Research Article
Volume-8 | Issue-1| Jan-Mar-2022|

VEETHIKA-An International Interdisciplinary Research Journal
E-ISSN: 2454-342x
Double Blind Peer Reviewed Journal
URL: https://veethika.qtanalytics.in

Aphid seasonality and host plant relationship: A Review

Debkumar Sahoo[1], Biplab Mandal[2], Sudipta Kumar Ghorai[3*]

[1]Coastal Ecology Research laboratory, Medinipur, West Bengal, INDIA
[2]Department of Zoology, Vidyasagar University, Medinipur, West Bengal, INDIA
[3]Department of Zoology, Egra Sarada Shashi Bhusan College, Medinipur, West Bengal, INDIA

[*]Corresponding author: sudiptag8@gmail.com

ABSTRACT: Aphids are harmful agricultural insect pests that feed on the phloem sap of their hosts, infecting them with diseases. Plant-aphid interaction is a dynamic system that is always changing and varying. During their life cycle, several aphid species change their host plant. They travel between main and secondary host plant species in the spring and fall. This host shift has happened due to the phloem sap's nutritional importance and necessity for reproduction. According to certain experiments, the aphid parasitism impact reduces the number of inflorescences and the average weight of floral buds. With the aid of enzymatic adaptability and sequestering secondary metabolites, the host plant possesses biochemical and physical defence mechanisms. Aphids circumvent this by secreting Mixed Function Oxidase (MFO), which catalyses oxidative reactions, allowing them to eat, develop, and breed on their host plant.

KEYWORDS: Aphids, secondary metabolite, phloem sap, MFO

1. INTRODUCTION

Aphids are phyto-succivorous insects that eat plants. The region's geographic location, terrain, climate, and abundant vegetation have combined to create a perfect ecological complex for the assemblages to grow into an extremely rich and diversified aphid fauna (Agarwala et al., 2012; Agarwala et al., 1987; Blackman and Eastop, 2008). They devitalized plants by interfering with their natural physiology. Many aphids migrate seasonally between two host plants: one is the main host (woody plants), which is used for sexual reproduction, and the other is the secondary host (herbaceous plants), which is used for parthenogenetic reproduction. Aphids may cause harm to their host plants by destroying seedlings, inflorescences, fruits, and other parts of the plant's physiology. Some aphids have developed mechanisms to circumvent plant defence barriers, allowing them to eat and breed on their host plants.

2. SEASONAL VARIATION

Wingless females mate with winged males on main host plants in the winter and lay eggs. All winged adult aphid hatches from an egg find a secondary host in the spring. The development of aphid host alternation may be explained by one of two theories. According to the first theory, host alternation is an adaptation to seasonal fluctuations in the nutritional content of the host plant phloem sap (Dixon, 1973). The nutritional value of phloem sap from woody plants is greater in the summer than in winter. In the summer, the nitrogen content of phloem sap is inadequate. As a result, the nutrition quality of herbaceous plants' phloem sap is greater than that of woody plants. As a result, aphids may increase their number by shifting from woody to herbaceous plants in the summer (Blackman and Eastop, 2008). According to the second theory, evolutionary limitations cause host alternation. The sexual generations are phylogenetically limited to woody plants, aphids that alternate hosts must return to woody plants before overwintering in the fall (Debnath, 2020; Debnath and Chakrabarti, 2020).

3. HOST ASSOCIATION

Aphids are classified into three groups based on their host range: monophagous (Celaphidinae subfamily),

DOI: https://doi.org/10.48001/veethika.2022.08.01.001

oligophagous (Drepanosiphinae and Hormaphidinae), and polyphagous (Aphididae). Monophagous aphids feed on a single plant, oligophagous aphids feed on plants of related genera, and polyphagous aphids feed on plants of unrelated genera. The majority of aphids transfer pathogens to their hosts (Dey et al., 2016; Dey and De, 2018). Wingless females mate with winged males on main host plants in the winter and lay eggs. All winged adult aphid hatches from an egg find a secondary host in the spring. The development of aphid host alternation may be explained by one of two theories. According to the first theory, host alternation is an adaptation to seasonal fluctuations in the nutritional content of the host plant phloem sap (Dixon, 1973). The nutritional value of phloem sap from woody plants is greater in the summer. The biochemical changes in the phloem sap in the host plant correspond with the budding of inflorescences, and most aphid colonies die off during the budding in late summer. The survivor aphid may suppress the budding inflorescences in late fall, allowing their genetic line to survive until the next year. As a result, the aphid did not affect the development of the host plant, but it did reduce the number of inflorescences and the average weight of floral buds. Aphids initially determine whether or not the plant is acceptable. Aphids ingest their styles to the host plant after landing on it. As a consequence, plants strengthen their physical defences. Aphids may fight back by releasing a specific enzyme. Phenol oxidases, peroxidases, hydrolases, glucosidases, acetylcholine esterase, and esterase are among the enzymatic proteins found in aphids that feed on phloem sap.

4. APHIDS AND THEIR HOST PLANT

Aphid systematics and aphidological study have been done, and India has been the subject of substantial examination since the 1960s (Chakrabarti et al., 2012, Agarwala and Das, 2012). Aphids are a diverse group of fragile and harmful insects, and they exhibit a great degree of variety.

Fig. 1. Aphid attacks the leaves of the Mangrove plant.

5. APHID ENZYME

Aphids produce detoxifying enzymes to protect themselves from plant toxins. It aids in reducing glucosinolate levels, which is beneficial to specialised aphids that rely on these substances for defence. These aphids regularly detoxify plant defence chemicals. Aphid saliva protein components display certain species-specific contradictions. For generalist A. fabae, an increase in -Glucosidase to overcome the plant induced defensive chemical activity, while for specialists, a reduction in -Glucosidase was better for specialist recruitment by the right host plant. Because of the high toxicity and alkaloid content of C. acutum, phenol oxidases are more abundant. This is related to the capacity to sequester and deploy the toxins, as suggested by as, and on Maize due to their high phenolic content, which may detoxify them and transform their anti-probing action accordingly. Aphids are a wide family of piercing-sucking insects that eat sieve components. Our understanding of the nature of proteins in aphid saliva and salivary glands has grown in recent years. For example, five enzymes were found in the saliva of the green peach aphid Myzus persicae: glucose oxidase, glucose dehydrogenase, NADH dehydrogenase, -glucosidase, and -amylase (Pollard, 1973; Harmel, 2008). Plants use enzymes and secondary metabolites to defend against pests (Cai et al., 2004). In pest-resistant plants, peroxidase (POD), phenylalanine ammonia-lyase (PAL), and polyphenol oxidase (PPO) are key biochemical indicators (Sha et al., 2015). POD and PPO activities increase in various sorghum cultivars under aphid stress, according to Chang and coworkers (2008). In addition, the enzyme tyrosine ammonia-lyase (TAL) is activated (Khan et al., 2003). The activities of TAL and PAL are connected to the concentrations of cellulose, hemicellulose, and lignin, which may help enhance the structural barrier. Plant cell ATPases are essential regulators of plant physiology and may be thought of as "master enzymes" that govern various processes at the cellular and organ levels (Serrano, 1989).

6. CONCLUSION

Aphid stress may cause a variety of plant responses, ranging from physiological metabolisms to molecular processes, depending on the species. Predators linked with species of Aphididae are among the most varied and numerous in the animal kingdom. They infest plants that are economically valuable, cultivated, or wild. The following are some of how such insects cause damage to their host plants: by devitalizing the plant; by interfering with the normal development of seedlings, inflorescences, fruits, and so on; by interfering with the normal physiology of plants, such as transpiration and photosynthesis, by occluding stomatal openings with heavy secretion and deposition of honeydew on the leaf surface; by interfering with the normal development of the seed. The aphids may be described as a collection of defenceless yet harmful insects. Polymorphism with a high degree of polymorphism is still a mystery. Aphids exhibit Host Alteration Characters in response to the nourishment provided by their host plant. Aphids may use enzymatic activity to negate the host plant's defence

DOI: https://doi.org/10.48001/veethika.2022.08.01.001

system and feed on its food. To put it another way, several aphids exhibit a regular seasonal migration between two host plants, often with distant taxonomic relations, one of which is referred to as the primary host used for sexual relation and the other as the secondary host used for parthenogenetic reproduction, with the primary host serving as the primary host for the second. In conclusion, it can be said that aphids are a group of insects that are both vulnerable and harmful in nature. Polymorphic organisms with a high degree of polymorphism are still a mystery. Flower richness and different ecological circumstances in hilly terrains may be considered as key contributing elements in the formation of the aphid fauna, which is the first of an obligatory group of polyphagous insects.

ACKNOWLEDGEMENT

The authors are thankful to all coastal ecology research lab members in Egra Sarada Shashi Bhusan College, West Bengal, India.

REFERENCES

Agarwala, B. K. and Das, K. (2012). Host-plant based morphological, ecological & esterase variation in Aphis gossypii population (Homoptera: Aphididae). Entomon. 32: 89-95.

Agarwala, B. K., Das, S. and Bhowmik, A. K. (1987). Natural food range and feeding habits of aphidophagous insects in Northeast India. Journal of Aphidology. 1 (1/2): 10-22.

Blackman, R. L and Eastop, V. F. (2008). Aphids on the world's Herbaceous plants andshrubs. Willey Publications. Natural History Meseum.

Cai, Q. N., Zhang, Q. W. and Cheo, M. (2004). Contribution of indole alkaloids to Sitobion avenae (F.) resistance in wheat. J. Appl. Entomol. 128: 517–521.

Chakrabarti, S., Sarkar, S. and Debnath, M. (2012). Diversity and Biosystematics of aphidophagous predators of eastern Himalaya and Northeast India. In: Biodiversitat und Naturausstatung im Himalaya III, Hartman, M & Weipert, J. Ed., Verein der Freunde & forderer des Naturkundemeuseums Erfurt e, IV. Pp. 129-149.

Chang, J. H., Zhang, L., Shen, S. X. and Ma, Z.Y. (2008). Correlation analysis of physical and chemical characteristics with resistance to sorghum aphid (Melanaphis sacchari) in different sorghum genotypes. J. Plant Genet. Resour. 9: 55–61.

Debnath, M. (2020). Aphidophagous Predator diversity in Kalimpong District, India. International Journal of Experimental Research and Review (IJERR). 22: 30-36.

Debnath, M. and Chakrabarti, S. (2020). Diversity, Bioecology and Biosystematics of Aphids (Hemiptera: Aphididae) in Darjeeling Himalaya. International Journal of Experimental Research and Review (IJERR). 21: 10-18.

Dey, S. R., Sikdar, S. R., Ghose, T. K. and De, M. (2016). Study of the efficiency of Neuropteran predator, Hemerobius indicus Kimmins as potential biocontrol agent of notorious aphid, Lipaphis erysimi (Kaltenbuch) on Brassica campestris Linn. (cv. B-9). International Journal of Experimental Research and Review (IJERR). 7: 21-31.

Dey, S. R. and Mitu De, M. (2018). Report on winter crop plant-aphid- aphidophagous Chrysopidae (Neuroptera: Insecta) association from Murshidabad district, West Bengal, India. International Journal of Experimental Research and Review (IJERR). 16: 7-13.

Dixon, A.F.G. (1973). Biology of aphids. Studies in Biology. No.44. Edward Arnold (Publisher), London Pp. 1-58.

Harmel, N. (2008). Identification of aphid salivary proteins: a proteomic investigation of Myzus persicae. Insect Mol. Biol. 17: 165–174.

Khan, W., Prithiviraj, B. and Smith, D. L. (2003). Chitosan and chitin oligomers increase phenylalanine ammonia-lyase and tyrosine ammonia-lyase activities in soybean leaves. J. Plant Physiol. 160: 859–863.

Pollard, D. G. (1973). Plant Penetration by Feeding Aphids (Hemiptera, Aphidoidea). Bull. Entomol. Res. 62: 631–714.

Serrano, R. (1989). Structure and function of plasma membrane ATPase. Annu. Rev. Plant Physiol. Plant Mol Biol. 40: 61–94.

Sha, P. J., Fan, Y. J., Wang, Z. C. and Shi, X. Y. (2015). Response dynamics of three defense related enzymes in cotton leaves to the interactive stress of Helicoverpa armigera (Hübner) herbivory and omethoate application. J. Integr. Agric. 14: 355–364.

Table 1- Different important types of aphid species and their host plant in India

Aphid Species	Host Plants
Acyrthosiphon rubi elliptici Stroyan and Nagaich	*Rubus* sp.
Akkaia bengalensis Basu, A.N	*Polygonum* sp.
Amphicercdus indicus Basu, A.N	*Lonicera glabrata*
Amphorophora ampullata bengalensis Basu, A.N	Ferns
Anthracosiphoniella maculatum Basu, A.N	Fern
Aphis citricola v.d.G	*Capsicum frutecens*
Aphis craccivora Koch	*Ipomia balsamina*
Aphis craccivora Koch	*Solanum arvensis*
Aphis craccivora Koch	*Artemesia vulgaris*
Aphis craccivora Koch	*Dolichos lablab*
Aphis craccivora Koch	*Vicia faba*
Aphis fabae solanella Theobald	*Solanum niagrum*
Aphis gossypii Glover	*Ageratum conyzoides*
Aphis gossypii Glover	*Capsicum frutescens*
Aphis gossypii Glover	*Galinsuga parviflora*
Aphis gossypii Glover	*Tagetes patula*
Aphis kurosawai Takahashi	*Artemisia vulgaris*
Aphis ruborum longisetosus Basu, A.N	*Rubus lineatus*
Aphis spiraecola Patch	*Bidens Pilosa*
Aulacorthum dendrobii Basu, A.N	*Dendrobium* sp.
Aulacorthum (Perillaaphis) perillae (Shinji)	*Perilla frutescens*
Aulacorthum anthraxoni (Takahashi)	Grass
Aulacorthum dicentrae Basu, A.N	*Dicentra thalictifolia*
Aulacorthum magnoliae (Essing and Kuwana)	*Sechium edule*
Aulacorthum magnoliae (Essing and Kuwana)	*Cucarbita moschata*
Aulacorthum nipponicum (Essing and Kuwana)	*Paederia foetida*
Aulacorthum solani (Kaltb.)	*Poa* sp.
Aulacorthum solani (Kaltb.)	*Solanum tuberosum*
Aulacorthum solani (Kaltb.)	*Oxalis* sp.
Brachycaudus helichrysi (Kaltb)	*Prunus persica*
Brachycaudus helichrysi (Kaltb.)	*Gynura angutosa*
Brachycaudus sp.	*Crotolaria saltiana*
Brachymyzus jasmini Basu, A.N	*Jasminum humile*
Brachysiphoniella montana (van der Goot)	*Eleusine* sp., *Poa* sp.
Cavariella nigra Basu, A.N	*Salix elegans*
Cryptosiphum artemisiae Buckton	*Artemisia vulgaris*
Dysaphis multisetosa Basu, A.N	*Pyrus communis*
Haythurstia atriplicis (Linnaeus)	*Chenopodium album*
Hillerislambersia darjeelingi Basu, A.N	*Lonicera* sp.

DOI: https://doi.org/10.48001/veethika.2022.08.01.001

Hyalomyzus sp.	*Rubus* sp.
Hyalopterus pruni (Geoffroy)	*Aurondo donox*
Impatientinum smilaceti (Agarwalaet *al*)	*Salix macrophylla*
Indiaphis crassicornis Basu, A.N	*Rhododendron* sp.
Indiaphis setosum Basu, A.N	*Pentapterygium serpens*
Indomasonaphis anaphalidis Basu, A.N	*Anaphalis triplinervis*
Kurisakia indica Basu, A.N	*Engelhardtia spicata*
Liosmaphis himalayensis Basu, A.N	*Berberis umbellate*
Lipaphis erysimi (Kaltenbach)	*Brassica nigra*
Macrosiphonella pseudoartemisiae Shinji	*Chrysanthemum coronarium*
Macrosiphoniella kikungshana Takahashi	*Artemisia vulgaris*
Macrosiphoniella sanborni Gil	*Chrysenthemum*
Macrosiphoniella spinipes Basu, A.N	*Artemisia vulgaris*
Macrosiphum rosae(L.)	*Rosa* sp.
Macrosiphum rosae (L.)	*Rosa* sp.
Megoura abnormis Basu, A.N	*Unidentified Leguminosae*
Megoura pallipes Basu,A.N	*Indigofora teysmanni*
Metopolophium (*Microlophium*) *darjeeligense lacheni*	*Rubus* sp.
Micromyzus kalimpongensis Basu, A.N	*Hedychium coronarium*
Myzakkaia himalayensis Basu, A.N	*Polygonum* sp.
Myzakkaia polygonicola Basu, A.N	*Polygonum runcinatum*
Myzus (Sciamyzus) cymbalariae Stroyan	*Solanum* sp.
Myzus brevisiphon Basu, A.N	*Polygonum capitatum*
Myzus ornatus Laing	*Cineraria* sp.
Myzus ornatus Laing	*Dahlia* sp.
Myzus ornatus Laing	*Gladiolus* sp.
Myzus ornatus Laing	*Fragaria* sp.
Myzus ornatus Laing	*Solanum aurantiacum*
Myzus ornatus Laing	*Viola tricolor*
Myzus persicae (Sulzer)	*Solanum niagrum*
Myzus persicae (Sulzer)	*Foeniculum vulgare*
Myzus persicae (Sulzer)	*Gynura angutosa*
Oedisiphum soureni Basu, A.N	*Anaphalis triplinervis*
Pentalonia nigronervosa Coquerel	*Musa sp.*
Pseudoacyrthosiphon holsti (Takahashi)	*Rhododendron sp.*
Rhodobium porosum (Sanderson)	*Rosa sp.*
Rhophalosiphum maidis (Fitch)	*Zea mays*
Rhophalosiphum maidis (Fitch)	*Hordeum vulgare*
Schizaphis graminum (Rondani)	*Unidentified grass*
Shinjia pterdifoliae (Shinji)	*Unidentified ferns*
Sinomegoura photiniae Takahashi	*Photinia integrifolia*
Sitobion indicum Basu, A.N	*Cymbidium sp.*
Sitobion luteum (Buckton)	*Cymbidium sp.*

DOI: https://doi.org/10.48001/veethika.2022.08.01.001

Sitobion luteum (Buckton)	*Dendrobium sp.*
Sitobion miscanthi Takahashi	*Hordeum vulgare*
Sitobion rosaeformis (Das)	*Rosa cania*
Stobion rosaeformis (Das)	*Rosa sp.*
Subovatomyzus leucosceptri Basu, A.N	*Turnera sp.*
Subovatomyzus leucosceptri Basu, A.N	*Leucosceptrum canum*
Toxoptera aurantia (B.D.Fonscolombe)	*Schima wallichii*
Tricaudatus polygonituberculatus (Narzykulov)	*Polygonum mole*
Tricaudatus polygonituberculatus (Narzykulov)	*Spiraea corymbose*
Trichosiphoniella polygoniformosanas (Takahashi)	*Polygonum perfoliatum*
Trichosiphoniella sasakii (Matsumura)	*Artemisia vulgaris*
Uroleucon tanaceti indica Basu, A.N	*Unidentified plant*
Vesiculaphiscaricis (Fullaway)	*Cyperus rotundus*
Vesiculaphis grandis Basu, A.N	*Rhododendron sp.*
Vesiculaphis pieridis Basu, A.N	*Pieris ovalifolia*

DOI: https://doi.org/10.48001/veethika.2022.08.01.001