# Acaricide Resistance of the Kanzawa Spider Mite, *Tetranychus Kanzawai* Kishida, Parasitic on Tea Plant

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Kanzawa spider mite is injurious to many plants, including tea, mulberry, soybean, hop, grape, citrus, apple and peach. It has widely spread especially among tea plants during recent years. In Japan, control against these mites has become of prime importance.

In India, Sri Lanka, Formosa and other tea-producing countries in Southeast Asia another type of tea red spider mite, *Oligonychus coffeae* (Nietner), is said to cause heavy damage to tea but it is not found in Japanese tea fields at all.

Phenkapton, Kelthane and Estox have been used for the control of Kanzawa spider mite since 1957, 1960 and spring in 1964 respectively and showed good effects as acaricides in the tea fields. In some tea fields of Shizuoka, Mie and Kyoto prefectures, however, controlling effects of Phenkapton, Estox and Kelthane reduced remarkably since 1961, late autumn in 1964 and 1965–66 respectively. Especially, the resistant mites to Phenkapton and Estox in organophosphorus compounds are now spreading all over the country.

This paper deals with the present status of occurrence and distribution of resistant mites to chemicals in Japanese tea plantations, effective acaricides for the resistant mites to Phenkapton, Estox and Kelthane, cross-resistance to the other chemicals in the resistant mites to Estox and Kelthane, and the factors for the development of chemical resistance of mites in the tea fields.

## Present status of occurrence and distribution of resistant mites to chemicals in Japanese tea plantation

As mentioned above, the resistant mites to organophosphorus and chlorophenyl compounds occurred in Japanese tea plantations. According to the results of field survey during recent years, the resistant mites to Phenkapton and Estox in organophosphorus compounds were widely distributed in Japanese tea producing prefectures and discovered from the tea fields of Saitama and Kanagawa prefectures in Kanto district; Shizuoka, Aichi, Gifu, Mie, Shiga, Kyoto and Nara prefectures in Tokai-Kinki district; and Fukuoka, Saga, Kumamoto, Miyazaki and Kagoshima prefectures in Kyushu district.

Resistant mites to Kelthane in chlorophenyl compounds which developed multiple resistance between Kelthane and Phenkapton or Estox were also detected in some tea fields in Shizuoka, Mie, Kyoto and Nara prefectures. However, the resistant mites to these chemicals were not found in the tea fields in Okayama Prefecture in Chugoku district and Kagawa, Tokushima and Kochi prefectures in Shikoku district (Fig. 1).

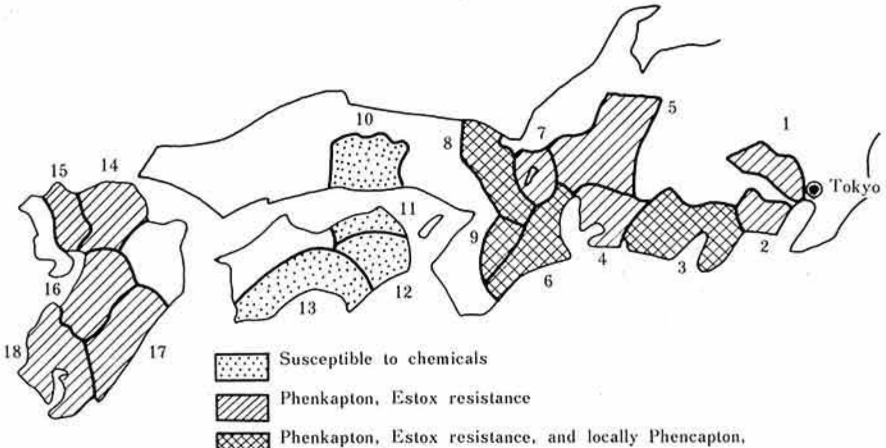


Fig. 1. Present status of the occurrence and distribution of resistant mites to chemicals in Japanese tea cultivating areas
1. Saitama, 2. Kanagawa, 3. Shizuoka, 4. Aichi, 5. Gifu, 6. Mie, 7. Shiga, 8. Kyoto, 9. Nara, 10. Okayama, 11. Kagawa, 12. Tokushima, 13. Kōchi, 14. Fukuoka, 15. Saga, 16. Kumamoto, 17. Miyazaki, 18. Kagoshima prefectures

## Effective acaricides for resistant mites to Phenkapton, Estox and Kelthane

According to the results of laboratory and field tests, effective acaricides for the resistant mites to Phenkapton, Estox and Kelthane were as follows.

*Effective acaricides for resitant mites to Phenkapton and Estox*

Omite (2-(p-tert Buthylphenoxy) cyclophexylpropynylsulfid), Kelthane, Chlorobenzilate, Milbex (4-Chlorophenyl 2, 4, 5 trichlorophenylazosulfide and Dimite Mixed), New-mite (Ovex, Aramite and Dimite mixed), Checkcide (Dimite and Chlorobenzilate mixed), Smite (2-(2-(p-tert Buthylphenoxy) isopropoxy) isopropyl-2-chloroethylsulfide), Banmite (Kelthane and Karathane mixed), Danitop (Aramite and Azoxybenzen mixed), Azomite (Smite and Azoxybenzen mixed), Acricid and Plictran.

*Effective acaricides for resistant mites to Kelthane*

Omite, New-mite, Smite, Danitop, Azomite, EPN, Phenkapton, Hosalon, Mecarbam, Thiometon, Estox, Imidan, DDVP, Dimethoate, Papthion (0, 0-Dimethyl S-(1-ethoxycarbonyl 1-phenyl methyl) phosphorodithioate), Methyldimeton, Vamidothion, Malathion, Ethion, Amiphos (0, 0-Dimethyl S-2-(acethylamino) phosphorodithioate), Dibrom, Nissol (N-Methyl-N-(1-naphthyl) monofluoroacetamide), Acricid, Karathane, Plictran and Mitecigin (Polinactin complex and 2-sec Buthylphenyl-N-methylcarbamate mixed).

## Cross-resistance to other chemicals in resistant mites to Estox and Kelthane

Resistant mites to Estox showed cross-resistance to the other organophosphorus compounds such as EPN, Phenkapton, Hosalon, Thiometon, DDVP, Imidan, Vamidothion, Malathion, Papthion and Amiphos.

Resistant mites to Kelthane also indicated cross-resistance to Chlorobenzilate, Mitran (Ovex and Dimite mixed), Double (Tedion and Kelthane mixed), Chlormite, Spanon (N-N-Dimethyl N-(2-methyl-4-chlorophenyl)-formamidine - hydrochloride), Milbex and Checkcide in chlorophenyl, Akarol (Isopropyl-4, 4-dibromobenzilate) in phenisobromolate, and

Morestan in kinokisarin compounds respectively, but the other compounds were not cleared.

## Factors for development of chemical resistance of mites in tea fields

It was believed that chemical spraying, the inheritance of resistivity of mites, and the vitality of resistant mites to chemicals may have influenced intensively the development of chemical resistance of mites in the tea fields. The results of laboratory and field tests were as follows.

*Influence of chemical spraying*

Susceptible mites turned to resistant one after the treatment of adult female mite for five generations with 0.005% emulsion of Estox, and their resistant level in $LC_{50}$ values increased about seventy times larger than that of first generation.

Susceptible population of mites turned quickly to homogeneous resistant population by the few treatments with 0.01% emulsion of Estox as compared with 0.001% emulsion of one, but the relationship between the spray pressure (different dilution) and the level of resistivity of mites to Estox could not be cleared.

As previously mentioned, the resistant mites to Phenkapton or Estox and Kelthane indicated a cross-resistance to the other organophosphorus and some of chlorophenyl, phenisobromolate and kinokisarin compounds respectively.

On the other hand, susceptible mites turned to resistant one after few continuous treatments with high concentration of Estox. These phenomena revealed that the development of resistivities of mites to these chemicals was not only induced by the continuous use or high concentration of chemical spraying but also by cross-resistance among the chemicals used for the control of mites and pests in the tea fields at the same time.

According to the results of spray-record survey in the tea fields which developed the resistant mites to Kelthane in Kyoto Prefecture, the relationship between the spraying frequency of Kelthane and the resistivity of mites to Kelthane were as follows: the mites in the fields sprayed less than 10 times to Kelthane showed non-resistance, about 20 times indicated low resistance and about 30 times or more showed high resistance to Kelthane respectively.

If the development of chemical resistance of mites is induced by the exclusion of susceptible mites from the population treated with the chemicals, the resistant population may change to susceptible one by the exclusion of mites having a resistant gene to chemicals from the population.

The results of laboratory tests showed the above-mentioned possibilities; namely, the resistant mites to Phenkapton and Estox turned clearly susceptible one after thirteen times of selection which reared only the eggs laid by susceptible mites after checking the resistivity to Phenkapton or Estox on each adult female mite of every generation.

Resistant mites to Phenkatpon or Estox reared for about two years or three and half months respectively under the chemical non-spraying condition at 25°C did not show a larger difference on the resistivity compared with that of the former population, but the resistivity of mites to Kelthane reared for about four months under the non-spraying condition reduced remarkably, and their resistivities shown by $LC_{50}$ values reduced to about 1/4 as compared with that of the beginning population.

From the results of the chemical spraying tests mentioned above, it was thought that the resistant mites to Phenkapton, Estox and Kelthane developed in Japanese tea plantations might be promoted mainly by the aid of frequent spraying with the same kind of chemicals used in controlling mites and pests in the fields.

*Influence of inheritance of chemical resistance*

Inheritance of the resistant mites to Estox showed a dominant one but the resistant mites to Kelthane indicated a recessive inheritance. On the other hand, the resistant mites to Estox and Kelthane have cross-resistance to the other organophosphorus and some of chlorophenyl, phenisobromolate and kinokisarin compounds respectively.

From these phenomena, it was believed that the inheritance of resistant mites to Estox might operate to the development and maintenance of the resistivities of mites to Estox and the other organophosphorus compounds, but the genetic properties of resistant mites to Kelthane might probably participate upon the decrease of resistivities of mites to Kelthane and some of chlorophenyl, phenisobromolate and kinokisarin compounds in the tea fields.

*Influence of vitality of resistant mites*

Under suitable conditions, the number of lay eggs, hatchability, growth rate, adult emergence and sex ratio of the resistant mites to Estox and Kelthane did not show so much different values as compared with those of susceptible ones. From these factors, it was thought that the vitalities of resistant mites to Estox and Kelthane may not greatly influence the development and reducement of the resistivities of mites to these chemicals in the tea fields.

## Conclusion

The rotation of acaricides is desirable to prevent the increase of chemical resistance in pests by continuous use because the development of resistivity of mites is mainly caused by the frequent spraying with the same kind of chemicals in the tea fields. However, it is considered that such rotation of acaricides for controlling mites is impossible unless all pesticides and fungicides applied to tea are rotated.

## References

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