Role of multi-trophic interactions in weed biological control – Its future

Puja Ray*
Department of Biological Sciences, Presidency University, 86/1 College Street, Kolkata 700 073, India
**Email: puja.ray@gmail.com*

Over the last few decades, investigations on insect-plant-pathogen interactions have been increasing (Caeser 2011; Moran 2004). Such interactions influence how plant communities affect herbivore/pathogen communities and in turn, how herbivore/pathogen affect the composition of plant communities. Such studies can form the interface between weed biological control and restoration of healthy, chemical-free environment.

Positive interactions in weed biocontrol

Insect herbivory makes plants susceptible to pathogen attack or plants suffering from phytopathogenic diseases may be destroyed by insect feeding (Ray and Hill 2012). For example, under field conditions, waterhyacinth, *Eichhornia crassipes* (Mart.) Solms. (Pontederiaceae) infested with the weevils *Neoechetina* spp. (Coleoptera: Curculionidae) or the moth *Niphograpta albiguttalis* (Warren) (Lepidoptera: Pyralidae) are more prone to the phytopathogen *Cercospora piaropi* (Tharp) (Mycosphaerellaceae), which is known to cause fatal leaf necrosis on the weed. Necrosis development isten-fold greater in insect attacked plants than those with pathogen alone (Moran 2004). Insects are known to carry spores of fungal pathogens by aiding the spread of diseases. For example, the beetle *Chrysolina hyperici* Forest. (Coleoptera: Chrysomelidae) can augment biocontrol of St. Johnswort *Hypericum perforatum* L. (Clusiaceae) seedlings by transmitting the fungal pathogen *Colletotrichum gloeosporioides* f. sp. *hypericum* (Penz.) Penz. and Sacc. (Glomerellaceae) during foraging and feeding (Morrison *et al.* 1998).

Negative interactions in weed biocontrol

Multitrophic interaction may not always prove beneficial to weed biocontrol. Weevil *Oxyops vitiosa* Pascoe (Coleoptera: Curculionidae) prefer laying eggs on non-infected weed *Melaleuca quinquenervia*(Cav.) S.T. Blake (Myrtaceae). Percentage of egg-laying was reduced when females were made to oviposit on weeds infected by the rust fungus *Puccinia psidii* G. Wint. (Pucciniaceae). Both the weevil and the fungus can cause damage to the weed when they attack individually (*Rayamajhi et al.* 2006). Feeding by leaf-beetle *Gastrophysa viridula* Degeer (Coleoptera: Chrysomelidae) on *Rumex obtusifolius* L. (Polygonaceae) induced a systemic resistance that reduced the subsequent infection by the rust *Uromyces rumicis* (Schum) Wint (Pucciniaceae) (Hatcher and Paul 2001).

Competitive interactions between biological control agents may also impact weed control mechanism. For example, *Galerucella calmariensis* (L.) and *G. pusilla* (Duftschmidt) (Chrysomelidae), the biological control agents of purple loosestrife, *Lythrum salicaria* (L.) (Lythraceae), feed primarily on the foliage. After heavy defoliation, the flowering of purple loosestrife is suppressed, resulting in a food shortage for another control agent, *Nanophyes marmoratus* Goeze (Coleoptera: Brentidae), a flower-feeder (*Julien and Griffiths 1998*).

CONCLUSION

Often a particular biological control agent is successful in one place and less or unsuccessful elsewhere. Such failures have been associated to various reasons from unpredictable climate causing slow build of biological control agent population, natural calamities and inappropriate application of herbicide, etc. But one aspect has been highly ignored is the interaction between the plant and associated biological control agent.

Studies on multi-trophic interaction may hold great importance in weed biological control and can introduce a new era of progress in weed management research. Additive or synergistic effects among herbivores and phytopathogens are necessary to achieve biological control of hardy weeds. Use of chemicals for weed control can be reduced if biological control agents are utilized in a proper way. The few analyses given in this article highlights the efficacy of muti-trophic interactions in eradicating invasive weeds more effectively. Extensive studies involving multi-trophic interactions should be an essential part of pre-release evaluation studies. This will tremendously enhance the success rates of biological control of noxious weeds.

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