The Biology of *Liriomyza trifolii* on Beans and Chrysanthemums

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Liriomyza trifolii has been reported in the literature occurring on at least 47 genera in 10 families of plants (Stegmaier, 1966). In a preliminary survey of many ornamental, vegetable and weed hosts, we found that bean, pea, celery, melon and cucumber were preferred to chrysanthemum by female flies for feeding and oviposition, and that development of the flies proceeded fastest in the legumes. Because we wanted to get an idea of the potential for growth of this pest under optimum conditions, we conducted many of our biological studies using pink beans and blackeyed peas as host plants.

Developmental times of the various stages of *L. trifolii* were measured in pink beans at eight different constant temperatures (Table 1). Development from egg to adult was fastest at 32.5°C, taking an average of only 12.2 days. It appears that this is near the upper threshold for development (Fig. 1). Total time to develop at 13.8°C took over two months. At 11.5°C, eggs did not hatch within 34 days (though they would hatch when brought into warmer temperature cabinets), larval development was slowed to 30.9 days, while pupal development took 50 6 days. Apparently, the lower threshold for development is near 11°C (Pig. 1). At all temperatures, approximately half the life of the fly was spent in the pupal stage.

Time to develop of *L. trifolii* in Show Off chrysanthemum, a variety which is often heavily damaged by leafminers, was measured at 20. 0°C, 25.0°C, 30.0°C, and 32.5°C (Table 2). It is evident from Figure 1, that development at all temperatures is considerably slower in this mum than in pink bean, and that the optimum temperature for development in the mum is slightly lower than in the bean host.

Table 1. Developmental times of *Liriomyza trifolii* at various constant temperatures when reared on pink beans

Temperature		Developmental time (days)			
°C	°F	Egg	Larva	Pupa	Total[a]
32.5	90.5	2.0	3.4	6.9	12.2
30.0	86.0	2.2	3.7	6.8	12.5
25.0	77.0	2.9	4.5	8.5	15.8
23.8	75.0	3.1	4.2	8.8	16.1
20.0	68.0	4.2	6.7	9.4	20.3
14.8	58.5	10.7	12.6	28.0	51.2
13.8	57.0	11.2	17.0	36.5	64.7
11.5	52.5	none	30.9	50.6	none

[a] Observations made at 8 and 12 hour intervals depending on the temperature.

Table 2. Developmental times of *L. trifolii* at various constant temperatures when reared on Show Of f chrysanthemums.

Temperature		Developmental time (days)			
°C	°F	Egg	Larva	Pupa	Total[a]
32.5	90.5	3.0	4.5	7.6	14.3
30.0	86.0	2.2	5.1	6.7	13.8
25.0	77.0	3.8	5.8	8.2	16.7
20.0	68.0	5.2	8.0	10.6	24.1

[a] Observations made at 8 and 12 hour intervals depending on the temperature.

Percent mortality of immature stages of *L. trifolii* were measured at 23.8°C in pink bean, blackeyed pea, and two chrysanthemum varieties, Show Off and Yellow Knight (a spider mum that has shown considerable resistance to leafminers) (Table 3). The data clearly demonstrate that the legumes were more suitable hosts for leafminers than the chrysanthemums. Percent mortality, particularly of the larval stages of the fly, differed markedly among host plants. In the peas and beans, only 5-8% larval mortality occurred, while 35.1% of the larvae died in the leaves of the Show Off mum, and 99.0% died in the Yellow Knight leaves. (Interestingly, only 2 of 198 larvae completed development in the Yellow Knight mums and these were in the oldest, already senescing leaves.) Development was fastest in the legumes and somewhat faster in the susceptible than in the resistant mum variety.

Preference of *L. trifolii* females for feeding and ovipositing in excised leaves of pink bean, blackeyed pea, Yellow Knight and Hurricane (a susceptible variety chrysanthemum) were studied in the laboratory (Table 4). Legumes were more often chosen by female flies for feeding and egg laying than were mums. Between mum varieties, however, no significant preference was demonstrated.

Table 3. Percent mortality of immature stages of *L. trifolii* grown on different host plants at 23.8°C.

Host plant	% mortality		
	Larva	Pupae	Total
Pinkbean	8.0	20.8	26.9
Blackeyed pea	5.0	23.1	26.8
Show Off mum	35.1	27.0	52.6
Yellow Knight mum	99.0	0.0	99.0

Table 4. Preference of *L. trifolii* females for different host plants measured by mean numbers of eggs laid and feeding punctures made per square centimeter of leaf area.

Host plant	Mean number eggs/ cm^2 leaf[a]	Mean number punctures/ cm^2 leaf[a]
Pink.bean	1.29 a	9.88 a
Blackeyed pea	1.26 a	9.46 a
Hurricane. mum	0.30 b	3.00 b
Yellow Knight mum	0.41 b	6.60 ab

[a] Numbers in the same column followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

Adult longevity was studied in hairless blackeyed peas because the hooked trichomes on pink bean leaves caused premature death of flies. We found that longevity was very dependent on a carbohydrate food source (Table 5). Even though females fed at leaf punctures, longevity was two to three times longer when adults were fed honey.

Fecundity was also greatly increased by a carbohydrate food source (Table 6). At 23.8°C, *L. trifolii* females averaged 439 eggs/female when given honey, but only 177 eggs/female when fed on blackeyed peas alone. This is important as it is likely that aphid honeydew and floral nectars could greatly increase leafminer numbers. It is also interesting that more feeding punctures/egg were made when no other food source was available.

Table 5. Longevity of *Liriomyza trifolii* adults at 23.8°C (75°F) when provided different types of food.

Food	Longevity (days) ?	?
No food	2.7	3.0
Water	2.9	3.2
Blackeyed pea	2.3	7.2
Blackeyed pea + honey	13.9	22.7
Honey alone	15.5	16.3

Table 6. Fecundity of *Liriomyza trifolii* females with and without a carbohydrate food source.

Temp.	Food source	Total eggs/?	Leaf punctures	Punctures /egg
23.8°C	Blackeyed pea	177	2008	11.3
23.8°C	Blackeyed pea + honey	439	4060	8.6

Daily activity of leafminers was studied in the greenhouse in July. Adults were found to feed throughout the daylight hours, but to oviposit most frequently around midday (Table 7). A pronounced diurnal periodicity in larval emergence from leaves and adult emergence from puparia was also apparent, both these activities occurring primarily between the hours of 9 a.m. and noon (Table 8). This information could be of importance in timing certain control strategies.

Table 7. Diuanal pattern of *Liriomyza trifolii* females feeding and ovipositing on blackeyed peas.

Time[a]	Leaf punctures	Eggs laid	Ratio punctures/eggs
0630	26	3	8.7
0730	90	2	45.0
0830	466	52	10.0
0930	588	75	7.8
1030	699	65	10.8
1130	839	133	6.3
1230	928	106	8.8
1330	902	104	8.2
1430	679	83	8.2
1530	822	81	10.2
1630	753	28	26.9
1730	660	31	21.3
1830	602	21	28.7
1930	456	10	45.6
2030	72	1	72.0

[a] Test conducted in a greenhouse in July with time expressed in daylight hours.

Table 8. Diurnal pattern of *Liriomyza trifolii* larval emergence from pea leaves and adult emergence from the soil.

Time[a]	Larval emergence	Adult emergene'e
0530	0.0	0.0
0630	2.0	0.0
0730	4.5	0.0
0830	17.0	2.0
0930	40.5	66.0
1030	47.5	68.0
1130	53.0	67.0
1230	17.5	23.0
1330	8.0	5.0
1430	2.0	2.0
1530.	2.5	0.0
1630	1.5	.0.0
1730	1.0	0.0
1830	0.0	0.0

[a] Experiment conducted in a greenhouse in July with time expressed as daylight time.

Most larvae, on emerging from the leaves, drop to the soil to pupate though some pupate in more exposed places. Several studies were made of the effects of humidity and free moisture on pupal emergence. Lab studies of pupae kept in different relative humidity chambers showed that there was increasing survival to adulthood as the air over the pupae became more moist (Table 9). Apparently the humid greenhouse environment is one well suited to pupal development and adult emergence of *L. trifolii*. When pupae were buried in sand and in peat with differing amounts of water added, adult emergence was relatively high (60-80%) until pupae were exposed to considerable free moisture (Table 10). However, it was found that when newly formed pupae were submerged in water at 25°C for different lengths of time, 88% could survive an eight hour submergence; 50% were still alive after one day, and 4% after two full days under water (Table 11). It seems there would be little hope of trying to kill *L. trifolii* pupae either by drying or by flooding the soil without adversely affecting plants as well.

Several attempts were made to induce diapause in *L. trifolii* by exposing eggs, larvae and pupae to short daylengths and cold temperatures both in the lab and outside in Berkeley, California in the fall. To date, no evidence of diapause has been found in any of the trials. Since *L. trifolii* was originally collected in Washington, D.C. and in Iowa, a winter diapause would be expected in this species. However, it is possible that a non-diapausing strain may have developed which could further enable this species to exploit the greenhouse environment.

Table 9. Emergence of *Liriomyza trifolii* adults when newly transformed pupae were held at various relative humidities

Relative humidity %[a]	Emergence %
11	6
15	22
32	40
51	64
62	65
76	65
94	72
100	88

[a] Completely exposed pupae were held at the indicated relative humidities using saturated salt solutions for humidity control at 25°C.

Table 10..Emergence of *Liriomyza trifolii* adults from pupae which were buried in sand and peat with various amounts of water added.

Substrate[a]	Water %	Emergence %
Sand	0	49
	3.8	61
	7.6	61
	11.4	75
	15.4	38
	19.2	0
	23.1	0
Peat	0	79
	27.0	86
	55.0	80
	83.0	79
	111.0	73
	139.0	12
	167.0	2
	194.0	0

[a] Pupae were buried about one cm and held at 25°C. The pupae were exposed to considerable free water when 19% water by weight was added to sand and when 139% water by weight was added to peat.

Table 11. Survival of newly formed *Liriomyza trifolii* pupae which were submerged in water for various lengths of time at 25°C.

Submergence time hours	Survival %
4	96
8	88
23	52
32	44
50	4
75	0
98	0
122	0
145	0

References Cited

Stegmaier, C. E., Jr. 1966. Host plants and parasites of *Liriomyza trifolii* in Florida (Diptera: Agromyzidae). Fla. Ent. 49(2):81-86.

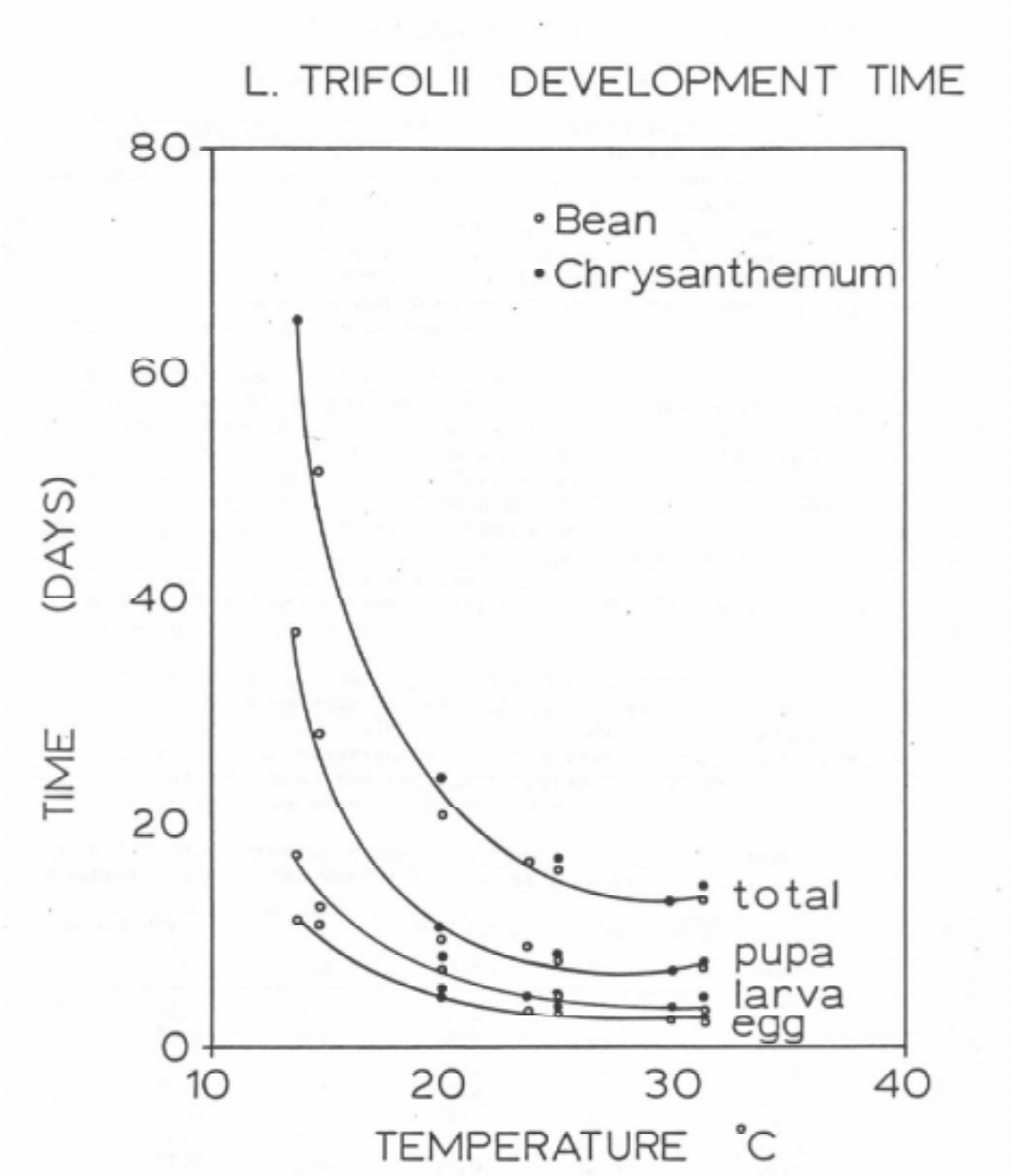

Fig. 1. Developmental time of *L. trifolii* in beans (open circles) and in Show Off a favorable chrysanthemum variety (closed circles).