Conserving natural enemies in crop ecosystem

G. R. Hithesh, Sachin S. Suroshe and P.R. Shashank

Biological control is the regulation of pest populations by the activity of natural enemies *viz*., predators, parasitiods and pathogens. It consists of three principles introduction, augmentation and conservation among which, conservation is widely practiced as it is easy to understand by the growers. It is defined as modification of the environment to protect and enhance or increase specific natural enemies to reduce the effect of pests. It takes the advantage of resident natural enemies (predators and parasitoids) and involves management strategies which conserve their populations to uplift ecosystem services they provide. Generally, there are two general approaches that are followed for conserving the natural enemy population. The first one involves habitat manipulations to increase the abundance and activity of natural enemies (Landis *et al.,* 2000) and the second one involves the use of semiochemicals to attract predators and parasitoids, thus helps in reducing the use of pesticides, that may harm natural enemies. The biodiversity of natural enemies depends on two components *viz*., species richness and evenness. The different approaches that are used for conservation of natural enemies in vegetable crops are vegetation diversity, semiochemicals, insectary plants, food sprays, oviposition sites and shelters, mixed diet food, banker plant, trap crops, beetle bank and flower strips.

Vegetation diversity: The conventional method is used where no manipulation of habitat leads to high pest numbers and few natural enemies are entering into the crop from the surrounding fields. In this case, as there is no habitat manipulation, it is impossible to conserve the natural enemies in the field conditions. Addition of intercropping, cover cropping and supplemental food sources in an agroecosystem may lead to increase in natural enemies abundance and addition of lures Herbivore Induced Plant Volatiles (HIPV'S) may attract natural enemies into crop ecosystem to enhance the biological control. In okra crop, when coriander was used as an intercrop and maize as border crop, it enhanced the coccinellid population when compared with the sole crop.

Semiochemicals: These are the substance released by an organism that affect the behaviour of other organisms. When terminal bud gets infested by maize aphids, *Rophalosiphum maydis* (Fitch), the E-β-farnesene (Alarm pheromone) is released by herbivores and HIPV'S by plants helps in attracting coccinellids, other predators and parasitoids for aphid control (Powell *et al.*,2010).

Fig. 1. Corn pollen as a natural food supplement to enhance natural enemies. Photo credit: G. R. Hithesh

Food spray: Artificial or natural food supplements that can be sprayed or dusted on to the crop to enhance natural enemies in field conditions, where the nectar and pollen is not available or only present at low quantities. For predatory mites, pollen sprays can serve as a food and augment the biological control of thrips and whiteflies on cucumber (Rijn *et al.,* 2002). Narrow leaf cattail, *Typha angustifolia* L. pollen commercially sold as 'Nutrimite' are being used to increases population of pollen feeding predatory mites. It is commercially used in roses, poinsettia and in pepper before flowering and in cucumber with no pollen. The dosage that should be applied in the field is 500 g/ha. It is available in dust formulation and has to be applied once in 2 weeks. Maize or Corn pollen is also used for enhancing the populations of *Amblyseius swirskii* (Athias-Henroit) (Adar *et al.*,2014)

Plant providing food: Plants provide nectar, pollen and plant sap as food resources for natural enemies. Most of the natural enemies are omnivores feeding on both plant and prey. Adults of parasitiods, syrphids and gall midges increases their longevity and oviposition by feeding on nectar (Bozsik, 1992). The flowering plant like sweet alyssum, *Lobularia maritima* (L.) provide resource subsidies for the maintenance of the predatory bugs, *Orius laevigatus* (Fieber) during the scarcity of prey in cabbage crop.

Mixed diet food: The reproduction of predators can be increased by providing mixed diets of prey or mixture of different prey and non-prey food sources (corn pollen). It has been reported that the survival and reproduction of the predator, *Orius insidiosus* (Say) was enhanced, when the combination of aphids and thrips were supplemented as a prey source in soybean (Butler and Neil, 2007). The red velvet mite predator, *Balaustium sp.* developed better on a mixed diet of whitefly eggs and spider mites than on a diet of each prey alone in tomato crop.

Oviposition sites and shelters: The suitable oviposition sites are crucial for the

reproduction of predators. Predatory mites prefer plants with trichomes to attach their eggs. However, not all trichomes are favourable for natural enemies. Tomato plants produce glandular trichomes which strongly hamper the movement of predatory mites as well as Flower bug, *Orius sp* (Koller *et al.,* 2007). Sweet pepper plants have tuft of domatia in the vein axils that are used by predatory mites for oviposition. It reduce cannibalism and increase survival by providing a suitable micro climate.

Banker plant method: It is used to breed the predators within a crop and also when the crop is not favourable for natural enemies to establish. The example of banker plant grass species, *Leersia sayanuka* (L.) is planted adjacent to rice fields to attract a planthopper, *Nilaparvatha muiri* (Muir). It does not attack rice plants, but is an alternative host for an egg parasitoid, *Anagrus nilaparvatae* (Pang et Wang), which is the main natural enemy of BPH (Zheng *et al.,*2017).

Flower strips: Flower strips such as *Fagopyrum* sp., *Lobularia* sp. and coriander produce nectar, pollen and provide shelter to natural enemies like hover flies etc.

Selective use of pesticides: There is an urgent need to develop truly selective pesticides for the conservation of natural enemies by using active ingredients with the least non-target toxicity. Undesired side-effects of pesticides on natural enemies could be further reduced by adopting the timing, place and mode of application. The some of the examples for selective use of pesticides are spinosad, IGR'S and azadirachtin.

Trap crop: A plant species able to attract simultaneously both pests and their natural enemies can be used in a trap cropping system for conservation biological control program. Trap plant, Borage, *Borago officinalis* (L.) (Boraginaceae) has been found to attract aphids and its parasitoid, *Aphidius colemani* (Viereck) and Chrysopids in tomato crop (Zhu *et al.,*2005).

Beetle banks: Beetle banks are grassy ridges in the center of the field that provide shelter to hide, and overwintering habitat for more rapid colonization by predators. It can be constructed as means of raising a ridge (≈0.5×2.0 m; H×W) by carefully conducting two directional plowings. A mixture of perennial grass seeds should be sown along with dense shelter seeds of perennial flowers in order to attract and provide shelter for natural enemies such as syrphids, parasitoids, lady beetles, spiders and ground beetles. It is used in wheat crop in Europe.

Pest in first techniques: It is the riskiest method which requires intensive crop monitoring and the release needs to be in time. The predatory mite, *Phytoseiulus persimilis* (Athias- Henriot) is applied after the detection of hotspots of spider mites in the sweet pepper crop. It can also be posssible to inoculate plants with a low level of spider mites early in the growing season and release the predators shortly. Thus, allowing the low levels of the pests without risking crop damage for the conservation of predators.

Considering all of the advantages rendered by Conservation Biological Control (CBC), it must be accommodated in IPM

programmes for the management of dreaded insect pests.

References

Adar E, Moshe I, Shira G, Samuel G, Eric P. 2014. Pollen on-twine for food provisioning and oviposition of predatory mites in protected crops. Biological Control 59: 307-317.

Bozsik A. 1992. Natural Adult Food of Some Important *Chrysopa* Species (Planipennia: Chrysopidae). Acta Phyto-pathologica et Entomologica Hungarica 27 (1-4): 141-146.

Butler C D, Neil R J. 2007. Life history characteristics of *Orius insidiosus* fed diets of soybean aphid, *Aphis glycines* and soybean thrips, *Neohydatothrips variabilis*. Biological control 40: 339-346.

Koller M, Knapp M, Schausberger P. 2007. Direct and indirect adverse effects of tomato on the predatory mite, *Neoseiulus californicus* feeding on the spider mite *Tetranychus evansi*. Entomologia Experimentalis et Applicata 125: 297-305.

Landis D A, Wratten S D, Gurr G M. 2000. Habitat management to conserve natural enemies of arthropod pests in agriculture. Annual Review of Entomology 45: 175-201.

Powell W, Pennacchio F, Poppy G M, Tremblay E. 2010. Strategies involved in the location of host by the parasitoid, *Aphidiuservi*. Biological Control 11: 104-112.

Rijn van P C J, van Houten Y M, Sabelis M W. 2002. How plants benefit from providing food to predators even when it is also edible to herbivores. Ecology 83: 2664-2679.

Zheng X, Yanhui L, Zhu P, Zhang F, Tian J, Hongxing X, Chen G, Nansen C, Zhongxian L. 2017. Use of banker plant system for sustainable management of the most important insect pest in rice fields in china. Scientific Reports 7: 1-6

Zhu J, Cosse A A, Obrycki J J, Boo K S, Baker T C. 2005. Olfactory reactions of the twelve-spotted lady beetle, *Coleomegilla maculata* and the green lacewing, *Chrysoperla carnea* to semiochemicals released from their prey and host plant. Journal of Chemical Ecology 25: 1163–1177.

AUTHORS

G R Hithesh*(Corresponding author), Sachin S. Suroshe and P.R. Shashank, Division of Entomology, ICAR- Indian Agricultural Research Institute, New Delhi-110012

***Email: hitheshgr8374@gmail.com**