NEW ERA AGRICULTURE MAGAZINE

Manipulation of Biological techniques in weed management

[1]Meenakshi Meena and [2]Amit Kumar

Abstract:

Weeds are an important plant resource for insects, although feeding by insects on weeds can have both positive and negative effects on crop productivity. Weeds in natural habitats are increasingly becoming biocontrol targets. The conflict over agent selection continues, but host-specificity testing is well developed and reliable. Post-release impact evaluation is becoming more common, both on the target weed and on non-target plants. The most prevalent method of weed biocontrol is classical biological control, which involves the importation and release of exotic insects, mites, or diseases to provide long-term control. Inundative releases of predators and integrated pest management are less widely used.

Key words: Biological control, Inundative, Weed, Natural enemies

Introduction

Man's combat with weeds is never-ending. Even now, millions of acres of valuable land have been lost to weeds. Some weeds are simply impossible to eradicate. Some, although easily killed, grow on lands too low in value or too inaccessible for control by conventional means (C. B. Huffaker, 1959). “Weeds are notorious yield reducers that are, in many situations, economically more harmful than insects, fungi or other crop pests,” said a study, published in the journal, Crop Protection. Generally, alien weeds are especially amenable to biological control because of the lack of effective and hostspecific natural enemies to keep them under check in the new area(s) which they have colonised. In India *Parthenium hysterophorus* L. (Compositae) is one of the best examples of such an alien weed. Insects that damage different parts of the same weed may kill a weed or contribute to an overall reduction in its growth, vigour and reproductive potential.

[1]Meenakshi Meena and [2]Amit Kumar

[1]Ph.D. Research Scholar, Department of Agronomy ,Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan)-313001

[2]Ph.D. Research Scholar, Department of Entomology ,Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan)-313001

Therefore, if one species fails to control a weed adequately others may be used to enhance the level of control.

Manipulation of insects in weed management

Lantana, *Lantana camara* Linnaeus

The first attempt at biological weed control was made in Hawaii in 1902, where *L. camara* threatened ranching interests. Destruction of t his weed by the scale insect *Orthezia insignis* Douglas, There is actually an earlier example: "the ability of insects to destroy prickly pear had been known and applied in India and Ceylon since cochineal insects had been introduced" in 1795 to develop a dye industry, wrote Wilson. Which had arrived accidentally, had been not iced, and ranchers had engaged in establishing it on their ranches. Their efforts gave impetus to the plan of sending Koebele to collect Lantana insects in Mexico and Central America for introduction in Hawaii. Of the insects introduced, eight became established: a seed fly, *Agromyza lantanae* Froggatt, a lace bug, *Teleonemia scrupulosa* (Stal); a tortricid, *Epinotia lantana* (Busck); a moth, *Platyptilia pusillidactyla* (Walker); a leaf miner, *Cremastobombycia lantanella* Busck; a gall fly, *Butreta xanthochaeta* Aldrich; and two butterflies, Thecla echion Linnaeus and lycaenid butterflies, Thecla bazochi Godart.

Prickly pears, *Opuntia spp*.

This classic example of biological control is so well known that no effort will be made here to give it the coverage its importance merits. The problem in Australia and the ultimate solution were well documented by Dodd in 1940. *Dactylopius indicus* Green (=*D. ceylonicusn*.n.) was introduced in 1903.Cactus moth, *Cactoblastis cactorum* is also introduced. Insects introduced prior to *C. eaetorum*, including *Chelinidea tabulata* (Burmeister), *Dactylopius tomentosus* Lamarck, Olyee Uajune to Uneela (Hulst), and a mite, *Tetranyehus desertorum* Banks (= *T. apuntiae* Banks), made rapid progress from 1925 to 1927. From 1930 on, *C. eaetarum* mastered the prickly pears and eclipsed all other species.

Purple nut sedge, *Cyperus rotundus*:

Bactra verutana, the javelin moth, is a species of moth of the Tortricidae family, was introduced. The effectiveness of *Bactra verutana* Zeller, that is ineffectual in suppressing purple nutsedge, *Cyperus rotundus* L.,

Congress, *Parthenium hysterophorus* L.:

Different control approaches have been used for the management of Parthenium. Although manual and chemical methods are effective strategies to control the weed in agricultural fields, but these are not economical in pastures and large natural areas or wastelands (Krishnamurthy et al. 1977.

Biological control of Parthenium weed is considered to be the most cost effective, environmentally safe and ecologically viable method. It was documented to control Parthenium worth of Rs10 million in terms of herbicide cost after initial release of bioagent *Zygogramma bicolorata* Pallisterat Jabalpur, India, and it was estimated that this bioagent has checked the spread of Parthenium in about eight million hactares of land since its release in India. *Zygogramma bicolorata* is an effective biocontrol agent that can significantly reduce the vegetative and reproductive growth of Parthenium weed. However, the effectiveness of the biological control *Z. bicolarata* can be further enhanced if it is applied at the early growth stages (young or pre-flowering) of Parthenium weed.

Water hyacinth, *Eichhornia crassipes*

It was first introduced from South America into China as a good fodder plant in 1901, and had become a serious environmental problem in China by the early 21st century. The weevils *Neochetina eichhorniae* and *N. bruchi* were released in the USA for water hyacinth control during the early 1970s and have since been used in many other countries.

Alligator weed, *Alternanthera philoxeroides* (Mart.) Griseb. (Amaranthaceae)

Alligator weed is an invasive aquatic weed native to South America that began threatening Florida's waterways in the early 1900s. The alligator weed flea beetle, *Agasicles hygrophila* Selman and Vogt, was the first insect ever studied for biological control of an aquatic weed. The introduction of this insect into the United States was approved in 1963, but it was not successfully established on the invasive alligator weed until 1965. The insect was first released in 1964 in California, and subsequently, in Alabama, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas. Alligator weed flea beetles kill the alligator weed by destroying its stored food and interfering with photosynthesis by removing leaf tissue. Both adults and larvae feed on the leaves of alligator weed, often defoliating the stems.

Striga hermonthica:

Commonly known as purple witch weed or giant witch weed, is a hemi parasitic plant that belongs to the family Orobanchaceae. It is devastating to major crops such as sorghum (Sorghum bicolor) and rice (*Oryza sativa*.The reduction in seed production from gall-forming *Smicronyx* spp. is often substantial, but there has been no successful development of a biological control programme based on these weevils. Attempts to introduce *Smicronyx albovariegatus* and the moth, *Eulocastra argentisparsa* from India into Ethiopia apparently failed. Meanwhile, conclusions from a mathematical modelling project have suggested that Simicronyx spp.

would in any case be unlikely to have a significant impact on Striga population dynamics. Other potentially useful organisms for Striga management include the following: the butterfly Precis (=Junonia) species whose larvae feed on leaves, buds and capsules of many Striga species.

Manipulation of pathogens in weed control:

Biological Control of Weeds Using Fungi

Most commercial biological weed control products researched in North America have been based on formulations of fungal species, however, few have been successful in the long term. Examples include BioMal, a formulation of Colletotrichum gloeosporioides f.sp. malvae, introduced for the control of round leaf mallow (*Malva pusilla*) and *C. gloeosporioides* f.sp. aeschynomene, which was released for control of northern jointvetch (*Aeschynomene virginica*) in the United States in 1982 as Collego, Additionally, Sarritor, a formulation of Sclerotinia minor was introduced for the control of dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*) and broadleaf plantain (Plantago major) in turf. An investigation of the genomes of *C. gloeosporioides* and *C. orbiculare*, found that both species contained a number of candidate genes predicted to be associated with pathogenesis, including plant cell wall degrading enzymes and secreted disease effectors including small secreted proteins (SSPs), the latter of which were shown to be differentially expressed in planta according to stage of infection, suggesting that some of these proteins may have specific roles in the infection process (Gan et al., 2013). There is also evidence that both of these Colletotrichum species have the ability to produce indole acetic acid (Gan et al., 2013), a plant hormone, derivatives of which are well established herbicide templates (Grossmann, 2010).

Biological Control of Weeds Using Bacteria

A number of bacteria have also been investigated as potential biological weed control agents (Table 1). Of these, *Pseudomonas fluorescens* and *Xanthomonas campestris* have attracted the most attention. Biological weed control using bacteria has been suggested to have several advantages over the use of fungi, including more rapid growth of the bioherbicide agents (Johnson et al., 1996; Li et al., 2003), relatively simple propagation requirements (Li et al., 2003), and high suitability for genetic modification through either mutagenesis or gene transfer.

Biological Control of Weeds Using Viruses

In select cases, viruses that affect weed species have also been considered as bioherbicide candidates. This strategy is more commonly considered for management of invasive species in broader ecosystems rather than specifically managed areas. Viruses have been suggested to be inappropriate candidates for inundative biological control due to their genetic variability and lack of host specificity (Kazinczi et al., 2006). Examples of viruses that have been investigated for the potential to control invasive or undesirable species include Tobacco Mild Green Mosaic Tobamovirus for control of tropical soda apple (*Solanum viarum*) in Florida (Ferrell et al., 2008; Diaz et al., 2014), and Araujia Mosaic Virus for control of moth plant (*Araujia hortorum*) in New Zealand (Elliott et al., 2009).

References:

1. Abu-Dieyeh, M. H., and Watson, A. K. (2006). Effect of turfgrass mowing height on biocontrol of dandelion with Sclerotinia minor. Biocontrol. Sci. Technol. 16, 509–524. doi: 10.1080/09583150500532725
2. Abu-Dieyeh, M. H., and Watson, A. K. (2007a). Efficacy of Sclerotinia minor for dandelion control: effect of dandelion accession, age and grass competition. Weed Res. 47, 63–72. doi: 10.1111/j.1365-3180.2007.00542.x
3. Abu-Dieyeh, M. H., and Watson, A. K. (2007b). Grass overseeding and a fungus combine to control Taraxacum officinale. J. Appl. Ecol. 44, 115–124. doi: 10.1111/j.1365-2664.2006.01247.x
4. Bailey, K. L. (2014). "The bioherbicide approach to weed control using plant pathogens," in Integrated Pest Management: Current Concepts and Ecological Perspective, ed. D. P. Abrol. (San Diego, CA: Elsevier), 245–266.
5. C. B. Huffaker 1959. Biological control of weeds with insects. Annu. Rev. Entomol. 1959.4:251-276.
6. CABI, Invasive Species Compendium. Detailed coverage of invasive species threatening livelihoods and the environment worldwide, Sonchus arvensis (perennial sowthistle), 2017.https://www.cabi.org/isc/datasheet/50583#tonaturalEnemies. Invasive Species Council of British Columbia (ISC.Scentless chamomile, Matricaria perforate.
7. Center, T. D., Allen, D., Greg, P. J. 1999.Waterhyacinth Weevils (Neochetina eichhorniae and N. bruchi) Inhibit Waterhyacinth (Eichhornia crassipes) Colony Development.Biological Control15(1): 39-50.
8. Clemente Garcia, Jr. and Kenneth E. F. 1975. Bactra verutana, a Possible Biological Control Agent of Purple and Yellow Nutsedge: Large Scale Rearing on Artificial Diet. Annals of the Entomological Society of America,15–18pp.,1975.
9. Dane, F., and Shaw, J. J. (1996). Survival and persistence of bioluminescent

Xanthomonas campestris pv. campestris on host and non-host plants in the field environment. J. Appl. Bacteriol. 80, 73–80. doi: 10.1111/j.1365- 2672.1996.tb03192.x

10. Elliott, M. S., Massey, B., Cui, X., Hiebert, E., Charudattan, R., Waipara, N., et al. (2009). Supplemental host range of Araujia mosaic virus, a potential biological control agent of moth plant in New Zealand. Australas. Plant Pathol. 38, 603–607. doi: 10.1071/ap09046

11. Hynes, R. K., Chumala, P. B., Hupka, D., and Peng, G. (2010). A complex coacervate formulation for delivery of Colletotrichum truncatum 00-003B1. Weed Technol. 24, 185–192. doi: 10.1614/wt-d-09-00008.1

12. Kazinczi, G., Lukacs, D., Takacs, A., Horvath, J., Gaborjanyi, R., Nadasy, M., et al. (2006). Biological decline of Solanum nigrum due to virus infections. J. Plant Dis. Protect. 325–330.