Biological Weed Control for Sustainable Agriculture

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Abstract

Biological control utilizes natural living organism, such as insects, herbivorous fish, other animals, disease organisms and competitive plants to limit their growth. In biological control method, it is not possible to eradicate weeds but weed population can be reduced. This method is not useful to control all types of weeds. Introduced weeds are best targets for biological control. Biological control is least harmful to the environment, have no residual effect, relatively cheaper, having comparatively long lasting effect, harmless to non-targeted plants, very effective in control of weeds in non cropped areas. Besides this some of the fish, snails and other animals convert weed vegetation into seafood. This review enumerates various biological control mechanisms used for weed control. The classical examples of biological weed control have also been enlisted.

Keywords:

1. Introduction

The production of food grain should increase to 280 million tons by the year 2020 in order to meet the needs of the growing population. Beyond good agronomic and horticultural practices, growers often rely heavily on chemical fertilizers and pesticides. However, the environmental pollution caused by excessive use and misuse of agrochemicals, as well as fear mongering by some opponents of pesticides, has led to considerable changes in people's attitudes towards the use of chemicals in agriculture. Biological control should be integrated with other control measures because different methods are effective at different times and locations under varying conditions (McFadyen, 1998). Biological control means, Utilization of natural living organism, such as insects, herbivorous fish, other animals, disease organisms and competitive plants to limit their growth. In biological control method, it is not possible to eradicate weeds but weed population can be reduced. This method is not useful to control all types of weeds. Introduced weeds are best targets for biological control. The control *Opuntia* spp. (prickly pear) in Australia and lantana in Hawai with certain insect bioagents are two spectacular examples of early period biological control of weeds (Evans, 2002).

1.1. Merits

- Least harm to the environment
- No residual effect
- 3) Relatively cheaper and comparatively long lasting effect
- 4) Will not affect non-targeted plants and safer in usage
- 5) It is very effective in control of weeds in non cropped areas
- 6) Besides this some of the fish, snails and other animals convert weed vegetation into seafood

1.2. Demerits

- Multiplication is costlier
- Control is very slow
- Success of control is very limited
- Very few host specific bio-agents are available at present

2. Approaches in Biological Control

2.1. Classical biological control

Main objective of classical biological weed control is restoring balance between target alien weed and its natural enemies in the ecosystem by introduction of suitable, exotic bio-agent. Successful bio-agent reduce the weed population first then the Bio-agent population due to starvation of food. After some time the bio-agent population may recover. This process continues in cyclic fashion till the bio-agent and weed population gets established at a low level. This method is a slow operating and currently used in non cropped areas. In

crop fields, the bio-agent will not get opportunity to work on host weed due to frequent use of insecticides and fungicides in modern agriculture. Otherwise *Cyperus rotundus* can be controlled in crop fields with moth "*Bactra verutana"* and selective bio control of *Ludwigia parviflora* (water purslane) by *Haltica cyanea* (steel blue beetle) in rice fields (Strobel, 1991).

2.1.1. Criteria / Characteristics of successful bio-agent

2.1.1.1. Host-specific

Bio-agents should be host specific and they should not attack other economic plant spp. They should pass starvation test i.e. they prefer to starve to death rather feed upon other than host weeds. Lantana was controlled by *Teleonemia scrupulosa* insect bio-agent. But in India it is likely to damage teak (*Tectona grandis*) and sesame (*Sesamum indicum*). *Zygogramma bicolarata* is an effective leaf eating bio-agent against *Parthenium* (carrot grass). But it is found to attack sunflower in India.

2.1.1.2. Bioagent hardiness

Bio-agent should free from its own parasites and predators. Bio-agent should withstand starvation for short or long periods of food shortage when the target weed population is brought to low level. But carp can't survive even a short period of starvation.

2.1.1.3. Feeding habit

Bio-agents are more efficient in controlling weeds if they attack either flowers or seeds of the weed or bore into the stems than root and leaf feeders. But root-feeding insects are more effective in controlling perennial weeds.

2.1.1.4. Ease of multiplication

Bio-agent should have high rate and ease of natural reproduction. It is very important for insects, pathogens, snails and competitive plants. But it is not desirable with carp as its increased population compete with natural fish.

2.2. Kinds of classical bio-agents

Bio agent may be either specific or non specific. Specific bio agent attack only one or two specific weeds, while non specific bio agent feed upon a variety of vegetation. Specific bio agents are insects, plant pathogens and competitive plants. Non specific bio agents are Carp fish, snails, mites.

2.3. Six kinds of Bio-agents were used to control weeds

2.3.1. Insects

These are largely host specific *i.e.* one insect spp is employed to destroy the only one weed sp. First successful example reported from Hawai in 1902 *Lantana camara* controlled by Moth, *Crocidosema lantana*. Insects that were found effective belong to Lepidoptera, Hemiptera, Coleoptera, Diptera.

2.3.2. Carp fish

Certain fresh water Carp fish consume large quantities of aquatic weeds. Whiteamur (Chines grass carp) "*Ctenopharyngo donidella"* is promising spp for aquatic weed control. This can grow more than its body weight i.e 5kg / year and attaining up to 50kg at its full size.. Herbivorous fish are not food specific. Whereas the common carp (*Cyprinus carpio*) a non herbivorous fish used to control submerged aquatic weeds.

2.3.3. Plant pathogen

Many fungi attack specific weed species. For instance *Acacia glauca* controlled by spore suspension of *Cephalosporium zonatum.* Skeleton weed *(Chondrilla juncia)* controlled by rust causing fungi, *Puccinia chondrillana.*

2.3.4. Competitive plants

Certain plants sp are very competitive in suppressing specific weeds. Slender spike rush (*Eleocharisa cicularis*) aquatic plant can cover the canal bottom and it is not allowing to establish destructive tall weeds. *Typha* species can be controlled by *Panicum purpurascens* or *Brachiari amutica (Para grass)*. Marigold has potential to displacing *Parthenium* spp*. Cassia sericea* also suppressed

2.3.5. Slender spikerush

Brachiari amutica, Marigold displacing *Parthenium*

2.3.6. Snails

The large tropical fresh water snail, *Marisa cornuarietis* feed on aquatic weeds. Marisa feed on roots of water hyacinth, water lettuce and leaves of *Salvinia. Marisa cornuarietis* feed on aquatic weeds

3. Outstanding Example of Classcical Biocontrol

Lantana Camera: Lantana was the first weed controlled successfully with certain insect bioagents in Hawaii. Of these *Crocidosema lantana*, a moth was found to be promising in destroying flowers and seeds of lantana. In Australia, three successful insect biocontrol agents are hispine beetles (*Octotoma scabripennis and Uroplata girardi)* and tingid or lantana bug (*Teleonemia scrupulosa).*

Prickly pear (*Opuntia* sp): In Austrlia biocontrol of *Opuntia inermis* with a moth *Cactoblastis cactorum*. In Tamilnadu and Maharashtra 40,000 ha land was recovered from the weed *Opuntia delini* by releasing *Dactyloplius tomentosus,* a Cochineal scale insect.

Water hyclinth: (*Eichornea crassipes*) it is worldwide aquatic weed infested transplanted paddy fields including India. Hyacinth moth, *Sameodes albiguttalis* feed up on young leaves and apical buds. Besides this beetles *Neochetina bruchii* and *N. eichorniae* are also damaging the water hyacinth

Salvinia (*Salvinia molesta)*: In Kerala (India) curculionid beetle *Cytrobagous salviniae* used to clear the fresh water courses and paddy fields. They feed on terminal buds and rhizomes and petioles of salvinia.

4. Bioherbicide Philosophy Of Weed Control

Bioherbicides are pathogens cultured artificially and made

Table 1: Some other example of biological control

Weeds	Bio-agent	Reporting country	Kinds of bio-agent
Chondrilla juncea	Puccina chondrillina	Australia	Plant pathogen
Cirsium arvense	Septoria cirsii		Plant pathogen
Cyperus rotundus	Bactra verutana	India, pakistan, USA	Shoot boring moth
Echinochloa spp.	i. Emmalocera sp. ii. Trpos spp.		i.Stemborin moth ii.Shripm
Hydrilla verticillata	Hydrellia pakistanae	USA	Shoot fly
Orobanche cernua	Sclerotinia sp.	USA	Plant pathogen
Parthenium hysterophorus	Zygogramma bicolorate Epiblema strenuana Contrachelus sp.	India Australia Australia	Leaf eating beetle Stem galling insect Stem galling insect
Rumex spp.	Uromyces rumicis Gastrphsa viridula	USA USA	Plant pathogen Beetle
Tribulusterrestris	Microlarrinus lareynii and M. lypriformi	USA	Pod weevil

Table 2: Some Commercial Mycoherbicides in Use Abroad

Devine	A liquid suspension of fungal spores of Phytophthora palmivora. It causes root rot in the weed.	Strangler-vine. (Morrentia odorata) in citrus orchards.
Collego	Wettable powder containing fungal spores of Colletotrichum gloesporiodes sub sp. aeschynomone	Joint vetch (Aeschynomone sp). In rice fields. The bioherbicide causes stem and leaf blight in the weed.
Bipolaris	A suspension of fungal spores of Bipolaris sorghicola.	Johnsongrass (Sorghum halepense)
Biolophos	A microbial toxin produced as fermentation product of Streptomyces hygroscopicus.	Non-specific, general vegetation.
Luboa-2	Colletotrichum gloesporiodes, Cuscuta spp.	Cuscuta

available in sprayable formulations; just like a chemical herbicide. The pathogen selected for the purpose is usually from the native place of the weed, but it could also be from other places. The bioherbicides are also sometimes called mycoherbicides. A mycoherbicides can be both specific and non-specific.

The bioherbicide philosophy differs from the classical biocontrol philosophy referred to earlier, in certain ways as follows.Bio herbicide remains active only on the current weed population, without any chance of cyclic perpetuation of the weed (or of the bio gent); each new flush of the weed thus requiring retreatment with it. Bio herbicide can be developed for selective control of weeds in a crop just like any other selective herbicide, which is not the case with the classical philosophy bio agents (Julien, 1987). The development of bio herbicides is of great interest to industrialists since it involves every season requirement of the product for field use. In variance with it, the classical biological control approach has no incentive to the private, profit-oriented organizations; it must depend solely upon public sector support.

5. Conclusion

For growth of agricultural production has led several new challenges, making further growth possible only if these challenges are met appropriately and timely. Increase in crop production from the modern farming techniques reaching a plateau is the most of the countries including India and the environmental problems due to excessive use of chemical fertilizers and pesticides becoming a matter of concern. So, the biological control can be alternate system, which may play an important role in achieving the goal of agriculture.

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