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Full Length Research Paper

Detrimental effects of species of Tenthredinidae (Insecta: Hymenoptera) on plants and control methods

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Tenthredinidae family is included in suborder Symphyta of order Hymenoptera (Insecta). The species belonging to this family is harmful by feeding on leaf, stem, bud, flower, etc., of plants. The detrimental effects of these species are especially constituted by larval forms. Larva damages plants by eating plant tissue, forming gal and opening galleries in leaf, stem and bud of plants. These harmful species can be controlled with biological, cultural and chemical methods. The control methods change according to the species. However, although chemical control is harmful for nature on a large scale, it is generally being used.

Key words: Tenthredinidae, Hymenoptera, Symphyta, sawfly, biological control, cultural control, chemical control.

INTRODUCTION

Animal groups constitute three-fourths of living organisms today and have important roles for ecosystem balance and continuation of the food chain (Daly et al., 1998). Insects also contribute to nitrogen circulation of the world by feeding on decayed plants and animal matters. They are superior to all other terrestrial animals from the point of view of both species number and individual number. Although insects are terrestrial animals, they provide harmony at many various biotopes like deep caves, forests, meadowland fields, deserts, planted fields, cities, cold regions, salt waters and oil ponds except bottoms of deep seas. They, therefore, feed with various external nutriments (Bonor et al., 1992). Their thousands species are phytophages, especially feeding on all parts of green plants like leaf, root, stem, branch, twig, flower and fruit (Daly et al., 1998) and they cause great product losses for plants.

Insect damages on a large scale. In a large sense, it can be said that one-third of the crops in the world is eradicated by these animals. In the North America, thousands of hectares of forested area were destroyed by phytophage species of the order Hymenoptera (Gauld and Bolton, 1988).

While adults of Tenthredinidae species feed on nectars in flowers, larvae feed on various parts of plants. There are many harmful effects of these species, particularly their larvae on the plants. They eat their leaves, hollow the twist out and make galls on various parts of the plants (Gauld and Bolton, 1988; Gaulet and Huber, 1993).

Harmful effects of species of Tenthredinidae family on plants

Adult species belonging to the family Tenthredinidae feed on nectar and plant juice; larvae feed on plant tissue like leaf, stem, fruit etc. Therefore, damages of this family species have been done by larva forms on plants. Damages of larvae occurred on plants' tissues differ in various ways according to the species.

Damages of larvae on plants

Tenthredinidae larvae damage by forming gall and boring gallery on various parts of plant; they are harmful on leaves and fruits, too.

Their harmful effects on plant leaves

Most of the larvae belonging to the *Tenthredinidae*

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family feed on lower surface of the leaf. With this feeding way, larvae exhaust all organic materials in the leaf completely by eating all parts of the leaf including epidermis, except for the veins. The remaining part of the leaf resembles a skeleton (Vikberg, 1975).

Some larvae belonging to *Tenthredinidae* family are also harmful by eating edges of the leaves from outside to the median veins. Plant leaves were eaten completely by the larvae. For the damages occurred in this way, plant can it make photo-synthesis and don it produce food necessary for it. The plant dries in the course of time (Smith, 1981).

Their harmful effects occurred by forming gall in plant tissues

Some larvae of *Tenthredinidae* family damage by forming gall in leaves, shoot and fruits of the plant. These galls formed by larvae, affect plant metabolism negatively. Larvae cause harmful effects with this characteristic behavior such as to stop the development of the shoot and fruit, to fall fruits early. By this time, galls cause destruction of the plant tissue completely and kill the plant.

Their harmful effects by boring gallery in plant tissues

Another damage type formed by larvae is to bore galleries in various parts of plants like stem, shoot and bud etc. The damage is greater on the part of the plant, nearer to the gallery formation in plant stems by larvae (Smith, 1981). Opened galleries spoil plant tis-sue. Metabolic activities in the plant stop. By the time, if damage occurs at many parts of the plant, the plant dies.

Their harmful effects on fruits

Larvae of some species of Tenthredinidae family also are harmful to fruits. They eat pips of fruits, cause spots and destruction on fruits. Some of the destructed fruits fall early before maturation. The destruction on fruits causes a decrease of quality and loss of production.

THE CONTROL METHODS OF SPECIES OF TENTHREDINIDAE FAMILY

Cultural control methods

Working up soil and to collect fruit

Since the species are harmful especially in orchard, its larvae must be killed in cocoons by working up soil on autumn. In this method of control, 15 cm layer of soil underside of trees is worked up and cocoons collected is worked up part. In this way, releasing of the adults are prevented. Another cultural method is to fall fruits that are damaged before by the larvae in orchards. In this way, passing of larvae to the other fruits are prevented. The collected fruits are cleared away by firing.

Setting up a trap

The snare is named “white sticky snare” and is used for catching this family of species. This method is used for catching the first adult of harmful species at orchards and determining the control time. Snares are hanged at the beginning of the blossoms, one week before the sawfly adults start coming out. The snare forms a sticky panel with four wings. It is hanged to the branch of the plant at 1.5-2 m above ground and one snare is used for 15 trees. Hanged snares are controlled one time at week during the coming out of adults of fruit sawflies. If coating sticky of insect is smeared on snare gets dirty or dries, sticky substance is smeared again after the snare is cleaned. Snares are collected before harvest and they are used again. If they are not affected by sun light and environ-mental conditions, they may be used for two years.

Biological control methods

It is possible to make a biological control with harmful species, that is, the biological control can be made by using the species of *Neurotoma flaviventris* Retz and *Neurotoma nernoralis* L. which are parasites on Hoplo-campa species that are harmful to orchards. Once again, it is also possible to use biological control with *Angitia macrostorna* Thoms which is a natural enemy of Hoplocampa species. The releasing out of female adults of this parasite matches Hoplocompa species’. Female adult of the parasite lays its eggs on Hoplocompa larvae and parasite larvae develop on Hoplocompa. The parasite larvae complete their development at the begin-ning of February and make their cocoons in Hoplocompa larvae that they have killed.

Chemical control methods

Adults are eradicated by using various insecticides. How-ever, it must be taken account that the useful species such as honeybees may also die when insecticides are applied to adults. The most appropriate time of applying insecticides is the time when the eggs start to open. Especially in orchards, the time when the eggs start to open changes according to full blossom period. Never-theless, insecticides must be applied when the corollas of

Table 1. Host plants, damages and control methods of Tenthredinidae subfamilies.

Subfamily	Harmful phase	Host plants	Damages	Control
Selandrinae	Larva	Ferns Rushes	They bore galleries in stem and eat leaves	Chemical
Susaninae	Larva	Cypress Juniper	They eat leaves and shoots	Chemical Cultural
Nematinae	Larva	Rose Willow Poplar Fruit trees Oak Cistus etc.	They form galls on stem, shoots, petioles, buds or leaves; bore galleries in leaves and petioles of leaf; damage fruits.	Chemical Cultural
Heterarthrinae	Larva	Rose Willow Poplar, Chestnut etc.	They eat leaves; bore galleries in leaves	Chemical Cultural

the flowers are fallen to conserve the honeybees that they are active at this period. For determination of this time, an enumeration is made when the corollas of the flowers are beginning to fall at early blossom varieties. At the enumeration, the healthy and damaged flowers must be counted randomly at contamination twenty bouquets from at least five plants; insecticide must be applied if contamination ratio is over 10%. Before eggs are opened, insecticides can be applied by using 0.03 - 0.04% of doses of the preparates with 45% of Parathion, 0.2 - 0.3% of doses of the preparates with 15% gamma BHC, 1% of dose of the preparates with 20% Nicotine, and 0.2% of dose of the prepartes with 50% DDT. In addition, rather good results can be seen applying insecticides by using 0.02% of dose of the preparates with Parathion after blossoming.

THE MOST IMPORTANT SPECIES OF TENTHREDINIDAE DAMAGING THE PLANTS

The subfamilies and their larvae of Tenthredinidae family make various damages on different plants. Subfamilies involving harmful species and their damages on the plants have been seen Table 1.

Almost all larvae of the subfamily Selandriinae are harmful by eating leaves of trees externally. Species of Heptalamus damage by boring gallery on stem of ferns only. The most widespread species of this subfamily generally feed on ferns. Nevertheless, species that feed on wild grasses exist (Shaw, 1978). Larvae of the species belong to subfamily Susaninae feed on leaves of cypress and juniper trees. For this reason, they accelerate the destruction of forests that contain especially cypress and juniper trees. Sometimes they can cause drying of trees to a large extend (Zombori, 1972; 1973). Larvae of the species belonging to subfamily Nematinae are particularly found at orchards and they feed on fruits. They cause fruits to fall prematurely.

Some larvae of this subfamily also form gall in stems, shoots, petioles, buds or leaves of trees; some of them bore gallery in petiole of leaves.

Species that are most important for our country in economical terms and cause losing of large products are *Hoplocampa testudinea* (Apple Sawfly), *Hoplocampa rutilicornis* (Plum Sawfly), *Caliroa limacina* (Cherry Sawfly) (Özeren, 1952; Wolf, 1968) and *Caliroa cerasi* (Aslantaş et al., 2007).

Hoplocampa testudinea (Apple Sawfly)

Biology: They pass winter as a mature larva in their cocoons inside the soil. In spring, they complete prepup and pup phase. They complete their pup period on March and come out from soil as adults at the first week of April. After mating they begin to lay their eggs. They complete destruction for one month and they go under the soil for 10 months. The coming out of the adults shows appropriateness for plant penology that they live on it. The coming out of adults generally begins at first week of April. First, male adults come out. After one or two days, females begin to come out, too. Their first food is nectar and pollens of the flowers. After female adults come out, they feed like males. Females live at least 5 - 6 days. But they begin to mate and lay their eggs during the last days. Females lay their eggs 24 h after mating. They live at least 1 - 2 days after laying their eggs. Adults fall down on their backs and die after 2 - 3 h. Females lay white eggs by their ovipositor in pouch that is open parallel with upper side of the flower at the bottom of the apple flower. Generally, they lay one egg on each flower. Eggs open after 10 - 14 days.

After fertilization of the apple flowers, larva comes out

Table 2. Insecticides used for chemical control of *H. testudinea* (Apple Sawfly).

The name and ratio of effective matter	Dose (Prepares/100 L Su)
Carbaryl, 50 g/l	200 g
Malathion, 190 g/l	400 ml
Malathion, 650 g/l	125 ml
Phosalone, 350 g/l	200 ml
Phosalone, 30 g/l	200 g
Fenthion, 525 g/l	150 ml
Deltamethrin, 25 g/l	30 ml

from egg and damage fruits by feeding at 1 - 2 mm under ovary membrane. Then membrane layer on fruit ovary dries by cracking and sticks to damaged gallery. This destruction continues as much as one week. Larvae changing its first slough, go forward slowly pericarb by ending damage of surface. This one week strolling period is very important in terms of control.

After larvae change their slough (sometimes before), they pass to another apple and continue damaging until they change their second slough there. They change their second slough after 5 - 6 days and are generally in 18 - 22 mm diameter of apple in this period. Larvae in this period, feed more and sometimes they damage pips of the apple, too.

The third change of slough occurs at the second week of May. In 6 - 7 days, larvae complete their third period and they begin to eat perycarb. At the third week of May, larvae complete their fourth period in 45 days, chance their slough and continue doing damage on 3 cm diameter of apples.

Damage: Inside of the fruits is scooped out by gnawing and filled with sweepings. There is a gnawed hole on the fruit, too. The fruits on the tree have also the same holes hanging. Larvae eat the young fruit spirally and superficially. This spiral shapes remain thus up to harvest. Then, larvae pass other fruits to eat their inside and eaten fruits fall later. One larva can eat 3 and even 4 fruits by boring them. Larvae throw their nutriment as a liquid with recession movement, outside of the hole that they enter. This destruction shape is characteristic for *Hoplocampa testudinea*. Damaged fruits can be easily recognized by holes on them and blackish sticky liquid flowing from these holes. The holes on damaged apples are round in shape and deep. Inside of the holes are filled with dirty piles. In addition, darken dirty piles encircled surrounding of the holes, are smelled as bedbug. Even though damaged fruits are not fallen, their shapes are destroyed and they become oblique. Especially apples lose their marketing value due to their type color and shape which are not standard.

Control: Biological control can be made by collecting cocoons, collecting and eradicating damaged fruits, using a white sticky snare. The chemical control can be applied at coming out time of adults. Insecticides used for chemical control are given in Table 2.

Hoplocampa rutilicornis (Plum Sawfly)

Biology: They pass winter as a mature larva in their cocoons inside of the soil. At spring, they complete their prepup and pup periods. Adults generally appear in the middle of March, three weeks before the adults of *H. testudinea.* Coming out time of adults continue as much as 10 - 12 days. Male individuals come out first. Females come out later and they feed on pollens on wildflowers because the plum flowers are little. At the beginning, females also lay their eggs on young buds.

Generally, they lay one egg on each flower. Larvae come out of egg at 14-15 days. Larvae that change their first slough are harmful at 5-6 mm diameter plums. 4-5 days after they changed their second slough and are harmful at 7-8 mm diameter plums and feed more. The third slough is changed on the first week of April Larvae completing their third period in 5-6 days and after 6-7 days changed their fourth slough by completing fourth period. At the same time, while the pips of the plums are getting harder larvae become mature. Pests, that changed their fourth slough between March and April, become mature larvae and pass to the soil. In two weeks by completing the cocoon they change their fifth slough and complete the fifth larval period larvae become prepupa in January and pass to the pup phase in February. On March adults start to come out.

Damage: Larvae of plum sawfly hole the fruit at the almond period that or as big as pea or nut and results in the skied of fruit. They eat the stone of the fruit. Larvae cause an easily noticed black colored hole on plum fruit.

Dark colored liquid flow out from this hole. Some dirt comes together with this liquid at one side of hole. This dirt dry in time and it accumulates on the fruit remains and smells like bedbug. Damaged plum fruits lose their quality. Fruits, whose pips damaged by larvae, are fallen on to the ground because of wild wind and their weight before the maturation. This type of shedding is important for product loss during the epidermic invasion years.

Control: For cultural control, damage is reduced by working up soil on winter in orchards that sawflies are seen in them. For chemical control, one of the insecticides containing an effective substance like Parathion Methyl, Endosulphan, Phosalone or Azinphos-Methyl is applied by dissolving 200 ml of it in 100 ml water at the period of blossom or corollas of flowers are fallen.

Caliroa limacina (Cherry Leech - Cherry Sawfly)

Biology: Adults are 5 mm in length and bright black

Table 3. Insecticides that used for chemical control of *Caliroa limacina* (Cherry Leech).

The name and ratio of effective matter	Dose (Prepares/100 L Su)
Malathion, 190 g/l	200 ml
Formothion, 336 g/l	150 ml
Diazinon, 185 g/l	200 ml

colored. Their tops are covered with mucoid slippery matter. Appearance of this cover resemble leech. For this reason, the name of "cherry leech" is given to them. They survive the winter in 5-10 cm depth of soil, at period of larva or usually prepupa in cocoon. They have pup at spring. Adults come out after trees leaf out completely (at the end of April). Females open hole in epidermis of leaf in order to lay their eggs and lay their eggs under the upper epidermis of leaf. Eggs open in 9-15 days. Larvae hatching out, feed with epidermis of leaves. Larvae continue their feeding for 3-5 weeks and then complete their development. Larvae complete their development in the soil.

Damage: Larvae damage by eating upper epidermis of leaves and they make them as slim as tulle. This damage type is very characteristic. Thin and thick veins of leaves are not damaged. Leaves become reddish-brown by time. In the case that population is high; trees can lose their leaves completely. This situation affects the vitality of trees and cause production loss.

Control: Cultural control is realized by working up soil on autumn and killing some larvae in cocoons. But, at the places where the population is high, cherry orchards that are known to be smeared more before are controlled by the end of April. In orchards, insecticides are applied when the larvae are seen densely. If it is necessary, insecticide can be repeatedly applied to larvae of first and second generation after 13-15 days. Control is done only at smeared trees. The insecticides that are used for chemical control are given at Table 3.

PERSPECTIVES

Tenthredinidae species cause important damages on plants. These damages are done particularly by larvae forms. Larvae can damage the tissue of the plants when they feed on them. Their effects are more at parts of the plant like leaf, stem fruit and shoot. Species of the family that is especially harmful as orchard increase in number and it needs control. Although chemical control is possible, the insecticides cause pollution in nature and damage other useful insect species. This spoils ecosystem balance. For this reason, cultural and biologic control should be selected instead of chemical control methods.

The cultural control can be realized with these pests that are especially harmful at orchard such as working up soil, collecting cocoons under soil, collecting fruits with larvae in order to conserve the orchard plants. Development of larvae can be hindered by using the synthetic forms of juvenile hormones that are effective at larva development. This type of control does not damage environment.

Although, there are various methods for cultural control, the parasite and predator species used for biological control, are not known well enough, because there are not enough studies concerned with the biology of the species of this family. Further detailed studies on this subject are needed from the biological and economical point of view.

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