Chapter Nine

Major Insect Pests of Tea in Viet Nam

9.1 How to determine which insect pest is damaging the crop

If you already have seen an insect feeding on your tea, then you can go directly to the section of the chapter that tells about that insect.

But, often it is hard to observe or catch the insect in the field. Maybe you have only seen some damage or some unusual changes in your tea plants. If you have not yet found the insect that is causing the problem, then look in the following table to find the symptoms that you are seeing in your tea field. You may have several different symptoms at the same time. Then, read the sections of the Guide that match your symptoms. Remember: some plant diseases (and even some chemicals) cause symptoms that look like damage from insects!

Symptoms	Possible cause(s)	Read this section:
Curled, deformed leaves	Aphids, mites, mosquito bug (see also diseases, Chapter 11)	9.2
Leaves with dark brown stripes or spots	Red spider mite, mosquito bug (see also diseases, Chapter 11)	9.2
Leaves changing color	Aphids, mites, mosquito bug, green leafhopper (see also diseases, Chapter 11)	9.2
Sooty mold growing on leaves	Aphids, scales	9.2
Leaves or buds folded or tied with silk	Bud rollers, leaf tiers, and leaf folders	9.3.1
Holes in leaves	Caterpillars	9.3
Dried, dead leaves	Mosquito bugs, mites, red borer, termites (see also diseases, Chapter 11)	9.2 or 9.4 or 9.5
Pluckers or other workers with burns on their skin	Nettle caterpillars and saddleback caterpillars	9.3.3
Tubes made out of sawdust or mud on the surface of trunk or branches	Termites	9.5
Big pieces of sawdust on the ground under tree	Red borer	9.4

9.2 Small sucking insects on leaves or buds

These insects are mostly found on undersides of leaves or inside buds. Leaves that are damaged by their feeding usually are curled, discolored, or dried.

Insect	Movement	Size and shape	Color
Tea green leafhopper	Move **actively** (walk sideways or jump)	Small (2-4 mm long); **shaped like a tiny rice grain**	**Green** (although young nymphs are white)
Mosquito bug	Move actively (fly or drop off plant)	Small (4-5 mm long); **shaped like a mosquito**, with a club growing out of the back.	**Green** body, **brown** head, **yellow or orange** legs
Mites	Move **very slowly**	**Tiny**, less than 1 mm long.	Red **or** white
Thrips	Move **very slowly**	Tiny (0.5 - 1.2 mm long), **shaped like a tiny grain of rice**	**Pale brownish-red** to **flesh-color** to **pale green-yellow**
Aphids	Move **very slowly**	Small (1.5 - 2 mm long); **shaped like a tiny pear**	**Dark brown**
Scale insects	**Do not move**	Small (1-2 mm), **covered with a hard waxy shield**, round or elongated	**Yellow-green** or **brown**

9.2.1 Tea green leafhopper

Vietnamese name: RÇy xanh
Scientific names: *Empoasca onukii*, *Empoasca vitis*, or *Jacobiasca formosana*
(Order Homoptera, Family Cicadellidae; sometimes called Family Jassidae)
Several of these species may be present at the same time.

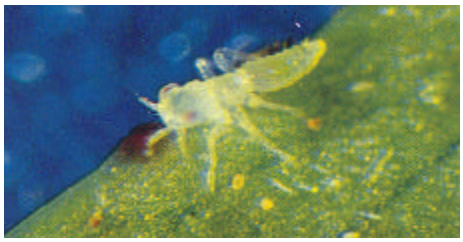
Tea green leafhopper is one of the biggest pest problems for tea growers in the northern part of Vietnam.

Description and Behavior

Leafhoppers do not like direct sunlight and therefore prefer to stay on the underside of the leaves. When they walk, they move sideways. When the plant is disturbed, they jump very quickly to another place.

The **adult** leafhopper is 2 - 4 mm long and has the green color of rice seedlings. The wings are transparent and green. Leafhopper **nymphs** have no wings, but for the rest they look like the adults. A newly hatched nymph is a little bigger than a rice bran cell, with a transparent white color (see pictures). The older nymphal stages (*instars*) get the green color and each instar is a little bigger than the previous one (see photographs and drawing, below). The last instar is about 2 mm long.

Tea green leafhopper adult.



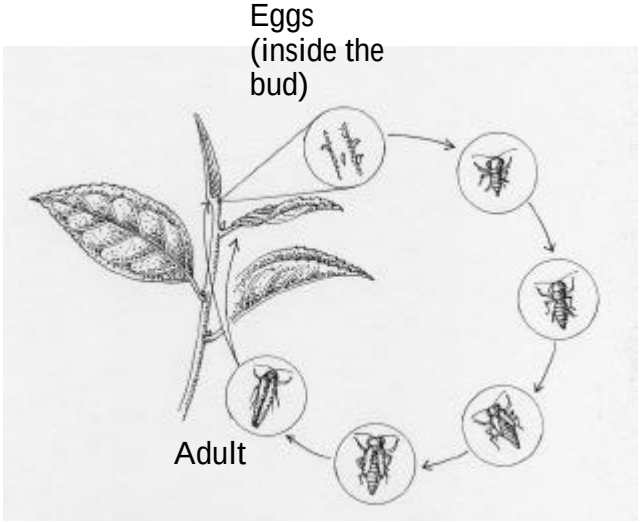
Nymph (immature stage).

Source: Suh-Neu Hsiao et al. 1983. Monograph on tea pests and diseases in Taiwan (in Chinese). Wen Shan Tea Plant Improvement Station, Taiwan.

Life cycle

Eggs are laid inside the soft tissue of new tea buds, particularly in the internode. In one bud, from 1 - 7 eggs can be found. One female can produce up to 100 eggs during her lifetime. Depending on the temperature, the eggs will hatch after 5 - 10 days, producing nymphs.

There are four instars during the **nymph** stage. In other words, the nymph sheds its skin 4 times as it grows into an adult. The total duration of the nymph stage is 7 - 16 days depending on the weather (faster in warm weather). So, it takes from 12 - 30 days for leafhoppers to complete a generation (from when eggs are laid until the new adults are ready to lay eggs themselves). There can be as many as 10 generations in a year. The life span of the **adults** is 14 - 21 days; females in general live longer than males.



Lifecycle of the tea green leafhopper. *Source: original drawing by Wendy Gibbs.*

Plant damage and plant tolerance

Both nymphs and adult leafhoppers use their needle-like mouthparts to suck sap from the leaves. By feeding in this way the hoppers make wounds in the leaves, causing the leaves to become covered with small yellow spots. With continued feeding the leaves become stunted and, especially under dry conditions, the upper part can dry out (see picture). The less seriously affected leaves can have a purple color. The damage to the plant is caused by the removal of sap and by the actual injury to the plant tissues, which prevents the leaf from receiving nutrients from other plant parts.

Damage from tea green leafhopper feeding. *Sources: left photograph from Suh-Neu Hsiao et al. 1983. Monograph on tea pests and diseases in Taiwan (in Chinese). Wen Shan Tea Plant Improvement Station, Taiwan. Right photograph from Nguyen Phong Thai (editor), 1998. Insect Pests, Diseases and Weeds of Tea (in Vietnamese). Agricultural Publishing House, Hanoi, Vietnam.*

For newly planted tea, especially when less than 4 - 5 months old, leafhoppers can cause the drying out of new shoots, with the plant becoming stunted and growing more slowly. If feeding is severe and prolonged, newly-planted tea plants could even die. Larger tea plants (branch formation stage and older) are much more able to tolerate leafhopper feeding. However, high populations of leafhoppers can considerably reduce the yield and quality of the tea bud.

Natural enemies

Different kinds of spiders such as the white gray spider, the black spider, the long-legged spider and the small black spider, were found to be predators of leafhoppers. Carabid beetles, ladybeetles, and dragonflies also feed on leafhoppers. All these natural enemies prey on both young and adult hoppers, but they seem to prefer the nymphs.

Predators of Tea Green Leafhopper

During field studies in Thai Nguyen we found that "small black spiders" were often the most numerous of the spiders found in the tea field. But in the Insect Zoo, we discovered that this spider ate few leafhoppers compared to the other spider species. The opposite was true for “long-legged spiders”. The density of "long-legged spiders" was often lowest, but the preying capacity of this spider was highest: on average, one long-legged spider could eat 4 - 5 leafhoppers per day.

We have almost no information from Vietnam about parasitoids of leafhoppers, but in Taiwan several egg parasitoids have been identified. These Taiwan parasitoids are very closely related to the egg parasitoids of brown plant hopper (a rice pest) found in Vietnam.

Parasitoids of Tea Green Leafhopper

In Taiwan a large number of egg parasitoids of leafhopper were identified. These parasitoids belong to the same genera as some of the egg parasitoids of the rice brown plant hopper found in northern Vietnam. Some studies in Taiwan found that up to 60% of tea leafhopper eggs were killed by parasitoids, and that they played an important role in controlling the leafhopper.

Management practices: prevention and control

a. Prevention

Grow a strong crop that can tolerate leafhoppers

The most important in controlling leafhoppers is to practice good cultivation techniques in order to have a strong tea crop. If pruning and plucking are not carried out well then the tea plants will grow weakly and many leafhopper eggs will hatch in the field. Good fertiliser management is also important, making sure that all necessary elements are given and not only nitrogen (urea).

Pluck frequently to remove leafhopper eggs

The frequency of plucking plays an important role in limiting leafhopper populations. When plucking is done at short intervals, based on when the buds meet the criteria and not just once a month or so, the availability of suitable sites for egg laying is reduced. Also, with the harvested buds many eggs will be brought out from the field before they have a chance to hatch.

Protect natural enemies by using less insecticides.

Leafhopper is killed a lot by natural enemies, especially spiders. Preservation of natural enemies is therefore very important for better control of leafhoppers. To achieve this it is essential to limit as much as possible the use of pesticides. The leafhopper problem is often made worse because of the destruction of natural enemies by the use of broad-spectrum

pesticides such as Monitor, Wofatox and Bi-58. Especially the regular use of Monitor to stimulate the development of new shoots can kill many natural enemies. It is believed that the increased use of these pesticides has caused the leafhopper to become a much bigger problem than in the past, making this insect one of the most difficult tea pests to control.

Encourage natural enemies by managing the crop

Provide natural enemies with the shelter they need by planting cover crops between the rows, or permitting beneficial weeds to grow there. Mulching between the rows may also help encourage higher populations of predators.

Plant shade trees

Growing tea underneath shade trees (such as "muong la nhon") tends to reduce problems with leafhoppers. Mulching also helps to increase humidity and therefore reduce leafhopper populations.

Other ways to prevent leafhopper outbreaks

There is not much known about host plants other than tea. So, it is not known whether eliminating certain wild plants in nearby fields or between rows would help control leafhoppers. It would be useful for farmers to search for leafhoppers on shrubs and weeds near their tea fields to learn more about this.

b. Field monitoring and decision making

There are generally two periods when leafhopper populations become very high: March - May and September - December. This is probably due to favorable climatic and crop conditions. Too much rain or too dry weather are not favorable for the development of the insect.

Sampling should be done every week since the development of the leafhopper can be very fast. Just searching in the leaves for leafhoppers can be difficult because the leafhopper is small and very active. To overcome this problem a sampling tray can be used. The recommended size of the tray is 20 x 20 x 5 cm and it is used by holding it at a angle of about 45 degree under the tea plant canopy and then vigorously tapping the plant three times. The number of leafhoppers in the tray can then be counted. Measurements should be made in at least 10 places in each field.

⇒ Note: there should be a thin layer of soapy water or grease in the tray in order to make the leafhoppers stay there.

c. Control methods

Make your decision based not only on how many leafhoppers you find, but also:

- how old the tea is (young tea plants are more sensitive to leafhopper)
- how the number of leafhoppers has been changing for the past few weeks (going up or going down?)
- number of natural enemies you find
- weather forecast (rainy weather can help control leafhoppers)
- whether you could control the leafhoppers without spraying (for example, by plucking more often).

If you decide that you need to spray, avoid insecticides that will kill many natural enemies, such as broad-spectrum ones and pyrethroids. Instead, farmers could try some botanical pesticides such as "xuan" tree (scientific name *Melia azadirachta*), or solutions of soap plus water. Any sprays should be directed at the bottoms of leaves, where leafhoppers are most abundant.

9.2.2 Mosquito bug

Vietnamese name: Bä xÝt muçi
Scientific names: *Helopeltis antonii* or *Helopeltis theivora (= H. theobromae)*
(Order Hemiptera, Family Miridae). Both of these species may be present at the same time.

Mosquito bugs are found in most of the tea growing locations in northern Vietnam. Both young and adult mosquito bugs damage the tea plant by sucking sap from the tea buds.

Description and Behavior

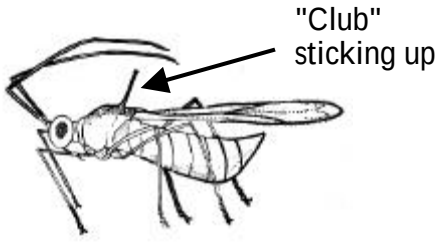
The **adult** female mosquito bug is about 5-10 mm long. The male is a little smaller, about 4 mm long. Both females and males look a bit like very large mosquitoes (see picture). The **head** of the insect is brown with a broad yellow stripe, and is smaller at the neck. The eyes are brown – black. The insect has long brown antennae that become thinner and darker at the ends farthest from the head. The **back** of the insect has a small club sticking out of it, shaped like a short pin with the head upwards (see drawing). The insect's legs are dark yellow or copper-color. The **body (abdomen)** of females is green (the color of rice seedlings). Males have a more bluish color.

During hot or sunny periods, the adult mosquito bugs are more active during the cooler parts of the day (in early morning, late afternoon, or just after rains). During the hottest time of the day, the mosquito bugs hide under the tea leaves and are hard to find. During cool overcast days, the mosquito bugs are active during the whole day. During cold months, mosquito bugs are most active during the warmest part of the day (from about noon until 3 p.m.).

Young **nymphs** look a bit like ants, and range in color from copper or orange to green (see picture). Nymphs often stay in groups of 2 - 3 individuals on a bud or at the young leaves near the bud. Older nymphs are green-yellow, and the club and the wing pads (growing wings) are yellow. The nymphs often let themselves drop off the plant when disturbed.

The **egg** is oval and has a clear white color. Eggs are laid inside tender green stems. At the smaller end of the egg there are two long hairs of unequal length (see picture). If you are using a strong magnifying glass, these hairs can be seen sticking out from the hiding place of the eggs.

Mosquito bug adult. ***Source: Suh-Neu Hsiao et al.*** *1983. Monograph on tea pests and diseases in Taiwan. (in Chinese). Wen Shan Tea Plant Improvement Station, Taiwan.*

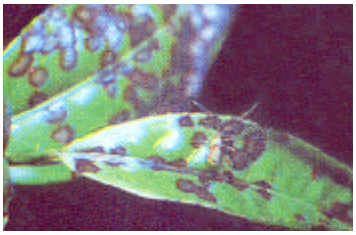


Side view, showing the "club".
Source: J.E. Cranham. 1966. Insect and mite pests of tea in Ceylon and their control. Tea Research Institute, Talawakelle, Sri Lanka.

Mosquito bug nymph, feeding.
The feeding has caused a discolored spot on the leaf, which will later turn black.

Mosquito bug egg, greatly magnified.
Eggs are hidden inside young stems.

Source: Suh-Neu Hsiao et al. 1983. Monograph on tea pests and diseases in Taiwan.(in Chinese). Wen Shan Tea Plant Improvement Station, Taiwan.



Leaf spots caused by feeding of mosquito bug.
Sources: left photograph from Nguyen Phong Thai (editor). 1998. Insect pests, diseases, and weeds of tea and prevention methods. Agricultural Publishing House, Hanoi, Viet Nam. Right photograph by Michael Zeiss.

Life cycle

One female mosquito bug can produce 12 - 74 **eggs**. It lays eggs singly or in groups of 2 - 3 eggs, inserted into tender young stems. Eggs will hatch after 5 - 10 days depending on the temperature (faster in warm temperatures).

There are five instars during the **nymph** stage. In other words, the nymph sheds its skin 4 times as it grows into an adult. The total duration of the nymph stage is 9 - 19 days depending on the weather.

Adult mosquito bugs start mating 2 - 3 days after the last moult. About 1 - 3 days after copulation, they start laying eggs. This means that it takes from 17 to 35 days (depending on the season) for the insect to complete a generation (from when eggs are laid until the new adults are ready to lay eggs themselves). There are about 8 generations per year.

The adults can live for 8 - 13 days.

Plant damage and plant tolerance

Both young and adult mosquito bugs have sucking mouthparts like a sharp drinking straw. They use their mouthparts to pierce the young parts of the plant (young leaves or buds) and suck the sap of the plant. Nymphs often cause heavier damage than adults because the nymphs move less than the adults do.

The part of the plant where a mosquito bug has sucked develops a circular stain that is dark-brown or black (see picture on previous page). Nymphs make smaller but more numerous sucking stains than adults. Tea buds or shoots with many sucking stains become curled, dried, and black, producing no yield (see picture on previous page). Some farmers call this “foggy burning disease”, but it has nothing to do with the damage sometimes caused by foggy weather.

Badly damaged buds cannot be plucked, which badly affects the next flush of shoots. In addition, affected buds and shoots often become infected with the disease of tea stem leprosy, in which the stems become covered with many small dark pimples, or with swollen trunk disease. Swollen trunk disease often appears about two months after a heavy attack by mosquito bug. The most seriously affected tea plants have darker green color and are stunted. Mosquito bugs often start from a small area in the tea field and attack a group of neighboring plants. This gives the tea field the appearance of uneven development.

Natural enemies

Natural enemies of mosquito bugs are spiders, dragonflies, praying mantis, and some kinds of ants. These natural enemies can kill both nymph and adult mosquito bugs. Other general predators (like lady beetles and ground beetles) probably eat some mosquito bug nymphs.

Management practices: prevention and control

a. Prevention

Good plucking and tending to help the plants recover

A more frequent plucking schedule is helpful to remove mosquito bug eggs. Plucking every 10-15 days removes insect eggs and young insects before they can grow large enough to cause a lot of damage. Try to pluck out all the damaged buds, even if they are so badly damaged that you cannot harvest them. The reason is, plucking the damaged shoots stimulates the plant to grow new shoots. Also, provide good tending practices so that the tea

can rapidly produce new shoots. If fields are seriously affected, light or moderate pruning will limit very much the population of mosquito bug.

Protect natural enemies by using less insecticides.

Populations of natural enemies can be dramatically reduced after each application of pesticide. Preserve these natural enemies by using as little insecticide as possible against mosquito bug or any other pest.

Eliminate trees that provide food to mosquito bugs

Mosquito bugs feed and reproduce on many trees, including:

Vietnamese name	English name	Scientific name
C©y së		
C©y æi	guava	*Psidium guajava*
Såi	oak	*Quercus* spp.
Mua	melastoma	*Melastoma* sp.
Chã ®Î	thoroughwort	*Eupatorium* sp.
Cá lµo	fragrant thoroughwort	*Eupatorium odoratum*
Thµi lµi	dayflower	*Commelina* spp.
Cacao	cacao or cocoa	*Theobroma cacao*
§iÒn thanh	sesbania	*Sesbania cannibina*
Canhkina	quinine	*Cichona* spp.
Mit	jackfruit	*Artrocarpus heterophylla*
Sim	tomentose rose myrtle	*Rhodomyrtus tomentosa*
Dao lon hot Cay hat dieu	cashew	*Anacardium occidentale*

Clear out these trees from the tea field and from neighboring fields. If there are wild trees or plants nearby, but you do not know if they can provide food for mosquito bugs, check the wild plants for the feeding stains caused by mosquito bug. Or, if you can find some mosquito bugs in your tea, do an insect zoo to see if the mosquito bugs can feed on the wild plants or trees.

Clear out any wild trees that show a lot of feeding stains, or trees that mosquito bugs fed on during an insect zoo. As far as is known, mosquito bugs do not feed on the “muong la nhon” trees (scientific name *Indigofera zollingeriana*) that are often used to provide shade in tea fields.

Be sure that tea is not growing under too much shade

Mosquito bugs prefers moist conditions and mild temperatures. Probably for that reason, mosquito bug populations are often higher under heavy shade. For example, “keo” trees (*Acacia arabica*) were often planted in tea fields as part of the PAM program. But, it is recommended to not plant tea under dense stands of “keo”, because the tea plant will get too much shade. If you are growing your tea under shade trees, be sure to maintain the trees by lopping some branches so they don’t make too much shade. If you have trouble with mosquito bugs year after year, you might wish to reduce or eliminate the shade trees. But remember: if you have no shade at all, you will have more problems with other insects (especially leafhoppers, thrips, and red spider mites).

b. Field monitoring and decision making

Mosquito bug populations increase most quickly when the temperature is between 20 - 27 degrees and humidity is high (greater than 90%). For this reason, mosquito bugs are most damaging during the most humid months of the rainy season. In many years, mosquito bug populations show the following cycle:

- from April - May: Start to occur in small numbers, causing little damage
- from July - August: Peak populations, causing serious damage
- from October - December: High population, causing moderate damage.

During this period, pay special attention to mosquito bug when doing your agro-ecosystem analysis. Farmers should continue to check for mosquito bug even after application of insecticide.

There are two methods recommended for measuring mosquito bugs: counting the average number of bugs per bud, or counting the percent of affected buds (buds with feeding stains, blackened, shriveled, etc.) It is easier to count the percent of affected buds. But the disadvantage is, it is hard to tell when the affected buds were damaged. You might end up spraying after the mosquito bugs had already stopped damaging your field.

As for any pest, don't base your control decision only on how many pests or how much damage you have. Instead, you should also consider:

- how the number of mosquito bugs or affected buds has been changing for the past few weeks (going up or going down?)
- number of natural enemies you find in the field
- weather forecast (hot dry weather may help control mosquito bugs).
- whether you could control the mosquito bugs without spraying (for example, by plucking more often).

If you decide you need to spray, avoid insecticides that will kill many natural enemies, including broad-spectrum insecticides and pyrethroids. Instead, use a selective insecticide. Spray during the cool part of the day (early morning or late afternoon) when mosquito bugs are more active.

9.2.3 Mites (including Red spider mite)

Scientific and Vietnamese names: see the box, below. Several mite species may be present at the same time.

Mites are tiny animals like insects. Scientists do not call mites insects because most mites have 8 legs (insects never have 8 legs). Mites suck the sap from leaves, causing leaves to change color, curl, dry up, and even fall off. In tea, mites are found on the leaves, concentrated near the central vein of the leaf. One mite, the Red spider mite, is a serious pest of tea in Viet Nam. Other types of tea mites are not yet common in Vietnam, but are important pests in other countries, and seem to be increasing on the new tea varieties in Vietnam (for example, on the Yabukita variety imported from Japan).

Because mites are so small, it can be difficult to identify which type of mite is present on your tea. In fact, several types of mites may be present on the same leaf. Nonetheless, it is worthwhile for farmers to identify their mites (or to get an expert to help them identify their mites). The reason is, each type of mite requires different control methods.

Mites on tea in Southeast Asia

Here is a list of some mite species found on tea in neighboring countries. Many of these mites are probably present in Viet Nam. In fact, Tea Research Institute reports that some of these mites are starting to be found on some of the new tea varieties that have been imported into Viet Nam. So, trainers and farmers should learn about these new mites and be watching for them in their tea fields:

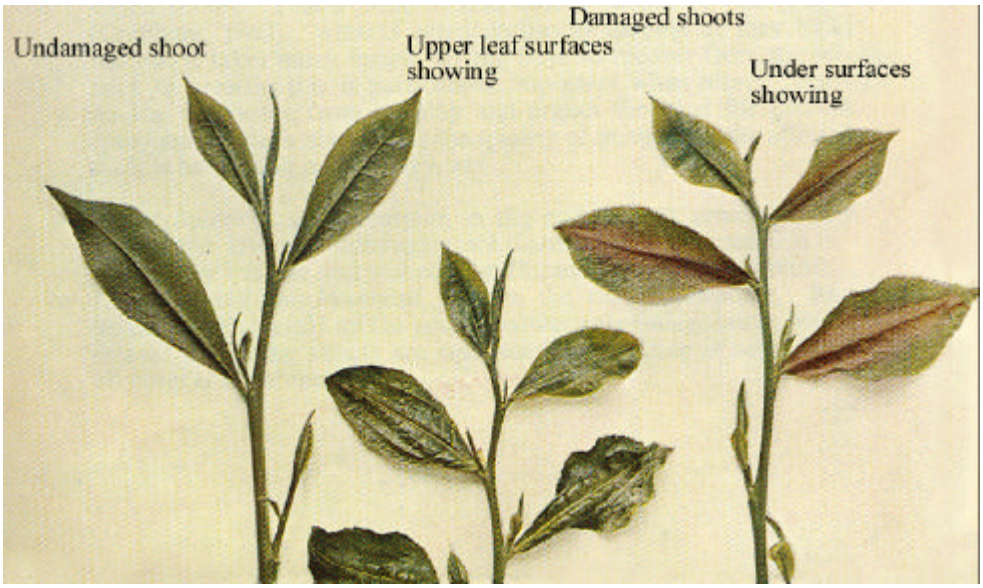
English name	Vietnamese name	Scientific names
Red spider mite	nhÖn ®á n©u	*Oligonychus coffeae* (= *Tetranychus bioculatus*) (= *Metatetranychus bioculatus*), *Tetranychus cinnabarinus* *Tetranychus kanzawai* *Tetranychus urticae* (Family Tetranychidae: spider mites, make silk)
Scarlet mite (also called the "red and black flat mite")	nhÖn ®á t-¬i	*Brevipalpus californicus* *Brevipalpus phoenicis* (Family Tenuipalpidae: false spider mites, no silk)
Purple mite	nhÖn säc tr¾ng	*Calacarus carinatus* (Family Eriophyidae: rust mites and gall mites)
Pink mite	nhÖn hång	*Acaphylla theae* (=*Eryophyes theae*) (Family Eriophyidae)
Yellow mite	nhÖn vµng	*Polyphagotarsonemus latus* (Family Tarsonemidae: leaf mites)

Description and Behavior

Because mites are so small, it is easiest to identify them based on the symptoms that they cause. But remember: symptoms vary from one variety of tea to another, and from one season to another. So, an identification based on symptoms should be considered as tentative. If possible, confirm your identification by having an expert look at some of your mites under a microscope.

a. Identification based on symptoms

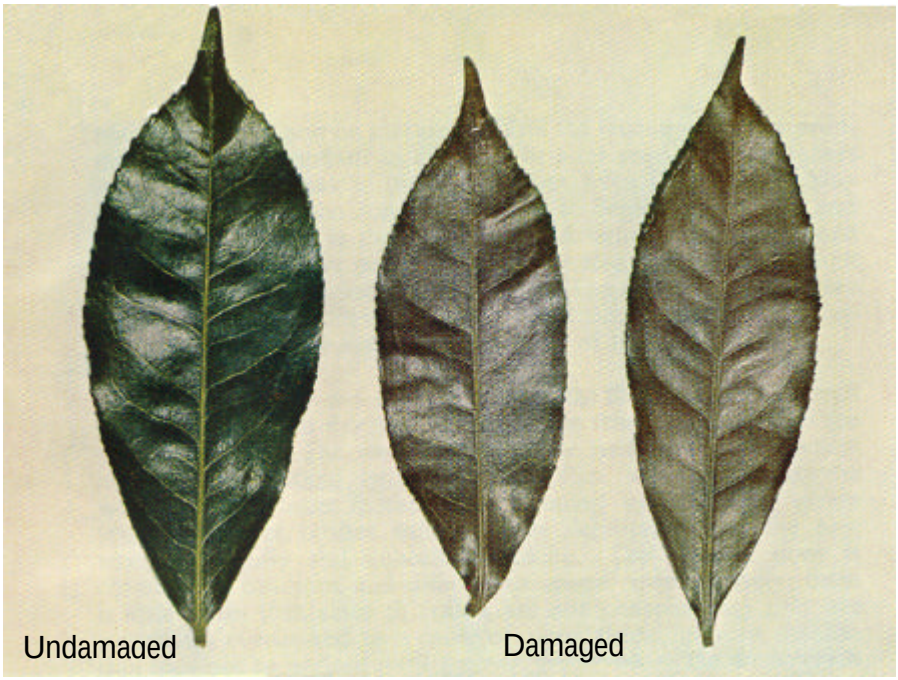
If symptoms are on the flush (tender new shoots):
probably caused by yellow mite.
Yellow mites cause the flush to become stunted, pale, and often curled or deformed. Also, on the undersides of the flush leaves, yellow mites cause a brown stripe of dry tissue like cork along the midrib (see the picture below). Be careful: this type of damage can also be caused by thrips that were feeding inside the curled-up bud.



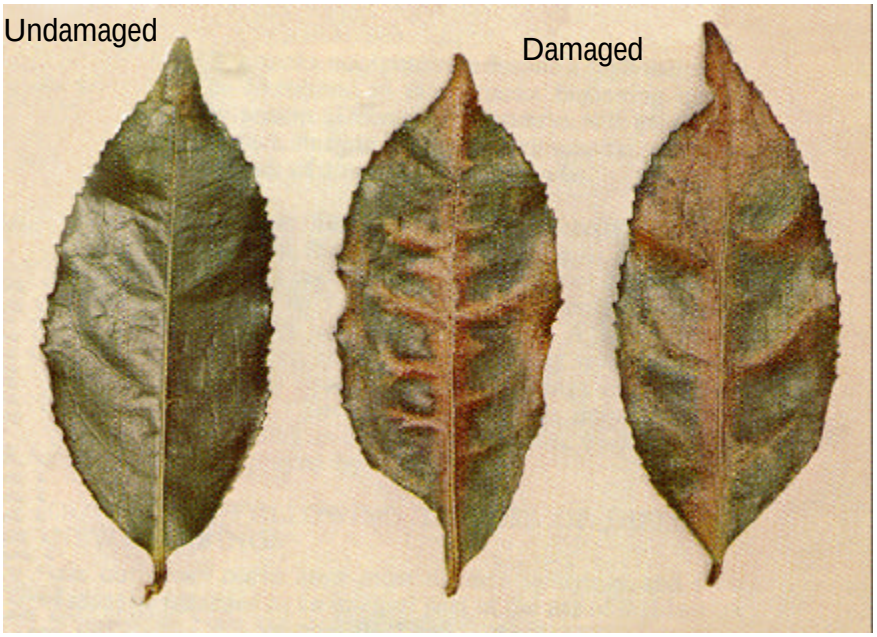
Symptoms on the young tender leaves ("flush"), caused by yellow mites.
Source:J.E. Cranham. 1966. Insect and mite pests of tea in Ceylon and their control. Tea Research Institute, Talawakelle, Sri Lanka.

If symptoms are on the maintenance foliage (mature leaves):
use the following table and see the pictures on the following pages to decide which mite.

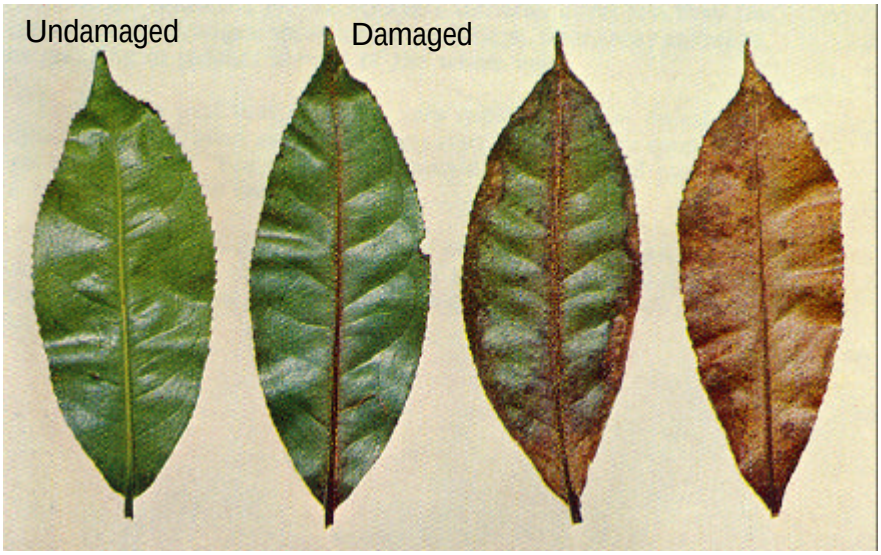
Type of mite	Does it cause brown patches or bands on the leaves?	Does it cause the leaves to fall off?
Purple mite and pink mite	**No**; the entire leaf becomes dull (not shining) and changes color (remains green but becomes tinted with bronze or purple color).	**Very few** leaves, **or no** leaves
Red spider mite	**Yes**, on the **upper** surfaces. Clearly visible reddish-brown patches or bands, starting along the midvein then spreading outward. In severe attacks the entire leaf may become brick-red.	**Yes**; in severe attacks the older leaves fall off.
Scarlet mite	**Yes**, on the **lower** surfaces. Dead brown patches along the midvein and the petiole (the "stem" of the leaf), and dead brown patches along the outside edges of the leaf.	**Yes**; in severe attacks the older leaves fall off.



Damage on mature leaves, caused by purple mite.
All three leaves show the upper surfaces.
The damage caused by pink mite is very similar.
Source:J.E. Cranham. 1966. Insect and mite pests of tea in Ceylon and their control. Tea Research Institute, Talawakelle, Sri Lanka.



Damage on mature leaves, caused by red spider mite.
All three leaves show the upper surfaces.
Source:J.E. Cranham. 1966. Insect and mite pests of tea in Ceylon and their control. Tea Research Institute, Talawakelle, Sri Lanka.

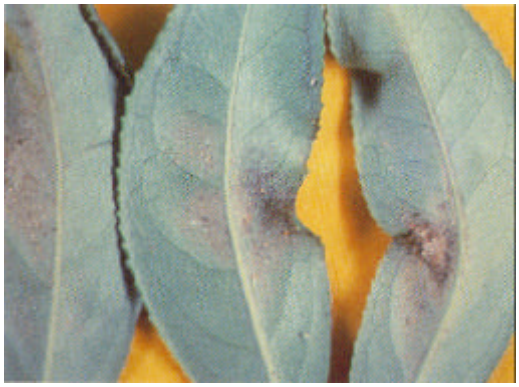


Damage on mature leaves, caused by scarlet mite.
All four leaves show the under surfaces.
Source:J.E. Cranham. 1966. Insect and mite pests of tea in Ceylon and their control. Tea Research Institute, Talawakelle, Sri Lanka.

b. Identification based on shape and behavior

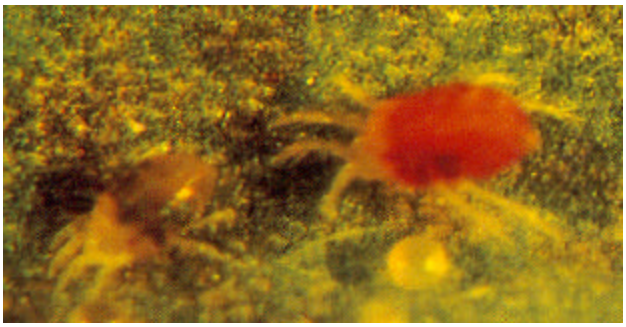
Although they are very small, both red spider mites and scarlet mites can be seen with the unaided eye. But, it is best to use a strong magnifying glass.

Red spider mites are found on both sides of the leaf and are concentrated along the central rib of the leaf. They walk very slowly. When they are feeding, they usually do not move at all. Groups of spider mites often cover themselves lightly with a "cobweb" of short strands of silk (see picture). This is why they are called "spider" mites. The spider mites can be found underneath the silk, walking slowly on the leaf surface. Other types of mites do not produce silk.

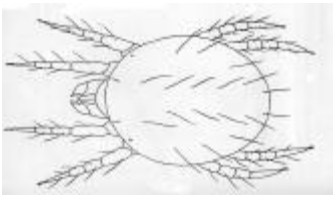


Groups of red spider mites, covered with silk, on under sides of leaves.
Source: Suh-Neu Hsiao et al. 1983. Monograph on tea pests and diseases in Taiwan.(in Chinese). Wen Shan Tea Plant Improvement Station, Taiwan.

The **adult** red spider mite is about 0.5 mm long, with a pink or light red color (see drawing). The female has a round shape, while the male has a more elongated body. Adults and most **nymphs** have 8 legs (though when they first hatch out of the eggs, the young nymphs have only six legs). The **eggs** are round, dark red, and shiny. Leaves with heavy mite populations often have many tiny white spots on the surface; these are the empty shed skins of the mites (see picture).



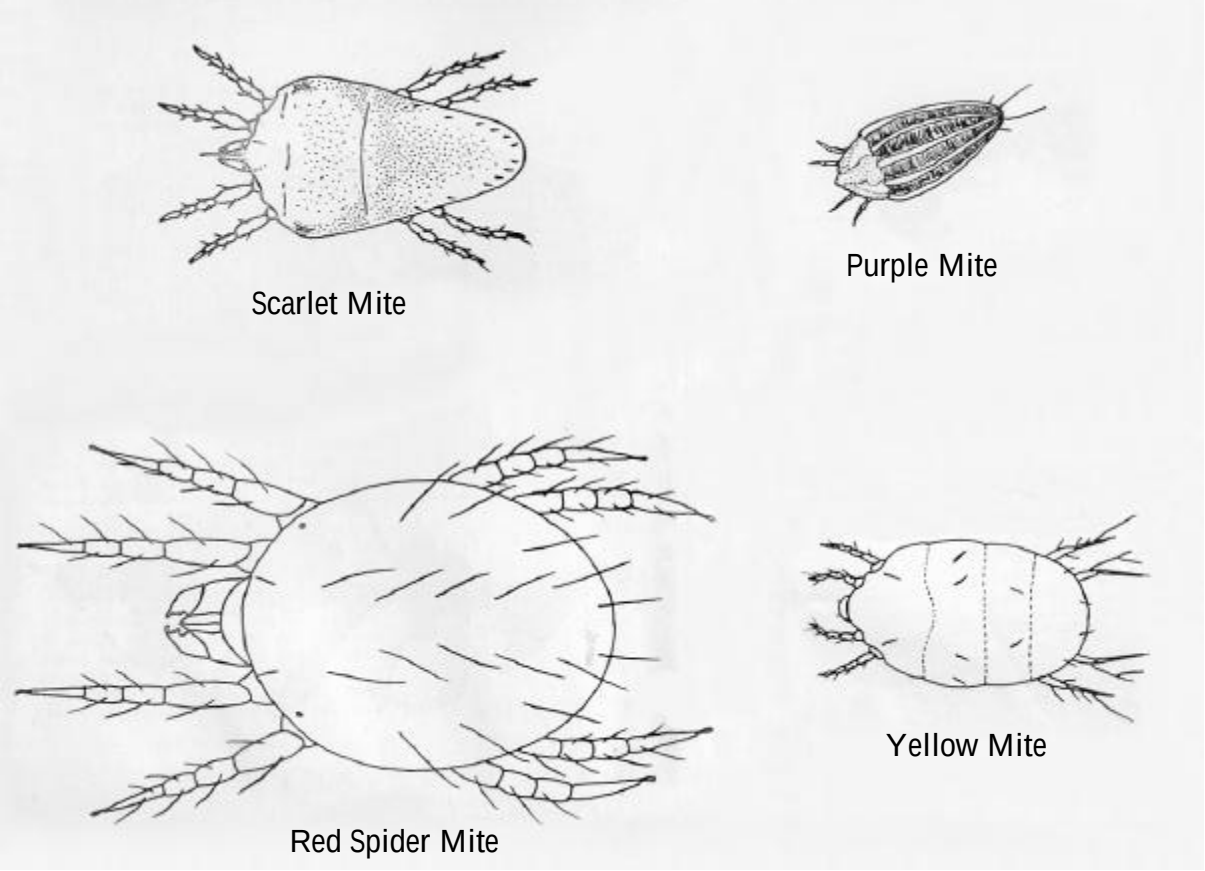
Red spider mites (immature on left, adult on right).
Source: Suh-Neu Hsiao et al. 1983. Monograph on tea pests and diseases in Taiwan.(in Chinese). Wen Shan Tea Plant Improvement Station, Taiwan.



Red spider mite drawing.
Source: J.E. Cranham. 1966. Insect and mite pests of tea in Ceylon and their control. Tea Research Institute, Talawakelle, Sri Lanka.

Scarlet mites look similar to spider mites, but are smaller (about 0.3 mm long) and flatter (see drawing, below). And, scarlet mites do not make silk like spider mites. **Adults and nymphs** are usually red with some black on the body. They are concentrated on the lower surfaces of leaves, especially at the leaf base and the petiole ("stem" of the leaf). **Eggs** are bright reddish-orange, and are deposited in cracks, crevices and other protected areas on the plant surface.

Yellow mites are barely visible with the unaided eye as a fine dust on the undersides of the youngest leaves. If you use a strong (10X) magnifying glass, you can see that the "dust" is actually many tiny, pale or amber-colored mites (see drawing, below). **Purple mites** are so small that you cannot see them with the unaided eye. If you use a strong magnifying glass, you may see hundreds of tiny white shed skins of the purple mite. The mites themselves are purple, and are difficult to see because their color does not contrast with that of the leaf. They occur on both surfaces of the leaf, although outbreaks usually start on the lower surfaces. Although they are not shown in the drawing, **pink mites** are similar to purple mites.



The four common types of mites on tea, showing their relative sizes.
Source: Drawing by E.F.W. Fernando. From J.E. Cranham. 1966. Insect and mite pests of tea in Ceylon and their control. Tea Research Institute, Talawakelle, Sri Lanka.

Life cycle

All the mites on tea have very short life cycles. Therefore, even during a few weeks, their populations can increase very quickly.

Red spider mites produce many continuous generations during the year. Red spider mite populations grow fastest under dry and hot weather conditions. The duration of the egg stage is usually 3 - 8 days and of the nymph stage is usually 4 - 12 days. In warm summer months, spider mites can complete a generation (from egg to new adults that are ready to lay eggs) in as little as 9 days! And, each female lays about 90 eggs. For both of these reasons, spider mite populations can increase very rapidly. In cooler winter months, a generation can require as much as 28 days. Spider mite adults live for 10 - 20 days.

Scarlet mites can also produce many generations per year. However, they require more time for each generation (about 20-47 days from eggs to new adults that are ready to lay eggs). Also, each female lays fewer eggs (only about 30 eggs per female). For both of these reasons, scarlet mite populations increase more slowly than red spider mite populations. Scarlet mite adults live for 30 days or more.

Yellow mites can complete a generation in only 5 days! Each female lays about 20 eggs.

Purple mites require about 6-13 days to complete a generation.

Plant damage and plant tolerance

Red spider mite is a serious pest problem on tea. It sucks the sap of the plant and causes the older leaves to fall off, which reduces photosynthesis. When tea fields are very seriously affected, young leaves will also fall off, which severely reduces the yield of harvested tea. It takes quite a long time for the tea plants to recover after severe damage by this pest.

Scarlet mite can cause similar damage as red spider mite. But, because scarlet mites reproduce more slowly, they don't build up damaging populations as often as red spider mite.

Yellow mite, which attacks the flush of new leaves, causes the most direct and immediate loss of the crop. It is most common on tea recovering from pruning. Attacks can often disappear as fast as they built up. But, the tea can take a long time to recover from an attack. This is especially true if the tea is recovering from pruning.

Purple mite is considered the least damaging of the mites on tea. But, farmers should study it carefully. Because purple mites are so small, farmers often do not notice them in the field. So, perhaps farmers are underestimating the importance of purple mite just because they do not notice it.

Natural enemies

In Viet Nam, thesis research was conducted in 1999 in Thai Nguyen Province by Le Thi Thu Huong to study which natural enemies attack mites on tea. According to the thesis, some of the most important natural enemies are:

- **predatory mites**. These are larger, fast-running mites that can catch and overpower the pest mites. Some scientific names of predatory (useful) mites are *Phytoseiulus*, *Amblyseius*, *Typhlodromus*, and *Mexecheles*.
- **tiny black lady beetles** (like *Sticholotis punctata* or *Stethorus cantonensis*), both as larvae and adults. These beetles are only about twice as big as a red spider mite, and therefore are easily overlooked They look like large black mites (see pictures in Chapter Eight).
- **tiny black rove beetles**
- **tiny web-spinning spiders** that hunt on the leaf surface and catch and eat mites
- **lacewing larvae** (like *Chrysopa*) are important predators in other Asian countries, but were less important in the thesis study in Viet Nam. But, farmers should look for them; they might be very important in some Viet Nam fields.

All of these natural enemies are most common when mites are very abundant. Unfortunately, by that time, the mites have already caused lots of damage. So, farmers need to learn how to help these natural enemies become abundant before mites start damaging the tea plants.

Farmers need to do experiments on how tea crop management can build up numbers of natural enemies. For example, the thesis research found that natural enemies of mites were more abundant in fields that were sprinkled with water by overhead sprinklers. Would spraying clean water with a backpack sprayer also help to build up numbers of natural enemies?

In addition, it is thought that the small black spider, and some types of ants, might be natural enemies of mites in Viet Nam.

Farmers need to do insect-zoo experiments to test which Viet Nam natural enemies eat mites.

Management practices: prevention and control

a. Prevention

Use shade and mulching to increase humidity

Red spider mite is favored by dry and hot weather conditions. Planting shade trees is one of the best ways to reduce mite populations. Mulching also helps to increase humidity in the field, and therefore may help to control mites.

Spraying with water might help

Red spider mite is a very small insect, living on the surface of the leaves, so it can be washed away very easily. Spraying foliage with water (or water mixed with a little soap) might be a good way to reduce the red spider mite population. Especially, spray the plant's "plucking table" (the flat canopy). In Thailand, farmers commonly spray water on fruit trees to control mites there.

Be careful about walking out of a part of the field that has mites

Mites move from place to place mostly by the wind, but also on people's clothing (pluckers and other workers). Try to organize the work so that workers do not walk from part of the field that has mites into the cleaner parts of the field.

Grow a strong crop that can tolerate mites

Mite attack is not limited to weak tea fields. However, damage from red spider mite is often more serious in the weaker, more stunted bushes. Therefore, better field tending is very important to reduce damage from red spider mite. Especially, use balanced fertilization and (if possible) water during the dry season.

Protect natural enemies by using less pesticides

In nearly every type of crop, mite populations explode after pesticides are used. The reason is, pesticides kill the natural enemies that help control mites. So, reducing pesticide use is very important for managing mites. This is not just true for broad-spectrum insecticides, but also for pyrethroids. Pyrethroids are well-known to cause outbreaks of mites by killing natural enemies.

For mites, even fungicides can trigger outbreaks. Copper fungicides (which are often used to control blister blight on tea) have been shown clearly to increase the number of red spider mites and scarlet mites. This may be because the fungicides also kill beneficial fungi that cause diseases in the mites. So, reduce as much as possible your applications of fungicides and (especially) insecticides.

Give natural enemies a "head start" by rearing them on bean seedlings

This method was successful for farmers in Taiwan, but has not yet been tried in Viet Nam. It might make a good topic for research by farmers who have graduated from a Farmers Field School. It would be easiest to try this experiment if you had two tea fields: one in which both red spider mites and natural enemies were abundant, and the other field in which red spider mites were just starting to cause problems.

Natural enemies of red spider mites (including large, fast-running predator mites and tiny black lady-bird beetles) often become abundant **after** mite outbreaks occur. The problem is, the natural enemies are too late; the red spider mites have already damaged the tea. To give natural enemies a "head start" in their race with red spider mites, the natural enemies can be reared in cages on bean seedlings, and then released into the tea plantation.

To raise natural enemies, first grow seedlings of lima beans or peas in pots or any other containers (old La Vie water bottles, etc.) Do not use any insecticides on the bean or pea seedlings. About 15 days after the seedlings emerge from the soil, put red spider mites from tea onto the seedlings. The red spider mites will serve as food for the natural enemies. Once the red spider mites are established on the bean seedlings (about 10 days later), add natural enemies collected from the tea plantation. Once the natural enemies are abundant on the beans (about 15 days later), the containers of bean seedlings can be carried to the tea field where natural enemies are not yet abundant. The natural enemies can then move from the bean seedlings onto the tea plants, and control the pest mites.

Consider your pruning schedule when you make decisions about mites

Pruning greatly reduces the population of scarlet mites. Because its population growth rate is slow, scarlet mite seldom becomes abundant until 3 years or more after pruning. But be sure you know which kind of mite you have. Pruning is less effective for controlling red spider mite. The reason is, red spider mite reproduces so quickly that even the few mites that survive after pruning can quickly re-populate the field.

Eliminate plants that provide food for spider mites

As for mosquito bug, it may be helpful to eliminate wild plants that mites live on (see the lists below). Unfortunately, tea mites live on some cultivated plants that are useful and valuable (like citrus trees and bananas). Most farmers probably will not want to destroy these useful trees. But at least, if farmers are planning to plant new trees that are mite hosts, they should plant the trees far from their tea fields.

Red spider mite has a fairly wide range of host plants. It can survive on lima bean, pea, and some flowers, but is usually more common on bushes or trees, especially the shade trees *Grevillea robusta* and *Albizzia falcata*.

Scarlet mite has been reported on the following plant species:

Vietnamese name	English name	Scientific name
	rose	*Rosa* sp.
	rose mallow	*Hibiscus rosa-sinensis*
	geranium	*Pelargonium zonale*
	aster	*Aster amellus*
	anthurium	
	banana	
		Hemigraphis sp.
	macademia nut	
	orchid	
	papaya	
	passion fruit	*Passiflora edulis*
	[a tree used for shade in India]	*Albizzia falcata*
	[a tree used for shade in India]	*Grevillea robusta*
	citrus fruit trees (including lemon)	*Citrus* spp.

Yellow mite has been reported on the following plant species:

Vietnamese name	English name	Scientific name
	rubber	*Hevea*
		Cinchona
	cotton	
	citrus fruit trees	*Citrus* spp.
	tomato	
	potato	
	jute	

Purple mite occurs on a few other plants, but seems to be mostly limited to tea.

b. Field monitoring and decision making

In general, the red spider mite becomes a bigger problem under dry and hot weather conditions. Mites usually are most abundant from late May till late August (others say from April - June, and from September - November). Therefore, field monitoring for mites should be done weekly from April until November.

Farmers may be able to save time by monitoring only the parts of the field where mite attacks are most likely to start: **along roadsides, footpaths, and drains**. Mite attacks are usually more severe in these areas (perhaps because these areas are more accessible and therefore receive higher doses of fungicides; or perhaps because the leaves get more dusty, which can

favor mites). Also, monitor the **weakest bushes**. Mites can attack even fields that are vigorous, but within a field, the weakest bushes often suffer heavier attacks. **If there are no mites (or symptoms) in those areas, it probably is not necessary to check the rest of the field.**

Once the farmer has found mites (or symptoms), he or she should start monitoring the whole field. Use a magnifying glass to count the average number of mites per leaf. Or, for red spider mites or scarlet mites, fold a piece of white paper around the tea leaf and press the paper firmly with your hand. Then count the number of brown stains on the paper - one brown stain is equivalent to one red spider mite or one scarlet mite (this may not work with yellow or purple mites, because they are so small).

As for any pest, don't base your decision only on how many pests you have, but also consider:

- how the number of mites or affected leaves has been changing for the past few weeks (going up or going down?)
- number of natural enemies you find in the field (especially large, fast-running predatory mites)
- weather forecast (rains and cool humid weather may help control mites)
- your pruning schedule (if you will prune soon, that may be the only action necessary to control scarlet mite)
- whether you could control the mites without pesticides (for example, by spraying water mixed with a little soap).

c. Control methods

If you decide you need to spray, avoid insecticides that will kill many natural enemies. Especially, avoid pyrethroids, which are well known to increase problems with mites, because they kill the natural enemies of the mites. In fact, many common insecticides are not very good for killing mites. Instead, use a pesticide intended for mites (a "miticide"). Try to select one that is less harmful to natural enemies. Direct your spray to the sides of the leaves where mites are most concentrated. For example, scarlet mite are concentrated on the lower surfaces, but red spider mites can be on both sides of the leaf (often are concentrated on the upper surface).

If you have to spray more than once per crop, it is important to use a different miticide for each application ("rotate" your miticides). The reason is, mites can quickly become resistant to any single miticide. Mites have such a short generation time (sometimes only 5 days!) that they can quickly breed new strains that are resistant.