

The leaf miner, *Liriomyza trifolii* Burgess (Diptera: Agromyzidae), a Serious Insect Pest of Faba Bean (*Vicia faba* L.) in the Sudan.

1. Identification of the Pest, Natural Enemies and Abundance

N. Sharaf El-Din¹, H. Kannan¹, A. Babiker¹, S. Weigand² and M.C. Saxena²

(1) Agricultural Research Corporation (ARC), Wad Medani, Sudan

(2) ICARDA, P.O. Box 5466, Aleppo, Syria.

Abstract

Sharaf El-Din, N., H. Kannan, A. Babiker, S. Weigand and M.C. Saxena. 1997. The leaf miner, *Liriomyza trifolii* Burgess (Diptera: Agromyzidae), a serious insect pest of faba bean (*Vicia faba* L.) in the Sudan. 1. Identification of the pest, natural enemies and abundance. Arab J. Pl. Prot. 15(1): 39-42.

Traditionally, faba bean (*Vicia faba* L.) is grown in the northern part of the Sudan (16-22°N). It was seriously damaged by the leaf miner, *Liriomyza trifolii* Burgess, which was reported for the first time in the country when its production was extended to south of Khartoum (13-15°N) in the mid-eighties, for reasons of land scarcity and high cost of production in the north. Accordingly, some basic studies were conducted to investigate the identity of the pest, the relative abundance throughout the cropping season, host plants and parasitism. Two leaf miner species, *L. trifolii* Burgess, and *Tropicomyia vigneae* Seguy were identified. The former is the dominant species and identified on 12 plant species, while the latter was identified only from *Dolichos lablab*. Two species of the leaf miner parasitoids, *Chrysonotomyia formosa* Westwood and *Hemiptarsenus semialbicalva* Girault were identified from leaf miners infesting a number of host plants, the former being the dominant species. The relative abundance of *L. trifolii* and its parasitoids were studied in unsprayed faba bean fields during November - February, 1987/88, with peak infestations in late December-early January. Parasitism level reached about 25% in late January-early February but levels as high as 60% were also recorded. Leaf miner adult flight activity was monitored by sticky traps throughout the year (July-August) and by light traps during the cropping season (November-January) and that was compared with the incidence and abundance of the pest on the faba bean crop. Biological studies revealed a high percentage of incomplete development of prepupae and pupae because of death or diapause, although no clear evidence of diapause was obtained. The importance of the high parasitism recorded, its practical implications and the need to maintain and enhance the role of the natural enemies is discussed and emphasized.

Key words: *Liriomyza trifolii*, natural enemies, faba bean, Sudan.

Introduction

Faba bean (*Vicia faba* L.) is grown in the Northern part of the Sudan (16-22°N), where winter months (November to February) are cool with average temperatures between 15 and 25°C. The crop is planted in November/December and grown under irrigation as this area is arid and rainfall is scarce. Due to the increasing demand for faba bean, which is an important food crop and an important component in the human diet in the Sudan, production had to be increased to achieve self-sufficiency. Since agricultural land in the north is scarce and cost of production high, the possibility of extending faba bean production to new areas was explored. Due to efforts in a joint project between the Agricultural Research Corporation (ARC) and the International Center for Agricultural Research in the Dry Areas (ICARDA), faba bean production was rendered possible for the first time in the mid-eighties south of Khartoum (13-15°N).

In the northern traditional production areas, faba bean is attacked by about 15 different insect species belonging to six orders (7). The major insect includes beet army worm (*Spodoptera exigua* HB.); cowpea aphid (*Aphis craccivora* Koch), green aphid (*Acyrtosiphon* spp.), the grey cotton thrips (*Caliothrips sudanensis* Bagn and Cam.) and pod borer (*Helicoverpa armigera* HB.) (4, 6, 9, 12). However, in most years, such situation did not necessitate chemical control measures (10, 11). Nevertheless, faba bean production in the new areas was faced by a new insect problem, the leaf miner, *Liriomyza trifolii* Burgess which caused serious damage. The incidence of this pest was first recorded in 1985 (8). Since this was a new pest in Sudan, some basic studies were conducted to generate the

information needed for developing appropriate control measures.

Materials and Methods

1. Identification of the pest and its host range

Two fields of faba bean each of about one hectare situated in North and South of the Gezira Research Farm (GRF) were weekly sampled from crop emergence to harvest (December - March, 1985/86 and 1986/87). The two fields were placed away from sprayed areas. Samples of 50 infested leaflets were randomly collected and brought to the laboratory and kept in petri-dishes with moistened filter papers at a temperature of 25°C and relative humidity of 60%. Three weeks later, the samples were inspected and the number of leaf miners and parasitoids was recorded. At the same time intensive surveys were made in the area to collect samples of infested leaves from other cultivated plants and weeds. The samples were kept in the laboratory under the same conditions. All emerging adult insects were collected and sent to the British Museum for identification.

2. Seasonal abundance of leaf miner and parasitoids

The seasonal development of leaf miner population and its parasitoids was followed in a one hectare field of faba bean, variety BF 2/2 at Rahad and Gezira over two growing seasons, 1985/86 and 1986/87.

The faba bean crop was planted in the first week of November using the standard cultural practices and left without chemical treatment. At 7 to 15 days intervals throughout the season, 25 samples of half meter length were taken at random and the infested and non-infested plants were counted. At the same time two plants were taken from

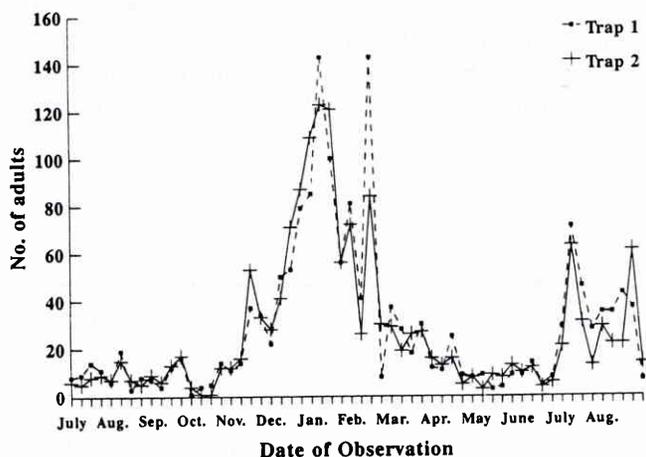


Figure 1. Weekly sticky trap catches of the leaf miner, *L. trifolii* adults in the Gezira, Sudan (1985/86)

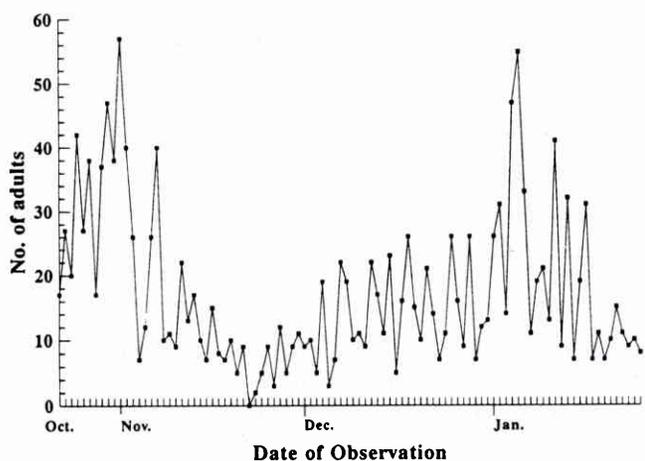


Figure 2. Daily light trap catches of the leaf miner, *L. trifolii* adults in the Gezira, Sudan (1985/86).

The discrepancy in the pattern of catches between the sticky and the light trap is likely due to the movement of adults during the day within the crop and between fields in search of ovipositing sites when they get caught in the sticky traps, while at night the pest tends to stay on the plants and their movement is minimal, and accordingly few adults were caught by the light trap.

The population development of the leaf miner and parasitoids are shown in Table 2. The number of the leaf miner pupae in the leaflet samples was high in the first sampling dates, decreased and then increased again towards the end of the season. This was comparable with the infestation percentage given in Table 1. The percentage of adult emergence increased from about 40% in the early season to 50-60% later. The low percentage in the second sampling is likely due to the high percentage of unhatched pupae rather than a decrease of number of leaf miner. The percent parasitism was low in the beginning, but increased to 25% in January. In another season (1990/91), parasitism rates were even higher reaching 40 to 60% at the end of the season showing that later in the season parasitoids might have a potential as biological control agents. This finding

agrees with the findings of Sugimoto *et al.* (13), Cornelius *et al.* (1) and Hills *et al.* (3) who reported parasitization of some leaf miner species by the adults of 15-20 parasitoids and the consequent remarkable reduction of the miner populations. Thus, care has to be taken not to disrupt these parasitoids but to enhance their population early in the season by avoiding or delaying any chemical treatment.

Table 2. Percent emerged adult leaf miner, parasitoids and remaining pupae of faba bean leaflets sampled in season 1987/88 at Gezira, Sudan.

Date of sampling	No. of pupae	% emerging		
		L. miner adult	% emerging parasitoid	% pupae
6.12	54	41	7	52
16.12	35	23	5	72
26.12	14	43	21	36
5.1	80	67	16	17
16.1	83	53	23	24
26.1	98	56	27	17
5.2	112	57	25	18
16.2	54	50	20	30

The percent of unhatched pupae was high, especially in the first three sampling dates (52, 72 and 36%). Most likely these pupae were either in diapause or dead because of conditions of pupation in the perti-dishes instead of the soil. Relevant studies by Keularts *et al.* (5) showed that mortality of prepupae and pupae of *L. trifolii* was high at low relative humidities and that at less than 50% RH, mortality of the prepupae reached 70-85% while pupae mortality reached 50% at 20% RH. When evaluating the effect of polythene soil coverings on the survival of prepupae and pupae, a lower infestation was noticed on the crop in soils covered with polythene due to death of the pupae. These findings emphasized the importance of RH to emergence and multiplication of the leaf miner population and perhaps explains the high mortality of the pupae incurred in the current studies. They also pose the need to revise methodologies adopted in these studies.

Occurrence of diapause in *L. trifolii* is not yet clear. Although it has been reported in case of other species, Dimetry (2) and Keularts (5) in their biological studies on *L. trifolii* did not report occurrence of diapause. However, this phenomenon is of practical importance, as when diapause occurs, crop rotation would be one way to reduce the initial infestation.

Acknowledgment

This study was conducted during the joint Nile Valley Project for the improvement of faba bean, between ICARDA/IFAD and the Agricultural Research Corporation (ARC), Sudan. The project was financially and technically supported by ICARDA. Compiling the results of few years studies and writing them in a form of scientific paper was made possible by the continuous encouragement and support of ICARDA administration during the stay of the senior author on a consultancy at ICARDA/Aleppo, for which he is

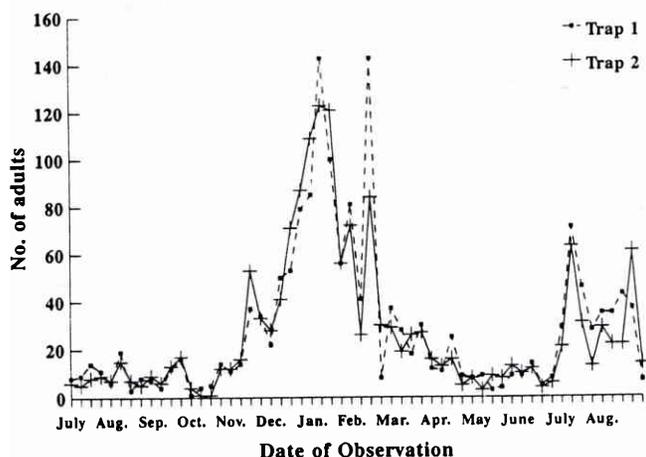


Figure 1. Weekly sticky trap catches of the leaf miner, *L. trifolii* adults in the Gezira, Sudan (1985/86)

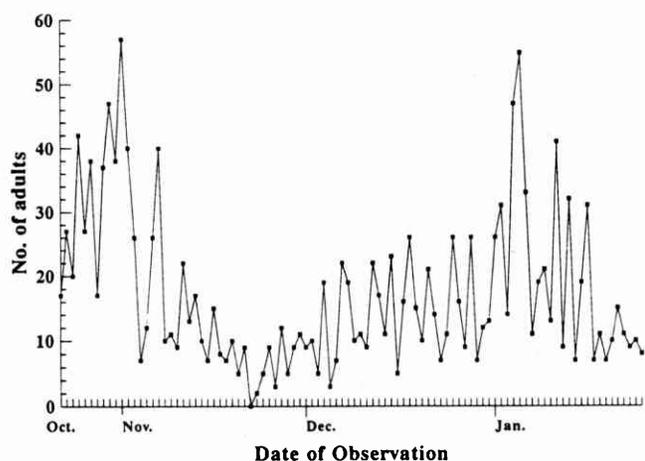


Figure 2. Daily light trap catches of the leaf miner, *L. trifolii* adults in the Gezira, Sudan (1985/86).

The discrepancy in the pattern of catches between the sticky and the light trap is likely due to the movement of adults during the day within the crop and between fields in search of ovipositing sites when they get caught in the sticky traps, while at night the pest tends to stay on the plants and their movement is minimal, and accordingly few adults were caught by the light trap.

The population development of the leaf miner and parasitoids are shown in Table 2. The number of the leaf miner pupae in the leaflet samples was high in the first sampling dates, decreased and then increased again towards the end of the season. This was comparable with the infestation percentage given in Table 1. The percentage of adult emergence increased from about 40% in the early season to 50-60% later. The low percentage in the second sampling is likely due to the high percentage of unhatched pupae rather than a decrease of number of leaf miner. The percent parasitism was low in the beginning, but increased to 25% in January. In another season (1990/91), parasitism rates were even higher reaching 40 to 60% at the end of the season showing that later in the season parasitoids might have a potential as biological control agents. This finding

agrees with the findings of Sugimoto *et al.* (13), Cornelius *et al.* (1) and Hills *et al.* (3) who reported parasitization of some leaf miner species by the adults of 15-20 parasitoids and the consequent remarkable reduction of the miner populations. Thus, care has to be taken not to disrupt these parasitoids but to enhance their population early in the season by avoiding or delaying any chemical treatment.

Table 2. Percent emerged adult leaf miner, parasitoids and remaining pupae of faba bean leaflets sampled in season 1987/88 at Gezira, Sudan.

Date of sampling	No. of pupae	%		
		L. miner adult	% emerging parasitoid	% pupae
6.12	54	41	7	52
16.12	35	23	5	72
26.12	14	43	21	36
5.1	80	67	16	17
16.1	83	53	23	24
26.1	98	56	27	17
5.2	112	57	25	18
16.2	54	50	20	30

The percent of unhatched pupae was high, especially in the first three sampling dates (52, 72 and 36%). Most likely these pupae were either in diapause or dead because of conditions of pupation in the pети-dishes instead of the soil. Relevant studies by Keularts *et al.* (5) showed that mortality of prepupae and pupae of *L. trifolii* was high at low relative humidities and that at less than 50% RH, mortality of the prepupae reached 70-85% while pupae mortality reached 50% at 20% RH. When evaluating the effect of polythene soil coverings on the survival of prepupae and pupae, a lower infestation was noticed on the crop in soils covered with polythene due to death of the pupae. These findings emphasized the importance of RH to emergence and multiplication of the leaf miner population and perhaps explains the high mortality of the pupae incurred in the current studies. They also pose the need to revise methodologies adopted in these studies.

Occurrence if diapause in *L. trifolii* is not yet clear. Although it has been reported in case of other species, Dimetry (2) and Keularts (5) in their biological studies on *L. trifolii* did not report occurrence of diapause. However, this phenomenon is of practical importance, as when diapause occurs, crop rotation would be one way to reduce the initial infestation.

Acknowledgment

This study was conducted during the joint Nile Valley Project for the improvement of faba bean, between ICARDA/IFAD and the Agricultural Research Corporation (ARC), Sudan. The project was financially and technically supported by ICARDA. Compiling the results of few years studies and writing them in a form of scientific paper was made possible by the continuous encouragement and support of ICARDA administration during the stay of the senior author on a consultancy at ICARDA/Aleppo, for which he is

most grateful. The manuscript has been revised by Drs. K. Makkouk and B. Bayaa (ICARDA) and the authors are grateful to their useful suggestions. The approval of the Director General/ARC, Sudan to publish this work is gratefully acknowledged.

الى الروح الطاهرة التي فارقتنا قبل أن ترى هذه المقالة النور، إلى روح الدكتور نصر الدين شرف الدين الذي لم يقو على مقاومة مرضه العضال.

The senior author of this paper, Dr. Nasreldin Sharaf El-Din, passed away before this paper could be published and after a long illness. May the departed soul rest in peace.

المخلص

شرف الدين، نصر الدين، حسان كنان، أحمد بابكر، سوزان وايقاند وموهان ساكسينا. 1997. حفار خنادق الأوراق *Liriomyza trifolii* Burgess، آفة إقتصادية على الفول المصري *Vicia faba* L. في السودان. مجلة وقاية النبات العربية. 15 (1): 39-42. يزرع الفول المصري تقليدياً في شمال السودان. ونظراً لضيق المساحات المستزرعة وتكلفة الإنتاج العالية فقد تم توسيع زراعة الفول لما بعد جنوب الخرطوم في منتصف الثمانينات وعلى إثره أصيب محصول الفول المصري، لأول مرة في تاريخ السودان، بأفة ذبابة الأوراق. للتعرف على الحشرة فقد تمت دراسات أولية لمعرفة نوع الحشرة، كثافتها، المدى العائلي والأعداء الطبيعية. تم التعرف على نوعين من ذبابة الأوراق هما: *Liriomyza trifolii* Burgess و *Tropicomyia vignear* Seguy حيث وجدت الأولى على 12 نباتاً بينما وجدت الأخيرة على اللوبيا/ اللبلاب *Dolichos lablab* فقط، كما تم التعرف على نوعين من الطفيليات هما: *Chrysonotomyia formosa* و *Hemiptarsenus semialbicalva* Girault. دلت الدراسات على أن الإصابة بالآفة تبدأ في كانون أول/ ديسمبر وتصل ذروتها في كانون ثاني/ يناير بينما تصل نسبة التطفل أعلاها في آخر كانون الثاني/ يناير وشباط/ فبراير وتصل حوالي 60% تطفل. هذه النسبة عالية ويمكن توظيفها في عملية مكافحة المتكاملة مع الإبقاء والمحافظة على هذه الأعداء الطبيعية بالامتناع عن استعمال المبيدات الكيماوية في أول الموسم أو استعمال المبيدات الإختيارية عند الضرورة القصوى. أظهرت الدراسات البيولوجية عدم إكمال نمو العذارى بنسب عالية وصلت 72% في أول الموسم وقد عزي هذا إما لموتها بسبب قلة الرطوبة النسبية عند النمو أو لحفظ العذارى في أطباق بتري زجاجية بدلاً من وجودها تحت سطح الأرض كما يحدث في الطبيعية. أما السبب الثاني فهو احتمال وجود العذارى في حالة سكون (Diapause)، ولهذا الظاهرة أهمية عملية من حيث تخطيط الدورات الزراعية للتقليل من الإصابة. تشير هذه النتائج والملاحظات إلى أهمية مراجعة طرق الدراسة لهذا الآفة مستقبلاً.

كلمات مفتاحية: *Liriomyza trifolii*، أعداء طبيعية، الفول المصري، السودان.

References

1. Cornelius, S.J. and H. Godfray. 1984. Natural parasitism of the Chrysanthemum leaf miner *Chromatomyia synenesiae* H. (Diptera: Agromyzidae). *Entomophaga* 29:344-345.
2. Dimetry, N.Z. 1971. Biological studies on a leaf mining Diptera, *Liriomyza trifolii* Burgess attacking bean in Egypt. *Bull. Soc. Ent. Egypt* LV:55-69.
3. Hills, O.A. and E.A. Tylor. 1951. Parasitization of Dipterous leaf miner in cantaloupes and lettuce in the salt River Valley. *Airzona J. Econ. Entomol.* 44:759-762.
4. Hussein, M.H. 1963. Pests of crops in the Northern Sudan. Annual Report, 4. Hudeiba Research Station, Agricultural Research Corporation.
5. Keulars, J. and R.K. Lindquist. 1989. Increase in mortality of prepupae and pupae of *Liriomyza trifolii* (Diptera: Agromyzide) by manipulation of relative humidity and substrate. *Environ. Entomol.* 18(3): 499-503.
6. Romaine, F. 1961. Pest survey of crops at Hudeiba. Annual Report, Hudeiba Research Station, Agricultural Research Corporation.
7. Saxena, M.C. and R.A. Stewart (Eds.). 1983. Faba bean in the Nile Valley. ICARDA/IFAD Nile Valley Project and Martinus Nijhoff Publisher, The Hague/The Netherlands, P. 125-132.
8. Sharaf El Din, N. 1986. Entomological problems in the new areas. Seventh Annual Co-ordination Meeting, ICARDA/IFAD Nile Valley Project on faba bean Improvement. Addis Ababa, 23-27 September, 1986.
9. Siddiq, A.S. 1967. Pest survey in the Northern Province of the Sudan. *Proc. 10th Agric. Res. Coll. of Sudan.*
10. Siddiq, A.S. 1969. Evaluation of insecticides to protect full musri against *Laphygma exigua*, thrips and aphids on *Vicia faba*. Annual Report, Hudeiba Research Station, 41.
11. Siddiq, A.S. 1972. Evaluation of insecticides for the control of *Spodoptera exigua* thrips and aphids on *Vicia faba*. Annual Report, Hedeiba Research Station, Agricultural Research Corporation.
12. Siddiq, A.S. 1982. Major pests of faba bean in Sudan. Hawtin and Webb (eds.). Faba bean improvement. ICARDA/IFAD Nile Valley Project and Martinus Nijhoff publishers, The Hague/The Netherlands. P.277-283.
13. Sugimoto, T., Y. Sakurantani, Y. Sirro and I. Haneda. 1983. Communities of parasitoids attacking leaf mining host, *Phytomyza* sp. (Hymenoptera: Eulophidae) Mem. Fac. Agri. Kinli University. 16-41-47.