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Survey on the Incidence and Population Build-up of *Chauliops fallax* Sweet and Schaeffer (Hemiptera: Malcidae) on Different Legume Crops under Low and Mid Hills of Himachal Pradesh

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A B S T R A C T

Incidence of the bean bug *Chauliops fallax* Sweet and Schaeffer (Hemiptera: Malcidae) was recorded on soybean and pulses grown during *Kharif* at five different locations under low and mid hills of Himachal Pradesh during 2016. Its incidence varied from 0.20 to 28.8 bugs per 10 plants on soybean and pulses at different locations. The maximum incidence was recorded at Sundernagar on soybean crop (28.80 bugs/ 10 plants) whereas minimum incidence was observed at Una (0.20 bugs/ 10 plants). Seasonal abundance of the bug was studied on soybean, cowpea and black gram (mash) at Palampur starting from third week of June, 2016 till last week of September, 2016. The bug appeared just after germination of the crops and remained feeding on them up to their maturity or harvesting. Peak population on soybean (188 bugs/ 10 plants) was observed during 1st week of August. Peak population on cowpea (68 bugs/ 10 plants) and mash (40 bugs/ 10 plants) was observed during 2nd week of August. Among weather parameters, rainfall and relative humidity had a significant positive correlation with bug population on the three hosts.

Introduction

C. fallax is a diminutive bug of approximately 2.5mm long in the adult stage, with a unique form of eyestalk also known as stalk-eyed bug (Tomokuni *et al.*, 1993). The body is elongate, oval, narrowing anteriorly and posteriorly and slightly constricted at the junction of thorax and abdomen. Adults of this pest are brown to dark brown and nymphs are dark coloured. The nymphs cling tightly to the under surface of the leaf and tend to aggregate together (Rawat and Sahu, 1973). The nymphs are unusual in that they bear remarkably flat hairs with glandular apices. There are two scent glands on the abdomen between segments 3 to 5 and 5 to 6. The eggs are laid glued by a thick, dark secretion on the under surface of the leaf along the leaf veins and in plant hairs on stems and shoots.

The insects live on the leaf surface, usually the under surface, and when disturbed, the adults drop off quickly, falling on the ground. Two to three generations has been reported in a year (Suzuki *et al.*, 2011).

In India, *C. fallax* commonly called the bean

bug, was recorded from Chikkaballapura (Karnataka) for the first time (Distant 1918). Later on the known range of distribution of the bug in the country extended from Kangra (Himachal Pradesh) in north to Chikkaballapura (Karnataka) in the south and from Ranchi (Bihar) in the east to Hissar (Haryana) in the west (Chopra and Rustogi 1982). In Himachal Pradesh, *C. fallax* have been reported to cause damage on number of important crops including soybean, French bean, black gram, green gram, cowpea, horse gram etc. (Sharma and Bhalla, 1964; Kashyap and Adlakha, 1971; Lal 1975; Kumar *et al.,* 2014). Another related species, *C. nigriscens*, commonly called the black bean bug, has been mainly recorded to feed on French bean in the state (Chaudhari, 1961; Sharma *et al.*, 1993; Mehta *et al.,* 2001). Both nymphs and adults of the bug suck plant sap usually from the lower surface of leaves whereas the tender shoots and upper surface of the leaves harbor less number of insects. As a result of sap sucking the chlorophyll content appears to be reduced which ultimately affects the quality and yield of crops. Badly damaged leaves show several minute whitish spots caused by feeding and small black pustules formed by the dried up excreta of the pest. The leaves attacked by this species show numerous minute yellowish specks with a loss of chlorophyll content (Lal, 1975). When feeding on the leaves, the leaves become covered with tiny pale spots representing the removal of parenchyma tissues and chlorophyll. The leaves then gradually turn yellow, wither and drop from the plant. The badly infested plants thus, lose all leaves and die prematurely. The damage to crops is particularly serious during the rainy season (Lal, 1981).

Materials and Methods

The present study on "Survey on the incidence and population build-up of *Chauliops fallax* Sweet and Schaeffer (Hemiptera: Malcidae) was carried out on three different hosts *viz.*, soybean, cowpea and black gram (mash) under lab and field conditions. The experiments on the biology of the bean bug were conducted in the Post Graduate Lab of the Department of Entomology whereas field experiments were conducted in the experimental farms of the Department of Crop Improvement and Department of Plant Pathology, College of Agriculture, CSK Himachal Pradesh Krishi Vishvavidyalaya (CSKHPKV), Palampur, situated at an altitude of 1291 meter above mean sea level between 32^0 06' North latitude and 76^0 03' East longitude during *Kharif* 2016. The incidence of *C. fallax* was recorded by surveying different locations in low and mid hills of Himachal Pradesh during the season. A detailed account of materials used and methods adopted during the course of study is being presented in this chapter.

Raising of crops

Seeds of soybean (cv. Him Soya), cowpea (cv. C 475) and mash (cv. Him Mash1) cowpea and mash were procured from the Department of Seed Science and Technology, CSKHPKV. These crops were sown on 18th June, 2016 at experimental area of the Department of Entomology to collect the *adults* of bean bug for initiating the culture under laboratory conditions and also to get the fresh leaves for maintaining laboratory culture. Fresh leaves from these crops were also obtained for feeding the bug during lab experiments. The crops were raised following recommended package of practices (Anonymous, 2011).

Maintenance of the stock in the laboratory

Stock culture of the bean bug was maintained separately on potted plants of three hosts *viz.*, soybean (Him Soya), cowpea (C 475) and black gram (Him Mash-1) under caged conditions in Department of Entomology

throughout the course of this study. For this purpose, the copulating adults of bean bug were collected from naturally infested plants of soybean, cowpea and black gram grown under field conditions and released on potted plants of respective crops maintained separately under caged conditions in the lab. The insects were allowed to feed and multiply on the potted plants. Dried and matured plants were periodically replaced with young plants of the same varieties. Various stages of the insect required for the experimentation were obtained from the stock culture and for their feeding fresh leaves of different hosts were obtained from the field.

Seasonal abundance

Incidence of *C. fallax* on different crops in low and mid hills of Himachal Pradesh

Different locations under low and mid hills of Himachal Pradesh (Table 1) were surveyed during *Kharif*-2016 to record incidence of bean bug on various host crops. For this purpose data on the incidence (no. of bugs/ 10 plants) of bug was recorded on 50 randomly selected plants of various crops at vegetative and flowering stages.

Population build-up of *C. fallax* on different crops at Palampur

Population build-up of *C. fallax* was studied on three host crops *viz.*, soybean, cowpea, and black gram (mash) at Palampur following the methodology adopted by Sharma and Sharma (1998) in case of *C. nigrescens*. For this purpose, data were recorded on the mean population of bug per 10 plants (no. of eggs, nymphs and adults/ plant) at weekly intervals starting from germination of the crops till its harvesting. In case of soybean, the observations were recorded on variety Him Palam Hara Soya -1 which was sown on 14th June, 2016 in the experimental area of the Department of Crop Improvement, CSKHPKV. In case of cowpea and mash observations were recorded on varieties C-475 and Pant U19, respectively. Cowpea and mash were sown in the experimental area of the Department of Plant Pathology, CSKHPKV on 27th June, 2016 and 2nd July, 2016, respectively. Observations were recorded on randomly selected plants of each host just after germination till harvesting of the crop at weekly intervals. Number of observations varied with the stage of host plant *i.e.* from 30-100. At each sampling date, entire plant was sampled for the presence of eggs, nymphs and adults. Different stages of the bug were counted separately and their means were worked out on the basis of per 10 plants. Sum of the number of eggs, nymphs and adults per 10 plants was considered as the total population of the bug. Per cent infestation of the bug was also calculated on three hosts by using the formula:

$$\text{Infestation (\%)} = \frac{\text{Number of infested plants}}{\text{Total number of sampled plants}} \times 100$$

Correlation co-efficient between bean bug population and weather parameters

Weekly averages of various weather parameters pertaining to the study period (Appendix-I) were used to worked out their correlation coefficients with mean population of bug per 10 plants recorded at weekly intervals on the three hosts through simple correlation analysis (Chandel, 1993).

Results and Discussion

Incidence of *C. fallax* on different crops in low and mid hills of Himachal Pradesh

Incidence of the bean bug, *C. fallax* was recorded on soybean (cv. Him Soya), cowpea (cv. C 475 & C 519) mash (black gram, cv.

Pant U19) and 'mung' (green gram, cv. Suketi) at various locations under low and mid hills of Himachal Pradesh during July-September, 2016 by conducting general surveys. Results of the survey revealed the prevalence of the bug on different crops at all the locations surveyed during the study (Table 2). Incidence of the bug varied from 0.2 to 28 no. of bugs per 10 plants at different locations. Very low level of incidence (0.2 no. of bugs/ 10 plants) was recorded at Una on 3rd week of July on soybean. Maximum incidence (28.8no. of bugs/ 10 plants) was found at Sundernagar during 2nd week of July on the same crop. In case of pulse crops, the incidence of the bug was noted at Kangra (on cowpea) and at Berthin, district Bilaspur (on cowpea, mash and 'mung'). Among pulses, maximum incidence was recorded on 'mung' (26 bugs/ 10 plants) at Berthin during 2nd week of July.

These results are indicative of the widespread prevalence of the bug at different locations under low and mid hills of Himachal Pradesh on soybean and on different pulses grown during *Kharif* season. The results provide some useful information about population density levels of the pest at different locations and its potential to cause economic damage to soybean and important pulses. Earlier the bug was reported to infest soybean in Kangra valley (Kashyap and Adlakha, 1971; Kumar *et al.,* 2014) and on French bean, horse gram, black gram, green gram, cowpea and soybean from Kullu valley (Lal, 1974).

Seasonal abundance of *C. fallax* on different hosts

Seasonal abundance of *C. fallax* was studied on soybean, cowpea and mash (black gram) at Palampur during 2016. Data pertaining to this have been presented in tables 3 to 5. The bug started appearing on these crops just after their germination and remained active throughout the cropping season till the maturity and harvesting of the crops in the last week of September. Results on seasonal abundance of the bug are being described and discussed below:

In soybean, first appearance of copulating adults was observed on 22nd June, 8 days after sowing of the crop. Eggs and nymphs were noted after 3-4 weeks of adult appearance on the crop. The total number of bugs (no. of eggs, nymphs and adults taken together) varied from 3 to 188 per 10 plants during the observation period starting from the 4th week of June till last week of the September. In the beginning the population was low which gradually increased and attained peak during first week of August then it gradually decreased to very low levels because of yellowing and falling of leaves due to crop maturity. The maximum number of eggs (48/ 10 plants) and nymphs (115/ 10 plants) were recorded during first week of August resulting into increase in adult population which was maximum (58/ 10 plants) during 5th week of August. Data on per cent plant infestation by this bug varied from 17 to 93 per cent. It was maximum during 3rd week of August. Nymphs and adults of the bug were generally observed feeding on the lower side of the leaf and their heavy infestation resulted into appearance of whitish spots or patches on the upper side of the leaf (Plate 1).

Data presented in tables 3 and 5 showed that the population build-up of the bug exhibited almost same trend in cowpea and mash as in case of soybean. The first appearance of adults of the bug on these crops was recorded during 2nd and 3rd week of July, respectively. Delayed appearance of the bug on these crops was due to their late sowing as compared to the sowing of soybean. The bug population varied from 2 to 68 per 10 plants in cowpea during the observation period (2nd week of July to last week of September).

Table.1 Crops and locations surveyed to record incidence of *C. fallax*

Crops observed	Locations	Period of observation
Soybean	Sundernagar, Mandi	2nd week of July
	Una	3rd week of July
	Kangra	4th week of July
	Palampur	2nd week of September
Cowpea	Berthin, Bilaspur	2nd week of July
	Kangra	2nd week of July
Mash	Berthin	2nd week of July
Mung	Berthin	2nd week of July

Table.2 Incidence of *C. fallax* on different crops in low and mid hills of Himachal Pradesh during July-September (*Kharif*), 2016

Crops	Varieties	Period of observation	Locations	No. of bugs/ 10 plants
Soybean	Him Soya	2nd week of July	Sundernagar	28.80
		3rd week of July	Una	0.20
		4th week of July	Kangra	20.40
		2nd week of September	Palampur	22.80
Cowpea	C 475	2nd week of July	Berthin	18.42
	C 519	2nd week of July	Kangra	19.87
Mash	Pant U19	2nd week of July	Berthin	24.56
Mung	Suketi	2nd week of July	Berthin	26.00

Table.3 Population build-up of *C. fallax* on soybean at Palampur during 2016

	Mean population/ 10 plants					
Date of Observation	**DAS**	**Eggs**	**Nymphs**	**Adults**	**Total**	**Infestation (%)**
22	8	0	0	3	3	17.00
29	15	0	0	8	8	52.00
July, 2016						
6	21	0	0	13	13	56.00
13	28	16	0	17	33	33.00
20	35	19	18	21	58	34.00
27	42	10	35	16	61	22.00
August, 2016						
3	49	48	115	25	188	92.30
10	56	24	87	10	121	73.33
17	63	18	108	36	162	93.00
24	70	10	82	24	116	90.00
31	77	0	73	58	131	73.33
September, 2016						
7	84	6	57	31	94	69.23
14	91	0	35	26	61	35.71
21	98	0	12	18	30	51.00
28	105	0	2	7	9	40.00

*DAS = Days After Sowing

Table.4 Population build-up of *C. fallax* on cowpea at Palampur during 2016

	Mean population/ 10 plants					
Date of observation	**DAS**	**Eggs**	**Nymphs**	**Adults**	**Total**	**Infestation (%)**
July, 2016						
6	9	0	0	6	6	32.00
13	16	0	0	8	8	40.00
20	23	14	6	12	32	36.00
27	30	9	15	8	32	76.66
August, 2016						
3	37	32	11	13	56	53.33
10	44	21	32	15	68	79.00
17	51	10	26	18	54	81.48
24	58	4	23	15	42	71.42
31	65	0	20	8	28	78.57
September, 2016						
7	72	0	27	19	46	92.85
14	79	0	8	2	10	62.00
21	84	0	4	4	8	57.00
28	91	0	0	2	2	60.00

*DAS = Days After Sowing

Table.5 Population build-up of *C. fallax* on mash at Palampur during 2016

	Mean population/ 10 plants					
Date of observation	**DAS**	**Eggs**	**Nymphs**	**Adults**	**Total**	**Infestation (%)**
July, 2016						
6	4	0	0	6	6	32.00
13	11	0	0	8	8	40.00
20	18	14	6	12	32	36.00
27	25	9	15	8	32	76.66
August, 2016						
3	32	32	11	13	56	53.33
10	39	21	32	15	68	79.00
17	46	10	26	18	54	81.48
24	53	4	23	15	42	71.42
31	60	0	20	8	28	78.57
September, 2016						
7	67	0	27	19	46	92.85
14	74	0	8	2	10	62.00
21	81	0	4	4	8	57.00
28	88	0	0	2	2	60.00

*DAS = Days After Sowing

Table.6 Correlation coefficients between weather parameters and population of *C. fallax* on different hosts

Hosts	**Temperature ($T_{max.}$) (ºC)**	**Temperature ($T_{min.}$) (ºC)**	**Rainfall (mm)**	**RH (%)**	**Wind Speed (km/hr)**	**Sunshine (hrs)**
Soybean	-0.6101*	-0.4391	0.6496*	0.6677*	-0.1180	-0.1802
Cowpea	-0.3570	-0.1957	0.6312*	0.5244	0.2604	-0.5044
Mash	-0.4551	-0.2056	0.6168*	0.6005*	0.2653	-0.4761

* Significant at p = 0.05

Fig.1 Population build-up of *C. fallax* in relation to weather parameter on different host

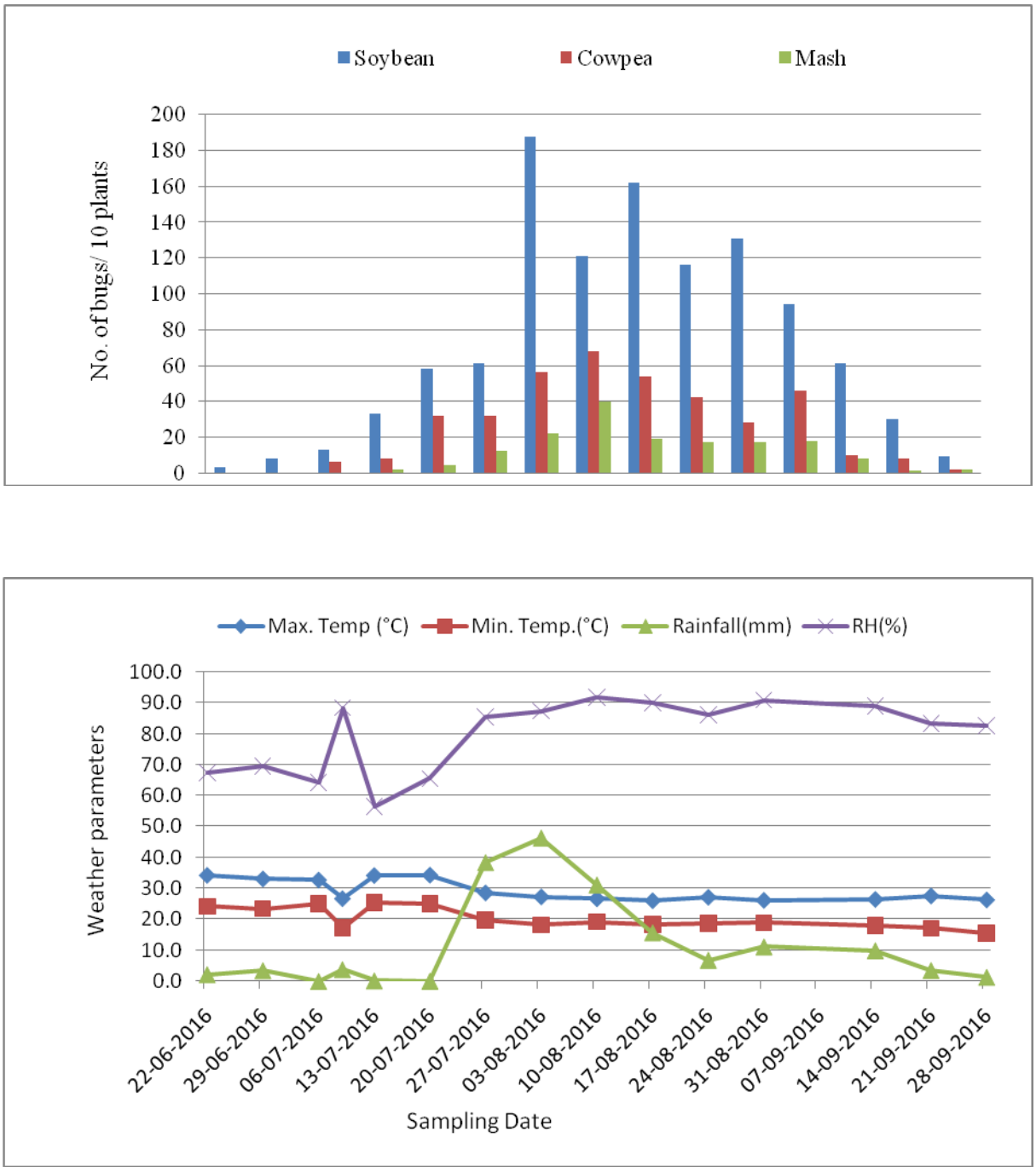

Plate.1 Symptoms of damage by *C. fallax* on soybean

Maximum number of eggs (32/ 10 plants) and adults (19/ 10 plants) was recorded in the 1st and 2nd week of August and in 2nd week of September, respectively. During the season 32 to 92.85 per cent infestation by the bug was recorded on this crop

The bug population on mash varied from 1 to 40 per 10 plants during different dates of observations. It was maximum during 2nd week of August. The maximum number of eggs (19/ 10 plants) was also recorded during 2nd week of August. Per cent infestation varied from 10 to 83.33 per cent.

It can be concluded from the results on seasonal abundance of *C. fallax* on soybean cowpea and mash that the overwintering adults of the bug appeared just after germination of these crops and remained associated with the crop till its maturity and harvesting in the last week of September. The bug was most active during July and August. These results are in conformity with the findings of earlier workers (Lal 1974, 1981; Singh *et al.*, 1987; Kumar *et al.*, 2014) who reported that that *C. fallax* was active on the crop from July to October with peaks occurring during August.

Correlation coefficients between weather parameters and population of the bean bug

Correlation coefficient between weekly data recorded on seasonal abundance of the bug on soybean, cowpea and mash at Palampur and weather data of Palampur for the corresponding period were worked out to record impact of weather parameters on the population build-up of bug population on different hosts (Table 6). Daily averages of weather parameters such as (max. and min.) temperature, relative humidity, sunshine and wind speed pertaining to the observation period (June-September) varied from 26.0 to 34.2°C, 15.5 to 25.3°C, 0 to 46.2mm, 56.4 to 91.8%, 0 to 18.9hrs and 1.3 to 7.6 km/ hr.

In case of soybean, the bug population showed a significant negative correlation with max. temperature (r = -0.610) and non-significant negative correlation with min. temperature (r= -0.439), wind speed (r= -0.118) and sunshine hours (r= -0.180). A significant positive correlation with rainfall (r= 0.645) and relative humidity (r= 0.668) was observed. Similarly in cowpea non-significant negative correlation with max. (r= -0.357) and min. temperature (r= -0.198) and sunshine (r= -0.504) was recorded.

A significant positive correlation was found with rainfall (r= 0.631) and non-significant positive correlation with relative humidity (r= 0.524) and wind speed (r= 0.260). Bug population on mash showed non-significant negative correlation with max. (r= -0.455), min. temperature (r= -0.206) and sunshine (r= -0.476). It registered significant positive correlation with rainfall (r= 0.617) and relative humidity (r= 0.601).

The relationship of the bug population with weather factors depicted in Figure 1 indicates that the bug population was affected by weather factors prevailing in the preceding period. Relative humidity and rainfall were found to have positive impact on the population build-up of bean bug, *C. fallax* on all the three hosts. This is accordance with the findings of Lal (1974, 1981). Sharma and Sharma (1998) also found a significant positive correlation of total population of *C. nigrescens* with relative humidity and negative correlation with sunshine hours.

From the results of the present study following conclusions and significance are drawn

The bean bug, *C. fallax* is prevalent with varying levels of its population density under low and mid hill conditions of Himachal Pradesh infesting soybean and pulses grown in *Kharif* season. This was due to different climatic condition in different areas of Himachal Pradesh. Its population was found maximum in temperate areas rather than tropical. The infestation of the bug starts just after emergence of the crops and it continues up to their maturity or harvesting with peaks occurring during August. From population build up, the peak and minimum population of the pest was known which help in taking suitable measure at peak population or at most vulnerable stage. The bug population shows significant positive correlation with rainfall and relative humidity. Through correlation between bug population and weather parameters

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