Appl. Ent. Zool. **11** (1): 33—37 (1976)

Differences in Oviposition of the Smaller Brown Planthopper, *Laodelphax striatellus*, in Response to Various Amino Acid Solutions (Hemiptera : Delphacidae)

Kenji KOYAMA and Jun MITSUHASHI

Division of Entomology, National Institute of Agricultural Sciences, Nishigahara, Kita-ku, Tokyo 114, *Japan*

(Received September 16, 1975)

The smaller brown planthopper, *Laodelphax striatellus*, exhibited egg deposition into a 5% sucrose solution through a Parafilm membrane, however, when a mixture of amino acids was added to the 5% sucrose solution, no eggs were laid. Among 23 individually tested amino acids, arginine, glutamic acid, tyrosine, and valine showed an inhibitory effect upon oviposition, whereas the influence of cystine was stimulative.

INTRODUCTION

A technique has already been reported by which the smaller brown planthopper, *Laodelphax striatellus*, lays its eggs into an artificial medium through a Parafilm membrane (MITSUHASHI, 1970). Solutions of 5–10% sucrose were found to be the preferred artificial medium for oviposition (MITSUHASHI and KOYAMA, 1975), whereas MED-1 synthetic diet, on which *L. striatellus* demonstrated good growth was found unsuitable (MITSUHASHI and KOYAMA, 1972). This was demonstrated quite easily by placing a female planthopper into a glass cylinder, of which one opening was covered with a sachet containing 5% sucrose solution, and another with a sachet containing MED-1 diet. The planthoppers always chose that side having the 5% sucrose solution as a site for oviposition, and no eggs were laid on that side with the MED-1 diet. Since the MED-1 diet was apparently sucked by the planthoppers, it was assumed, that some component of this diet had an inhibitory action on oviposition. The MED-1 diet consisted of inorganic salts, sugar, amino acids, vitamins, and trace metals. Preliminary experiments showed that inorganic salts, sugar, vitamins and trace metals had no effect on oviposition. In the present study, egg deposition as affected by various amino acid solutions was examined.

MATERIALS AND METHODS

L. striatellus was reared on rice seedlings at 25°C under a photoperiod of 16 hours illumination per day. Only female adults 7–14 days old were used, because egg laying by females of this stage was maximal and relatively constant. For each experimental plot, 50 females were used individually. The vessel used for oviposition was a glass cylinder 30 mm in diameter and 45 mm in height. The test solutions were "sandwiched" between two layers of stretched Parafilm, which were then used to seal both ends of the

Table 1. OVIPOSITION OF *L. striatellus* INTO AMINO ACID MIXTURES THROUGH A PARAFILM MEMBRANE[a]

Solutions	Total no. of eggs laid	Average no. of eggs[c]	No. of oviposited females	No. of Eggs per oviposited female[c]
5% sucrose (control)	264	5.3±1.1	27	9.8±1.5
Original mixture[b]	0	0	0	0
One-half dilution	22	0.4±0.2	5	4.4±1.4
One-fourth dilution	58	1.2±0.4	13	4.5±1.4
One-eighth dilution	86	1.7±0.6	10	8.6±1.8

[a] Fifty females were tested individually.
[b] Original mixture consisted of 5% sucrose and 23 amino acids whose concentrations were equivalent to those in MED-1.
[c] Values are means±S. E.

Table 2. OVIPOSITION OF *L. striatellus* INTO SINGLE AMINO ACID SOLUTIONS THROUGH A PARAFILM MEMBRANE[a]

Amino acids	Conc. of amino acid in 5% sucrose solution (mg/100 ml)	Total no of eggs laid	Average no. of eggs[b]	No. of oviposited females	No. of eggs per oviposited female[b]
L-α-Alanine	100	253	5.1±1.0	27	9.4±1.5
γ-Aminobutyric acid	20	238	4.8±0.8	27	8.8±1.0
L-Arginine-HCl	400	128	2.6±0.7*	19	6.7±1.3
L-Asparagine	300	222	4.4±0.9	26	8.5±1.2
L-Aspartic acid	100	196	3.9±0.9	25	7.8±1.3
L-Cysteine	50	218	4.4±1.0	25	8.7±1.5
L-Cystine-HCl	5	462	9.2±1.3*	35	13.2±1.4
L-Glutamic acid	200	124	2.7±0.7*	16	8.4±1.4
L-Glutamine	600	196	3.9±0.8	26	7.5±1.2
Glycine	20	291	5.8±1.2	28	10.4±1.6
L-Histidine	200	233	4.7±1.1	21	11.1±2.0
DL-Homoserine	800	207	4.1±1.1	21	9.9±2.0
L-Isoleucine	200	255	5.1±1.1	26	9.8±1.5
L-Leucine	200	159	3.2±0.8	24	6.6±1.4
L-Lysine-HCl	200	148	3.0±1.0	23	6.4±1.4
L-Methionine	100	214	4.3±1.1	20	10.7±2.0
L-Phenylalanine	100	172	3.4±0.9	20	8.6±1.8
L-Proline	100	198	4.0±0.8	24	8.3±1.2
DL-Serine	100	271	5.6±0.9	27	10.3±1.0
L-Threonine	200	213	4.2±0.9	27	8.1±1.3
L-Tryptophan	100	149	3.0±0.7	20	7.5±1.1
L-Tyrosine	20	34	0.7±0.3*	8	4.7±1.7
L-Valine	200	85	1.7±0.6*	13	6.5±1.5
Control (5% sucrose)		264	5.3±1.1	27	9.8±1.5

[a] Fifty females were tested individually.
[b] Values are means±S. E.
[c] * indicates significant difference from the control at 5% level (*t*-test).

glass cylinder containing a single female. The number of eggs laid during a 24 hours period was recorded. A 5% sucrose solution was used as the control solution, and all tested amino acids were dissolved in 5% sucrose solution.

RESULTS

Oviposition response associated with an amino acid mixture

A mixture of 23 amino acids which were contained in the MED-1 diet was prepared so as to make the concentration of each amino acid equivalent to that of the MED-1 diet; this amino acid mixture also contained 5% sucrose. Twofold dilutions were made leaving the concentration of sucrose unchanged. The oviposition response of *L. striatellus* into these solutions are summarized in Table 1.

The oviposition into the amino acid mixture was extremely low compared with that into the 5% sucrose solution. There was a tendency for increased oviposition at lower concentrations of the amino acid mixture. These results suggested that some amino acids have an inhibitory effect on oviposition of *L. striatellus*.

Oviposition into solutions of single amino acids

In order to find out the amino acids inhibitory to the oviposition of *L. striatellus*, amino acid solutions, which consisted of single amino acid and 5% sucrose, were prepared so as to make the concentration of each amino acid equivalent to that of the MED-1 diet. Oviposition response into 23 such solutions are summarized in Table 2.

Most of the amino acids were found to have no affect upon oviposition of *L. striatellus* at the concentration which was used for the MED-1 diet. Only five amino acids showed significant differences in the average number of eggs in comparison to the control. Among these arginine, glutamic acid, tyrosine, and valine acted as oviposition inhibitors. Cystine was the only amino acid which stimulated oviposition.

Oviposition into amino acid solutions at various concentrations

Two-fold dilutions and two-fold concentrations were made based upon the concentrations used in the preceeding experiment, for the five amino acids which showed significant difference from the control; the concentration of sucrose was maintained at 5%. Measurements of oviposition into these solutions are shown in Table 3.

For arginine, glutamic acid, and tyrosine, a tendency was observed for a decrease in the average number of oviposited eggs with increasing amino acid contentration. Valine did not show dose-dependent change. Cystine gave better results for oviposition at concentrations of 5 and 10 mg per 100 ml than the 5% sucrose solution. The best record for oviposition was obtained at a concentration of 5 mg per 100 ml, and a decrease or an increase in the concentration resulted in reduction of egg deposition.

DISCUSSION

Arginine, glutamic acid, tyrosine, and valine were found to inhibit oviposition of *L. striatellus*. The fact that no eggs were laid into the amino acid mixture could be attributed to an effect of these 4 amino acids. The amino acid mixture used in this study also contained cystine, which was found to be stimulative for oviposition of *L.*

TABLE 3. THE OVIPOSITION OF *L. striatellus* INTO SEVERAL AMINO ACID SOLUTIONS OF VARIOUS CONCENTRATIONS THROUGH A PARAFILM MEMBRANE[a]

Amino acids	Conc. of amino acid in 5% sucrose solution (mg/100 ml)[b]	Total no. of eggs laid	Average no. of eggs[c]	No. of oviposited females	No. of eggs per oviposited females[c]
Arginine	100	203	4.1±1.0	22	9.2±1.8
	200	133	2.7±0.8	19	7.0±1.7
	400*	128	2.6±0.7	19	6.7±1.3
	800	67	1.3±0.6	11	6.1±2.0
	1600	79	1.6±0.7	9	8.8±3.0
Cystine	1.25	193	3.9±1.0	26	7.4±1.7
	2.5	232	4.6±1.1	30	7.7±1.6
	5*	462	9.2±1.3	35	13.2±1.4
	10	405	8.1±1.3	35	11.6±1.4
	20	171	3.4±0.6	27	6.3±0.8
Glutamic acid	50	96	1.9±0.5	19	5.1±0.9
	100	191	3.8±1.0	18	10.6±2.1
	200*	124	2.7±0.7	16	8.4±1.4
	400	29	0.6±0.3	6	4.8±1.9
Tyrosine	5	182	3.6±0.7	25	7.3±1.0
	10	116	2.3±0.8	19	6.1±1.7
	20*	34	0.7±0.3	8	4.7±1.7
	40	81	1.6±0.5	16	5.1±1.0
Valine	50	171	3.4±0.9	17	10.1±1.7
	100	78	1.6±0.5	18	4.3±1.1
	200*	85	1.7±0.6	13	6.5±1.5
	400	201	4.0±1.0	21	9.6±1.9
	800	122	2.4±1.0	12	10.2±3.1

[a] Fifty females were tested individually.
[b] The concentration with an asterisk is equivalent to that in the MED-1 diet.
[c] Values are means±S. E.

striatellus, but such an effect might have been masked by the effects of the 4 inhibitory amino acids.

The concentrations of amino acids used in the present experiments were based upon compositions in the MED-1 diet. Since some amino acids were in relatively small quantities in the MED-1 diet, these amino acids might inhibit the oviposition, if they were used in much larger doses.

The mechanism by which amino acids affect oviposition of *L. stiatellus* is not yet understood. However, it is likely that the sense organ around the pharynx discriminates the fluid as being suitable or unsuitable for an oviposition site. Since the MED-1 diet, which contains four amino acids inhibitory to oviposition was imbibed, the discrimination of a fluid for oviposition should be different from that for diet. An alternative is the presence of a sense organ at the tip of the ovipositor, which can discriminate suitability of sites for oviposition. However, such an organ has never been reported in either *L. striatellus* or other leafhoppers.

From the view point of applied entomology, it may be possible to use these four inhibitory amino acids to reduce field population of *L. striatellus*. If it is possible to make rice plants rich in these amino acids, *L. striatellus* will not oviposit or will reduce the number of eggs laid on such rice plants. On the other hand, a substance such as cystine which is capable of stimulating egg deposition can be useful in the collection of *L. striatellus* eggs on an artificial medium. The eggs so collected will provide good materials for any type of experiments. Studies on these applications are presently under way.

REFERENCES

MITSUHASHI, J. (1970) A device for collecting planthopper and leafhopper eggs (Hemiptera, Delphacidae and Deltocephalidae). *Appl. Ent. Zool.* **5**, 47–49.

MITSUHASHI, J. and K. KOYAMA (1972) Artificial rearing of the smaller brown planthopper, *Laodelphax striatellus* FALLÉN, with special reference to rearing conditions for the first instar nymphs. *Jap. J. appl. Ent. Zool.* **16**, 8–17 (in Japanese with English summary).

MITSUHASHI, J. and K. KOYAMA (1975) Oviposition of smaller brown planthopper, *Laodelphax striatellus* into various carbohydrate solutions through a Parafilm membrane (Hemiptera: Delphacidae). *Appl. Ent. Zool.* **10**, 123–129.