International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 25-04-2024, Accepted: 17-05-2024, Published: 10-06-2024
Volume 9, Issue 6, 2024, Page No. 18-23

Biodiversity of aphid parasitoids (Aphidiinae: Braconidae: Hymenoptera) in Ayodhya district, Uttar Pradesh, India

K M Tiwari[1], P N Tripathi[1], Rajendra Singh[2]
[1] Department of Zoology, K.S. Saket P.G. College, Ayodhya, Uttar Pradesh, India
[2] Department of Zoology, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur, Uttar Pradesh, India

Abstract
The present paper deals with the diversity and host relationship between aphid parasitoids, aphids and their host plants in Ayodhya district of eastern Uttar Pradesh (India). The result demonstrated the presence of a total of 10 species of parasitoids belonging to 7 genera under 2 families parasitising 13 species of aphids belonging to 9 genera infesting 31 plant species belonging to 9 families in 102 villages/town areas of Ayodhya district. Most of the host plants are highly economically important agricultural crops. About 28% tritrophic associations (parasitoids - hosts - host plants) are new record from India out of total 60 such associations observed. Aphelinidae is represented by a single species, *Aphelinus gossypii* Timberlake, 1924 while Aphidiinae (Braconidae) comprises 9 species, among which *Binodoxys indicus* (Subba Rao & Sharma) and *Lipolexis oregmae* (Gahan) are polyphagous and diversified parasitising 4 and 3 species of aphids infesting 11 and 10 plant species in 27 and 24 villages of Ayodhya, respectively. Other species of parasitoids parasitise 1-3 aphid species on 1-5 host plant species.

Keywords: Aphid parasitoids, Aphidiinae, Aphelinidae, *Binodoxys indicus*, *Lipolexis oregmae*, bioagents, biocontrol

Introduction

Aphids are small sap sucking insects and considered as major pests of several crops of agricultural and horticultural importance. They have evolved several reproductive tactices to overcome adverse biotic and abiotic stress [1]. The parasitoids are natural bioagents that kill the aphids by parasitising them. Indeed, they lay their eggs inside aphid, after hatching, the larvae feed the living hosts. The parasitoids may be monophagous (parasitising only one species), oligophagous (parasitising a few closely-related species) or polyphagous (parasitising distantly-related several hosts) [2]. Most aphid parasitoids belong to Hymenoptera (Aphidiinae: Braconidae, and Aphelinidae), and a few to Diptera (Cecidomyiidae). Aphidiinae is a monophyletic group that parasitise only aphids [3]. They are solitary koinobiotic endoparasitoids as their larva develops in a living host that continues to feed and grow. Some species of aphid parasitoids are cosmopolitan in distribution so that one species, *Diaeretiella rapae* (McIntosh), parasitises about 98 species of the aphids infesting more than 180 plant species belonging to 43 plant families and distributed in 87 countries throughout the world [2]. Most of the aphidiine parasitoids used in biocontrol belong to the genera *Aphidius*, *Binodoxys*, *Diaeretiella*, *Ephedrus*, *Praon*, and *Trioxys* [4, 5].

For the utilisation of the parasitoids in biocontrol programme, their screening in the target area is essential which is based on the survey and their correct identification and true association with the pest (aphid) and food plants. Earlier, the preliminary information from Terai belt of eastern Uttar Pradesh was studied by Singh & Tripathi [6] and Ahmad & Singh [7, 8]. The present paper deals the relationship between plants, aphids and parasitoids complex in Ayodhya district of Uttar Pradesh. For this, an extensive survey of the aphids was done in the target area during three consecutive years (January 2021 to March 2024).

Matrials and Methods

Site of survey work

Ayodhya district (formerly Faizabad) (area: 2,764 km^2; latitude: 26.75907 to 26.83907 N; longitude: 82.16523 to 82.24523 E; average elevation: 94 m) shares border with Ambedkar Nagar district to the southeast, Barabanki district to the west, Basti district to the east, Gonda district to the north, Sultanpur and Amethi districts to the south, Figure 1). Most of the lands in the district are used for agriculture purposes. The chief agricultural products in the district are wheat, rice, oil seed, maize, gram, pea, bean, sugarcane, onion, potato, tomato, brinjal, brassica and cucurbit vegetables. An extensive survey for aphid infestation along with their natural enemies was made in several villages of the districts both on cultivated as well as on wild plants.

Collection, Preservation and Identification

Aphids in the fields are often collected on the plant material as tender leaves, apical portion, stem, flower, twigs, fruits, inflorescence, root, bark, bud by cutting that part and placed in plastic bags and tightened with rubber bands or in plastic vials of standard width with cotton plug and were brought back to the laboratory. Then, some aphids were transferred to the glass vials (4 x 0.5 cm) containing 70 per cent ethyl alcohol and glycerol (5:1) for mount preparation for taxanomical studies. The aphids were mounted in Berlese medium after clearing [9].

For obtaining parasitoids, aphids were reared in plastic containers, the open mouth of which was tied with thick mesh muslin cloth. If parasitised, the aphids turned into mummies from which adult parasitoids egressed out. These adults were kept in 70% alcohol for their identification. Aphids were identified with the help of *Aphid Taxakey (Aphids on the World Crops)* (computer software developed by CAB, London, British Museum Natural Histroy, London [10]. Parasitoids were identified following Starý & Schlinger [11].

Results and Discussion

The analysis of data revealed that a total of 10 species of parasitoids belonging to 7 genera under 2 families parasitise 13 species of aphids belonging to 9 genera infesting 31 plant species belonging to 9 families in 102 villages/town areas of Ayodhya district (Table 1). A total of 17 (28%) tritrophic associations (parasitoids - hosts - host plants) are new record from India out of total 60 such associations. These relationships are marked by asterisk (*) in Table 1. *Aphis gossypii* Glover was observed parasitised on maximum 10 species of crops by two parasitoids followed by *Myzus persicae* (Sulzer) which is parasitised by 4 parasitoids on 9 food plants (Table 2). Data also reveals that the vegetable crop brinjal (*Solanum melongena* L.) is infested by maximum 4 species of aphids and also attract as many as 3 species of parasitoids in the target area (Table 3) that naturally control their population to some extent.

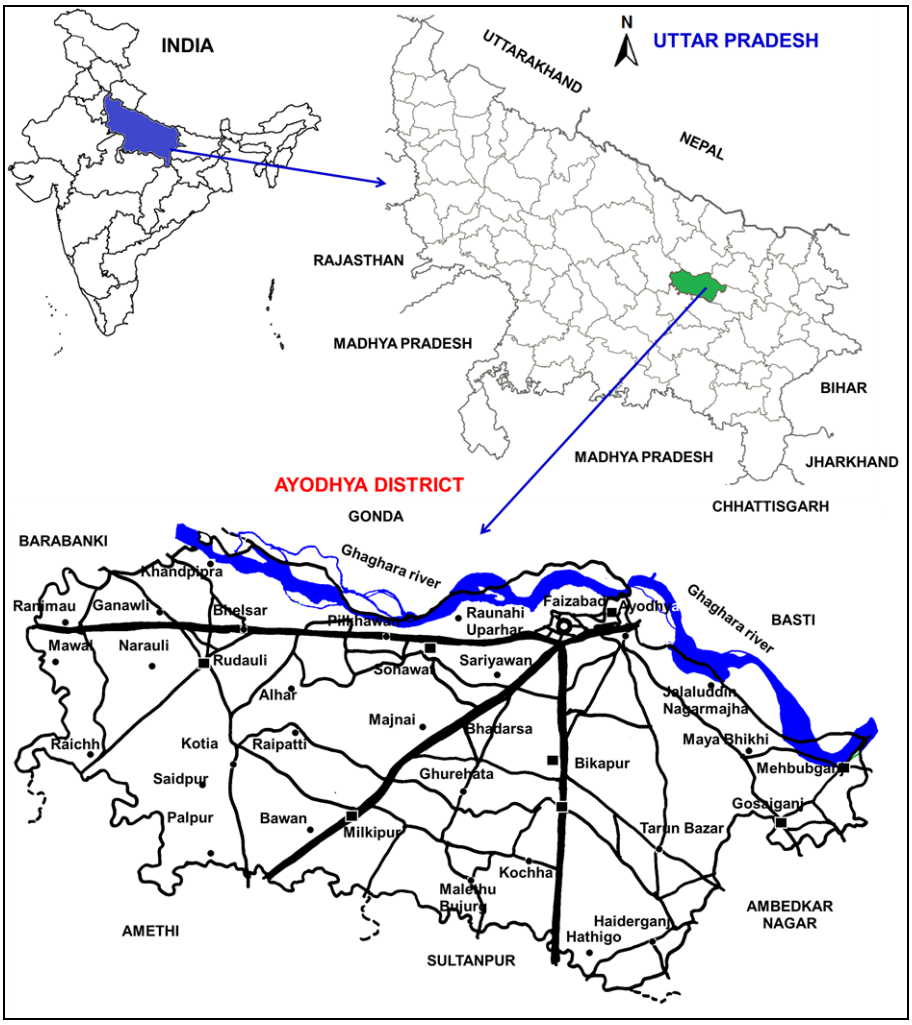

Fig 1: Map showing the study area in Ayodhya district, Uttar Pradesh.

Out of 10 parasitoid species, 9 belong to the family Braconidae (subfamily Aphidiinae). Earlier, Ahmad & Singh [7] recorded 13 species of parasitoids parasitising 25 species of aphids in 4 districts of northeast Uttar Pradesh, *viz*., Kushinagar, Deoria, Gorakhpur and Meharajganj while Mall [12] recorded 11 species of parasitoids parasitising 24 species of aphids in 11 districts (Ambedkar Nagar, Azamgarh, Ballia, Chandauli, Gazipur, Jaunpur, Maunath Bhanjan, Mirzapur, Sant Ravidas Nagar, Sonbhadra, and Varanasi) of southeast Uttar Pradesh. Dey & Akhtar [13] and Akhtar *et al*. [14] catalogued aphid parasitoids of India enlisting 125 species of aphid parasitoids belonging to 22 genera.

Aphelinus gossypii Timberlake is the only member of the family Aphelinidae (Hymenoptera) that parasitised 5 species of aphids infesting 6 host plant species. Among the braconids, *Binodoxys indicus* (Subba Rao & Sharma) and *Lipolexis oregmae* (Gahan) are polyphagous and diversified parasitising 4 and 3 species of aphids infesting 11 and 10 plant species in 27 and 24 villages of Ayodhya, respectively followed by *Lysiphlebia japonica* (Ashmead, 1906) (parasitises 3 species of aphids on 5 host plant species) and *Aphidius uzbekistanicus* Luzhetzki, 1960 (parasitises 2 species of aphids on 5 plant species). Other species of parasitoids parasitise 1-2 aphid species on 1-3 host plant species.

The data demonstrated that in the target area, parasitoid fauna is not very rich and most of the aphids as crop pests attract only 1-3 species of parasitoids. However, few of them, for example, *Binodoxys indicus* (Subba Rao & Sharma), *Lipolexis oregmae* (Gahan) and *Lysiphlebia japonica* (Ashmead) were earlier found promising biocontrol agents against their host aphids [15]. Hence, their conservation in field population is urgently needed by avoiding excess of nitrogen fertilisers that attract aphids and judiciously using selective pesticides that are selective and not harmful for predators.

Table 1: List of aphid parasitoids of different aphid species associated with different food plants in different villages of Ayodhya district. *denotes new record of this tritrophic association from India.

Family/ Parasitoid species	Aphid species (hosts)/Food plant of aphid	Family of food plants	Villages
Family: Aphelinidae			
1. *Aphelinus gossypii* Timberlake, 1924			
Aphis (Aphis) gossypii Glover, 1877			
	Cajanus cajan (L.) Millsp.	Fabaceae	Aadil Pur, Jainabad, Kadanpur, Mahawan, Mohammad Pur, Pilkhawan, Rampur Halwara, Uparhar, Ranikpur, Ranimau
	Vicia faba L.	Fabaceae	Jasmand
Aphis (Aphis) solanella Theobald, 1854			
	Capsicum frutescens L.	Solanaceae	Deora Kot, Sohawal
	**Solanum melongena* L.	Solanaceae	Katrauli
Aphis (Aphis) spiraecola Patch, 1914			
	Cajanus cajan (L.) Millsp.	Fabaceae	Aadil Pur, Rautawa
Myzus (Nectarosiphon) persicae (Sulzer, 1776)			
	**Solanum melongena* L.	Solanaceae	Bhaisauli, Janaura, Khirauni
	Solanum tuberosum L.	Solanaceae	Katrauli, Kola, Kot Saray, Rauzagaon, Sahni, Saranga Pur
	**Vicia faba* L.	Fabaceae	Amsin, Bhaisauli, Jamdra
Schizaphis (Schizaphis) graminum (Rondani, 1852)			
	Cenchrus americanus (L.) Morrone	Poaceae	Khairi
Family: Braconidae			
1. *Adialytus ambiguus* (Haliday, 1834) [syn. *Adialytus arvicola* (Stary, 1961); *Aphidius ambiguus* Haliday, 1834; *Aphidius delhiensis* Subba Rao & Sharma 1960; *Lysiphlebus ambiguus* (Haliday, 1834); *Lysiphlebus delhiensis* (Subba Rao & Sharma 1960)]			
Melanaphis sacchari (Zehntner, 1897)			
	Cenchrus americanus (L.) Morrone	Poaceae	Hariharpur, Jarayal Kalan, Khandasa, Narauli, Rautawa
	Saccharum officinarum L.	Poaceae	Janaura, Jarayal Kalan, Karma Kondari
Rhopalosiphum maidis (Fitch, 1856)			
	Cenchrus americanus (L.) Morrone	Poaceae	Dalsarai, Deora Kot, Gondwa, Kadanpur, Kadanpur, Nimdi
	Zea mays L.	Poaceae	Jainabad, Lalpur Uparhar, Moiya Kapoor Pur, Nimdi, Paliagoa
2. *Aphidius colemani* Viereck, 1912			
Myzus (Nectarosiphon) persicae (Sulzer, 1776)			
	Brassica rapa L.	Brassicaceae	Jarayal Kalan, Jasmand, Kail, Rauzagaon, Rudaulia
	Solanum lycopersicum L.	Solanaceae	Dalsarai, Jarayal Kalan, Manapur
3. *Aphidius matricariae* Haliday, 1834			
Myzus (Nectarosiphon) persicae (Sulzer, 1776)			
	**Raphanus sativus* L.	Brassicaceae	Gokula, Hisamuddin Pur, Kapasi, Khairi
4. *Aphidius smithi* Sharma & Subba Rao, 1959			
Acyrthosiphon (Acyrthosiphon) pisum (Harris, 1776)			
	Pisum sativum L.	Fabaceae	Ghurehata, Hisamuddin Pur, Jaganpur, Kanakpur, Kapasi, Pilkhawan, Raipatti
	Vicia faba L.	Fabaceae	Kot Saray, Paratajpur, Rudaulia,
5. *Aphidius uzbekistanicus* Luzhetzki, 1960			
Rhopalosiphum maidis (Fitch, 1856)			
	Cenchrus americanus (L.) Morrone	Poaceae	Akhtiyar Pur, Banvir Pur, Baragaon
	Hordeum vulgare L.	Poaceae	Jarayal Kalan, Mohammad Pur
	**Saccharum officinarum* L.	Poaceae	Nara
	Sorghum bicolor (L.) Moench	Poaceae	Saidpur
	**Triticum aestivum* L.	Poaceae	Bhikhapur, Ghatuli, Jarayal Kalan,
Sitobion (Sitobion) miscanthi (Takahashi, 1921)			
	Triticum aestivum L.	Poaceae	Deoie, Faizabad, Mau Yaduvansh Pur, Milkipur, Sewara
6. *Binodoxys indicus* (Subba Rao & Sharma, 1958) [syn. *Trioxys indicus* Subba Rao & Sharma, 1958; *Trioxys (Binodoxys) indicus)* Subba Rao & Sharma, 1958]			
Aphis (Aphis) craccivora Koch, 1854			
	Ageratum conyzoides L.	Asteraceae	Pirkhauli
	Lablab purpureus (L.) Sweet ssp. *purpureus*	Fabaceae	Khanpur, Masodha, Pilkhawan, Sulem Pur
	Solanum lycopersicum L.	Solanaceae	Amiala Pur
Aphis (Aphis) gossypii Glover, 1877			
	**Hibiscus cannabinus* L.	Malvaceae	Ayodhya
	Hibiscus rosa-sinensis L.	Malvaceae	Jainabad, Jakhauli, Kuchera, Malik Pur

	Lagenaria siceraria (Molino) Standl.	Cucurbitaceae	Aadil Pur
	Momordica charantia L.	Cucurbitaceae	Ayodhya, Faizabad, Mohammad Pur
	**Musa paradisiaca*L.	Musaceae	Deoriya
	Solanum melongena L.	Solanaceae	Chirauli, Deogaon, Deoie
	Solanum tuberosum L.	Solanaceae	Jakhauli, Kushmaha, Phelsanda
	**Tagetes erecta* L.	Asteraceae	Khairi
***Aphis (Aphis) spiraecola* Patch, 1914**			
	Cestrum diurnum L.	Solanaceae	Ayodhya, Baboo Pur, Kot Saray
***Myzus (Nectarosiphon) persicae* (Sulzer, 1776)**			
	Solanum melongena L.	Solanaceae	Mau Yaduvansh Pur, Mehbubganj, Raja Nagar, Tiwaripur
7. *Diaeretiella rapae* (McIntosh, 1855) [*Aphidius brassicae* Marshall, 1896; *Aphidius rapae* Curtis, 1860; *Aphidius rapae* McIntosh, 1855; *Diaeretiella aphidum* (Mukerji & Chatterjee, 1950); *Diaeretiella brassicae* (Marshall, 1896); *Diaeretiella rapae* (Curtis, 1860); *Diaeretus aphidium* Mukerji & Chatterjee, 1950]			
Brevicoryne brassicae (Linnaeus, 1758)			
	Brassica oleracea L.var.*botrytis* L.	Brassicaceae	Ayodhya, Baboo Pur, Bandanpur, Kochha, Madhopur, Surwari
	Raphanus sativus L.	Brassicaceae	Aadil Pur, Ayodhya, Bandanpur, Kot Saray
	Brassica oleracea L. var. *botrytis*	Brassicaceae	Daulat Pur, Faizabad, Khanpur,Masodha
	Brassica rapa L.	Brassicaceae	Sahni, Maholi Uparhar, Milkipur
	Raphanus sativus L.	Brassicaceae	Jalaluddin Nagar, Majha Jarayal Kalan, Raja Nagar, Sheikhpur Jafar
8. *Lipolexis oregmae* (Gahan, 1932) [syn. *Lipolexis pseudoscutellaris* Pramanik & Raychaudhuri, 1984]			
Aphis (Aphis) craccivora Koch, 1854			
	Lablab purpureus (L.) Sweet ssp. *purpureus*	Fabaceae	Jasmand, Karaundi, Majnawa, Mohammad Pur, Rampur
Aphis (Aphis) fabae Scopoli, 1763			
	**Chenopodium album* L.	Amaranthaceae	Deora Kot, Mehbubganj, Nimdi
	**Impatiens balsamina* L.	Balsaminaceae	Katrauli, Birauli
	**Rosa indica* L.	Rosaeceae	Halderganj
	**Ruellia prostrata* Poir	Asteraceae	Milkipur
	**Solanum melongena* L.	Solanaceae	Bandanpur, Chetaipur
	**Solanum nigrum* L.	Solanaceae	Chetaipur, Raja Nagar
	Vicia faba L.	Fabaceae	Khirauni, Raja Nagar
Myzus (Nectarosiphon) persicae (Sulzer, 1776)			
	Capsicum frutescens L.	Solanaceae	Kail, Phelsanda, Sarai Sura, Saranga Pur
	**Chenopodium album* L.	Chenopodiaceae	Ayodhya
	**Coriandrum sativum* L.	Apiaceae	Ankari Pur, Kurmihaya, Rauzagaon
9. *Lysiphlebia japonica* (Ashmead, 1906) [syn. *Lysiphlebia mirzai* Shuja-Uddin, 1975]			
Melanaphis sacchari sacchari (Zehntner, 1897) [syn. *Longiunguis saccharii* (Zehntner, 1897)]			
	Saccharum officinarum L.	Poaceae	Bari, Milkipur
Melanaphis sacchari (Zehntner, 1897)			
	Zea mays L.	Poaceae	Bari, Barwa, Baswar Buzurg
Rhopalosiphum maidis (Fitch, 1856)			
	Hordeum vulgare L.	Poaceae	Bawan, Kadanpur
	Sorghum bicolor (L.) Moench	Poaceae	Saidpur
	Triticum aestivum L.	Poaceae	Ghatuli, Jarayal Kalan, Milkipur,
Schizaphis (Schizaphis) graminum (Rondani, 1852)			
	Hordeum vulgare L.	Poaceae	Bankat
	Triticum aestivum L.	Poaceae	Gohaniya

Table 2: Aphid - parasitoid - host plant association in Ayodhya district, Uttar Pradesh, India.

Aphid species	Parasitoids species	Host plant species
Acyrthosiphon pisum	*Aphidius smithi*	*Pisum sativu, Vicia faba*
Aphis craccivora	*Binodoxys indicus*	*Ageratum conyzoides, Lablab purpureus* ssp. *purpureus, Solanum lycopersicum*
	Lipolexis oregmae	*Lablab purpureus* ssp. *purpureus*
Aphis fabae	*Lipolexis oregmae*	*Chenopodium album, Impatiens balsamina, Rosa indica, Ruellia prostrata, Solanum melongena, Solanum nigrum, Vicia faba*
Aphis gossypii	*Aphelinus gossypii*	*Cajanus cajan , Vicia faba*
	Binodoxys indicus	*Hibiscus cannabinus, Hibiscus rosa-sinensis, Lagenaria siceraria Momordica charantia, Musa paradisiaca, Solanum melongena, Solanum tuberosum, Tagetes erecta*
Aphis solanella	*Aphelinus gossypii*	*Capsicum frutescens, Solanum melongena*
Aphis spiraecola	*Aphelinus gossypii*	*Cajanus cajan*
	Binodoxys indicus	*Cestrum diurnum*

Brevicoryne brassicae	*Diaeretiella rapae*	*Brassica oleracea* var. *botrytis, Raphanus sativus*
Lipaphis erysimi	*Diaeretiella rapae*	*Brassica oleracea* var. *botrytis,Brassica rapa, Raphanus sativus*
Melanaphis sacchari	*Adialytus ambiguus*	*Cenchrus americanus, Saccharum officinarum*
	Lysiphlebia japonica	*Zea mays, Saccharum officinarum*
Myzus persicae	*Aphelinus gossypii*	*Solanum melongena, Solanum tuberosum, Vicia faba*
	Aphidius colemani	*Brassica rapa, Solanum lycopersicum*
	Aphidius matricariae	*Raphanus sativus*
	Binodoxys indicus	*Solanum melongena*
	Lipolexis oregmae	*Capsicum frutescens, Chenopodium album, Coriandrum sativum*
Rhopalosiphum maidis	*Adialytus ambiguus*	*Cenchrus americanus, Zea mays*
	Aphidius uzbekistanicus	*Cenchrus americanus, Hordeum vulgare, Saccharum officinarum, Sorghum bicolor, Triticum aestivum*
	Lysiphlebia japonica	*Hordeum vulgare, Sorghum bicolor, Triticum aestivum*
Schizaphis graminum	*Aphelinus gossypii*	*Cenchrus americanus*
	Lysiphlebia japonica	*Hordeum vulgare, Triticum aestivum*
Sitobion miscanthi	*Aphidius uzbekistanicus*	*Triticum aestivum*

Table 3: Host plant - aphid - parasitoid relationship in Ayodhya district, Uttar Pradesh, India.

Host plant species	Aphid species	Parasitoid species
Ageratum conyzoides	*Aphis craccivora*	*Binodoxys indicus*
Brassica oleracea var. *botrytis*	*Brevicoryne brassicae*	*Diaeretiella rapae*
	Lipaphis erysimi	*Diaeretiella rapae*
Brassica rapa	*Lipaphis erysimi*	*Diaeretiella rapae*
	Myzus persicae	*Aphidius colemani*
Cajanus cajan	*Aphis gossypii*	*Aphelinus gossypii*
	Aphis spiraecola	*Aphelinus gossypii*
Capsicum frutescens	*Aphis solanella*	*Aphelinus gossypii*
	Myzus persicae	*Lipolexis oregmae*
Cenchrus americanus	*Melanaphis sacchari*	*Adialytus ambiguus*
	Rhopalosiphum maidis	*Adialytus ambiguous Aphidius uzbekistanicus*
	Schizaphis graminum	*Aphelinus gossypii*
Cestrum diurnum	*Aphis spiraecola*	*Binodoxys indicus*
Chenopodium album	*Aphis fabae*	*Lipolexis oregmae*
	Myzus persicae	*Lipolexis oregmae*
Coriandrum sativum	*Myzus persicae*	*Lipolexis oregmae*
Hibiscus cannabinus	*Aphis gossypii*	*Binodoxys indicus*
Hibiscus rosa-sinensis	*Aphis gossypii*	*Binodoxys indicus*
Hordeum vulgare	*Rhopalosiphum maidis*	*Aphidius uzbekistanicus Lysiphlebia japonica*
	Schizaphis graminum	*Lysiphlebia japonica*
Impatiens balsamina	*Aphis fabae*	*Lipolexis oregmae*
Lablab purpureus ssp. *purpureus*	*Aphis craccivora*	*Binodoxys indicus Lipolexis oregmae*
Lagenaria siceraria	*Aphis gossypii*	*Binodoxys indicus*
Momordica charantia	*Aphis gossypii*	*Binodoxys indicus*
Musa paradisiaca	*Aphis gossypii*	*Binodoxys indicus*
Pisum sativum	*Acyrthosiphon pisum*	*Aphidius smithi*
Raphanus sativus	*Brevicoryne brassicae*	*Diaeretiella rapae*
	Lipaphis erysimi	*Diaeretiella rapae*
	Myzus persicae	*Aphidius matricariae*
Rosa indica	*Aphis fabae*	*Lipolexis oregmae*
Ruellia prostrata	*Aphis fabae*	*Lipolexis oregmae*
Saccharum officinarum	*Melanaphis sacchari*	*Adialytus ambiguus*
	Melanaphis sacchari sacchari	*Lysiphlebia japonica*
	Rhopalosiphum maidis	*Aphidius uzbekistanicus*
Solanum lycopersicum	*Aphis craccivora*	*Binodoxys indicus*
	Myzus persicae	*Aphidius colemani*
Solanum melongena	*Aphis fabae*	*Lipolexis oregmae*
	Aphis gossypii	*Binodoxys indicus*

	Aphis solanella	*Aphelinus gossypii Binodoxys indicus*
Solanum nigrum	*Aphis fabae*	*Lipolexis oregmae*
Solanum tuberosum	*Aphis gossypii*	*Binodoxys indicus*
	Myzus persicae	*Aphelinus gossypii*
Sorghum bicolor	*Rhopalosiphum maidis*	*Aphidius uzbekistanicus Lysiphlebia japonica*
Tagetes erecta	*Aphis gossypii*	*Binodoxys indicus*
Triticum aestivum	*Rhopalosiphum maidis*	*Aphidius uzbekistanicus Lysiphlebia japonica*
	Schizaphis graminum	*Lysiphlebia japonica*
	Sitobion miscanthi	*Aphidius uzbekistanicus*
Vicia faba	*Acyrthosiphon (Acyrthosiphon) pisum*	*Aphidius smithi*
	Aphis fabae	*Lipolexis oregmae*
	Aphis gossypii	*Aphelinus gossypii*
	Myzus persicae	*Aphelinus gossypii*
Zea mays	*Melanaphis sacchari*	*Lysiphlebia japonica*
	Rhopalosiphum maidis	*Adialytus ambiguus*

References

1. Ahmad ME, Singh R. Records of aphid parasitoids from north eastern Uttar Pradesh. *J Aphidol*,1993:6/7:7-14.
2. Ahmad ME, Singh R. Survey of parasitoids of aphids in north-eastern Uttar Pradesh for possible use in biological control. *Ann Entomol*,1995:13:87-96.
3. Akhtar MS, Dey D, Usmani MK. A catalogue of aphid parasitoids (Hymenoptera: Braconidae: Aphidiinae) from India. *Insecta Mundi*,2011:0151:1-31.
4. Blackman RL, Eastop VF, Kibby GG. *Taxakey: Aphids on the World's Crops*. CD-ROM. CAB International and The Natural History Museum,1997. ISBN 0 85199 172 6.
5. Boivin G, Hance T, Brodeur J. Aphid parasitoids in biological control. *Can J Plant Sci*,2012:92(1):1-12. doi: 10.4141/cjps2011-045
6. Dey D, Akhtar MS. Diversity of natural enemies of aphids belonging to Aphidiinae (Hymenoptera: Braconidae) in India. *J Asia-Pac Entomol*,2007:10(4):281-296. doi: 10.1016/S1226-8615(08)60364-7
7. Ghosh AK. *The Fauna of India. Homoptera: Aphidioidea. Part - I. General Introduction and Subfamily Chaitophorinae.* Zoological Survey of India, Calcutta,1980:124 pp.
8. Kambhampati S, Völkl W, Mackauer M. Phylogenetic relationships among genera of Aphidiinae (Hymenoptera: Braconidae) based on DNA sequence of the mitochondrial 16S rRNA gene. *Syst Entomol*,2000:25:437-445. doi: 10.1046/j.1365-3113.2000.00129.x
9. Mall N. *Faunistic survey of aphids and their natural enemies in southeastern Uttar Pradesh.* Ph. D. Thesis, D.D.U. Gorakhpur University, Gorakhpur,2013:455 pp. http://hdl.handle.net/10603/223978
10. Singh R, Singh G. Systematics, distribution and host range of Diaeretiella rapae (McIntosh) (Hymenoptera: Braconidae, Aphidiinae). *Int J Res Stud Biosci*,2015:3(1):1-36.
11. Singh R, Singh G. Aphids and Their Biocontrol. In: Omkar (Ed.). *Ecofriendly Pest Management for Food Security*. Academic Press,2016:63-108.
12. Singh R, Singh G. Reproductive strategies in aphids. In: Omkar, Mishra G (Eds.). *Reproductive Strategies in Insects*. Taylor & Francis Group, LLC,2022:259-282.
13. Singh R, Tripathi RN. Records of aphid parasitoids from Terai belt of eastern Uttar Pradesh - I. *J Aphidol*,1987:1:89-92.
14. Singh R. Biological control of the aphids by utilizing parasitoids. In: Upadhyay RK, Mukerji KG, Chamola BP (Eds.). *Biocontrol Potential and its Exploitation in Sustainable Agriculture, Volume 2.* Kulwer Academic/Plenum Publishers, USA,2001:57-73.
15. Starý P, Schlinger EI. *A Revision of the Far East Asian Aphidiidae (Hymenoptera).* Springer Science & Business Media, B.V,2013:204 pp. doi: 10.1007/978-94-017-6337-0