THE MITE PESTS OF TEA: A REVIEW

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Mites are common pests of a wide variety of crops in many countries, and experience elsewhere is useful in considering mites on tea in Ceylon. The present article is addressed to tea planters and relates certain aspects of local mite problems to overseas experience. We are often asked whether mites are insects, whether the species on Ceylon tea are peculiar to Ceylon, whether chemical sprays that are effective elsewhere can be used on tea, why mite problems on tea have been more serious in recent years, and similar questions. It is these issues which will concern us here.

Mites are not insects; together with ticks they form the order Acari, of the class Arachnida (including spiders). This group is no more closely related to insects than, say, birds are to mammals. There is practical significance in this point, not least in the differing response to insecticides, many of which are not only valueless against mites but sometimes actually lead to increased populations.

The study of mites is less advanced than that of insects. Because of their small size, they are seldom conspicuous, although there is a vast number of species and they are found in almost every habitat available to animal life—in the soil, in both fresh and salt waters, in stored food and other stored products, and parasitic both on other animals and on plants. Of the phytophagous (plant-feeding) mites, there are four families most commonly concerned, all of which are represented by species on tea.

The **Tetranychidae** or spider mite family, of which hundreds of species have been recorded on plants, several of major economic importance as pests, contains the Tea Red Spider Mite (*Oligonychus coffeae* Nietner). Some other members of the group are the Fruit Tree Red Spider Mite (*Panonychus ulmi* Koch), the Glasshouse Red Spider Mite (*Tetranychus telarius* L.) and the Citrus Red Mite (*Panonychus citri* McG.). *Oligonychus coffeae* occurs on tea in most, if not all, tea areas of S.E. Asia; in N.E. India it is a more serious pest than it is in Ceylon. This species has also been recorded from the Transvaal, Florida, and Queensland, Australia (Pritchard and Baker, 1955). It has a fairly wide range of host plants (Das, 1959) but in Ceylon high numbers are common only on tea, *Grevillea robusta* and *Albizzia moluccana*. The last host plant is synonymous with *Albizzia falcata*, considered by Holland (1931) to be the correct name.

The family **Tenuipalpidae,** or False Spider Mites, includes the Scarlet Mites on tea (*Brevipalpus californicus* Banks and other *Brevipalpus* species). This family is not of such great economic importance as the allied Tetranychidae, but several species are pests of fruit crops and ornamental plants, chiefly in Mediterranean and sub-tropical climates. *Brevipalpus californicus* has a very wide geographical distribution and 43 host plants are listed by Pritchard and Baker (1958) including citrus, tea, and ornamental plants.

The family **Tarsonemidae,** which is very different from the other two mentioned above, includes the Yellow Mite (*Hemitarsonemus latus* Banks). This species is also recorded on citrus, tomato, vines, etc. in the U.S.A., *Cinchona* and *Hevea* species in Indonesia (Ewing, 1939), glasshouse ornamentals in the U.K. (Fox-Wilson, 1950), cotton in the Belgian Congo (Vrydagh, 1942), and potatoes in Queensland, Australia (Hooper, 1956). This species is therefore very widely known. Other tarsonemids are pests of bulbs, mushrooms, strawberries and oats.

The **Eriophyidae** include the Purple Mite (*Calacarus carinatus* Green); the family contains a great many species, variously called blister mites, rust mites, bud mites and gall mites, according to their habits. These are minute worm-like mites with only two pairs of legs. Various species are serious pests on fig, citrus, peach, pear and blackcurrents, in many countries. Purple Mite is recorded only on tea in India, Ceylon, S.E. Asia and Indonesia. Most eriophyid species are confined to one host plant.

The Damage Caused by Tea Mites

Scarlet Mite, Red Spider and Purple Mite feed mainly on the mature leaves and are not found on the 'flush,' except when it is hardened because of prolonged mite attacks on the bush or for other reasons. Yellow Mite, on the other hand, can breed in numbers only on the first two or three leaves of each flushing point. This species can and does cause immediate loss of crop, usually over relatively short periods (a few weeks), and high populations decrease as quickly as they build up.

Scarlet Mite and Red Spider do not normally injure the flush directly, but the damage caused by feeding on the mature leaves often causes defoliation. Evidence suggests that bushes stand very considerable defoliation without apparently affecting productivity (weight of crop taken) in the same pruning cycle. With severe Scarlet Mite attack, bushes suffer serious debilitation, and the new wood is spindly and unhealthy looking; it is often necessary to rest such bushes for some months before pruning or many fail to recover after pruning. The damage done by Scarlet Mite is thus chronic and insidious, and difficult to assess quantitatively; it is quite common, particularly up-country, and there is little doubt that, since the mites are not conspicuous, they are often overlooked as a cause of poor fields. This type of effect by leaf-feeding mites is quite typical; there are very few data on crop losses caused by any species of mites, even those which have been extensively investigated, *e.g.* Fruit Tree Red Spider.

Tea Red Spider has a greater capacity for rapid increase than Scarlet Mite; the mites are larger, more active and on the top surface of the leaves, so that heavy infestations are conspicuous and may cause acute damage. Moderate infestations may be largely overlooked and may cause the same long-term effect as Scarlet Mite. Red Spider is common in all mid-country districts around Kandy, in Uva (especially Haputale) and in some low-country districts. Damage due to Scarlet Mite, however, appears to be more common generally, and usually more serious.

Purple Mite attacks often occur in the first year after pruning in up-country tea and cause a purplish bronzing of the mature leaves, generally without defoliation. Purple Mite is, on the general evidence, the least injurious of the four mites on tea, and though often most apparent on weak and debilitated bushes, it is believed that the mites flourish most readily on weakly bushes, and not that they cause the weakness. It is quite possible, however, that attack by Purple Mite occurring early in the pruning cycle hardens the leaves sufficiently to render them more suitable to Scarlet Mite and Red Spider. In attacks of the latter two species, there are usually present abundant case skins of Purple Mites, which were active previously.

Certain fields have been noted in which all four species of mites are numerous, often with Green Bug (*Coccus viridis* Green) as well; such fields are then in very poor condition. The factors which lead to such a condition and the history of such fields require study. Mite attack is by no means confined to poor fields, however, although the weaker bushes present will usually suffer more.

Chemical Control

Sulphur in various forms is the oldest acaricide or miticide and is effective against all four species on tea. Unfortunately it taints the tea made from sprayed leaf and necessitates the discarding of at least three plucking rounds after spraying.

In many countries, mites have assumed much greater importance as economic pests in the last two or three decades. Of the factors which have caused this, the extensive use of the newer insecticides is unquestionably the most important, for they can reduce enormously the natural predators of plant-feeding mites.

It has been shown that DDT may induce increased mite populations by other effects additional to the destruction of predators; and this may apply to other insecticides. Davis (1952) showed that mites (*Tetranychus multisetis* McG.) on squash plants became very active shortly after contact with DDT, and scattered widely over the host plants, and that this dispersion resulted in an earlier mite build-up. Hueck (1953) has shown that DDT at low concentrations can induce an increased rate of egg-laying by the Fruit Tree Red Spider Mite, and has reviewed the literature on the subject.

Consequently, there has been extensive research to find new effective synthetic acaricides with desirable properties, *e.g.* toxicity to mite eggs (ovicidal) as well as to active stages, specific toxicity to mites, high persistence on foliage, and low mammalian toxicity. The older materials, such as sulphur, derris (rotenone) and 'white oils' (petroleum fractions) are no longer considered more than palliative (and sometimes useless) on fruit and other crops where they have been used extensively. It is outside the scope of this article to describe the large number of acaricides now available, several of which are remarkable pesticides having the desired properties. Unfortunately, mites (Red Spider Mites particularly) have demonstrated an aptitude for developing strains that are highly resistant to particular chemicals; and this has occurred on several crops where acaricides are used widely and repeatedly. Large quantities of synthetic acaricides are still used effectively by growers, but resistance has often developed with unusual rapidity and is a major problem.

From this brief outline of developments in acaricides, it will be seen that we might reasonably hope that some of these materials would be highly effective against tea mites and non-tainting to made tea. The occasional local use of such chemicals would, in theory, not be so liable to induce resistance as the more general and frequent use on, say, fruit crops. Tests at the T.R.I. have covered a range of materials, but so far nothing has proved more effective than sulphur. Certain materials are roughly as effective as sulphur against Scarlet Mite and Red Spider and do not taint after the normal seven day interval. These are chlorbenzilate, Kelthane, and Karathane. They are naturally more costly than elemental sulphur, so that to justify using them, the profit lost from the crop discarded when using sulphur must exceed the increased cost of the chemicals. This is often the case.

We do not know why certain synthetic acaricides which are much more effective than sulphur on, say, top fruit, are not so on tea. There are several possible reasons, and the result is probably due to a complex of them. Mite species, even closely related species, vary a great deal in their susceptibility to different materials and very little work has been done elsewhere on the control of our most important pest, Scarlet Mite. Initial spray residues may be less on tea, persistence (under heavy rainfall and bright sun) may be less, and spray coverage on mature tea is certainly poor by comparison with many crops. These and other factors have not been critically studied on tea; study might lead to the more efficient use of acaricides. Sulphur does not give as high a degree of control as is desirable. It is neither ovicidal nor very persistent and repeated applications are necessary. One virtue may be its volatility. Investigations by Lees (1923) and Goodwin and Martin (1929) showed that sulphur spray deposits at ordinary temperatures produce sufficient sulphur vapour to exert a fumigant acaricidal effect on Blackcurrant Big-Bud Mite (*Phytoptus ribis* Nal.). This is more marked in hot weather, and may be of particular importance on tea, where spray coverage is poor and the foliage canopy thick.

Effect of Copper Fungicides and Insecticides on Tea Mites

Planters often ask why in the last decade the mite problem on tea has become worse. The evidence that it is worse is not very convincing; though indeed it may be worse, we must bear in mind the fallibility of human memory, and the fact that the apparent numbers of such a pest depend very much on the interest of and recognition by the observer.

It is notable that all four species were recorded by E. Green between 1890 and 1900, Scarlet Mite and Yellow Mite as serious pests. Red Spider, which is more serious in N.E. India, was also serious there 60 years ago (Watt and Mann, 1903). In this respect therefore the mite problem on tea is unlike that on many crops where the increase in mites has unquestionably followed the use of synthetic insecticides, including DDT and some of the phosphorous insecticides. The use of these insecticides on Ceylon tea is so local and infrequent that it is inconceivable that they have had this sort of effect generally. In fact, there has not been a single case noted in Ceylon of DDT leading to an increase of mites or any other pest. This is certainly not to say that we can be sure that DDT is safe in this respect, but the evidence in Ceylon on tea does not suggest that it is very dangerous. By comparison, post-blossom sprays of DDT on top fruit in the U.K. almost invariably result in high numbers of Fruit Tree Red Spider.

The only chemicals that have been used on Ceylon tea very widely and frequently, are, of course, copper fungicides, mostly wettable powders of cuprous oxide and cuprous oxychloride. Many planters believe that these have caused a greater incidence of mites. This is certainly possible, but so far the T.R.I. has failed to establish conclusive evidence. Work was previously carried out by Loos who gave certain reasons (Loos, 1954) why he thought this effect was unlikely, namely (1) that copper sprays cover the flush and not the mature foliage on which the mites live and (2) that mites are most numerous when copper spraying ceases, in the dry season. Neither of these reasons seems valid to the writer. Yellow Mite lives only on the flush, and in point of fact copper sprays reach much of the top mature foliage bearing Scarlet Mite and Red Spider. Further, after the Yellow Mite is common in the intermonsoonal period (August-October) and just after the N. E. Monsoon (January-February) and not in the driest months. It is true that Scarlet Mite reaches peak numbers in April-May but the level of population then could easily depend on the numbers surviving the monsoon, which in turn could be affected by copper.

Recorded instances of copper causing such an increase in mites are rare, though they do exist, but copper is not now extensively used on many crops that suffer from mites. Thompson (1939) recorded that infestations of a rust mite (*Eriophyes oleivorus* Ashm.) developed on citrus in California with unusual consistency after copper sprays, although he was mainly concerned with the marked increase in a scale insect (*Lepidosaphes beckii* Newm.). Other pests were involved too, including Citrus Red Mite (*Panonychus citri* McG.). Holloway *et al* (1942) also recorded increase of *P. citri* McG. on California citrus after the use of sprays containing Bordeaux mixture and also sprays of zinc sulphate and soda ash.

It should be remembered that, in Ceylon, certain other cultural trends have developed over the same period, *e.g.* higher manuring and, up-country, lighter pruning. The latter quite probably affects the survival rate of Scarlet Mite at pruning time. There are various theories as to why copper sprays may result in increased mite populations, if indeed they do. It is not possible to investigate these until we can produce such an effect fairly consistently in experimental work.

Biological Control

Biological control is the control of pests by their naturally occurring predators or parasites, or by others introduced by man for the purpose. The insect and mite predators of certain Red Spider and tarsonemid mites have been studied considerably. Very little information is recorded on predators of Scarlet Mites (*Brevipalpus* spp.). Investigation has in several instances, *e.g.* Fruit Tree Red Spider (Collyer, 1953) and Cyclamen Mite on strawberries (Huffaker & Kennett, 1953), shown that naturally occurring insect or mite predators will, in the absence of upset by chemical sprays, maintain the host species most of the time at a low level of population. Unfortunately, in commercial fruit growing, it is hardly ever possible to avoid the use of insecticides and fungicides for the control of other pests and diseases. In Nova Scotia, workers have devised spraying programmes that minimize the destruction of predators of Fruit Tree Red Spider (*see* Lord, 1949), but apple growing in this province is not highly commercialised, and the same sort of thing is not practicable for instance in British Columbia or the U.K. In California, Huffaker and Kennett (1956) have had some success in building up the numbers of mite predators of Cyclamen Mite on strawberries by artificial spread of prunings from older fields, carrying predators and prey species, to new fields of strawberries.

With a very few notable exceptions, however, it has not yet been possible to use the knowledge gained on mite predators to develop techniques of practical value. In this, the work is less advanced than that on the biological control of insect pests, which was for instance extraordinarily successful in Ceylon with the introduction of the *Macrocentrus* parasite of Tea Tortrix in 1935-1936 (Gadd, 1941). It can fairly be surmised, however, that the possibilities on a crop such as tea, on which there is no intensive spray programme, are considerably greater than, say, on top fruit.

Biology of Mites

A knowledge of the biology of a pest is usually vitally important in planning both preventative and curative measures. Mites quite often have resting or protected stages for surviving adverse climatic conditions; in temperate countries this usually means the winter, *e.g.* the winter eggs of Fruit Tree Red Spider on the bark of trees, the dormant adult phase of Glasshouse Red Spider, and the Big-Bud Mites (*Phytoptus ribis* Nal.) inside the dormant buds of blackcurrant bushes. A knowledge of the emergence periods and behaviour of these mites is very valuable.

In Ceylon, the adverse conditions for mites appear to occur during the monsoon, but as far as is known, none of the four species on tea has a special resting or protected stage with the function of surviving this period; smaller numbers of the normal stages can be found on the foliage, reproducing more slowly. Furthermore, all four species are very widely distributed in small numbers, and tea is a monoculture over large areas. The reproductive potential, even of the slower-breeding Scarlet Mite, is very great. They normally fail to achieve this potential because of various limiting factors, such as climatic factors, predators, and suitable host plants in the right condition.

Outbreaks occur when the complex of limiting factors becomes temporarily less stringent. Our knowledge of these limiting factors is very sketchy, particularly in regard to the condition of the host plant which stimulates or permits the rapid increase of mites. This involves both genetic factors (*e.g.* Scarlet Mite is generally more abundant on high-jat tea) and factors affecting the physiological condition of the plant, such as nutrient status, water balance and soil pH.

Planters often ask about the method of dispersal of tea mites. It is probable that it occurs largely by wind, by pluckers carrying the mites on clothing, and by animals, possibly including flying insects. There is no reason to think that dispersal is a very important factor contributing to outbreaks, for the mites are very widely distributed and their potential for increase is great. The main artificial break in the population occurs at pruning time. Unless pruning is completely clean (*i.e.*

all foliage and green twigs removed) and the area is also clean-weeded, mites survive in small numbers on the few leaves left and on various weeds. If completely clean pruning and weeding were carried out, then re-infestation from outside would necessarily be the cause of subsequent infestation. In the case of Scarlet Mite, leaves falling from the shade trees *Grevillea* and *Albizzia moluccana* are usually infested (Easteal, 1958; Baptist and Ranaweera, 1955). The importance of this has not been critically examined, but it is likely that only a few mites are needed under optimum conditions to build up to an outbreak.

From this brief discussion, it will be apparent that studies are required on the dynamics of mite populations and on the factors in the environment that control and limit their numbers, *i.e.* their whole environment, generally divisible into the interacting factors of climate, predators, food-supply and a place in which to live (Andrewartha and Birch, 1954). Such knowledge would help in planning preventative and curative measures. The fundamental question of practical ecology is 'Why is this pest more abundant here than there?', just as the fundamental question of practical medicine is 'Why is this man sick and not that man?'. At present, it is seldom possible, with any insect pest, to answer this question more than in a very limited way; but it is this knowledge that we seek.

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