Importance

This group of diseases is becoming one of the most important, capable of reducing yields and even killing bushes. Unfortunately, dead twig diseases in Viet Nam are not well understood.

> ☞ These diseases are a good topic for farmer research. Try to observe the disease cycle from its earliest beginning. At what moment in the disease cycle can farmers act to control the diseases? Is it effective (and profitable) to use disinfectants after pruning?

Symptoms over time

The first symptom seems to be that mature leaves change color (turn darker-green and softer). Then, these leaves turn brown, dry out, and die. The disease spreads into the shoots, which become dry and dead. Unlike bud decay disease, dead twig diseases spread into the brown woody parts of twigs and branches. After more time, the entire branch can die from the top downwards (see picture).

Branches that are dying often have “cankers”, which are shallow slowly-spreading wounds that are surrounded by a thick area of bark. Or, patches of the bark may die. Often small velvety “cushions” grow on the diseased branch; these are a kind of mushroom. The entire bush may die, but it is more common for only some branches to die, followed by the growth of new, weak, thin shoots. It is easy to confuse the final symptoms (dead leaves and branches) with the symptoms of root-rots (discussed later in this chapter).

Advanced symptoms of dead-twig disease.
Source: original photograph by Michael Zeiss.

Disease cycle

The fungi produce spores ("seeds") on the small cushion-like mushrooms that grow on dead branches. These cushions can survive for several weeks on pruned branches left in the field. The spores are carried by the wind or splashed by rain onto other tea bushes. Most spores die unless they land on a wound, where they can more easily sprout and grow into the shoot. Spores of some of the fungi can invade young shoots through leaves or green bark, even if there is no wound. Once inside the shoot, the fungus grows and spreads. Eventually, the fungus produces spores in cushions on the outside of the new shoot.

Conditions that make the disease worse

- High doses of nitrogen (urea), especially if not balanced with other nutrients.
- Most damaging in January-February (although the first infections may occur earlier).
- Little else is known about the disease.

Natural enemies

A mixture of two species of beneficial fungi, *Trichoderma harzianum* and *Trichoderma polysporum,* is sold commercially in Europe for control of diseases that affect tree wounds. The mixture can be painted onto pruning wounds. Manufacturers/Distributors:

1. Bio-Innovation AB, Bredholmen, Box 56, S-545 02, ALGARAS, Sweden.
2. Henry Doubleday Research Association Sales ltd., Ryton on Dunsmore, Coventry, CV8 3LG, United Kingdom.

Management practices: Prevention and control

When pruning, be careful not to spread the disease. After pruning a bush with dead twig disease, burn the pruned branches instead of leaving them in the field. If practical, clean off the clippers with a disinfectant before pruning a healthy bush. Use whatever is cheapest and most convenient: boiling water, lime, iodine solution, etc.

In many countries, wounds caused by pruning are painted with chemical fungicides to prevent disease. There are also biological fungicides (contain antagonists) that can be painted onto wounds. Farmers should do experiments to decide whether either type of fungicide would be profitable in Viet Nam.

Avoid excessive doses of nitrogen, and provide good tending after pruning to help the plant heal its wounds quickly.

If dead twig disease is present, prune off and burn infected branches.

11.3.4 Bacterial shoot blight

Vietnamese name:

Scientific name: *Pseudomonas syringae* pv. *theae* (a bacterium in the family Pseudomonadaceae). These bacteria have several long "tails" that they use to swim through water.

Importance

This disease causes symptoms very similar to dead twig diseases. Indeed, some farmers who say they have "dead twig disease" probably have bacterial shoot blight instead.

Easiest symptom to recognize

The easiest symptom to recognize is cankers on shoots. A canker is a shallow slowly-spreading wound that is surrounded by a thick area of bark. But: *Pseudomonas* does not produce cankers on many shoots that it kills. Also, remember that dead twig diseases can also cause cankers. To try to tell them apart, look for these characteristics:

Characteristic	Cankers from dead twig diseases (caused by fungi)	Cankers from *Pseudomonas* (bacteria)
A thick sticky liquid slowly oozes from the canker	Usually **no**	Usually **yes**
Small velvety "cushions" grow on the diseased branch	**Sometimes**	**No**

Another way to recognize *Pseudomonas* is that, if diseased shoots are split open, they will show streaks of brown extending into the healthy tissue both above and below the canker.

Symptoms over time

The disease usually begins during autumn and winter, when the tea bushes are sleeping. On some shoots, the disease just kills a few buds, which become brown and soft. But usually small areas of reddish-brown discoloration appear on shoots, either near a sleeping bud or around a small wound, depending on where the bacteria entered the shoot. The brown discoloration spreads upwards and, to a lesser extent, downwards and sideways on the shoot. Infected areas are sunken, moist, and a darker brown color than the surrounding healthy bark. When the infected area gets big enough to "strangle" the shoot, the leaves above it start to curl and droop, and turn light green and then yellow. Within a few weeks, the shoot or branch above the canker is dead.

This bacteria sometimes causes infections on young, tender leaves. The infections start out as small water-soaked spots that can be circular or rectangular. As the leaves mature the infected spots become brown and dry, and eventually fall out, giving the leaf a shot-hole or tattered appearance.

Disease cycle

The bacteria survive in cankers, in buds and leaves from sick tea plants, and possibly on weeds and woody plants. Bacteria in infected shoots oozes onto the surface of the shoot as a thick sticky liquid. The liquid is spread to another bush when shoots from neighboring bushes brush against it, or is spread by wind-blown rain. On the new bush, the bacteria swim into wounds or natural openings at the bases of the buds. Once inside the shoots, the bacteria reproduce in the tubes that the plant uses for transporting water from the roots to the leaves (the "xylem"). The bacteria clog the tubes, which causes the brown streaks inside the shoot. The leaves cannot get water from the clogged tubes, and eventually die. As the bacteria continues to reproduce, it builds up pressure, and oozes to the surface of the shoot as a thick liquid.

Conditions that make the disease worse

- Cool, wet springs
- Periods of high winds. Wind blows the bacteria from one bush to another, and makes small wounds through which the bacteria can enter.

Natural enemies

The beneficial bacterium *Pseudomonas fluorescens* can be sprayed onto bushes to inhibit the growth of the *Pseudomonas* species that cause disease. It is available as the commercial product "BlightBan A506". Manufacturer/Distributor: Plant Health Technologies, 926 East Santa Ana, Fresno, California 93704 U.S.A.

Management practices: Prevention and control

Use adequate density and spacing to reduce spread and reduce humidity. Prune infected shoots and branches below the canker, and burn them. If necessary, spray with a product that is effective against bacteria (many fungicides are not effective against *Pseudomonas*).

11.3.5 Swollen trunk disease, or club-branch disease

Vietnamese name:
Scientific name: unknown (thought to be caused by a bacterium).

This disease is poorly understood, but can be quite important.

Symptom that is easiest to recognize

One or more main branches swells at the lower end, looking like a club (see pictures).

Two bushes with swollen trunk disease. *Source: original photographs by Michael Zeiss.*

Symptoms over time

The disease starts from August-December. First, small diseased spots are seen on the bark of branches. The diseased spots start on mature branches, seldom on green shoots. The spots are brownish and sunken and about 3 mm long. The spots extend deeply into the heartwood. Next, bark around the spots becomes rotten and turns black. Then, the tissues around the spots swells into a hump. Swollen branches may crack, and the bark become scabby. The swollen segment may be 30 cm long. Leaves on swollen branches are dark green as if they lack water. Leaves of seriously diseased trees become dry and drop off, and branches are easily broken. Diseased trees usually continue to grow, but more slowly, with no buds and very few flowers. Young trees that become infected may die.

Disease cycle

It is not known how the disease spreads.

Conditions that make the disease worse

- Swollen shoot disease is said to be made worse by mosquito bug. The disease appears about 2 months after attack by mosquito bug, and the more severe the mosquito bug attack, the more severe will be the swollen trunk disease.
- Tea that is growing luxuriantly and planted on rich soil is more susceptible.
- Tea at the foot of the hill is more affected than tea growing on the slope or the top of the hill. The steeper the hill, the less the trees are affected by the disease.
- Tea grown under shade is more affected.

Natural enemies

Not known.

Management practices: Prevention and control

- The best way to prevent the disease is said to be to control mosquito bug.
- Because luxuriant tea is more susceptible, it is recommendable to avoid excessive doses of nitrogen fertilizer.
- For fields where swollen trunk disease is already severe, TRI recommends heavy pruning to encourage tea growth. Prune 15-35 cm below the swollen area, depending on the tea's age and the location of the diseased spots. Burn the pruned branches. After pruning, provide good tending to help the tea recover.
- If you are growing your tea under shade, and you have many problems with swollen trunk disease, you may want to reduce or eliminate the shade trees. But remember: if you eliminate shade, you will probably have more problems with insects like thrips and mites.

11.4 Root diseases

11.4.1 Root rots

Vietnamese names: BÖnh thèi kh«, BÖnh thèi rÔ, BÖnh chÕt loang
Scientific names: **many fungi cause root-rot on tea in Asia**, including:
Armillaria (= *Armillariella*) *mellea*, *Ganoderma philippi, Hypoxylon asarcodes, Phellinus lamaensis*, *Phellinus (= Fomes) noxius, Poria* spp., *Rosellinia arcuata*, *Rosellinia necatrix*, *Sphaerostilbe repens,* and *Ustulina* spp.

These fungi are from a broad range of taxonomic groups. *Armillaria*, *Ganoderma, Phellinus,* and *Poria* are in the Phylum Basidiomycotina. *Hypoxylon, Rosellinia*, and *Ustulina* are in the Phylum Ascomycotina. *Sphaerostilbe* is in the Phylum Deuteromycotina. Several of these species may be present at the same time. It might be useful for experts to help farmers identify which root-rot fungi they have. But on the other hand, most fungal root-rots have the same disease cycle and require the same management practices.

Importance

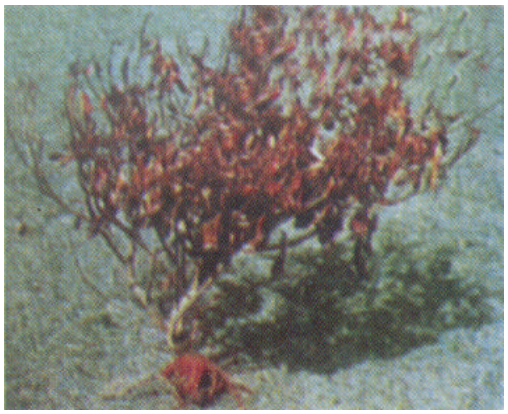
Root rots are usually present only in patches, but when present, they often kill the bushes.

Symptoms over time

Usually this disease is not detected until several neighboring bushes are seriously affected. Growth of the bushes slows down, leaves turn yellow, and during the flowering season the bushes often produce excessive numbers of flowers. The bark of the trunk may become much thicker as the bush tries to resist the fungus. As the disease becomes more serious, leaves wilt and die (though usually remain attached to the bush), and the bush dies (see picture). The trunk of the bush may split or crack. Underneath the bark of the trunk, or on the surface of the roots, the fungus often forms:

- Whitish mats or patches, shaped like hands with many fingers, or like the leaves of ferns.
- Threads or strings, usually dark-colored.

In addition, the fungus sometimes forms velvety "pillows" or mushrooms on the surface of the roots or trunk.



Tea bush showing symptoms of a root rot. *Note that the leaves do not always turn red.*
Source: Nguyen Phong Thai (editor). 1998. Insect pests, diseases, and weeds of tea and prevention methods (in Vietnamese). Agricultural Publishing House, Hanoi, Viet Nam.

Disease cycle

The fungi first develop in stumps or roots of dead trees that were left behind when clearing the land. The fungi spread to tea roots when troots of a tea bush grow long enough to touch the roots of the dead tree. Also, the fungi can grow through the soil as threads or strings until they reach tea roots. Then, the fungus grows on the surface of the tea roots and inside the tea roots. The fungus can spread by growing as threads or strings from an infected tea bush to neighboring bushes.

Conditions that make the disease worse

- Worse in wet or poorly-drained soils.
- Worse in soils that have a shallow "hard-pan", a hard layer that is difficult for roots to penetrate.
- The most important thing is the presence of stumps or roots of dead trees.
- Many trees with the scientific name *Albizzia* and *Tephrosia,* which are used to provide shade in tea plantations, are susceptible to root-rot fungi. Of course, the trees will not become infected if planted in clean soil. But if there are roots from forest trees left in the soil, these shade trees may become infected. And because the shade trees have large root systems, this helps build up a large population of root-rot fungi that can later attack tea.

Natural enemies

Several beneficial bacteria and fungi help control the fungi that cause root rots. One option for obtaining these natural enemies is to apply compost. Well-decomposed compost is often rich in these beneficial micro-organisms. A second option is to buy the beneficial micro-organisms which are sold commercially under several trade names (see table). A third option is to purchase the natural enemy *Trichoderma* from the National Institute of Plant Protection (NIPP) in Ha Noi, which is producing *Trichoderma* in its laboratories

Name of natural enemy	Names of commercial product
Bacillus subtilis	Epic, Kodiak, Serenade
Burkholderia cepacia	Deny, Intercept
Gliocladium virens	SoilGard
Trichoderma harzianum and *Trichoderma viride*	many products; also available from NIPP (Ha Noi)

Management practices: Prevention and control

Root rots must be managed by prevention. Once a bush becomes infected, there is little that can be done to help it. Because root-rots spread from the roots upward, pruning and burning dead shoots is <u>not</u> very effective (unlike for dead twig disease, bud decay, or bacterial shoot blight).

To prevent root rots, the most important thing is to correctly remove any trees before planting tea. One year before cutting down any tree, cut a ring in the bark of its trunk so that the tree uses up the energy supplies in its roots (see Chapter Five). Then, after cutting down the tree, dig out the stump and the roots. If you or your neighbors have had problems with root rots, it may be helpful to apply *Trichoderma* or other natural enemies in each planting hole before planting tea seedlings.

During the first few years after planting tea, organize patrols to locate infected bushes. If you have planted trees to provide shade, check them also. Dig up and burn any infected bushes or trees. Carefully check the neighboring bushes, and dig up and burn any that are infected. Remove and discard the soil closest to the roots of the infected bushes. Expose the hole to the sun, then treat the hole with lime and wood ashes to help kill the root rot remaining behind. Plant the area to grass for a year or more (grass is not susceptible to root rots, so this gives the beneficial micro-organisms in the soil a chance to kill the root-rot fungi). Then, re-plant with healthy tea seedlings (please read Section 6.4 for recommendations on re-planting). When re-planting, use plenty of compost and, if possible, treat the planting holes with *Trichoderma* or other natural enemies.

11.4.2 Nematodes

Root-knot nematodes:

Vietnamese name: Tuyõn trïng g©y nèt sÇn ë rô chÌ
Scientific name: *Meloidogyne arenaria* (on tea seedlings or nursery plants; once tea plants reach the age of 12-14 months, they become resistant to *M. arenaria*).

Root-lesion nematodes

Vietnamese name: Tuyõn trïng g©y h¹i rô t¬ cña chÌ
Scientific name: *Paratrichodorus porosus, Pratylenchus* spp., or *Rotylenchus reniformis* (on young or mature tea).

Other species (especially, other species of *Meloidogyne* on young tea) probably also are present in Viet Nam; and several species may be present at the same time.

Nematodes on tea are considered relatively unimportant in Viet Nam. However, they may be more important than is thought, because their symptoms are easy to confuse with root-rots caused by fungi.

Symptoms over time

Infected plants show weak, spindly growth with fewer leaves. The leaves become dull and yellowish in color. Heavily-damaged young plants may wilt or even die. All these symptoms are caused by the damaged roots not being able to absorb enough water and nutrients. Infected mature bushes tend to begin flowering and setting fruit earlier than healthy bushes. If plants are dug up and the roots examined, the root system will have far fewer thin feeder roots compared to a healthy plant. The roots that are present may be:

- brown and dried up (*Paratrichodorus, Pratylenchus*, or *Rotylenchus*) or may be
- swollen into irregular lumps (*Meloidogyne*).

Disease cycle

Nematodes are microscopic worms (see Chapter Ten). They feed on living roots, and cannot survive in soil for more than a few months. However, they can "sleep" for several years inside thick dead tea roots left in soil. Young nematodes move out of living or dead tea roots, and can crawl and swim for a few centimeters through the soil until they find another tea root nearby. Other ways that nematodes can reach new tea roots are:

- movement of nematode-contaminated soil from one area to another (for example, by soil erosion, by dirty weeding tools, or by using contaminated soil in nurseries).

- using contaminated water in nurseries (water collected from ravines that drain contaminated tea plantations).

Once nematodes are in contact with a living tea root, they start feeding on it. *Pratylenchus, Rotylenchus* and *Meloidogyne* all live and feed inside the root. But, only *Meloidogyne* cause the roots to swell into lumps. Paratrichodorus live in the soil very near the root, and feed on the root tips. About 3-6 weeks after starting to feed, adult nematodes lay eggs on the surface of the root. The young nematodes that hatch either attack the same root or crawl away to search for another root.

Conditions that make the disease worse

- The presence of certain legume trees including *Acacia* spp., *Sesbania* spp., and *Tephrosia vogeli* increases the abundance of the nematode *Pratylenchus loosi* in tea fields. Nematodes in the *Meloidogyne* group attack many plants other than tea. But, because *Meloidogyne arenaria* attacks tea only as young nursery plants, the presence of alternate host plants in mature tea fields has little effect.
- Worse in soils that have a shallow "hard-pan", a hard layer that is difficult for roots to penetrate.
- Unbalanced use of nitrogen, without application of potassium ("kali"), increased the damage from *Pratylenchus*.
- Young plants are most susceptible, because they have fewer roots.

Natural enemies

The beneficial bacterium *Burkholderia cepacia* helps control nematodes. It is available in the U.S. as a commercial product called "Deny", which can be used to drench the roots of seedlings before or after planting.

Management practices: Prevention and control

a. <u>In nurseries:</u>

Use clean soil

Nematodes that infect your seedlings or cuttings will move with them to the field. So, it is very important to use clean soil for your nursery. See Chapter Five for details about using subsoil, and about solarizing soil.

Use clean water

If you irrigate the nursery with water from streams that flow through tea plantations, the silt that is suspended in the water may be contaminated with nematodes. Therefore, it is recommended to let the water stand in a container for two days before using it, so that the silt and the nematodes can settle to the bottom.

b. Before planting a new field:

Plant grass for two years

If you have up-rooted an established tea field, and want to re-plant it to tea, first plant grass for two years. This is especially important if you had problems with nematodes (or root rots) in the previous tea crop. Grass is not susceptible to tea nematodes, and also produces lots of organic matter. Cut the grass periodically and apply it as green manure to stimulate the growth of beneficial micro-organisms in the soil. Two grasses that have given good results are:

Vietnamese name	English name	Scientific name
	Guatemala grass	*Tripsacum laxum*
	Mana grass	*Cymbopogon confertiflorus*

Use compost at planting

Well-decomposed compost helps control nematodes, probably because it is rich in beneficial micro-organisms. So, mix a lot of compost into each planting hole.

Consider applying natural enemies (Burkholderia bacteria) to the planting holes

Because young plants are most susceptible, this could help protect the young plants until they grow large enough to resist nematodes. Farmers should do experiments to see if the benefit justifies the cost.

c. In established (mature) fields:

Incorporate manure or compost

Large amounts of manure and well-decomposed compost help suppress nematode populations. This is probably because manure and compost encourage the growth of beneficial micro-organisms in the soil.

Fork the soil to break any hardpan

Tea plants growing on soil that has a shallow "hard pan" suffer the most from nematodes. Regular cultivation with a long-handled fork helps break the hard pan and improves the growth of feeder roots. Tea fields that were suffering from *Pratylenchus* nematodes have recovered after a program of regular forking.

Apply balanced fertilizer

Increasing the dose of potassium ("kali") fertilizer can reduce the population of *Pratylenchus* in roots.

Think carefully before applying chemical nematicides

Chemical control of nematodes is almost never economical, because it is expensive and must be repeated every few years. Better to manage nematodes by prevention (manure and compost, forking, and fertilizer).

11.5 Nutrient deficiencies and physiological disorders

Sometimes, a tea plant has problems that look like disease symptoms. But in fact, there is no disease organism that is causing the problem. Instead, the problem is due to the conditions in which the tea plant is growing, including:

- a lack of (or excess of) certain nutrients
- misuse of pesticides
- age or physiological problems of the plant (sometimes made worse by weather).

The following table may help you decide among the possible causes. But, after using the table, you should do an experiment to confirm your idea about what is causing the problem:

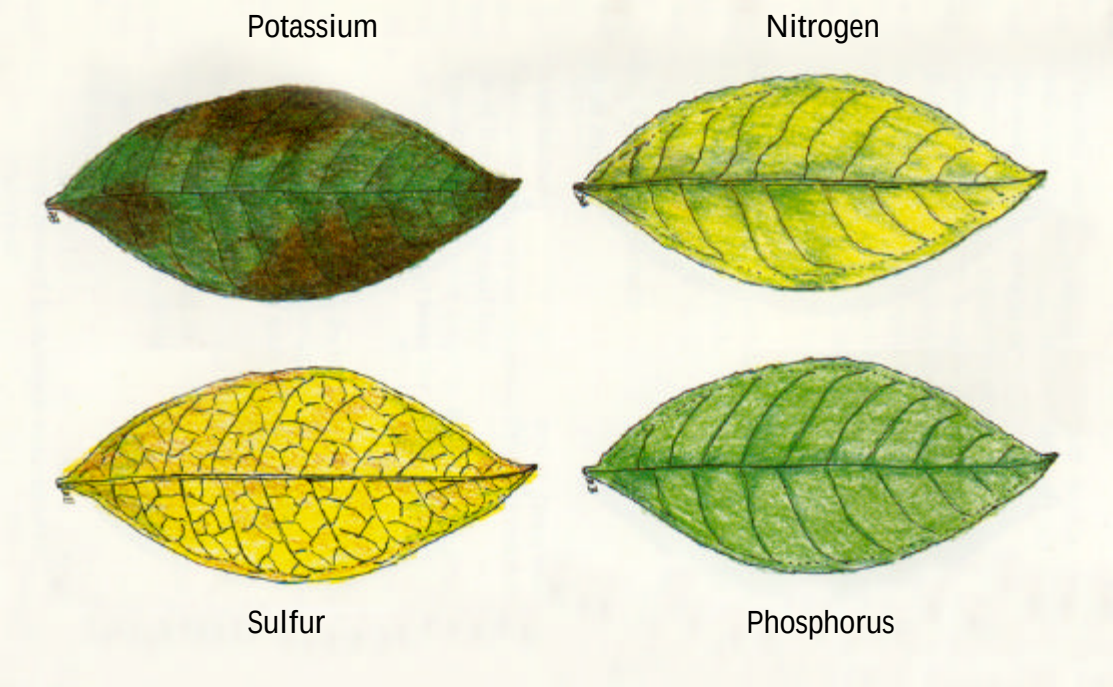
Characteristics of the symptoms	**Diseases**	**Nutrient deficiencies or excesses**	**Misuse of pesticides**	**Physiological problems**
How quickly did the symptoms appear?	Slowly or quickly	Slowly	Very quickly	Slowly (or quickly if severe weather)
Are the symptoms present on both young and old leaves?	Usually strongest on oldest, or youngest, but not both	Usually strongest on oldest, or youngest, but not both	Often present on both young and old leaves	Usually strongest on oldest, or youngest, but not both
Do most tea bushes in that part of the field have the symptoms?	May be limited to a few bushes	Usually yes	Usually yes	Usually yes
Do weeds in that part of the field have the symptoms?	No	Usually no	Usually yes	No
During a few months, do symptoms spread into new parts of the field?	Usually yes	No	No	No

11.5.1 Nutrient deficiencies

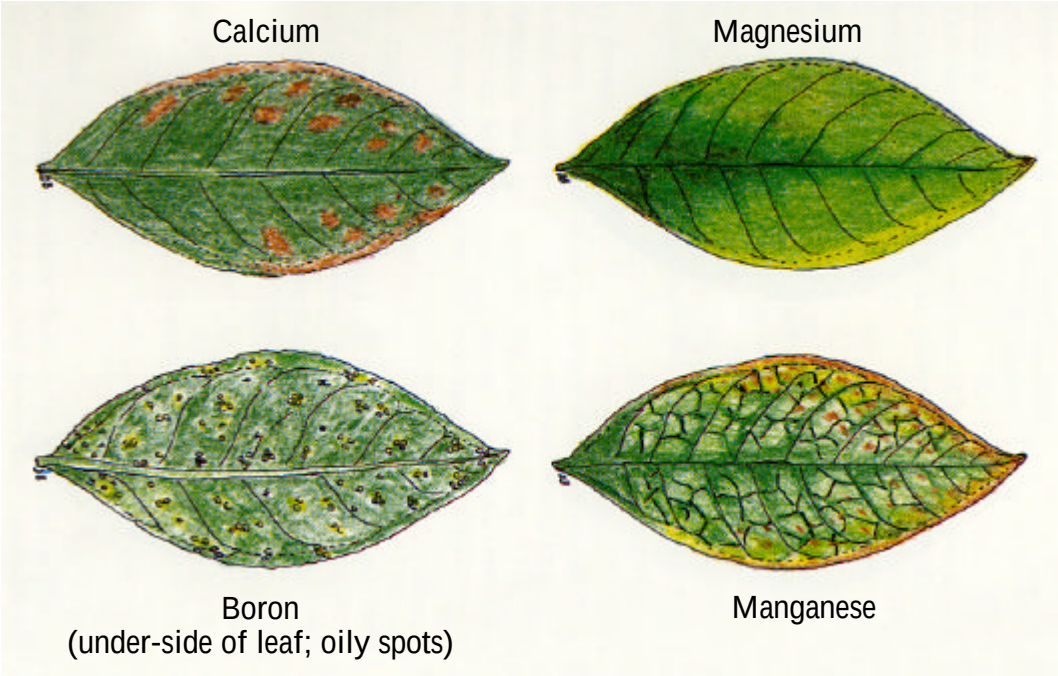
When a plant lacks ("is deficient in") a certain nutrient, characteristic symptoms will be produced on the plant. When a few bushes in a section of tea exhibit these symptoms, it is a warning that the whole section may be suffering from a shortage of that particular nutrient. The main deficiency symptoms in tea are briefly described in the following table, and are illustrated in the drawings below.

Deficient element	Deficiency symptoms
MACRO-NUTRIENTS (NEEDED IN LARGE AMOUNTS, USUALLY APPLIED TO THE SOIL):	
Nitrogen	Stunted growth of the plant; slowing down in the rate of growth; leaves pale yellow to white; defoliation begins with the lower leaves and extends to the upper leaves.
Phosphorus	Surface of mature leaves smooth which darkens and occasionally becomes slightly purple; leaves yellow at the tip.
Potassium	Very distinctive foliar symptoms of marginal scorch; thin stems; internodes usually longer.
Calcium	Downward curving of mature leaf, followed by marginal scorch starting from the leaf tip; apical activity much reduced; the later-formed leaves drop and growth virtually ceases; translucent patches on the lower surface of some leaves, the patches gradually coalesce and develop into brown necrotic areas.
Magnesium	Distinctive interveinal chlorosis on mature leaves but intensity of symptoms varies from clone to clone; defoliation of young plants starting from the lower leaves.
MICRO-NUTRIENTS (NEEDED IN SMALL AMOUNTS, USUALLY APPLIED AS FOLIAR FERTILIZERS):	
Sulphur	Very distinctive chlorotic symptoms; younger leaves appear pale-green to yellow; veins stand out clearly as a green network against a pale-yellow background.
Boron	Shoot apices die; axillary buds abort and clusters of small shoots appear in the axils; leaves become dark-green and thick; cork formation as excrescence on the upper side of leaf stalk, spreading to main veins and laterals.
Manganese	Interveinal chlorosis of old and young leaves; irregular mottling, veins and surrounding areas remain green, necrotic spots develop within the chlorotic patches, mainly close to the leaf margin; severe deformation of young leaves and buds.
Zinc	Leaves smaller, darker and sickle-shaped due to unequal development of the lamina on either side of the mid-rib; internodes shorter.

No specific symptoms have been noted for deficiencies of other micro-nutrients (copper, iron, molybdenum, aluminium, fluorine or chlorine).



Symptoms of deficiencies of major nutrients *(those nutrients that plants require in relatively large quantities). Note that the exact symptoms will depend on many factors including the tea variety and the type of soil.* *Source: D. Bonheure. 1990. Tea. In the series entitled The Tropical Agriculturalist. Maisonneuve et Larose, Paris, France.*



Symptoms of deficiencies of minor nutrients *(those nutrients that plants require in relatively small quantities). Note that the exact symptoms will depend on many factors including the tea variety and the type of soil.* *Source: D. Bonheure. 1990. Tea. In the series entitled The Tropical Agriculturalist. Maisonneuve et Larose, Paris, France.*

Before deciding that your tea plants have a nutrient deficiency, check for:

- root rots (see Section 11.4)
- small sucking insects (see Section 9.2)
- physiological disorders (see Section 11.5.4)
- too much fertiliser (see Section 11.5.2).

All of these problems can cause symptoms similar to nutrient deficiencies.

If you think your plants are deficient in a macro-nutrient, do an experiment with increasing the rate of this nutrient the next time you apply fertiliser to the soil.

If you think your plants are deficient in a micro-nutrient, do an experiment with a foliar fertiliser. Consider making your own foliar fertiliser (see Section 6.3.6).

11.5.2 Too much fertilizer

Nutrients are like food: too much can be just as dangerous as not enough. Both boron and copper can be harmful to tea plants if they are present in too high concentrations. An excess quantity of boron causes irregular dead patches between the veins of the leaves, with patches concentrated near the edges of the leaves. These problems are uncommon, but are useful lessons that micro-nutrients should not be applied unless they are necessary.

Macro-nutrients can also cause problems if applied at excessive doses. First, too much nitrogen increases the susceptibility of the tea plant to many diseases and insects. Also, high concentrations of one nutrient can prevent the plant from absorbing other nutrients. For example, high concentrations of calcium prevent the plant from absorbing enough potassium. And, high concentrations of potassium prevent the plant from absorbing enough magnesium.

If you think your plants are suffering from excess fertilizer, do an experiment reducing the amount of fertilizer or micro-nutrients that you have been using. It may take many months to see an effect, because the excess nutrients will remain in the soil.

11.5.3 Misuse of pesticides

Pesticides (especially herbicides) can be harmful to plants. In general, if symptoms are caused by a pesticide:

- symptoms will appear suddenly
- weeds in that part of the field probably will show the same symptoms
- if the symptoms are burns, both young and old leaves will probably show symptoms. However, if the symptoms are curling or distortion of leaves, these might be strongest on young leaves.

High doses of any pesticide, or even of the “non-toxic” parts of a spray mixture like spreaders and stickers, can cause burned spots on leaves. These burned spots look similar to the early stages of leaf diseases (see Section 11.2).

Some herbicides, even in fairly low doses, can cause leaves to curl, become deformed, and change color. These symptoms are easy to confuse with sucking insects (Section 9.2) or nutrient deficiencies (Section 11.5.1).

If you think your bushes are suffering from a pesticide, the best advice is: wait. Check the bushes every few days to see how the symptoms change. The symptoms may get worse for a few days or even a few weeks. But, fairly soon, they will stop getting worse (and hopefully, start getting better). Also, symptoms will not spread into new parts of the field. If the symptoms continue to get worse and spread, you probably have a disease.

11.5.4 Physiology and weather (including "white leaf" and "yellow leaf virus")

Some symptoms seem to be caused simply by a weakened physiological state of the tea. This can be due to old age, the genes that the tea inherited from its parents, poor tending for many years, and/or extreme weather conditions (drought or very cold weather). The following condition has been seen by trainers and researchers in Viet Nam, and seems to be due to physiological conditions:

White leaf of tea (albinism)

Tea leaves, especially young leaves, become very pale or white. This may be related to extreme weather, but others say no. Regrowth of new shoots is slow. If shoots regrow, they may recover their normal green color.

What about "yellow leaf virus" of tea?

Symptoms are similar to the "greening disease" seen in oranges and mangoes: the veins stay green but the leaf tissue between the veins turns yellow. Usually seen on old bushes that have not had good tending.

So, is it a disease, a nutrient deficiency, or a physiological problem? As always, the best answer is found by doing an experiment.

A researcher at TRI took cuttings from branches that had the symptoms of "yellow leaf virus". he or she grew these cuttings in soil that had a good, balanced supply of fertilizer. The plants that grew from the cuttings did not have any symptoms! So, it seems very likely that this "disease" is nothing more than the symptoms of a nutrient deficiency.

Farmers can try this same experiment if they find symptoms that they are not sure about.