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Preliminary study of predation of the multi-colored lady beetle, *Leis axyridis (Pallas),* on two species of aphids

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Abstract Adults of multi-colored lady beetle, *Leis axyridis* were starved for 24-hour, and allowed to prey on soybean aphid, *Aphis glycines* Matsumura, and corn leaf aphid, *Rhopalosiphum maidis*(Fitch) which were at various densities. By comparing and analyzing its predatory potential, we consider that both *L. axyridis'* preying on *A. glycines* and *on R. maidis* were fitted with type II response, which can be simulated by Holling disc equation, and expressed as: $Na_{com} = 0.6792N/(1+0.0022N)$ and $Na_{soybean} = 0.9463N/(1+0.0023N)$, respectively. In addition, by comparing its functional parameters, we found that *L. axyridis'* ability to control *A. glycines* is significantly stronger than that of *R. maidis*.

Keyword *Leis axyridis*, soybean aphid, *Aphis glycines,* corn aphid, *R. maidis*, Predation.

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The multi-colored lady beetle, *Leis axyridis*, is one of the important natural enemies of aphids. There is a negative inter-species relation as well as a complicated statistical relationship of predator-prey interaction between the multi-colored lady beetle and the aphids. It is a basic practice in biological control to use functional response to express inter-species relation and mathematically construct a set of models to mimic the dynamic variation of pest populations of insects and their natural enemies. Though there were a number of reports about functional response of lady beetle's predation on pest insects, we could not find direct reports on soybean aphid and *R. maidis* till now. In order to have a better understanding on *L. axyridis'* effect on *A. glycines* and *R. maidis,* we studied its predatory potential under room conditions in July 1997.

1 Materials and Methods

1.1 Test insects: Large number of *A. glycines*, *R. maidis* and *adult L. axyridis* were gathered from soybean field and corn field. They were used as test insects.

1.2 Testing methods: The gathered *A. glycines* were sorted into 8 groups according to age and body shape, each group had 5, 20, 30, 40, 50, 60, 100, and 200 *A. glycines*,

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respectively. We put these 8 groups of *A. glycines* into culture dishes (Diameter=90mm) with tender soybean leaves separately. In the same way, the gathered *R. maidis* were sorted into 11 according to age and body shape, each group had 5, 10, 15, 20, 30, 40, 50, 60, 80, 100, and *120 R. maidis*, respectively. We put these 11 groups of *R. maidis* into separate culture dishes (Diameter=90mm) with tender corn leaves. There were three replications. In each culture dish, after the aphids got settled, we put a randomly selected adult *L. axyridis* starved for 24 hours. We recorded the number of aphids left after 24 hours in each culture dish. Then, we calculated the number of aphids preyed, and used Holling disc equation to fit and analyze the results.

2 Results and analysis

The test results are given in table 1.

Table 1 Results of *L. axyridis* preying on *A. glycines* and *R. maidis* under different densities

Density	5	10	15	20	30	40	50	60	80	100	120	200
No. of *R. maidis* Preyed	3.3	6.7	10.0	14.0	19.7	23.7	28.7	35.3	43.7	52.7	61.7	_
No. of *A. glycines* Preyed	4.7	_	_	19.0	29.3	33.7	41.0	49.7	_	73.7	_	121.7

Table 1 shows that, under the similar conditions, the quantity of *A. glycines* preyed by *L. axyridis* was distinctly larger than that of *R. maidis*. It also showed that the denser the aphid population, the more would be the predation. *L. axyridis* showed a faster progressive preying on low aphid populations. There was a slower predation on high aphid density beyond a threshold level. That means, *L. axyridis'* preying behavior had negative correlation with aphid densities, which conforms "Vertebrate curve" or namely "type II response" and can be fitted by Holling disc equation.

Holling equation is given as follows:

$$Na = \frac{a'NT}{1 + T_h a'N}$$

where, N is the aphid population density, Na is numbers of preyed aphids, T is testing time (here, the time taken by *L. axyridis* to find aphids), T_h is average time *that L. axyridis* took to devour the aphids, a' is instantaneous attack rate. When $N \to \infty$, Na gets its maximum.

We processed the above Holling equation with reciprocal transition. We took $1/a'N$, T_h/T as linear regression coefficients. We calculated a', T_h with least square method and also calculated functional response parameters such as maximal preying coefficients. All of these coefficients are shown in table 2.

Table 2 Functional response coefficients of *L. axyridis* preying on *A. glycines* and *R. maidis*

Aphid species	Instantaneous attack rate a'	Devouring time T_h (Min)	Maximal preying coefficient
R. maidis	0.0283	4.608	312.5
A. glycines	0.0394	3.456	416.7

Table 2 shows that *L. axyridis* had a distinctly stronger attacking ability on *A. glycines* than on *R. maidis*. On *A. glycines, L. axyridis* also had distinct advantages in preying speed and preying potential compared to on *R. maidis*. Thus *L. axyridis* was found to have control potential on A. glycines.

Putting the above coefficients into Holling equation we got functional response curves under different densities. X^2 fitting test was also done for these curves. Results are shown in table 3.

Table 3 Functional response models of *Leis axyridis* preying on *Aphis glycines* and Rhopalosiphum maidis

Aphid species	Functional response model	X^2 fitting test
R. maidis	$\mathrm{Na} = 0.6792\mathrm{N}/(1+0.0022\mathrm{N})$	$\sum X^2 = 0.684 << F0.05 = 19.68$
A. glycines	$\mathrm{Na} = 0.9463\mathrm{N}/(1+0.0023\mathrm{N})$	$\sum X^2 = 1.020 << F0.05 = 15.51$