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# Important predaceous insects of citrus aphids (Hemiptera: Aphididae) in the north of Iran

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**ABSTRACT-** Several species of aphids cause severe damage to citrus in the north of Iran. Predatory insects play an important role in biological control of the pests in citrus orchards. In this study, potential predatory insects of citrus aphids, *Aphis spiraecola*, *A. gossypii* and *Toxoptera aurantii*, were identified and their seasonal population dynamics on *Citrus unshiu* and *C. sinensis* were investigated during 2016-2017. Overall, four species were identified as dominant predatory insects of citrus aphids in Mazandaran province including *Xanthogramma pedissequum* (Syrphidae), *Scymnus subvillosus*, *Coccinella septempunctata* (Coccinellidae), and *Aphidoletes aphidomyza* (Cecidomyiidae). Among these species, *X. pedissequum* and *S. subvillossus* were more abundant predators in the *C. sinensis* and *C. unshiu* orchards compared to the two other species. The predatory insects were observed when means of environmental temperature was about 15-20ºC. Population fluctuations, population densities and presence periods of the predatory insects were different on the two host plants. Results of this study can be used in integrated pest management programs of citrus aphids in citrus orchards in the north of Iran.

## INTRODUCTION

Aphids are important pests in citrus orchards in the north of Iran (Rajabi, 1986). The pests damage their host plants in diverse ways. They weaken the host plants by phloem sap feeding. Also, during feeding, injection of insect saliva plants causes phytotoxicity and physiological problems in the host plants. Sooty molds grow on the aphids' honeydew and hinder photosynthesis (Blackman and Eastop, 2000; Dedryver et al., 2010). Aphids can also transmit viruses to plants and indirectly damage them. A few aphids transmit citrus tristeza virus (CTV) in Iran. This virus causes severe damage to citrus plants (Delkhosh and Tousi, 2009). Natural enemies (NEs) play an important role in biological control of aphids in citrus orchards. Many natural enemies including predators, parasitoids and pathogens attack the citrus aphids (Smith et al., 1997). NEs of some citrus pests and their population have been studied in some regions of Iran. For instance, NEs of citrus psyllid, *Diaphorina citri* Kuwayama, in the south of Iran were investigated that resulted in characterization of seven predators as well as three parasitoids of this insect species (Rakhshani and Saeedifar, 2012). Also, thirteen insect species were reported as natural enemies of pulvinarin scale, *Pulvinaria aurantii* (Cockerel), in the north of Iran (Bozorg Amirkolaee et al., 2017). Seasonal population dynamics of an aphidophagous predator, *Scymnus syriacus* Marseul (Col: Coccinellidae), was studied in Gilan province (Emami et al., 2004). In this study, important predatory insects of aphid pests on two citrus species, Satsuma mandarin, *Citrus unshiu* Markovich, and Thomson navel orange, *Citrus sinensis* L., were studied and their seasonal population dynamics were investigated in the north of Iran.

## MATERIALS AND METHODS

Samplings of predatory insects of *Aphis spiraecola* Patch, *A. gossypii* Glover and *Toxoptera aurantii* Boyer de Fonscolombe were performed in an experimental citrus orchard of Citrus and Subtropical Fruits Research Center, 20 hectares, in Ramsar, Mazandaran province, the north of Iran, 36°54'24.2"N 50°39'26.7"E. No pesticides were applied against insects in the experimental citrus orchard during the study period. Samplings were weekly performed during January 2016 to August 2017. At each sampling date, ten Thompson navel orange and ten Satsuma mandarin trees (20 years old) were randomly selected. From three heights (1, 1.5 and 2 meters) of each main direction (north, south, east and west), six shoots, and totally 24 shoots from each selected tree, were randomly taken. The samples were transferred to the entomology laboratory of the Citrus and Subtropical Fruits Research Center and numbers of immature life stages of each predator on each sample were separately recorded under stereomicroscope. Recording of numbers of adult predators was done in situ. To identify unknown species, their specimens were sent to the Department of Insect Taxonomy of Iranian Research Institute of Plant Protection. Seasonal population dynamic charts were plotted by Microsoft Excel 2010.

## RESULTS AND DISCUSSION

### Seasonal population dynamics of aphid predators

Overall, four species, *Xanthogramma pedissequum* Harris (Dip., Syrphidae), *Scymnus subvillosus* (Goeze) (Col., Coccinellidae), *Coccinella septempunctata* L. (Col., Coccinellidae) and *Aphidoletes aphidomyza* Rondani (Dip., Cecidomyiidae), were identified as predatory insects of citrus aphids. The seasonal abundance of natural enemies of *Toxoptera citricida* Kirkaldy has already been investigated in Puerto Rico (Michaud and Browning 1999). Similarly, they showed that syrphid larvae and coccinellid beetles were two important groups of predators of the citrus aphids.

Seasonal population dynamics of aphid predators on Satsuma mandarin and Thomson navel orange, mean of environmental temperature and relative humidity % during two growing seasons are presented in Fig. 1.

On Satsuma mandarin during 2016, the first *X. pedisequum* egg and larvae were observed in early May (Fig. 1). The larval density dramatically increased and peaked on May 18 2016 (0.6 larvae per shoot). The syrphid fly was not observed during June to early October 2016 (Fig. 1). No recording of the predator flying during this period may be related to environmental conditions or lack of preys. The second activity period of *X. pedissequum* was recorded during mid to the end of October 2016 with a lower density level (0.016 and 0.008 larvae per shoot (Fig. 1). The first occurrence and peak density of the syrphid larvae were 0.27 eggs and 0.36 larvae per shoot at mid-May 2017 (Fig. 2). The first population of the syrphid egg and larvae we observed at Early-May 2016 on Thomson navel orange (Fig. 3). The peak of larval population took place on October 16 2016 (0.2 larvae per shoot). Overall, the syrphid fly was active during five months on Thomson navel orange which was longer than the period of insect presence on Satsuma mandarin.

The first larvae of *S. subvillosus* on both host plants were observed on May 3 2016 (Figs. 1 and 3). The peak of the ladybird larvae was recorded on May 18 2016 (0.6 larvae per shoot). There were no larvae of *S. subvillosus* during summer months on both host plants. This may be related to specific environmental conditions or lack of aphids as its preys. The ladybird was observed again during October 2016 with a low density. At the second activity period, the peak of *S. subvillosus* larvae was observed on October 6 and October16 2016 with the densities of 0.029 and 0.037 larvae per shoot on Satsuma mandarin (Fig 1) and Thomson navel orange (Fig 3), respectively.

In 2017, the first larvae of this predator was observed on May18 and on April 4 on Satsuma mandarin and Thomson navel orange, respectively (Figs. 2 and 4). The predatory ladybird larvae peaked on May 18 2017 (1.21 larvae per shoot) and on June 4 2017 (0.16 larvae per shoot) on Satsuma mandarin (Fig. 2) and Thomson navel orange (Fig. 4), respectively. These results showed that predatory ladybird was present on Satsuma mandarin with a higher density and for a longer period compared to those on Thomson navel orange. Host plant characteristics may modify interactions between herbivores and their enemies by operating directly on the herbivore, the enemy, or both. The characteristics may be either chemical (such as toxins, digestibility-reducers, and nutrient balance) or physical (such as pubescence and tissue toughness) (Price et al., 1980).

On Satsuma mandarin, *C. septempunctata* was active only during May 2016 (Fig. 1). This activation period may be related to the effect of host plant on the predator or aphids, as its preyes. The first occurrence and peak of *C. septempunctata* L. egg and larvae population were recorded on May 3 2016 (0.029 insects per shoot). The same trend was observed on Thomson navel orange (Fig. 3). During 2017, the predators were present on Satsuma mandarin during mid-May to mid-June (Fig. 2). Overall, the population density of *C. septempunctata* was higher on Satsuma mandarin than on Thomson navel orange and the presence period of this insect on Satsuma mandarin was longer compared to insect presence period on Thomson navel orange. For *A. aphidomyza*, the predatory midge was observed during May 2016. Larvae of the predator peaked on May 18 2016 with densities of 0.154 and 0.191 larvae per shoot on Satsuma mandarin (Fig. 1) and Thomson navel orange (Fig. 3), respectively. On Satsuma mandarin, the predator larvae were present during early May to mid-June 2017 with density peak of 1.36 larvae per shoot (on May 18 2017) (Fig. 2). But on Thomson navel orange, the predatory larvae were observed only on June 4 2016 (0.079 larvae per shoot) (Fig 3). Therefore, this predatory midge was more active on Satsuma mandarin compared to Thomson navel orange. More density of aphid predators on Satsuma mandarin may be due to attractive infochemicals which emit from the host plants.

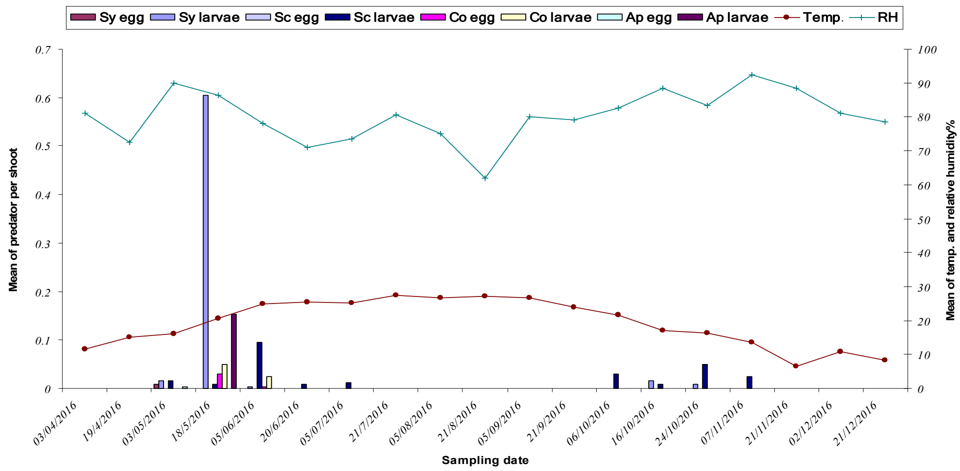


**Fig. 1.** Seasonal population dynamics of aphid predators on Satsuma mandarin during 2016 (Sy: *Xanthogerama pedisequum* (Syrphid fly); Sc: *Scymnus subvillesus*; Co: *Coccinella septempunctata*; Ap: *Aphidoletes aphidomyza*). RH: Relative Humidity %

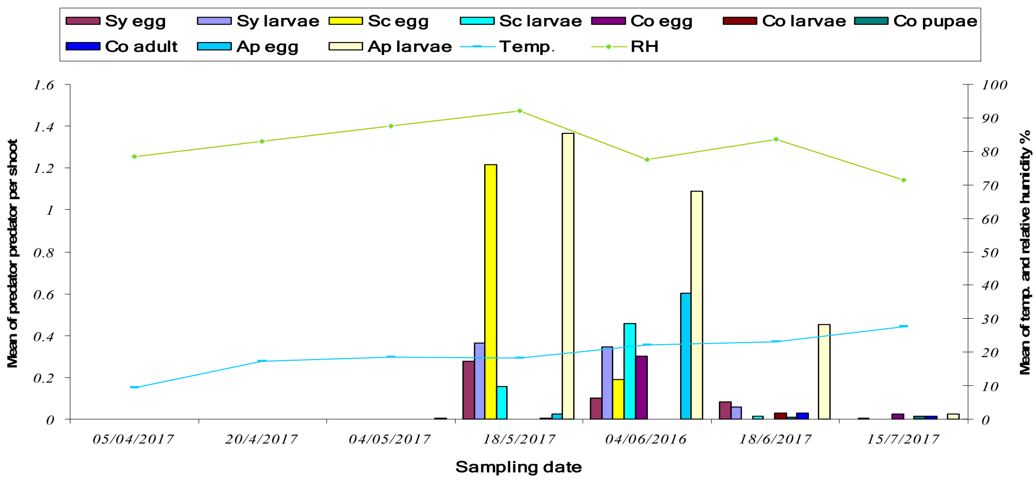


**Fig. 2.** Seasonal population dynamics of aphid predators on Satsuma mandarin during 2017 (Sy: *Xanthogerama pedisequum* (Syrphid fly); Sc: *Scymnus subvillesus*; Co: *Coccinella septempunctata*; Ap: *Aphidoletes aphidomyza*). RH: Relative Humidity %

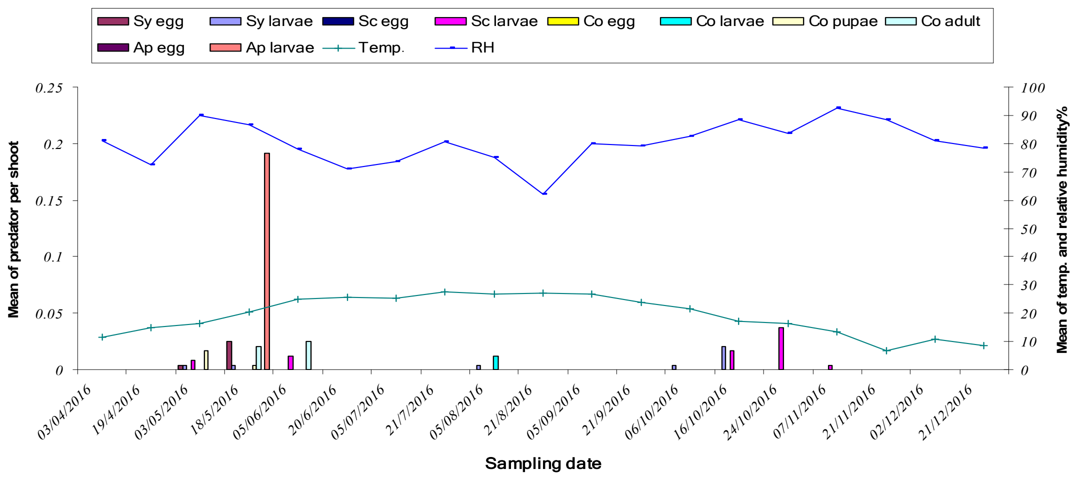


**Fig. 3.** Seasonal population dynamics of aphid predators on Thomson orange during 2016 (Sy: *Xanthogerama pedisequum* (Syrphid fly); Sc: *Scymnus subvillesus*; Co: *Coccinella septempunctata*; Ap: *Aphidoletes aphidomyza*). RH: Relative Humidity %

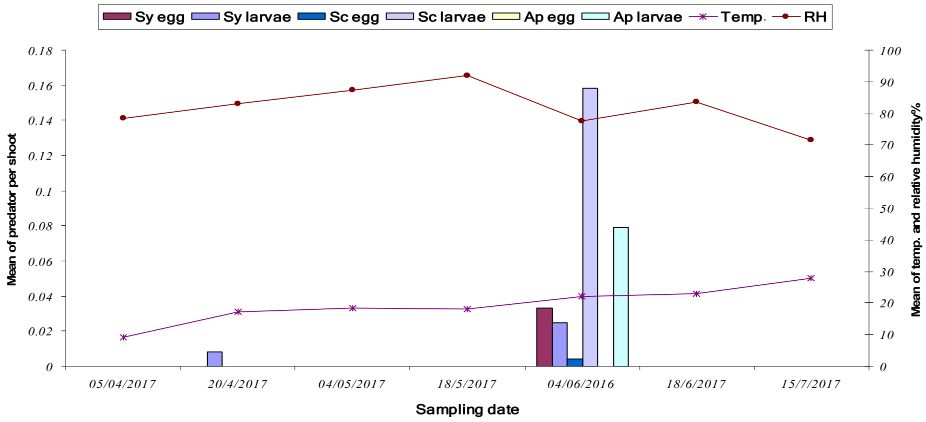


**Fig. 4.** Seasonal population dynamics of aphid predators on Thomson orange during 2017 (Sy: *Xanthogerama pedisequum* (Syrphid fly); Sc: *Scymnus subvillesus*; Co: *Coccinella septempunctat*; Ap: *Aphidoletes aphidomyza*). RH: Relative Humidity %

Volatile compounds can cause immigration of the predators to infested trees. Natural enemies plan their foraging decisions according to the information they received from different trophic levels; so, it was reported that chemical information plays a critical role in behavior of the natural enemies (Dicke et al., 1990). The importance of the infochemicals in foraging of predators has been documented. For instance, broad bean plants emitted infochemicals, (E)-β-Farnesene, which has been shown to be attractive for *A. bipunctata* (Francis et al., 2004) and *Episyrphus balteatus* DeGeer (Dip., Syrphidae) (Francis et al., 2005). Also, it has been reported that searching and ovipositional behaviors of *E. balteatus* were significantly affected by volatile terpenoids released from potato infested with *Myzus persicae* Sulzer.

Overall, the results of this study showed that population densities and activity period of the predators on Satsuma mandarin were more than those on Thomson navel orange. Price et al. (1980) explained that host plant directly and indirectly affects the population of natural enemies. The population of herbivores may be influenced by different host plants and, therefore, the efficacy and density of the herbivore's natural enemies may be indirectly affected by the different host plants. For instance, it was demonstrated that life table parameters of *A. spiraecola* on seven host plants were different (Tsai and Wang, 2001). Also, Johnson (2008) proved the effects of plant genotype (28 genotypes of *Oenothera biennis* L.) on aphid density and their natural enemies in field conditions. Our previous study showed that citrus aphids, *A. spiraecola*, *A. gossypii* and *T. aurantii*, were more abundant on Satsuma mandarin than on Thomson navel orange (Alizadeh Kafeshani, 2018). The effect of host plants on aphids and their predators in a tri-trophic interaction system was previously reported for *M. persicae* Sulzer and *Adalia bipunctata* L. (Col., Coccinellidae) (Birch et al., 1999; Francis et al., 2001), *Rhopalosiphum maidis* Fitch and *Coleomegilla maculata* DeGeer (Col., Coccinellidae) (Lundgren and Widenmann, 2005) and *Diuraphis noxia* Mordvilko and *Chrysoperla plorabunda* Fitch (Neu., Chrysopidae) (Messina and Sorenson, 2001). In all cases, efficacy and population of the predators were significantly affected by host plants of the aphids.

Results of this study showed that predatory insects were present when the mean of environmental temperature was about 15-20ºC. Our previous study showed that population peaks of the citrus aphids took place at the above temperature range (15-20ºC) (Alizadeh Kafeshani , 2018).

## CONCLUSIONS

Overall, four predaceous species: *X. pedissequum*, *S. subvillosus*, *C. septempunctata* and *A. aphidomyza* were identified as predatory insects of citrus aphids in Mazandaran province, the North of Iran. Among them, *X. pedissequum* and *S. subvillosus* were more abundant predators. The optimum range temperature for the predatory insects was 15-20ºC. Population fluctuations, population densities and presence period of the predatory insects were different on Satsuma mandarin and Thomson navel orange. *X. pedissequum* occurred earlier than other species in the citrus orchards. Results of this study can be used in integrated pest management program of citrus aphids.

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## REFERENCES

Alizadeh Kafeshani, F. (2018). Investigation on bio-ecology of dominant aphids on orange (var. Thomson navel) and mandarin (var. Onshu) in Ramsar, west of Mazandaran province. M.Sc. Thesis of Entomology, Ramin Agriculture and Natural Resources University of Khuzestan.

Birch, A.N., Geoghegan, I.E., Majerus, M.E.N., McNicol, J.W., Hackett, C.A., Gatehouse, A.M.R., & Gatehouse, J.A. (1999). Tri-trophic interactions involving pest aphids, predatory 2-spot ladybirds and transgenic potatoes expressing snowdrop lectin for aphid resistance. *Molecular Breeding*, 5, 75-83.

Blackman, R. L., & Eastop, V.F. (2000*). Aphids on the World's Crops: An Identification and Information Guide, (2nd ed)*. UK: John Wiely and Sons.

Bozorg Amirkolaee, M., Fathi, S.A.A., Golizadeh, A., Mahdavian, S.E. (2017). Species diversity of natural enemies of the orange pulvinaria scale, *Pulvinaria aurantii* (Hem.: Coccidae) on different citrus species of Tonekabon region, Northern Iran. *Journal of Plant Protection*, 93(4), 1-12. (In Persian with English abstract)

Dedryver, C.A., Ralec, A.L., & Fabre, F. (2010). The conflicting relationships between aphids and men: A review of aphid damage and control strategies. *Comptes Rendus Biologies*, 333, 539-553.

Delkhosh, H.R., & Tousi, N. (2009). Historical review of Citrus tristeza virus and its vectors in Iran. In: D'Onghi A. M., Djelouah K., Roistacher C. N. (Eds.), *Citrus tristeza virus and Toxoptera citricidus: a serious threat to the Mediterranean citrus industry* (p. 135-140). CIHEAM

Dicke, M., Sabellis, M.W., Takabayashi, J., Bruin, J., & Posthumus, M.A. (1990). Plant strategies of manipulating predator–prey interactions through allelochemicals: Prospects for application in pest control. *Journal of Chemical Ecology*, 16, 3091-3118.

Emami, M. S., Sahragard, A., & Hajizadeh, J. (2004). Studies on biology of *Scymnus syriacus* Marseul (Col: Coccinellidae) in Gilan province. *Pajoohesh va Sazandegi*, 17(2), 17-20.

Francis, F., Haubruge, E., Hastir, P., & Gasper, C. (2001). Effect of aphid host plant on development and reproduction of the third trophic level, the predator *Adalia bipunctata* (Coleoptera: Coccinellidae). *Environmental Entomology*, 30 (5), 947-952.

Francis, F., Lognay, G., & Haubruge, E. (2004). Olfactory responses to aphid and host plant volatile releases: (E)-β-Farnesene an effective Kairomone for the predator *Adalia bipunctata*. *Journal of Chemical Ecology*, 30(4): 741-755.

Francis, F., Martin, T., Lognay, G., & Haubruge, E. (2005). Role of (E)-β-farnesene in systematic aphid prey location by *Episyrphus balteatus* larvae (Diptera: Syrphidae). *European Journal of Entomology*, 102, 431-436.

Johnson, M.T.J. (2008). Bottom up effects of plant genotype on aphids, ants, and predators. *Ecology*, 89(1), 145-154.

Lundgren, J., & Widenmann, R.N. (2005). Tritrophic interactions among *Bt* (Cry3Bb1) corn, aphid prey, and the predator *Coleomegilla maculata* (Coleoptera: Coccinellidae). *Environmental Entomology*, 34(6), 1621-1625.

Messina, F.J., & Sorenson, S.M. (2001). Effectiveness of lacewing larvae in reducing Russian wheat aphid populations on susceptible and resistant wheat. *Biological Control*, 21, 19-26.

Michaud, J.P., & Browning, H.W. (1999). Seasonal abundance of the brown citrus aphid, *Toxoptera citricida*, (Homoptera: Aphididae) and its natural enemies in Puerto Rico. *Florida Entomologist*, 83 (3), 424-447.

Price, P.W., Bouton, C.E., Gross, P., McPheron, B.A., Thompson, J.N., & Weis, A.E. (1980). Interactions among three trophic levels: Influence of plants on interactions between insect herbivores and natural enemies. *Annual Review of Ecology and Systematics*, 11, 41-65.

Rajabi, G.R. (1986). Insect's harmful fruit trees of Iran. Ministry of Agricultural Research, Education and Extension Organization. Research Institute Pests and Diseases, Tehran.

Rakhshani, E., & Saeedifar, A. (2012). Seasonal fluctuations, spatial distribution and natural enemies of Asian citrus psyllid *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae) in Iran. *Entomological Science*, 16(1), 17-25.

Smith, D., Broadley, R.H., & Beattie, G.A.C. (1997). Citrus pests and their natural enemies: Integrated pest management in Australia. Horticultural Research and Development Corporation, 272p.

Tsai, J.H., & Wang, J.J. (2001). Effects of host plants on biology and life table parameters of *Aphis spiraecola* (Homoptera: Aphididae). *Environmental Entomology*, 30(1), 44-50.

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دانشگاه شیراز

# حشرات مهم شکارگر شته‌های مرکبات (Hemiptera: Aphididae) در شمال ایران

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***واژه های کلیدی:***

Aphididae

شرایط محیطی

میزبان‌های گیاهی

نوسانات جمعیت

شکارگران

**چکیده–** بسیاری از گونه‌های شته‌ها موجب خسارت شدید مرکبات در شمال ایران می‌شوند. حشرات شکارگر نقش مهمی در کنترل طبیعی این آفات در باغات مرکبات دارند. در این مطالعه، حشرات مهم شکارگر شته‌های مرکبات (*Aphis spiraecola*، *A. gossypii* و *Toxoptera aurantii*) شناسایی شدند و تغییرات فصلی جمعیت آنها روی نارنگی انشو (*Citrus unshiu*) و پرتقال تامسون ناول (*Citrus sinensis*) در طی سال‌های ۱۳۹۴-۱۳۹۶ مورد ارزیابی قرار گرفت. درکل، چهارگونه شامل *Xanthogramma pedissequum* (Syrphidae)، *Scymnus subvillosus* و *Coccinella septempunctata* (Coccinellidae) و *Aphidoletes aphidomyza* (Cecidomyiidae) به عنوان حشرات شکارگر مهم شته‌های مرکبات در استان مازندران شناسایی شدند. در میان این‌ها، گونه‌های *X. pedissequum* و *S. subvillosus* فراوان‌ترین حشرات شکارگر روی درختان نارنگی انشو و پرتقال تامسون ناول بودند. این حشرات شکارگر زمانی که میانگین دمای محیط بین ۱۵ تا ۲۰ درجه سانتی-گراد بود، حضور داشتند. نوسانات جمعیت، تراکم‌های جمعیت و دوره حضور این حشرات شکارگر روی دو میزبان گیاهی متفاوت بود. نتایج این تحقیق می تواند در برنامه‌های کنترل تلفیقی آفات شته‌های مرکبات در باغات شمال کشور مورد استفاده قرار گیرد.