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Aphids and Their Biological Control in Pakistan

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Abstract: Aphids are important pests of cultivated crops in Pakistan. They not only reduce the yield of crops but also serve as vectors of disease. There are about 92 species of aphids in Pakistan. Some of these are serious pests of crucifer crops, vegetables and fruit trees. In Pakistan, aphids have mostly been controlled by insecticidal applications. However, due to adverse effects of insecticides, total reliance on them can not be made. Alternative control strategy is Integrated Pest Management (IPM). In IPM the role of parasitoids and predators is very important. The parasitoids attacking various aphids amount to 30 belonging to 6 families. Similarly the apidivorous predators are 42. Pathogens have not been recorded. Thus a large complex of natural enemies exists in the aphid environment. The possibility of biological based IPM has been explored and discussed.

Key words: Aphids, biological control, predators, parasitoids

Introduction

Insects are the limiting factor for healthy growth of cultivated plants, hence it is difficult to cultivate a crop without sound plant protection measures. Among insects, aphids are important throughout the world. Aphids suck sap from the plants, weaken the plant, and subsequently reduce the yield. In Pakistan aphids are the pests of oilseeds like sarson, rapeseed, canola, sunflower, etc., fruit trees like peach, plums; vegetables like cauliflower, cabbage, potato; graminacious crops like wheat, maize, barley and forage; legume crops like lucerne and cotton. *Acyrthosiphon pisum* (Harris) , *Aphis craccivora* Koch., *Theraphis trifolii* attacks on legumes ,*Rhopalosiphum maidis* (Fitch), *R. padi* (L), *Shizaphis graminum,* Rond., *Macrosiphum avenae* (F.) and *M. granarium* Kby attacks on gramincous crops. *Myzus persicae* (Sulz.) affects fruit crops while *Liphaphis erysimi*(Kltb), *L. pseudobrassicae* (Davis) and *Myzus persicae* attack on brassicas. These are the important aphid species of Pakistan (Aheer *et al*., 1997; Ahmad and Soomro, 1997; Amjad *et al*., 1999; Azimi, 1987; Inayatullah *et al*., 1993; Karimullah *et al*., 1995; Nasir and Yousaf,1992; Soomro and Khalid, 1994). They are known vectors of diseases as reported by Soomro *et al*. (1992). At present they are mostly controlled through insecticides. However, due to adverse effects of insecticides their rational use is being advocated. Use of pesticides to control pests is generally bounced back when these chemicals indiscriminately kill the naturaly occurring agents like, predators and parasitoids As a result there is pest resurgence. Therefore, now biological based Integrated Pest Management (IPM) is recommended. For this purpose detailed information of a pest and its environment is required.

Occurrence: The importance of aphids on various crops is established. All these crops are either cash or staple food of the people. It also shows that aphid are widespread in Pakistan. However, they have not been documented comprehensively. The reported species compiled from the literature are given in Table 1.

Table 1: Aphids and Their Host Plants in Pakistan

1. *Acyrthosiphon gossypii* Gloveron *Medicago hispida.*
2. *A.pisum* (Harris) on *Lathyrus odoratus, Pisum sativum.*
3. *Acyrthosiphon* sp. on , *Euphorbia helioscopia,, Sonchus oleracea.*
4. *Anuraphis helichrysi* Katt. on *Prunus persicae.*
5. *Aphidura* sp.nr. *bozhkoae* Narzik on *Hordeum vulgare.*
6. *Aphis achyrathi* Theobald on *Achyranthes aspera.*
7. *A. harmalae* Das on *Peganum harmala.*
8. *A. nerii* Boyer on *Calotropis procera.*
9. *A. verbasci* Schrank *Verbascum thapsus.*
10. *A. craccivora* Koch. on, *Arachus hypogea, Asparagus* sp., *Cestrum* sp., *Lens esculenta, Medicago denticulata, M. hispida,M. sativa, Phaseolus aureus, P. radiatus, P. vulgaris, Tribulus terrestris, Vigna sinensis* and *Visca* spp.
11. *A. sp.? emicus* Theoblad on *Rumex* spp.
12. *A. fabae* Theoblad on *Cestrum nocturnum, Chenopodium* sp., *Cucurbita* sp., *Euphorbia* sp, sp.*Malva sylvesris, Peganum harmala* and *Solanum nigrum.*
13. *A. gossypii* Glover on *Albizzia lebbek, Althaea rosea, Astragulus punjabicus, Brassica oleracea. Capsicum annuum, Cestrum noctrnum, Cnicus wallichii , Convolvulus arvensis, Dodonaea* sp., *Eriobotrya japonica, , Cucurbita pepo, Gossypium herbaceum, Grewia asiatica, Hibiscus esculentis, Hibscus syriacus, Langenaria vulgaris,Lantana camara, Luffa* sp., *Malvastrum coromandelianum , Malvastrum* sp., *Mentha longifolia , Nerium indicum,, Raphanus sativa, Rhamnus* sp.,*Rosa* sp.,*Rumex dentatus, Salvia plebeia, Solanum nigrum, S. surattense, Tecoma capsensis, Trifolium* sp.,*Trichodesma indicum, Verbascum thapsus, Withania somnifera, Woodforidia fruiticosa.*
14. *A. ruborum* Borner on *Rubus* sp.
15. *A. punicae* Pass on *Duranta plumier, Punica granatum.*
16. *A. solanella* Theobald on *Calendula officinalis, Hibiscus rosachinensis,Malvavicus* sp.,*Nerium indicum, Rumex dentatus, Solanum nigrum.*
17. *Aphis.* sp. on *Abutilon* sp., *Buddleia neemda, Cardus nutans , Euphorbia* sp., *Jacaranda ovalifolia, Lathyrus odoratus,, Malvavicus* sp., *Punica granatum,Rubus fruiticosus,Rumex dentatus, Tamarix articulata,, Verbascum thapsus, Withania somnifera*
18. *Baizongia* sp. on *Cassia* sp.
19. *Brachycaudus* sp. nr. *helichrysi* Kalt. on *Prunus persicae, Pyrus sinensis, Stachys* sp.
20. *Brachyunguis carthami* Das on *Carthamus oxyacantha.*
21. *B. carduii* L. on *Cnicus wallichii.*
22. *Capitophorus caruinus* (Wlk.) on *Cnicus wallichiii.*
23. *C. elaeagni* (Deg.) on *Caduus edelbergi.*
24. *C. happophaes* H.K.L. on *Polygonum caespitosum.*
25. *Cavariella* sp. on *Salix acmophylla.*
26. *Ceruraphis* sp. on *Viburnum nervosum.*
27. *Chaitophorus albus* on *Populus alba.*
28. *C . indica* Ghosh on *Poplus* sp.
29. *C. murreensis* Nasir &Yousaf on *Platinum orientalis.*
30. *C .*sp. *? himalaynesis* Das on *Salix acmophylla.*
31. *Chaitophorus* sp. on *Salix acmophylla.*
32. *Cinara (Todolachnus)* sp.*? abieticolus* Chol. on *Abies pindrow.*
33. *Coloradoa rufomaculata* (Wilson) on *Chrysanthemum leucanthemum.*
34. *Dactynous carthami* H.R.L. on Safflower.
35. *D. sonchi* L. on, *Sonchus* sp., *Ageratum conyzoides.*
36. *Dactynotus* sp on *Ageratum* sp.
37. *Diuraphis* sp on *Hordeum vulgare.*
38. *Eriosoma lanigerum* Haus on *Malus pumila.*
39. *Eriosoma* sp. on *Andrachne cordifolia.*
40. *Hayurstia atriplicis* L. on *Chenopodium album, C. opalifolium.*
41. *Hyadaphis* sp.*? coriandri* Das on *Amaranthus spinosus, Mentha longifolia.*
42. *H.*sp.*? foeniculus* (Pass) on unidentified plant.
43. *Hyalopterus* sp. *? amygdalis* (Blanch) on *Prunus bokhariensis*
44. *H. pruni* (Geoffroy) on *Prunus persicae.*
45. *Hyperomyzus* sp. on *Sonchus oleraceus.*
46. *Lachnus* sp.*? oyri* Buckton on *Pyrus pasdhia.*

47. *Lachus* sp. on *Pyrus pasdhia, Rosa* sp.
48. *Liphaphis erysimi* (Kltb.) on *Artemsia scoparia, Brassica camprestris, Brasicca oleracea, Raphanus sativus.*
49. *L. lepidii* (Nevsky) on *Chrysanthemum leucanthemum, Lepidium repens.*
50. *L. pseudobrasicae* (Davis) on *Brassica campestris, B. napus, B. oleracea,Raphanus sativus.*
51. *Longiunguis donacis* (Pass) on *Nerium indicum, Arundo donax.*
52. *L. sacchari* Zehnt. on *Sorghum* sp.
53. *Macrosiphoniella sanborni* (Gillette) on *Chrysanthemum leucanthemum.*
54. *Macrosiphum avenae* (F.) on *Hordeum vulgare,Triticum aestivum*
55. *M. granarium* Kby. on *Hordeum vulgare,Triticum aestivum.*
56. *M. rosae* (L.) on *Dipsacus inermis, Rosa sp.*
57. *M. rosaeformis* Das on *Abis pindrow, Rosa* sp.
58. *Macrosiphum* sp. on *Rosa* sp., *Malvaviscus* sp.
59. *Melanaphis sacchari* Zehnt on *Sorghum* sp.
60. *Microlophium* sp.nr. *carnosum* Buckton on *Utrica* sp.
61. *Mindarus* sp. on *Abies pindrow.*
62. *Myzus dycei* Canver on *Utrica* sp.
63. *M. obtuirostris* David on *Zea mays.*
64. *M. persicae* (Sulzer.) on *Althea rosea, Brassica campestris, B. napus, Cassia fistula. Chrysnathemum leucanthemum, Convolvulus arvensis,Coriandrum sativum, Euphorbia heliscopia,Geranium* sp.,*Hedera napalensis,Ipomeia palmata, Kickxia ramosissima, Lactuca sativa, Lepidium repens, Malva parviflora, Nicotiana tabacum, Raphanus sativus, Salix acmophylla, Solanum nigrum, Solanum surttense,Tagetes africana.*
65. *M. rosarum* (Sulzer)on *Rosa* sp.
66. *Myzus* sp. on *Hibiscus rosa-chinensis.*
67. *Pemphigus imaicus* Chol. on *Populus* sp.
68. *P. lichtensteini* Tullgran on *Populus nigra.*
69. *P.mordvilkoi* Chol. on *Populus* sp.
70. *Pemphigus* sp. on *Populus ciliata, P. nigra.*
71. *Pentalonia nigronervosa* Conq. on *Mus sapientum.*
72. *Phyloemyzus passerinii* Sign. on *Populus* sp.
73. *Prosiphilus* sp. nr. on *Pinus wallichiana.*
74. *P.*.sp. nr. *micheliae* H.R.L. on unidentified plant.
75. *Prosiphilus* sp. on *Pinus griffithi.*
76. *Pterochloroides persicae* (Cholodkovsly) on *Prunus armeniaca, P. bokhariensis, P. persicae, Pyrus communis, P. pasdhia.*
77. *Pterocoma* sp. on *Salix acmophyla.*
78. *R .maidis* (Fitch) on *Hordeum vulgare, Peganum harmala, Rosa* sp. *Sorghum* sp., *Triticum aestivum, Zea mays.*
79. *R . nymphaeae* (L) on *Colocassia esculenta, Cyperus* sp.,*Rumex* sp.,
80. *R. padi* (L.) on *Hordeum vulgare,Triticum aestivum.*
81. *R. rufiabdominalis* (Saski) on *Oryza sativa, Triticum aestivum.*
82. *Schizaphis graminum* (Rond.) on *Hordeum vulgare, Sorghum sp., Triticum aestivum.*
83. *S* .sp.? *celti* Das on *Celtis eriocarpa.*
84. *S .cyperi* V.D.G. on *Pyrus* sp.
85. *S. minuta* V.D.G. on *Cyperus rotundus.*
86. *Sipha maydis* Pass on *Sorghum* sp.
87. *Smynthurodes betae* (Westwood) on *Abutilon* spp.
88. *Theriaphis maculatum* (Buckton) on *Medicago sativa.*
89. *T. triffolli* Monell on *Medicago denticulata, ,M. hispida, M. indica, M. sativa, Trifolium alexandinum, T. resupinatum.*
90. *Titanosiphon* sp. on *Artemesia scoparia.*
91. *Tuberolachnus* sp on *Salix acmophylla.*
92. *Xanothoracaphis* sp. on *Quercus incana.*

Table 2: Parasitiods of Aphids in Pakistan

Hymenoptera

Aphelinidae

1. *Aplelinus basalis* Westwood from *Aphis craccivora* Koch. Peshawar.
2. *Aphelinus* sp. from *Aphis fabae* Theobald, *Aphis gossypii* Glover, *Pemphigus* sp., *Brachycaudus* sp.nr. *helichrysi* Kalt. Pakistan.
3. *Coccophagus* sp. from *Aphis* sp. Nowshera, Peshawar, Pakistan.

Braconidae

4. *Aphidius absinthii* Marsh from *Acyrthosiphon pisum* Harris, *A. craccivora,* Swat, Murree, Abbottabad.
5. *A. colemani* Vier. from *Shizaphis graminum* Rond. Pakistan.
6. *A. matricariae* Haliday from *Myzus persicae* (Sulz.). Swat, Murree, Abbottabad, Peshawar.
7. *A .sp. nr. ribis* Hal. from *Myzus persicae.* Pakistan.
8. *A . rosea* Hal. from *Liphaphis erysimi* (Davis),*Macrosiphum* sp. Northern Pakistan.
9. *A. smithi* Subba Rao & Sharma from *Acrythosiphon pisum* Peshawar.
10. *A. transcaspicus* Telenga from *Hyalopterus pruni* (Geoffroy) Peshawar.
11. *A. urticae* Hald from *Acrythosiphon pisum*.Peshawar, Kaghan
12. *Aphidius* sp. from *Acyrthosiphon pisum,,Aphis fabae,A. craccivora ,A. gossypii, Shizaphis graminum ,Myzus persicae, Aphis ruborum* Borner, *Aphis craccivora ,Lipaphis erysimi, Chaitophorus* sp. Pakistan
13. *Binodoxys indicus* (Subba Rao & Sharma) from *Aphis fabae, A. gossypii.* Rawalpindi, Kohat.
14. *Diaeretus rapae* M'int. from *Rhopalosiphon maidis* Fitch.,*Lipaphis pseudobrassicae* (Davis) Parachinar.
15. *Diaeretiella rapae* M'Intosh from *Aphis* sp., *S . graminum, Lipaphis erysimi , L. lepidii* (Nevsky), *L. pseudobrassicae, M . persicae* Peshawar, Rawalpindi, Swat.
16. *Ephedrus* sp. from *S. graminum , Aphis.craccivora ., A . fabae, Longuinguis donacis* Pass. Northern Pakistan.
17. *Lipolexis* sp. from *A. fabae, A. gossypii* Peshawar, Rawalpindi, Kohat.
18. *Lysiphlebus fabarum* Marshal from *Aphis fabae, A. gossypii, A. pisum, A. craccivora.* Rawalpindi, Peshawar.
19. *L. sp. nr. salicaphii* Fitch from *Chaitophorus* sp. Peshawar.
20. *Trioxys angelicae* Hal. from *Aphis fabae , Aphis solanella* Theoblad , *Aphis craccivora., A. gossypii ,Lipaphis psudobrassicae, Macrosiphum* sp., *Acyrthosiphon pisum,Myzus persicae.* Rawalpindi, Peshawar, Kaghan.
21. *T .* sp. nr. *heraclei* Hal. from *A .fabae, Pterochloroides persicae* (Cholod). Rawalpindi, Peshawar, Kohat.
22. *Trioxys* sp. from *Aphis gossypii , A .craccivora, A . fabae.* Rawalpindi, Swat.

Cynipidae

23. *Alloxysta* sp. from *Aphis craccivora, A . gossypii.* Pakistan.
24. *Charips* sp. from *Aphis fabae , A. gossypii, A. solanella.* Pakistan.

Encyritidae

25. *Anagyrus* sp. from *Aphis* spp.
26. *Aphidoencyrtus* sp. from *Anuraphis helichrysi* katt.
27. *Microterys* sp. from *A. helichrysi.*

Eulophidae

28. *Tetrasticus* sp. from *Xanthoracaphis* sp., *Myzus persicae* . Pakistan.

Ptromelidae

29. *Asaphes vulgaris* Wlk. from *Aphis* sp.
30. *Pachyneuron* sp. from *Anuraphis helichrysi* .

From Pakistan 42 different species of predators have been reported (Table 3).

Control strategy: Before embarking on the control of any pest it is essential to know the biology and prevalence of it. Investigations on these aspects of aphids in Pakistan has been conducted by Buriro *et al.*(1997), Hamid (1987), Ismail (1980), Mahmood *et al.* (1990 a & b), Mustafa *et al.* (1996), Remaudiere *et al.* (1991), Shafique (1986) and Shah, (1988). There are many control methods. The effect of sowing dates on aphid population has been conducted by Aheer *et al.* (1993a and b) and impact of weather by Aheer *et al.* (1994). Role of fertilizers on aphid populations has been worked out by Marwat *et al.*(1985).

Evolvement of resistant varieties to reduce the insect pest population is widely acknowledged now a days. Role of varietal resistance on aphids in Pakistan has been explored by Aheer *et al.* (1993a &c),Ahmad *et al.* (1985),Chatta *et al.* (1981), Hamid (1988), Hussain (1983), Naheed *et al.* (1991), Tunio *et al.* (1986) and Ullah and Fareed, (1993).

Chemical control has remained important tool of control of pests and is also essential in the concept of IPM. Extensive work has been conducted on chemical control by Aheer *et al.* (1992), Azimi. (1987), Ghaffar *et al.* (1996), Haliemie *et al.* (1992), Ihsan *et al.* (1991), Iqbal (1990), Karimullah and Ahmad (1988), Khaliq and Liaquatullah (1987), Khattak and Hamid (1991), Manzoor and Stringam (1992), Munshi *et al.* (1985), Naqvi *et al.* (1984), Raja *et al.* (1985), Raqib *et al.* (1993), Rustmani *et al.* (1988), Tahir *et al.* (1999), Tariq *et al.*

(1990), Ullah *et al.* (1993), Zafar, (1985), Zaman (1990, 1991, 1992) and Zaman and Kawar (1985).

Table 3: Predators of Aphids in Pakistan

Coleoptera

Coccinellidae

1. *Adalia* sp. on *Chaitophorus* sp. Dir, Mardan, Swat, Thall.
2. *Adonia variegata* Goez. on *Anuraphis helichrysi* Katt, *Acrythosiphon pisum* Harris, *Aphis craccivora* Koch, *Therioaphis trifolii* Monell, *Schizaphis graminum* Rond., *Macrosiphum granarium* (kby), *Rhopalosiphum maidis* Fitch. Pakistan.
3. *Afissa manderstjernae* Muls. on *Aphis gossypii* Glover. Northern Pakistan.
4. *Ballia eucharis* Muls. on *Rhopalosiphum maidis*. Murree. Peshawar.
5. *Brumoides suturalis* F. on *Acrythosiphon pisum*, *Aphis craccivora*, *Aphis fabae* Theobald, *Aphis gossypii* , *Lipaphis pseudobrassicae* (Davis), *Chaitophorus* sp., *Myzus persicae* (Sulz), *Rhopalosiphum maidis* , *Pterochloroides persicae* (Chol.). Pakistan.
6. *Coccinella septempunctata* L. on *Acrythosiphon pisum* , *Aphis craccivora* , *Aphis fabae* Theobald, *Aphis gossypii*, *Lipaphis pseudobrassicae* , *Chaitophorus* sp., *Myzus persicae* , *Macrosiphum rsaeformus* Das. *Rhopalosiphum maidis* , *Pterochloroides persicae* . Pakistan.
7. *Exochomus flavipes* (Thun.) on *Rhopalosiphum maidis* , *Aphis fabae*.Rawalpindi, Swat, Murree, Peshawar, Wah, Kohat, Hangu, Dir.
8. *Evonia* sp. on *Aphis craccivora*. Peshawer.
9. *Hippodamia variagata* (Goeze) on *Shizaphis granium* , *Rhopalosiphum maidis*. Peshawar.
10. *Menochilus sexmaculata* F. on *Acyrthosiphon pisum* , *Aphis craccivora* , *Aphis fabae* , *A. gossypii* , *A. ruborum* Bor. *Lipaphis pseudobrassicae*,*Chaitophorus* sp., *Macrosiphum rosaeformis*, *Schizaphis graminum*, *Myzus persicae* , *Rhopalosiphum maidis* , *Pterochloroides persicae*. Pakistan.
11. *Oenopia sauzeti* Muls. on *Aphis gossypii* Glov., *Aphis craccivora*, *Chaitophorus* sp. *Acrythosiphon pisum*, *Hyadaphis sp.*,*Macrosiphum graminum*, *Macrosiphum rosaeformis* Das, *Schizaphis graminium*, *Rhopalosiphum maidis* . Northern Pakistan.
12. *Pharoscymnus flexibilis* (Muls.) on *Aphis* sp., *Chaitophorus* sp., Pakistan.
13. *Platynaspis saundersi* Cortch. on *Aphis* sp., *Brachcaudus* sp.
14. *Pullus guimeti* Muls on *Aphis fabae*, *A. gossypii* , *Shizaphis graminum*, *Macrosiphum graminum*, *Rhopalosiphum maidis*. Northern Pakistan.
15. *Pullus* sp. on *Aphis gossypii* , *Chaitophorus* sp. Peshawar.
16. *Scymnus quiemeti* Muls. on *Rhopalosiphum maidis* , *R. padi*. Peshawar.
17. *S. nubilus* Muls. on *Aphis fabae*, *A. gossypii* , *Chaitophorus* sp. , *Schizaphis graminum* , *Acrythosiphon maidis* . Pakistan.
18. *Scymnus* sp. on *Aphis fabae* , *Chaitophorus* sp. *Eriosoma lanigeruma* Haus. Northern Pakistan.
19. *Stethorus* sp. on *Aphis gossypii* , *Myzus persicae*. Northern Pakistan.

Diptera

Charnaemydae

20. *Leucopis* sp.nr.*griseola* Fall on *Pemphiginus* sp.

Syrphidae

21. *Baccha sapphirinia* Weid from *Anauraphis helichrysi*. Murree, Peshawer, Rawalpindi.
22. *Episyrphus balteatus* Deg. on *Eriosoma lanigerum*. Murree.
23. *Metasyrphus confrator* (Wed) on *Eriosoma lanigerum*. Murree.
24. *M. contractor* (Weid) on *Aphis pisum*, *Aphis craccivora*, *Eriosoma lanigerum* . Murree.
25. *M. corollae* F. on *Rhopalosiphum maidis* , *R. padi*. Peshawar.
26. *Paragus indicus* Brun. on *Shizaphis graminum* , *Macrosiphon gramanium* , *Rhophalosipho maidis*, *Myzus oblisirostus* David , *Melanaphis sacchari* Zehnt. Peshawar, Faisalabad, Parachinar.
27. *P. serratus* F. on *Shzaphis graminum* , *Macrosiphum gramanium* ,*Rhopalosiphon maidis*, *Myzus obtuirostri* , *Melanaphis sacchari*. Peshawar, Faisalabad, Parachinar.
28. *Scaeva pyrastri* L.on *Aphis gossypii*, *Lipaphis pseudobrassicae*, *Myzus persicae*. Northern Pakistan.
29. *Sphaelphora menthastri* L. on *Sitobian avenae* F. Peshawer.
30. *Sphaerophoria* sp. on *Shizaphis graminum.*, *Macrosiphum gramanium* ,*Rhopalosiphon maidis* ,*Myzus obtusirostri*, *Melanaphis sacchari*. Peshawar, Faisalabad, Parachinar.
31. *Syritta pipiens* L. on *Lisaphis brassicae* L. Norhern Pakistan.
32. *Syrphus balteatus* Deg. on *Chaitophorus* sp., *Myzus persicae* , *Schizaphis gramanum* , *Macrosiphum graminum* , *Rhopalosiphum maidis*, *Acrythosipum pisum* . Rawalpindi.
33. *S. confrater* Wied, on *Shizaphis graminum* , *Macrosiphum gramanium*, *Rhopalosiphumon maidis* , *Myzus obtrsirostri* , *Melanaphis sacchari*, *Eriosoma lanigeum* . Peshawar, Faisalabad, Parachinar.
34. *S. corollae* Fales on Aphids. Dir, Hangu.
35. *S. gorolla* F. on *Shizaphis graminum* , *Macrosiphon gramanium* , *Rhaphosiphon maidis*, *Myzus oblisirostus* , *Melanaphis sacchari* . Peshawar, Faisalabad, Parachinar.
36. *S. menthastri* L. on *Shizaphis graminum*, *Macrosiphum gramanium*, *Rhopalosiphon maidis* , *Myzus oblisirostus*, *Melanaphis sacchari* Peshawar, Faisalabad, Parachinar.
37. *Syrphus* sp. on *Lipaphis pseudobrassicae*. Rawalpindi.
38. *Xanthogramma acutellare* F. on *Shizaphis graminum*, *Macrosiphon gramanium* , *Rhaphosiphon maidis*, *Myzus oblisirostus*, *Melanaphis sacchari*. Peshawar, Faisalabad, Parachinar.

Hemiptera

Anthocoridae

39. *Orius* sp. on *Macrosiphum rosaeformis* , *Schizaphis graminim* , *Macrosiphum granarium*, *Rhoplosiphon maidis*. Northern Pakistan.

Lygaeidae

40. *Geocoris pulvisculatus* Dist on *Aphis gossypii*. Northern Pakistan.

Neuroptera

Chrysopidae

41. *Chrysoperla carnea* Steph. on *Eriosoma lanigerum* , *Schizaphis gramanium*, *Acrythosiphum pisum*, *Aphis craccivora*. Abbottabad, Mardan, Peshawer, Sialkot, Multan, Sahiwal.
42. *Chrysopa* sp. on *Eriosoma lanigerum*. Swat. Rawalpindi.

It is evident that enormous work has been conducted on chemical control of aphids alongwith studies on varietal resistance. However, varietal resistance work is mostly confined for the purpose of screening. No significant work has been conducted on field utilization of this component of control. Therefore control of aphids has mainly been attempted through chemicals. Varietal resistance can afford maximum profitability by virtue of inherent potential to safeguard against aphid infestations.

Biological control: The use of pesticide has inherent disadvantages, as it is not environmentally friendly, therefore reliance on biological control or biological based IPM has to be made. In this context little efforts have been made in the country. Now it is the need to exploit the natural enemies in this control concept. The importance of biological control in Pakistan has been discussed by Irshad, (1987) and Mohyuddin, (1981). Biological control work on aphid has been reported by Alam *et al.* (1969), CIBC (1977), Habib (1973), Hamid 83, 84, 85), Hamid *et al.* (1974), Khan *et al.* (1990), Khalil *et al.* (1990), Mughal and Munshi (1985), Mustafa *et al.* (1996), Pirzada *et al.* (1996), Stary *et al.* (1998), Suhail *et al.* (1999). Most of the work is concerned with the record of natural enemies, their incidence, biology, ecology and host range. Some feeding and parasitizing studies are also reported. Little work has been done on mass rearing these biotic agents. Almost negligible work on utilizing of these natural enemies in the fields of Pakistan is available. There are about 30 species of parasitoids of aphids in Pakistan (Table 2).

Discussion

Despite the extensive precautions, biological control, like all integrated pest management strategies, is not a panacea and also not risk-free. The consequences of inaction are far greater than the risks, as million of acres of rangeland, cropland, and wildlife habitat are affected each year by habitat disruption. Biological control takes many years to succeed. But it is often the best, safest, and most cost-effective approach to long-term management of pests. Sometimes it is the only practical approach.

The first step in biological control of aphid like other pests is to evaluate the natural enemy effectiveness by identifying

those species that have the high potential for use. Their use depends on the characteristics of the pest and cropping system in which it causes the damage. Variation in plant parts and prey species affects the survival, dispersal, and population size of some predators. The dispersal of adult predators varies, plant to plant and different plant parts. Therefore before conducting this venture, it should be given due consideration. Coccinelid beetles are important predators of aphids and their release should be done at night because at that time they will stay close, and in the morning, when they are hungry, they will munch on the aphids. A predator also needs a lot of different aphids, which means a lot of different plants, and she needs a really good infestation. Therefore release should be made in such periods when aphid populations are abundant. But they should not be allowed to cause economic loss. For this purpose a trap crop should be provided wherever necessary. One tenet of strategy of aphid control is interplanting, which should, over time, attract ladybeetles and other predators naturally. Thus a natural balance would be available for the population build up of aphids.

Interactions among predators can have a substantial effect on the total impact of the predator complex. The combined predation rate of two predators could nearly be double the sum of their individual predation rates. The strength of the synergistic interaction increases with increasing prey density. Although most aphid species are attacked by several predator species, predator-prey theory has historically focused on interactions between individual prey and predator species There are cases in which enemy complexes provide enhanced pest suppression but there are other instances in which predator complexes are less effective in reducing the pest populations. In biological control of aphids through predators in Pakistan these considerations must be given weight.

There are no reported instances of arthropod predators attacking prey displaced by predatory drivers or of synergism between two arthropod predators. Demonstrating such synergistic interactions among arthropod predators, and determining the mechanisms that underlie them, may provide new insight into the regulation of aphid populations and offer opportunities for improved pest management. Coccinelids, Chrysopids and Syrphid predators must be used in combination to get better aphid control in Pakistan.

Apart from releasing these natural enemies it is important to conserve their population through adjusting the chemical control as such that there is minimum effect on these natural enemies.

The important parasitoids of different aphids are *Aphidius colemani, A. matricariae, and Diaretiella rapae*. These have been used elsewhere in the world. These are easy to be mass reared. *A. colemani* has a scope in biological control of aphids. It has been recorded from *S. granarium* but it can be utilized against other aphids, as it is also found on other hosts in the world. It can easily be mass bred ion the laboratory and released in the field. It has been mass reared and used unsuccessfully against *Pentalonia nigronevosa* .*Diaretiella rapae* has multiple hosts and it is also not difficult to be mass reared. Therefore it has the potential to be used on vegetables, oilseed and cotton. Habib (1973) has discussed their biotic potential and found suitable as biotic agents. A prerequisite of augmentative releases of natural enemies is the ability to produce the natural enemy in sufficient numbers at economic costs.

The control potentials of some of these predators have been explored by Hamid (1985).The important predators are *Adonia variegata* , *Brumoides suturalis, Menochilus sexmaulatus* (Coccinellidae) *Metsyrphus contractor* , *Syrphus balteatus,* (Syrphidae), *Chrysoperla carnea* (Chrysopidae). *Aphelinus mali* has been imported from Switzerland for the control of *Erisoma lanigerum* on apple and has been established in the releases area of Murree hills (CIBC, 1987). It has reported to give good control. As a large complex of potentially important natural enemies is prevalent therefore they must be utilized in the aphid control strategy.

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