

REVIEW ON THE INVESTIGATION AND PROTECTION MEASUREMENTS OF SPIDERS IN TEA GARDENS IN CHINA

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ABSTRACT

Bio-control of tea pests by spiders in China has been reviewed by Chen Yinfang et.al. Spiders constitute 65% to 90% population of all the predacious natural enemies in tea gardens of China. Some 290 species belonging to 28 families predate on harmful insect pests and play a significant role in natural control of tea pests. The review profiles their occurrence, habits and hunting ability. Spiders prefer habitat with mild temperature and high humidity. Presence of interplant trees and some weeds help in building up their populations. However, spiders are sensitive to pesticide sprays, which reduce their populations by 20% to 90%.

Both the hunting and net-forming spiders have an enormous potential as agents of natural control of tea pests. They are voracious consumers of insect pests. On an average, each spider eats up 20 - 120 insect larvae, nymphs and adults per day. Female spiders are better hunters of insect pests than males. Cases have been reported where a single female consumed more than 295 adult hoppers in one day. This review suggests agro-techniques to regulate pest-predator ratio and maximize benefit by spider-actuated control of harmful pests in tea gardens.

Keywords: China; tea gardens; spiders

China is one of the main tea-producing countries of the world. Spiders, mantes, predating-beetles, predating-mites and dragonflies are some of the common natural enemies of the pests damaging tea plants. These natural enemies control naturally the pest population in tea gardens, in which the spider is one of ecological control agents. In order to keep the ecological equilibrium in tea gardens in favor of the production of insecticide-free teas and organic teas, it is necessary to learn about the natural enemies of the harmful insects, especially the species of spiders and their effect on controlling pests, as well as protection and utilization measurements. The research papers on spiders in Chinese tea gardens ranging from 1978 to 2004 are summed as follows.

DISTRIBUTION OF DOMINANT SPECIES OF SPIDERS IN TEA GARDENS

There are about 290 species of spiders belonging to 28 families in Chinese tea gardens (Chen Yinfang et al., 2000), much more than those in Japanese tea gardens that have 124 spider species belonging to 15 families (Takashige Terada et al., 1978). Most spiders in Chinese tea gardens belong to families Araneidae, Linyphiidae, Agelenidae, Tiiidiidae, Salticidae, Tetragnathidae, Clubionidae etc. There are 14 families having 114 species in Zhejiang Province, 22 families having 118 species in Anhui Province (Chen Wenhua et al, 1993), and 14 families having 116 species in Yunnan Province (Se Yuping, Tao Tao, 1996). Some of the dominant species of spiders distributed throughout in different tea growing areas in China are *Hylyphantes graminicolum*, *Coleosoma octomaculatum*, *Misumenops tricuspoidatus*, *Clubiona reichlini*, *Oxyopes sertatus* and *Phintella bifurcilinea*. (Table 1)

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Table 1. Distribution of Spiders in China

Tea region	Families	Dominant species
Eastern China	22	<i>Neriere radiata</i> , <i>Evarcha albaria</i> , <i>Tetragnatha maxillosa</i> , <i>Agelena layrinthica</i> .
Southern China	16	<i>Plexippus setipes</i> , <i>Clubiona japonicola</i> , <i>Evarcha albaria</i> .
Middle-Southern	14	<i>Agelena labyrinthica</i> , <i>Mymarrachne gisti</i> , <i>Jotus munitus</i> , <i>Evarcha albaria</i> , <i>Neoscona theisi</i> , <i>Araneus ejusmodi</i> .
Southwestern	18	<i>Nephila clavatal</i> , <i>Silerella vittata</i> , <i>Tetragnatha praedonia</i> and <i>Neriere macella</i> .

Sources : Lei Chao-liang et al 1992, Chen Wenhua, Zhao Jingzhao 1993, She Yupin ,Tao Tao 1996, Daixuan 1996 、1997, Chen Yin-fang et al 2000.

SPIDERS AND THEIR SUPPRESSION EFFECT

According to investigations, spiders in tea gardens are divided into two main groups: one is netting-spiders, and the other is hunting-spiders. *Linyphiidae*, *Agelenidae*, *Araneidae*, and *Tetragnathidae* belong to the netting group, and *Oxyopidae*, *Salticidae*, *Lycosidae* and *Pisauridae* belong to hunting group. All these spiders prey on harmful pests in tea gardens, such as *Dasychira baiharana*, *Euproctis pseudoconspersa*, *Arctornis olba*, *Buzura suppressaria*, *Empoasca formosana*, *Caloptilia theivora*, *Polyphaotaronemus latus*, *Acaphylla theae*, *Calacarus carinatus* and *Ectropis oblique*.

Spiders As Proportion Of Natural Enemies In Tea Gardens

Spiders form around 65%-98% of the natural enemies in tea gardens. These account for 83%-95% in Zhejiang Province, 83%-90% in Anhui

Province, more than 85% in Guizhou Province, 76%-95% in Fujian Province, 87%-93% in Guangxi Province, 68%-98% in Yunnan Province, and over 80% in Guangdong, Hunan and Hubei Provinces

Hunting Ability Of Spiders

According to the experimental data (Chenyinfang et al., 1991), *Hylyphantus graminicolum* can capture 21 aphids and 12 leafhopper nymphs per day, and 38 larvae or 26 adult pests and 120 second-instar larvae of *Euproctis pseudoconspersa*. *Misumenops tricuspispidatus* can eat 24 aphids, 12 leafhopper nymphs, 13 red mites and 10 second-instar larvae of *Euproctis pseudoconspersa* per day. *Jotus munitus* can eat 80 leafhopper nymphs or its adults of 48 heads. *Clubiona japonicola* can eat 28 heads of leafhopper nymphs or its adults of 20 heads. *Oxyopes sertatus* can eat second-instar 19.0 larvae of *Ectropis obliqua* per day and adult *Oxyopes sertatus* can eat 19.4 second-instar larvae of *Ectropis obliqua* per day. Generally, spiders of tea garden play an important role in controlling pests.

PREDATORY FUNCTIONAL RESPONSES OF SPIDER AND ITS COMMUNITY : LIST OF RESEARCH WORKS

Catching effect of *Hylyphantus graminicolum* on tea leafhopper (Guo Jianxiong, 1987). Reaction of catching function of *Phintella bifurcilinea* on *Empoasca vitis* and its mathematical model (Chen Yinfang, Zha Guoping 1994). Catching function of *Misumenops tricuspispidatus* on *Empoasca notat* and its mathematical model (Pan Yafei, Zhao Jingli 1995). Catching effect of *Oxyopes sertatus* on *Ectropis obliqua* (Pan Yafei and Zhao Jingli, 1996). Reaction of catching function of *Agelena layrinthica* on *Empoasca vitis* and its study (Zhao Dongxiang et al., 2001).

The controlling ability of the female predator of *Agenena labyrinthica* (Clerck) to the *Empoasca vitis* (Gothe) was larger than the male spiders, and their predatory upper limits were 295.3 adults and 120.7 adults respectively. This suggested the spiders had larger potential in controlling the leafhoppers (Lei Chao-liang et al., 1992).

FACTORS INFLUENCING THE POPULATION OF SPIDERS IN TEA GARDENS

Spray Of Chemical Pesticides

Application of chemical pesticides is the most important factor that reduces the quantity of spiders in tea gardens. During 90's of 20'th century, application of organic phosphorus pesticides such as methamidophos, parathion-vmethyl, parathion, monocrotophos, phosphamidon, phorate, isofenphos-methyl, terbufos, phosfolan-methyl, sulfotep, demeton, carbofuran, aldicarb, ethoprophos, phosfolan, coumaphos, fonofos, isazofos, fenamiphos, omethoate, phoxim, dicofol, killed at least 20% of total spiders of tea garden, and in some areas even 90%. Application of BHC and DDT made spiders rare in tea gardens. Spiders are sensitive to chemical pesticides. The application of pesticide often makes certain number of spiders die. According to the investigation, when a tea garden stopped using pesticide for one year, there were 24 kinds of spiders with total number of 687 as counted in Zhejiang province; while in the pesticides sprayed tea gardens there were only 11 kinds of spiders with total number of 215 heads. It is obvious that the application of pesticide lessens the individual number and species of spiders.

Incidence of Pests

The population of pests in tea garden influences the population of spiders. Usually when the population of pests increases, the population of

spiders also increases. Therefore, it is essential to keep a certain amount of pests in tea gardens to host the spiders.

Climate And Eco-Surroundings

Spiders usually live in habitats with mild temperature and high humidity. The tea gardens inter-cropped with fruit trees, woods and some weeds benefit spiders abundance.

UTILIZATION AND PROTECTION OF SPIDERS IN TEA GARDENS

The protection and utilization of spiders are suggested by following aspects:

Forecast The Number Of Spiders And Pests

For example, when the ratio of spider to *Empoasca notat* reaches 1:5, it is not necessary to use pesticide in tea garden. The number of *Empoasca notat* will not increase.

Adoption Of Farming Methods

Coverage of weeds in tea field can supply shelters for wolf-spiders to live through winter and summer. Picking up the tender tea shoots in time can suppress the incidence of pests and relieve the damage of aphid, *Empoasca formosana*, *Caloptilia theivora*, *Polyphaotaronemus latus*, *Acaphylla theae*, and *Calacarus carinatus* to tea leaves. Moderate pruning of tea tree surface after spring tea period can promote the growth of the tree and move away the surface layer of the tree in which *Empoasca vitis*, *Caloptilia theivora*, *Acaphylla theae*, *Calacarus carinatus* and aphid often perch on. *Homona coffearia*, *Homona magnanima* and *Caloptilia theivora* perch on deeper layer of the surface. Deep pruning of teas tree can move away those pests. When the tea garden suffers a serious damage by *Icerya purchasi*, *Ceroplastes pseudoceriferus*, and *Unaspis yanonensis* etc., it

is best to give the tea bush an appropriate pruning to control them. The above three kinds of pruning can play a role on controlling pests and protecting spiders.

Reasonable Application of Pesticides

1. Use right kind of pesticides: Those can control about 90% of pests and kill 30% of spiders in tea gardens. Microbial pesticides are less harmful to spiders, such as *Ectropis oblique* NVP (EoNVP), *Euproctis pseudoconspersa* NVP (EpNVp), entomogenous fungi, *Bacillus thuringiensis* etc. Pesticides, which can control about 90% of pests and kill 30% of spiders, are biologically based. Plant pesticides are nicotine, azadirachtin, rotenone, matrine etc. Mineral pesticides are petroleum oil and lime sulfur. Chemical pesticides are cypermethrin, beta-cypermethrin, bifenthrin, buprofezin, imidacloprid, acetamiprid, endosulfan and propargite.

2. Avoid use of prohibited pesticides: Some of the chemical pesticides not allowed to be used in tea gardens in China are BHC, DDT, methamidophos, omethoate, parathion-methyl, parathion, monocrotophos, phosphamidon, phorate, isofenphos-methyl, terbufos, phospholan-methyl, sulfotep, demeton, carbofuran, aldicarb, ethoprophos, phospholan, coumaphos, fonofos, isazofos, fenamiphos, dicofol, fenvalerate, abamectin and their preparations (Ordinance of Pesticides manage, The People's Republic of CHINA 1997).

3. Restricted usage of pesticides: If it is necessary to spray pesticide, the dosage and safety interval for picking up tealeaf should be strictly managed. The safe application of pesticides not only reduces the cost and pesticide residues in

tealeaves, but also protects natural enemies in tea gardens.

4. Improvement of spraying methods to reduce loss rate of spiders: The spraying of pesticides on a large scale and at high dosage in tea gardens should be limited. It is suggested to use different spraying methods to control different kinds of pests. For example, if we control the pests perching on branches of tea bushes, it is not necessary to spray the surface of the tea bushes.

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