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Syrphid fly: A potential bioagents and pollinators

Johnson Wahengbam*, A. M. Raut and A. Najitha Banu[1]
School of Agriculture, Lovely Professional University, Phagwara, Punjab
[1]School of Bioengeeniring and Bioscience, Lovely Professional University, Phagwara, Punjab
*Corresponding Email: luwangjohnson@gmail.com
ORCID: 0000-0003-3070-6672

Abstract

Pollinators and natural enemies provide good ecosystem service. Bees are well known pollinators though alarm declining has been reporting due to globalization, changes in landscape and modern agronomic practices. Adult of hover flies are efficient pollinator next to bees and larvae of different species has diverse habitat such as many are predators of sucking pest, some are scavenger, mycophagy and some live on heavily polluted water like rattled maggots. The diverse habitat made hover fly less affected by urbanization and modern agriculture. However some factors like barriers in landscape affected on dispersal and migration. The adult of hover flies use phonological traits of flower and population of prey as cues to forage and oviposition. The aphidophagouslarvae provide effective control of aphid and under high population 70-100 % control can be achieved. The larvae are sometime misidentified as pest due to similarity with caterpillars. Body color of larva is opaque with dorsal yellow line. Some species were reported to be eaten up to 1200 aphids during larval stages. Therefore syrphid are important bioagents, pollinators and bio-indicators.

***Key Words**: Syrphid, Predator, Pollinator, Landscape, Urbanization*

Introduction:

Habitat degradation, changes of landscape, modern agriculture and accelerating urbanizationare the main cause of declining wild bee's pollinator (Bates et al. 2011; Wahengbam et al, 2019). Flies provide a significant role in ecosystem service, pollinating wildflowers and supplying us with fruits and kitchen staples and fly don't sting like bees. Syrphid fly synonyms as hover fly or flower fly, belonging to family Syrphidae, Diptera. The adults are often found to hovering or nectaring at flowers and larvae has wide range of food habits, some feed on decay organic materials and some are insectivorous. The flies are distributed all over the world except Antarctica and approximately 6000 species has been described (Anonymous, 2019a). The adult drink nectar and carry pollen on their body from flower to flower and maggots feed on various sucking insect pest and thus benefited the plants in both pollination and pest control. The wide diversity of pollinators in field has generally proven to be beneficial to yields of many crops. However alarming decline in entophilly such as wild bees has been reported from several part of the world (Wahengbam et al. 2019). The importance of anthophilousdiptera has not been research sufficiently and probably hover flies are most important anthophilousDiptera(Larson et al. 2001). In addition, hover fly mimic to wasp and honey bee but they are harmless to other

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animals, drone flies *Eristalistenax*exhibit bestian mimicry and due to their coloring often mistaken as wasp or bees (Anonymous 2019b).

Hover flies are garden friendly and important pollinator next to bees. Females lay single eggs-whitish to gray oblong measuring 1mm near or within aphid colonies. The maggots are predator of aphids, completed three larval instar, leg less, opaque skin and often internal organs are visible, size varies from 1 to 13 mm depending on stage and species, varied color with majority possess yellow longitudinal stripe on back. Pupation site on plants or soil surface and pupa are oblong, pear shape and green to dark brown color (Bugg et al., 2008). The flies completed single or multiple generations in a year depending on species, some have long flight season and some overwinter as adults (Lavoipierre, 2007).

All hover flies larvae are not predator, some live in nest of social insects as scavenger. Some feeds on roots, stem and bulbs such as narcissus fly larvae though these do not cause significant losses (Lavoipierre, 2007). The larvae of drone fly also known as rattled maggots which possess long breathing tube on back and habitats in highly polluted water (Anonymous 2019b). The diverse habitat of syrphid makes less influence by landscape as compare to bee's pollinators. Species of syrphid are also use as bioindicators to assess loss biodiversity and the efficiency of restoration and conservation policies (Zheng et al. 2019).

Landscape and vegetation onsyrphid abundance

Syrphid species differentially utilize crops and non-crops habitats depending on traits such as dispersal rate or larva or adult food requirement. The flies provide two important ecosystem service biocontrol and pollination thus their role is important in intensively used agricultural landscape. Mass flowering crops like oilseeds and field beans has highly rewards the generalist syrphids with pollens and nectar that required for adult feeding and egg development (Jauker&Wolters 2008). Additionally, such flowering plants attract high population of sucking pest thus it provides high profit to aphidophagous larvae of syrphids. The abundance and attraction of aphidophagoussyrphids highly depends on landscape elements such as hedgerows, increase population in nearby field and high amounts of mass flowering like oilseed rape at the landscape restrict the movement of syrphid flies from crop-non crop. Therefore environmental schemes should consider landscape-scale for augmentation and sustainability of locally important ecosystem service (Haenke et al., 2014).

The experiment conducted in UK and New Zealand using *Phaceliatanacetifolia*pollen as marker to measure the movement of hover fly in farm landscaped reported that *Ephisyrphusbalteatus* and *Metasyrphuscorollae* (United Kingdom) and *Melanostomafasciatum* (New Zealand) covered a distance up to 200m from the source in the absence of barriers between flowers and flies trap. Other barriers such as post-and-wire fences, lines of poplars (*Populus* spp.) with gaps, dense poplars shown the poplar boundaries restricted the movement and the fence had no effect (Wratten, 2003). The study implicated the influence of field boundary on population dispersion

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and diversity of arthropod species. Roles of vegetation in species richness could give the crucial information on conservation of pollinators and bioagents.

Syrphid as bioagents

The larvae are often mistaken as pest as it resemble to small slug or caterpillar, blindly detect and grope the prey by lifting their head and swinging from side to side, seize and suck body content and discard the carcass. Some species of syrphid are able to detect prey through olfaction. Single larvae consume hundreds of aphids in a month. Some species are reported to be eaten 1200 aphids during larval stages and under high population able to control 70-100 % aphid population (Lavoipierre, 2007; Bugg et al., 2008).

Aphidophagous hoverflies are generalists and selective in prey choice and they can hunt in an optimal way (Sadeghi& Gilbert, 2000; Almohamad et al., 2007; Almohamad et al., 2008). In polyphagous syrphid like *E. balteatus*, the oviposition site significantly effect on larval performance as larvae have limited dispersal (Chandler, 1969). Moreover, the predation rates also depend on aphid species, quality of aphids is directly related to survival, development and reproduction (Sadeghi& Gilbert, 2000; Almohamad et al., 2007). The relationship between aphid parasitoids and hover fly (*E. balteatus*) depicted that both parasitized and unparasitized aphid are quality food for development and survival of second instar, indicating that oviposition sites are more important for insect that are incapable to migrate easily from poor food source (Peckarsky et al., 2000; Almohamad et al., 2008). However, many aphid specific predators including syrphid unwilling to feed on mummified prey and it has negative effect on growth and development of predator (Kindlmann&Ruzicka, 1992; Harizanova&Ekbom, 1997; Takizawa et al. 2000). Asante (1997) reported that hover flies predating on apple wooly aphids was 21%. *Aphelinusmali* has been known to be an effective bioagents of apple wooly aphid however predator exclusion experiments conducted on apple orchard revealed the important roles of other predator such as coccinelids, syrphids and mirid proved that *A. mali*alone did not provide effective control (Walker, 1985). Moreover, three species of hover flies *Heringiacalcarata* (Loew), *Eupeodesamericanus* (Weidemann) and *Syrphusrectus*OstenSacken, were the most abundantaphidophagous predators in apple orchards near Winchester, VA during widespread outbreak of wooly apple aphid in Mid-Atlantic region (Bergh and Louque2000).

Pollination:

Syrphid fly are frequent visitor of diverse flower of forest, agriculture and wild plants. They are most important pollinators after wild bees. Bees carry a larger volume of pollen on their body but hover fly able to compensate by increasing number of visit. Generally hover fly foraging are non-selective but some are species specific such as Cheilosiaalbitarsis visit only Ranunculus repens (Haslett, 1989). Several factors influence the attractiveness such as flower color and shape, pollen and nectar availability (Sutherland et al., 1999), shelter and availability of prey (Colley & Luna, 2000). Many species prefer to visit white and yellow color

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actenomorphicflowers (Ajjad&Saeed, 2010). Moreover pollen ingestion varies from species to species, species with small, sparsely haired with unbranched hairs, simple bristle and short proboscis ingested 99% anemophilous pollens while species with large size, dense hairy with pollen collecting hair, long, spirally grooved bristles, and long proboscis ingested pollens entirely from nectarbearing flowers. Majority species of Syrphidae and Acroceridae collect pollens with branched or curlytipped hairs (Holloway, 1976).

Foraging behavior of E. balteatus showed more preference to higher nectar concentration while no behavioral changes with increasing pollen (Sutherland, 1999). Adult of hover flies nutrition depends on floral resources, provide energy through nectar and proteins, lipids and vitamins from pollen (Faegri&Pijl, 1979). The floral visitation are also affected by phylogenetic relatedness, body size and plant traits, analysis on flower visitation rate of three sub families; Eristalinae, Pipizinae and Syrphinae based on plant traits revealed that visitation rate increased with plant height in Eristalinae, size of inflorescence positively related to small species of all three sub families but larger species were independent of floral size and preference of flower color varied on all sub families where Eristalinae strongly preferred white, Pipizinae- white and yellow and Syrphinae less depend on flower color (Klecka et al., 2018). Fruit setting and quality of fruits depends on the pollinators, Eristalistenax pollination on sweet pepper attributes desirable traits by increasing seed set and weight of fruit (Jarlan, 1996).

Promoting Syrphid Flies

Conservation and promotion of beneficial organism depends of agricultural practices, landscape and vegetation. Global warming is one of the major factors for dispersal of organism and declination of pollinators (Wahengbam et al., 2019). Inclusion of pollinator preferred plant in farm provides good ecosystem services. Planting of sweet alyssum in apple orchards and collards greatly increased syrphid population which providing pollination and reduced aphid infestation as well (Ribeiro&Gontijo, 2017). Similar studies in California, transplanting of 1 to 2 alyssums per 50 lettuce transplant efficiently attract aphid predators (Brennan, 2015). Provision of flowering plants strips such as coriander and chrysanthemum in iceberg lettuce increased syrphid population results in effective control of lettuce aphid (Pascual-Villalobos et al., 2006). Population densities of syrphid fly are positive with abundance of flower and negative with temperature and humidity (Sajjad et al., 2010). Previous discussion revealed the effect of landscape and barriers on dispersal of syrphid. Therefore planning of farm layout should be done which are more advantageous to pollinators to achieve better ecosystem service.

Conclusion

Syrphid fly are distributed globally except Antratica and important pollinators next to bee. The fly not only hover on flower and pollinate, their larva are predaceous to sucking insect pest. Promoting population through adoption of fly friendly agricultural practices will assure the

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environmental friendly pest management and also increase the quality of several traits of plants like fruit setting, seed weight, productivity etc.

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