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Deepakar Rupakheti
Program Manager,
Nepal Agriculture Cooperative Central Federation Limited, Bakhundole, Lalitpur, Nepal

Shiva Shankar Bhattarai
Assistant Professor,
Department of Horticulture and Plant Protection, Tribhuwan University, Institute of Agriculture and Animal Sciences, Paklihawa Campus, Siddharthanagar, Nepal

Correspondence
Deepakar Rupakheti
Program Manager,
Nepal Agriculture Cooperative Central Federation Limited, Bakhundole, Lalitpur, Nepal

Assessment of potato leaf miner (*Liriomyza huidobrensis* Blanchard) infestation throughout the important commercial potato production pockets of the country Nepal

Deepakar Rupakheti and Shiva Shankar Bhattarai

Abstract
The study on abundance of *Liriomyza huidobrensis* infestation in Potato was conducted in four districts of Nepal, namely Lalitpur, Kathmandu, Kavre and Bhaktapur, which are the major potato growing pocket areas of the country. Frequent survey regarding incidence and infestation of insects was done during the flowering and harvesting stages of the crop in the respective districts. The analysis of data indicated that the types of foliage damage, i.e., lower, middle and top, is significantly different to each other in every districts of the country. Altitude wise, the lower and middle leaf damage is significant which increased with increase in altitude from 1300 to 1700 masl (metre above sea level), whereas the top leaf damage is insignificant in any of the altitude. The average damage on foliage leaves was recorded highest in Kavre district (50±0.16%) followed by Bhaktapur (41±0.15%), Kathmandu (39±0.22%) and Lalitpur (26±0.24%), respectively. Thus, the old aged leaves and higher altitude are the two factors that affected the damage by leaf miner. This result will help the farmers to apply the suitable cultivation practices and management options in the particular place of Nepal and altitude for the control of the very insect pest.

Keywords: *Liriomyza huidobrensis*, survey, foliage, damage, flowering, harvesting

1. Introduction
Potato (*Solanum tuberosum* L.) is an important cash crop in Nepal [1]. It is superior to pre-existing staple crops because it provides more vitamins and nutrients that support life better than any other crops [2, 3]. The average productivity of potato is less in Nepal as compared to the world's productivity [4]. According to Neupane (2000), among different factors responsible for low productivity, insect loss accounts 15-25% [5]. In developing countries, potato crop loss due to pests and diseases during crop stand and storage is 32% [6]. One of the major constraints of low productivity is the insect pests, including highly invasive exotic pests i.e., Leaf miner. It has been reported that more than 40 insect species have been found to be associated with potato crops in Nepal [7]. Among them, loss by leaf miner is prominent than the rest of the insect pests.
Leaf miner, *Liriomyza. huidobrensis* (Blanchard) originally from the neotropics, was reported in Mexico, and Central and South America, but later spread to other countries in Europe, Africa and Asia [8]. It can cause direct damage to the photosynthetic tissue of host plants because of larval leaf mining and aesthetic damage because of feeding punctures (stipples) produced by adult females [9]. Despite its economic importance, few studies have been carried out on this insect group in Nepal. Keeping in view the above facts and the need of economic study, the study in abundance of leaf miner's infestation in major potato growing areas of the country Nepal was done. It is hoped that this study will help further for the monitoring and management of the leaf miner insect pest.

2. Materials and Methods
2.1 Survey and surveillance of the potato leaf miner *(L. huidobrensis)*
A roving survey was done to know the status of potato leaf miner in potato ecosystem of four districts, namely: Lalitpur, Kathmandu, Kavre and Bhaktapur.

2.1.1 Method of survey
To study the incidence of leaf miner, different wards and VDCs (Village Development Committee) of the respective districts were selected. Survey was undertaken during the flowering and harvesting stages of the crop. Twenty three sites from Bhaktapur, twenty five from Kathmandu, twenty nine from Kavre and twenty six from Lalitpur were selected for the survey. Ten plants were sampled randomly from each site; three leaves of each plant from bottom, middle and upper leaves were selected. In total one hundred three farmer's fields were visited for the determination of pest. Three leaves (one from bottom, one from middle and one from the top of the plant) were observed for the evaluation of damage due to the leaf miner fly. Damaged leaflets per total leaflets in a compound leaf were calculated to determine the percentage loss. Average of thirty leaves from ten plants gives the damage percentage of one farmer's field. Average of the farmers gives locality damage and averages of locality finally provides the district damage level and if calculated average of each districts, the figure shows the status of the pest in the major potato growing region of Nepal.

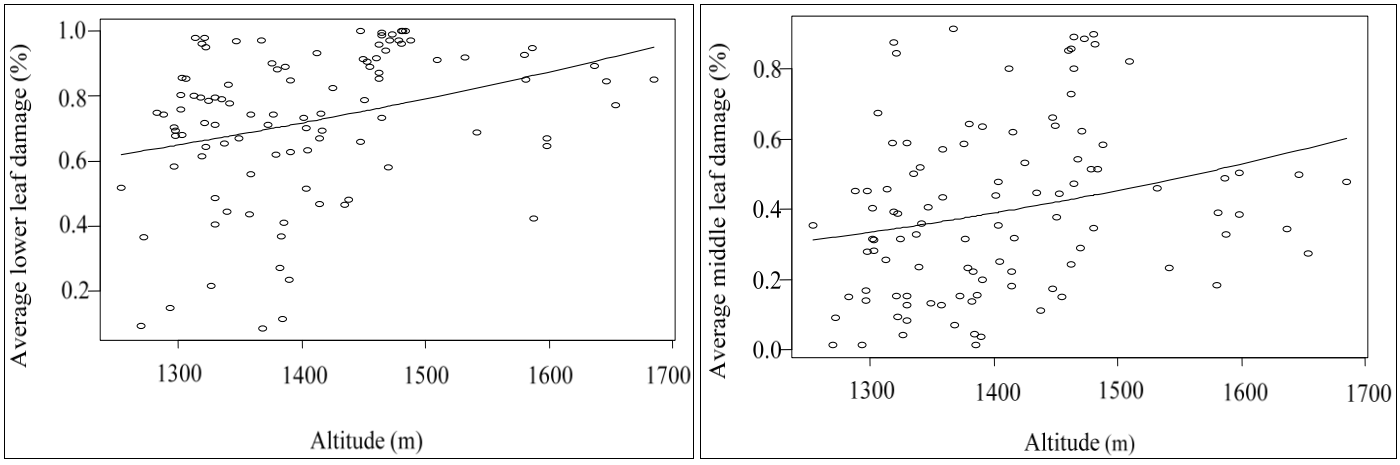
2.1.2 Frequency of survey
A total of two surveys were undertaken during the flowering and harvesting stages of the crop to know the foliar damage due to insect and existence of the pest in the respective districts. A survey during the harvesting stage was useful to correlate the production with the rate of infestation.

2.1.3 Data analysis
The survey data were analysed by the statistical packages like Microsoft Excel, SPSS, GPS data mapping, and R software. Average lower damage was treated as the response variables and regressed against altitude. A log linear model with a Poisson error distribution was used for the analysis due to the count nature of the response variables. A quasi- poison error distribution with F- test was used to handle the over dispersion of the deviance [10]. The significance of each model was tested against the null model as well as with each other up to the third-order polynomials. Forward selection of model was done. R version 2.10.1 was used for regression analyses and graphical representation [11].

3. Result
3.1 Infestation of *L. huidobrensis* in different locations of different districts
Among different visited locations of Lalitpur, Imadol was the most prone area of the *L. huidobrensis*. More than 25% foliage damage was seen in every visited places of Lalitpur except in Salkophat, where it was accounted 5%. Similarly, Goldunga and Kathanchowk of Kathmandu were severely infested by the pests in which 64% of the damage was recorded. Least damage was recorded in the location around Salinadi (9%). Lower foliage was heavily damaged by this pest which was recorded up to 97% in Kathanchok.
In Kavre district, the highest damage (69%) was recorded from Nala and the least damage (20%) from Panchthali. Katunje (55%) and Jorpati (32%) of Bhaktapur were the highest and the least infested area recorded, respectively. It was found that the lower foliage level was heavily infested in the study districts.

3.2 District wise *L. huidobrensis* infestation
Among the four survey districts, all types of foliage damages (lower (p<0.05; F=11.376), middle (p<0.05; F=10.320) and upper leaves (p<0.05; F=2.697)) were significantly different with each other. In general, most of the larval mines, i.e. the infestations were concentrated in the lower level than in the middle and upper level.
Table 1 shows level wise foliage damage in four districts. The lower foliage damage was recorded the highest in Kavre district (86±0.2%) which was followed by Bhaktapur (74±0.3%), Kathmandu (72±0.4%) and Lalitpur (55±0.4%), respectively. Damage was different among the four surveyed districts (p<0.05). The average damage of *L. huidobrensis* was found more in the Kavre district, almost 50±0.16% followed by Bhaktapur (41±0.15%), Kathmandu (39±0.22%) and Lalitpur (26±0.24%), respectively.

3.3 Damage influencing factors
The damage pattern of lower leaves (F-value=10.46; p<0.01) and middle leaves (F-value=6.557; p<0.05) at potato production pockets and altitude seemed to be significantly different. It was observed that the damage increased with increase in altitude which is shown in the figure 1, whereas the damage pattern of upper leaves at potato production pockets and altitude seemed to be non-significant (F-value= 0.4461; p>0.05).



a. Lower leaves damage

b. Middle leaves damage

Fig 1: Relationship between altitude and foliage damage (the line is fitted with 1st order GLM (General linear model) (Lower leaves damage, Middle leaves damage)

Table 1: Damage of foliage leaves (lower, middle, and upper leaves) in different districts.

Survey district	Lower foliage leaves	Middle foliage leaves	Upper foliage leaves	Average damage
Bhaktapur	74±0.31	41±0.3	7.4±0.1	41±0.21
Kavre	86±0.2	54±0.4	1.0±0.1	50±0.27
Kathmandu	72±0.44	38±0.5	7.0±0.2	39±0.353
Lalitpur	55±0.48	22±0.29	3.0±0.08	26±0.24

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

4. Discussion

The leaf miner (*Liriomyza huidobrensis* Blanchard) is a highly polyphagous leaf mining dipteran which can cause both economic and cosmetic damage to a wide range of edible and ornamental crops [9]. Lightly mined leaves show significantly impaired photosynthesis resulting in reduced yields [12]. This study confirmed that the damage level of *Liriomyza huidobrensis* Blanchard which increased with increasing altitude. In this study, infestation varied at different elevation, i.e. 1000 to 2000 masl. Similarly, *Liriomyza* spp. spread out of 1,000 meters to 2,200 meters above sea level with different infestation levels depending on location and plant age leading into early senescence and mortality was confirmed by Chandler and Gilstrap (1987) [13]. Also Rauf *et al.* (2000) [14], Sivapragasam and Syed (1999) [15] and Spencer (1989) [16] revealed that *Liriomyza huidobrensis* Blanchard is the dominant agromyzid which was found at higher elevations (>1000 m) in tropical Asia and has caused much damage to potato.

So, *L. huidobrensis* can be now considered as a cosmopolitan species [9, 17]. Its wide distribution can be due to its wide range of hosts [18] and quick migratory nature and building up of resistance against wide range of insecticides as reported by Olivera and Bordat (1996) [19] and Weintraub and Horowitz (1995) [20]. Even it is continuing to spread to new areas of the atlas [21]. Scheffer (2000) [22] and Dumont (1988) [23] are in the same line and have explained that *L. huidobrensis* is a major pest of flowers and vegetables in many parts of the world, sometimes causing complete crop loss. Similarly, Lynch (1987) [24] found significantly greater densities of *Liriomyza* larvae at the plant base of watermelon as compared with the distal end of vine in a study to evaluate the accuracy of random sampling compared to stratified sampling of watermelon foliage with respect to leaf size and distance from the plant base for *L. sativae* and *L. trifolii* larvae. Similar results were also obtained by Hanna *et al.* (1987) [25] 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. Present study is in line, that the lower foliage damage was more than the middle and upper foliage level.

5. Conclusion

The pea leaf miner, *Liriomyza huidobrensis* Blanchard, is a new pest on potatoes in Nepal. It was almost unknown to the farmers of commercially potato growing areas. The study included: survey and distribution of pea leaf miner throughout the commercial potato production pockets in Nepal. Farmers of Tukucha, Nala, Kavre noticed the presence of the insect in their potato field for the first time. Survey study revealed that the pest *L. huidobrensis* was found in almost all the four districts and in almost all the locations of commercial potato growing areas. The damage level was more in case of lower leaves. Major factors influencing the level of damage was the altitude of the location. So, the pest is becoming severe and distributing countrywide in Nepal. This study confirmed that the damage level of this pest was increasing with altitude.

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