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Investigations into the temperature related development of the Serpentine leaf miner *Liriomyza trifolii* (BURGESS) on beans (*Phaseolus vulgaris* L.)

With 1 figure

The leafminer *Liriomyza trifolii* is known as a permanent pest of young bean plants in the Republic of Cuba. The damage caused by the pest especially on the primary leaves is very apparent, but the attack by this species alone induces only minor yield losses, while the bean plants are greatly capable to tolerate higher damage during their earlier developmental stages. In connection with other pests, however total plant losses are possible which must be prevented in interest of higher yields. In order to elaborate the fundamentals for monitoring and prognosis systems for insect pests in beans investigations were necessary also into the influence of temperature on the development of *L. trifolii*.

Besides it should be noted that the Serpentine leafminer today is spread all over the world and has become a serious pest of *chrysanthemum* and tomato production in European greenhouses (FRIJTERS et al., 1986). From this point of view the presentation of the results is likewise important.

Material and methods

All experiments were carried out in laboratories of the Institute „ALEJANDRO DE HUMBOLDT" (INIFAT) in Cuba and the Institute of Tropical Agriculture of the KARL-MARX-University of Leipzig (ItL) in the years 1980–1984. The material for both sites came from bean fields of the Cuban organisation.

For every developmental stage the investigations were made on 7–13 constant temperature levels, utilizing climatic chambers and rooms with controlled atmosphere. The temperatures are given in Tab. 2. Bean plants of the dark and redshelled varieties C-25-9 Rojo, C-25-9 Negro and ICA-PIJAO 32 of Cuban origin were grown under greenhouse conditions. When reaching the primary leaf stage the plants were set in rearing cages for 3 to 12 hours. After this exposure time they were held under constant temperature conditions.

Several times a day egg and larvae development were registered by using a stereo microscope with translucent light (ItL) or by determining the damage symptoms (INIFAT).

Above that we could utilize pupae from the continuous mass rearing of the flies (younger than one day) to investigate the temperature needs in this developmental stage.

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For these experiments the individuals were put into emerging glasses, which were lined with moist filter paper and also held under constant temperature conditions. The glasses were observed daily to check the hatching of the flies.

The data obtained were processed according to the equation of BLUNCK (1923) and by regression analyses with the following target:

- determination of the relationship between duration of development (DE) and constant temperature (KT)
- determination of the daily rate of development (speed) (RE_i), and
- calculation of the developmental thresholds (t_0).

Results

Under the influence of different temperatures levels the duration of development of the single life stages of *L. trifolii* varied clearly. To see Fig. 1. After this, an optimum development of all leafminer stages is possible in the temperature range of 24 to 30 °C and the duration of the life cycle decreases significantly.

Below these temperature values the time of development extends rapidly. Temperatures above 30 °C as well induce an increase in individual development times.

These statements could be specified by regression analyses of the test data. For all developmental stages we could state good approxemations to the quadratic equation DE; $RE_i = a + bKT + cKT^2$, the parameters of which are quoted in Tab. 1. According to these calculations the life span of egg, larvae and pupae is 5,13; 5,35 and 19,35 days respectively, when temperature amounts to 20 °C. Thermal conditions of 30 °C reduce these values to 1,57; 2,89 and 4,95 days. The complete life cycle at the mentioned temperatures terminated after 30,82 and 10,12 days. The developmental thresholds as well as the effective temperature values (day degrees) calculated in dependence on the duration of development are shown in Tab. 2.

Table 1
Equation parameters to describe the influence of temperature on the duration of development (DE) and the developmental rate (RE_i) in the preimaginal stages of *Liriomyza trifolii* (BURGESS)

Duration of development in days (DE)	Equation parameters a	b	c	B	α	S
Egg	18,25	−0,856	0,010	0,872	0,01	0,61
Larvae	16,25	−0,745	0,010	0,859	0,01	0,53
Pupae	135,15	−8,690	0,145	0,960	0,01	1,87
Complete life cycle	165,82	−9,878	0,156	0,996	0,01	2,14
Developmental rate days^{-1} (RE_i)	**a**	**b**	**c**	**B**	**α**	**S**
Egg	−0,2527	0,0215	–	0,94	0,01	0,0256
Larvae	−0,8593	0,0626	−0,0006	0,97	0,01	0,0297
Pupae	−0,2082	0,0171	−0,0002	0,96	0,01	0,0106
Complete life cycle	−0,2197	0,0169	−0,0002	0,98	0,01	0,0036

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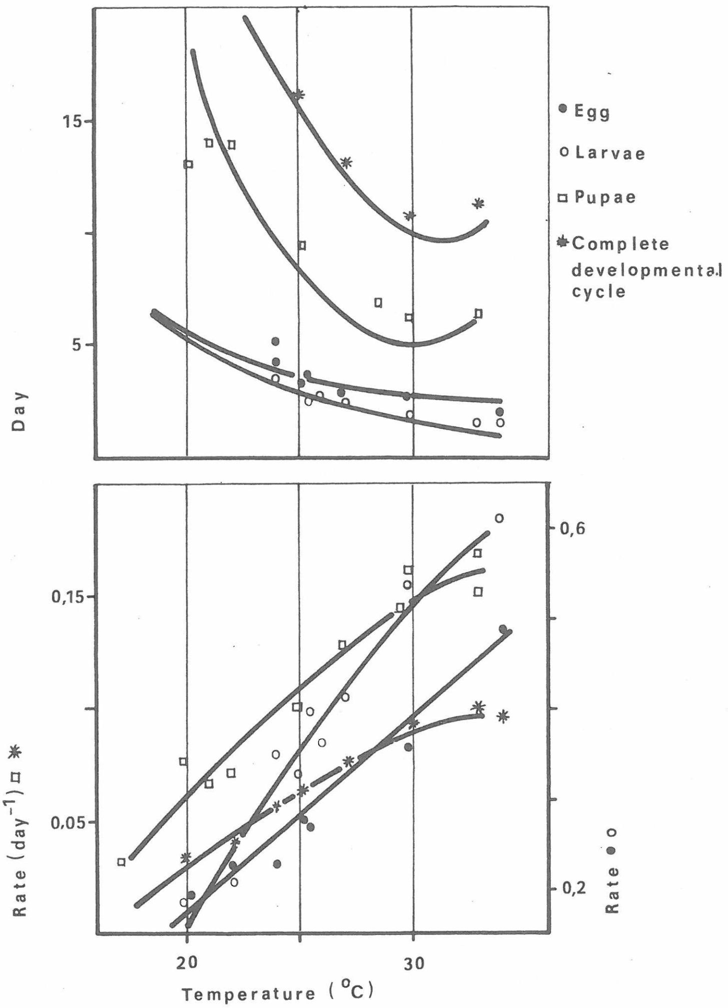

Fig. 1: Influence of the temperature regime on the development of *Liriomyza trifolii* (BURGESS)

According to these findings, only minimum differences exist between the developmental thresholds of the different life stages, which indicates that their temperature needs are nearly equivalent.

The calculated effective temperature sums, too, reveal only slight variations. Only in the very low (15 °C) and in higher temperature ranges (33 – 34 °C) the values deviated more largly.

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Table 2
Developmental thresholds (in parentesis) and effective temperature sum totals for the preimaginal stages of *Liriomyza trifolii* (BURGESS) of the test sites INIFAT (A) and ItL (B)

Temperature in °C	Egg (14,0)		Larvae (13,8)		Pupae (13,6)		Complete life cycle (14,7)	
	A	B	A	B	A	B	A	B
15,0						49,0		
17,0					107,4			
17,5						85,3		
20,0		18,0		37,2	83,2	108,8		111,3
21,0					107,3			
22,0					118,4			
22,5						115,7		
24,0	43,5		28,9					
25,0	38,3	22,0	34,2	56,0	108,3	125,4	165,1	175,1
25,5	42,8		29,3					
26,0			33,2					
27,0	36,4	26,0	31,7	52,8	107,2		160,0	172,2
27,5						111,2		
29,5					111,3			
30,0	43,5		30,0		102,2	114,8	165,1	
33,0			29,7		121,3			
34,0	40,2		32,9				199,6	
$\bar{x}$	40,8		31,5		107,4	101,4	172,5	

Discussion

The presented results produced by the investigations offer a generally suitable basis to elaborate prognostic- and monitoring techniques. Now we have possibilities to elucidate and understand the population dynamics of *L. trifolii* by use of the noted effective temperature values, and in doing so both field and glasshouse conditions may be considered. In this connection the following recommendations, supplementations and limitations should be noted:

- The regression equations reflect the main times for the transition from one life stage to the other. In reality, however, we record remarkable variations. They are most significant for the hatch of the adult flies and reveal a notable degree of proterandry. It ist also notable that unusually late hatching pupae are infested by parasites, as a rule by individuals of Opius dimidiatus Ashm. (BRUNNER, SCARAMUZZA & OTERO, 1975).
- The recorded results show a very good conformity of the two experimental locations and the data from CHARLTON & ALLEN (1981). Smaller differences in the optimum temperature span have methodological causes. Under suboptimum temperature conditions, however, greater differences, not only in the data of the regression model but also in the effective temperature sum total were recorded as compared with the findings by the last mentioned authors.

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Till now causes for these deviations are not clear. Except of possible inaccuracy of the quadratic equation type in lower temperature ranges also biological peculiarities seem to be important. They may be associated with the above — mentioned earlier hatching of the males, if different mortality rates for both sexes are recorded under low temperature conditions.

- With a development threshold of 13 to 14 °C the florida leafminer puts high claims to the environmental temperature, which are nearly equivalent for each life stage. These bracket values have also been confirmed by investigations of CHARLTON & ALLEN (1981), because 13,8 °C still allowed a development of the fly within 65 days, at 11,5 °C as much as 115 days were required. This long time might be connected with high mortality rates, sinces temperatures of 15 °C decreases the hatch rate of the adults down to 40% (FRÖHLICH & RICHTER, 1987).
- Except of the temperature also the host plant itself exerted an influence on the developmental time of *L. trifolii*. It's more rapidly in the phaseolus bean and slows down in chrysanthemums and tomatoes by 3 and 6 days at a temperature of 20 °C (MINKENBERG & LENTEREN, 1986). The registered retardation in the development seems to be induced in the detrimental larval stage. Compared to it different temperature regimes effect primarily the duration of pupal dormancy.

Zusammenfassung

Unter konstanten Temperaturbedingungen wurden die Entwicklungsdauer und -geschwindigkeit sowie die Temperatursummen und Entwicklungsnullpunkte von *Liriomyza trifolii* (BURGESS) bestimmt. Bei 25 °C läuft die Ontogenese in 16 Tagen ab. Das entspricht einer täglichen Entwicklungsrate von 6,25%. Die Temperatursummen und Entwicklungsnullpunkte der Einzelstadien sind 40,8; 14,0 (Ei), 31,5; 13,8 (Larve), 107,4; 13,6 (Puppe) sowie 172,5; 14,7 für die Gesamtentwicklung. Zwischen den Ergebnissen beider Untersuchungsstandorte (KARL-MARX-Universität Leipzig, DDR und Institut für Grundlagen der tropischen Landwirtschaft Santiago de las Vegas, Kuba) bestanden nur geringfügige Unterschiede.

Summary

The duration and rate of development and the temperature sums and initial points of development of *Liriomyza trifolii* (BURGESS) were determined under conditions of constant temperature. At 25 °C the ontogenesis takes 16 days. This puts the daily rate of development at 6.25%. The temperature sums and initial points of development for the different stages are 40.8; 14.0 (egg), 31.5; 13.8 (larva), 107.4; 13.6 (pupa), and 172.5; 14.7 for the total development. The results obtained at the two places of investigation (Karl-Marx-Universität Leipzig, GDR, and Institute for the Foundations of Tropical Agriculture, Santiago de las Vegas, Cuba) showed only slight differences.

Резюме

Название работы: Изучение развития *Liriomyza trifolii* (BURGESS) на фасоли (*Phaseolus vulgaris* L.) в зависимости от температуры. В постоянных температурных условиях определили продолжительность и скорость развития, а также суммы эффективных температур и исходные пункты фаз развития *Liriomyza trifolii* (BURGESS). При температуре 25 °C онтогенез протекает за 16 дней, т.е. суточный темп развития составляет 6,25%. Сумма температур и исходные пункты отдельных фаз развития следующие: 40,8 °C; 14,0 °C (яйцо), 31,5 °C; 13,8 °C (личунка), 107,4 °C; 13,6 °C (куколка) и 172,5 °C; 14,7 °C для всего процесса развития. Разницы между обоими местами исследований (Университет им. Карла Маркса в г. Лейпциг, ГДР и НИИ основ тпопического сельского хозяйства в г. Сантьяго-де-лас-вегас, Куба) были незначительные.

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References

BRUNER, S. C., SCARAMUZZA, L. C. & OTERO, A. R.: Catalogo de insectos que atacan a las plantas economicas de Cuba. Academia de Ciencias de Cuba, Instituto de Zoologia, segunda edicion revisada y aumentada. — La Habana 1975. — 400 S.

CHARLTON, C. A. & ALLEN, W. W.: The biology of *Liriomyza trifolii* on beans and chrysanthemums. — Proc. IFAS — Ind. Conf. Biol. Cont. *Liriomyza* leafminers, 1981. — S. 42—49.

FRIJTERS, A. J. M., MINKENBERG, O. P. J. M., WOETS, J. & RAVENSBERG, W. J.: Chrysocharis parksi in commercial greenhouses for the biological control of leafminers, *Liriomyza bryoniae* and *L. trifolii*, on tomatos; case studies and sampling techniques. — In: Med. Fac. Landbouww. Rijksuniv. — Gent, **51** (1986) 3a. — S. 987—997.

FRÖHLICH, G. & RICHTER, S.: Beitrag zur Morphologie und Entwicklung von *Liriomyza* spec., einem schädlichen Minierer an *Phaseolus vulgaris* L. in Kuba. — In: Beitr. Entomol. — Berlin **37** (1987). — S. 189—196.

HEYER, W., CHIANG LOK, MA.-L., CABALLERO, R. & CRUZ, B.: Zum Einfluß manueller Defoliationen auf die Ertragsleistungen der Bohne (*Phaseolus vulgaris* L.). — In: Archiv für Acker- und Pflanzenbau und Bodenkunde. — Berlin 33 (1989). — S. 179—187.

MINKENBERG, O. P. J. M. & LENTEREN VAN, J. C.: The leafminers *Liriomyza bryoniae* and *L. trifolii* (Diptera: Agromyzidae), their parasites and host plants: a review. — In: Agricultural University Wageningen Papers. — Wageningen **86** (1986) 2. — 50 S.

Besprechungen

BROWN, R. G. & HODKINSON, I. D.: **Taxonomy and ecology of the jumping plant-lice of Panama (Homoptera: Psylloidea).** — Leiden: Verl. BRILL and Scand. Science Press Ltd., 1988. — 304 S. — (Entomonograph; 9). — Preis: US$ 68,—

Bei diesem Buch handelt es sich um die erste Revision der in Panama vorkommenden Psylloidea. Das Hauptziel der Autoren besteht darin, genaue Beschreibungen der panamesischen Blattflöhe und Bestimmungsschlüssel für die entsprechenden Taxa vorzulegen. Da in Panama ein beträchtlicher Teil der bekannten neotropischen Gattungen nachgewiesen werden konnte, bietet die Revision eine gute Grundlage für die weitere taxonomische und biologische Erforschung der Psylloidea der Neotropis. Nach einer kurzen Charakterisierung des Untersuchungsgebietes werden die morphologischen Merkmale der Gruppe und ihre taxonomische Verwendbarkeit erläutert. Im taxonomischen Teil werden alle Taxa, für die keine hinreichenden Beschreibungen vorliegen, beschrieben. Soweit es sich um schon beschriebene Arten handelte, wurden nach Möglichkeit die Holo- oder Lectotypen untersucht, letztere ggf. festgelegt. Die Autoren beschreiben im Rahmen der Revision sechs neue Gattungen (fünf in der Familie Psyllidae, eine in bei den Calophyidae) und 96 neue Arten. Die Arbeit ist reich mit Strichzeichnungen illustriert (150 Figuren mit ca. 1500 Einzelabbildungen). Im Zusammenhang mit der Bearbeitung versuchen die Autoren, stammesgeschichtliche Fragen zu klären. Unter den derzeitigen Bedingungen war es noch nicht möglich, ein vollständiges phylogenetisches System zu erstellen, doch konnten zahlreiche monophyletische Gruppen wahrscheinlich gemacht werden. Hieraus ergab sich in vielen Fällen die Notwendigkeit der Neudefinierung schon beschriebener Grundlagen. Am Schluß des Buches setzen sich die Autoren mit der Frage der Koevolution der Psylloidea und ihrer Wirtspflanzen auseinander. Außerdem sind kurzgefaßte Bemerkungen über Biogeographie, Diversität und Biologie der panamesischen Psylloidea angeschlossen. Literaturverzeichnis und Register runden die Revision ab.

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