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Non-Chemical Weed Management Practices

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Abstract—*In agricultural science plants are categorised into 'crops' which are of great use to humans and the other are 'weeds' that are grown to compete with the crops of human interest. These extremely noxious, useless, unwanted and sometime poisonous plants causes great losses in agriculture and also causes menace to human health . It is estimated that alone weeds causes around 45% of damage per year in agriculture. The extent of loses due to weeds depends upon the intensity of infestation, time of occurrence and the type of weed. Thus management and destruction of weed becomes very important. Every year millions of dollars are spent on chemicals, called 'Herbicides' to destroy vegetation of weeds. But these chemicals are poisonous and they also cause environment pollution, thus it is always advised to use herbicide as last option because there are many non-chemical methods available to control weeds.*

The herbicide free weed management practices are categorised into Cultural control, Mechanical control and Biological control. All these three categories of weed control are useful either at initial emergence stage of weed or when the weed plantation is bellow ETL(Economic Threshold Level). The cultural control methods include use of clean agricultural equipments, deep tillage to kill weeds before new crop plantation, soil solarisation etc. The mechanical weed management practices include hand weeding, mowing, burning of weeds etc. The last, most popular these days is biological weed management. It includes use of bio agents like insect, nematodes, bacteria, fungi etc to control weeds. If chemical use are to be decreased, then farmers are needed to be aware of other alternatives of herbicides they can opt.

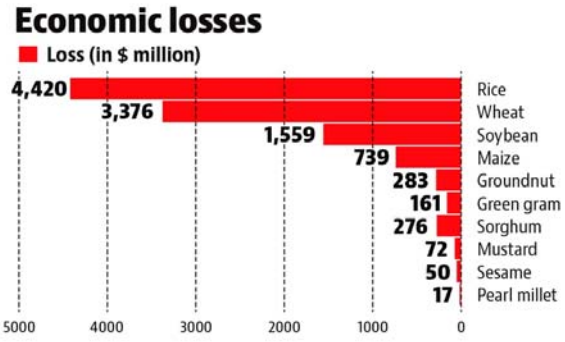
1. INTRODUCTION

The term 'WEED' was first coined by Jethro Tull, an eminent agriculturist from Berkshire,UK[i]. In 1731, he stated that, weeds are the plant, which grow where they are not needed and also referred weeds as plants out of place[ii]. Due to amazing survival tactics of weeds, they compete with the main crop and degrade crop's quality. Thus it becomes mandatory to control plant population. Every year farmers spend alot of time and money to eradicate weeds from their fields. The most popular and easy means of complete removal of weeds include use of chemical herbicides like glyphosat; 2,4-D ;paraquat; simazine, atrazine etc. But these chemical herbicides are well known to pose health hazards to humans and animals along with degrading environment. Thus now a day's many of the herbicides are banned by the government and non-herbicide weed management techniques are being promoted. These include hand weeding, use of mulches, intercultivation, use of bioagents etc.

2. NEED FOR WEED MANAGEMENT

It is observed that in agro ecosystem weeds can adapt easily than main crop plants. Weeds are capable of easily destroying the main crop plants, and the reason is that they can compete for principle factors of crops. Those principal factors include nutrient, moisture, light and food. This competition can cause great losses like reduction in quality of land, loss in crop quality, loss in crop yield, reduction in quality of livestock produce, increase in the cost of cultivation, increase in pest population etc.[iii]

It is estimated that, Weeds led India losing an average of $11 billion each year in 10 major crops, shows data(in figure.1) from 1,581 farm trials in 18 states.[iv] Thus it becomes an urgent need to manage weed at proper stage.



"figure.1: Economic losses caused by weeds in 10 major crops in India."

3. NEGATIVE IMPACTS OF HERBICIDES

Herbicides are the chemicals used to kill the undesirable plant population, called weed. Herbicides can be selective i:e they only kill target weed plants and not the main crop, and non-selective herbicides, which kill all plant vegetation.

Herbicide usage may be the quickest and cheapest source of weed eradication but our health and our environment are

worth more than that. Excessive use of herbicide causes accumulation of toxicity in soil, water, plant and ultimately affect animal and human health and leads to environment degradation. Biomagnifications of many herbicides have been observed over the past year. WHO has banned many herbicides like 2,4-D (dichlorophenoxyacetic acid) due to its carcinogenic properties. **In March 2015 IARC declared the world's most widely used weed killer –glyphosate– a "probable human carcinogen"**[v] . Thus one should minimise use of such chemical and should opt other non chemical weed management practices.

4. PRINCIPLES OF WEED CONTROL

Before designing any weed control programme one should know about weed's interaction with changing environment, its respond to herbicides, the nature and habitat of weeds in any given area. One should also know about basic principles of weed control, as these principles form foundation of various weed control technique.

Following are the principal's of weed control[vi]:

A. Prevention
B. Eradication
C. Control
D. Management

(A.) Prevention: It is believed that no weed control programme is successful if proper preventive measures are not taken to reduce weed infestation.

It include all measures taken to prevent the introduction or establishment and spread of weeds.

The following preventive measures are suggested for adoption:

- Keep irrigation channels, fence-lines, and non-cultivated areas clean.
- Avoid use of crops infested with weed seeds.
- Do not add weeds into manure pits.
- Inspect nurseries for presence of weed seedlings, tubers, rhizomes,etc.
- In all countries quarantine regulations are present which deny entry of weed seeds into a country through airports and shipyards.
- Clean the farm machinery thoroughly, especially seed drills before moving it from one field to another.

(B.) Eradication: Eradication is often used in high value areas such as green house, ornamental plant beds and container. It involves total eradication of all living weeds including their seeds. It is a bit difficult approach than preventive measure, that is why it is usually attempted only in smaller area such as few hectares of land.

(C.) Control: It is a process of limiting weed infestation and decreasing competition with crops. When weeds are limited they have minimal effect on crop growth and yield. This principle is applied when problem of weed exists. In general the degree of weed control obtained is dependent on the characters of weeds involved and the effectiveness of the control method used[vii].

(D.) Weed Management: Weed management is a system approach whereby whole land use planning is done in advance to minimize the very invasion of weeds in aggressive forms and give crop plants a strong competitive advantage over the weeds.

Weed management practices include practices such as Cultural, Physical, Chemical and Biological.

Chemical practices include use of herbicides and in this paper we will focus on non chemical methods only.

5. NON- CHEMICAL WEED MANAGEMENT PRACTICES

The non chemical practices include:

5.1 Mechanical Weed Control

5.2 Cultural Weed Control

5.3 Biological Weed Control

5.1 MECHANICAL WEED CONTROL: The mechanical weed control is the physical method of weed control which is being employed by man since old time . It includes:

5.1.1 Hand Weeding- It is done either by pulling weeds with hand or simply removing with khurpi. One of the oldest method is useful against many weeds

5.1.2 Burning- With fire or burning we can dispose of vegetation of weeds, kill green weeds at places where cultivation and other common methods are impracticable

5.1.3 Hoeing- It include use of tool called hoe. It is more effective on annuals and biennial weeds. It is a useful tool to obtain results effectively and cheaply.

5.1.4 Digging- it is useful in case of perennial weeds to remove the underground propagating Parts of weeds from deeper layers of soil.

5.14 Flooding- It works against weed species sensitive to submergence in water. It kills plants by reducing oxygen availability for plant growth.

5.15 Mowing- it is a machine operated practice mostly done on lawns, parks, roadsides.

5.2 CULTURAL WEED CONTROL: It is done for creating favourable conditions for crop. They are always done with combination of other measures for effective results. It includes:

5.2.1 Off- season tillage –To check the growth of perennial weeds off- season or summer tillage is of great use. Primary tillage encourages clod formation, consisting of weed propagules which desiccate upon drying. Subsequent tillage operations break the clods and expose the weeds to scorching sun.

5.2.2 Mulching- Mulching is done by straws, plastic sheets or polythene films. It is a protecting covering material on soil which exclude light from the photosynthetic portion of a plant and is affective against annual plants and some perennials like *Cynodon dactylon.*

5.2.3 Solarisation- In this method solar energy is utilised for desiccation of weeds. In this method soil temperature is raised by 5-10°C by covering a pre- soaked fallow field by thin transparent plastic sheet. It checks the reflected radiation from the soil and prevents loss of energy by hindering moisture evaporation.

5.2.4 Stale Seedbed- In this method weeds are allowed to germinate by soaking a well prepared field with either irrigation or rain. The emerging plants are killed either by mild herbicide dose like glyphosate, paraquat or by mild cultivation. This is followed by immediate sowing and crop germinate in weed free environment.

5.2.5 Crop rotation- The weed growing capacity increases if the same crop is grown year after year. Thus one should practice crop rotation.

5.2.6 Intercultivation- It is an effective and cheap method of weed crop in line sown crops. Variety of intercultivation implements are available which have blades which cuts the weeds just below the soil surface.

5.3 BIOLOGICAL WEED CONTROL: These days the interest is increasing in biological weed control. It can be defined as weed control measure in which one uses living organisms to suppress a pest population, making it less abundant and thus less damaging than that it would otherwise be. It is the suppression of unwanted vegetation by the action of one or more organisms through natural means. This method does not promise complete eradication of weeds, but only reduction in weed population.

Qualities of Bioagent [viii]:-

- It must easily adapt to environment conditions.
- The bioagent must feed only on one host, i:e it should be host specific in nature.
- Bioagent must be able to seek out itself to the host.
- It must be free of predators or parasites.
- It must be able to kill the weed or atleast prevent its reproduction in some direct or indirect way.
- It must possess reproductive capacity sufficient to overtake the increase of its host species, without too much delay.

Following are the examples of Biological weed control :

- Cuscuta spp. is controlled by *Melanagroma cuscutae.*
- *Cyperus rotundus* is controlled by *Bactra verutana* a moth borer.
- Herbivorous fish Tilapia controls algae. And snails can control submerged weeds.
- For more examples refer to "Table no':1 "[ix]

"Table no':2"- Bioagents and weeds they can control

Bioagent	Weeds
Insect	
Two beetles: Octotoma scabripennis and Uroplata giraldi	Lantana camara
Scale insect Dactylopius tomentosus.	Prickly-pear weed - Opuntia
Flea beetle Agasicles hygrophyla	Alligator weed – Alternanthera philoxeroides
Fish	
Common carp (Cyprimus carpio) Chinese carp	Aquatic weeds
Mammals Manetee or sea-cow	Water hyacinth
Snails Marisa sp and other fresh water snails	Submerged weeds like coontail and algae
Fungi Rhizoctinia blight.	Hyacinth
Mites	
Tetranychus sp	Prickly pear
Plants Cowpea as intercrop in sorghum	Effectively reduces the growth of weeds in sorghum

6. BIO-HERBICIDES:

Bioherbicides include use of plant pathogens which are expected to kill the targeted weeds. These are native pathogens, cultured artificially and sprayed just like post-emergence herbicides each season on target weeds, particularly in crop areas[x]. For example- Devine TM, Collego TM, BioMal etc.

It is observed that fungal pathogens are excessively used than bacterial, nematode or viral pathogens. It is because bacteria and viruses are not as effective and penetrating into host to initiate disease as fungal pathogens.

MYCOHERBICIDES are the fungal pathogen, when applied in abundance kill plants by causing disease. In this fungal spores or their fermentation product is sprayed against the target weed.

Following(Table no':2) are the examples of registered mycoherbicides around the world:-

Table no' : 2,Some examples of mychoherbicide

No'	Product	Content	Target weed
1	Collego	Wettable powder containing fungal spores of Colletotrichum gloeosporoides causes stem and leaf blight	Joint vetch (Aeschyomone virginica) in rice, soybean.

2	Biolophos	A microbial toxin produced as fermentation product of steptomyces hygroscopicus	Non-specific, general vegetation.
3	Bipolaris	A suspension of fungal spores of Bipolaris sorghicola	Jhonson grass (Sorghum halepense)
4	Devine	A liquid suspension of fungal spores of Phytophthora palmivora causes root rot.	Strangle vine (Morrenia odorata) in citrus.

7. CONCLUSION

According to a study, exposure to chemical herbicides can produce mild symptoms like nausea, headache and rashes. It can even cause more dangerous symptoms such as seizers, convulsions and even death. Therefore non- chemical weed management practices should be encouraged among farmers through advertisements or seminars. Government should promote bio- herbicides and mycoherbicides and they should also create awareness about ban carcinogenic herbicides. Herbicide application should be the last option; strict regulations should be laid regarding dosage of available herbicides for usage.

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