Even the most experienced gardener may suffer problems caused by plant diseases and disorders, the ravages of pests, and the choking of plants by weeds. By following the principles of good cultivation and garden management, however, it should be possible to keep these problems to a minimum.

When problems do occur, it is important first to diagnose them correctly, before deciding upon the appropriate course of action required to remedy the situation. For some problems, treatments include a wide variety of organic and biological methods in addition to the use of chemicals.

Pests, diseases, and physiological disorders

Most plant problem symptoms are easy to see. A tree, shrub, or plant may wilt or become discoloured, or it may fail to come into leaf or to bloom at all. Pests, which may be the cause of the plant's poor health, may be seen on part or all of the plant. Sometimes an infestation or disease in the roots may be noticed first through symptoms in the leaves. This chapter gives detailed information on how to prevent and control the pests, diseases, and physiological disorders that can cause such problems.

What is a pest?

Pests are animals that cause damage to cultivated plants. Some, such as slugs, snails, and rabbits, are well known; most, however, are small invertebrates such as nits, eelworms, woodlice, and millipedes, which are less evidently plant pests. The largest group by far in this category are the insects. Pests may damage or destroy any part of a plant or, in some cases, even the whole plant. They feed in various ways - by sap sucking, leaf mining, defoliating, or tunnelling through stems, roots, or fruits. Sometimes they cause abnormal growths known as galls. Some pests also indirectly damage plants by spreading viral or fungal diseases, while others coat plants with a sugary excrement that encourages the growth of sooty moulds.

What is a disease?

A plant disease is any pathological condition caused by other organisms, such as bacteria, fungi, or viruses. Fungal diseases are commonest; bacterial diseases relatively rare. The symptoms that these organisms produce vary considerably in appearance and severity, but the growth or health of the plant is almost always affected and, in severe attacks, the plant may even be killed. The rate of infection is affected by factors such as weather and growing conditions. In some cases, the disease-causing organism (pathogen) is spread by a carrier, such as an aphid. The pathogen is sometimes visible as a discolouration on the plant, as with rusts. Symptoms such as discolouration, distortion, or wilting are typical signs of disease infection.

What is a disorder?

Plant disorders usually result from nutritional deficiencies or from unsuitable growing or storage conditions. An inappropriate temperature range, inadequate or erratic water or food supply, poor light, or unsatisfactory atmospheric conditions may all lead to physiological disorders. Problems may also be caused by deficiencies of the mineral salts that are essential for healthy plant growth.

Weather, cultural, or soil conditions may lead to a range of plants being affected. The problems become apparent through symptoms such as discoloured leaves or stem wilt. A plant that lacks water, food, or the right environmental conditions will not only appear unhealthy but will also be less able to resist attack from insect pests or diseases caused by fungi, viruses, or bacteria. Unless problems are correctly diagnosed and treated, in extreme circumstances affected plants may die.

How to use this chapter

This chapter is organized according to the site of symptoms (such as distorted flowers or discoloured leaves), in sections covering leaves, stems, flowers, fruit, roots and tubers, bulbs, whole plant, and lawns. Within these, symptoms are grouped by type; for example, all yellow leaf spots will be found together.

To identify a problem, look in the appropriate section. If you cannot find it there, turn to the cross-references at the end of that section. Each entry lists the plants affected, the symptoms, the cause of the problem, and how to control it. Some notes on the controls currently approved appear on p.668; however these are subject to change. Always check labelling for specific uses, as not all brands of any one chemical are recommended for the same problems or the same plants.
Integrated control

The phrase “integrated control” is used to describe what is widely agreed to be best practice in the limitation and management of pest and disease problems. It aims firstly to do everything possible to prevent problems occurring, but then, should this be inadequate, to consider all the options for dealing with a problem — for example, using organic or biological controls — before resorting to chemicals. Gardeners practising integrated control combine the best aspects of organic and inorganic methods, always opting for the organic one first. They choose resistant plants and maintain high standards of garden hygiene, ensuring plants are healthy and thus have the best chance of resisting attack; they practise crop rotation. They seek to prevent pests from landing on plants, by the use of traps, barriers, and repellents. Plants are inspected regularly to spot problems early, and care is taken to ensure an accurate diagnosis. Chemicals are used sensibly and correctly, and only when warranted by serious pest or disease attack.

Prevention of problems

Always buy strong, vigorous plants that look healthy. Do not purchase plants that are showing dieback or discoloured stems, that have leaves that are an abnormal colour for the time of year, or that are wilted or distorted. Do not buy plants showing significant pest infestations or disease. Check the root ball of container-grown trees and shrubs: do not buy them if they are either pot-bound or showing poor root development.

Garden hygiene

Maintaining a tidy and well-managed garden is one of the most important ways to reduce the risk of pest and disease attack. Examine plants regularly to identify any new problem as soon as possible, since a well-established infection or infestation is far more difficult to deal with than one that is identified and treated early.

The regular removal and disposal of diseased parts of plants, and some pests such as cabbage white caterpillars, may be laborious but certainly helps to control problems. Debris from infested or diseased plants should in many cases be burnt; diseased plants should in many cases be burnt; otherwise the pest or pathogen may survive, overwinter, and re-infect plants in spring.

If a plant is badly diseased or infested by pests, it may be impossible to revive it; such plants should be removed, especially if there is a risk that the trouble might spread to healthy plants nearby.

Crop rotation and replant problems

Rotating vegetable crops, usually on a three- or four-year basis, helps prevent soil-borne pests and diseases from building up to a damaging level. For further details on planning a crop rotation system, see GROWING VEGETABLES, "Crop rotation", p.498. Although a strict rotation plan is generally used for vegetables, it is also worth rotating annuals and bulbs where feasible, as this reduces the build-up of diseases like foot and root rots and tulip fire. Growing a particular kind of plant in the same ground for a number of years may also lead to problems (see, for example, "Rose-sick soil", p.156). If a disease such as foot or root rot becomes evident, remove all the plants and grow other botanically unrelated plants that are not susceptible to the disease.

Resistant plants

Some plants are resistant to attack by pests or diseases. Plant breeders have been able to profit from this and have produced cultivars with a higher-than-average resistance to some pests or diseases. Cultivated plants resistant to pests include some butterhead lettuces, which are seldom affected by the lettuce root aphid. Plants resistant to disease include some tomato cultivars, which resist tomato leaf mould, and the climbing rose ‘Maigold’, which shows some resistance to diseases such as powdery mildew, rust, and black spot.

In some cases, the resistance appears to be total, but even a resistant plant may succumb to a given disease if its growing conditions are poor, for example, or if other factors, such as the weather, weaken the plant. Before buying plants, check if there are disease- or pest-resistant cultivars readily available. The range of resistant plants varies from year to year, so check catalogues annually for this type of information.

Correcting cultural disorders and deficiencies

Unsatisfactory growing conditions may result not only in poor general growth, but also in some very specific symptoms that closely resemble those caused by pests and diseases. When problems manifest themselves and an obvious cause — such as a pest infestation — is not immediately apparent, it is worth considering the plant’s growing environment as a whole — recent weather conditions, for example, or the health of your soil, or indeed whether some aspect of plant care was not provided. At best, the plant may be restored to complete health by some simple measure — the addition of a mineral supplement, for example, or less frequent watering. At worst, you may have to accept plant loss.

SYMPTOMS OF CULTURAL DISORDER

Bitter pit in apples, caused by a lack of calcium, may be triggered by dry conditions in soils that in fact do contain sufficient calcium levels.
losses caused by freak extremes of weather – or learn that certain plants simply are not suited to the conditions you are able to provide.

It is also worth remembering that the risk of certain pest and disease problems can be minimized by altering growing conditions. Liming in the vegetable garden (see p.625) is a classic example; by increasing the alkalinity of the soil, it reduces the risk of clubroot affecting brassica crops.

Organic controls

Organic control uses natural methods to help plants both resist and recover from attack by pests and diseases. Such methods have long played their part in gardening, but in recent years they have attracted an increasing level of interest, especially as some harmful organisms have become immune to chemicals that once controlled them. Gardeners have become increasingly aware of the damage that irresponsible use of chemicals can do to the environment, and especially to creatures that are the gardener’s natural allies – those that are predators or parasites of plant pests.

Attracting pest predators

Insects and other creatures found in gardens are by no means all destructive. Many are not only useful to the plant but actually essential for its survival; for example, a large number of fruits, vegetables, and flowers rely on pollinating insects, such as honey bees, to carry pollen from one flower to another to enable fertilization to take place. In other cases, some species of natural predator can help to control certain types of pest and should therefore be encouraged to visit the garden. A natural balance between pests and predators may take a few years to accomplish but, once established, such a garden will be much healthier than one that relies on chemical remedies alone.

Areas of undisturbed land will attract beneficial animals, especially if planted with a wide range of native species. Flat stones placed in the bed or border will be used by thrushes as anvils on which to smash snail shells. Predators such as hoverflies and ladybirds can also be encouraged by the introduction of colourful flowers, especially if flat or open-centred in form, and so they, too, will help keep pests to a minimum.

Recognizing beneficial garden animals

Hedgehogs, shrews, frogs and toads feed on many ground-dwelling plant pests such as slugs and snails. Birds may be the cause of some damage in the garden, but this disadvantage is usually far outweighed by the enormous quantities of insect pests that many devour. Some invertebrates, for example centipedes, prey on soil-dwelling pests. It is possible to distinguish centipedes from the somewhat similar millipedes (which are often harmful) by the number of legs that are carried on each segment of their bodies: centipedes have only one pair per body segment, whereas millipedes have two pairs (see also Friends and Foes, above).

Spiders are also useful allies as their webs trap countless insects. Certain insects, however, may be invaluable in the garden. Ladybird beetles are a familiar example in many countries, and both the larvae and the adult beetles feed on destructive pests such as aphids. Lacewing larvae, too, have a voracious appetite for aphids, and they can be encouraged by planting flowers, such as pot marigolds (Calendula), and the provision of a nesting box in which they can overwinter. Ants and wasps, whose activities might damage some plants, may still help the gardener by preying on other insect pests. Ground beetles are voracious consumers of numerous pest species.

Companion planting

Certain companion plants grown in association with flowers may help to reduce pest attack. For example, some strong-smelling herbs such as mint and garlic may repel pests that are attracted to plants by smell, thereby keeping them away from nearby plants. Deliberate planting of host plants may deflect pests away from other plants or attract predators to feed on the pests: nasturtiums (Tropaeolum), for example, are susceptible to aphids, so plant French marigolds (Tagetes patula) nearby as these attract hoverflies, which have larvae that feed on the aphids.

Traps, barriers, and repellents

These work by stopping pests getting near plants. Many can be constructed from everyday items. Earwigs may be trapped in inverted flower pots, and wireworms in old potatoes or carrots spitted on a stick and buried. In the greenhouse, sauces of water and vinegar, or eggshells, which will kill ants and woodlice – not in themselves pests of established plants, but partial to delicate seedlings. Glasshouse whiteflies, being attracted to the colour yellow, may be caught on strips of yellow plastic covered in non-dry glue. Place these near the top of plants and move them up as the plants grow. Consider introducing biological controls (see p.642) if the infestation is increasing.

Pheromone traps can be purchased from some garden centres and by mail order. They release the chemicals used by specific insects, such as the codling moth, to attract a mate. The trap captures the males by luring them onto a sticky sheet, thereby reducing the mating success of the remaining females. Such a trap also allows the gardener to monitor infestation levels, and determine whether and when further control methods are needed.

ORGANIC EARWIG TRAP

An inverted flower pot filled with dried grass and placed over a cane attracts earwigs (see p.644). Examine the pot and remove any earwigs daily.

CODLING MOTH TRAP

Hang a pheromone trap in apple and pear trees in late spring. It will catch male codling moths and so reduce mating opportunities.
### Controlling slugs and snails

Gardeners who prefer not to use slug pellets can try various alternative methods of control. Do not underestimate the value of picking the pests off individually, especially when several pairs of hands are available to help. Slugs and snails are most active at night, and can be readily spotted by torchlight, especially on a damp evening. Gather up the pests and kill them by dropping in a strong salt solution.

- Use biological control with a nematode that infects soil-dwelling slugs with a fatal bacterial disease. Apply to moist soil in spring to autumn.
- Lure slugs and snails into a hollowed-out grapefruit or orange half that is set, open side downwards, on stones just above the ground. Slugs and snails attracted by the citrus scent will move under the fruit skin and are likely to remain there, until morning at least. They can then be drowned in a strong salt solution.
- Part-fill a jar with beer or milk and almost sink it in the ground. The rim should be about 1 cm (1/2 in) above the surface to prevent useful predators such as ground beetles from toppling in. The smell of the beer or milk will attract slugs and snails, which should fall in and drown. Specially designed slug “traps” are available by mail order.
- Create a wide, physical barrier of a coarse material such as sand, grit, wood ash, soot, pine needles, or broken eggshells around special plants. These should be either too dry or too scratchy for slugs and snails to be attracted to cross.
- Cover or surround vulnerable seedlings and small plants using plastic bottles that have had their tops and bottoms cut off (see picture opposite). Press the bottles into the soil so that they encircle individual plants.
- Place a proprietary porous mineral product as a barrier around plants that need protection. However, such barriers are less effective in wet conditions, when pests are most active.

### Acceptable organic treatments

A few chemical preparations originate from natural sources; pyrethrum, for example, is derived from the pyrethrum daisy. Other organic treatments are rotenone, soft soap, plant oils, and sulphur dust, and these may be obtained as ready-made powders or liquid sprays. They have short persistence, however, and are ready-to-use or can be introduced onto your plants or into the soil later for disease among them. For example, the microscopic pathogenic nematode *Steinernema kraussei* is effective against slugs and snails (see “Controlling slugs and snails”). Larger barriers, from horticultural fleece to fruit cages, can be erected around and over plants to deter winged insects such as carrot fly and cabbage root fly, as well as birds, rabbits, and deer. Grease bands bar the way to pests climbing up trees and pots, and proprietary brassica collars, or ones cut from carpet or underlay, will prevent female cabbage root fly from laying their eggs around young brassica plants (see p.660).

Repellents, such as ultrasonic devices or humming tapes, are sometimes used to protect plants against moles, cats, and birds, which can be encouraged to move elsewhere. However, individuals differ in sensitivity to sound and, while bird-scaring devices and pet repellents may work initially, they often require changing frequently as the creatures become familiar with them.

### Biological control

Some of the most troublesome pests, especially red spider mite, whiteflies, and vine weevil grubs, can be dealt with very effectively using biological controls. The term biological control describes the limiting of pest damage by the deliberate introduction of natural enemies, such as predators, parasites, or diseases. Biological controls are living organisms, usually nematodes or small predator insects or mites, which have no detrimental effects on non-target species. They are bred and supplied under the control conditions, and as they are alive, they must be introduced onto your plants or into the soil initially, they often require changing frequently as the creatures become familiar with them.

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ensure that the pest has been correctly identified and therefore the appropriate specific control measures adopted. If you are not sure what pests you have, see pp 644–668.

Biological controls may be obtained from mail-order specialist suppliers. These generally advertise in the gardening press and on the internet. Good garden centres will also be able to provide advice on suitable controls and where to buy them.

Greenhouse controls
Some biological controls are suitable for use only in the greenhouse or conservatory. Introduce the control before plants are heavily infested, as it may be a number of weeks before it becomes effective. Restrict the use of pesticides, since most are harmful to biological controls; the least harmful are fatty acids and plant oils, which control a range of small insects and mites.

Open-garden biological controls
Use of biological controls is less practicable in the relatively uncontrolled conditions of the open garden, especially where pesticides are used, since they may kill the controls as well as the pests. Of the controls listed in Table 21 (facing page), only those for chafers, grubs, leatherjackets, vine weevil, and underground slugs are suitable for use in the open ground, provided the soil temperature is suitably high.

Chemical control
Chemical control is the term used to describe the action of destroying plant pests and diseases by applying synthetic compounds to plants or soil. Although the emphasis on organic control is presently becoming stronger, the responsible and sparing use of chemicals still has a valuable role to play in pest and disease control. A sensible combination of the most suitable aspects of both methods may provide the best solution to difficult and often recurrent problems.

Pesticides and fungicides
Most pesticides (which are used to kill insects, mites, and other pests) and fungicides (which are used to control diseases caused by fungi) either work by being brought into contact with the pest or disease organisms, or are systemic.

Contact pesticides kill pests when they crawl over a treated surface or when they are directly hit by the chemical (when sprayed, for example). Contact fungicides may kill germinating fungal spores and prevent further infection, but they have little effect on established fungal growths.

Systemic chemicals are absorbed into the plant tissues and are sometimes transported by the sap stream throughout the entire plant. Fungicides of this type, for example myclobutanil, kill fungi in the plant tissues. Systemic pesticides, such as imidacloprid and thiacloprid, are predominantly used against certain sap-sucking pests but will also control some pests that have chewing mouthparts, such as vine weevil grubs and some beetles and caterpillars. Thorough spraying of affected plants, especially on the undersides of leaves, is essential if these pesticides are to work.

Pesticide-resistant strains can occur, particularly with persistent greenhouse pests such as whitefly and red spider mite. Fungi that are frequently treated with systemic fungicides may also develop resistant strains. This problem can sometimes be overcome by using a different type of compound, but with greenhouse pests the use of biological control (where possible) is often a better alternative (see p.642).

Formulation of chemical preparations
The active ingredient of a chemical preparation kills the organism, and the way in which a preparation has been formulated determines its efficacy and use. Pesticides and fungicides are available as concentrated liquids, dusts, powders (with which a wetter may be incorporated to ensure thorough penetration of the active ingredient), smokes, baits, and ready-to-use dilute liquids. These are formulated for maximum effectiveness and safety, for gardeners and for the environment.

Phytotoxicity
A few plants suffer adverse reactions to fungicides and insecticides. This is known as phytotoxicity. The manufacturer’s instructions often list those species that should not be treated. However, such lists cannot be complete, since the reaction of many ornamental plants to certain chemicals may be unknown. If in doubt about whether a certain chemical is suitable, first test the fungicide or pesticide on a small area of the plant before undertaking treatment of the whole plant. Alternatively, where several plants of the same type are grown together, test the chemical on only one of them.

Various other factors, including the stage of growth and the environmental conditions surrounding the plant, can increase the likelihood of a plant being damaged by chemical treatments. For example, young seedlings, cuttings, and flower petals are much more sensitive than mature foliage to variations in the growing conditions, and may therefore be adversely affected by the application of some chemical treatments.

Similarly, plants that are suffering any stress should never be treated with chemicals.

In order to avoid problems with side-effects on plants, never spray them when they are in bright sunlight, or when they are either dry at the roots or have been exposed to unusually high or low temperatures.

APPLYING CHEMICALS WITH CARE

Thorough application
To avoid a wasted application, spray well into the centre of plants and beneath foliage, especially with products that have a contact action.

Separate equipment
Keep watering cans, sprayers and nozzles specifically for use with herbicides; residues in equipment can harm non-targeted garden plants.

Using chemicals safely
If you follow the instructions precisely — that is, only in the way and for the purpose that the manufacturer describes — chemicals should be effective with little risk to the user or the environment. It is now illegal in the UK and other countries for gardeners to use chemicals other than in accordance with the instructions. Always take the following precautions:

- think before you spray: is it really necessary, or could you use organic remedies or biological controls instead?
- choose the chemical carefully — make sure it is the right one for the job;
- apply the preparation at the rate and frequency stated on the label;
- never use any type of chemical on plants in ponds;
- never mix different chemicals unless the manufacturer recommends this;
- always observe any suggested precautions;
- always spray when the wind is still, or almost still, to avoid damaging adjacent plants;
- always spray in the evening, when there are few bees and hoverflies around;
- do not spray on hot, sunny days, as such weather increases the risk of scorching plants;
- avoid contact with the skin and eyes by wearing goggles, rubber gloves, and long-sleeved clothing;
- do not inhale dusts, smokes, or sprays.
- make sure that the chemical does not drift into other people’s gardens;
- keep pets and children away during treatment;
- never eat, drink, or smoke when applying a chemical;
- dispose of any excess carefully and wash out any apparatus thoroughly;
- do not use apparatus for anything other than chemicals;
- store chemicals out of reach of children and animals;
- store chemicals in their original containers, with their original labels, and keep any explanatory leaflets with them.