Role of Abiotic Factors in the Distribution and Abundance of Gall Aphids on *Alstonia Scholaris* in Jammu Region

Anjali Dhar
Corresponding Author, Central University of Jammu, Jammu

Reference to this paper should be made as follows:

Anjali Dhar,
"Role of Abiotic Factors in the Distribution and Abundance of Gall Aphids on *Alstonia Scholaris* in Jammu Region",
Voyager: Vol. VIII, No. 2, Dec 2017, pp.146-153

Abstract

Foliar gall aphids have been the important foliar pests of Jammu region mainly infesting Alstonia scholaris. This paper identifies and integrates the existing information regarding the distribution and abundance of this psyllid species. Early foliar colonization patterns by psyllids were examined relative to the landscape parameters like temperature and humidity including density of nearby Alstonia trees . Though the pest abundance explained the psyllid colonization and population density, a density-dependent effect was also observed. When psyllid populations were low, more adults were found in the vicinity of Alstonia leaves. When their populations were higher, the adults were found farther from foliar areas hinting their dispersion to new areas . Galls occur at isolated areas or agglomerate on the abaxial surface of the leaf. The insect along with the egg deposits some physiologic fluid which act as a stimulant for the induction of the gall. This stimulus brings about hypertrophy followed by hyperplasia of cells next to the location of the deposited eggs. The homopterans presents three nymphal instars, from eclosion of the egg to the adult.

Key words*: Foliar galls, abiotic factors, immature, psyllid.*

Introduction

Alstonia scholaris (Common name: Satwin, chattin) belongs to family Apocynaceae.

It has an Indian origin and is having a medicinal use. Its bark is bitter in taste and is used as an astringent. It is used as anti-diarrhoea and anti-dysentery.The milky juice of bark is applied to sores and ulcers. Bark also yields a fibre. Flowers yield an alkaloid 'Picrinine which acts as a anti- depressant on the central nervous system.The same plant had been introduced along the road dividers to add to the greenery across the roads . This plant is easy to manage in polluted areas and consumes less water. This is why it was planted in large numbers across National Highway. They utilize the vehicular pollutants (carbon dioxde) in order to keep surrounding environment free from pollution.

But an epidemic of foliar galls on *A. scholaris* in Jammu has created a menace. This ornamental plant has turned into a shabby vegetation .The causative organism of Alstonia leaf galls was identified as a psyllid (jumping plant louse), *Pauropsylla tuberculata* (Albert et al 2011).This infection is spreading fast and hence measures need to be taken for its safe propagation and control.

Four super families of Hemiptera namely Aphidoidea, Psylloidea, Coccoidea and Aleyrodoidea include gall inducing species (Raman 2003). These insects while extracting the sap from the xylem, phloem and non conducting tissues of the plant form pouch galls on both sides of leaves opening out by a pore called ostiole which is very small in immature galls .But as the adult liberate out of them their ostiole size enlarges (Saini and Sarin, 2012). The psyllids has five nymphal instars, from eclosion of the egg to the adult instar.

The present set up was planned to study the effect of abiotic factors on the population dynamics of *P. tuberculata* and devising the new control strategies for reducing its infestations on *A. scholaris.*

Psyllid galls are complex structures, and can be found either as isolated or aggregated mass (Hodkinson 1984, Dreger-Jauffret and Shorthouse 1992, Raman 2003) in distribution. Leaf gall causative agent , *Pauropsylla tuberculata* Crawford (Psyllidae: Homoptera) is one of the major pest of *A. scholaris* There was an epidemic of black or brown galls on *A. scholaris* leaves in Punjab, Haryana, Chandigarh and Delhi. The causal organism of Alstonia leaf galls was identified as a psyllid (jumping plant louse*), P. tuberculata* (Albert *et. al.* 2011). Free feeding psyllids are more active during periods of high humidity while others produce wax as a strategy to avoid water loss (Hodkinson 1984) Many authors have reported different morphological types of galls on the same plant caused by different insects (Gonçalves Alvim and Fernandes 2001, Scareli-Santos and Varanda 2003). In *A. scholaris* only one type of gall was observed. According to Rohfritsch (1992), young plant tissues are recorded to present responses against inducing insects when compared to already differentiated tissues.

Galls in *A. scholaris* occur on both young and mature leaf tissues indicating that tissues in such species react against the inducing insects regardless of the leaf age of *Baccharis dracunculifolia* (Arduin and Kraus 2005), in *Pouteria torta* (Scareli-Santos *et. al.* 2008).

Jain and Dhiman (2014) reported that the gall insect, *P. tuberculata* Crawford which forms galls on *A. scholaris*, begins in the last week of March which coincides with the emergence of new flush of leaves. Adult female of *P. tuberculata* lays eggs at the side of midribs and veins on the ventral surface of the leaves. Galls are considered a significant drain on leaf resources (Fay et al 1993, Nyman and Julkunen-Tiitto 2001). Accumulation of food materials in cells around the nymphal chamber is commonly observed in the foliar galls (Arduin et al 2005). Shrinkage and dying up of cells lining the opening in the mature gall has been observed. The size of the ostiole increases facilitating the escape of the insect nymph. The nymph moves through this cleaved passage towards the exit, moults and escapes as an adult winged insect. At gall senescence, around the insect chamber and the exit channel a healing tissue is formed (Albert *et. al.* 2011)

Materials and Methods

The study study site included Temporary academic block (TAB) park area, TAB sports ground area ,divider green area along the road side of National highway, Channi and Sainik colony. Main Focus was on Alstonia plant.Mature galled and ungalled leaves of *Alstonia scholaris* were collected from infested and uninfested trees. The methodology in the present study. focussed on the experimental site, abiotic factors and population dynamics of gall aphids on Alstonia trees under different abiotic conditions.The temperature, rainfall and relative humidity of the area around Alstonian trees were recorded and correlated with Meterological Deparment in Jammu.Twenty five leaves from each tree were randomly collected. The total number of galls/leaf and total number of galls/pods were counted. These leaves were placed in glass jars and covered with muslin for recording the emergence of aphids from galls. Their presence on leaf, galls from March 2017 to October 2017 was noted. Three replicates of each experimental set ups were taken for the experimental study.

Different developmental stages were dissected out of small and mature galls. The youngest gall developmental stage was determined based on the smallest diameter observed as a small spot bulged on the leaf blade. The mature ungalled leaves and galls of different developmental stages were taken to the laboratory for morphological analysis. Galls were observed morphologically under dissecting microscope in the laboratory.

Observations and Results

Initiation of the gall formation resulted from the oviposition on the leaves The first visible change is seen as a slight decolourisation on the areas where the eggs are deposited. A small cavity is formed within which the egg lies. Gradually the

decolourized area increases in size and forms a small outgrowth on the lower side of leaf where the gall appears enlarged. At initial stage the gall grows towards the upper side of the leaf but later on its growth is towards the lower side as well.

When the leaves are heavily infested with galls, the lamina is reduced to a single yellowish mass of cells. With the increased number of galls, the leaves appear crumbled and deformed. Role of the environmental factors (temperature, day length, rainfall and humidity) in the abundance and phenology of gall aphid (including the factors which support alate production and migratory behavior) were examined.

Normal- With one-2 galls-Increased gall infection Heavily infested- Alstonia leaf

Colonization patterns made by the Alstonian galls were examined. Density of galls with respect to their population density was noted . When aphid populations were low, more aphids were found in the vicinity host Alstonian leaves.When aphid populations were higher, more aphids were found farther from the original host infesting nearby leaves and plants of Alstonia.

The quantification of galls was done per leaf by manual counting. The gall aphid presence was defined as at least one aphid observed during sampling of a studied area in the TAB lawn. Gall aphid colonization was defined as any number of galls observed on at least two of the sampled leaves of *Alstonia* plant in the lawn

Temperature proved an important abiotic factor for propagation of infestation. Besides, influence of **light intensity** and **relative humid**ity was also conspicious.

Temperature being an important abiotic factor has a significant effect on the **developmental duration** as well as on the percentage of **longevity of females**, while mortality, emergence, fecundity and host feeding was slightly affected.

Relative humidity only affected the developmental duration of Alstonian gall aphids. Light intensity had mostly affected its biological and ecological traits .High light intensity resulted in a shorter developmental duration, higher incidence and longer life span of the female .

S. No.	Months in a year	TEMP °C	Mean number of galls per leaf	humidity	% of of galls aphids emerged per leaf
1.	March	27	20.48 ± 4.11	48 %	50%
2.	April	35	30.01 ± 5.34	58%	56%
3.	May	38	34.28 ± 5.11	47%	60%
4.	June	42	38.46 ±4.88	59%	72%
5.	July	39	46.23 ± 6.33	77%	78%
6.	August	34	52.33 ± 6.24	79%	81%
7.	September	34	41.28 ± 5.28	75%	71%
8.	October	30	38.27 ± 5.14	73%	54%

Percentage of gall aphids and mean number of galls per leaf from spring to autumn under different temperatures and humidity.

(Table 1)

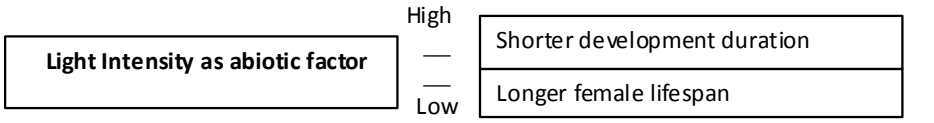
Significantly higher infestations (46.23 July , 52.30- August 2017, 41.28- September 2017) were recorded during June to September months

Gall aphid density per leaf

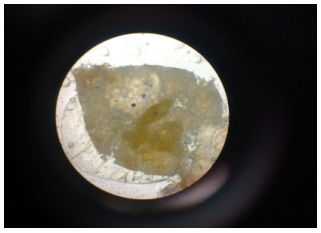
(Table 2)

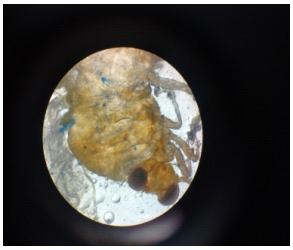
S. No	Variables evaluated	Early Spring	Late spring	Early Summer	Late Summer	Early Monsoon	Late monsoon
1.	Aphid presence	40%	55%	58%	72%	74%	81%
2	Aphid colonisation	28%	44%	38%	41%	42%	88%
3	Aphid density	10%	28%	32%	38%	51%	66%
4	Aphid colony evacuation	6%	19%	20%	40%	53%	75%

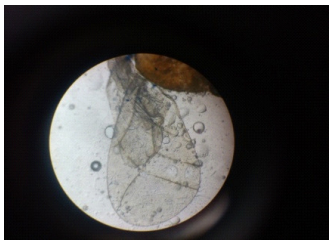
Gall aphid density per leaf was highest during monsoons. Their presence was more conspicious in late monsoon, however their colony evacuation process also was more in monsoons.The aphid population showed its presence in early spring . During the same period they started their colonisation also .The process of colonisation and increase in their density starts from early spring till late monsoon .Soon after the onset of monsoons the process of colony evacuation starts till onset of winters but the evacuation is more till late monsoons.




Appendages and legs visible


Abdomen


Prominent eyes


Alate form

Metrological Observations with respect to Temperature, Humidity, Daylight and rainfall in Jammu (Table 3)

S.No	Name of month	Mean High Temp.	Mean low Temp	Mean humidity	Sun light	Rainfall (%)l	
1	March	27	12	48 %	14hrs	21	
2	April	35	19	58%	14hrs	22	
3	May	38	24	47%	16hrs	34	
4	June	42	30	59%	16hrs	65	
5	July	39	28	77%	16 hrs	67	
6	August	34	25	79%	15.5 hrs	72	
7	September	34	23	75%	13 hrs	61	
8	October	30	18	73%	12 hrs	35	

Discussion

Multiple factors are responsible for gall infestation in *Alstonia.* These include morphological, biochemical and physiological metabolic machinery of the plant which provide a generous shelter for the psyllid to persist. Besides the abiotic factors add to these intrinsic factors making the Alstonia vulnerable to infestation. Chemical stimulus from these psyllids brings about degeneration

of surrounding cells . As a result a small cavity is formed in which the egg is posted. Gradually the decolourized area increases in size and forms a small outgrowth on lower side where the gall appears in a depression. At the initial stage the gall grows towards the upper side of the leaf but later on its growth is towards lower side and develops into a dome shaped structure. Physiological secretion from the mother insect saliva causes the lysis of cells of the epidermis and mesophyll. The space increases and deepens the crack indicating the pathway of the stimulus . Adjacent cells show presence of dark contents. These factual observations are supported by the literature review of Schmidt *et. al.* 2012 who postulated that the flights from the overwintering host to colonize the summer host are thought to be relatively local and short in duration. Further Welsman *et. al.* 2007 proposed that nutritional cues from host plants are also presumed to impact the timing of spring migrations from *R. cathartica*. Many host-alternating aphid species produce alates in response to decreasing nitrogen content of the maturing leaves of their primary host (Harrison 1980) .Migration is also known to play an important role in the population dynamics of this species. Like other economically important species of aphid (e.g.: green peach aphid *Myzus persicae* (Zhu *et. al.* 2006b)) clonal lines of *A. glycines* are not limited to the soybean fields they initially colonize after migrating from the primary host.

Conclusion

In order to minimize the crop loss due to gall insect, we can adapt the Integrated Pest Management (IPM) package for higher crop yield and minimum environmental pollution in ornamental plant culture. At present, IPM package comprising of cultural, mechanical, and chemical control measures is in practice to manage/control the gall fly in *Alstonia* cultivation.

Recent pest management practices are being developed based on the chemical cues i.e. herbivore induced plant volatiles (HIPV) emitted by the herbivore infested plant where the chemical can be identified, extracted, synthesized and can be used in ornamental devil tree protection against gall fly.

So it is the high time to take up some strategic planning or new crop protection strategies to control or suppress the pest population in its cultivation.

References

Ananthakrishnan TN (1998): Insect gall systems: Patterens, processes and adaptive diversity. *Curr Sci 75*: **672-76**.

Arduin, M., Fernandes, G.W. & Kraus, J.E. (2005). Morphogenesis of gall induced by *Baccharopelma dracundulifoliae*(Hemiptera: Psyllidae) on *Baccharis dracunculifolia* (Asteraceae) leaves. *Brazilian J. Bio.* 65:**559-571**.

Arora D K and Patni V (2001): Localization of the metabolites and enzymes in insect induced rachis gall and normal tissues of *Prosopis cineraria* (Linn.) Druce. *J Phytol Res 14*: **179-81**.

Chen J and Qiao G X (2011) Galling Aphids (Hemiptera: Aphidoidea) in China: Diversity and host specificity. *Psyche 2012*: **1155-66**.

Gullan P J and Martin J H (2003) Sternorrhyncha (jumping plant-lice, whiteflies, aphids and scale insects). Pp 1079-89. In: Resh V and Carde R (ed) Encyclopedia of Insects. Academic Press, Amsterda (cross reference)

Gonçalves-Alvim, S.J. & G.W. Fernandes. (2001): Biodiversity of galling insects: historical, community and habitat effects in four Neotropical savannas. *Biodivers. Conserv*. 10:**79-98**.

Harrison R.(1980): Dispersal polymorphisms in insects. *Ann. Rev. Ecol. Syst*. **11**, 95–118 Cross reference

Hartley SE. (1998): The chemical composition of plant galls: are level of nutrients and secondary compounds controlled by the gall- former *Oecologia*, 113:**492-501**.

Hodkinson ID. (1984): The biology and ecology of gall-forming Psylloidea. In: Ananthakrishnan, T.N. (ed.), Biology of Gall Insects. Oxford & IBH Publishing Company Private Limited, New Delhi, India, **59-77**. (cross reference)

Jain S and Dhiman S C,(2014): Some ecological aspects of *Pauropsylla tuberculata* Crawford induced galls on *Alstonia scholaris*. *J Exp Zool India* 17: **431-36**.

Kar PK, Jena KB, Srivastava AK, Giri S, Sinha MK.(2013): Gall induced stress in the leaves of *Terminalia arjuna*, food plant of tropical tasar silkworm, *Antheraea mylitta*. Emir. *I. Food Agric*; 25(3):**201-210**.

Mukherjee S, Lokesh G, Aruna A S, Sharma S P and Sahay A, (2016) :Studies on the foliar biochemical changes in the gall (*Trioza fletcheri* minor) infested tasar food plants *Terminalia arjuna* and *Terminalia tomentosa*. *J Ent Zoo Studies* 4: **154-58**

Raman A, Singh, RN, Maryanska-Nadachowska A, (1997): Biology and Karyology of a Cecidogenous Psylloid, *Trioza fletcheri* minor (Homoptera: Psylloidea) and Morphogenesis of galls on the leaves of *Terminalia tomentosa* and *T. arjuna* (Combretaceae). *Insecta Matsumurana*, 53:**117-134**.

Raman A, (2007):. Insect-induced plant galls of India: unresolved questions. *Curr. Sci.; 92*:**748-757.**

Saini D and Sarin R, (2012): SDS-PAGE analysis of leaf galls of *A. scholaris* (L) R. Br. *J. Pl. Pathol. Microbiol. 3*: **121**.

Scareli- Santos C and Varanda E M (2003) :Morphological and histochemical study of leaf galls of *Tabebuia ochracea* (Cham.) Standl. (Bignoniaceae). *Phytomorphol 53*: **207- 17**.