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Evaluation of Biological Activity of Meadow Spittlebug *Philaenus spumarius* (L.) (Cercopide: Homoptera) on *Alhagi pseudalhagi* (M. Bieb.) Desv. Camel Thorn Plant in Mashhad Region, Khorasan Razavi Province, Iran

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Abstract: Meadow spittlebug, *Philaenus spumarius* (L.), has recently been a subject of interest to biologists due to various genetic factors. This species is widely distributed and has been reported to exist in different parts of the world. Dlabola reported the species for the first time from Iran. A number of studies have been done on substantial activities of this spittle bug on *Alhaghi pseudalhagi* (M. Bieb.) Desv. camel thorn plant from Fabaceae family in Mashhad region, Khorasan Razavi during 2005-2006. In weekly investigations, it was noted that the spittlebug begins its activity from early spring as first instars and produces froth after nourishing on camel thorn plant. The bug had 5 instar ages in total and they spend the whole first year of their lives in their self-produced foam. The adult spittle bug appeared in late May without any froth production activity however, they produced a thin liquid-like discharge. This spittlebug had 3 generations on the camel thorn plant among which, unlike the first generation instars, the 2nd and the 3rd instars had fully grown wings, were able to move freely on the plant and were resilient to some extent. The latter generations did not produce any froth and still had a very thin discharge which moisturized the total body of the plant as well as the ground around it. Density of the 2nd and the 3rd generations of spittle bugs were higher than the first generation. Those spittle bugs from the 3rd generation which managed to reach their adulthood, mated and after laying eggs, entered their hibernation period. According to our investigations, duration of one generation of the spittle bug in Mashhad region fluctuates from approximately 60-83 days in spring and 44-56 days in summer. The population of the bug reached its maximum in summer in 2006 and early summer in 2007. We found out that the bug, among all different species of camel thorn plant in natural growth areas, is only activating on few specific species of the plant.

Key words: *Philaenus spumarius* (spittlebug), *Alhagi pseudalhagi* (camel thorn), biological activity

INTRODUCTION

Meadow spittlebug is one of the most common insect all around the world and has reported from either palearctic or neoarctic regions (Drosopoulos and Asche, 1991).

The Meadow spittlebug has expanded from North Lapland to Mediterranean in Europe (Berry, 1983; Nixon Okely, 1975; Halkka and Halkka, 1990; Stewart and Lees, 1996), North of Africa (Dlabola, 1974a), Afghanistan (Dlabola, 1957b), Japan (Haper, 1974) and from different part of America, Louisiana region till Minnesota towards East of America (Weaver and King, 1954; Ohio Pest Management, 2008) and also reported from Iran (Dlabola and Jiri, 1981). First report is about late 16th century (Weaver and King, 1954).

Meadow spittlebug has polyphagous nature which with it's highly adaptation could survive and this is why it can be found in terrestrial habitats (Halkka and Halkka, 1990).

Nymphs and adults are found on various plants in habitats moist enough to provide them with sufficient and moisture to keep them alive, such as fields, roadsides, forests, hay fields, parks and gardens.

Meadow spittlebug has hundreds host plants which have been reported from north of America (Weaver and King, 1954), New Zealand (Archibald and Cox, 1979), Europe (Yurtsever 1999) and Iran (Dlabola and Jiri, 1981).

These plants range are from grasses to different trees, meadow crops, herbs, thistle, garden plants, shrubs, conifers, dicotyledonous plants and monocotyledonous plants.

Nymphs and adults are nourished from all parts of plant, over soil which has growing activity. Plants with more amino acids in their xylem sap are more favorite for nourishment (Carmen *et al*., 2000). The Meadow spittlebug is an important economic pest for alfalfa (*Medicago sativa* L.), clover (*Trifolium* sp.) and strawberry (*fragaria* sp.) (Zajac and Wilson, 1984).

Meadow spittlebug can weaken the plants which causes significant bad formation, off color, stunting and decreases plant green parts growth (Simplot, 2008). Damaged field have a weak product and effect of damage would have been continued.

The Meadow spittlebug from plants like *Tamarix* (Marand region), alfalfa (Tabriz), *Juncus* (North of Iran 2000-3000 m height), *Astragalus* sp. (Alborz region) are from Iran only have reported without any attention to them as a pest (Dlabola and Jiri, 1981).

Due to it's interesting biological aspects, Meadow spittlebug has received great attention from biologists for decades. It has been one of the extensively studied species in ecology and genetics, while there is no considerable information in Iran.

Aim of this study is giving some information to researchers who like to continue study about Meadow spittlebug.

MATERIALS AND METHODS

Biological activity of Meadow spittlebug in natural growth area of different region of Mashhad (Khorasan Razavi Province-Iran) during 2006-2007 have been studied.

Three net cages 1×1×1 m were fixed on healthy growing camelthorn plant on late march. Ten first nymphs were collected from natural area and transferred to each cage late april.

Estimaition of biological activity of meadow spittlebug and life cycle: From early may, every 7-10 days once, observation of nature growth area meadow spittlebug and also bushes inside the cages have been done and as soon as foam observation, which is begining of feeding of spittlebug in early season, randomized sampling from 5 stem in the cage and 20 stem from nature growth area applied. Samples transferred by plastic box to the lab and freezed for 15-20 min.

Growthing of nymph stages were observed by stereo microscope and nymphs were counted.

In early june, when adult insect observed 5 couples (male and female spittlebug) were left in cage and after counting, the rest were omitted.

This analysis repeated in late july because third generation were grown. Identification of male and female was the next and terminal abdominal segments was noticed. It was width to narrow in female and also with ovipositor, while it was width in males.

As second and third generation of spittlebug are very active and free, their sampling is different using aspirator. Five stems under cage and 20 stems in nature growth area are randomizing chosen and counted.

Estimation of population and separation of nymph stages, lead to determination of life cycle of one generation. Separation have been done by measuring head capsule width, body length, growing wing and genitalia.

For determination of laying egg and egg observation, leaves and stem colouring method were used, in order to carry some leaves and stem from the cage after laying eggs in to lab, to boil them in 96% ethanol, in this method chlorophyl went off and getting white and then putting them in phenol crystal, lactic acid, glycerin, distillated water and fushin acid for 3 min, till red colour appeared. Then, material were left in same mixture without using fushin acid. And after 2-3 h getting them off and washing in 50% ethanol. Eggs as a swallowed red spot on leaves and under stem skin can be seen.

All plant with a foam sign from late march weekly visited and their host were identified. Finally, the samples were sent to the National Research Plant Protection of Iran for recognition (Personal Communication, 2007).

RESULTS AND DISCUSSION

Meadowspittlebug, *Philaenus spumarius* (L.) has strong oval elongate body, 8-10 mm length, color brownish (light to dark), the wing are yellowish-cream with pale spots, small antenna, compound eyes are big (Fig. 1). Eggs are elongate, white, 1 mm length, 0.36 mm width and have a dark orange pigmented shell at one end.

This spittle has 3 generations and 5 nymphal stages in Mashhad region, first nymph, 1.25 mm, orangish without growing of wings and genitalia, with less activity, foam production of them is very little.

Second nymph (Fig. 2) is nearly 3 mm, orange color without wings and genitalia growing. Third nymph is 3.5 mm, yellowish to green color, while wing pads are nearly appeared. Forth nymph is nearly 4.75 mm, green color with appeared yellow wing pads and genitalia. Fifth nymph is 8.5 mm with fully growing wings and genitalia.

Philaenus spumarius (L.) overwinter as egg mass inside of leaves tissue and underneath of camel thorn stem skin *Alhagi pseudalhagi* in Mashhad region.

From late April, eggs are hatching and first nymphs appear on young stem and by sucking of xylem sap, feeding is started. As a result of nourishment, spittle mass appears, so that nymphs are able to hide inside of foam and can also easily move (Fig. 3). It means spittle is a protective and moisturizer agent. Foam secretion with nymph growth increases and when stems are getting full, leaking of spittle would have been started.

Nymph locating on stem during nourishment is up side down, head to down, feet to up. Young nymphs are located on lower part of plant above soil.

Fig. 1: *Philaenus spumarius* (L.) adult under ×6.4 magnification

Fig. 2: Second instar of the first generation under ×40 magnification

Fig. 3: Nymph activity of first generation through the froth on camel thorn plant

Fig. 4: Third nymph instar of second generation under ×10 magnification

Study of old nymph instar showed that they move to upper part of plant, 3rd nymph to 20-30 cm height, 5th nymph to nearly 50 cm height on plant. All of the nymphs are spittle producer except adult which doesn't produce spittle. Nymph activity on plant gradually increases and 5th nymph is last presence of spittlebug inside of the foam.

Adults appear in late of May and they stay under the spittle mass until the cuticule getting hard and fully pigmented. Then they leave the spittle mass. Adult doesn't produce foam but they exerted un sweet extraction, which after getting dry look likes a white dry powder.

Adults are very active and strong leaper. Females appear sooner than males and also rate of females are more than males. After 7-10 days of their appearance, females mate and after 2-3 days are laying eggs.

The numbers of eggs laid by female on bush in cage are averaged 15-20 individual on leaves or under stem skin. Incubation period depends to climate condition (tem-moisture) in order it took 15-20 days in spring.

Nymphs of 2nd generation are very active with growing wing, without spittle production (Fig. 4). They move easily on plants and from early July, adult of second generation are appeared.

Activation of 3rd generation on plant is similar to second generation. After spittle nourishment from plant, fluid is produced and after wetting a plant leaks on ground so make it wet (Fig. 5a and b).

Although, due to cool climate, there isn't a possibility for all the third generation to gain maturity or to lay eggs, but insects which had an earlier adulthood, will move to camel thorn plants and for overwintering lay eggs inside the plant tissues.

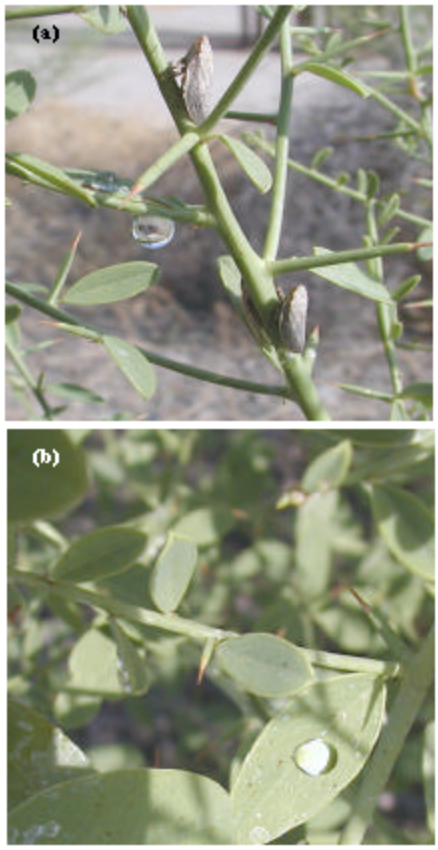

Fig. 5: Second and third generation fluid secretion

Table 1: Average of essential temperature and humidity for emerging generations of *Philaenus spumariusin* 2006-2007, Mashhad region

Generation	Life time of each generation (day)	Humidity (%)	Temperature (c°)	Month
First	60-83	38-42	21-27.5	May-June
Second	40-65	34-36.3	28.1-29.7	June-July
Third	44-56	33-34.2	29.7-31	July-August

The length of incubation period in spring climate was 15-20 and 12-15 days in summer. Nymphal period was 25-35 days in spring and 16-21 days in summer. Adult life cycle in spring was 20-28 days, in summer was16-20 days. Therefore life cycle of one generation in natural condition, tolerated between 60-83 days in spring and 44-56 days in summer (Table 1). Abundance of spittlebug in spring is less than summer time (Fig. 6).

As one of the most important result, I found that, this spittle doesn't have activity on all species of camel thorn plant in natural growth area and prefers only specific species of camel thorn plant.

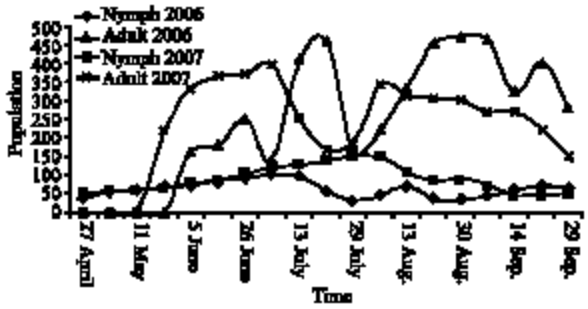

Fig. 6: Population fluctuation of *Philaenus spumarius* (L.) in Mashhad region in 2006-2007

Meadew spittlebug have observed on another host plant such as alfalfa (*Medicago sativa*), clover (*Trifolium* sp.) and *Astragalus* sp. in Mashhad region

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