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Population trend and distribution pattern of aphid (*Aiceona robustiseta* G&R) on Som (*Persea bombycina* Kost.): A primary food plant of Muga silkworm

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Abstract

Aiceona robustiseta G&R infestation started in the middle of February and continued till the end of September. Incidence, intensity of attack and population density of *A. robustiseta* varied during different months. It increased gradually during the warmer months and reached a peak during the end of July. No aphid population were found from October to February. Distribution of *A. robustiseta* followed contagious or aggregated pattern during the period of investigation. Clumping was due to micro-environmental variation and active behaviour of colony formation.

Keywords: *Aiceona robustiseta*, Som, muga silkworm, *Meterological parameter*

Introduction

Muga, the golden yellow silk is produced by the insect species *Antheraea assama* Westwood (Saturniidae: Lepidoptera). Muga silkworm is multivoltine and polyphagus in nature. It feeds on various plants *viz*., *Persea bombycina, Litsea polyantha, L. citrate, L. salicifolia, Magnolia sphenocarpa, Zizyphus jujube* etc. Rearing of muga is conducted generally on *Persea bombycina* and *Litsea polyantha* in Assam.

All the primary and secondary food plants of muga silkworm belong to botanical family Lauraceae. These are aromatic trees with alternate leaves. These are deciduous in temperate regions, evergreen in tropics and sub-tropics with stipules. Som (*Persea bombycina*) plants become suitable for rearing of muga worm after 4-5 years and their suitability continues till 20-25 years. A plantation of som can be used wice in a year for muga silkworm rearing without any detriment to the tree. Muga silkworm passes its larval stage on the trees. As muga silkworm is reared throughout the year, the availability of healthy food plants with plentiful of leaves is necessary for successful muga rearing. One of the important yield-reducing factors of silk production is the attack of insect pest on silkworm food plants. Negi and Sengupta (1992) [10] reported over twenty species of insect pests on primary muga food plants. Over 25 species of insect pests have been reported to be feeding on muga food plants (Anon, 1989) [1] and the majority of these species have been reported on Som plant. Among different insect pests, the som aphid (*Aiceona robustiseta*, G&R) (Ghosh & Raychaudhuri, 1962) is the major sucking pest of som plant and has become menance to the production of leaf of som plant (Das, 1996) [5]. Both nymphs and adults suck the cell sap from the plants. Desapping of leaves resulted in the reduction in size of leaf, leaf blade deformation and mild yellowing of leaves which ultimately reduces the leaf yield. Moreover, the information pertaining to its seasonal incidence and distribution pattern on som plant were found scanty. In view of the of the pest in the state, an invsestigation was undertaken to study the population trend, peak period of activity and distribution pattern of aphid on som plant to gather information for developing and management strategy.

Materials and Methods

The present investigation has been carried out to study the population build up and distribution pattern of *Aiceona robustiseta* G&R on Som. The field studies were conducted in the garden of muga food plantation of Department of Sericulture, Assam Agricultural University, Jorhat during 2016-17.

1. Field studies on population build up of som aphid were carried out during February 2016 to February 2017 on muga food plant plantation. The population density of aphid were recorded on ten randomly selected som plant with four branches in each plant at 15 days interval starting from the day of first appearance of the aphid. Data on population density were counted from 10cm length of infested shoots. Population counts were taken insitu between 7:30 a.m. and 9:00 a.m.
2. Sampling procedure: Aphid infestation was measured by counting the number of plants with and without aphid and expressed as percentage of plants infested. The percentage of leaf infestation was worked out by counting the total number of leaves and number of infested leaves from randomly selected branches of each selected plant. As the aphid prefers tender leaves and shoots for feeding, these plant parts were selected as sampling unit in estimating aphid population. Forty tender leaves were selected randomly from each selected plant, thus a total of 400 leaves were sampled on each sampling occasion from 10 randomly selected plants.
3. Distribution pattern of *Aiceona robustiseta* G&R: For determining the different parameters related to distribution pattern, the methods outlines in Southwood (1978) [13] and Atwal and Bains (1974) [3] were followed. The mean population density (number/plant) of total aphids was worked out for each plant for each sampling occasion. Variance was also worked out for each plant for each sampling occasion.
   - Variance to mean ratio: For determination of spatial distribution, the variance/mean ratio ($s^2/\bar{x}$) is the simplest approach. In the case of random distribution, variance of the population is equal to the mean; hence the ratio is equal to unity. A variance to mean ratio greater than unity indicates contagious distribution, while a ratio smaller than unity indicates a regular distribution.
   - Dispersion parameter or exponent K: The negative binomial distribution is described by two parameters, the mean and the exponent K which is a measure of aggregation. The exponent K was estimated by the following formula given by Southwood (1978) [13].

$$K = x^2/s^2 - \bar{x}$$

Where
$\bar{x}$=Mean
s^2=Variance

If K is greater than eight, clumping is low and there is a tendency towards randomness. Lower K value indicates high amount of aggregation (Southwood, 1978) [13].

- Coefficient of variation: The smaller the K value, greater is the extent of aggregation, whereas a large values (over eight) indicates that the distribution is approaching a poisson. This may be appreciated from the relationship of K to the coefficient of variation.

$$C.V. = s/\bar{x}$$

Where
s^2=Variance
$\bar{x}$=Mean

- Index of Clumping: The index of clumping (IDM) for finding out the distribution pattern of population was given by David and Moore (1954) [6].

$$\mathbf{IDM} = \frac{s^2}{x} - 1$$

IDM takes a value of Zero for a randomly distributed population. Positive and negative values of IDM shows contagious and regularity in distribution.

- Index of mean crowding: The index of mean crowing (x*) was calculated following Lloyd's formula (1967) [9].

$$x^* = \bar{x} + \left[\frac{s^2}{\bar{x}} - 1\right]$$

Where
s^2=Variance
$\bar{x}$=Mean

If the value of mean crowding is equal to or less than mean, the distribution is poisson. On the other hand a mean crowding value greater than mean shows contagiousness of distribution.

- Lloyd's Index of patchiness: Lloyd's Index of patchiness (1967) [9] was worked out as the ratio of the mean crowding to mean density. The value of this index equals unity in a random distribution but values greater and smaller than unity indicate contagious and regular distribution respectively.
- Mean colony size: Tanigoshi *et al*. (1975) [15] gave the formula of mean colony size (C*) as

$$C^* = x^* + 1$$

Where, x* = mean crowding
The concept of mean colony size is useful, when the sample unit contains an entire colony.

Mean clump size: Mean clump size (λ) is calculated for ascertaining the cause of aggregation following Arbous & Kerrich (1951) [2].

$$\lambda = \frac{\bar{x}}{2K} v$$

Where $\bar{x}$ = mean, v = a function with a x^2 distribution with 2K degree of freedom at 0.05 probability level. If λ is less than two, the aggregation is due to environmental heterogeneity, while a value greater than two indicated that both environmental heterogeneity and insect behaviour are affecting together.

Results and Discussion

Seasonal incidence and peak period of activity

The data on population build up of *A. robustiseta* on som and the meterological data are shown in figure 1. *A. robustiseta* made its appearance in February and continued attack till September. Initial aphid population was low but it picked up soon to reach the peak population in July. From April onwards the colonies increased in size. The incidence and intensity of attack also increased during the warmer months.

Gradual increase in temperature (both maximum and minimum) till July was conducive to the multiplication of aphid. During that period rainfall was also moderately high with more rainy days. Temperature, rainfall and number of rainy days exerted positive influence on the aphid population density. No aphid was recorded from October onwards. A gradual change in a *A. robustiseta* is possible due to emigration of winged adults, when conditions of the host plant are not favourable. Climate, natural enemies and host plant effects are the three major factors of population changes of *A. robustiseta.* Aphid infestation started in the month of February with a population density of 0.81 aphid/leaf infesting 5.25 percent leaves of the infested plants (20.00%) (Table 1.). Aphid infestation gradually increased during the summer months to reach a peak population of 18.12 aphids/leaf and peak intensity of attack of 54 percent infested leaves in July when 100 percent of the plants were infested. Aphid attack declined afterwards reaching the population density 4.14 aphids/leaf, leaf infestation (18.75 percent) and plant infestation 40 percent in September and ultimately disappeared in October. No aphids were recorded from October to February. The seasonal mean infestation of the plant, leaf and population density were 42.30 percent, 16.08 percent and 5.07 percent respectively.

In the present study, the peak was recorded in the end of July. Negi and Sengupta (1992) [10] recorded peak attack of aphid in February-March. The minor shift of peak might be due to the host plant effect and presence of natural enemy. Present observation on peak activity period agreed fairly with the observation of Das (1996) [5]. Sunil *et al*., (2016) [14] initially recorded the population of aphid (*Aphis craccivora* Koch) 12.79 aphid/leaf in February and then declined. Higher population 17.45-24.98 aphid/leaf was recorded during 2nd week of September to 1st week of October.

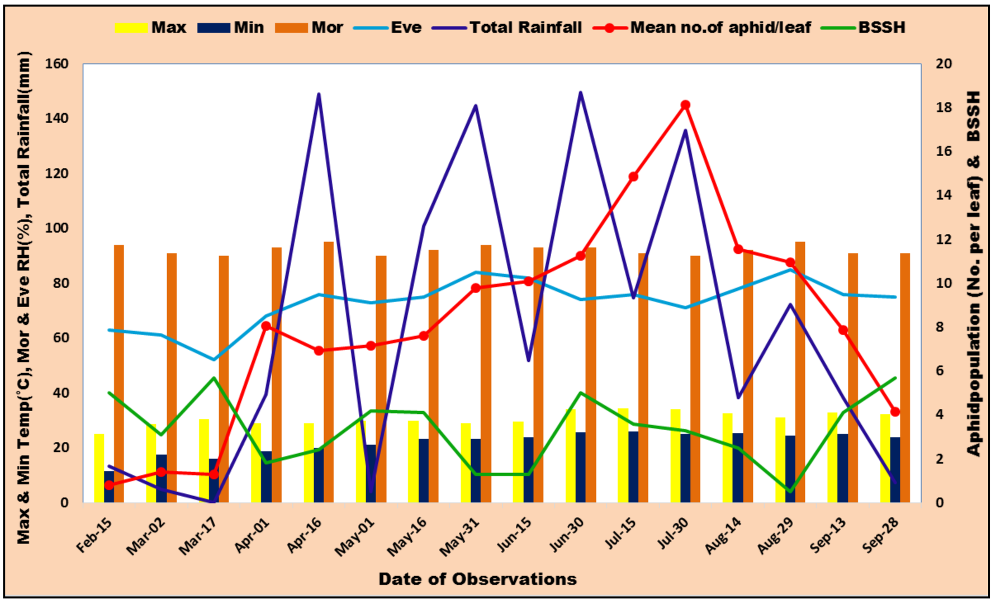

Fig 1: Population build up of A.robustiseta G&R and meterological data during 2016-17

Table 1: Infestation build up of Som aphid *Aiceona robustiseta* on Som during 2016-17

Sampling	Incidence (%plant infested)	Intensity of attack (% leaf infested)	No. of aphid per plant	Population density(No. of aphid per leaf)
February 15	20	5.25	32.40	0.81
March 2	50	6.56	57.00	1.42
March 17	40	8.75	51.00	1.28
April 1	80	23.75	322.30	8.07
April 16	70	20.00	276.80	6.92
May 1	80	16.25	285.60	7.14
May 16	80	21.25	304.00	7.60
May 31	90	25.00	391.40	9.78
June 15	60	28.50	404.30	10.10
June 30	80	37.50	450.00	11.25
July 15	90	48.00	594.60	14.86
July 30	100	54.00	725.10	18.12
August 14	90	45.00	461.60	11.54
August 29	70	35.00	438.30	10.95
September 13	60	25.00	314.90	7.87
September 28	40	18.75	165.70	4.14
October 13	-	-	-	-
October 28	-	-	-	-
November 12	-	-	-	-
November 27	-	-	-	-
December 12	-	-	-	-
December 27	-	-	-	-
January 11	-	-	-	-

January 26	-	-	-	-
February 10	-	-	-	-
February 25		-		-
Seasonal mean	42.30	16.08	202.91	5.07

Data based on 10 plants (4 branch each)
Data based on 400 leaves from 10 plants

Spatial distribution pattern of *Aiceona robustiseta*

The parameters pertaining to the pattern of distribution of *Aiceona robustiseta* on som plants are shown in Table 2 and Table 3.

Aphids appeared in the field in the middle of February 2016 with a mean population of 32.4 aphids/plant. Aphid infestation gradually increased during the summer months to reach a peak population of 725.1 aphids/plant, in July, when 100 percent of the plants were infested. Aphid population declined afterwards reaching the population density of 165.7 aphids/plant in September and ultimately disappeared in October. The mean population density remained less than the variance throughout the period of investigation. Variance was higher than the mean density in all sampling occasions. Thus, the variance to mean ratios were greater than unity, indicating contagious distribution of the aphid. Similarity, the values of dispersion parameters (K) were also indicative of the non-clumped distribution of the aphid, which suggested that the distribution is contagious and the population showed a degree of contagiousness. Coefficient of variation, David and Moore's index of clumping, Lloyd's mean crowding index and Lloyd's patchiness index also showed a high aggregated distribution pattern for all the sampling occasions. Computation of mean colony size also showed that *A. robustiseta* tended to aggregate on all the sampling occasions. Analysis of mean clump size for the contagious distribution recorded on all sampling occasions showed that clumping was due to heterogeneity of micro-environment in som plantation.

A. robustiseta appeared in the field during the middle of February. Their presence was observed in the field throughout the warmer months and the mean density exceeded more than one in each sampling area. The variance to mean ratio which is a measure of deviation from randomness exceeded unity in each sampling occasion. Exponent K of negative binomial also showed clumping K values lower than 8 means contagiousness. Other parameters like index of clumping, index of mean crowding, Lloyd's patchiness index also showed that *A. robustiseta* population confirmed to contagious distribution.

The contagious pattern of distribution throughout the period of investigation was probably because of the fact that aphid preferred to settle on succulent and vigorously growing parts of plants and the nymphs they produced preffered the lower leaf surface and shady portions for colony formation. Aggregations were affected both by micro-environment and inherent behaviour of aggregation of the nymphs. Distribution of similar types were also observed by previous workers with aphids like *Aphis craccivora* on greengram (Barman, 1992) [4], *Rhapalosiphum maidis* on maize (Shukla & Pathak, 1987) [12]. Following the formula of Atwal and Bains (1974) [3] and Ruesink (1980) [11] the optimum number of plants required for a reasonably accurate estimate of the population of *A. robustiseta* at 10 percent and 20 percent margins of error were 394, 99 and 99, 26 respectively. Keeping in view the accuracy feasibility and the time factor a sample size of 99 at 10 percent margin of error are reasonably good for ecological studies and for pest management studies the reasonable sample would be 26. Kalita (1992) [8] also determined sample size of *Spilosoma oblique* Walker on greengram in a similar manner.

Table 2: Statistical parameter for distribution pattern of *Aiceona robustiseta* G&R on som plants

Sampling	Mean density (x)	Variance (s^2)	Variance to mean ratio (s^2 / x)	Dispersion parameter (K)	Coefficient of variation (s/x)	Index of clumping (IDM)
February 15	32.4	5362.48	165.50s	0.169	2.260	164.50
March 2	57.0	4277.55	75.09	0.769	1.140	74.04
March 17	51.3	5863.56	114.29	0.452	1.492	113.29
April 1	322.8	53345.51	165.25	1.965	0.715	165.25
April 16	276.8	51045.07	184.41	1.509	0.816	183.41
May 1	285.6	22291.65	78.05	3.706	0.522	77.05
May 16	304.0	38469.11	126.5	2.421	0.645	125.54
May 31	391.4	36065.82	92.14	4.294	0.485	91.14
June 15	404.3	142464.5	352.37	1.150	0.933	351.37
June 30	450.0	89584.66	199.07	2.271	0.665	198.07
July 15	594.6	80312.26	135.06	4.435	0.476	134.06
July 30	725.1	64684.98	130.58	5.595	0.424	129.58
August 14	461.6	42576.26	92.23	5.059	0.447	91.23
August 29	438.3	121671.3	277.59	1.589	0.795	276.59
September 13	314.9	80520.76	255.70	1.236	0.901	254.70
September 28	165.7	45225.92	272.93	0.609	1.283	271.93

Table 3: Statistical parameter for distribution pattern of *Aiceona robustiseta* G&R on Som during 2016-17

Sampling	Index of crowding (x*)	Lloyd's index of patchiness (x*/x)	Mean colony (C*)	Departure from randomness	2K	x² function for 2k d.f (v)	Mean clump size (I)
February 15	169.90	6.07	197.90	C	0.393	3.841	368.190
March 2	131.04	2.29	132.04	C	1.538	5.991	222.033
March 17	164.59	3.20	165.59	C	0.904	3.841	217.968
April 1	487.05	1.50	488.05	C	3.930	9.488	779.319
April 16	460.21	1.66	461.21	C	3.018	7.815	716.763
May 1	362.65	1.26	363.65	C	7.412	14.067	542.031
May 16	429.54	1.41	430.54	C	4.892	11.070	695.018
May 31	482.54	1.23	483.54	C	8.588	16.919	771.087
June 15	755.67	1.86	756.67	C	2.300	7.779	1367.412
June 30	648.07	1.44	649.07	C	4.542	11.070	1096.763
July 15	728.66	1.22	729.66	C	8.870	16.919	1134.164
July 30	854.68	1.17	855.60	C	11.190	19.075	1274.910
August 14	552.83	1.19	553.83	C	10.118	18.307	835.195
August 29	714.89	1.63	715.89	C	3.168	7.815	1081.223
September 13	569.60	1.80	570.60	C	2.472	5.991	763.173
September 28	437.63	2.64	438.63	C	1.218	3.841	522.539

Conclusion

Both nymphs and adult of *A. robustiseta* preferred to suck sap from the under surface of the leaves, buds and tender shoots, continuous sucking of sap by aphids resulted in leaf curling and reduction in size of leaves, which ultimately reduced the leaf yield. Honeydew secretion of aphid encouraged the growth of saprophytic fungi *Meliola* spp. which caused black sooty mould on the leaves. Honeydew secretion attracted the ants to the plants and made the plants unsuitable for muga silkworm rearing.

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