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RESEARCH ARTICLE

THE NATURE AND EXTENT OF DAMAGE BY THE BROWN SLUG, *FILICAULIS ALTE* FERUSSAC, TO SOME VEGETABLE CROPS IN BARNALA AND SANGRUR DISTRICTS, PUNJAB

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Abstract

The brown slugs, *Filicaulis alte* Ferussac, were found damaging vegetable crops in Punjab. Two villages viz; Bhadalwad and Sanghera of district Barnala and one village i.e. Dasaunda Singh Wala of district Sangrur were surveyed. Damage to the vegetable sapling and irregular holes in leaf lamina were observed however, no fruit damage was observed in all the three villages. In Bhadalwad and Dasaunda Singh Wala, highest damage was observed in cauliflower at 6-leaf stage during October (25.03%) and at 4-leaf stage during September (26.58%) respectively whereas in Sanghera field turnip was the most affected crop at 2-leaf stage (22.98%). The study revealed broccoli as the least affected crop in Bhadalwad, Sanghera at 6- leaf stage and Dasaunda Singh Wala at 2- leaf stage with mean percent of damage 17.11, 19.06 and 17.57 respectively. Maximum leaf damage was observed in cabbage in all the three villages during the month of November. Arvi crop was most affected at 4- leaf stage in the month of March to first week of April. Arvi leaves are most affected in Bhadalwad out of three villages during the month of May. Maximum damage was observed in September to first week of October and in March to April, due to optimum temperature and moisture conditions for slug activity on surface. Other factors like height of crop plants, growth stage of the crop and shade availability had direct bearing on the pest incidence.

Introduction

Gastropods including slugs and snails are a very diverse group of molluscs. Most are marine, but many occur in fresh water and terrestrial habitats. Worldwide, terrestrial gastropods have been estimated to number about 35,000 species (Barker, 1999). In India, 14 species of slugs have been reported to be pests of ornamental plants, vegetables and other crops causing damage by their rasping feeding (Kaur and Kaur, 2008a). Even though the damage caused by slugs to vegetable fields, fruit orchards, paddy, tea and mulberry plant is immense, insufficient work on their management exists in the literature as compared to that on insects, rodents and bird pests (Raut and Ghose, 1984).

Slugs are the major pests in agriculture, horticulture and floriculture, causing considerable damage to wheat, alfalfa, corn, soybean and tobacco (Donell et al., 2008). In India, where the pressure of population on land is continuously increasing, vegetables play a significant role in supplying balanced diet. Vegetables are a complex group of plants with diverse form of edible parts like fruits, leaves, stem, roots, tubers and bulb etc. The degree of damage inflicted upon any agricultural plantation depends not only on the activity of each individual slug but also on the density of slug population. The damage caused by slugs is enhanced by factors like damp weather or continuous rains; heavy coarse loamy soil; slow growth of plants under cultivation, for example beans, cucumber, as a result of cool weather

during germination and early stages and late autumn sowing seed (Godan, 1983).

Slugs injure plants by chewing holes in various sizes in the leaves and stems. These holes may be in the middle of the leaf or on the edge. The early seedlings stages are most susceptible to slugs; slugs can sometimes consume the entire seedling. Slugs are completely feed on small leaves while mature leaves show holes on them or eaten away around the edge. In case of slug damage to tomato fruit, complete pericarp was eaten away within an overnight period leaving behind the inner core (Jagtap, 2000). More was the organic matter, phosphorous and potassium in soil in plant nurseries, the more was the slug, *F.alte* density and the more was the damage inflicted to ornamental plants (Chhabra, 2008).

Materials and Methods

Vegetable crops at Bhadalwad, Sanghera and Dasaunda Singh Wala villages were sown and observed carefully to study the nature and extent of damage inflicted by slugs to vegetable crops. Plants in rows with respect to each type of damage were counted. Following vegetable crops were surveyed for damage inflicted by slugs at experimental fields:

1. Cauliflower - *Brassica oleracea var. botrytis*
2. Cabbage - *Brassica oleracea var. capitata*
3. Broccoli - *Brassica oleracea var italica*
4. Radish - *Raphnus sativus*
5. Turnip - *Brassica campestris var. rapa*
6. Arvi - *Colocasia esculenta*

Three replicates each of 10 m^2 for each vegetable crop were taken. Total plants in rows along with damaged ones were counted in each replicate. Plants were observed carefully for slug damage at weekly intervals. Per cent plant damage was calculated by the formula:

$$\text{Per cent damage per replicate} = \frac{\text{Number of damaged plants}}{\text{Total number of plants}} \times 100$$

Results and Discussion

Results of assessment of damage inflicted by slug, *F. alte* to vegetable crops (cauliflower, cabbage, broccoli, radish and turnip) in three villages viz; Bhadalwad, Sanghera and Dasaunda Singh Wala are presented in Table 1, 2, 3 and Plates 1, 2, 3 respectively. Results of assessment of damage to arvi crop in all the three villages are presented in Table 4. Gastropods carved irregular holes within the leaves from April-October as animals were in hibernation from November to February. Slugs attacked the leaves of vegetable crops by nibbling the margins and forming irregular holes on leaf lamina.

Damage to Vegetable Crops

1. Cauliflower (*Brassica oleracea var. botrytis*): Cauliflower is one of several vegetables in the species *B. oleracea*, in the family Brassicaceae. It is nutritious, and may be eaten cooked, raw or pickled. The sowing of cauliflower was done in last week of August in all the fields. The leaves were eaten by making irregular holes in them which were unfit for sale. In Bhadalwad field, 20.49 per cent seedlings were consumed completely by slugs as recorded on 1st September. This damage was further increased to 25.03 per cent at 6- leaf stage on 3 October. Minimum seedling damage was observed at 4- leaf stage i.e. 18.40 per cent on 17 September. Maximum leaf damage was observed on 4 November i.e. 41.11 per cent and minimum leaf damage was noticed as 22.40 per cent on 19 October. In Sanghera field, damage was observed from 3 September 14 November. Maximum mean per cent damage to seedling was observed on 3 September i.e. 20.28 per cent which was further decreased to 15.56 per cent at 6- leaf stage on 5 October. Minimum damage to seedling was noticed on 19 September i.e. 15.48 per cent at 4- leaf stage. Maximum leaf damage was observed on 6 November i.e. 40.96 per cent and minimum leaf damage was noticed on 21 October i.e. 16.75 per cent. In Dasaunda Singh Wala field, maximum mean per cent damage to seedling was observed on 22 September at 4- leaf stage which was further decreased to 19.62 per cent at 6- leaf stage on 8 October and 14.21 per cent at multiple leaf stage on 16 October. Minimum leaf damage was noticed to 24.50 per cent on 24 October which was further increased to 40.53 per cent till 17 November. Barker (2002) observed severe damage, usually occurred in years with high rainfall in summer and autumn. They damaged the crop from August onwards and continued throughout

autumn. They ate leaves and flowers heads of cauliflower. Kaur and Kaur (2003) also reported two types of damage to cauliflower saplings in laboratory i.e. eating of leaf margins in 20 per cent saplings and girdling of stem (16.60 per cent) by slugs. Kaur and Kaur (2008b) noticed that about 61 per cent cauliflower was damaged by slugs during September and October.

2. Cabbage (*Brassica oleracea var. capitata*): Slugs ate cabbage leaves and made irregular holes in them. In Bhadalwad field, about 19.31 per cent damage was observed on 1 September which was further increased to 23.62 per cent at 4- leaf stage on 25 September and it was again decreased to 18.44 per cent on 3 October at 6- leaf stage. Minimum leaf damage was observed on 19 October i.e. 19.62 per cent and which was further increased to 46.11 per cent on 12 November. In Sanghera field, maximum mean per cent seedling damage was observed as 21.31 per cent on 27 September at 4- leaf stage and minimum damage was observed as 18.69 per cent on 5 October and 12.57 per cent on 13 October at 6- leaf stage and multiple leaf stage respectively. Damage to leaves was observed to 21.90 per cent on 21 October which was increased to 46.40 per cent on 14 November. In Dasaunda Singh Wala field, about 21.41 per cent damage to seedling was observed on 6 September which was further increased to 26.02 per cent at 2- leaf stage on 14 September. This damage was again decreased to 15.22 per cent on 16 October at multiple leaf stage. Maximum leaf damage was observed on 9 November i.e. 40.63 per cent and minimum damage observed on 24 October i.e. 23.73 per cent. Cabbage crop was highly preferred by gastropods, which are most damaging during wet weather in spring and autumn. Leaf damage is most severe after formation of the heads as *D. reticulatum* shelter within the developing cabbage (Kaur and Kaur, 2003).

3. Broccoli (*Brassica oleracea var italica*): In Bhadalwad field, mean percent damage to seedling was observed from 1 September to 11 October. About 15.04 per cent damage was noticed on 1 September which was further increased to 17.11 per cent on 3 October at 6- leaf stage and it was again decreased to 4.18 per cent at multiple leaf stage. Damage to leaves was observed from 19 October to 12 November and it was maximum on 12 November i.e. 23.44 per cent. In Sanghera field, mean per cent damage was noted throughout crop period. About 14.48 per cent damage to seedling was observed on 3 September which was further increased to 19.06 per cent at 6- leaf stage on 27 September. This damage again deceased to 6.23 per cent at multiple leaf stage on 13 October. Maximum leaf damage was observed as 25.45 per cent on 14 November. In Dasaunda Singh Wala field, maximum mean per cent damage to seedling was observed as 17.57 per cent on 14 September at 2- leaf stage, which was further decreased to 14.35 per cent on 8 October and 6.85 per cent on 16 October at 6- leaf stage and multiple leaf stage respectively. Minimum and maximum leaf damage was observed as 9.83 per cent and 18.08 per cent on 24 October and 17 November respectively. Snails and slugs eat both living plants and dead or decaying vegetation, chewing irregular holes with smooth edges in leaves and flowers. Some plants that can be seriously damaged include basil, broccoli, beans, cabbage, lettuce and strawberries. The seedling stage is the most vulnerable (Davis et al., 2006).

4. Radish (*Raphnus sativus*): In Bhadalwad field, maximum damage to seedling was recorded on 25 September i.e. 23.55 per cent at 4- leaf stage. The extent of damage stated decreasing during first week of October i.e. 21.89 per cent on 3 October at 6- leaf stage. Maximum leaf damage was observed as 42.32 per cent on 4 November and minimum leaf damage as 23.29 per cent on 19 October. In Sanghera field, maximum mean per cent seedling damage was observed as 21.96 per cent on 11 September at 2-leaf stage. This damage further decreased to 18.01 per cent on 5 October at 6- leaf stage and 4.71 per cent on 13 October at multiple leaf stage. 17.42 per cent leaf damage was observed on 21 October which was further increased to 32.70 per cent on 14 November. In Dasaunda Singh Wala field, about 22 per cent damage to seedling was observed on 6 September which was further decreased to 18.78 per cent at 6- leaf stage on 8 October and 14.47 per cent at multiple leaf stage on 16 October. Maximum leaf damage was observed to 33.95 per cent on 1, 9 and 17 November. Barker (2002) reported that young leaves were eaten down to soil level or if the infestation takes place at later stages, the mature leaves were scraped away in place or have holes in them or the leaf tips were eaten; occasionally only the leaf vein remained. Kaur and Kaur (2008b) reported that 64 per cent damage was noticed to radish plant during September and October. The slug, *Limax maximus* consumed white radish 4.2 to 15.8 per cent and radish 13.9 to 17.5 per cent in laboratory (Godan, 1983).

5. Turnip (*Brassica campestris var. rapa*): In Bhadalwad field, maximum mean per cent damage to turnip crop was 19.76 per cent on 25 September at 4- leaf stage which was further decreased to 15.85 per cent on 3 October and 11.33 per cent on 11 October at 6- leaf stage and multiple leaf stage respectively. 19.16 per cent leaf

damage was observed on 19 October which was further increased to 38.62 per cent on 4 November. In Sanghera field, maximum mean per cent damage to seedling was observed on 11 September at 2- leaf stage i.e. 22.96 per cent which was further decreased to 17.07 per cent on 5 October and 10.97 per cent on 13 October at 6- leaf stage and multiple leaf stage. Maximum leaf damage was observed to 31.25 per cent on 6 November. In Dasaunda Singh Wala field, about 20.16 per cent damage to seedling was observed on 6 September which was further increased to 21.80 per cent on 30 September at 4- leaf stage. Again this damage was decreased to 15.75 per cent at multiple leaf stage on 16 October. About 25.89 per cent leaf damage was obtained on 24 October which was further increased to 35.99 on 17 November. No damage noticed to fruits. **Barratt et al (1994) observed that** turnips, which suffered only minor losses from slugs during establishment, consequently showed no yield reductions at maturity.

6. Arvi (*Colocasia esculenta*): Arvi is rich source of carbohydrates. It is cultivated for its edible corns, but its tender shoots and leaves are also used like palak. Leaves of arvi were eaten from margins and center making regular holes in them. Sowing of arvi was done between 1 to 6 March in three villages. In Bhadalwad field, maximum mean per cent damage to seedling was shown in 4- leaf stage i.e. 19.86 per cent on 23 March, which was further decreased to 19.78 per cent on 8 April and 18.46 per cent on 16 April at 6- leaf stage and multiple leaf stage respectively. Damage to leaves was recorded maximum on 10 and 18 May i.e. 43.26 per cent and minimum on 24 April i.e. 23.31 per cent. In Sanghera field, maximum seedling damage was recorded on 25 March at 4- leaf stage i.e. 19.16 per cent which was further decreased to 9.01 per cent at multiple leaf stage on 18 April. Leaf damage was recorded from 26 April to 20 May. It was observed maximum on 20 May i.e. 33.51 per cent. In Dasaunda Singh Wala field, about 7.65 per cent seedling damage was observed on 12 March, which was further increased to 15.13 per cent at 4- leaf stage on 28 March and become maximum on 5 April at 4- leaf stage i.e. 20.26 per cent. This damage again decreased to 7.30 per cent at multiple leaf stage on 21 April. Maximum leaf damage was observed on 23 May i.e. 33.96 per cent and minimum leaf damage was observed on 29 April i.e. 18.15 per cent. Kaur (2003) reported that leaves of arvi were eaten from margins and center making regular holes in them and young stems were also debarked resulting in reduced growth of the crop. Damage to leaves of arvi observed was very high being 60 per cent.

Table 1: Mean per cent damage inflicted by the brown slug, *F. alte* to whole seedlings/saplings and leaves of some vegetables per replicate (area=10m^2) throughout crop period at Bhadalwad village, Barnala

Dates/Year 2013	Cauliflower	Cabbage	Broccoli	Radish	Turnip
Damage to whole seedlings/saplings					
1-Sept	20.49±1.76	19.31±1.93	15.04±3.03	17.52±2.03	17.51±0.12
9-Sept	18.95±0.79*	20.52±1.86*	14.68±3.52*	17.32±1.90*	18.10±0.16*
17-Sept	18.40±1.94**	21.70±3.30**	14.72±1.71**	16.18±0.85**	19.64±1.47**
25-Sept	22.55±2.44***	23.62±0.28**	13.36±0.46***	23.55±1.30**	19.76±1.29**
3-Oct	25.03±1.80***	18.44±2.86***	17.11±2.31***	21.89±3.81***	15.85±1.94***
11-Oct	10.55±3.38^{MLS}	9.36±2.50^{MLS}	4.18±2.32^{MLS}	9.18±2.33^{MLS}	11.33±2.24^{MLS}
Damage to leaves					
19-Oct	22.40±1.45	19.68±0.32	12.52±3.13	23.29±1.77	19.16±1.06
27-Oct	36.11±2.00	37.76±2.22	22.10±4.92	37.40±1.24	32.08±3.17

4- Nov	41.11±3.90	43.88±5.81	22.10±4.92	42.32±1.71	38.62±4.90
12-Nov	41.11±3.90	46.11±7.74	23.44±4.21	42.32±1.71	38.62±4.90
Nature of leaf damage	Holes in leaves	Holes in leaves	Holes in leaves	Holes in leaves	Holes in leaves

All values are Mean±S.E.
Damage to * 2-leaf stage, ** 4-leaf stage, *** 6-leaf stage, MLS- Multiple leaf stage

Table 2: Mean per cent damage inflicted by the brown slug, *F. alte* to whole seedlings/saplings and leaves of some vegetables per replicate (area=10m^2) throughout crop period at Sanghera village, Barnala

Dates/Year 2013	**Cauliflower**	**Cabbage**	**Broccoli**	**Radish**	**Turnip**
Damage to whole seedlings/saplings					
3-Sept	20.28±3.85	20.21±1.26	14.48±1.41	17.28±0.45	20.21±1.70
11-Sept	19.66±1.07*	19.48±0.62*	15.97±1.55*	21.96±1.07*	22.96±1.14*
19-Sept	15.48±0.41**	18.85±1.90**	18.78±1.79**	19.98±0.71**	19.95±2.64**
27-Sept	18.32±0.58***	21.31±0.67**	19.06±2.17***	20.45±2.28**	18.41±2.19**
5-Oct	15.56±1.65***	18.69±1.18***	18.03±3.07***	18.01±1.01***	17.07±2.67***
13-Oct	7.51±1.38^{MLS}	12.57±4.90^{MLS}	6.23±2.15^{MLS}	4.71±0.28^{MLS}	10.97±4.25^{MLS}
Damage to leaves					
21-Oct	16.75±1.87	21.90±4.40	9.94±2.38	17.42±2.35	16.11±4.85
29-Oct	30.40±2.21	35.13±4.51	21.95±0.59	29.75±1.28	26.11±5.71
6- Nov	40.96±1.07	42.51±4.00	23.70±1.36	32.70±1.04	31.25±6.26
14-Nov	40.96±1.07	46.40±5.38	25.45±3.09	32.70±1.04	31.25±6.26
Nature of leaf damage	Holes in leaves	Holes in leaves	Holes in leaves	Holes in leaves, Margins eaten	Holes in leaves

All values are Mean±S.E.
Damage to * 2-leaf stage, ** 4-leaf stage, *** 6-leaf stage, MLS- Multiple leaf stage

Table 3: Mean per cent damage inflicted by the brown slug, *F. alte* to whole seedlings/saplings and leaves of some vegetables per replicate (area=10m^2) throughout crop period at Dasaunda Singh Wala village, Sangrur

Dates/Year 2013	Cauliflower	Cabbage	Broccoli	Radish	Turnip
Damage to whole seedlings/saplings					
6-Sept	23.52±1.77	21.41±1.20	16.31±1.43	22.00± 1.10	20.16±0.86
14-Sept	25.83±2.27*	26.02±1.94*	17.57±1.81*	18.94±0.52*	21.00±2.12*
22-Sept	26.58±2.74**	25.35±0.82**	14.46±2.22**	20.83±2.08**	21.08±1.18**
30-Sept	23.96±1.86***	25.71±1.02**	17.07±3.02***	20.93±2.14**	21.80±1.17**
8-Oct	19.62±1.62***	22.37±3.75***	14.35±1.41***	18.78±0.60***	17.78±0.69***
16-Oct	14.21±1.71^{MLS}	15.22±3.11^{MLS}	6.85±1.55^{MLS}	14.47±2.30^{MLS}	15.75±3.60^{MLS}
Damage to leaves					
24-Oct	24.50±0.49	23.73±3.22	9.83±2.26	24.26±0.52	25.89±8.51
1-Nov	40.53±2.82	33.78±2.69	16.49±1.52	33.95±1.19	34.48±4.54
9- Nov	40.53±2.82	40.63±2.69	16.49±1.52	33.95±1.19	34.48±4.54
17-Nov	40.53±2.82	40.63±2.96	18.08±2.98	33.95±1.19	35.99±3.46
Nature of leaf damage	Holes in leaves	Holes in leaves	Holes in leaves	Holes in leaves, Margins eaten	Holes in leaves, Margins eaten

All values are Mean±S.E.
Damage to * 2-leaf stage, ** 4-leaf stage, *** 6-leaf stage, MLS- Multiple leaf stage

Table 4: Mean per cent damage inflicted by the brown slug, *F. alte* to whole seedlings/saplings and leaves of Arvi crop per replicate (area=10m^2) throughout crop period in all villages

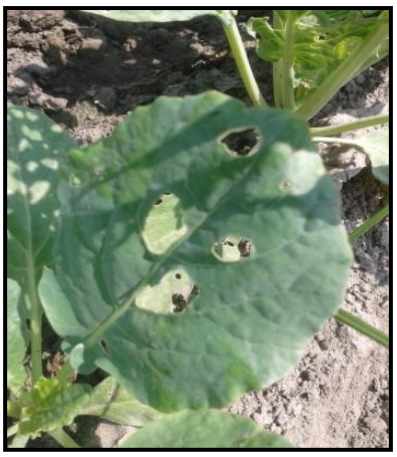
Dates/Year 2013	BHADALWAD	Dates/Year 2013	SANGHERA	Dates/Year 2013	DASAUNDA SINGH WALA
Damage to whole seedlings/saplings					
7-Mar	16.33±0.88	**9-Mar**	10.74±0.75	**12-Mar**	7.65±1.14

15-Mar	16.53±0.98*	**17-Mar**	9.58±0.89*	**20-Mar**	8.32±1.34*
23-Mar	19.86±1.41**	**25-Mar**	19.16±1.10**	**28-Mar**	15.13±1.20**
31-Mar	19.11±3.78**	**2-Apr**	12.87±2.55**	**5-Apr**	20.26±2.67**
8-Apr	19.78±1.56***	**10-Apr**	11.43±3.12***	**13-Apr**	18.29±2.43***
16-Apr	18.46±2.09^{MLS}	**18-Apr**	9.01±1.44^{MLS}	**21-Apr**	7.30±0.55^{MLS}
Damage to leaves					
24-Apr	23.31±0.85	**26-Apr**	17.82±1.13	**29-Apr**	18.15±1.98
2-May	34.71±3.63	**4-May**	26.80±1.42	**7-May**	26.65±1.27
10-May	43.26±3.43	**12-May**	29.96±0.66	**15-May**	33.96±1.77
18-May	43.26±3.43	**20-May**	33.51±1.78	**23-May**	33.96±1.77

All values are Mean±S.E.
Damage to * 2-leaf stage, ** 4-leaf stage, *** 6-leaf stage, MLS- Multiple leaf stage

a

b



c

d

e

Plate 1: Nature of damage inflicted by brown slug *F. alte* towards vegetable crops in Bhadalwad village

a) **Cauliflower - Brassica oleracea var. botrytis**
b) **Cabbage - Brassica oleracea var. capitata**
c) **Broccoli - Brassica oleracea var italica**
d) **Radish - Raphnus sativus**
e) **Turnip - Brassica campestris var. rapa**

a

b

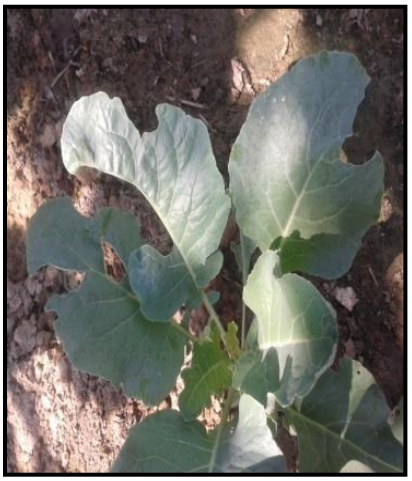
c

d  e 

Plate 2: Nature of damage inflicted by brown slug *F. alte* towards vegetable crops in Sanghera village

a) **Cauliflower - Brassica oleracea var. botrytis**
b) **Cabbage - Brassica oleracea var. capitata**
c) **Broccoli - Brassica oleracea var italica**
d) **Radish - Raphnus sativus**
e) **Turnip - Brassica campestris var. rapa**

a 

b 

c 

d  **e** 

Plate 3: Nature of damage inflicted by brown slug *F. alte* towards vegetable crops in Dasaunda Singh Wala village

a) Cauliflower - Brassica oleracea var. botrytis
b) Cabbage - Brassica oleracea var. capitata
c) Broccoli - Brassica oleracea var italica
d) Radish - Raphnus sativus
e) Turnip - Brassica campestris var. rapa

Conclusion

These results therefore suggested that the extent of damage to vegetable crops depends on increased activity of slugs in the field due to prevailing climatic conditions, stage and height of crop plant and shelter availability. In general, young seedling stage of plant was more vulnerable to slug attack. More damage was observed in September-October and March-April in vegetable crops. So, it is suggested that slug control measures must be adopted during these months to minimize the slug damage.

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