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EMPLOYMENT OF CHINESE COCCINELLIDAE IN BIOLOGICAL CONTROL OF APHIDS IN GREENHOUSE IN PRIMORYE

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The results of introduction of Chinese coccinellids for biological control of aphids in greenhouses in Primorye are discussed. Most effective was release of II instar larvae of *Leis demidiata* and *Lemnia bipagiata*. At ratio predator : victim = 1 : 20 they kill 85-90 % of aphids within short period of time that allows abandon treatments of vegetable crops with insecticides.

KEY WORDS: Lady beetles, biological control, Russian Far East, China.

В. Н. Кузнецов¹⁾, Х. Панг²⁾. Применение китайских кокциnellид в биологической борьбе с тлями в теплицах в Приморском крае // Дальневосточный энтомолог. 2002. N 119. С. 1-5.

Обсуждаются результаты применения китайских кокциnellид в биологической борьбе с тлями овощных культур в теплицах Приморского края. Наиболее эффективным оказалось применение личинок второго возраста *Leis demidiata* и *Lemnia bipagiata*. При соотношении хищник : жертва как 1 : 20 они за короткий период уничтожают 85-90 % тлей, что позволяет исключить химическую обработку овощных культур.

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INTRODUCTION

Suctorial insects make the serious damage to vegetable cultures in greenhouses in Primorye. The most dangerous of them are *Aphis frangulae gossypii* Glover, 1877, *Myzus persicae* (Sulzer, 1776), *Thrips tabaci* Lindemann, 1888, *Trialeurodes vaporariorum* (Westwood, 1856). The increased harm of aphids and other pests needs repeated treatments with insecticides. The treatments being applied are ineffective, dangerous for people health and environment. Using pesticides on vegetable cultures in greenhouses are prohibited last years and may be allowed in exclusive cases only. Due this the important role is taken off for biological methods of plants protection. The predatory Coccinellidae are widely used against aphids in greenhouses.

In the greenhouses the following coccinellid species were used: *Adalia bipunctata* (Linnaeus, 1758), *Cheilomenes lunata* (Fabricius, 1755), *Coccinella septempunctata brucki* Mulsant, 1866, *C. transversoguttata* Faldermann, 1835, *C. trifasciata* Linnaeus, 1758, *Coleomegilla maculata* (De Geer, 1775), *Cycloneda limbifer* Casey, 1899, *C. sanguinea* (Linnaeus, 1763), *Harmonia axyridis* (Pallas, 1773), *H. conformis* (Boisduval, 1835), *Hippodamia convergens* (Guerin, 1842), *Menochilus sexmaculatus* (Fabricius, 1781), *Olla v-nigrum* (Mulsant, 1866), *Propylea japonica* (Thunberg, 1781) (Ruzhichka, 1989). The results were successful but there were the problems with big quantities of aphids and artificial diet experimental study sometimes.

The conditions of plant cultivation in greenhouses are similar to nature climatic characteristics of tropical regions. Therefore we made research work on introduction and using Coccinellidae from South-Eastern Asia (Southern China and Vietnam) in closed ground (Kuznetsov, 1997). Earlier the Cuban giant lady beetle (*Cycloneda limbifer*) was widely used in Russia but its using was stopped due the high migration activity of beetles and weak effectiveness.

MATERIALS AND METHODS

In the beginning for mass lady beetles reproduction Semyaninov's technique (Semyanov, 1974, 1980, 1996) was used, at which the beetles and larvae of predators were reared on peach aphids affecting fodder beans. Then we have developed a technique of mass reproduction of predatory Coccinellidae on cereal aphid, which was bred on wheat shoots.

Wheat was cultivated in plastic cuvettes. Before sowing into the cuvettes, wheat seeds were germinated. Germinated seeds were planted in wood sawdust. After sowing the seeds were strewed with thin layer of sawdust and covered with several layers of a damp paper. Sprouts usually appeared at the second day after crop. Then the cuvettes with plants were transferred on illuminated shelves and inhabited by aphids. For 7-8 days after populating the cuvettes with aphids were placed in cases where lady beetles were bred. Besides as forage for beetles and larvae we used natural aphids gathering on peppers, cucumbers, tomatoes, tobaccos and other vegetable cultures growing in greenhouses.

RESULTS AND DISCUSSION

In 1990 nine species of predatory Coccinellidae eating aphids were introduced from Southern China in cooperation with V.P. Semyanov (Zoological Institute, St.-Peterburg, Russia). High temperature and air moisture in greenhouses are in accordance to the conditions of ecological needs of Chinese Coccinellidae. In the biological laboratory of the greenhouse 'Primorye' were made up the methods of mass breeding of these Chinese lady beetles on different aphid species affecting many culture plants. Then the beetles and larvae were released in the centers of aphids on vegetable crops. Good results in biological aphids control have been received with mass reproduction and releases of two Chinese lady beetles: *Leis dimidiata* (Fabricius, 1871) and *Lemnia bipagiata* (Swartz, 1808). The most active predator for melon, greenhouse and big potato aphids on cucumbers and peppers turned to be *Leis dimidiata*. Later we paid more attention to study of this species biology, breeding methods and using it in aphid control in closed ground.

The lady beetle *Leis dimidiata* occurs in China, Vietnam, India, Nepal, Pakistan and other countries of South -East Asia. In natural conditions this species develops on many aphid species affecting agricultural cultures and grassy plants. Specimens introduced from China were collected on the fields of South China Agricultural University on corn in the gatherings of *Rhopalosiphum maidis* (Fitch, 1856).

In laboratory conditions *L. dimidiata* eats 9 aphid species [*Myzus persicae* (Sulzer, 1776), *Aphis frangulae gossypii* Glover, 1877, *A. craccivora* Koch, 1854, *A. glycines* Matsumura, 1917, *A. fabae* Scopoli, 1763, *Macrosiphum eupharbiae* (Thomas, 1878), *Schizaphis graminum* (Rondani, 1847), *Macrosiphum rosae* (Linnaeus, 1758), *Acyrtosiphon pisum* (Harris, 1776)]. Most effective breeding was on *M. persicae* and *Sch. graminum*. Imago of the species does not have photoperiodic diapause that means this species may develop all the year round. Besides, the lady beetles have a weak migratory activity. A female lay up to 3000 eggs during her life. The mean fecundity was 1892 ± 448 eggs, with minimum 1085 and maximum 3017 eggs per female (Semyanov, 1999). The most favorable temperature for species developing is 20-25°C. At 25°C one generation develops (from egg to imago) 22 days, at 20°C - 35 days. Egg stage lasts 3-5 days, larva - 14-22 days, pupa - 5-8 days. While lack of aphids in laboratory the beetles may be kept in refrigerator at 15°C for 4 months. When 10% honey solution was given to the beetles, about 90 % of the livestock survived.

In laboratory the beetles can lay many eggs per day (20 females laid more than 1000 eggs per day). Larvae hatch in 3-4 days and may be released into greenhouses for aphid control. Larvae are very voracious and wipe aphids out in the gatherings in a short time. A larva ate up to 940 adults of *Myzus persicae* during its life.

Lemnia bipagiata is known in Japan, Korea, China, Myanmar, India and Philippines (Hoang, 1983). In its habitats the species is a very effective predator for aphids on many agricultural cultures.

In the laboratory and greenhouse conditions *Lemnia bipagiata* developed well on cereal (*Schizaphis graminum*), lucerne (*Aphis craccivora*), soya (*A. glycines*), bean (*A. fabae*), pea (*Acyrtosiphon pisum*) and rose (*Macrosiphum rosae*) aphids. A female lay up to 1200 egg during its life. Additional feeding with sugar or honey syrup increases females' fertility. The development of one generation takes 17-28 days at 20-25°C. Egg stage lasts 3-5, larva - 10-16, pupa 4-7 days. During its life one larva eats up to 350 aphids.

Using *Leis dimidiata* is the most effective in the centers of melon aphids on cucumbers with the releases of II instar larvae. The efficacy of larvae releases with the ratio predator : victim = 1 : 20 is 85-90 %. Being very voracious and having high searching ability larvae wiped out the centers of aphids in short time. Young beetles may be kept in storing conditions for accumulating and colonizing them in the greenhouses. Beetles may be kept well for 4-5 months at 12-15°C and with feeding them up with 10 % sugar or honey syrup.

Chinese lady beetles well develop at temperature 22-25°C, one generation develops for 18-25 days. The beetles do not have diapause and can be bred all the year round. Females have a high fertility and consequently in short time it is possible to receive a quantity of larvae for release on plants affected by aphids. It is possible to store emerged beetles and accumulate them for colonization. Lady beetles elder larvae are highly voracious (more than 200 specimens of melon aphid are eaten per day) and do not leave plant leaves before total aphid extirpation. The larvae also eat aphids on buds, ovaries and old leaves. If there is a lack of aphids, larvae inspect next leaves and plants crawling away in some meters sometimes. In 2-3 weeks after eating aphids larvae became pupae. Therefore we repeated the releases when the mass reproduction of aphids had occurred.

The releases of larvae are more effective as the beetles migrate due the lack of aphids from the rarefied aphids centers. Larvae eat up all the aphids on a leaf and then crawl over the next. Even with a high number of melons aphids on the leaves 1 or 2 larvae are capable to clear a cucumber leaf from aphids in a day. The high efficacy of *Leis dimidiata* larvae is reached in the melon aphid gatherings when the releases in the ratio predator : victim = 1 : 10 or 1 : 20 are made. For melon aphid suppression on the large areas a quantity of the lady beetles larvae is necessary (300-400 thousands of larvae per 1 hectare). For breeding such a quantity of the bioagents large expenses on reproduction of their natural forage – aphids are necessary. Hereinafter it is necessary to develop a technique of lady beetles reproduction on artificial forage.

Taking into account a high reproduction potential of aphids and long vegetative period of the cultures being cultivated in closed ground, applying the pest-killers does not always give a reliable protection. Therefore application of the biological agents eating aphids allows to suppress aphids number for a long time and to receive a high crop of vegetables. The carried out experiments on using predatory lady beetles in a complex with other aphids predators in the greenhouse complexes "Primorye" and "Lazurny" have shown that larvae of *Leis dimidiata* successfully suppress aphids on cucumbers, peppers and eggplants.

Using the predatory Coccinellidae in the system of biological protection of vegetable cultures in closed ground has allowed to protect the cultures being cultivated from a group of suctorial pests practically without applying insecticides. Using the biological methods of protection with application of the predatory Chinese lady beetles provides an increase of cucumbers crop in 1.5-2 kg/sq.m. Taking into account high fertility of females of *Leis dimidiata* and *Lemnia bipagiata*, high voraciousness of adults and larvae and positive results in our experiments we recommend this species to control aphids in greenhouses.

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