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Protection of overwintering aphid parasitoid, *Lysiphlebia japonica* [Hym.: Aphidiidae]

GAO Junfeng

(General Station of Agriculture, Tonghua County, Jilin)

YU Kai

(The Broadcasting Agricultural School of Tonghua, Jilin)

Tonghua County is located in the Changbaishan mountain area where there are about 130 days yearly with average temperature below 0°C and the lowest temperature can reach - 35°C. To understand the natural survival of overwintering *Lysiphlebia japonica*, we observed the survival of overwintering parasitoids and carried out overwintering protection experiments.

1. Natural survival of overwintering *Lysiphlebia japonica*

Late larvae of *Lysiphlebia japonica* overwinter in the hosts* located on the roots* 1-3 cm underground in late October. The parasitoids emerge in late April to early May of the next year. We observed the overwintering parasitoids in sandy soil fields, black-soil fields, sun-facing and non-sun-facing fields from late October in 1987-1988. About 1000 mummies were observed at each site and protective procedures were applied to protect the mummies. Mummies were covered by a screen from April 20 of the next year, and emerged wasps were recorded every 3 days. Unemerged mummies were brought back to the lab for dissection after May 20. Living parasitoid pupae were viewed as emerged parasitoids (see Table 1).

Table 1 Survival of *Lysiphlebia japonica* at different overwintering sites

Overwintering Sites	Year	Mummies	Wasps emerged	Survival rate (%)	Earliest date of emergence (month. day)
Black-soil fields	1987	1000	213	21.3	5.13
	1988	1000	187	18.7	5.7
Sandy soil fields	1987	983	741	75.4	4.24
	1988	1000	635	63.5	4.21
Sun-facing fields	1987	994	614	61.8	4.21
	1988	981	637	64.9	4.27
Non-sun-facing fields	1987	1000	341	34.1	5.19
	1988	967	159	16.4	5.16

* Note from the translator: no species names of host insect or plant were given in the original paper.

Parasitoids from black-soil and non-sun-facing fields had lower emergence rates and later emergence dates than those from sun-facing and sand-soil fields. Better aperture, lower water content and higher temperatures in sandy soil and sun-facing fields possibly make a contribution to the overwintering and emergence of parasitoids.

2. Experiments on protection of overwintering *Lysiphlebia japonica*

We designed the overwintering protection experiments in 1989-1990 on the basis of 1987-1988 results and an analysis of favorite overwintering sites of parasitoids. Sandy soil was used to plant motherwort *Leonurus heterophyllus* in pots. Motherwort aphids (Translator: no species name given in the original paper) and parasitoids were inoculated in early August and mid September. Overwintering protection experiments were carried out when the temperature was below -5°C. Four treatments were used: basement, indoor, ditch and outdoor (control).

The windows and doors of basement (minus 3°C) and vacant room (minus 10°C) were sealed by plastic materials. The potted motherwort plants with aphids were put in the basement and vacant room. The windows were not sealed if water content of soil in the pots was over 20%, and water would evaporate. When water content of soil was 15-20%, the windows were sealed.

Treated pots were put in a ditch (50 cm wide, 30 cm deep) outdoors. The ditch was covered with wood and plastic, then by soil and maize stems or straws on the top.

A control experiment was performed outdoors. The pots were put at 20°C, 75% R.H. in mid April of the next year.

Table 2 Protection of overwintering *Lysiphlebia japonica*

Overwintering sites	Year	Wasps emerged	Survival rate (%)	Sex ratios (♂: ♀)
Basement	1989	2937	97.9	1:1.25
	1990	2962	98.7	1:1.1
Indoors	1989	2814	93.8	1:1.5
	1990	2807	93.6	1:1.25
Ditch	1989	2437	81.2	1:1.5
	1990	2396	79.9	1:1.5
Control	1989	1042	34.7	0.3:1
	1990	1164	38.8	0.25:1

Note: 3000 mummies were surveyed in each treatment.

Indoor and basement preservations were better for the protection of overwintering parasitoids (Table 2). Under these circumstances, overwintering survival rates were over 90%, the parasitoids were stronger after emergence with 200-400 eggs per female and appropriate sex ratios. However, the overwintering survival rates were around 80% and only 34.7-38.8% if preserved in the ditch and under control. The sex ratios (proportion females) decreased significantly, and females laid 100-200 eggs only and the life span of adult parasitoids were 2-3 d shorter than those stored in the basement and indoors.