A Review of weed control methods

Abstract

Weeds in the crop field were found to be a major concern. In terms of nutrients, water, food, space, sunlight, etc., weeds compete with the primary crop. Utilizing the nutrients that are given to the primary crop, weeds can occasionally completely overtake it. Some weeds are extremely poisonous and dangerous to both people and animals. Herbicide use to manage weeds clearly shows that it has a negative impact on soil quality, water quality, and the environment. This is evident from studies done in the field of weeds. Additionally, consistent use of the same pesticide develops resistance in the weeds to it.Weeds can be controlled in a variety of ways, including mechanical, cultural, chemical, and biological methods. However, the use of various herbicides in chemical control is now so pervasive. Chemical fertilizers should not be used excessively as this lowers environmental quality and damages soil health. As a result, a brand-new strategy known as Integrated Weed Management (IWM) was developed, in which all existing strategies are combined to cut down on the use of herbicides alone.

Key words: Weed control, Cultural methods, Mechanical methods, biological methods, Chemical methods and advance of IWM.

Introduction

Weeds have been there since the beginning of time. Weeds are plants that are not crop plants or are planted in the main field alongside crop plants. Weeds not only grow alongside the primary crop, but also compete with it for fundamental necessities such as food, space, sunlight, nutrients, and so on, causing significant losses in agricultural production (Das 2008). Weeds are impossible to completely eradicate from the main field since they spread in a variety of methods, including dormant seed dissemination, vegetative propagules, and soon. (Singh *et al.*,2014). Weed management success is directly related to overall agricultural success (David *et al.*,2012). Weeds are an important component of the agricultural system, consuming a large amount of the resources available for plant growth (Oerke 2006). Improper weed management or failure to control weeds at the appropriate time results in a significant drop in crop output and an increase in production costs (Sharma 2014). Weeds reduce yield by up to 90%, and crop failure can occur as a result of weeds. Previously, crop rotation, seed cleansing, tillage practices, and other methods were used to eliminate weeds. Cultural control entails making changes to the cropping system in order to avoid the impact of weeds on the main crop (Dubey 2014). On the other side, biological control alternatives are limited, which is why it is not widely used. So, in physical control, hand weeding or hand hoeing is done, whereas in chemical control, herbicides are employed, and this type of weed control is quite

popular among farmers. The overuse of chemical fertilizers and their impact on soil and the environment has become a worldwide concern.Efforts to manage weeds like cleaning of seeds, cleaning farm equipment, keeping irrigation channels clean etc. had been adopted by farmers since ancient times. The description of different weed control methods is given below:

I. Cultural/ Ecological/ Agronomical methods

It is known as crop management practices. Several cultural practices like tillage, planting, fertilizer application, irrigation etc., are employed for creating favorable condition for the crop. These practices if used properly, help in controlling weeds. Cultural methods, alone cannot control weeds, but help in reducing weed population. They should, therefore, be used in combination with other methods. In cultural methods, tillage, fertilizer application and irrigation are important. In addition, aspects like selection of variety, time of sowing, cropping system, cleanliness of the farm etc., are also useful incontrolling weeds (Kumar *et al.*,2014).

1. Field preparation

The field has to be kept weed free. Flowering of weeds should not be allowed. This helps in prevention of buildup of weed seed population.

2. Summer tillage

The practice of summer tillage or off-season tillage is one of the effective cultural methods to check the growth of perennial weed population in crop cultivation. Initial tillagebefore cropping should encourage clod formation. These clods, which have the weed propagules, upon drying desiccate the same. Subsequent tillage operations should break the clods into small units to further expose the shriveled weeds to the hot sun(Badiyala*et al.*,2015).

3. Crop density

It is considered as one of the most important components to suppress weed growth. Optimum plant population in the field provides competition to weeds and inhibit their growth by occupying space or taking available nutrients (Meena *et al.*,2010).

4. Fertilizer application

Application of fertilizer in proper amount, at proper time and at proper place helps to reduce weeds as the main crop will gain all the nutrients (Dubey 2014).

5. Maintenance of optimum plant population

Lack of adequate plant population is prone to heavy weed infestation, which becomes, difficult to control later. Therefore, practices like selection of proper seed, right method of sowing, adequate seed rate protection of seed from soil borne pests and diseases etc. are very important to obtain proper and uniform crop stand capable of offering competition to the weeds (Kumar *et al*., 2005).

6. Crop rotation

The possibility of a certain weed species or group of species occurring is greater if the same crop is grown year after year. In many instances, crop rotation can eliminate at least reduce difficult weed problems. The obnoxious weeds like Cyperus rotundas can be controlled effectively by including low land rice in crop rotation (Das *et al.*,2012). For e.g., rotation of crops like wheat, maize or soybean leads to decrease number of weeds (Teasdale *et al.*,2004).

7. Time of sowing

Early sowing of crops provides tough competition to weeds (Sindhu *et al.*,2010) as crops emerge before the weeds emerge and therefore, weeds do not get enough space, nutrients or light for growth (Cici*et al.*,2008). For e.g., planting of rice crop during monsoon provides best yield and also number of weeds lessen.

8. Method of sowing

Sowing methods have great influence on lowering the weed population (Dev *et al.*,2013). For e.g., in wheat crop Zero tillage proved to be best to control weeds and increase in yield also took place (Jat *et al.*,2013).

9. Growing of intercrops

Inter cropping suppresses weeds better than sole cropping and thus provides an opportunity to utilize crops themselves as tools of weed management. Many short duration pulses viz., green gram and soybean effectively smother weeds without causing reduction in the yield of maincrop (Shah *et al.*,2011).

This method also decreases cost of weeding which leads to higher net income by lowering input cost. For e.g., intercropping of crops like legumes, cucurbits,

sweet potato etc. suppress the growth of weeds and also, they help to reduce the risk of soil erosion.

10. Stale seedbed technique

A stale seedbed is one where initial one or two flushes of weeds are destroyed before planting of a crop. This is achieved by soaking a well-prepared field with either irrigation or rain and allowing the weeds to germinate. At this stage a shallow tillage or non- residual herbicide like paraquat may be used to destroy the dense flush of young weed seedlings. (Singh 2014). This may be followed immediately by sowing. This technique allows the crop to germinate in almost weedfree environment (Sindhu *et al.*,2010).

11. Blind tillage

The tillage of the soil after sowing a crop before the crop plants emerge is known as blind tillage. It is extensively employed to minimize weed intensity in drill sowing crops whereemergence of crop seedling is hindered by soil crust formed on receipt of rain or irrigation immediately after sowing

Merits of Cultural Method

1. Low cost for weed control
2. Easy to adopt
3. No residual Problem
4. Technical skill is not involved
5. No damage to crops
6. Effective weed control
7. Crop-weed ecosystem is maintained

Demerits of Cultural Method

1. Immediate and quick weed control is not possible
2. Weeds are kept under suppressed condition
3. Perennial and problematic weeds cannot be controlled
4. Practical difficulty in adoption

II. Mechanical/ Physical methods

Mechanical or physical methods of weed control are being employed ever since man began to grow crops. The mechanical methods include tillage, hoeing, hand weeding, digging cheeling, sickling, mowing, burning, flooding, mulching etc.

1. Tillage

Tillage removes weeds from the soil resulting in their death. It may weaken plants through injury of root and stem pruning, reducing their competitiveness or regenerative capacity. Tillage also buries weeds. Tillage operation includes ploughing, discing, harrowing and leveling which is used to promote the germination of weeds through soil turnover and exposure of seeds to sunlight, which can be destroyed effectively later. In case of perennials, both top and underground growth is injured and destroyed by tillage (Kumar *et al*., 2011).

2. Hand weeding

It is done by physical removal or pulling out of weeds by hand or removal by implements called khurpi, which resembles sickle. It is probably the oldest method of controlling weeds and it is still a practical and efficient method of eliminating weeds in cropped and non-cropped lands. It is very effective against annuals, biennials and controls only upper portions of perennials (Angiras *et al*., 2008).

3. Hand Hoeing

Hoe has been the most appropriate and widely used weeding tool. It is a very useful implement to obtain results effectively and cheaply. It supplements the cultivator in row crops. Hoeing is particularly more effective on annuals and biennials as weed growth can be completely destroyed. In case of perennials, it destroyed the top growth with little effect on underground plant parts resulting in re-growth.

4. Sickling

Sickling is also done by hand with the help of sickle to remove the top growth of weeds to prevent seed production and to starve the underground parts. It is popular in sloppy

areas where only the tall weed growth is sickled leaving the root system to hold the soil in place to prevent soil erosion (Gupta O.P. 2007).

5. Digging &Cheeling

Digging is very useful in the case of perennial weeds to remove the underground propagating parts of weeds from the deeper layer of the soil.Cheelingis done by hand using a cheel hoe, similar to a spade with a long handle. It cuts and shapes the above ground weed growth.

6. Mulching

Mulch is a protective covering of material maintained on soil surface. Mulching has smothering effect on weed control by excluding light from the photosynthetic portions of a plant and thus inhibiting the top growth (Verma & Singh 2008). It is very effective against annual weeds and some perennial weedslike Cynodondactylon. Mulching is done by dry or green crop residues, plastic sheet or polythene film. To be effective the mulch should be thick enough to prevent light transmission and eliminate photosynthesis(Goswami and Saha 2006).

7. Mowing & Slashing

Mowing is adopted mainly under non-crop situations like canal bunds, farm roads, parks and lawns, whereas slashing may be adopted under both cropped and non-cropped situations.(Senarathne *et al.*,2011).Sometimes mowing by sickle mower, rotary mower is recommended for weed control in widely-spaced fruits and plantation crops.Mowing and slashing are useful for controlling tall annual weeds, but not perennial weeds since they cut only top growth of weeds and not the horizontal, prostrate and under-ground growth (Das T.K. 2009).

8. Burning & Flaming

Burning is the cheapest methods of eliminating mature unwanted vegetation from uncropped areas like range lands, field bund, roadsides, ditch, banks etc.It is used to(a) dispose of

vegetation (b) destroy dry tops of weeds that have matured (c) kill green weed growth in situations where cultivations and other common methods are impracticable.Flaming ismomentary exposure of green weeds to a very high temperature of 1000^{0}C by the flamesemanating from burning liquid petroleum gas. Flames are directed towards weeds in between the rows with a hood cover. It kills plants their cell protoplasm (Singh 2014). In some western countries, flaming is used for selective control of inter-row weeds in onion,soybean, sorghum etc.

9.Flooding

Flooding is successful against weed species sensitive to longer periods of submergenceinwater. Flooding kills plants by reducing oxygen availability for plant growth. The success offlooding depends upon complete submergence of weeds for longer periods.Flooding is an efficient methods of weed control for some perennial weeds like Cyperus spp. *Cynodondactylon* and *Convolvulus arvensis*.

10. Chaining & Dredging

Chaining & Dredging used against aquatic weeds.Chaining- pulling a heavy chain through the bottom of a ditch by two tractors moving on either bank of the ditch. These heavy chains cut and uproot the roots which later float on the surface and gets collected.Dredging-mechanical pulling of weeds along with their roots and rhizomes covered in mud.It is used for removal of sub-merged and emerged aquatic weeds. (Rana *et al*., 2015).

11. Soil solarization

It is method of utilization of solar energy for weed desiccation in fallow fields during hot summer months. It is based on the concept that light received from the sun in the form of electromagnetic short waves, which easily pass through the transparent colorless thin polyethylene films (20-25 mm) and reach to the soil 2-4weeks.This raises the soil temperature up to 10-12 ^{0}C and it reach up to 55-60^{0}C which controls most of the weed species whose seeds are present up to top 5 cm soil layer(Arora and Tomar 2012).

Merits of Mechanical Method

1) Oldest, effective and economical method
2) Large area can be covered in shorter time
3) Safe method for environment
4) Does not involve any skill
5) Weeding is possible in between plants
6) Deep rooted weeds can be controlled effectively

Demerits of Mechanical Method

1) Labour consuming
2) Possibility of damaging crop
3) Requires ideal and optimum specific condition

III. Biological control

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, itis not possible to eradicate weeds but weed population can be reduced. This method is notuseful to control all types of weeds. Introduced weeds are best targets for biological control (Bellgardstanley 2008). 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(Tiwari *et al.*,2013).It's an eco- friendly method and is not too much expensive. In India this method is basically used to control Partheniumhysterophorus (Kumar and Ray 2011).

Promising bioagents of weeds:

Weed	**Bioagent**	**Reporting country**	**Kind of bioagents**
Chondrillajuncea	*Pucciniachondrillina*	Auatralia	Plant pathogens
Cirsiumarvense	*Septoniacirsii*	-	Plant pathogens
Cyperusrotundus	*Bactra vendana*	India, USA	Shoot boring moth
Hydrillaverticillata	*Hydrillapakistanae*	USA	Shoot fly
Orobanchecernua	*Sclerotiniaspp*	USA	Plant pathogenes
Partheniumhysterophorus	*Zygogrammabicolarata* *Epiblemastrenuana* *Conotrachelusspp*	India Australia Australia	Leaf eating insect Stem galling insect Stem galling insect
Rumexspp	*Uromycesrumicis*	USA	Plant pathogens
	Gastrophysaviridula	USA	Beetle
Tribilusterrestris	*Microlarinuslareynii*	USA	Pod weevil

Merits of biological control

1) Least harm to the environment

2)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

Demerits of biological control

1)Multiplication is costlier

2)Control is very slow

3)Success of control is very limited

4) Very few hosts specific bio-agents are available at present

IV. Chemical methods

Herbicides or inorganic chemicals are employed to destroy weeds in this weed control method. Herbicides can be sprayed on leaves or applied to the soil. Farmers have been using more and more chemicals since the Green Revolution to prevent weed growth or to increase their profits. Herbicides may be one of the most efficient ways to control weeds, but they also have a number of drawbacks since they harm the environment and the soil. They become weed-resistant as a result of their prolonged use. Therefore, their ideal application is good, but using these chemicals extensively harms the ecosystem, raising alarms of impending danger.

V. Integrated Weed Management (IWM)

The fundamental challenge facing agricultural or weed scientists is the creation of a technique that is less expensive, highly effective, time-free, and labor-intensive. Weeding operations have an extremely high production cost since they must be done by hand, which raises the overall cost of production. The country loses a lot of money every year as a result of poor weed management techniques. By implementing effective weed management practices, the cost of production can be reduced.To achieve the goal of sustainable crop production, it is vital to establish a labor-free weed management strategy. Then, a novel strategy known as INM was created in which two or more weed management techniques are combined to control weeds.IWM is an efficient, low-input weed management method that is currently a crucial component of the agricultural system (Riemens*et al.*,2007). It could be viewed as a long-term weed management strategy that integrates chemical, biological,

mechanical, and cultural techniques (Kewat 2014). For instance, utilizing manual weeding in addition to pre- and post-emergence herbicides on wheat crops produced the best results when compared to using pesticides alone. Farmer should follow integrated weed management as this method is very environment friendly and in this inorganic chemical are used but in very low amount means optimum amount of chemicals are used along with cultural and mechanical methods to affect weed control. Farmers in India are adopting chemical weedcontrol method which are very effective, ideal and practical.

Advantages of IWM

1. It shifts the crop-weed competition in favour of crop
2. Prevents weed shift towards perennial nature
3. Prevents resistance in weeds to herbicides
4. No danger of herbicide residue in soil or plant
5. No environmental pollution
6. Gives higher net return

Conclusion

Weeds are a major biotic constraint to production in different cropping systems. A single method of control will not provide adequate long-term weed management, instead often resulting in the development of resistance. Weeds are the cause of significant yield loss, even after the application of a particular control method. There is a growing necessity to reduce this yield loss in order to feed an ever-increasing human population. Therefore, there is a need to develop effective and sustainable IWM programs.

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