertility and the quality of the environment can be improved.

The best approach to good vegetable production would be to try to avoid problems as far as possible, instead of trying to cure them. The only way to avoid problems from occurring in your garden is to make sure that the soil is healthy and that the environment that the plant is growing in is stable and balanced.

There are a number of things that should be kept in mind when trying to implement natural control in a system:

- Crop protection builds on traditional knowledge: developing and improving it.
- Pesticides can be used, but only in cases of emergency.
- Methods should be locally adapted, simple, inexpensive and easy to manage.
- The small-scale farmer needs to understand correlations and act independently. S/he must be the crop protection expert.
- People must learn to use nature itself to help them in their struggle against pests and diseases.
2. ENEMIES OR FRIENDS

Plants, animals and micro-organisms can influence the productivity in your garden. About 99% of all plants, animals and microorganisms are beneficial to agriculture and the general economy. It is only 1% of all living creatures that causes so much trouble in gardens around the world. If left undisturbed, natural enemies could mostly keep this troublesome 1% under control. Modern agriculture techniques generally do not consider the relationship between organisms, or the balance between different populations that keep pest explosions in check.

Small scale farmers may attempt to grow crops in poor soils under less than ideal conditions. Plants stressed in this way are easily susceptible to pest and disease attack.

2.1 PLANTS

Unwanted plants are called weeds. Weeds can cause damage to crops in several ways:

- They take up water and nutrients from the soil, in competition with the crop.
- They can shade crops from the sun. Sunlight is very important for the growth of crop plants.
- They can host insect pests that can damage the crops.
- They can reduce the quality of the produce, e.g. weed seeds found in cotton would reduce the price considerably.

Weeds aren't always pests

They can be used to your advantage:

- Weeds can be slashed and used as a green manure to feed the soil.
- They cover the soil and can prevent soil erosion.
- They can attract and host very valuable beneficial insects (predators and parasites).
- They can act as wind breaks.

2.2 ANIMALS

These include large mammals, rodents, birds, slugs and snails, insects and nematodes.

2.2.1 Large mammals

Buck, pigs, goats, cattle, rabbits, dogs and cats are considered to be large mammals. If these are not kept out of the garden they could cause considerable damage.

- Animal manure can be very useful in feeding the soil.
2.2.2 Rodents
Rodents include mice, rats and mole rats and moles. These animals can cause damage to your crops and stored grain and should be controlled.

2.2.3 Birds
Birds can be divided into two large groups: the meat-eaters and the plant/seed eaters. The plant/seed eating birds can damage your crops by eating the seedlings, fruits and seeds of the crop. Such birds are: crows, sparrows, pigeons and finches.

➢ Not all birds are pests
The meat-eating birds can be very beneficial in your lands, as they will reduce the numbers of insects and rodents in the crops. Such birds are owls, swallows and hawks.

2.2.4 Slugs and snails
These creatures can cause considerable damage to your crops if they are not controlled.

2.2.5 Insect Pests
Insect pests can be divided into two categories:
Sap-sucking pests
Examples are aphids, scale insects, mealy bugs, leaf and plant hoppers, whiteflies, thrips, mites and red spider mites.

Plant-eating/chewing pests
Examples are caterpillars (armyworms, leaf-miners, cutworms), beetles, locusts and crickets.

- Not all insects are pests
Some insects are beneficial to your crops, such as:
  - Bees that pollinate crops,
  - Predators that feed on insect pests (e.g. wasps) and
  - Insects that help to decompose organic material (e.g. dung beetles).

2.2.6 Nematodes
Nematodes are very small worms that can hardly be seen with the naked eye. These tiny worm-like creatures feed mainly on the roots of plants. At first the damage will not be noticed, but as the numbers of these little creatures increase, the plants will decline and could eventually die.

- Not all nematodes are harmful to plants.
Only a small percentage of nematodes are plant eaters, the rest live on organic material in the soil or feed on small animals in the soil.

2.3 MICRO-ORGANISMS
Micro-organisms are tiny creatures that can usually not be observed with the naked eye. They can, however, be seen when they occur in large numbers. Micro-organisms are responsible for diseases and can be classified as fungi, bacteria and viruses.
2.3.1 Fungi
There are quite a variety of fungi that can influence our lives. Fungi that cause plant diseases are usually tiny parasitic organisms that grow on or inside plants. A mass of these usually consists of tiny threads (called hyphae), which infect the cells of the plant. Fungal spores can disperse through the air or with water or with the help of other organisms and cause new infections. They can lie dormant in the soil for several years, as sporing structures. Most fungi prefer moist, warm weather. Fungi can be devastating in a crop. Fungi cause diseases such as blights, mildews, and certain root rots.

- Fungi are not always disease causing.

Some fungi are very useful and even crucial for life on earth. Some of these fungi are bigger and can be seen with the naked eye. For example the mushrooms and bracket fungi that are found on fallen trees. These fungi help with the decomposition of the wood and the nutrients in the wood are made available to other organisms. Other fungi are used by ants and other small insects as a food source.

2.3.2 Bacteria
Bacterial diseases are caused by minute organisms that reproduce rapidly by division. Bacterial diseases in plants are difficult to cure. The best way to prevent serious damage is to destroy affected plants. Bacteria cause diseases such as soft rots and some leaf spots.

2.3.3 Viruses
Viruses are amongst the smallest of all living organisms. They cannot be seen with the naked eye. Only the symptoms can be seen on the plants. Viruses cannot reproduce without the help of another organism. They also need a vector to infect a plant. Many sap-sucking insects
act as vectors. Generally there are no cures for virus diseases and affected plants should be destroyed.

- **Not all micro-organisms are pests**

Many species of micro-organisms can help plants by feeding them. Such beneficial micro-organisms are encouraged by healthy soils.

## 2.4 DIAGNOSING PLANT PROBLEMS

Before symptoms can be treated it is important to have an idea of the cause of the problem. Damage to plants can be caused by insects, animals, micro-organisms, natural causes (such as drought and nutritional disorders), or by chemical injury.

It is not always easy to identify the cause of a problem immediately from visual symptoms. There are hundreds of causes of plant problems and two or more of the causes might produce the same symptoms. A single visual symptom can also be caused by a number of different problems.

Identification of the cause of a particular symptom requires years of experience, but guidelines can be given to make it easier.

### 2.4.1 Ways to identify insect damage

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ragged leaves, holes in wood, fruit or seed. Mining on leaves. Wilted or dead plants. The presence of larvae</td>
<td>Chewing insects</td>
</tr>
<tr>
<td>Foliage and fruit are off-colour and sometimes a bit distorted</td>
<td>Sucking insects removing sap and cell contents from the plant and injecting toxins into the plant</td>
</tr>
<tr>
<td>Black sooty substance covering the leaves, twigs, branches and fruit. The sooty cover can easily be removed by rubbing the leaves.</td>
<td>Honeydew excreted by certain insects leads to the growth of sooty mould. Leaves suffocate and plants do not grow well.</td>
</tr>
<tr>
<td>Galls on leaves, twigs, buds and roots</td>
<td>Gall forming insects</td>
</tr>
<tr>
<td>Scars on stems, twigs, bark and fruit. Fruit is sometimes infested with larvae</td>
<td>Insects laying their eggs in or on the plants.</td>
</tr>
</tbody>
</table>

The symptoms of diseases are often similar to nutrient deficiencies and can easily be confused.

It is important to note that the following are rough guidelines.
2.4.2 Ways to identify disease damage

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
<th>CAUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilting, root rots and stunting</td>
<td>Clogging of water-conducting cells of the plant</td>
</tr>
<tr>
<td>Blotching, scab, black spots on leaves</td>
<td>Destruction of the chlorophyll in the leaves</td>
</tr>
<tr>
<td>Unusual growths on flowers, twigs and roots</td>
<td>Gall forming bacteria that disrupt normal cellular organization</td>
</tr>
<tr>
<td>Flower and seed rots</td>
<td>Fire blight and bacterial rots</td>
</tr>
<tr>
<td>Wilting, dwarfing and off-coloured foliage, usually patchy in appearance, leaves become distorted</td>
<td>Viral diseases carried from one plant to another by aphids and other sap sucking insects</td>
</tr>
<tr>
<td>Soft rotting of fruit, foul smelling.</td>
<td>Bacterial soft rots; usually in a wet environment</td>
</tr>
</tbody>
</table>

2.5 BIO-INDICATORS

Pests and diseases can be helpful in a way too. When these are spotted in the garden, they are indicators that something is wrong. In order to fix the problem, you need to know what the indicator is telling you. By just killing off the pests and diseases with chemicals, you will never fix the problem. The solution would be to make the plant and its environment healthy enough to fix itself. Healthy plants have a natural resistance against pests and diseases.

Weeds can also be used as bio indicators. They can tell us a lot about the soil they are growing in. Weeds with very strong taproots indicate soil compaction. The weeds grow there to break up the soil and improve the soil structure. Ferns and Oxalis indicate acidic soils, while nutgrass and sedges indicate that there is not enough air in the soil, because of compaction or water logging. Amaranthus (shown alongside) indicates fertile soil with bad structure, but very rich in nitrogen. Weeds also take up minerals from the soil and keep them from washing away or leaching into the soil. Blackjack has the ability to take up nutrients that are not available to crop plants. If you take out the weeds from your land and burn them or just throw them out, you are losing vital minerals. Try to incorporate them back into the soil, so that the minerals can be used by your crops.
3. CONTROL

3.1 THE CHOICE
Pests and diseases have been with us from the very beginning. We read about them in the Bible: moths, ants, mosquitoes, rust, locusts, etc. The war against pests was declared about 10 000 years ago, when we first got serious about agriculture. In those times the only means of controlling pests was mechanically. Our ancestors probably used the sun, water, mud, ashes, salt and their bodies (hands, feet and voice) to control these pests.

As humanity developed, so control methods developed. As a result we have access to highly technological solutions such as specialised chemicals and hybrid and genetically modified plant varieties.

Because of all this new technology, many of the older methods of controlling pests have been forgotten or neglected. The purpose of this book is to make people aware of the existence of these forgotten processes and remedies to control pests.

Unlike our ancestors, we have a choice today of how to control the pests in our gardens. The choice lies between chemical control and natural control; or a combination of both.

3.2 CHEMICAL CONTROL
In this book chemical control will refer to synthetic pesticides, which includes any pesticide that is man-made in a chemical laboratory or factory.

Chemical control of agricultural pests originated during the First World War. The chemicals that were discovered and used were later introduced into agriculture to be used to control pests.

Chemical control has its advantages. It is effective and results can be expected almost immediately. In many cases only the positive side of chemicals is shown to the farmers, and the farmers regard chemicals as a “quick fix” to all their problems.

Many chemicals are not suitable for use by ordinary small-scale farmers, for the following reasons:
3.2.1 Chemicals are poisonous and dangerous

People are poisoned every year by pesticides. Even people who do not have direct contact with pesticides are exposed to the health risks of pesticides:

- Chemical residues on fruit and vegetables are taken in by humans and can build up in their bodies.
- Pesticides are known to accumulate in body fats and can be transferred to babies via mothers’ milk.
- Some pesticides break down the melanin in the skin. This can lead to severe sunburn or skin cancer.
- Some pesticides become even more dangerous when cooked with food.
- They can destroy the liver and damage the kidneys.
- They can cause breast cancer in women and reduce fertility in men.
- They affect the nervous system of humans and can cause brain damage.

Pesticides poison birds and useful insects. Pesticides can also contribute to the pollution of air, soil and water. Some pesticides, especially herbicides, are only registered for a few crops, and the carry-over can damage sensitive crops that are planted in the following season.

3.2.2 Resistance to pesticides

Many pests and diseases have developed resistance to chemicals which are used on a regular basis, making the chemicals ineffective. More research on the development of new chemicals then becomes necessary. The problem gets worse every year.

3.2.3 Non-selectiveness of pesticides

A major disadvantage of all pesticides is their non-selectiveness. They do not only kill the targeted pests but also beneficial insects and birds. Chemicals kill 99% of the pest population, but also kill about 99% of the predators in the area. Beneficial insects include natural enemies of pests and diseases, pollinators and scavengers that help to break down organic materials to be recycled into the system. After this treatment the remaining 1% of the pest population will explode, because there are no natural enemies to keep their numbers down. The predators will not increase in numbers rapidly, because their food source has been cut off.

3.2.4 Chemicals are usually very expensive

To produce most pesticides, high technology and sometimes expensive processes are needed and this makes the final product very expensive to buy. In many cases chemicals are over-used. People spray “just in case”. This can be very expensive in the long run, especially if it was not necessary, in which case it will not be economically viable.
3.2.5 Chemicals are not always readily available to small-scale farmers
Many chemicals are only sold by big chemical companies, and might not be accessible to small-scale farmers in rural areas.

3.2.6 Illiteracy among small-scale farmers
Most pesticides are supplied with written instructions. These instructions are often complicated and poorly understood. The actual application of the chemicals and the calibration of the equipment also requires a high degree of skill. If pesticides are applied at the wrong dosage or incorrectly, they can cause severe losses in yield for the farmer.

3.2.7 Many chemicals are available in large containers, only
Most chemicals are directed at the commercial market and so the packaging is done in bulk, for sale to the commercial farmers. The small-scale farmer cannot buy in bulk and if he did, would not use all of it.

3.2.8 Most pesticides need to be applied with special equipment
Some of the equipment needed to apply the pesticide efficiently is expensive, hard to come by or difficult to use by the farmer himself.

3.2.9 Safe storage
The lack of suitable safe storage space for chemicals in rural areas is a further problem, creating a serious health hazard for the community.

3.2.10 Slow breakdown in the soil
Some chemicals have a very slow breakdown rate in soils. If only applied once in an area, it can take many years to break down and get out of the system. If chemicals are used on a regular basis, the effect is synergistic, and many problems can be created.

3.2.11 No chemical is perfect
No chemical will give you a hundred percent control under all conditions. The weather can play quite an important role in the effectiveness of the chemical sprayed. Only about 2% of all insecticides sprayed onto crops finds its target. The rest will be wasted and will just pollute the water and soil.

Pesticides cannot be ignored, and they will not go away. We are heading for the 21st century, so chemical control has been integrated into our everyday lives in the form of insecticides and other pesticides. There are also times when the pest problem gets too big to be handled with natural control and, in this case, chemical control will be the only option.
3.3 NATURAL CONTROL

Natural control is the control of pests and diseases without the use of synthetic chemicals.

Natural control includes:

- **Cultural methods** - preventing disease and pest damage by using certain cultural methods.
- **Physical control methods** - barriers, traps and artificial guards
- **Biological control methods** - encouraging the natural enemies of the pests and diseases
- **Botanical remedies** - mixtures made from plant material to control pests and diseases.
- **Organic remedies** - mixtures made from organic material to control pests and diseases.

Natural methods of pest management are based on making the best use of systems in nature. The idea is that farmers use the resources available to them, to fight pests and diseases.

Natural control starts by building a healthy soil. If the soil is healthy, the plants will be strong and they will resist diseases far better.

Natural control methods do not always get rid of the pests completely, but can reduce their numbers, and their ability to damage the crops.

3.4 IS IT POSSIBLE TO PRODUCE QUALITY CROPS WITHOUT CHEMICALS?

The key to producing good quality crops is to keep the plants healthy. Plants are just like people, if they are fed well and supplied with all the necessary minerals, they will be healthy and relatively disease free.

Plants get their minerals from the soil, so it is important to feed the soil and to ensure that all the elements needed for healthy plants are present in the soil in a form that can be taken up by the plants.

It is also important to realise that the soil hosts a wide range of microorganisms, which are crucial in keeping the soil environment healthy. In a forest, the top 15 cm of soil contains 5 to 20 tons of living creatures per hectare. The micro-organisms in the soil help to break down organic material and make nutrients available to plants. If the soil micro-organisms are in a healthy balance, they keep the disease-causing micro-organisms under control, so that they will not increase in such numbers that they will be a threat to crops. The more life there is in the soil, the more fertile the soil will be. Chemicals kill the life in the soil.
4 PREVENTION
Prevention is always better than cure. By creating a healthy environment, you will not have serious problems with pests and diseases. It is possible to create a pest disease-discouraging environment. The following methods should help with this:

- Garden sanitation
- Timing of planting
- Plant spacing
- Mixed cropping
- Correct plant feeding
- Resistant or tolerant varieties of plants
- Cultivation methods
- Protecting crops with other plants

4.1 GARDEN SANITATION
By removing infected plant material, the chance of disease spread is reduced. Infested crop residues can be burned (although this loses valuable organic matter), or used in compost heaps (as long as they are hot enough to kill the disease causing organisms).

Try not to walk on infested soil and then on a new, clean land. The soil clinging to your boots or feet can carry the disease causing organism to the new field and other crops can be infected.

When working with infected plants, clean your hands and the implements used in the infected field, before moving on to a new area. Implements, boots and your hands can spread several of the diseases from one plant to another. Do not wash your hands in the same water that is used to water the plants. You will spread diseases.

4.2 TIMING OF PLANTING
Many pests and diseases can be avoided by planting crops when the pests and diseases are dormant or relatively inactive. This is called escape cropping. Generally, cold weather reduces pest and disease activity. It is important to know if the crops can survive the cold, if this method is to be used. By knowing the pest’s life cycle, one can partially prevent trouble with pests. Early planting and the use of fast maturing varieties are well known strategies for endemic pests to an area. Early cultivation of seedlings also gives the crop an advantage over weeds.

It is also important to plant crops in the season that they prefer. Planting crops out of season places them under stress and makes them more susceptible to pest attacks and diseases.
4.3 PLANT SPACING
Plant spacing can make a big difference, especially in the case of diseases. Most diseases like wet conditions. If plants are sown too close together, the incidence of certain diseases can be increased or favoured.

4.3 MIXED CROPPING
Crops can be inter-cropped to gain advantages such as sharing of:

- Nutrients through different uptake by different crop types.
- Space above the ground. Different crops have different growth habits, some growing closer to the ground some growing taller and can share space in this way.
- Space below the ground. Different crops have different shapes and sizes of root systems and can thus easily share space underground.
- Sunlight. Some crops are shade tolerant and need cooler conditions than others and can be planted under the partial canopies of larger crops.

4.4 CORRECT PLANT FEEDING
Pests tend to attack weak plants. It is claimed that plants grown on rich organic soils are more healthy and less attractive to pests. One of the most important minerals that helps prevent attack from pests and diseases is calcium. This mineral reinforces the cell walls in the plant itself, thus making it more difficult to be penetrated by insects and diseases.

4.4.1 Natural fertilizers
- Composted plant wastes
- Animal manure
- Green manure
- Earthworms

Composted plant wastes
Compost is the best organic fertilizer, because it contains all 16 elements or plant nutrients in the proper amounts. Compost discourages a number of diseases and it balances the soil by neutralizing it. If diseased materials are composted well, they are safe to use in the garden, as disease-causing

How to make a compost heap
Dig out a square in the soil. Put layers of coarse plant material at the bottom of the hole for drainage and air circulation.

Make layers with plant material and soil and bone meal and cover the top with soil. Put some hay right at the top of the heap. This will ensure that the heap won’t dry out.

Turn compost heaps on a regular basis to ensure good composting throughout the heap. Leave to compost.

Compost can be used as a mulch as well. A mulch is very effective in keeping the soil moist and in restricting weeds.
organisms will be killed. Composting will kill some weed seeds, but not all. Compost or humus in the soil also:

- Generates porous soils and stabilizes soil structure;
- Helps retain water in the soil and prevents nutrients from leaching out of the soil;
- Prevents soil loss from wind and water erosion;
- Generates high levels of beneficial soil organisms, especially earthworms;
- Regulates soil temperature; and
- Opens up small channels for seedling roots to follow into the soil.

**Animal manure**

Fresh manure should never be applied. **Only well-composted well matured manure should be used.** Fresh manure does not have nutrients in plant-available forms and it must first be decomposed in the soil before the nutrients become available. If manure is left in a heap to decompose, keep it covered with straw or any other organic material. If not covered, the manure can lose up to 70% of its nitrogen content before it is applied to the crops. Horse (and mule and donkey) manure and sheep (and goat) manure contain a lot more of the three main plant nutrients (nitrogen, phosphorus and potassium) than cattle and pig manure. Tests were done on the use of composted material containing mainly horse manure and straw bedding. The results concluded that the watery extracts of the compost reduced the disease incidence of powdery mildews on barley and cucumbers and late blight on tomato leaves. It seems that live micro-organisms in the compost are the “active ingredient” that reduces the disease incidence on the plants.

**Green manuring**

**Green manuring** can improve the soil structure, water retention and improve soil fertility. The following plants are commonly used as green manures: Sunnhemp, oats, mustard spinach or fodder radish and legumes such as clover, vetch and lucerne *(shown alongside)*. It is also possible to use weeds, and other plant materials as mulches. Here organic matter is left on top of the soil so that it can decompose naturally with the help of bacteria and fungi. Comfrey for example *(shown alongside)* is also a good source of minerals and specifically potassium (K).
**Earthworms**

Normal digging of the soil can help with the drainage and aeration of the soil. There are natural diggers in the soil—earthworms. They can dig just as well or even better than humans can dig with tools. Ploughing with tractors and hoes can kill many of these natural diggers and will compact the soil.

A way of increasing the fertility of the soil is to add earthworms to it. Earthworms serve several vital functions, including:

- Breaking down dead organic matter in the soil.
- Burrowing and moving under the soil, thus naturally aerating the soil.
- Providing a source of nutrients to other organisms when they die.

It is also possible and well worth while to farm with earthworms to create vermin-compost and vermi-compost liquid manure for use in gardens (shown alongside). The worms create compost from the organic matter, including kitchen scraps, crop residues, manure or almost any other organic material.

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**Making vermi-compost**

To start, use any dark container with a drainage hole at the bottom. Place a layer of stones and paper at the bottom. Fill around half the container with grass, manure, kitchen scarps and other organic matter. Place the worms in the container and continue to fill. Make sure this mixture remains moist and continue to ‘feed’ the wormery on a weekly basis. In time everything will be reduced to thick crumbly humus. The worms move to the top of the bin/container and the humus can be removed from the bottom, with a few worms, and used in garden beds.

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**4.5 RESISTANT OR TOLERANT VARIETIES OF PLANTS**

In nature it is the law that the fittest will survive. Weak plants are eliminated by pests and diseases. In traditional farming systems, farmers saved the seeds from the best plants in the crop to use for the next season. By doing this the farmers speeded up the natural selection process of nature. They also selected the best varieties for their specific area. Plants adapt to the environment they are grown in and produce
seeds that carry those local adaptations, producing healthier plants that are better able to cope with
the local environment.

Seed saving can have disadvantages as well. Seed-borne diseases can be carried over from one season
to the next by this practice.

Using modern techniques, the yields of crops can be improved through cross-breeding or hybridization.
Plant varieties are manipulated to cross, so that specific characteristics such as resistance to drought or
a particular disease for example become evident. These varieties generally would not cross in nature.
These plants are also usually bred to grow optimally with chemical fertilizers and pesticides, as well as
irrigation and will not perform as well without them. They can however still be very useful in a
gardening situation. Resistance to bacterial wilt for example is one of the few ways to deal with this
devastating and long lasting soil borne disease of crops such as potatoes, tomatoes
and cucurbits

4.6 CULTIVATION METHODS
Cultivation practices include tillage, crop rotation and mulching.

4.6.1 Tillage
Tillage modifies the soil structure and aerates the soil. By tilling the soil, pests are brought to the surface
of the soil where they can shrivel in the sun or be eaten by birds.
Warning: Tillage can also increase soil erosion and compact the soil.

4.6.2 Crop rotation
Crop rotation is the best method to control soil-borne diseases. Crop rotation will reduce the build-up of
diseases on a particular crop.

Species with few or no pests in common should be chosen (for example, crops from different plant
families). This measure is of crucial importance for the control of soil-borne diseases and pests, such as
nematodes.
If crops like sunflower, sorghum and other small grain crops are planted and the residues, after harvesting, are left on the surface to decompose they release natural herbicides called allelochemicals that can be very useful in weed control. Cover crops also suppress the growth of weeds.

Rotations can improve soil fertility, as different families add and subtract different things in their growing cycle. Legumes add nitrogen to the soil, while potatoes break up the soil, and leave their fibrous roots behind, opening up the soil structure.

Commercial farmers are beginning to see the value of crop rotation and they are getting higher yields in their crops, especially when maize is planted in a field where legumes (such as soya beans) have been growing for a season.

A four year rotation for vegetable crops is advisable. This system is shown below.

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From: The People's Farming Workbook, EDA, 1995
4.6.3 Mulching

Mulching is the process of covering the bare soil with organic matter. Mulches are beneficial to plants as they maintain uniform soil temperature and keep moisture in the soil. Mulches also add nutrients to the soil.

If mulch (grass and other organic material) is spread 15cm thick between vegetables it will keep weeds down and will also help to keep the soil moist. In this case you will not have to water the garden as often as was needed before mulching. Mulching can protect the soil against rainwater-splash.

It also acts as organic fertilizer when it breaks down. Less erosion will occur when a mulch is used.

Right: Well mulched and terraced vegetable beds, Mahlathini Organics, 2010

4.7 PROTECTING CROPS WITH OTHER PLANTS

Plants can be protected from insects and other pests by other plants.

4.7.1 Interplanting

Interplanting, also referred to as intercropping, mixed cropping or multiple cropping, is when many different crops are grown in a mixed fashion on the same piece of land.

There are a number of reasons why intercropping systems are a good method of crop protection:
Plants in a monoculture are more susceptible to pests and diseases. When plants are grown in mixed fashion, the smells and shapes of the crops are disguised and insects are not attracted to the field. Diseases attack specific crops, so if different plants are grown next to one another it restricts the spread of diseases. Insect pests and diseases spread more slowly in intercropping systems.

Right: Mixed cropping cabbages, onions and chilies have been planted in the same bed (Potshini, KZN, 2008).

When space is optimally used by ground cover and crops with dense foliage, the weed population is reduced or weakened and diseases cannot spread by soil splashing onto the leaves of the crops.

Windbreaks can also help to reduce the spread of diseases by trapping insect pests or acting as preferential hosts.

A good mix of plants encourages a healthy variety of insect life, and natural enemies of the pest species are attracted to the garden.

Inter planting sometimes involves planting alternating rows of vegetables, herbs and green manure plants (such as vetch, lupins, faba beans and lucerne), so that the different plant varieties reinforce each other, while providing enhanced protection against pests and diseases.

Strips of natural vegetation around crops can encourage predators that will help in keeping the pest population tinder control.
4.7.2 Companion planting

Companion planting is the practice of planting specific plants that support each other together. This refers to combinations of crop-producing plants that grow better and are relatively free from pests and diseases. Companion plants stimulate the growth of other plants and help protect each other from insect and disease attack.

*Right: an intercrop of companions; cabbage, spring onion and beetroot.*

Complex physical and chemical interactions occur, which may be difficult to explain fully. One of the physical interactions could be that plants with deep roots loosen up compact soil to allow plants with smaller roots to increase their nutritional catchment areas.

*Below: An intercrop of lines planted to beetroot, tomatoes and carrots. Tree tomatoes at the left hand side of the picture act as a windbreak and pest deterrent. (Gogela, EC, 2010.)*

Many plants have very good insect-repellant properties. Often they are strong-smelling plants, like onions, garlic and some herbs. Their smell masks that of the vulnerable crop.

Herbs, medicinal plants and multi-functional plants should be planted around the garden. They will bring colour and attract beneficial insects to your garden. Flowers attract many beneficial insects and also function as crop guards, especially when attracting predators.

4.7.3 Trap cropping

Marigolds

Marigolds are known to reduce root-knot nematode populations. If marigolds are inter planted with tomatoes, the tomatoes are protected from nematodes as the plant exudes allelopathic substances from its roots.

The leaves and flowers are also pest deterents and will reduce red spider mite incidence in tomatoes.

They also attract natural enemies or pest predators such as wasps.
Some plants are favoured as a host by the pest involved. They can be deliberately planted to repel the pest from the crop.

The catch crop must be destroyed by composting or burning when it becomes severely infested. Milkweed, sow thistle and nightshade (shown alongside) are favoured by aphids.

➤ This strategy does not apply to diseases. If a certain plant is vulnerable to diseases, it should be removed and destroyed.

4.8 WHERE TO START

Step 1: Feed the soil
Add organic matter to the soil – compost, manure, bone meal and other organic matter
Mulch - cover the surface of soil between crops by mulching or green manuring.
Use vermin-compost and earthworms

Step 2: Create habitats for insect predators
Plant trees and herbs in and around the garden.
Natural vegetation in and around gardens can house many beneficial insects.
Create micro-habitats using multi-purpose plants, small ponds, rocks and logs.

Step 3: Plant diversity
Replace mono-cropping with inter-planting practices.
Companion planting.
Use crop rotations.

Step 4: Reduce the use of chemicals
Use fewer pesticides, while building up your garden to the stage where no more chemicals will be needed. Do not stop using chemicals right away if you were dependent on them for a good crop.
Replace chemical fertilisers with organic fertilisers before removing all pesticides. It takes a while for the natural balance to return to your garden.
5 BIOLOGICAL PEST CONTROL

5.1 BENEFICIAL INSECTS
A relatively small number of insects can be regarded as pests. The majority of insects are harmless or do insignificant damage to crops.

Some insects are beneficial to the farmer in various ways. It is important to encourage the activities of these beneficial insects.

The beneficial insects can be divided into three major categories:

5.1.1 Natural enemies
Many insects eat other insects that are possible pests of crops. In this way the numbers of the pest insects are kept down.

These insects include:

- **Dragonflies** - Feed on insects and worms.
- **Mantids** - Feed on insects.
- **Ground beetles** - Some species feed on aphids and caterpillars, snails, fly larvae, eggs or pupae, white others are vegetarian, living on seeds or green plants.
- **Ladybirds** - Feed on aphids, leafhoppers, plant hoppers, scale insects and mites.
- **Lacewings** - The adults and the larvae prey upon many pest species such as: plant hoppers, leafhoppers, aphids, scale insects, larvae of moths and mites.
- **Ant-lions** - Feed on small crawling insects trapped in their pits.
- **Maggots of hover flies** - Feed on aphids. The flies feed on pollen and nectar.
- **Robber flies** - Feed on small flying insects and small grasshoppers.
- **Parasitic wasps** - Parasites of pest species like caterpillars. They can also parasitise the eggs of pest species.
Advantages of biological control

- The agent targets the pest species and are non-toxic to other species and to human beings.
- Once the population of biological control agents are established, it normally retains itself.
- The development of genetic resistance is minimised, because the pest and the predator develops together.

Disadvantages of biological control

- Biological agents are slow to react. You will not get immediate protection from pests.
- Predators will have to be protected from pesticides sprayed elsewhere, because most pesticides kill all insects.

5.1.2 Pollinators
Bees are the main pollinators, but insects like butterflies, moths, several fly species and some wasps can also assist in the pollination process.

5.1.3 Scavengers
Some insects live on dead organic material and help in the breakdown of plant debris in compost heaps and in gardens. Animal wastes and dead animal tissue are also broken down in this manner, e.g. dung beetles.

5.2 ENCOURAGING PREDATORS
It is important to recognize other predators of insects as well. The encouragement of predators can help control pests and diseases. A soil with a good structure can host a number of beneficial soil organisms.

Birds - Some birds feed on insects and can help in protecting your crop. Seed-eating birds will damage your crop.

Chickens - feed on insects, but can damage seedlings.
Geese are used for weeding of orchards. They will eat fruit that has dropped from the trees, preventing them from rotting and contaminating other fruit.

Chameleons - Feed on insects that can damage your crops.

Lizards - Predators of insects.

Frogs are good for controlling insect pests.

Snakes eat rodents and insects.

Spiders eat insects. The majority of spiders are harmless to human beings and they can be very helpful in keeping pests away.
6 PHYSICAL CONTROL METHODS

This is the use of physical methods to prevent or control the outbreak of pests or diseases. Physical control methods include barriers, traps and artificial guards. Some physical crop protection methods are still in use, but are mostly not regarded as important. Fly traps and sticky yellow insect traps are commonly used and very effective.

Right: A home made fly and fruit fly trap and Far right; a sticky yellow insect trap.

6.1 PROTECTIVE BORDERS AND BARRIERS

Set up boards about 10cm high around your crop and paint them with fuel or oil, or use bands made of cloth or board on larger stems or trees. These boards or bands will discourage crawling insects from getting into the crop.

A tin can open at both ends, or toilet roll centers, can be placed over seedlings as collars to keep cutworms away from the seedlings. They should be pushed firmly into the soil (Shown alongside).

6.2 TRAPS

Snail and slug traps

– Stale beer in a shallow plate or container, dug into the ground. The slug or snail will crawl into the liquid and drown. Other liquids containing yeast will also act as baits.

– An inverted cabbage leaf placed on the ground will attract snails, slugs, cutworms and other pests that hide during the day and forage at night.

Right: A beer trap for snails and slugs.

Ants can be lured into containers baited with sugar water, fats or any other food residue.

Grasshoppers are attracted by all kinds of scents: citrus fruit, lemon or vanilla extracts, beer, vinegar, salt, soap and smoke.
Cockroaches can be trapped by greasing the inner neck of a bottle baited with a raw potato or stale beer.

Some flying insects can be attracted by light. Red, orange and yellow lights are avoided or ignored by almost all insects.

Aphids, wasps and all kind of flies are attracted to the colour yellow. A trap can be made with a shallow yellow-painted bowl, filled with soapy water.

Many insects are attracted to different colours. Try experimenting with different colours. The collected pests can provide food for fish and chickens.

Rodents can be trapped in several ways. It is important to place the traps in the regular paths of the rodents, and they must be attractive to the rodents, so that they will investigate and not avoid the trap.

Rodents can be trapped and drowned when a large bucket is dug into the soil and almost filled with water. About 3 cm below the top edge a line of peanut butter is smeared. The animals fall into the trap and drown when trying to eat the peanut butter.

6.3 ARTIFICIAL GUARDS
Black cotton threads can be used to scare birds away from crops. The threads should be spread wide and loosely between the branches of fruit trees or around crops. The birds will fly into the threads and be scared away, without being trapped.

Scarecrows, cans and aluminium foil strips on strings, as well as old cds’ can be very effective in scaring birds and other animals away shown alongside). Care should be taken to move them on a regular basis so that the animals don’t get used to them.

Rodents and seed-eating birds can be scared by cutting out cardboard silhouettes of owls or other birds of prey and suspending them over the ground by attaching them to a rope and on top of a high pole. The shadow is cast on the ground and is mistaken for the real thing (shown alongside).

Other physical control methods
Burning of infected plant material, ploughing back, etc., can be regarded as physical control.
Pupated maize stalk borers can be destroyed by making animal feed or fuel out of the maize stalks.

Stored beans can be protected by storing them in sand.

Weeds should be slashed before they flower to reduce reproduction by seeds.

Ants can be controlled by constantly destroying their nests and re-mixing the soil.

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**Hot water seed treatment to eliminate seed borne diseases**

Seed can be treated using the following process:
- Place 250g of seed in a cotton back
- Soak the seed for 30 seconds in cold water and for 20 minutes in water heated to and maintained at 50°C (just too hot to touch)
- Cool the seed in fresh cold water
- Spread immediately in the shade to dry

Most plant material such as bulbs, rhizomes, tubers and cuttings can be treated in this way to reduce or eliminate disease.
7 BOTANICAL REMEDIES

7.1 REMEDIES MADE FROM PLANT MATERIAL

In this chapter a few recipes for plant mixtures are given that can be used to control insects and diseases. **Be sure to read the warnings, where present, carefully. No responsibility will be taken for damage to plants, animals, people or property.**

Spraying with herbal poisons or plant teas can control pests and diseases to a large extent. Some of the most widely used insecticides originally came from plants. The flowers, leaves, or roots have been finely ground and used in this form, or the toxic ingredients have been extracted and used alone or in mixtures with other toxicants. The active chemical from the plant was then identified and reproduced as a synthetic chemical in the laboratory and sold as a chemical. These synthetic chemicals have the same properties as the natural chemicals but do not break down as easily as the natural chemicals and can thus damage the environment.

Another advantage of natural or organic remedies is that they are cheap. **But it must be realized that some organic remedies are as poisonous as some chemicals and that some chemicals are less poisonous than some of the organic remedies.**

Many plants with control possibilities are known and probably many others are yet to be discovered. Leaves of many strong-smelling, bitter-tasting plants like gums, lantana, khaki weed, tomato or any other herbs have great potential for insect sprays. Plants that do not get attacked while in among affected plants are also potential remedies.

At least 3000 plant species have already been studied in laboratories to determine their effectiveness for controlling plant pests and diseases. Of these, approximately 1800 plants have been shown to be more or less effective against certain pests.

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**General points regarding aromatic plant sprays**

Sprays can be made up from the chopped up leaves of different strong smelling plants. Plants like garlic, chilli and onion work well.

The sprays have to be re-applied after rain or irrigation as they are washed off with water.

Green bar soap can be added to make the spray stick to the plants and the insects.

Generally the sprays are made up in 1 liter of water. They are diluted from there; 1 part solution to four parts water before being applied.

Most botanical insecticides are contact poisons. Spraying has to be done rather intensively to ensure all insects have been covered by the spray.

Sunlight breaks down the sprays, so they should be prepared and stored out of direct sunlight.

Some crops are damaged by sap from other plants and it is possible for some of these remedies to ‘burn’ the leaves of plants they are applied to. Always test a new remedy on a small number of plants first.

For most applications against insects the best time of day to spray is in the late afternoon.
7.1.1 Agave (Agave spp.)

Other names
English: American agave, invading agave, sisal
Afrikaans: Garingboom

Plant description
Large plant with big fleshy leaves growing in a rosette from the base of the plant. The plant has a pale grey-green colour. The leaves are thick and heavy and contain tough fibers. The plant itself can grow up to 2m high and a flowering pole is produced that can be as high as 5-9m. The flowers are pale yellow. This plant is an invader in South Africa.

Targets
Insects in general.

Method
Crush plant parts in water, (1 part plant material to five parts water or less) and use as a field spray. Leaves can also be cut and boiled and cooled before the extract is sprayed. Dry and grind plant parts for dusting.

7.1.2 Aloe (Aloe spp.)

Other names
Afrikaans: Aalwyn
Zulu: Umhlaba, inhlaba, isikutsha, unhabana

Plant description
Succulent plant with a single upright stem. There are a number of different species that differ considerably in height and growth habit. The edges of the thick leaves are covered in thorns and sometimes the surfaces of the leaves as well. Flowers are small, orange to yellow and are carried in plumes. The plant has a very bitter taste. Aloes are very abundant in KwaZulu-Natal.

Targets
Insects in general: pests in stored grain and termites (*Shown alongside*).

Method
Crush plant parts in water, (1 part plant material to five parts water or less) and use as a field spray. Or boil and cool before spraying. Dry and grind materials for dusting.
7.1.3 Amaranth (*Amaranthus* spp.)

**Other names**
- English: Pigweed
- Afrikaans: Misbredie, rooikatstert
- Zulu: Imbuya

**Plant description**
Upright, annual weed. Stems are rough and can have a red tinge. Flowers are very small and carried in a spike on the growing tips. Flowers can be red or green in colour. Plants can grow up to 2m high. This plant is used and sold as a spinach. If cattle eat large quantities of this plant, they may be poisoned and die.

**Targets**
Various fungi, such as:
*Alternaria* - fruit rot, early blight, purple blotch, leaf spot.

*Right: Alternaria symptoms on cabbage (above and tomato (below) In tomatoes it is known as late blight*

*Cercospora* - leaf mould, leaf spot, early blight, frog-eye
*Colletotrichum* - leaf spot, anthracnose, fruit rot, smudge.
*Curvularia* - leaf spot, leaf blight.
*Helminthosporium* - leaf blight.
*Pestalotia* - leaf spot.

**Method**
Extract the juice of 1 kg leaves, then mix the juice with 3 litres of water and use as a spray.

7.1.4 Basil (*Ocimum basilicum*)

**Other names**
- English: Sweet basil
- Afrikaans: Basiliekruid
- Zulu: Amakha

**Plant description**
Herbaceous plant with light green leaves, sometimes with a purple tinge on the underside. Whitish flowers are produced. A delightful smell is released when the leaves are bruised.
**Targets**
Insects in general: flies, mosquitoes, aphids, cockroaches, cotton strainers, mites and ticks.
Fungi in general.

**Method**
The oil of this plant has been used to control pests in fields and buildings. Various extracts can be prepared from dried and powdered leaves, flowers or the entire plant. Whole plants, when dried, can act as an insect repellent. Dusting powder can be made by drying the leaves in the sun.

Soak crushed leaves in water for 24 hours, filter and spray, or drench the soil before planting. Basil is traditionally used for treating seedbeds against all kinds of soil-borne diseases and pests.

### 7.1.5 Blackjack (*Bidens pilosa*)

**Other names**
- English: Common blackjack
- Afrikaans: Gewone knapsekérel, wewenaar
- Zulu: Amalenjane, uqadolo, ucucuza

**Plant description**
Annual weed. Flowers are white with yellow centers. Seeds are small, black and slender with little claws on one end. These seeds can stick to your clothes or to an animal’s fur.

**Targets**
Insects in general: aphids, ants, beetles, cabbage root fly, caterpillars, crickets, mites, termites and whitefly.

**Method**
All the plant parts can be used, but in particular the mature seeds. Cover a cupful of mature seeds with water, boil for 10 min (or soak for 24 hours), cool, add 1 litre of water and a teaspoon of soap and spray immediately. Seeds can be spread around bushes to deter termites. If this method is used the plants can get out of hand, creating a weed problem.

**Warning**
High concentrations may affect the flowers of some plants.
7.1.6 Black pepper (*Piper nigrum*)

**Other names**
Afrikaans: Swartpeper  
Zulu: Uphepha, upelepele

**Plant description**
Fruits are small and round and carried in spikes. Colour of seeds changes from green to black or red. The seeds have a spicy taste.

**Targets**
Insects: cotton stainers, diamond back moths, cutworms and maize weevils.

*Right: typical diamond back moth damage on cabbage*

**Method**
Crush the seeds, mix with water and spray. The powder can also be spread around stored grains.

7.1.7 Cassava (*Manihot esculenta*)

**Other names**
Afrikaans: Kassawe, broodwortel  
Zulu: Indumbula, umdumbula

**Plant description**
Shrub-like plant that can grow up to 2 m high. Leaves are dark green and shiny. The leaves are lobed and have about 6 fingers per leaf. This plant produces big fleshy roots that are very rich in starch. The leaves are rich in protein.

**Targets**
Nematodes and aphids.

**Method**
Obtain juice by crushing roots, dilute 1:1 with water, spray immediately, using 4 litres diluted extract per square metre. Wait 20 days before sowing and then use cassava peelings as a mulch against nematodes. The starchy extract after boiling cassava can be used on aphids.
**7.1.8 Castor oil plant (Ricinus communis)**

**Other names**
Afrikaans: Kaster-olie boom, bloubottel boom
Zulu: Inhlakuva, udlatshana, umhlakuva, umhlafutho

**Plant description**
Annual shrub or small tree. It is an invader in South Africa. It can grow up to 4m tall. The leaves are dark green and shiny, with a reddish tinge. The leaves are divided into five to nine lobes or fingers. Flowers are cream to reddish in colour. The fruit are green, brown or reddish and covered in soft spines.

**Targets**
Insects in general: aphids, leaf cutting ants, caterpillars, cutworms, mites, stink bugs, termites, fleas, lice, ticks and storage insect pests.
Fungi: Anthracnose, brown patch, damping off root rot,
*Colletorichum*,
*Fusarium* spp.,
*Rhizoctonia*.

Nematodes.
Moles and rats.

**Method**
As a general spray, soak green seeds, leaves and roots in water for 24 hours, filter and spray or drench the soil. It is also effective against human and animal ecto-parasites like fleas and lice.

Dry seeds and leaves and grind for dusting powder. Varieties with red stems are said to be more effective than those with green stems.

For cutworm: put 4 cups of crushed shelled seeds into 2 litres of water, boil for 10 minutes, add 2 teaspoons of paraffin and some soap, dilute to 10 litres and water immediately into the soil.

Growing plants can be protected against ground-dwelling nematodes. By digging seeds or leaves into the soil some fungal diseases will be killed. This works very well if the soil is treated in this way 3 weeks before planting. Mulch with branches and leaves to repel termites.
The oil of the caster-oil plant is used for protection of stored peas and beans against storage pests and weevils, by mixing it with the seeds to be protected. Five to 10 ml per kg are sufficient to ensure good protection for 4 to 6 months. No effects have been experienced by people or animals that ate food treated in this way. Put green seeds into mole holes or rat nests as an effective repellant.

**Warning**
Seeds are poisonous to human beings, and poultry. Ten seeds can be fatal to adults and even one seed can be fatal to a child. No adverse effects have been noted for the oil from the castor oil plant.

### 7.1.9 Chilli (Capsicum frutescens)

**Other names**
- English: Hot pepper
- Afrikaans: Rissie
- Zulu: Ibelebile, upelepele

**Plant description**
Small shrub-like plant with a shiny leaf. Bears small red fruit with a very strong, stinging taste.

**Targets**
- Insects in general: aphids, ants, cabbage worms, caterpillars, cutworms, rice moths and storage insect pests.
- Slugs and snails.
- Fungi and bacteria in general.
- Viruses: Cucumber Mosaic Virus *(shown alongside)* and ringspot virus.

**Method**
Grind 2 handfuls of ripe chilli pods, soak in 1 litre of water for 1 day. Shake well for a few minutes, filter, and add 5 litres of water and a little soap. Sieve and spray.

Chilli powder can be applied around the base of plants to repel ants, cutworm, slugs, snails, and a wide range of soil pests. Chillies are often planted as a repellant.
7.1.10 Citronella grass (*Cymbopogon nardus*)

**Other names**
- Afrikaans: Tamboekiegras
- Zulu: Isicunge, isiqunga, iwozawoza, usukasihamba, umtshiki

**Plant description**
Perennial grass that is aromatic, similar to lemon grass. It grows in temperate and tropical areas and can grow up to 2 metres high.

**Targets**
- Insects: storage pests, cockroaches, mosquitoes, fruit flies and various human and animal ecto-parasites.
- Fungi: *Aspergillus niger* (shown alongside) and *Macrophomina phaseolina*.
- Bacteria: *Erwinia carotovora*.

**Method**
Crops can be protected from fungal and bacterial diseases by spraying them with the oil of *C. nardus*.

The oil of this plant also has a strong repellent effect on mosquitoes, cockroaches, human and animal ecto-parasites, etc. It has a strong attractant effect on fruit flies. This property could be used to lure the pests into glue-coated traps.

**Warning**
Leaves of crops can be burned if the mixture is too strong. Avoid contact with eyes and skin as this can result in severe irritation. Only use disease free chilli plants, otherwise the viruses or other organisms can be passed on to the plant being sprayed.
7.1.11 Finger millet (*Eleusine coracane*)

**Plant description**
This is a small grain crop with grass like leaves. Grains are carried in fingers at the top end of the stem.

**Targets**
Insects in general: army worms, caterpillars, cutworms and fruit flies.
Snails.

**Method**
Use the residues as mulch for soil pests.
Grow as a trap crop for armyworm.
Soak the residue in water for spraying fruit fly and other insects.

7.1.12 French marigold (*Tagetes patula*)

**Other names**
Afrikaans: Afrikaners
Zulu: Uhiobo iwesitliambo esinezimbali eziliphuzi

African marigolds (*Tagetes erecta*) are very similar and have similar properties

**Plant description**
Herbaceous plant with a yellow or orange flower. It is known as an ornamental plant. The leaves of this plant are strongly aromatic.

**Targets**
Insects in general: rice green leafhoppers, brown plant hoppers, diamond back moths, black bean aphids, aphids, ants, beetles, cotton stainers, flies, maize borers and storage insect pests.

Fungi in general: *Cochilobolus miyabeanus* (*Helminthosporium oryzae*), *Pyricularia oryzae*, *Uramyces appendiculatus* (*Uramyces phaseoli*) and late blight.
Nematodes in general.
Bacteria in general.
It can suppress some weeds.

**Method**
Crush 100-200g of leaves, roots, flowers, pour on 1 litre of boiling water, soak for 24 hours, add 1 litre of cold water and some green bar soap, mix and spray on plants or into soil.

Soak 10 to 15 mature, chopped marigold plants in 20 litres of boiled hot water. Add sieved wood ash. Strain and spray the affected plants or water around them. The coarse materials remaining from the solution can be used as a mulch around plants and to repel insects.

Usually, the *Tagetes* spp. have been planted together with other plants susceptible to attack by nematodes; the roots exude a substance with nematicidal effect, qualifying marigolds as natural enemies of free-living nematodes that attack the roots of plants. For a mixture that can kill nematodes, pound around 1kg of roots, collect the extract, mix with 1 litre water and spray into the soil.

Leaves of marigold can be dug into the soil or the tea sprinkled on the soil to discourage many insects from feeding. The leaves can also be mixed with stored grain to prevent damage.

A number of pests can also be controlled by dusting plants with dried and powdered parts of *Tagetes erecta*.

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**7.1.13 Garlic (Allium sativum)**

**Other names**
- Afrikaans: Knoffel
- Zulu: Ugaliga

**Plant description**
Strong-smelling bulbous herb.

**Targets**
Insects in general:
- mosquitoes, cotton stainers, aphids, flies, army worms, ticks, ants, beetles, caterpillars, diamondback moths, false codling moths, grubs, mites, peach borers and termites.

The flowers, in powdered form are added to the feed of laying chickens to give the yolk of the eggs a bright orange colour.

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False codling moth larvae and moth
Others: birds, mice, moles, mole rats and nematodes.  

Right: A mole rat. Notice large teeth. These creatures eat roots and bulbs of plants.

Far right: A cape mole. They have very pronounced claws, eyes are sometimes so small as to be almost invisible and they are insectivorous.

**Fungi**: scab, mildew, bean rust and tomato blight.

*Alternaria* - fruit rot, early blight, purple blotch, leaf spot.

*Cercospora* - leaf mould, leaf spot, early blight, frog-eye.

*Colletotrichum* - leaf spot, anthracnose, fruit rot, smudge.

*Curvularia* - leaf spot, leaf blight.

*Diplodia* - fruit and stem rot.

*Fusarium* - damping off, stein and root rot, early blight, wilt and curly top.

*Helminthosporium* - leaf blight.

*Pestalotia* - leaf spot.

*Cochliobolus miyabeanus* (*Helminthosporium oryzae*).

*Pyricidaria oryzae*.

**Bacteria**: *Xanthomonas* spp.

Right: Bacterial blight on strawberries, caused by *Xanthomonas campestris*

**Method**
Chop some cloves finely (one large bulb, or two medium bulbs) and soak in 2 teaspoons of oil for one day or in liquid paraffin for two days. Use a glass jar, not a tin. Mix with half a litre of soapy water and filter. Mix 1 part solution with 10 parts of water and use as a spray. Shake well before applying.

The bulbs can be dried, crushed and used as a powder. The powder can be made into a spray recommended for scab, mildew, bean rust and tomato blight.
Garlic planted around fruit trees and other plants will repel aphids, beetles, fruit tree borers like peach borer, mice, moles and termites. Garlic bulbs are often planted as a repellant.

**Warning**
Garlic is a broad spectrum insecticide which will kill beneficial insects as well as pests. Do not use on legumes as garlic inhibits the growth of the nitrogen fixing bacteria. For the same reason garlic is not inter-cropped with legumes.

7.1.14 Ginger (Zingiber officinale)

**Other names**
- Afrikaans: Gemmer
- Zulu: Ujinja

**Plant description**
Herb with a fleshy root with a strong smell and a strong taste. It is widely used in food for seasoning.

**Targets**
Fungi: *Cercospora* - leaf mould, leaf spot, early blight, frog-eye.

**Method**
Extract the juice from the rhizome and use it as a spray.

7.1.15 Goat weed (Ageratum conyzoides)

**Other names**
- English: Blue weed, billy-goat weed, invading ageratum
- Afrikaans: Indringer-ageratum, bokkruid

**Plant description**
Invader in South Africa. It is an annual plant that can grow up to 1.5m high. Stems are green, purplish or reddish in colour with bright green leaves. The flowers are fluffy blue, white or purplish.

**Targets**
Insects in general: diamond back moths, cotton stainers, flies, snout beetles, maize weevils and beetles in stored products.
Nematodes.
Bacteria in general. Weeds in general.

**Method**
Dried and powdered plant material can be used, or water extracts can be sprayed. Simply by planting goat weed, neighboring plants are protected from pest attack. It can also be used as a mulch.

7.1.16 Gum tree (*Eucalyptus* spp.)

**Other names**
Afrikaans: Bloekomboom
Zulu: Impisikayihlangulwa, umdlavusa, umdlebe

**Plant description**
Tall evergreen tree with smooth bark, peeling in long thin strips, revealing the new, light grey coloured, smooth bark. Leaves are dark green and glossy. Flowers are cream coloured.

**Targets**
Insects in general: stalk borer moths.

**Method**
Take some of the young leaves, dry and grind them into a powder for dusting. Crush fresh leaves in water until the water is green, add a little soap and spray. The powder mixed with water has been used as a spray to repel stalk borer moths, at the times when the moths are active.

**Warning**
This mixture can burn plants.
7.1.17 Lantana (Lantana camara)

Other names
English: Tickberry
Afrikaans: Gomdagga
Zulu: Ubuhobhe

Plant description
Invader that is a woody shrub up to 2m high. Stems are usually rough. Leaves are dark green and strong smelling when crushed. Flowers can be pink, red, crimson, orange, yellow or white. Flowers are small and compact, usually with more than one colour per flowerhead. Fruit are clumps of green to purplish-black, fleshy fruit.

Targets
Insects in general: maize weevils, beetles, leaf miners and insects in stored grain.

Method
Crush 1 handful of leaves in 1 litre of water, add a little soap and spray. Dry and grind into a dusting powder. Burn the branches and dust the ashes over beetles and leaf miners. Pound the flowers, leaves and/or branches and spread around stored grains as an insect repellant.

Warning
Poisonous to cattle - causes photosensitivity

7.1.18 Lemon grass (Andropogon citratus)

Other names
Afrikaans: Sitroengras, lemoengras, suurpol

Plant description
Tall grass with a strong lemon smell when crushed.

Targets
Insects in general: storage pests, mosquitoes, aphids, flies, mites and ticks.
Nematodes: Meloidogyne incognita.
Method
If an emulsion, containing oil, is sprayed onto pest-afflicted crops, it destroys aphids, mites and ticks. Just by rubbing the fresh leaves of this plant onto a surface keeps away flies and mosquitoes. The burning of the plant oil also repels insects. A diluted solution of the juice obtained by pressing out the roots can also be used effectively for pest control. For control of nematodes, it is recommended to grow the grass on infested plots. This results in a rapid decrease in the nematode population in the soil.

7.1.20 Mexican marigold (Tagetes minuta)

Other names
English: Tall khaki weed
Afrikaans: Kakiebos, langkakiebos

Plant description
Herbaceous weed with a very strong smell. Small yellow flowers are produced on the plants.

Targets
Insects in general: ants, aphids, blowflies, caterpillars, flies, fleas, maggots, mosquitoes and termites.
Fungi in general: Late blight and mildews.

Nematodes in general

Method
Soak crushed parts of 1 mature plant in 2 litres of water for 24 hours, filter and spray. A handful of wood ash can be added to improve the insect range. Apply weekly for prevention of fungal diseases.

Ants can be repelled either by watering the liquid from the crushed plants well into the soil around the plants to be protected or by digging the freshly crushed leaves of Tagetes into the soil before planting.

Grow in rotation for nematode control. Dry and grind for dusting powder against fleas, etc. Leaves rubbed on the skin will repel mosquitoes. The Mexican marigold can also be used as a soil improver.
7.1.21 Mexican poppy (*Agromone mexicana*)

**Other names**
Afhkaans: Bloudistel, Mexikanse papawer
Zulu: Uhlobo lwembali okwenziwa ngayo i-ophiyamu

**Plant description**
Herbaceous annual with pretty open yellow to orange flowers. The flowers can look floppy and wrinkled. The fruit is a capsule that holds seed.

**Targets**
Insects in general: stem borers, termites, ants, cotton stainers, army worms, snout beetles, beetles, caterpillars, grubs and weevils.
Fungi in general: *Alternaria alternata* (*Alternaria tenuis*) and *Cochliobolus miyabeanus* (*Helminthosporium oryzae*).
Nematodes in general: *Meloidogyne incognita* and *Meloidogyne javanica*.
Bacteria in general.

**Method**
Water extracts, obtained from either the seeds or the whole plant, control some pests. The oil of the plant is the best and is used for repelling ants and termites.

Dusting plants with the seeds of the Mexican poppy in powdered form is a quite successful method of controlling pests.

7.1.22 Onion (*Allium cepa*)

**Other names**
Aftikaans: Ui
Zulu: U-anychini

**Plant description**
Strong-smelling, bulbous herb. Juice droplets irritate the human eye.

**Targets**
Insects: aphids, ants, cabbage butterfly, mites, scale insects, thrips, tomato flies, ticks and whitefly.
Fungi: *Cercospora* - leaf mould, leaf spot, early blight, frog-eye.
*Colletotrichum* - leaf spot, anthracnose, fruit rot, smudge.
*Curvularia* - leaf spot, leaf blight.
*Fusarium* - damping off, stem and root rot, early blight, wilt and curly top.
*Helminthosporium* - leaf blight.
Pestalotia - leaf spot.
Animals: mice and moles.

**Method**
Crush 500g of onions and add to 5 litres of water and leave for 24 hours. Strain and spray.

Chop some cloves finely and soak in 2 teaspoons of oil for one day. Mix with half a litre of soapy water and filter. Mix 1 part solution with 20 parts water and use it as a spray.

Onions can be planted to repel cabbage butterfly, mice, moles and other pests. Onion flowers attract pest predators, like parasitic wasps to the garden.

### 7.1.23 Pawpaw (*Carica papaya*)

**Other names**
- Afrikaans: Papaja
- Zulu: Upopo

**Plant description**
Tropical tree with round hollow stem that produces big yellow to orange coloured fruit. The fruit is soft, with lots of small black pips inside.

**Targets**
- Insects in general: army worms, aphids, caterpillars, cutworms and termites.
- Fungi in general: coffee rust, powdery mildew, rice brown leaf spot - *Cochliobolus miyabeanus (shown alongside)*
- *Cercospora* - leaf mould, leaf spot, early blight, frog-eye.
- *Diplodia* - fruit and stem rot.
- Nematodes in general: root-knot nematodes.

**Method**
Add 1kg of finely shredded leaves to 1 litre of water, shake vigorously, filter and add 4 litres of water. Add 2 teaspoons of paraffin and a little soap. Spray or water into the soil for cutworm. Used as a spray the solution is also effective for controlling fungi.

A juice obtained by pressing out the roots has been shown to destroy nematodes when worked into the soil. Extract the juice from immature fruit to control termites.
7.1.24 Pyrethrum (Chrysanthemum spp.)

Other names
Afrikaans: Krisant, aster, madeliefie

Plant description
Herbaceous ornamental plant which produces daisy-like flowers of different colours: white and yellow, pink, orange or just yellow. The variety with white flowers is the preferred variety for insecticidal properties.

Targets
Insects in general: white flies leafhoppers, spider mites, cabbage worms, aphids, cockroaches, flies, mosquitos, caterpillars, tobacco lice, beetles, locusts, mites, thrips and moths.

Method
Pyrethrum is a traditionally well-known insect poison derived from the daisy species (Chrysanthemum spp.). Pyrethrin in the plant acts as a nerve and contact poison on insects, but is harmless for all warm-blooded creatures (human beings and animals).

To obtain natural pyrethrin, the flower heads of Chrysanthemum are gathered by hand and dried. The powder can be applied mixed either with gypsum or talc. The effectiveness of the powder increases if ground finer. Make sure that you dust the underside of the leaves. Under favourable conditions, the flowers can be harvested throughout the year.

Draw one tablespoon of pyrethrum powder in half a litre of water, with a little liquid soap for 30 min. Filtrate and spray immediately.

Pour 1 litre of boiling water over 50g pyrethrum flowers (or 20g powder), soak for several hours, add a little soap, filter and spray. Apply late in the evening and spray selectively to protect beneficial insects.

The active constituents of Chrysanthemum spp. rapidly decompose when exposed to light and oxygen (within 48 hours). As a result, crops must be treated at relatively short intervals.
7.1.25 Soyabean (*Glycine max*)

**Other names**
Afrikaans: Sojaboon
Zulu: Uhlobo lukabhontshisi, usoya

**Plant description**
Legume, produced widely as a valuable food source. The whole plant is covered in short hairs. Pods are very high in protein.

**Targets**
Insects in general: ants, woolly aphids and codling moths.

**Method**
The spray is prepared by soaking the stems in water and using the water as a spray.

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7.1.27 Sweet peppers (*Capsicum annuum*)

**Other names**
Afrikaans: Soetrissie

**Plant description**
Small, shrub-like plant, with shiny leaves. Produces large hollow green fruit. The fruit has a sweet spicy taste.

**Targets**
Viruses in general: Mosaic virus.

**Method**
The juice from sweet peppers will control mosaic virus and inhibit the spread of other viruses.

**Warning**
Be sure to use plants that are not infected by any kind of virus, as this will only spread the virus to the plants being sprayed.
7.1.27 Sweet potato (*Ipomoea batatas*)

**Other names**
- Afrikaans: Patat
- Zulu: Ubhatata, umhlaza

**Plant description**
Vine with underground swollen roots that are used as a food source. The swollen roots can have a dark red skin with white flesh or a more brown-coloured skin. The flesh can also be orange, depending on the cultivar. The roots are rich in starch.

**Targets**
- Insects: aphids.
- Fungi in general: rice brown spot mid rice blast fungus.

**Method**
The leaves are crushed, soaked in water and sprayed. Heavily starched water from cooking the potatoes can be tried on some smaller insects such as aphids.

7.1.28 Syringa (*Melia azedarach*)

**Other names**
- English: Chinaberry tree, Persian lilac, umbrella tree
- Afrikaans: Bessieboom, Kaapse sering, makboom
- Zulu: Umsilinga

**Plant description**
Deciduous tree with small, purplish flowers and small, yellow, berry-like fruit. It is a declared weed.

**Targets**
- Insects in general: ants, aphids, armyworms, beetles, bollworms, cabbage root fly, caterpillars, plant- and leaf-hoppers, grubs, stem borers, weevils, red spider mites and termites.
- Fungi and nematodes in general.
Method
Soak 150g fresh (or 50g dried) leaves in 1 litre cold water for 24 hours, filter and spray.

A handful of leaves and berries boiled in 5 litres of water is said to make a general fungicide and insecticide. The mixture will repel moles if made stronger.

For termites: mulch with leaves and berries or dig them into planting holes; dry and grind plant parts for dusting powder.

Warning
The syringa berries are poisonous. The mixture can burn your plants, so ensure you dilute your mixtures and try them out on a few plants first.

7.1.29 Tea (Cammelia sinensis)

Other names
Afrikaans: Tee
Zulu: Itiye

Plant description
Shrub with leaves that are very rich in caffeine. The leaves are used to make teas. The bush also produces small white flowers.

Targets
Insects in general: woolly aphids, squash bugs and termites. Snails.

Method
The used leaves can be spread around plants to repel snails.
The liquid (tea) when cooled can be sprayed onto plants.

The fruit can be soaked in water and used to repel termites (shown alongside).
7.1.30 Thorn apple (Datura stramonium)

Other names
English: Jimson weed, apple of Peru, prickly apple, purple stink weed
Afrikaans: Olieboom, stinkblaar, blou stinkblaar, makolieboom
Zulu: iloyi, iyoli, iyoye, iyoyi

Plant description
Annual weed, grows up to 1m in height and has a distinct smell when crushed. Flowers are trumpet-like and can be white or purplish in colour. Fruit are born in capsules covered with short, soft spikes.

Targets
Insects in general: aphids, caterpillars, silk moths, seed weevils, cotton stainers, white grubs, army worms, cut worms.
Fungi in general: Alternaria alternata (Alternaria tenuis), Cochliobolus myiabeanus (Helminthosporium oryzae).
Nematodes.
Others: human and animal ecto-parasites.

Method
This plant can be used in pest control just by drying and powdering the leaves, stems and/or seeds and dusting afflicted crops with it.
For protection of stored produce, dried thorn apple leaves can be mixed in with the products.
Crush a handful of leaves in 1 litre of water, add a little soap, and use as a spray.

Warning
The plant is poisonous to human beings and animals (‘Malpitte’ in Afrikaans)

7.1.31 Tobacco (Nicotiana tabacum)

Other names
Afrikaans: Tabak
Zulu: Ugwayi

Plant description
Herbaceous plant with large, broad leaves that are pointed at the tip. The leaves are rich in nicotine and are used in cigarettes.

Targets
Insects in general: aphids, caterpillars, mites, stem borers, thrips, leaf miners, whitefly, leafhoppers, flea beetles, grain weevils, fleas, lawn caterpillars, scale insects, termites, ticks and spider mites. Fungi in general: rust.
Viruses in general: leaf curl virus.
Others: bilharzia snails, slugs and snails.

**Method**
It is estimated that nicotine extracts from tobacco have been used as insecticides since 1890. The extract is more effective during warm weather, but degrades quickly.

The whole plant can be used: soak 1 kg of bruised leaves and stalks in 15 litres of water for 24 hours. The solution is strained and a little soap added. The addition of slaked lime will increase the effectiveness of the spray. When the nicotine is exposed to sunlight, it breaks down within a few days. Use as a general spray.

A nicotine spray can be made using 10 cigarettes (or 50g of pipe tobacco or 50g tobacco dust). Put in 5 litres of hot water for 24 hours, strain, dilute with 25 litres of water and spray.

Dry and grind the plant very finely into a powder for dusting onto pests.
Dust on trees and crops to repel insects and to control leaf curl virus.

Mulch with scrap leaves to repel slugs and snails, nymphs and larvae hiding in the soil, or in other mulching material, and to repel aphids, flea beetles and thrips.

**Warning**
Tobacco is one of the natural remedies that is more poisonous than some chemicals.
Avoid contact with the liquid forms, use protective clothing when spraying or use a watering can. Be careful when using this spray as tobacco can be absorbed through the skin.
Do not harvest plants within 3 days of spraying.
Tobacco sprays can burn the leaves of plants, do dilute and use carefully.
Do not use the tobacco spray on the Solanacea family (tomatoes, potatoes, brinjals and peepers), as you may transfer tobacco mosaic virus to your plants.

Nicotine can kill earthworms and other beneficial soil organisms. Nicotine is poisonous to fish.
7.1.32 Tomato (Lycopersicon esculentum)

Other names
Afrikaans: Tamatie
Zulu: Utamatisi

Plant description
Small herbaceous plant with bright to dark green leaves. The plant produces a red fruit and is very common in vegetable gardens.

Targets
Insects in general: aphids, ants, asparagus beetles, cabbage worms, caterpillars, cockroaches, diamond back moths, flies, grasshoppers, grubs, larvae, mites, ticks, tomato hornworms, whitefly and maize borer.
Fungi in general.
Nematodes in general: *Hoplolaimus* spp. and *Tylenchorhynchus dubius*.
Bacteria in general: *Pseudomonas solanacearum*, bacterial wilt.

Method
Tomatoes have the properties of a feeding inhibitor and repellant.
Tomatoes also prevent egg laying in various insects.

Any plant part may be used to make a tea. Fresh leaves are best for making extracts but should be used immediately; these can be supplemented by stems and fruit (new growth). The plant material should be finely chopped and mixed with water. Take 2 handfuls of new growth and add to 2 litres of water. After waiting at least 5 hours, the mixture should be filtered and applied. A little soap can be added. Wood ash can also be added. Spray every 2 days.

Tomatoes planted around other plants will protect those plants from asparagus beetles. The whole plant hung up in orchards or in houses is said to protect the fruit trees from many insects and the houses from cockroaches.

Warning
The leaves are poisonous to human beings.
7.2 ENRICHED SPRAYS

Enriched sprays are liquid manures/teas that assist both with fertility and protection against pest and disease control.

These sprays build up the immunity of plant, assist with minor nutrient and mineral deficiencies balancing the nutrient uptake of plants as well as the microbial populations on the plant and in the soil around the plant. In the process of fermentation antibiotics develop that kill disease causing organism. The plants’ resistance is stimulated in the process.

The following sprays have been used in South America with great success, by Maria José Guazzelli, of Future Earth:

**Tips on mixtures**
If you do not have sugarcane or sugar, you can replace it with produce high in starch such as potatoes.

Urine can be used instead of milk, as it speeds up the fermentation process. Fish and cattle rumen can also be used to ferment the mixture.

Bones and horn contain phosphorous, calcium (Ca) and magnesium (Mg)

Agricultural lime contains Ca and Mg and can be replaced by egg shells

Diseased produce can be used in the mixtures – the disease causing organism are killed by the fermentation process.

It is important to dilute the mixtures before applying them to the leaves of crops, or they might burn the plants.

**NB: Eucalyptus, Suringa and Lantana should not be used for any of the enriched sprays.**

7.2.1 Vegetable & weed spray

This is a good all purpose spray that can be used as a foliar feed and to water the plants and the soil around the plants.

Mix the following ingredients in a 100 L container:

- 2.5 kg of chopped sugarcane
- 1 L milk
- 80 L of different vegetables - cabbage, cucumber, broccoli, fruit, etc.
  Add the vegetables gradually over the standing period. (Diseased produce can be used)
- 0.25 kg of crushed bones or bone meal
- 0.125 kg agricultural lime
- 0.75 wood ash
- 5 - 8 L chopped weeds

Top up the container with water and stir well.

Wait 20 - 30 days to ferment and sieve the mixture.

Add 2 - 5 L of the juice extract to 100 L water.

**Warning**

It is important to dilute the mixture before use, as it can burn the leaves of plants if too strong.
Use the preparation as a foliar spray. The quicker you use this mixture after it is ready, the greater the effect of the antibiotics will be.

### 7.2.2 Weed spray
Mix the following ingredients in a 100 L container:
- 15 kg of chopped weeds
- 60 L water
- 5 L milk
- 5 L sugarcane juice or 15 kg chopped sugarcane
- 4 kg wood ash
- 4 kg crushed bones or bone meal
- 3 - 5 kg agricultural lime

Leave for 10 - 20 days
Use 2 - 10 L of preparation in 100 L water

### 7.2.3 Manure and weed spray
Mix the following ingredients in a 100 L container:
- 30 kg of fresh cow manure
- 50 – 60 L water
- 5 L milk
- 5 L sugarcane juice or 15 kg of chopped sugarcane
- 4 kg of wood ash
- 4 kg crushed bones or bone meal
- 3 - 5 20 L buckets of chopped weeds
- 2 - 3 kg agricultural limestone

Leave for 10 – 15 days
Use 2 – 10 L of the preparation in 100£ water and use as a foliar spray.

- Bone meal and horn meal are rich in phosphorus - use as a supplement to keep the soil fertile.

### 7.2.4 Plant hormone mixture
Collect green material from non-cultivated vegetation (weeds, trees or grasses before they reach flowering).
Weigh and crush the collected material.
Place in a container and add water to just cover the material, leave to soak overnight.
Drain the liquid, bring it to the boil gradually and simmer for 2 hours.
For every kg of collected material add 20 L of water. Apply as a foliar spray twice in the growing cycle of the crop.

The mixture can be stored for up to 2 months in a cool, dark place. Make sure the container is covered to prevent direct sunlight and rain from entering.

**7.2.5 Soil topdressing for vegetables**
Mix the following ingredients in a 100 L container:
- 15 -25 kg of fresh cow manure
- 2.5 kg of thicken manure
- 10kg of sugarcane chopped

Fill the container with water.
Leave 7to 10 days.
Dilute 20 -50 L with 60€ of water and apply to the soil.
**Do not apply to the leaves of the plants - it will burn the plants.**
It can be used on the leaves, but it has to be diluted much more.

**7.2.6 Weed suppressor**
Take squash leaves and air dry them in the shade.
Soak in clean water for 2 hours (use rain water or tap water that was left in the sun for 1 day).
Dilute 5 kg of leaves with 95 L water.
Filter.
Irrigate the area.

**7.2.7 Tomato spray**
Mix the following ingredients in a 30 L container:
- 1 kg of Bougainvillea leaves - must be very well crushed
- 40 g soap (not detergent - green bar of sunlight soap)

Mix the above.
Leave for2-3 days.
Spray tomato seedlings 2 - 3 times before you transplant.
Spray tomatoes every 2 weeks once you have transplanted them.
7.2.8 Compost Spray

Compost targets most pests and diseases, as it gives the plants greater resistance to attack from pests and diseases.

Use well-rotted compost and plant materials. Spray the plants and the soil with a mixture of 1 shovelful of compost in 20 litres of water after the mix has been standing for three days to several weeks. Compost supplies the plants with much needed nutrients to help plants withstand attack and to increase yields. The longer the mix is left to stand, the stronger and more effective it becomes. The spray is applied once a week when plants are still young.

By increasing the compost level in the soil, plants can be protected against all pests and diseases.

Apply the spray as a preventative measure and as a regular weekly treatment once the disease appears.
8 ORGANIC REMEDIES

8.1 REMEDIES FROM ORGANIC MATERIAL

8.1.1 Ash

Targets
Insects in general: aphids, cabbage root fly, caterpillars, cucumber beetles, cutworms, grasshoppers, larvae, potato moths, root maggots, squash bugs, stalk borers, termites and weevils.
Fungi in general: mildew and clubroot.
Bacteria in general.
Others: slugs, snails, birds and nematodes.

Method
Spray with a mixture of 1 heaped tablespoon of wood ash in 1 litre of water, leave overnight, strain to remove solids, mix in 1 cup of sour milk and add 3 litres of water. This treatment is said to be successful against mildew and a range of pests.

Wood ash mixed with soapy water and/or lime can act as a general insecticide.

Soaking seed in wood ash and water for 24 hours before planting gives protection against fungal and bacterial diseases. If the juice or leaves of any strongly aromatic plant is added to the water it will also deter birds from eating the seed. **Some strong-smelling plants can, however, affect the viability of seed.**

Wood ash is a good alkaline fertilizer. Spreading a circle around the base of plants and soaking it in with water can control maggots, cutworms, cucumber beetles, squash bugs and slugs. The dust dehydrates soft-bodied insects. Ash can also be mixed with compost and dug into the soil.

Wood ash contains potassium, calcium and phosphorus.

**Warning**
Only wood ash can be sued. Never use ash from coal fires as this is poisonous to the soil and plants.
Do not allow ash to touch the stems of plants, especially seedlings.
Protect eyes from ash
Ensure that ash has cooled down properly before using it in the garden.
8.1.2 Bicarbonate of Soda

**Targets**
Insects: aphids and scale insects. Fungal diseases: mildew and rust,

**Method**
Mix 1 teaspoon of bicarbonate of soda with 1 teaspoon of liquid soap in 5 litres of water.
Use as a spray on affected plants.

**Warning**
Bicarbonate of soda can burn the leaves of plants if it is not diluted properly, and also if it is applied too often.

8.1.3 Bordeaux mixture

**Targets**
Fungi in general: powdery mildew, downy mildew, tomato and potato blight, black spot on beans, leaf curl on peaches, rust.

*Right; Leaf curl on peaches, a fungal disease that can be easily treated with Bordeaux mixture.*

**Method**
Mix 90g of blue copper sulphate with 4.5 litres of water in a nonmetallic container. In another non-metallic container, mix 125g of slaked lime (builders lime) with 4.5 litres of water. Stir and make sure the lime is well dissolved. Mix the two solutions and stir well. Test the mixture by putting an old nail in it for 30 seconds. If it turns blue, there is not enough lime in the mixture or the lime is not sufficiently dissolved in the water. Allow the lime to soak longer, otherwise the mixture will burn the leaves. Apply twice at 7 day intervals, but only if necessary.

**Warning**
At high concentrations the mixture is toxic to soil organisms, plants, animals and human beings.
8.1.4 Builders’ lime

Targets
Insects: larvae.
Slugs and snails.

Method
Spray lime and water mixtures onto tender plant parts only after the mixture has been allowed to stand for a few days for the heat of hydration to disappear.

Warning
Do not apply dry dust onto tender plant parts such as leaves.

8.1.5 Clay, lime and other powdery materials

(Any fine powdery materials such as clay, lime, flour, chalk, etc.)

Targets
Insects in general: ants, aphids, beetles, caterpillars, codling moths, cutworms, insect eggs, larvae, mites, scale insects, squash bugs, stink bugs, thrips and white fly.
Fungi: clubroot.
Others: slugs and snails.
Bacteria: canker.

Method
Dust onto leaves, the insects or their eggs, to suffocate them.
Dust around the base of plants to protect them from crawling insects.
Spray with a mixture of the powdery material in water.
Mix clay with fresh cattle manure to form a paste and paint the mixture on trunks of trees against codling moths and other pests and to seal cuts on the trees after pruning.
Fill wounds in trees, including those caused by cutting out canker, with moist clay rammed in tight.

Liming of acid soil reduces the incidence of cutworm and clubroot.
8.1.6 Coffee grounds and tea leaves

**Targets**
Insects in general.
Slugs and snails.

**Method**
Spread around the plants on the surface of the soil to protect plants from slugs and snails.
As sprays, fairly strong brews of tea leaves and coffee grounds have general insecticidal properties.
Use as frequently as necessary.

**Warning**
Coffee grounds and tea leaves may create acidic conditions in the soil in the long run.

8.1.7 Flour

**Targets**
Insects: spider mites, aphids and caterpillars.

**Method**
1 tablespoon of flour diluted in 1 litre of water, splashed with a branch or wiped onto the underside of leaves with spider mites or aphids makes the insects dry out. The remedy should be applied on in the morning of a sunny day and it sometimes needs repeating after 2 weeks.
Spray with a mixture of 4 cups of flour, half a cup of sour milk and 20 litres of water. Flour can be dusted onto vegetables prone to caterpillar attack.

**Warning**
Do not apply dry dust onto tender plant parts such as leaves.

8.1.8 Insects

**Targets**
Insects: armyworms, caterpillars, grasshoppers and locusts.
Others: slugs and millipedes.

**Method**
Remedies made from the pest insect itself often discourage others from eating.
Crush 10 to 20 pest insects and put in 5 litres of water and add a little soap. Sprinkle it over the crop affected by this particular insect pest.
Remedies made from insects are more effective when diseased insects are added. Sometimes a paralysed grasshopper can be found on top of a stalk of grass. A fungus grows inside it and when added to an insect remedy one can help to spread the disease to infect more grasshoppers.

Warning
Many colourful insects, such as blister beetles for example have poison in their bodies and a remedy made form them should be handled with care.

8.1.9 Milk

Targets
Insects: spider mites and caterpillars.
Fungi in general: blights and mildews.
Viruses in general: mosaic virus.

Method
Spray 1 litre of milk diluted with 10 to 15 litres of water. The spray has to be repeated after 10 days for diseases and after 3 weeks for insects.

Stir 1 heaped teaspoon of wood ash vigorously into 1 litre of water, leave overnight, strain to remove solids, add 1 cup of sour milk and add 3 litres of water. This mixture has been found to be effective in controlling mildew, when applied as a full-cover spray.

Sprays of skimmed milk have been used to control many viral diseases.

8.1.10 Paraffin

Targets
Birds.

Method
Dip seeds in paraffin before planting. It will prevent birds from digging up the newly-planted seeds.

Warning
Don’t use seed as food after treating with paraffin. Keep paraffin away from children and make sure it is stored in appropriate containers (not cool drink bottles).
8.1.11 Salt preparations

Targets
Insects in general: aphids, cabbage worms, caterpillars and whitefly.
Others: slugs and snails.

Method
Spray aphid and whitefly with a mixture of 1 teaspoon of salt to 1 tablespoon of vinegar and mix with 1 litre of water. Add half a teaspoon of liquid soap.
The above mixture has been recommended for use on aphids, cabbage worm and caterpillars and as a general repellant.

Sprinkle a few grains of dry salt on slugs and snails to make them shrivel up and die.

Warning
Too much salt can damage the structure of the soil.

8.1.12 Soap solutions

Targets
Insects in general: aphids, crickets, armyworms, caterpillars, leaf miners, mites, psyllid, whitefly, small beetles and thrips.
Fungi in general.
Others: slugs and snails.

Method
Soap has been used for the control of soft-bodied plant pests since 1787. Most of these soaps were derived from either plant oils (cottonseed, olive, palm or coconut) or from animal fat (whale oil or fish oil). Soap breaks down the membranes of insects and causes them to die, or it suffocates them.

Soap can be added to many of the plant remedies to increase the effectiveness of the solution. Soap makes the solution stick easily on plants and pests. Soap is also added in small quantities to other preparations as it helps the spray to stay on the leaves and to spread out into a thin coating. Many soft-bodied pests such as aphids, caterpillars and whitefly can be controlled with soap alone.

Take 50g soap and dissolve in 2 to 5 litres of water. Spray onto the pests and plants. Stronger soap solutions are needed for bigger insects. Some soaps are said to have a slight fungicidal effect.
8.1.13 Sugar
Targets
Nematodes in general.

Method
Dissolve 2 kg of sugar in a bucket of water and pour over the soil to dehydrate nematodes. The treatment will kill all nematodes within 24 hours. Soaking sweet potatoes in sugar water for 24 hours prior to planting has been used to remove nematodes.

Warning
Be careful not to use soap too often. Modern washing powders for clothes can burn plant leaves and will damage the structure of the soil. Even soft soap in strong concentrations can burn leaves.

It is thus important to use pure soap (green bar soap) and not detergents such as washing powder and dish washing liquid.

8.1.14 Vinegar
Targets
Insects: aphids, ants and mosquitoes.

Method
Spray with a mixture of 3 tablespoons of vinegar, 3 tablespoons of liquid soap, 2 tablespoons of liquid manure and 10 litres of water to kill off aphids and boost the plant at the same time. Apply as often as necessary: 2-3 times at 4-day intervals.

Warning
Do not apply this treatment more than once on a given piece of land, as it also kills beneficial organisms. This treatment is not suitable for large areas- due to the expense.
8.1.15 Mulch
(Dead plant material: crop residues, hay, leaves, weeds, etc.)

**Targets**
Insects: cutworms, grasshoppers, ground beetles, lawn caterpillars, moths, termites and thrips.
Others: nematodes, slugs and snails.

**Method**
Cover the soil with mulch, one finger deep, preferably. The mulch should consist of as wide a variety of plant material as possible.

Mulches of aromatic herbs are recommended for protecting plants from cutworms, ground beetles, thrips, slugs and snails. Covering the bare soil with mulch discourages grasshoppers, moths and certain beetles from laying their eggs in the soil. It also reduces the number of harmful nematodes in the soil.

To repel termites, include banana stems and mixtures of aromatic plants mid weeds. Wood chips can help in aerating the soil and increasing soil moisture.

8.1.16 Manure, dung and urine
(Cow, donkey, goat, predatory animal and poultry manure, and human and animal urine.)

**Targets**
Insects: aphids, bagrada bugs, caterpillars, codling moths, cutworms, fruit flies, grasshoppers, mealy bugs, mites, stalk borers and thrips.
Birds.
Fungi in general: mildew and scab.
Bacteria in general.
Viruses in general.

**Method**
Spray with a mixture of 1 shovelful of dry cow manure mixed thoroughly into 10 litres of water after it has been stirred once daily for 14 days. Clay dust can be sprinkled into the bucket to
reduce smells and to add some minerals. Dilute the mixture 3-5 times before spraying. It will repel aphids when sprayed onto plant leaves and protect plants from cutworms when sprayed onto the surface of the soil. It also acts as a foliar nutrient when sprayed onto the leaves and increases the plant’s resistance to bacterial and fungal diseases.

A shovelful of fresh donkey manure in a bucket of water, left overnight, can be effective against aphids, bagrada bugs and grasshoppers. Apply as often as required.

Spray with a mixture of 1 part urine (human or animal) to 1 part water to prevent infestation by aphids, caterpillars, cutworms, mealy bugs, mites, thrips, and for protection against fungal, bacterial and viral diseases. A diluted form is recommended for fungal diseases: scab and mildews.

Paint a mixture of clay and cattle manure onto the trunks of fruit trees to protect them from codling moths and other pests. Wood ash can be added to this mixture. The mixture can be applied to protect fresh cuts after pruning.

Spraying with cow urine that has been standing for two weeks and diluted with 6 parts of water is said to control stalk borer.

Soaking seeds for 24 hours in cow dung mixed with water is said to prevent birds from digging up seeds.

Giving seeds a coating of a mixture of clay and cow-dung prevents birds and mice from eating the seeds. This method will only be suitable for the bigger types of seed like maize and beans.

**Warning**
Vegetables or fruit sprayed with these mixtures must be washed thoroughly before consumption.
If used too often undiluted urine will burn plants and will render the soil toxic.
9. REFERENCES

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