the megasporogenesis proceeded rather regularly. Generally, their styles were somewhat curved, but pollen-tubes could grow down through them, and fecundation occurred in time, resulting in the formation of ample good seeds. Out of the male sterile hybrids, 4 obtained from crosses between Satsuma and Trovita orange, Iyo, Hirado and Hassaku have produced completely seedless fruits when isolated from the surrounding pollen sources. They were taken apparently as the parthenocarpic. Remaining 4 hybrid trees failed to set any fruit under isolated conditions. This fact indicates that they lack the ability to set parthenocarpic fruits (Table 3).

A male sterile hybrid between satsuma and Trovita orange was provedto have good quality, and in addition to be monoembryonic, producing entirely zygotic progeny. This will be taken up as a very useful seed parent in the future breeding programs.

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Biology and Controlling Methods of Tea Red Spider Mite, *Tetranychus Kanzawai* Kishida, in Japan

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Tetranychus kanzawai Kishida is an insect pest first found among mulberry in 1927.[1] This mite is injurious to many plants including tea, mulberry, soybean, hop and grape.[2] Especially, much ocurrence has been seen among tea in recent years. Control against the mites has become of prime importance.

In India, Ceylon, Formosa and other tea producing countries in the Southeastern Asia another type of tea red spider, *Oligonychus coffeae* (Nietner), is said to do great damage to tea,[3~5] but it is not found in Japanese tea fields at all.

Life-history[6]

Tetranychus kanzawai goes through four growing stages. They are adult, egg, larva and nymph. (The last stage includes the protonymphal and deutonymphal stages.) Between larval and protonymphal stages, between protonymphal and deutonymphal stages and between deutonymphal and adult stages there are nymphochrisalis, deutochrisalis and telochrisalis stages respectively, and moulting is carried out immediately after each chrisalis stgae. Thus, the mites moult three times in total. However, some of male have no deutonymphal stage so that they moult only twice.

The mites oviposit on the undersurface of tea leaves. The females lay about 40 to 50 eggs in their life or 2.0 to 2.5 eggs per day at temperature of 20°C on the average.

The growth rate differs widely with the temperature. At 20°C egg stage lasts eight

days, larval stage three to four days and nymphal stage five to six days. (Protonymphal and deutonymphal stages last 2.0 to 2.5 days and 2.5 to 3.0 days respectively.)

Although further studies are still required for determining the theoretical zero point for growth, according to author's experiment[6] it was 8.7°C for eggs, 14.6°C for larvae, 13.4°C for protonymphs and 13.2°C for deutonymphs. The optimum temperature for growth was 20 to 25°C, and the maximum temperature for growth was about 40°C.

The mites usually reproduce bisexually, but parthenogenesis is also possible. In the latter case only males are bred so that unless back cross takes place there can be no further reproduction.

The longevity of adult mites varies with the season and sex. Males live for 17 days in July and 35 days in October, and females live for 25 days in July and 40 days in October.

Biological habits of the mite in the tea field[6]

Seasonal fluctuation of population density of mites and damage to tea leaves: *Tetranychus kanzawai* parasitic on tea trees occurs more in spring (March to June) and autumn (September to December) and less in summer and winter. In this regard this species is quite different from the mite parasitic on fruit trees as the latter occurs more in summer.

Figure 1 shows the relationship between population density of mites and damage to tea leaves. Clearly damage to tea leaves by the mites is the most serious during the first plucking season.

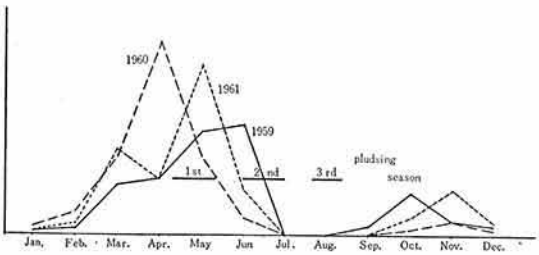

Fig.1. Seasonal fluctuation of Population density of mites

Feeding: *Tetranychus kanzawai* in tea fields in Japan is different from *Oligonychus coffeae* in those in the Southeastern Asia in that the former feeds only the underside of tea leaves.[3~5] It is capable of distinguishing the fitness of tea leaves as its food. The varietal difference among tea trees which the mites are parasitic on and their dispersion that can be seen in tea fields may be considered due to this host selectability of them.

Living site: Tea red spider mites like to live in hollow places on the undersurface of tea leaves. However, within tea bush as a whole, their living sites change with the season; during spring and autumn when they occur more many live on leaves belonging to the upper surface of the tea bush while during summer and winter when they occur less their living site is on leaves belonging to the lower and inner parts of the tea bush. They also have a habit of migrating to young leaves from the old to feed when tea shoots grow. Especially during the first tea plucking season adults and nymphs migrate in large numbers and do great damage to young leaves a few weeks before plucking. (The number of developed leaves on the shoot is three or four at this time.)

Hibernation and diapause: In tea fields the tea red spider mites hibernate on tea leaves, they never do so on fallen tea leaves or weeds. They winter as female adults in the diapause state in tea fields located in the north of Kinki and Northern Kyushu while in the "Southwestern warm areas" such as the southern part of Shikoku and Southern Kyushu the diapause state is variable, for mites of all growing stages live simultaneously even in winter. Female adults in diapause state are vermilion in color and they never lay eggs, while those not in diapause state are reddish or dark reddish and lay eggs. Thus they can also be distinguished by their color. Hibernation usually begins in November and ends in February.

Dispersion: They spread by walking or by attaching to things, men or beasts. Wind and rain also carry them away. Dispersion by wind is especially important with regard to the control of mites. Wind carries away adults and

nymphs, notably female adults. The mites spread most frequently from April to June when they occur. The distance of dispersion varies greatly with the weather condition. However, the fact that a mite blown by the wind is caught in the air at the height of 10 m. suggests it can reach a great distance under suitable condition.

Environmental resistance: The occurrence of tea red spider mites in tea fields depends on various factors. The factors which favor their occurrence include temperatures (within the growth temperature ranges–from about10 to 40°C–the higher the temperature the more the occurrence), frost at the first tea growing season, variety of tea (susceptible clone), manuring (nitrogen and phosphate fertilizers), shading of tea (especially at shaded tea fields). The factors which inhibit their occurrence include humidity (notably high humidity), rainfall (rainfall during rainy season has a most significant effect), variety of tea (resistant clone), manuring (potash fertilizers), the plucking of tea leaves, the pruning of tea twigs, acaricides, natural enemies, and the suitability of tea leaves for reproduction of mites (especially tea leaves during summer).

Controlling methods of the mite[6]

In seeking to control the ravages of mites the first consideration should be given to the protection of the shoot of first sprout from damage. According to ecological knowledge three applications of acaricides are required at (1) late autumn when the mites begin to winter, i. e. middle and late November, (2) early spring when they begin to lay eggs, i. e. from late February to early March and (3) midspring when the mites on old leaves are about to migrate to the shoot of first sprout, i. e. early and middle April. In case of extraordinary outbreak acaricides must be applied accordingly.

The mites always live on the undersurface of tea leaves and many live in their hollow places. Also, their living site in tea bushes changes with the season, it is mostly the upper surface of foliage in spring and autumn while it is the lower and inner parts in summer and winter. Therefore care should be taken as to the living site in applying acaricides.

In selecting fungicides and pesticides for diseases and pests control great care must be exercised as tea is a beverage which people drink everyday. What must be taken into consideration include : (1) the toxicity of acaricides (including residual toxicity on finished tea), (2) residual smells on finished tea, (3) phytotoxicity, (4) effectiveness against diseases and pests.

At present many types of acaricides such as Kelthane, Phenkapton, Neo Sappiran (Ovex+ Neotran) and Limesulfur are available for control of the mites parasitic on tea. However, recently there have been found mites that are resitant to organophosphorus compounds, e. g. Phenkapton and Metasystox - S. They are now spreading all over the country.[7] Thus consideration should be given to this point. In this regard the rotation of acaricides is called for to prevent the development of resistibility by their continuous use. But the author considers that the rotation of acaricides selected for control of mites is of no use unless all fungicides and pesticides applied for tea are rotated.

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