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LIFE TABLE OF POTATO LEAF MINER *Liriomyza huidobrensis* Blanchard (DIPTERA: AGROMYZIDAE) TO STUDY THE BIOLOGY AND NATURE OF DAMAGE UNDER LABORATORY CONDITION

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Abstract

The life table study of Pea leaf miner, Liriomyza huidobrensis Blanchard, was conducted in laboratory of Entomology division of Nepal Agricultural Research Council with the aim to understand the patterns in the development, survival and mortality of pea leaf miner along with the nature of damage in laboratory condition. The results explained that oviposition and feeding punctures were significantly higher in lower foliage than in upper foliage level. It was observed that there was low mortality in adult stages (13.72%) compared to other life stages (egg: 48.26%, larva: 41.17% and pupa: 27.14%, respectively). Male and female ratio was 1:1.39 with the average of 13.60±1.53:19.00±1.84 in the laboratory condition whereas in the field condition, it was 0.98:1. The average egg, larval, and pupal development period of L. huidobrensis recorded were 4.75±0.335; 10.08±0.238 and 12.19±0.233 days respectively. The average survival time period of male and female feeding only honey and water was 5.78±0.86 and 3.22±0.954 days, respectively. It was concluded that the mortality trend was stage specific and adult ovipositional and feeding preferences is more towards the older, thicker and larger lower leaves.

Key Words**:** *Pea leaf miner, punctures, lower foliage, mortality, stage*

INTRODUCTION

The pea leaf miner, *Liriomyza huidobrensis* Blanchard, is a polyphagous, cosmopolitan pest which was first found in Southern Ontario in 1998 (McDonald et al. 2000). It can cause direct damage to the photosynthetic tissue of host plants by making mines by the larvae and feeding punctures made by adult females (Spencer 1973). It is estimated that pea leaf miner has known hosts in at least 14 families of plants (Spencer 1990) but little is known about adult host preferences and host suitability for development of larval stages in this species. The distribution of *Liriomyza* spp. within the plant is characterised by a significantly higher number of punctures and larval mines on the lower level than to the middle and upper level of their host plants (Srinivasan et al. 1995, Hammad and Nemer 2000). The choice of insect habitat and food is done by ovipositing female where the larva is internal feeders and complete its entire development in single leaf. The choice of ovipositing female depends upon three main factors: (i) host plant suitability, (ii) presence or absence of other phytophagous organisms, and (iii) natural enemies (Faeth 1985). It is believed that these factors vary substantially within and among plants, and that such variations have a significant influence on the performance of insects feeding on them (Kimmerer and Potter 1987, Suomela and Nilson 1994, Fisher et al. 2000). Though the leaf miner pest is economically important and its life cycle and damaging nature should be known to protect the crops against it, very few or no works has been done towards it. Keeping in view the above facts, the life table study of leaf miner pest of potato in the scenario of Nepal has been done to understand the life cycle and damaging nature of leaf miner in potato. It is hoped that professionals will develop suitable time of pest management after knowing the life cycle and infestation level.

METHODOLOGY

Biology of the leaf miner, *Liriomyza huidobrensis* (Blanchard): Studies on the biology of *L. huidobrensis* was carried out at the laboratory of Entomology Division of Nepal Agriculture Research Council (NARC), Khumaltar, Lalitpur, Nepal, which is situated at 1326 masl, within 27°38.315' N and 85°22.883' E. The maximum and minimum temperature of 32 ºC and 21ºC recorded during the course of investigation.

Maintenance of Stock Culture: Stock culture of the leaf miner was initiated by collecting pupae from the infected plants and further maintained in the plastic bottle in the rearing cage throughout the experimental period in the laboratory condition. The newly emerged adults obtained from the rearing cages were allowed for mating. A cotton swab soaked in 10 percentage honey solution was provided as source of food for the adult flies during the oviposition. The cotton swab was changed as often as necessary to maintain a constant supply of food.

Counting the Feeding and Oviposition Punctures Per Day in the Different Foliage Parts (Lower, Middle and Upper Leaves): A pair of pea leaf miner (1 male: 1 female) was placed for puncturing in one composite leaf of each foliage in day 1 and the same case was repeated for number of days and the number of punctures were observed using the magnifying glass lens.

Calculation of Male and Female Ratio: Two types of examination, i.e. one with lab emerged adults and another with delta trapped adults in field were carried out. Five plastic bottles containing fifty pupas in each were kept under observation until the emergence of adult in the lab. Six delta traps were placed for identification of the number of male and female ratio in the field. These traps were set in the field.

Incubation Period: After oviposition, the test plants were daily checked for the emergence of larvae which revealed the days required for emergence of the larvae of the *L. huidobrensis* in the laboratory condition.

Pupal Period: The pupal period of the leaf miner was studied by observing the twenty pre-pupae kept individually in the petri-plate. The observations were made till the adult emergence. The period between pre-pupae till the adult emergence was noted as pupal period.

Adult Longevity: The longevity of the adult was recorded in presence and absence of food by enclosing twenty adults of each sex in a specimen tube (7.5 x 2.5 cm) obtained from the culture. The period from the adult emergence to death was taken as adult longevity. The total life cycle was computed from the day of egg laying to the emergence of the adult.

Life Table Studies: The study was carried out in laboratory of Entomology Division of Nepal Agriculture Research Council (NARC), Khumaltar, Lalitpur, Nepal. Initially, the study was carried out inside the rearing cage under laboratory condition. Initially, sufficient number of pupae of leaf miner was collected from the fields. After collection, rearing was carried out into the rearing cage. Leaf miner adult and parasitoids were separated. Then the two pairs of newly emerged adults were placed in separate rearing cages. Inside the rearing cage, there was potato plant in the pot. Then the oviposition punctures were detected due to its mining property. Then successive stage of development was evaluated for life table study, the abbreviations are expressed as:

x = Pivotal age class
lx = Number surviving at the start of age interval x
dx = Number dying during the age interval x to x +1
qx = Rate of mortality during the age interval x to x +1
Lx = Average of number of individuals between age x to x +1 (lx + lx =1)/2
Tx = Total number of individuals at age x and beyond (all Lx from bottom)
Ex = Life expectancy (Tx/lx)

Data analysis: The data were analysed by the statistical packages like Microsoft Excel, SPSS.

RESULTS

Maintenance of stock culture: The adult started emerging 4 days after the pupa were placed in the plastic bottle at room temperature and after emergence the male and female adults were placed for mating in the mating cage. The female adults were larger than male. Male emerged prior to female. The heavily sclerotized tube is present in case of female abdomen.

The feeding and oviposition punctures in foliage (Lower, Middle And Upper Leaves): Tables 1 and 2, show the average number of feeding and oviposition punctures in the different foliage level and figures 1, 2 and 3, show the numbers of feeding and oviposition punctures in each day. Feeding and oviposition punctures were significantly higher in lower foliage than in upper foliage level.

Table 1. Mean number of feeding puncture (per day) of *L. huidobrensis* under lab condition, Khumaltar

Foliage level	Observation (days)	Average number of feeding puncture per day
Upper leaves	18	50.38± 14.52 [a]
Middle leaves	17	100.82± 17.74[ab]
Lower leaves	18	144.11± 22.99 [b]

The value before ± indicates average number and after ± indicates standard error (S.E)

Table 2. Mean number of oviposition punctures of *L. huidobrensis* under lab condition, Khumaltar

Foliage level	Observation (days)	Average number of oviposition puncture per day

Upper leaves	18	11.00± 2.33 [a]
Middle leaves	17	20.94± 2.89 [b]
Lower leaves	18	24.50± 3.78 [b]

The value before ± indicates average number and after ± indicates standard error (S.E)

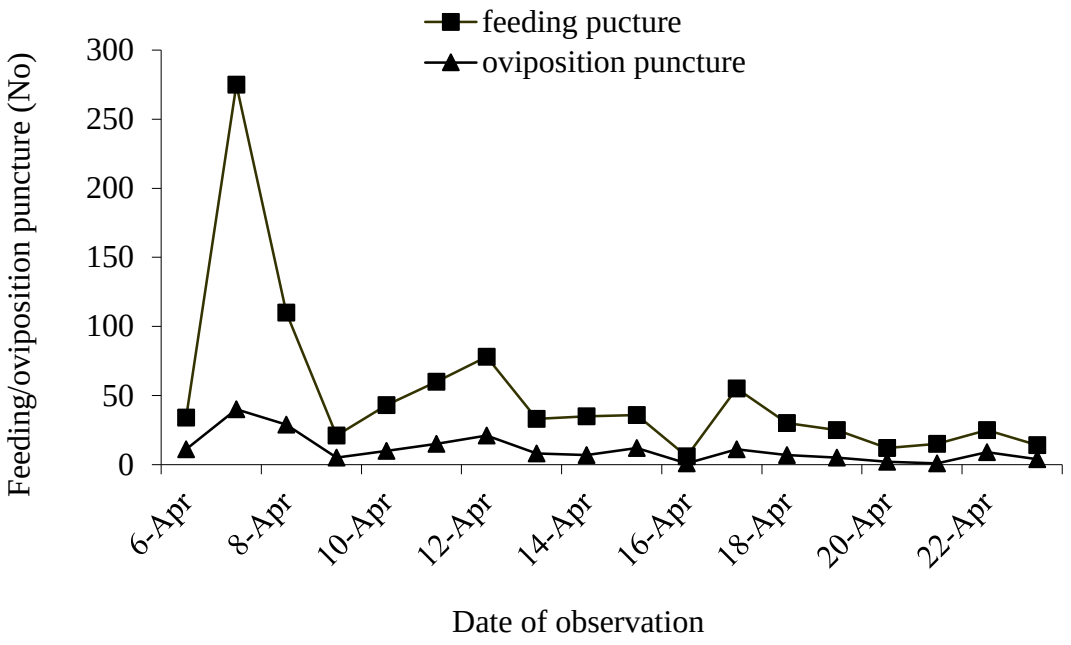

Figure 1. Number of feeding and oviposition puncture in upper foliage leaves

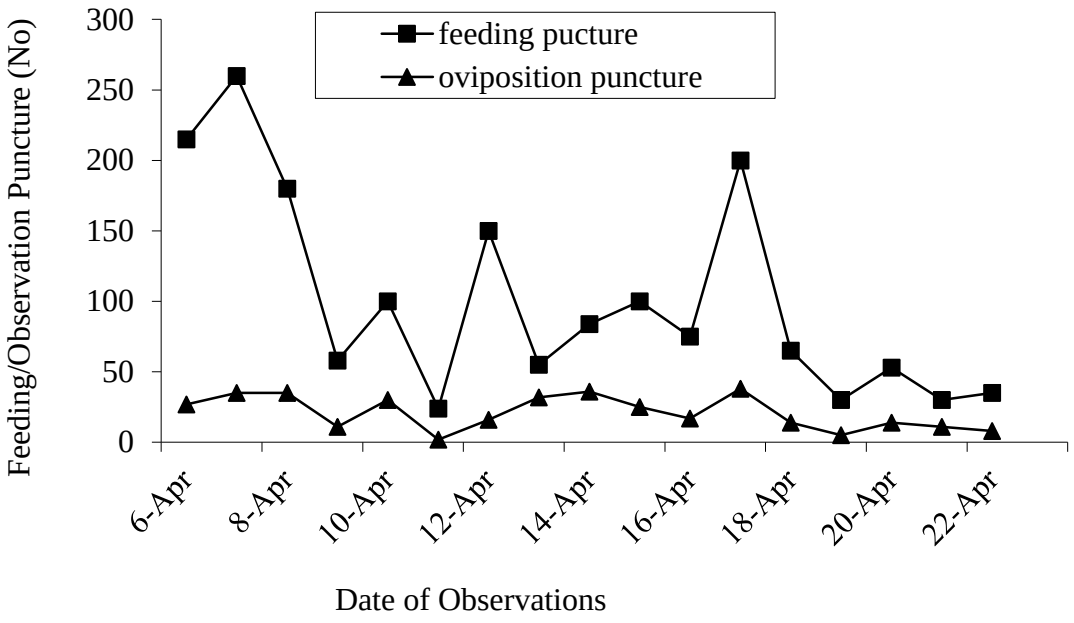

Figure 2. Number of feeding and oviposition puncture in middle foliage leaves

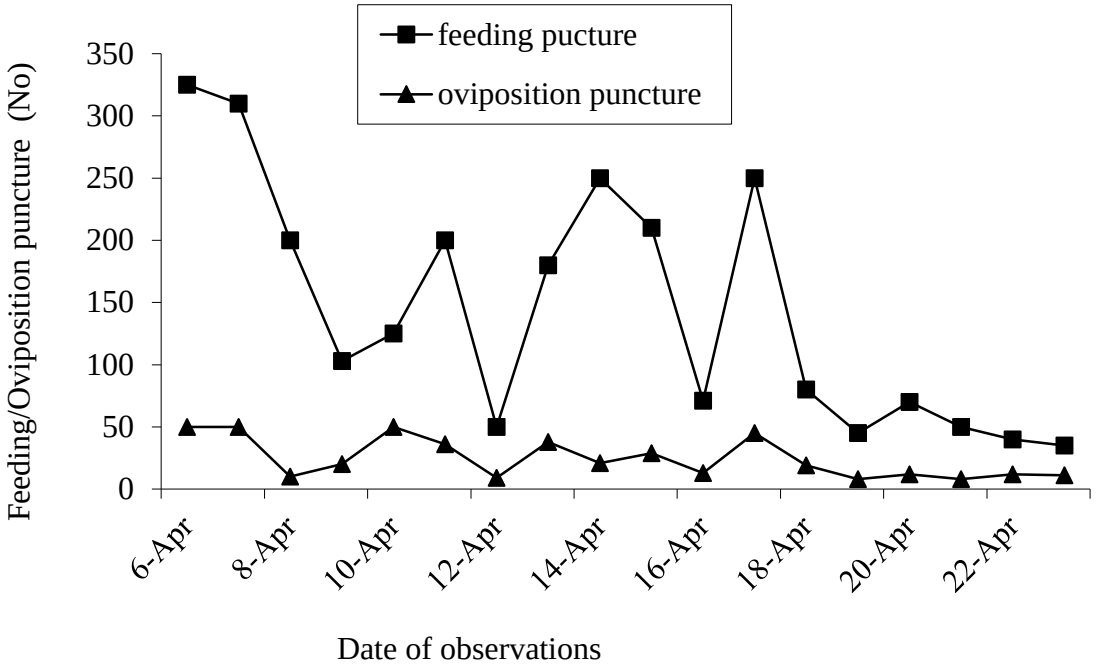

Figure 3. Number of feeding and oviposition puncture in lower foliage leaves

Male and Female Ratio of Delta Trap Captured and Lab Emerged Adults: Emergence started from the day 8. Out of 50 pupas placed in the screened potato plants in lab, average adult emergence was (35.40±3.31). Male and female ratio was 1:1.39 with the average of 13.60±1.53:19.00±1.84, while different male and female ratio (0.98:1) was obtained in the delta trapped adults on day 7 in the field.

Life Cycle under the Laboratory Condition: Table 3 presents the average development period of each stage of L. huidobrensis. The average egg, larval, and pupal development period of L. huidobrensis recorded were 4.75±0.335 (range: 4.00 – 6.00); 10.08±0.238 (range: 9.5-11) and 12.19±0.233 (range: 11.5-13.00) days respectively. The average survival periods of male and female feeding only honey and water were 5.78±0.86 and 3.22±0.954 days, respectively.

Table 3. Mean (± SE) development time (days) and longevity of the adult of *L. huidobrensis* under laboratory condition, Khumaltar

Stages	Mean (days)
Egg development period	4.75±0.335
Larval development period	10.08±0.238
Pupal development period	12.19±0.233
Survival of adults feeding honey water	
Male	5.78±0.86
Female	3.22±0.954

The value before ± indicates average number (days) and after ± indicates standard error (S.E)

Life table study: Table 4 clearly shows that the considerable number of mortality was recorded in the early instars larvae followed by advanced stages. Conversely, low mortality was observed in adult stages (13.72%) compared to initial life stages (egg: 48.26%, larva: 41.17% and pupa: 27.14%, respectively). The possible reasons might be due to unsuitable environment such as soil moisture and temperature coupled with the artificial food. In general, the result has shown that the life expectancy was considerably short during early instars larvae compared to advanced stages.

Table 4. Life table of *L. huidobrensis* under laboratory condition of Entomology Division, Kumaltar

Age (x)	Surviving at start (1x)	Number dying (dx)	Mort. rate (qx)	No. bet. age x and next (Lx)	No. beyond age x (Tx)	Expectancy of life (ex)
Egg	230	111	48.26	174.5	355	1.54
3rd Instar	119	49	41.17	94.5	180.5	1.51
Pupa	70	19	27.14	60.5	86	1.22
Adult	51	7	13.72	25.5	25.5	0.5

x = Pivotal age class
lx = Number surviving at the start of age interval x
dx = Number dying during the age interval x to x +1
qx = Rate of mortality during the age interval x to x +1
Lx = Average of number of individuals between age x to x +1 (lx + lx =1)/2
Tx = Total number of individuals at age x and beyond (all Lx from bottom)
Ex = Life expectancy (Tx/lx)

DISCUSSION

The result of male and female ratio was 1:1.13 with the average result of 13.60± 1.53:19.00±1.84 in the lab but in the field condition male and female ratio was 0.98:1. Field study was in line with Speyer and Parr (1948) and Parella et al. (1983). Sex ratios of adults emerging from pupae by Speyer and Parr (1948) indicated a 1:1 sex ratio. Beri (1974) recognized slight bias in favour of females. Research by Parella et al. (1983) revealed that the emergence ratio of *L. trifolii* for regular five years was 1:1. The result of the lab shows that during the unfavourable period female production is maximum than the male, which punctures on the foliage and destroys the mesophyll cells resulting into rapid destruction of the chlorophyll in the potato field. The deviation in result of lab may be due to the unfavourable temperature in the lab.

Feeding and oviposition puncture ratios ranged from 1:1 to 40:1 and vary with temperature, leaf quality, and host plant. Unless the leaf area exposed to flies (Zepp et al. 1982) and the number of flies released onto the plant can be held constant, these ratios are of little value. Mean egg production per female ranges from less than 100 to greater than 600. Egg development period was in the range of 4 to 6 days, this is in line with the study made by Beri (1974). The period of egg development varies with temperature and ranged 2-8 days (Beri 1974). Larval development period was in the range of 9.5 to 11 days which was similar to the study with Tontowijoyo and van de Fliert (2006), which lasted around 6-12 days. Pupal development period was in range of 11.5 to 13 days. Pupa development varied according to season and temperature. Then, adult emergence occured 7-14 days after pupation at temperatures between 20°C and 30°C (Leibee 1984). Male leaf miner survived for 3 to 10 days, female 1 to 8 days when given a supplementary food. There is slight bias in this case. Parella (1987) reported that when supplementary carbohydrate provided with their related host feeding, females could live 15-20 days and males 10-15 days, respectively.

Similarly, Lynch (1987) reported significantly greater number of *Liriomyza* larvae at the plant base of watermelon as compared with the distal end of vine. Similar results were also obtained by Hanna *et al.* (1987) on snap beans with mean number of leaf mines per leaf of 8.2, 6.8 and, 4.9 in the low, middle and upper leaf zones, respectively. Our study is in line, that the lower foliage damage was more than the middle and upper foliage level.

CONCLUSION

The pea leaf miner, *Liriomyza huidobrensis* Blanchard, is a new pest on potatoes in Nepal. The study included biological study of pea leaf miner in the lab. Biology study revealed that adult *L. huidobrensis* are black flies with thoracic yellow spot, and females were slightly larger than the males. The heavily sclerotised tube was present in case of female abdomen. Male and female ratio was 1:1.39 in the lab condition but it was slightly different under the field condition 0.98:1. Life table studies showed the low mortality in adult stages (13.72%) compared to initial life stages (egg: 48.26%, larva: 41.17% and pupae: 27.14%, respectively).

Also, leaf miner damaged mostly to lower foliage than upper foliage. However, one crop season of field research is inadequate to draw the conclusion about the effectiveness of these bio-rational compounds, which must be evaluated under different climatic conditions and different ecological zones as well. Further study in this regard is imperative.

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