Effect of Temperature on Oviposition Behaviour of *Female Liriomyza trifolii* and *L. huidobrensis (Diptera: Agromyzidae)* Leaf Miners

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Effect of Temperature on Oviposition Behaviour of Female *Liriomyza trifolii* and *L. huidobrensis (Diptera: Agromyzidae)* Leaf Miners.

Influence de la température sur le comportement de ponte des femelles de *Liriomyza trifolii* et *L. huidobrensis (Diptera : Agromyzidae)*, mouches mineuses des feuilles.

Influencia de la temperatura sobre el comportamiento de ovipusturas de *Lyriomiza trifolii* y *L. huidobrensis (Diptera : Agromyzidae)*, mosca minadora de las hojas.

ABSTRACT

The two leaf miners, *Liriomyza trifolii* (Burgess) and *L. huidobrensis* (Blanchard), originating from the American continent, were introduced into Europe by infested crops. We studied the influence of temperature on the oviposition behaviour of females of both species. Three temperatures (18°C, 23°C and 30°C) were tested. Significant differences in the oviposition behaviour of females in both species were observed, i.e. *L. huidobrensis* preferred lower temperatures than *L. trifolii.*

RÉSUMÉ

Les deux mouches mineuses des feuilles, *Lyriomiza trifolii* (Burgess) et *L. huidobrensis* (Blanchard), originaires d'Amérique, ont été introduites en Europe par des cultures infestées. L'influence de la température sur le comportement de ponte des femelles des deux espèces a été étudiée au laboratoire. Trois températures (18 °C, 23 °C et 30 °C) ont été testées. Des différences significatives entre le comportement des deux espèces ont été observées : pour *L. huidobrensis* les basses températures augmentent l'activité des femelles, tandis que pour *L. trifolii* c'est l'inverse.

RESUMEN

Las dos moscas minadoras de las hojas, *Lyriomiza trifolii* (Burgess) y *Lyriomiza huidobrensis* (Blanchard), originarias de América, fueron introducidas a Europa por medio de cultivos infectados. La influencia de la temperatura sobre el comportamiento de ovipusturas en las dos especies fue estudiada en condiciones de laboratorio. Tres valores de temperatura fueron evaluados (18, 23 y 30 °C). Se observaron diferencias significativas en cuanto al comportamiento de las especies : para el caso de *L. huidobrensis* la baja temperatura aumentó la actividad de las hembras. En *L. trifolii* sucedió lo contrario.

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KEYWORDS

Zoology, *Lyriomyza trifolii, Lyriomyza huidobrensis,* oviposition, feeding habits, laboratory experiments, temperature.

MOTS CLÉS

Zoologie, *Lyriomyza trifolii, Lyriomyza huidobrensis,* ponte, comportement alimentaire, expérimentation en laboratoire, température.

PALABRAS CLAVE

Zoologia, *Lyriomyza trifolii, Lyriomyza huidobrensis,* oviposición, hábitos alimentarios, experimentos en laboratorio, temperatura.

introduction

In developing countries, vegetables have been an essential component of domestic diets for more than a decade (DUMONT, 1988). In fact, it was shown that vegetable production in Africa increased 1.5-fold every year from 1979 to 1988 (ANON. 1988).

In most regions of the world, several different vegetables are attacked by leaf miners (DUMONT, 1988). The two leaf miner species considered in this study were originally from the American continent and then introduced in Europe.

Liriomyza trifolii (Burgess) causes considerable production and profit losses. In the Netherlands, these losses were found to be 20% in tomato greenhouse crops (MINKENBERG, 1990).

In Peru, *L. huidobrensis* (Blanchard) has become the most important pest over the last 20 years. Economic losses in potato crops caused by this pest increased by 35% in 1984 (CHAVEZ and RAMAN, 1987).

These two very polyphagous and widespread species have different geographical distributions. *L. trifolii* can survive in zones with stressing winter seasons (SPENCER, 1973), but mainly damages warm greenhouse crops. In contrast, *L. huidobrensis* causes considerable damage in cold temperate zones (during winter, on fields) or at high elevations in tropical countries.

The above facts prompted this investigation on the influence of temperature on the egg-laying behaviour of female leaf miners. The study was carried out at CIRAD-CA (Montpellier) in the laboratory of the Applied Entomology Unit.

materials and methods

The two insect species were reared in accordance with laboratory techniques used for many years (DALLE and BORDAT, 1993). The mass insect-rearing in this study was done in air-conditioned rooms under the following conditions: temperature: 25 ± 1°C; relative humidity: 75 ± 5%; photoperiod: 12L: 12D.

The *L. trifolii* strain was from Réunion and that of *L. huidobrensis* was from Réunion and the Perpignan area (France).

Yearly, new samples of these insects collected in the field were incorporated in the mass-rearing programme to avoid risk of genetic deterioration and ensure that the insect specimens used in the study were representative of the field population.

The plant used for oviposition was phaseolus bean (*Phaseolus vulgaris*), cv. Aiguillon.

This study was conducted at three different temperatures: 18°C, 23°C and 30°C with a variation of ± 1°C. The relative humidity ranged from 60% to 75% at each temperature. Inside the three rooms, the photoperiod was 12L: 12D, with 2300 ± 100 lux luminosity.

Each lot of 10 females from both species was divided into separate groups and placed in cylindrical transparent plastic boxes (110 mm diameter and 80 mm high). These boxes were sealed with lids having two holes, one with a very thin screen to allow air access and the other with a rubber bushing for inserting adults. Each box of female insects was placed into each of the three rooms for acclimatization at the temperature used in these experiments. A single drop of honey was placed at the bottom of each box to feed the females.

One day later, the 10 females were transferred to a plastic cube-shaped box, 450 mm wide, covered with fine muslin and fitted on one side with a screw-cover 180 mm diameter. This opening was used for inserting the adults and plants. A pot of four bean plants, with leaves at the post cotyledonary stage, had been previously placed inside each box.

After 24 h, the plants that had been exposed to the females were taken out of each box and let in a room at 25°C to permit normal larval development. At this time, the leaves were counted. Four or five days after oviposition, larvae readily visible on the leaves were counted. Sixteen replicates were done for each leaf miner species at each of the three tested temperatures.

results

Since the distribution of the two variables was far from normal, a statistical analysis was carried out using the non-parametric Friedman test, followed by Nemenyi and Wilcoxon tests for multiple paired comparisons.

The analysis included the number of larvae, the number of feeding points, and the relation between the number of feeding points and larvae. It is noteworthy that the results of the chi-squared analysis in the Friedman's test were highly significant (at the 1% level).

influence of temperature on the behaviour of *L. huidobrensis*

Temperature influenced the feeding behaviour of *L. huidobrensis* females (Figure 1). Indeed, at 18°C, 10 females made a mean 364 feeding points over 24 h, 1499 at 23°C, and 2122 at 30°C (Table 1).

Temperature also influenced the larval production (Figure 2), which was greatest (with 35 larvae / 10 females over 24 h) at 23°C, and 12 at 18°C, and 24 at 30°C (Table 1).

The relation between the number of feeding points and larvae was also affected by temperature (Figure 3). In this case, the statistical analysis concerned the relation between the number of larvae and the number of feeding points.

This, as opposed to the inverse situation, is easier to analyse because of some zero counts in the number of larvae.

There were no significant differences in the larvae / feeding point relation between 18°C and 23°C, 0.0518 and 0.0251 respectively, with even lower values at 30°C (0.0104) (Table 1).

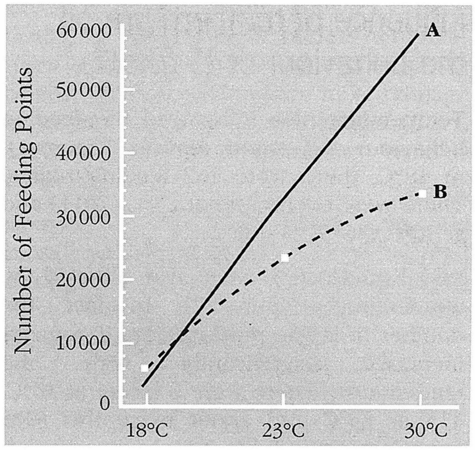

Figure 1
Influence of temperature on the number of feeding points produced by 160 L. trifolii *(A) and 160* L. huidobrensis *(B) females.*

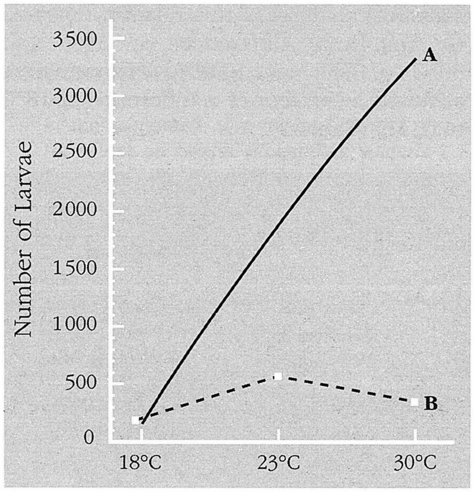

Figure 2
Influence of temperature on the number of larvae produced by 160 L. trifolii *(A) and 160* L. huidobrensis *(B) females.*

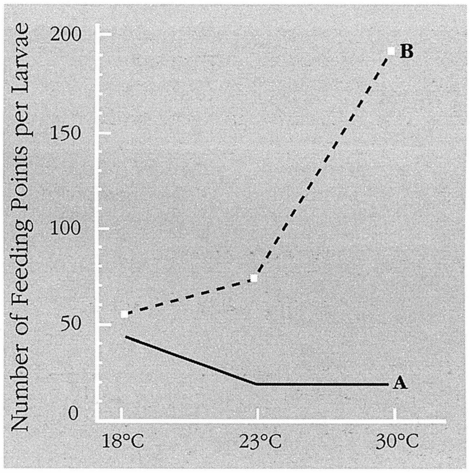

Figure 3
Influence of temperature on the number of feeding points per larvae made by 160 L. trifolii *(A) and 160* L. huidobrensis *(B) females.*

influence of temperature on the behaviour of *L. trifolii*

Temperature also influenced the feeding behaviour of *L. trifolii* females (Figure 1). At 18°C, there were 182 feeding points. There were even more at 23°C (2011) and at 30°C (3679) (Table 2).

Larval production was also affected by temperature (Figure 2). In fact, the number of larvae produced by 10 females increased significantly with the temperature. There were 6 larvae at 18°C, 113 at 23°C and about twice this (202 larvae) at 30°C (Table 2).

The relation between the number of feeding points and larvae was also influenced by temperature (Figure 3). The statistical analysis of this relation revealed no significant differences at 23°C and 30°C (0.0557 and 0.0546 respectively), and with even less of a difference at 18°C (0.0311) (Table 2).

Table 1
Effect of temperature on the oviposition behaviour of *L. huidobrensis* females.

	Number of feeding points for 10 females	Number of larvae for 10 females	Number of larvae per number of feeding points
18°C	363.7 (16) b	11.5 (23) b	0.0518 (37) a
23°C	1499.4 (34) a	35.4 (42) a	0.0241 (37) a
30°C	2122.2 (46) a	23.5 (31) ab	0.0104 (22) b
Chi2 (Friedman)	28,000 ***	11,375 ***	9,375 ***

*** : Signicant at the 1% level.
(...) : Sum of ranks with 16 replications.
a, b, : Significantly different at the 5% level by Nemenyi's test.

Table 2
Effect of temperature on the oviposition behaviour of *L. trifolii* females.

	Number of feeding points for 10 females	Number of larvae for 10 females	Number of larvae per number of feeding points
18°C	182.3 (16) c	5.8 (16) c	0.0311 (22) b
23°C	2011.1 (32) b	113.7 (32) b	0.0577 (38) a
30°C	3679.2 (48) a	202.3 (48) a	0.0546 (36) a
Chi2 (Friedman)	32,000 ***	32,000 ***	9,500 ***

*** : Signicant at the 1% level.
(...) : Sum of ranks with 16 replications.
a, b, c : Significantly different at the 5% level by Nemenyi's test.

discussion

effects of temperature on *L. huidobrensis*

The number of feeding points made by females on leaves increased with temperature. This is a normal phenomenon, warmer temperatures cause increased adult activity. More active feeding also enhances the reproduction potential. In fact, with *Liriomyza*, the number of feeding points is often correlated with the number of eggs laid. In this case, although female reproductivity increased normally from 18°C to 23°C, it diminished rapidly when the temperature rose above 23°C. This could be explained by a high-temperature discomfort effect on the species, and the increase in feeding could be due severe to dehydratation.

It thus seems that the optimal behaviour of *L. huidobrensis* occurs at moderate temperatures of around 20°C.

These results confirm the known tropical origin of the species, and the fact that it causes damage in high elevation areas which are cooler (Crozals, 1991).

effects of temperature on *L. trifolii*

The oviposition behaviour of *L. trifolii* seems to be markedly reduced at low temperatures, when very few eggs are laid. This confirms the results of other authors who found a total absence of ovipositioning at temperatures of less than 12°C (Parrella, 1984). However, at increased temperatures, the feeding habits and oviposition activity of females also increased, with optimal behaviour at about 30°C. These results confirm previous data showing that the optimal behaviour of *L. trifolii* is at 24°C to 30°C (Minkenberg, 1988; Heyer and Richter, 1990), that maximum productivity and fecundity occurs at about 30°C (Leibee, 1984; Miller and Isger, 1985), and that the maximum female feeding habit is at about 32°C (Parrella, 1984). These data are in keeping with the species tropical origin.

conclusion

The results of this study show the influence of temperature on the behaviour of the two species of Agromizidae, the leaf miners *Liriomyza trifolii* (Burgess) and *Liriomyza huidobrensis* (Blanchard).

These two species, both originating from the American continent, can breed on the same host plants (potatoes, beans, lettuce, etc.) and cause serious economic damage in areas with different climates. Specifically, *L. huidobrensis* prefers temperatures of around 20°C, and *L. trifolii* has its optimal growth and causes most damage in tropical areas, such as Senegal (Coly, 1992), where the temperature remains close to 30°C.

Conversely, *L. huidobrensis*, recently introduced in Réunion, is widespread throughout the island but causes much more damage at high elevations where the temperature is cooler.

references

ANONYMOUS, 1988.
Production. Rome (Italie) : FAO Statistics Series n° 84, 42, 350 p.

CHAVEZ G. L., RAMAN K. V., 1987.
Evaluation of trapping and trap types to reduce damage to potatoes by the leaf miner *Liriomyza huidobrensis (Diptera: Agromyzidae). Insect. Sci. Applic.,* 8, 369-372.

COLY E. V., 1992.
Biologie et écologie de la mineuse nord-américaine des feuilles, Liriomyza trifolii *(Burgess)* (Diptera : Agromyzidae) *ravageur des cultures maraîchères au Sénégal. Etude des possibilités de lutte.* Marseille (France) : Université de Droit, d'Economie et des Sciences d'Aix-Marseille, thèse de Doctorat en Sciences, 144 p.

CROZALS (DE) A., 1991.
Etude biologique de Liriomyza huidobrensis *(Blanchard)* Diptera Agromyzidae, *et de quelques parasites de l'île de la Réunion.* Le Havre (France) : ISTOM / CIRAD-CA, mémoire de fin d'études, 32 p.

DALLE M., BORDAT D., 1993.
Techniques d'élevage de masse permanent de *Liriomyza trifolii* (Burgess) et de *L. huidobrensis* (Blanchard) *(Diptera: Agromyzidae),* mouches mineuses des feuilles. In: *Proceedings, "Liriomyza" Conference,* Montpellier, 24-26 march 1993, 196 p. Montpellier, (France) : CIRAD-CA, 17-21.

DUMONT R., 1988.
Un monde intolérable, le libéralisme en question: "L'Histoire immédiate". Paris (France) : Le Seuil, 281 p.

HEYER W., RICHTER S., 1990.
Investigations into the related development of the serpentine leaf miner *Liriomyza trifolii* (Burgess) on beans (*Phaseolus vulgaris* L.). *Beitr. Ent.* 40, 259-263.

LEIBEE G. L., 1984.
Influence of temperature on development and fecundity of *Liriomyza trifolii* (Burgess), *Diptera: Agromyzidae,* on celery. *Environ. Entomol.,* 13, 497-501.

MILLER G. W., ISGER M. B., 1985.
Effects of temperature on development of *Liriomyza trifolii* (Burgess) *Diptera: Agromyzidae. Bull. Ent. Res.,* 75, 321-328.

MINKENBERG O.P. J.M., 1988.
Life history of the Agromyzid fly *Liriomyza trifolii* on tomato at different temperatures. *Entomol. Exp. Appl.,* 48, 73-78.

PARRELLA M.P., 1984.
Effect of temperature on oviposition, feeding and longevity of *Liriomyza trifolii (Diptera Agromyzidae). Can. Entomol.,* 116, 85-92.

SPENCER K. A., 1973.
Agromyzidae (Diptera) of economic importance. In: *Series Entomologica 9.* The Hague (Netherlands) : Junk, 153-229.