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Role of Biological Control for Management of Weeds

Divya S. Patel[1], Dharmraj M. Jethva[2] and Akash V. Kchot[3]
[1]Senior Project Assistant, [2]Associate Professor, and [3]Senior Research Fellow, Department of Entomology, Junagadh Agricultural University, Junagadh, Gujarat

SUMMARY

First successful classical biological control of a weed (prickly pear) was achieved unintentionally in India when cochineal insect, Dactylopius ceylonicus was mistakenly introduced from Brazil in place of D.cacti to produce dye from Opuntia vulgaris. This incident led to biological control of weeds. Biological control of weeds involves the use of living organisms to attack a weed population to keep at or below desirable level without significantly affecting useful and wanted plants. It is evidently proved that biological control methods do best on large infestation of a single weed species, which usually occurred in rangelands or in water bodies.There are many bio agents which have been introduced in other countries and have shown varying degree of success through combined effect.

INTRODUCTION

DeBach and Rosen (1991) gave the definition of biological control in the applied sense as "the utilization of natural enemies to reduce damage caused by noxious organisms to tolerable levels". Biological control has been defined in bulletin of commonwealth Institute of Biological Control as "It is the method of controlling the pest whether of plants, animals or man by exposing to natural enemies". Biological control research and implementation is even more relevant today. Foreign and native organisms that attack weeds are being evaluated for use as biological control agents. The problem with weeds can be defined as plants growing out of place. For example, water hyacinth is beautiful in floating gardens but can rapidly clog waterways, making navigation impossible (cover, center-left photo). Similarly, morning-glory is beautiful in the garden, but when it entwines corn stalks, it can destroy a farmer's crop.

Biological Weed Control

Biological weed control involves using living organisms, such as insects, nematodes, bacteria, or fungi, to reduce weed populations. In nature, plants are controlled biologically by naturally occurring organisms. Plants become pests - and are labeled "weeds" - when they run rampant because their natural enemies become ineffective or are nonexistent. The natural cycle may be interrupted when a plant is introduced into a new environment, or when humans disrupt the ecological system. When we purposefully introduce biological control agents, we are attempting to restore or enhance nature's systems.

How Does Biological Weed Control Work?

Roots provide plants with water and nutrients. Some biological control agents attach to roots and thereby stunt plant growth. Some bacteria live on root surfaces and release toxins that stunt root growth. Many fungi infect roots and disrupt the water transport system, which reduces leaf growth. Beneficial insects and nematodes feed directly on the weed roots causing injury which allows bacteria and fungi to penetrate. Plant leaves capture energy from the sun and store it as sugar. Insects that feed on leaves reduce the leaf surface available for energy capture. Fungi and bacteria that infect leaves reduce the ability of the leaf to make sugars. In either case, there is less energy available for weed growth. Whether through damage on roots or leaves, severe infestations of biological control agents can actually kill weeds, reducing their adverse effects on desirable plants. Many weed species survive from year to year by producing seeds. Fungi or insects that attack seeds can reduce the number of weed seeds stored in the soil, which in turn can reduce the size of future weed populations. This lowers the effort needed to control the remaining emerging weeds. Some bacteria and fungi applied as biological control agents do not survive from year to year. These organisms must be applied on an annual basis. This technique is called the "bio herbicide" strategy. With this tactic, biological agents are used as in manner similar to chemical herbicides. Weeds introduced from foreign countries often require a different strategy. Insects and pathogens are collected in the area of origin and evaluated for release. Insect agents often require a number of years to become fully effective. Their growth is often hindered by adverse climatic conditions. The release of biological control organisms in this manner

is termed the "classical" approach to biological control. Fungi that naturally spread and infect weeds can also be used in a classical biological control strategy.

Biological Weed Control Efforts and Success

Biological control of weeds was started with the accidental introduction of the insect, *Orthezia insignis* which proved as a check against the proliferation of Lantana, an ornamental plant brought in to Hawaii. The weed, *Hypera perforatum*, a native of Europe, is known as St. John's Wort in Australia and New Zealand as Klamath weed in the U.S.A. In California the weed was controlled by the introduced beetle, *Chrysomela gemellata*. Quite a few similar attempts on biological control of weeds in several countries have proved to be successful. The insects should not be considered for noxious weed control, if they have been recorded as attacking plants of economic value. Insects recorded as attacking only the genus to which the noxious weed belongs or allies of it, having no economic value, should be subjects of future study.

Control of Cacti:

One of the well-known examples on the use of insects in the biological control of weeds was the fight against cacti in Australia. The prickly pear, *Opuntia inermis* got accidentally introduced into Australia by about 1840. The cactus spread so rapidly that in the course of next thirty years about twenty to twenty four million hectares of arable land were rendered useless. The weed was attempted to be eradicated through the use of mechanical cutters, rollers and poisonous chemicals but without success. So, in 1925, the moth borer, *Cactoblastic cactorum* from Argentina was imported and released. The moth larvae burrowed into the cactus, grew and multiplied, and within 10 years had decimated the prickly pear population. Today, the cactus covers only 1% of the area it occupied in 1925. The prickly pear *Opuntia vulgaris* Miller was suppressed in Central and North India by introduction of the mealy bug *Dactylopius ceylonicus* (Green) from Brazil in 1795.Experience of biological control of weeds in South India is another interesting story. The cactus *Opuntia dillenii* was wrongly introduced in 1780 in the place of *O. coccinellifera* for cultivation of the commercial cochineal insect *Dactylopius cacti* (L.), valued for its dye. They got established. The cochineal insect was then obtained from Mexico. Since the insect was left with a wrong plant for its host, it did not thrive, allowing the cactus to spread rapidly and assume serious proportions as a noxious weed. Then the problem became one of eradication of the cactus. *Dactylopius opuntiae* Lichtenstein, a North American species, was introduced from Sri Lanka in 1926 and within two years the insect effected a striking control of *O. dillenii* and also of *O. elatior* (*O. nigricans*) to a lesser extent.

Control of Water-hyacinth *Eichhornia crassipes* (Pontederaceae)

Water-hyacinth is free-floating freshwater plant. It restricts flow of irrigation water, prevents free movements of boats; interferes with fishing and pisci culture, degrades the quality of water and increased silting and gradual drying of water bodies. It is also a threat to flooded rice fields where it reduces yield. In 1982 three exotic natural enemies (weevils) *viz*., *Neochetina bruchi* Hustache, *N.eichhorniae Warner* (Curculionidae) and the mite *Orthogalumma terebrantis* Wall work were introduced, and the former two have proved successful. *N. eichhorniae* adults are brownish-black and their body has grey and black scales. *N. bruchi* is reddish-black, broad-bodied, robust, densely clothed with agglutinate scales. Adults of both the weevils feed on the leaves of hyacinth and deposit their eggs below the epidermis of petioles and laminae. *N. bruchi* prefers basal ligules of outer leaves and *N. eichhorniae* prefers small, tender leaves. Whitish eggs of these species hatch in about a week.

The grubs are white or cream colored with yellow or orange head. The grubs tunnel into the petioles and crown where they form pockets to feed extensively. The grubs leave characteristic black tunnels and the damage is often followed by invasion of pathogens, which weaken the plants further. Grubs pupate on live roots by cutting a lateral rootlet for making a spherical cocoon around them. Larval and pupal periods are completed in two months. The adults of *N. eichhorniae* and *N. bruchi* live for 142 and 134 days and lay 981 and 681 eggs, respectively. The weevil migrates up to 30 km. These weevils can be used to control the weed. They can be reared in laboratories in large numbers under controlled conditions on the weeds and artificially inoculated on the weeds in natural conditions. Other management practices such as mechanical removal of the weed can also be followed simultaneously.

Control of Aquatic Weed *Salvinia molesta* (Salvinaceae)

This weed got introduced into India and first observed in the 1950s in Veli Lake in Thiruvananthapuram in Kerala. It became a serious weed since 1964. The weevil *Cyrtobagous salviniae* Calder and Sands, of Brazilian origin, was introduced from Australia in 1982 for the control of the aquatic fern *Salvinia molesta* and has now established in Kerala and Karnataka. Adults of the weevil feed on freshly emerged leaves and buds of *Salvinia.* They mate periodically throughout their life and the pre-oviposition period is 12.7 days. Adult males and females survive for up to 284 and 271 days respectively.

Females oviposit up to 263rd day and a female lays 148 to 383 eggs. The eggs are laid mostly in the leaf keel and to a lesser extent in the root zone. Adults damage the leaf buds and the young terminal leaves; and feeding by larvae causes browning and decay of leaves. The capacity of the adults to live for as long as eight months combined with their ability to lay eggs continuously throughout their lives may be contributing to the effectiveness of the weevil. The acridid grasshopper *Paulinia acuminata* (De Geer) introduced in 1974 got established but its potential as a bio-control agent has not been confirmed.

Control of Water-lettuce *Pistia stratiotes* L. (Araceae)

The water-lettuce has been noticed as a serious weed in Kerala. A noctuid caterpillar *Namagana pectinicoris* causes extensive damage to this weed and appears to be a potential bio-control agent.

Control of *Eupatorium adenophorum*

The exotic tephritid fly *Prcecidochares utilis,* introduced from New Zealand in 1963 on *Eupatorium adenophorum* in the Nilgiris, caused galls on the plant but did not exercise effective control of the weed.

Control of *Chromalaena odorata* (Asgeraceae)

Chromalaena odorata, which is known as Siam weed, got introduced into Kolkata in the 1840s and has now spread throughout India. In Karnataka and Tamil Nadu it is a serious pest in the plantation crops, forest areas, waste lands, and pastures. The leaf feeding moth *Pareuchaetes pseudoinsulata* Rego Barros (Arctiidae) was introduced in the 1980s in the Western Ghats. The seed feeding weevil *Apion brunneonigrum* (Apionidae) was also released in India but did not establish itself as a bio-control agent.

Control of Carrot Weed, *Parthenium hysterophorus* Linnaeus

Parthenium hysterophorus, also known as white top and congress grass, is native to the area around Gulf of Mexico including the West Indies, and central South America. It has accidentally been introduced, over the past five decades, into many countries including Australia, China, India, Israel, Madagascar, Mozambique, Nepal, South America and Vietnam. In India, it was recorded from Pune in 1955. It has spread all over India covering most of the vacant and marginal lands. *P. hysterophorus* is known to suppress local vegetation by release of growth inhibitors through leaching, exudation of roots, decay of residues, etc. It not only covers wasteland but also invades cultivated fields and poses a threat to crops such as cereals, vegetables, fruits, oil seeds, etc. It also inhibits fruit set in crops like tomato, brinjal, beans and capsicum when its pollen grains are deposited on the stigmatic surfaces. The health hazards caused by Parthenium are also well known and there is considerable documentation on contact dermatitis and rhinitis due to airborne pollen, which constituted 66.18% of the total annual pollen catch in Bangalore.

Control of *Lantana camara* (Verbenaceae):

In the case of lantana, the introduced coccid, *Orthezia insignis,* in addition to its failure to effectively check the weed began to infest economic plants like citrus, coffee, cinchona and tomato; the seed fly *Ophiomyia lantanae* (Froggatt) introduced from Hawaii in 1921did not establish itself in India. The Lantana bug *Telenomia scrupulosa* Stal. (Tingidae) was imported from Australia in 1941 and is suppressing the lantana weed successfully in some areas. In 1972 the chrysomelids *Octotoma scabripennis* Guerin Meneville and *Uroplata girardi* Were introduced which got established.

CONCLUSION

As a weed management method, biological control offer is environmentally friendly approach that complements conventional methods. It helps to meet the need for new weed management strategies since some weeds have become resistant to certain herbicides. Biological control agents target specific weeds. Moreover, this technology is safe for applicators and consumers.

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S.P. Singh. Project Coordinator – IPM Asian and Pacific Coconut Community (APCC) Lina Building, 3rd Floor, Jl. H.R. Rasuna Said Kav. B7 Kuningan, Jakarta 12920 INDONESIA

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