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Population density and spatial distribution of bean bug *Chauliops fallax* Sweet and Schaeffer (Hemiptera: Malcidae) on different legume crops under mid hills of Himachal Pradesh

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Abstract
The bean bug *Chauliops fallax* feeds exclusively on all leguminous crops in most regions of the world. The population density and spatial distribution of bean bug has been investigated on three different host plant i.e. soybean, cowpea and black gram (mash) under mid hill conditions of Himachal Pradesh during 2016. The fields of 600m^2 and 300m^2 area were selected as a sampling unit for sampling in soybean, cowpea and black gram. Him Palam Hara Soya -1, C-475 and Pant U19 genotypes of soybean, cowpea and mash were selected for the estimation of density and distribution of the bean bug. Different methods *viz.*, Morisita's index, Index of dispersion and Lewis index were used to calculate the density and distribution of the population of the pest. The mean population of bugs per plant was recorded on soybean (7.25) followed by cowpea (3.01) and black gram (1.21). Studies on knowing the distribution pattern of bean bug population under field conditions revealed that in soybean the distribution of bug was contagious (2.99) while in cowpea (2.44) and black gram (1.87) regular and contagious distribution pattern was found. The Z value of Morisita's index in case of soybean was 9.98 followed by 5.87 and 3.50 in case of cowpea and black gram. Similar trend was found in case of Index of dispersion and Lewis index. Optimum sample sizes for estimates of the pest density in all the three host plants are presented.

Keywords: *Chauliops fallax*, Population density, spatial distribution, soybean, cowpea and mash

Introduction
Pulses are the important sources of proteins, vitamins and minerals and are popularly known as "Poor man's meat" and "rich man's vegetable", contribute significantly to the nutritional security of the country. Grain legumes are major source of protein for large vegetarian population in developing countries in general in India in particular. Among pulses, soybean, mash and cowpea are highly nutritious. Blackgram/ mashbean/ Urdbean (*Vigna mungo* L.) with highly digestible dietary protein (20-24%), carbohydrates, minerals and vitamins. Besides, pulses also improve the soil productivity on account of biological nitrogen fixation and in addition of organic matter. Pluses constitute an important part of human food. The protein content of most pulses ranges from 17-24 per cent which is almost 2-3 times more than that found in cereals. In Himachal Pradesh, Kharif pulses are grown on an approximate area of 61.0 thousand hectares. Among Kharif pulses mash, kulthi and rajmash are the most important. Arhar and mung are the also grown on a very limited area. Even though India has the largest area under pulses in the world, the average productivity is very low and overall production is also not sufficient to meet out protein requirement of the country population. The pulses are also attacked by a diversity of insects pests with the *Chauliops fallax* commonly known as bean bug, the most important emerging pest of pulses including soybean, French bean, black gram, green gram, cowpea and horsegram etc. in most regions of India. Another related species, *C. nigrescens*, commonly called as black bean bug, has been mainly recorded to feed on French bean in Himachal Pradesh [1-4]. Another related species, *C. nigriscens*, commonly called the black bean bug, has been mainly recorded to feed on French bean in the state [5-7]. 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 [3]. 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 [8].

Estimating population densities of pest arthropods is one of the major part of basic research in agricultural ecosystems and one of the main components in pest management programs [9]. Many other properties are derived from the density measure [10]. Knowledge of the spatial distribution of insects is important in understanding the bioecology of species and the basis for the development of sampling protocol [10, 11]. A reliable sampling program to estimate density should include a proper sampling time, sampling unit and sampling size in which the determination of spatial distribution is crucial [12,13]. Sampling programs can be used in assessing crop loss [14], studying the population dynamics of pests [15, 16] and determination of levels of pest infestation in order to apply control measures [17]. Although the objectives of population sampling could differ, the development of a sampling procedure requires knowledge of the spatial distribution of the populations [18, 19]. Knowledge of the spatial distribution of insects is important in understanding the biology and ecology of a species and the basis for the development of sampling protocols [11]. Methods that are commonly used to describe dispersion of arthropods populations have been summarized by Southwood [19]. Several estimates based on the dispersion parameter k of the negative binomial distribution and on the relationship between variance and mean are used as indices of aggregation [20-22]. Sampling plans based on these indicators can minimize variation of sampling precision [23].

Materials and methods

The present study was carried out on three different hosts *viz.*, soybean, cowpea and black gram (mash) under field conditions from June to September 2016. The fields of 600m^2 and 300m^2 were selected for sampling in soybean, cowpea and mash. Plants were grown using standard agronomic practices recommended for Himachal Pradesh region. No insecticides were applied to these fields for bean bug management. The sampling fields (*viz.*, soybean, cowpea and mash) were selected as a sample unit. 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. The density of different biological stages (egg, nymphal and adult) of bean bug was estimated by sampling once a week from June to September. 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 (1st to 5th instars) and adults.

Spatial Distribution of the bean bug, *C. fallax*

The spatial distribution of *C. fallax* on different hosts was determined for each date of sampling from the weekly data recorded on the seasonal abundance of the bug. For this purpose various indices of dispersion were worked out separately for each host as per the following methods:

i. Variance to mean ratio (VMR)

The simplest approach used for determining the insect distribution was variance to mean ratio suggested by Patil and Stiteler [24].

$$VMR = S^2/\overline{X}$$

Where, S^2 : $\sum x^2 - (\sum x)^2/(n-1)$ –

$\overline{X}$: $\frac{1}{n}\sum_{i=1}^{n} Xi$

Where, $\overline{X}$ = Mean of n values

X = Observation or variable value

$\sum X$ = Sum of the observations

n = Number of observations in the sample

The value of VMR is one for 'Poisson' distribution, less than one for positive binomial and more than one for negative binomial distribution [24]. VMR also gives an idea about the population dispersion which reveals the value being > 1 contagious; <1: regular and =1 random distribution.

ii. Lewis index

Lewis index was also calculated as per the formula given hereunder to determine the dispersion of bean bug *C. fallax*.

$$\sqrt{\frac{S^2}{\overline{X}}}$$

The value of this index revealed >1 contagious; <1: regular and =1 random distribution.

iii. Index of dispersion (I_D)

Distribution pattern was further confirmed by 'Index of dispersion' which was calculated as suggested by Patil and Stiteler [24].

$$I_D = (n-1)\left(\frac{S^2}{\overline{X}}\right)$$

Where, I_D = Index of dispersion

n = the number of samples to be drawn

The Z- coefficient of I_D was also worked out to test its significance as

$$Z = \sqrt{2 I_D} - \sqrt{(2v-1)}$$

Where, v: degree of freedom (n-1)

If $1.96 \geq Z \geq -1.96$, the spatial distribution be random, but in case of $Z > 1.96$

and $Z < -1.96$ this parameter becomes aggregated and uniform, respectively.

iv. Morisita's coefficient of dispersion (I_δ)

Morisita [25] proposed a hypothesis for testing the uneven distribution coefficient of I_δ which is calculated by the following equation:

$$I_\delta = \frac{n\sum Xi(Xi-1)}{N(N-1)}$$

Where, n = number of sample units

Xi = the number of individuals in each sample

N= total number of individuals in n samples

The following large sample test of significance was used to determine whether the sampled population significantly differed from random:

$$Z=\frac{(I_\delta - 1)}{\sqrt{\frac{2}{n\overline{X}^2}}}$$

In case 1.96 ≥ Z ≥ - 1.96, the spatial distribution be random, but in case of Z < -1.96, Z >1.96 indicated the regular and aggregated distribution, respectively [10].

Results and Discussion

Spatial distribution pattern of *C. fallax* on different hosts

In order to study the distribution pattern or dispersion of the bug on three hosts *viz.*, soybean, cowpea and mash, the weekly data recorded on the population build-up of the bug were used to calculate indices of dispersion. Values of important indices of dispersion of the bug population on three hosts calculated for all the sampling dates have been given in tables 1 to 3.

The variance of the bug population on soybean remained more than mean value for all the sampling dates and thus, the variance to mean ratio remained more than one during all the sampling dates (Table 1). In many studies on insect population the variance is greater than the mean, indicating a contagious distribution [26]. A pest population with such distribution is called clumped, aggregated or over dispersed.

Z value calculated on the basis of index of dispersion (I_D) for all the sampling dates were greater than 1.96 except the one for the population sampled during last week of September. Z value more than 1.96 would indicate as significant departure from a random distribution. The Morisita index (I_δ) values for all sampling dates were significantly greater than one (Table 1), indicating the spatial distribution of this pest was aggregated. The value of Lewis index (Table 1) for all the sampling dates were also found to be more than one indicating that the distribution of the bug population was aggregated.

Table 1: Spatial distribution of *C. fallax* in relation to its weekly population density on soybean

Indices of dispersion								
Sampling date	**Mean population per plant ($\overline{X}$)**	**Variance (S^2)**	**Variance to mean ratio (VMR)**	**Index of dispersion (I_D)**	**Z value**	**Morisita's Index (I_δ)**	**Z value**	**Lewis Index**
June, 2016								
22	0.30	0.87	2.92	287.10	10.06	6.60	11.90	1.70
29	0.80	2.38	2.97	294.52	10.23	3.48	14.58	1.72
July, 2016								
6	1.30	3.74	2.88	284.81	13.88	2.44	13.33	1.69
13	3.30	10.37	3.14	153.53	7.68	1.64	10.66	1.77
20	5.80	26.57	4.58	224.47	11.35	1.76	22.35	2.14
27	6.10	41.84	6.86	336.09	16.08	1.94	29.37	2.61
August, 2016								
3	18.80	45.42	2.41	118.38	5.54	1.07	6.60	1.55
10	12.10	50.09	4.13	202.84	10.30	1.25	15.62	2.03
17	16.20	38.44	2.37	116.26	5.40	1.07	5.83	1.54
24	11.60	51.42	4.43	128.55	8.49	1.15	8.82	2.10
31	13.10	33.74	2.57	74.69	4.68	1.02	1.33	1.60
September, 2016								
7	9.40	21.41	2.27	43.27	3.22	1.11	5.23	1.50
14	6.10	12.41	2.03	38.65	2.71	1.16	5.00	1.42
21	3.00	7.89	2.63	49.97	3.91	1.52	7.87	1.62
28	0.90	1.46	1.62	30.82	1.77	1.69	3.13	1.27
Mean	7.25	23.20	2.99	139.73	7.01	1.48	9.98	1.63

The value of all the above mentioned indices of dispersion of the bug population on cowpea and mash calculated separately for all sampling dates have been presented in tables 2 to 3. These values were found to be more than one for all the sampling dates indicating that the bug population exhibited an aggregate distribution pattern on these crops. In case of cowpea, the variance to mean ratio in all sampling dates was found to be more than one presented the contagious distribution pattern of the bug population. In all sampling dates i.e. from the first week (sampling week) of the June to last week of September the value of variance was more than the mean value indicated the clumped, aggregated or over dispersed population. The Z value of index of dispersion (I_D) and Morisita's Index (I_δ) showed the pattern of random and aggregated population. The dispersion of the bug population was found to be contagious calculated from Lewis index.

Table 2: Spatial distribution of *C. fallax* in relation to its weekly population density on cowpea

Indices of dispersion								
Sampling date	Mean population per plant ($\overline{X}$)	Variance (S^2)	Variance to mean ratio (VMR)	Index of dispersion (I_D)	Z value	Morisita's Index (I_δ)	Z value	Lewis Index
July, 2016								
6	0.60	0.81	1.36	66.90	9.84	1.60	1.81	1.16
13	0.80	1.67	2.09	102.28	4.46	2.37	5.48	1.44
20	3.20	6.36	1.98	97.54	4.12	1.30	4.80	1.40
27	3.20	7.71	2.41	118.05	5.52	1.43	6.88	1.55
August, 2016								
3	5.60	15.69	2.80	81.30	5.21	1.31	6.73	1.67
10	6.80	32.51	4.78	138.64	9.11	1.54	14.59	2.18
17	5.40	12.59	2.33	67.61	4.08	1.23	4.89	1.52
24	4.20	23.20	5.52	160.19	10.35	2.04	17.04	2.35
31	2.80	3.26	1.16	33.86	0.68	1.05	0.54	1.07
September, 2016								
7	4.60	13.62	2.96	85.92	5.56	1.41	7.32	1.72
14	1.00	1.86	1.86	53.94	2.84	1.86	3.44	1.36
21	0.80	1.06	1.32	38.42	1.22	1.41	1.27	1.15
28	0.20	0.23	1.17	33.35	0.62	2.00	1.55	1.07
Mean	3.01	9.27	2.44	82.92	4.89	1.58	5.87	1.51

The results of variance to mean ratio of the bug population on black gram presented contagious and regular pattern of the population (Table 3). The Z value in case of index of dispersion (I_D) also depicted the uniform pattern where as Z value of Morisita's Index (I_δ) showed aggregated and random distribution. From Lewis index it was found that the dispersion pattern was regular and contagious.

Table 3: Spatial distribution of *C. fallax* in relation to its weekly population density on mash

Indices of dispersion								
Sampling date	Mean population per plant ($\overline{X}$)	Variance (S^2)	Variance to mean ratio (VMR)	Index of dispersion (I_D)	Z value	Morisita's Index (I_δ)	Z value	Lewis Index
July,2016								
13	0.20	0.17	0.82	24.65	-0.51	0.00	0.00	0.89
20	0.40	0.52	1.31	36.25	0.97	1.81	1.26	1.14
27	1.20	1.75	1.45	42.29	1.65	1.38	1.76	1.20
August, 2016								
3	2.20	3.40	1.54	44.95	1.94	1.24	2.05	1.24
10	4.00	14.55	3.63	105.48	6.98	1.64	10.00	1.90
17	1.70	5.73	3.37	97.74	6.44	2.37	9.13	1.83
24	1.70	2.56	1.50	43.67	1.80	1.29	1.93	1.22
31	1.80	3.06	1.70	49.30	2.38	1.38	2.03	1.30
September, 2016								
7	0.30	0.49	1.64	47.36	2.19	3.33	2.70	1.27
14	0.80	2.16	2.70	78.66	5.00	3.15	6.67	1.64
21	0.10	0.09	0.93	26.10	-0.01	0.00	0.00	0.94
28	0.20	0.37	1.86	53.60	2.81	6.00	4.58	1.36
Mean	1.21	2.88	1.87	54.17	2.63	1.96	3.50	1.32

Knowledge of the spatial distribution of insects is important in understanding the bioecology of species and the basis for the development of sampling protocol [10, 11]. However there is no report in literature regarding the distribution pattern of *Chauliops* spp. therefore, present results could not be compared. However, dispersion indices for other insects have been worked out and their values have been interpreted in similar manner [27, 28]. Subramanium and Arumugam [29] while studying the distribution pattern of *A. gossypii* reported that the Lewis index varied from 1.033 to 2.046 in all the weeks indicating aphid distribution was contagious in nature.

Overall means of the values of indices of dispersion of the bug population for different sampling dates on three hosts have been given in table 4 which also indicate that the overall bug population exhibited aggregated distribution on all the three hosts and its departure from randomness was significant as the Z values were more than 1.96.

Table 4: Overall means of various indices of dispersion of bug population on different hosts

Indices of dispersion	Soybean	Cowpea	Mash
Mean population per plant	7.25	3.01	1.21
Variance (S^2)	23.20	9.27	2.88
Variance to mean ratio (VMR)	2.99	2.44	1.87
Morisita's Index (I_δ)	1.48	1.58	1.96
Z value	9.98	5.87	3.50
Index of dispersion(I_D)	139.73	82.92	54.17
Z value	7.01	4.89	2.63
Lewis Index	1.63	1.51	1.32

Conclusion

In developing a sampling program for either research or management purposes, one must determine two characteristic features of any population, its density as well as its dispersion [11]. It is evident from these analyses that the spatial distribution of the bug is contagious type and this has significance in developing a proper sampling plan for its population estimation. The mean value of all indices of dispersion (Variance to mean ratio, Index of dispersion I_D, Morisita index I_δ and Lewis index) of bug population on all the three hosts calculated separately and was found to be more than one in maximum sampling dates indicating that the bug population exhibited an aggregate distribution pattern on these crops.

References

1. Sharma PL, Bhalla OP. Survey study of insect pests of economic importance in Himachal Pradesh. Indian Journal of Entomology. 1964; 26(3):318-331
2. Kashyap NP, Adlakha RL. New records of insect pests of soybean crop. Indian Journal of Entomology. 1971; 33(4):467-8.
3. Lal OP. Occurrence of *Chauliops fallax* Scott (Hemiptera: Lygaeidae) on French bean and horse gram in Himachal Pradesh. Indian Journal of Entomology. 1975; 36:67-68.
4. Kumar S, Singh A, Sharma J. Major insect-pests and diseases of soybean in Himachal Pradesh and their management. In: Proceedings of soycon-2014. International Soybean Research Conference Indore. 2014, 264-265.
5. Chaudhuri AN. Some new records of insects and nematodes as pests of agricultural and horticultural crops in Himachal Pradesh. Indian Journal of Entomology. 1961; 23:302-303
6. Sharma KC, Chauhan U, Verma AK, Sood AK. Biology of the black bean bug, *Chauliops nigrescens* (Hemiptera: Lygaeidae) infesting French bean, Phaseolus vulgaris (L.). Journal of Entomological Research. 1993; 17(4):305-307
7. Mehta PK, Sood AK, Vaidya DN, Kashyap NP. Insect pest complex of French bean in Kangra valley of Himachal Pradesh. Himachal Journal of Agricultural Research. 2001; 27:59-62.
8. Lal OP. A contribution to the knowledge of ecology, biology, host range and control of the lygaeid bug *Chauliops fallax* Scott (Hemiptera: Lygaeidae). A pest of the pulse crop in Kullu valley. Rivista di Agricoltura Subtropicale e Tropicale. 1981; 75:381-403
9. Kogan M, Herzog DC. Sampling methods in soybean entomology. Springer Verlag, New York. Ecological, 1980, 587.
10. Pedigo LP, Buntin GD. editors. Handbook of sampling methods for arthropods in agriculture. CRC Press, 1993.
11. Binns MR, Nyrop JP, van der Werf W, Werf W. Sampling and monitoring in crop protection: the theoretical basis for developing practical decision guides. CABI, 2000.
12. Boeve PJ, Weiss M. Spatial distribution and sampling plans with fixed levels of precision for cereal aphids (Homoptera: Aphididae) infesting spring wheat. The Canadian Entomologist. 1998; 130(1):67-77.
13. Southwood TRE, Henderson PA. Ecological methods. 3rd ed. Blackwell Sciences, Oxford, 2000.
14. Hughes GM. Incorporating spatial pattern of harmful organism into crop loss models. Crop Protection. 1996; 15(5):407-421.
15. Jarosik V, Honek A, Dixon AFG. Natural enemy ravine revisited importance of sample size for determining population growth. Ecological Entomology. 2003; 28:85-91.
16. Wilson LT. Estimating abundance, impact, and interactions among arthropods in cotton agroecosystems, In: Pedigo LP, Buntin GD (Eds.). Handbook of sampling methods for arthropods in agriculture. CRC Press, Boca Raton. 1994, 475-514.
17. Arnaldo PS, Torres LM. Spatial distibution and sampling of *Thaumetopoea pityocampa* (Lep: Thaumetopoeidae) populations of Pinus pinaster Ait. in Montesinho, N. Portugal. Forest Ecol Manage. 2005; 210:1-7.
18. Liu C, Wang G, Wang W, Zhou S. Spatial pattern of *Tetranychus urticae* population in apple tree garden. Journal of Applied Ecology. 2002; 13:993-996.
19. Southwood TRE. Ecological methods with particular reference to the study of insect populations. 2nd ed. Chapman and Hall, London, 1978.
20. Davis PM. Statistics for describing populations, In: Pedigo LP, Buntin GD (Eds.). Handbook of sampling methods for arthropods in agriculture. CRC Press, Boca Raton, Florida, 1994, 33-54.
21. Krebs CJ. Ecological methodology. 2nd ed. Addison Wesley Longman Inc, New York, 1999.
22. Ludwig JA, Reynolds JF. Statistical ecology-a primer on methods and computing. John Wiley and Sons Inc, New York, 1999.
23. Kuno E. Sampling and analysis of insect population. Annual Review of Entomology. 1991; 36(1):285-304.
24. Patil GP, Stiteler WM. Concepts of aggregation and their quantification: a critical review with some new results and applications. Researches on Population Ecology. 1974; 15(1):238-254.
25. Morisita M. I_δ-index a measure of dispersion of individuals. Research in Population Ecology 1974; 4:17
26. Atwal AS, Singh S. Pest Population and Assessment of Crop Losses. Publications and Information Division, 1990, 131.
27. Kianpour R, Fathipour Y, Kamali K, Naseri B. Bionomics of *Aphis gossypii* (Homoptera: Aphididae) and its predators *Coccinella septempunctata* and *Hippodamia variegata* (Coleoptera: Coccinellidae) in natural conditions. Journal of Agricultural Science and Technology. 2010; 12:1-11.
28. Mona MV, Ali G, Hooshang RD, Myron PZ, Mehndi H, Behram N. Population density and spatial distribution pattern of *Hypera postica* (Coleoptera: Curculionidae) in Ardabil, Iran. Notulae Botanicae Horti Agrobotanicae. 2011; 39:42-48.
29. Subramaniam R, Arumugam N. Spatial pattern of population distribution of cotton aphids (*Aphis gossypii* Glov.) and pink boll worm (*Pectinophora gossypiella*). Journal of Entomological Research. 2006; 30(1):17-19.