Deposition of chemicals on various parts of tea bushes sprayed on the plucking surface

Akira Kawai,1 Katsunori Kohata2 and Yuichi Yamaguchi2

Department of Tea Agronomy and 2Department of Tea Processing Technology, National Research Institute of Vegetables, Ornamental Plants and Tea (NIVOT), Kanaya, Shizuoka 428-8501, Japan

(Received 19 August 1998; Accepted 16 April 1999)

Abstract
The deposition of chemicals on various parts of tea bushes was measured when the plucking surface was sprayed. The depositions at the middle of the leaf layer and at the bottom (about 15 cm beneath the plucking surface) were about 20% and only 1 to 2%, respectively, of that at the plucking surface. The leaf layer of the tea bushes effectively blocked the penetration of chemicals. The importance of the part of the bush inside the plucking surface for integrated pest management of tea cultivation is discussed.

Key words: Tea plant, deposition of chemical, natural enemy

INTRODUCTION
In tea fields, Amblyseius wormersleyi Schicha effectively controls the population density of Tetranychus kanzawai Kishida even under insecticidal control (Hamamura, 1985). In addition, though the population densities of several species of natural enemies of T. kanzawai (Amblyseius wormersleyi, Scolothrips takahashii Priesner, Agistemus exertus Gonzalez and Feltiella sp.) were low on the leaves near the plucking surfaces of tea plants, they were high on the leaves beneath the plucking surfaces even under insecticidal control (Nagatomo et al., 1991). Thus, these natural enemies can survive being sprayed with insecticides.

Tea plants develop into a characteristic shape. The leaves grow thick beneath the plucking surface. Since insecticides are primarily sprayed on the plucking surface, the thick leaf layer blocks the penetration of chemicals into the parts of the bush inside the plucking surface. Matsuyama and Nagatomo (1987) confirmed that the deposition of chemicals below the plucking surface was less than that on the plucking surface by spraying water over the plucking surface and checking the degree of wetness. However, the deposition of chemicals on and inside the plucking surface was not measured.

This study measures the deposition of chemicals on various parts of tea bushes when the tops of the bushes are sprayed.

MATERIALS AND METHODS
The insecticides were sprayed above the plucking surfaces of tea fields planted with a 27-year-old variety of Yabukita at the National Research Institute of Vegetables, Ornamental Plants and Tea (NIVOT), Kanaya, Shizuoka, on July 1st, 1997. A mixture of carbaryl (850 ppm), bubrofenzin (250 ppm) and isoxathion (333 ppm) was sprayed at a rate of 200 l per 10 a. Spraying was done at 9 a.m. using a knapsack sprayer. Since new shoots had been cropped several days prior to spraying, there were no new shoots on the leaf layer, whose depth was approximately 15 cm.

After drying the surfaces of leaves, ten leaves were collected at 11 a.m. at three positions on the leaf layers: surface, middle, and bottom (Fig. 1). Leaves were collected from the three bushes.

Ten leaves were soaked in about 30 ml of hexane and the extract was transferred to a 100-ml volumetric flask. This extraction procedure was conducted twice. After addition of 0.1 μl of methyl myristate as a standard, 100 ml of the extract was prepared with hexane, and then concentrated in vacuo at 40°C to about 1 ml using a rotary evaporator. One microliter of the sample

1Present address: Department of Plant Protection and Soil Science, NIVOT, Ano, Mie 514-2392, Japan
was injected in GC-MS (JEOL SX-102A, Tokyo, Japan), and the peak areas of the samples were measured.

GC-MS conditions were as follows: column, 30 m × 0.25 mm (i.d.) fused silica capillary column DB-5 (J & W Scientific); injection temperature, 250°C; column over temperature, 100°C to 250°C (5°C/min); ionization method, EI; ion source temperature, 200°C; ionization energy, 700 eV.

RESULTS AND DISCUSSION

Depositions of chemicals on the various parts of tea bushes when the tops were sprayed are shown in Table 1. They were at their maxima on the plucking surface for all chemicals. At the middle of the bush (about 7.5 cm beneath the plucking surface), they were 18.9, 23.4 and 15.3% of those at the plucking surface for carbaryl, buprofezin and isoxathion, respectively. The differences among chemicals were small. At the bottom of the bush (about 15 cm beneath the plucking surface), they were 2.6, 1.1 and 1.1% of those at the plucking surface, respectively, giving a range of only 1 to 2%. This confirms that the leaf layer effectively blocked penetration of the chemicals.

Insecticides against pests which attack mature leaves, such as those of *T. kansawai* and *Homona magnanima* Diakonoff, are sprayed when there are no new shoots in the leaf layer, as in this study. On the contrary, insecticides against pests which attack new shoots, such as those of *Empoasca onkii* Matsuda and *Caloptilia theivora* (Walsingham), are sprayed on the new shoots. When insecticides are sprayed against pests which attack new shoots, the amount of insecticide inside the bushes would be less than the present study. The leaf layer of the tea bush effectively blocks the penetration of chemicals and, therefore, the effects of chemicals on any insects inside the tea bushes is weak.

Blocking the penetration of chemicals maintains the high population densities of several species of natural enemies of *T. kansawai* on the leaves beneath the plucking surfaces even under insecticidal control (Nagatomo et al., 1991). In particular, the population density of *A. wormersleyi* is high (Nagatomo et al., 1991) and it effectively controls the population density of *T. kansawai* even under insecticidal control (Hama- mura, 1985). *A. wormersleyi* in tea fields in Shizuoka Prefecture is known to have developed resistance against organophosphorus, carbamate and pyrethroid insecticides (Hamamura, 1986; Mochizuki, 1990, 1994). Ecological characteristics of tea fields as well as insecticide resistance of *A. wormersleyi* are due to the effective control of *T. kansawai* even under insecticidal control.

Kawai (1997) noted that the ecosystem of tea fields is the most complex and most stable agroecosystem in Japan. The tea plant is peren-
nial and evergreen with a characteristic shape and its leaves grow thick beneath the plucking surface. The effects of insecticides are limited on the part of the bush below the plucking surface. The part of the bush below the plucking surface is very important as a refuge for natural enemies. The conservation and utilization of indigenous natural enemies that live inside bushes is important for integrated pest management of tea cultivation in Japan.

REFERENCES


