Journal of Wildlife and Ecology (2020). 4(1):27-34

Review **Open Access**

Spider as a biological agent in pest control-A Review

Maria Saba[1*], Durr e Shawar Awan[1] and Shumaila Yousaf[1]

1. Department of Forestry and Wildlife, University of Haripur, Pakistan

***Corresponding author e-mail:** mc170201061@gmail.com

ABSTRACT

The use of the spiders as the biological agents in the control of pests in different crops is the most important alternative which can be used instead of the chemicals and insecticides. The ability of spider in searching their prey, wide range of host, multiplication and the nature of spider as polyphagous makes the spider as an excellent bio suppresser. This review explores the importance and the significance of the spiders regarding their potential to act as a biological control agent against different insects and pests. Spiders act as an effective biological agent to control pests in the agro ecosystem of the pest management. Mostly the Spiders have shown more rate of predation against thrips, mealybugs and arthropods which are the major invaders in orchards. In order to evaluate the impact of spiders on the population dynamics of different pests more research studies are needed. This research study also shows the complexity of spiders which are indigenous can also potentially contribute towards the control of different crops pests.

Keywords: Biological-agent, Spider, Bio-suppressors, Pesticides

Citation: Saba, M., D. S. Awan, S. Yousaf. 2020. Spider as a biological agent in pest control-A Review. Journal of Wildlife and Ecology. 4(1): 27-34.
Received: 17, 03, 2020**, Accepted**: 25, 03, 2020**, Published**: 30, 03, 2020

INTRODUCTION

Biological control is one of the modern methods for the control of pests like mites, insects, weeds and worms by the use of natural predators. This method involves herbivory, parasitism and predation (Singh *et al.*, 2019). Spiders are the arthropods which are considered as the most abundant and natural predators in ecosystems of agriculture. Nevertheless the role of spiders as a biological control agent is debatable due to the general predation characteristics of spider which not only kills the harmful pests but also be a harmful for other biological pests. This review focuses on the biological potential and its improvements to use spiders as a biological control agent.

The method which is commonly used to control harmful pests and insects are the chemical control methods using different insecticides despite their adverse effects to natural advantageous organisms like natural enemies, pollinators,

animals and humans as well (Shelton *et al.*, 2014). However it must be considered that the frequent use of insecticide and pesticides results in the development of resistance in pests as well as the outbreak of many secondary pests (Pekár *et al.*, 2013). It also effects the growth and yields of fruits and crops which are treated by chemicals and pesticides and are non selective (Košulič *et al.*, 2016; Niedobová *et al.*, 2016). The development of awareness of pesticides negative effects on the environment and have resulted in the use of practices to control pests which are environmentally-friendly like organic farming and IPM or integrated pest management. IPM use cultural, mechanical and biological methods in order to control pests (Vandermeer, 2011).

Most of the organisms in the natural ecosystem lived in the conditions of perfect harmony to balance the existence of each other by interacting among themselves in various different ecosystems in the nature before the introduction of the chemicals and pesticides in the field of agriculture to control the growth of pest using different chemical methods. It is observed that more than thirty grams of the chemicals which acts as pesticides is utilized by the farmers per hectare in order to control different pests in the vine and other fruit orchards. The use of these pesticides and chemicals on the natural fruits not only affects the non-target and beneficial species but also has the hazardous and toxic effects on human as well as the environment because of their long lasting residues presence (Kale, 2016). So, it is necessary to develop and explore different. It is, therefore, necessary to pest control measures to reduce the environmental burden and maintain high crops yields (Kleijn *et al.*, 2019). The most advantageous and effective method to control pest is the use of the natural organisms of ecosystem which are proven as environmentally-friendly. So, it is better to take effective preventive measures against pests rather than killing after the attack of pests. However due to complexity in the food webs and ecosystem and it is challenging to sort out the most effective practices to control pests in an economical way. In order to survive and manage the hazardous effects of the pesticides and chemicals it is the need of the hour to develop and discover the effective alternative ways, tools and methods for the control of pests. The utilization of various biological agents like spider as the agents to control the growth of the pests and harmful crop insects will optimistically anticipate and assists in the enhancement of the economic as well as the environmental-friendly methods of the pest management by maintenance of healthy ecosystem for the future.

SPIDER AS A BIO-PEST-CONTROL AGENT

Many programs for the management of pest including the IPM program known as integrated pest management and the environmental friendly and effective methods for the pest control have recently been evaluated for the practical implementation in the agro-ecosystem. The spiders are considered as the generalist predators spiders which are the significant constituent of terrestrial ecosystems and can play major vital role in the control of pests and insects in the agro-ecosystems (Picchi *et al.*, 2016). The Spiders, predominantly species assemblages, have been observed to show the effectiveness in the reduction of the insects and pests which

are involved causing damage to the crops fields (D. Chad *et al.*, 2006). The natural predators like spiders help to balance and maintain equilibrium among different organism of the ecosystem, by the process of consumption of their prey, changing the pattern and behavior of prey activities and the alteration of the habitat of the prey (Smee, 2012). The 7th largest group of the animal kingdom which belong to the phylum Arthopoda are belonging the Arachnida class and Araneae order. The total of 47439 different species of spiders are known and recorded till date all over the world (Platnick, 2018) and about 1698 species are found in South Asia (Keswani *et al.*, 2012). The 90 species of spider including 55 different genera and approximately 19 different families are present in National Park Zolambi (More, 2015). Spiders are found in the abundant numbers and can live in aquatic as well as terrestrial habitat so, are very important constituent of the ecosystem to function normally. Mostly the spiders are predators, which kill insects and pests in agro-ecosystem. Some studies showed the diversity of the spiders in response to habitat change on different scales in different orchards and vineyards (Smith, 2014).

The species of spider are very much ubiquitous and diversified that feed on other pests, insects and arthropod in both the natural as well as in the agricultural habitats (Kralj-Fišer and Gregorič, 2019). The role of the spider as biological control agent in the agriculture ecosystem is well known which have the significant top-down effects. The Spiders offer a corresponding function to kill various species of pest (Tooker *et al.*, 2020). Due to the involvement of Indo-Gangetic Plains spider role as a biological control agent is doubtful and limited. But the spiders along with other biological agents can exert effective services in natural biological control. The studies showed that thrips and whiteflies are the diet of spider's diet(Cotes *et al.*, 2018).Spiders are the most copious predators which depend on killing of other pests and insects to get their food in agro-ecosystems like wheat (Traugott *et al.*, 2012), vineyards (Rosas-Ramos *et al.*, 2018), rice (Betz and Tscharntke, 2017) and fruit orchards (Dumont *et al.*, 2019).

DIVERSITY OF SPIDERS

Simultaneously, the spiders are also considered as the most diversified predators (Sepulveda *et al.*, 2018), because they use very diverse strategies for hunting their prey which are usually insects and pests living in various niches that ranges from little plants, bushes, herbs to large tree canopy and are also distributed in different seasonal conditions and temperatures across the globe (Villanueva-Bonilla *et al.*, 2017). However like all of the other natural predators the spiders are also involved in disruption of the control of pest. All of the mentioned features of spider make the species of spider the ideal group to explore for its predators potential as a biological control agent. There is present a vast genera of spiders which includes different diverse species which possess countless exceptional individuality regarding their use as a biological control agents against variety of pests species. Spider's rate of capturing the natural pests which are the natural enemies of plants is the highest as compared to the other biological control agents because the spiders not only kill the pests but consume them in large number (Nyffeler and

Birkhofer, 2017). The spiders mostly prey the insects and arthropods (Petráková *et al.*, 2016). The spider diet consists of high proportions of Hemiptera, Diptera, Coleoptera and Hymenoptera. The data also showed that despite of general predators, spiders also have the selectivity regarding their prey (Pekár *et al.*, 2015).

The spiders adopt different mechanism to prey the pests like engulfing, suffocating the prey etc. Spiders have the ability to distinguish between different species of prey species such as the *Philodromus* spiders distinguished the *Dictyna* and psylla before the attack (Petráková *et al.*, 2016). One of the specialties of spiders is that they are well adapted to the changing environments and can survive in harsh weather condition and continue to grow and are well adapted to maintain high number seven when the cultivation season and pests during periods are not abundant in the crops. Therefore, the spiders have the ability to substantiate the high pressure of predation on insects and pest when they start invading the orchards and crops. Consequently, the spiders own effective potential characteristics to act and use as the biological control agents. Many researches shows that spiders have been showing effective control of pests like spiders showed the reduction of wheat pests like aphids (Dhir, 2017), in orchard of apple they were effective against aphids and moths in the orchard of olive against dipteran pest (Picchi *et al.*, 2016) and in the orchards of pear against psyllids (Michalko and Pekár, 2017). Conversely, there are many characteristics of spiders which make it questionable to consider them as the most effective agents for pest control. There is observed a slow reproduction in spiders and also the slow aggregative response in the fields so it is assumed that spiders cannot corroborate the pest tracking which depend on density of the pest and their growth in population.

Spiders are observed to be involved in the enhancement of the biological pest control along with killing of the other insects like in case of wheat crops the thrips in as the spider prey the natural insects and pests. The effectiveness of the biological control is largely unresolved topic various studies showed that in presence of the other prey the biological control results in reduction, no effect, or also the enhancement in the suppression of pest (Welch *et al.*, 2016).In order to improve the efficiency of spiders as a pest control agent, it is essential to scrutinize not only those factors which effects the diversity and abundance of the spiders in agricultural ecosystems (Baba and Tanaka, 2016), but bond it with the tropical ecology of the spiders, which is not given any importance. There is the necessity to use such approaches which combine both the approaches of spider's diversity and abundances in growth as well (Tscharntke *et al.*, 2016).

To use the spiders as biological agents it is necessary to consider the interactions of spiders with their prey and other natural pest. Spiders are the general predators. However the prey which are complementary to the nutrition of the spider enhance the spider fitness and maintain the high growth and abundances in ecosystem, which in turns increase the pressure of predation on pests (Tsutsui *et al.*, 2016). The tropical niches of the spider help to evaluate the biological potential of spider in identification and suppressing of growth of

specific pests. The interaction of spider with the prey also determines the potential of spider as biological pest control agent like the interference between the predators also decreases the prey capturing ratio. Due to the low rate of capture, the high spider's density will not be able to increase pressure of predation on pest (Michalko and Pekár, 2017).Like all the other predators Spiders do not influence prey by process of direct consumption rather it undergoes non-consumptive effects. Due to the non-consumptive approach by the spider the population of pest can be greatly suppressed (Beleznai *et al.*, 2017). The spiders dislodge the other pests including the aphids and caterpillars which results in the mortality of the pests which are susceptible to the other natural predators and implies stressful conditions and result in starvation or it can also increase the mobility of pests to flee away and emigrate. But this can increase the foraging of pests to satisfy stress and metabolism by predator vigilance, which can cause damage to crops (Rendon *et al.*, 2016)

CONCLUSION

In the agricultural ecosystem Spiders are one of the top most abundant enemies of the insects and pests. But the role of spider as a biocontrol agent is still due to the fact that they suppress the pests as well as disrupt the function of other insects which acts as biocontrol agents. The diet of spider is mostly pests like Hemiptera and Diptera which are captured and killed by spider using different strategies of hunting efficiently. The hunting strategies of spider have great influence on the community of herbivore in orchards. It is effective to employ such practices for the management of pests which are economical, ecofriendly as well as beneficial for the crops yield.

REFERENCES

Baba, Y.G., K. Tanaka. 2016. Environmentally friendly farming and multi-scale environmental factors influence generalist predator community in rice paddy ecosystems of Japan. NIEAS Ser. 6: 171-179.

Beleznai, O., J. Dreyer, Z. Tóth, F. Samu. 2017. Natural enemies partially compensate for warming induced excess herbivory in an organic growth system. Scientific reports. 7: 1-9.

Betz, L., T. Tscharntke. 2017. Enhancing spider families and spider webs in Indian rice fields for conservation biological control, considering local and landscape management. Journal of Insect Conservation. 21: 495-508.

Cotes, B., M. González, E. Benítez, E. De Mas, G. Clemente-Orta, M. Campos, E. Rodríguez. 2018. Spider communities and biological control in native habitats surrounding greenhouses. Insects. 9: 33.

D. Chad, Hoefler, Andy Chen, M.E. Jakob. 2006. The Potentials of a Jumping Spider, Phidippus clarus as Biological Agent. . J. Econ.Entomology. 02: 432- 443.

Dhir, B. 2017. Biofertilizers and biopesticides: eco-friendly biological agents Advances in Environmental Biotechnology. p 167-188. Springer.

Dumont, F., D. Réale, É. Lucas. 2019. Can Isogroup Selection of Highly Zoophagous Lines of a Zoophytophagous Bug Improve Biocontrol of Spider Mites in Apple Orchards? Insects. 10: 303.

Kale, C. 2016. Pesticide Consumption on Agriculture in Western Maharashtra: A Geographical Perspective. IJSR. 1965-1968.

Keswani, Hadole, Rajora. 2012. Checklist of Spiders (Arachnida : Araneae) from India. Indian journal of Arachnology. 1: 7-90.

Kleijn, D., R. Bommarco, T.P. Fijen, L.A. Garibaldi, S.G. Potts, W.H. van der Putten. 2019. Ecological intensification: bridging the gap between science and practice. Trends in ecology & evolution. 34: 154-166.

Košulič, O., R. Michalko, V. Hula. 2016. Impact of canopy openness on spider communities: implications for conservation management of formerly coppiced oak forests. PLoS One. 11.

Kralj-Fišer, S., M. Gregorič. 2019. Spider Welfare The Welfare of Invertebrate Animals. p 105-122. Springer.

Michalko, R., S. Pekár. 2017. The behavioral type of a top predator drives the short-term dynamic of intraguild predation. The American Naturalist. 189: 242-253.

More. 2015. Diversity of Spiders from Zolambi Region of Chandoli National Park. . IOSR-JPBS. 10: 30-33.

Niedobová, J., V. Hula, R. Michalko. 2016. Sublethal effect of agronomical surfactants on the spider Pardosa agrestis. Environmental Pollution. 213: 84-89.

Nyffeler, M., K. Birkhofer. 2017. An estimated 400–800 million tons of prey are annually killed by the global spider community. The Science of Nature. 104: 30.

Pekár, S., R. Michalko, S. Korenko, O. Šedo, E. Líznarová, L. Sentenská, Z. Zdráhal. 2013. Phenotypic integration in a series of trophic traits: tracing the evolution of myrmecophagy in spiders (Araneae). Zoology. 116: 27-35.

Pekár, S., R. Michalko, P. Loverre, E. Líznarová, Ľ. Černecká. 2015. Biological control in winter: novel evidence for the importance of generalist predators. Journal of Applied Ecology. 52: 270-279.

Petráková, L., R. Michalko, P. Loverre, L. Sentenská, S. Korenko, S. Pekár. 2016. Intraguild predation among spiders and their effect on the pear psylla during winter. Agriculture, Ecosystems & Environment. 233: 67-74.

Picchi, M.S., G. Bocci, R. Petacchi, M.H. Entling. 2016. Effects of local and landscape factors on spiders and olive fruit flies. Agriculture, Ecosystems & Environment. 222: 138-147.

Platnick. 2018. World Spider Catalogue In: B. Natural history museum (ed.).

Rendon, D., M.E. Whitehouse, P.W. Taylor. 2016. Consumptive and non-consumptive effects of wolf spiders on cotton bollworms. Entomologia Experimentalis et Applicata. 158: 170-183.

Rosas-Ramos, N., L. Baños-Picón, E. Tobajas, V. de Paz, J. Tormos, J.D. Asís. 2018. Value of ecological infrastructure diversity in the maintenance of spider assemblages: A case study of Mediterranean vineyard agroecosystems. Agriculture, Ecosystems & Environment. 265: 244-253.

Sepulveda, V., R. Solar, A. Inostrosa-Psijas, V. Gil-Costa, M. Marin, V. Chan. 2018. Towards rapid population genetics forward-in-time simulations: 2017 Winter Simulation Conference, WSC 2017.

Shelton, J.F., E.M. Geraghty, D.J. Tancredi, L.D. Delwiche, R.J. Schmidt, B. Ritz, R.L. Hansen, I. Hertz-Picciotto. 2014. Neurodevelopmental disorders and prenatal residential proximity to agricultural pesticides: the CHARGE study. Environmental health perspectives. 122: 1103-1109.

Singh, A., R. Bhardwaj, I.K. Singh. 2019. Biocontrol Agents: Potential of Biopesticides for Integrated Pest Management Biofertilizers for Sustainable Agriculture and Environment. p 413-433. Springer.

Smee. 2012. Species With a Large Impact on Community Structure Nature Education Knowledge. 03: 40.

Smith, G.A. 2014. Spider Family Response to Changes in Habitat Diversity at the Field and Landscape Scales of Wine Grape Vineyards in Napa and Sonoma Counties.

Tooker, J.F., M.E. O'Neal, C. Rodriguez-Saona. 2020. Balancing disturbance and conservation in agroecosystems to improve biological control. Annual Review of Entomology. 65: 81-100.

Traugott, M., J. Bell, L. Raso, D. Sint, W.O.C. Symondson. 2012. Generalist predators disrupt parasitoid aphid control by direct and coincidental intraguild predation. Bulletin of Entomological Research. 102: 239-247.

Tscharntke, T., D.S. Karp, R. Chaplin-Kramer, P. Batáry, F. DeClerck, C. Gratton, L. Hunt, A. Ives, M. Jonsson, A. Larsen. 2016. When natural habitat fails to enhance biological pest control–Five hypotheses. Biological Conservation. 204: 449-458.

Tsutsui, M.H., K. Tanaka, Y.G. Baba, T. Miyashita. 2016. Spatio-temporal dynamics of generalist predators (Tetragnatha spider) in environmentally friendly paddy fields. Applied entomology and zoology. 51: 631-640.

Vandermeer, J. 2011. The ecology of agroecosystems. Jones & Bartlett Learning.

Villanueva-Bonilla, G.A., A.T. Salomão, J. Vasconcellos-Neto. 2017. Trunk structural traits explain habitat use of a tree-dwelling spider (Selenopidae) in a tropical forest. Acta Oecologica. 85: 108-115.

Welch, K., T. Whitney, J. Harwood. 2016. Non-pest prey do not disrupt aphid predation by a web-building spider. Bulletin of entomological research. 106: 91-98.

***Competing interests**:* The authors have declared that no competing interests exist.
***Funding**:* Authors have no source of funding for this work.
Authors' contributions: Saba has designed project and written this article; Awan and Yousaf have critically analyzed this article and approved as final.