Integrated Weed Management

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A farming system that utilizes an array of inter dependent cultural, biological and herbicidal weed control practices is generally referred as Integrated Weed Management. It is important that IWM includes a variety of tools, including rotation of available herbicide groups, which ensures that weeds are exposed to different control mechanisms. The main goal of IWM is to reduce selection for resistance to any single insecticide and to delay or prevent the development of herbicide-resistant weeds. More over there is also problem of resurgence of weeds.

Principles of Integrated weed management:

- ✓ IWM place the crop in competitive advantage over the weeds by manipulating the crop habitat by utilizing some biological differences between crops and weeds.
- ✓ The goal of IWM interventions should be to reduce weeds' ability to survive in the soil.
- ✓ Each component of the weed control process should be beneficial to the environment and non-destructive.
- ✓ Weed management practices should be flexible to accommodate possible innovations and experiences of progressive farmers.

The different components of IWM are discussed below:

(A) Preventive methods

Preventive measures usually don not offer remedy over the already existing population of weeds in the crop fields but they focus on the prevention of further introduction and spread from different external sources. Preventive method of weed control include use of weed free crop seeds, weed free manure, clear equipments and elimination of weed infestation in and around irrigation channels and cultivated fields.

(1) Pure and clean crop seeds and seed certification

It is always advised to use pure and clean seeds of crops as possible. Clean crop seeds do not add seeds of the existing or new weeds species to soil seed bank. It acts as a check against increasing weed problems in the long run. Seed should be certified and purchased from some authentic sources.

(2) Use of well decomposed organic manures

Fresh or undecomposed FYM/compost is a source of weed seeds. Therefore, it should be well decomposed and well rotten and free from weed seeds.

(3) Clean farm machineries and farm animals

The farm machineries like tillage and harvest implements should be cleaned properly and the soil sticking/adhered to the implements must be removed before carried to another field. Farm animals should also be cleansed in a similar manner.

(4) Clean irrigation channels and irrigation systems

Irrigation water carries soil and weed seeds to a field crop. Therefore, irrigation channels should be kept clean and weed free. Weedy irrigation channels also cause chocking/plugging problem.

(5) Clean farm bunds, road sides, fences and non-crop fields

Weeds on farm bunds, roads and fences should be controlled occasionally always before they go for flowering to avoid weed perpetuation in the field.

(6) Transport of sand and soil

Sand and soil from an infested area should not be transported and used to a clean or cultivated area.

(7) Weed control in nurseries

In the nursery of vegetables and rice, appropriate weed control practices should be implemented. Before bringing the uprooted weeds to the main field, the seedlings should be eliminated during the uprooting process.

(8) Plant/weed quarantine law

All weed species in general and noxious plants in particular are prevented from spreading physically across areas, states, or nations by weed laws.

(B) Cultural methods: Cultural/ecological methods of weed control exploits the crop's competitive

behaviour. growing environment and crop management practices towards smothering of weeds.

(1) Crop species

Crop species differ in their germination pattern, tillering, branching, nature and orientation of inclination of leaf, root growth, plant height, total growing duration, etc. Therefore, variation in their competitive and weed smothering ability is quite apparent.

(2) Crop variety/cultivar

Crop variety/cultivar also very in their ability to compete with weeds on the same principles as crop plants.

(3) Sowing of crop (time, method, seed rate, spacing)

The environment in which crop germination and initial growth occur could be weed-free or less weedy if the initial flush of weed germination at one point in time is avoided by adjusting the time of crop sowing (a little sooner or later).

Line sowing usually encounters less weed infestation and provide more ease of controlling them than broadcasting method.

Greater initial seedling vigour of crop would result in healthy and competitive crop which itself would be able to smother weeds. Normally higher the density of a crop, lower is weed competition. For grain crops, the population must be maintained; however, for fodder and forage crops, the population may be raised. Generally closer row spacing reduces weed competition in crops. Therefore, suitable row spacing close enough which does not invite intra species competition among crop plants needs to be searched out.

(4) Crop rotation

Crop rotation modifies the environment and crops in each field on a regular basis. Crop rotation is seen as a "panacca" for managing weeds, diseases, and insect pests in crop field ecosystems in order to preserve soil health and long-term crop productivity. Crop rotation is effective in controlling of crop associated and crop bound weeds such as *Avena fatua* in wheat and *Cuscuta* in lucerne.

(5) Cropping practice

Crop variety according to situations and location offers an advantage over monoculture in terms of weed competition reduction. It is best to choose a compatible crop mixture (such as intercropping or mixed cropping) that lowers weed competition while also increasing overall production. Intercrops that suppress weeds include companion crops like smother crops, cover crops, and live mulches.

(a) Live mulch/cover crop

Live mulch is a living cover maintained by growing a cover crop. e.g. Live cover can be established between widely spaced rows of fruit and plantation crops. Intercrop having good weed smothering ability can be introduced in inter rows of an economic crop.

(b) Trap and catch-crops

Trap crops are false hosts which exude germination stimulants and induce weed seed germination, but after germination, weed may die for want of real host. This is called suicidal germination.

Catch crops are parasitic weed susceptible variety of crop, which is grown and ploughed into soil prior to the flowering of parasitic weeds and sowing of a crop of principal interest.

(6) Irrigation

Weed emergence and growth are influenced by irrigation time and technique; many weeds can be suppressed by submergence, drip irrigation minimizes weed development by wetting less soil area near the crops, and furrow irrigation suppresses weeds in arid environments.

(7) Fertilizer application

Fertilizers used in scientific alteration of the soil, crop, and weed environment will selectively stimulate crop development, which could act as a weed-smothering mechanism in and of itself.

Certain weed species may be selectively affected by the type of fertilizer used. While P and K are sprayed as a base coat, N must be treated in segments so that weeds cannot share much of it. Following manual weeding of the weed control measure, top dressing might be advised. To lessen weed competition, fertilizer should be applied to the

crop by hand, as a side dressing, or beneath the crop rows prior to planting. In general, weed development is inhibited by higher fertilizer rates, especially N.

(8) Stale seed bed

First irrigation is applied to the field and then ploughed on optimum moisture status and levelled. Crop sowing is withheld for about a fortnight to allow germination of weeds. Weeds are then controlled by shallow cultivation.

(9) Summer fallowing

One of the most efficient cultural techniques to slow the spread of perennial weeds in crop cultivation is the application of summer or off-season tillage. Farmers expose their fields to the sun in April, May, and June to combat weeds and other soil-born pests. Roots, rhizomes and tubers of shallow rooted perennials like Bermuda grass and nut sedge.

(C) Mechanical methods

This method includes such practices as hand weeding, hoeing, moving, flooding, mulching, burning and tilling the soil for the reduction of weeds

(1) Hand weeding & hoeing

The oldest technique for controlling weeds is hand weeding. It is labour-intensive, time-consuming, and frequently more expensive. Annual weeds are well controlled by it. Hand hoeing is an interculturing technique used after planting that loosens and stirs the soil. When used against annual weeds, it works well.

(2) Tillage

Tillage destroys weeds by removing them from the soil. Through damage from root and stem trimming, it may weaken plants, decreasing their ability to regenerate or compete: Tillage performed prior to planting helps in burying existing weeds.

(3) Moving and Slashing

The principle behind moving and cutting is suppression of weed seed formation and dispersion through concurrent control of weeds or wild vegetation mostly under non-crop scenario such as canal bunds, farm roads, parks and lawns.

(4) Flooding

Flooding creates anaerobic condition, which prevents weed seed germination and root respiration of already germinated seeds and kills plants by reducing oxygen supply for growth. It is followed in both cropped and non-cropped areas.

(5) Burning and flaming

Burning is primarily used in non-crop situations to control weeds without being selective. In addition to illnesses and insect pests, it also eliminates weed seeds. Flaming could be used in a non-selective or selective manner. Since the flame is pointed downward, crop damage can be prevented.

(6) Digging

Digging in small scale may be carried out to remove the underground vegetative structures from deeper layer of soil if found perennial weeds.

(7) Chaining and dredging

Dredging is the mechanical removal of aquatic weeds and their roots and rhizomes from the mud. When chaining, tractors are used to drag a large, heavy chain over the ditch's bottom to create ditch embankments.

(8) Mulching

The mulch provides a physical barrier on the soil surface and must block nearly all light reaching the surface so that the weeds which emerge beneath the mulch do not have sufficient light to survive. For instance, polythene sheets and organic materials such as sawdust, powdered nut shells, and rice husk. If polythene is put in continuous sheets, its efficiency increases (more polythene). Both annual and perennial weeds can be successfully eradicated with it.

(a) Live mulch e.g. cover crop, inter-crop, green manure

(b) Dead mulch

a) Organic: Residue, trash, sawdust, organic matter, *etc.*

b) Synthetic: Polythene film

c) Soil dust mulch

(9) Soil solarization

The core concept behind soil solarization is that sunlight's short-wave radiation can readily enter soil through a transparent, colourless polythene layer. Long wave radiation is released and the soil gets heated as a result. This prevents heat from building up or being trapped in translucent polythene sheeting. Weeds, worms, and soil pathogens would all perish

from the ensuing temperature rise. The temperature of the surface soil may rise to 55–60°C during the hot summer months as a result of solarization.

(D) Biological methods

Table 1: Different bio-agents used for weed control

Weed	Bio-agent	Reporting Country	Kind of bio agent
Chondrilla juncea	*Puccina chondrillina*	Australia	Plant pathogen
Eupatorium riparium	*Entyloma compositarum*	USA	Plant pathogen
Hydrilla verticillata	*Hydrellia pakistanae*	USA	Shoot fly
Orobanche cornea	*Sclerotinia sp.*	USA	Plant pathogen
Parthenium hysterophorus	*Zygogramma bicolorata*	India	Leaf eating beetle

Table 2: Some Commercial Mycoherbicides used in weed control

Product	Content	Weed controlled
De-Vine	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.*	Johnson grass (*Sorghum halepense*)
Biolophos	A microbial toxin produced as fermentation product of *Streptomyces hygroscopicus.*	Non-specific, general vegetation.

This method involves utilization of natural enemies for the control of certain weeds. This can be achieved by direct or indirect action of biological control agents. In direct action, firstly the bio control agent bores into plant, weakens its structure which leading to its collapse and consumes as food and destroys the vital plant parts. In indirect action the bio control agent reserves the competitive ability of weed over other plants and enhances the condition favourable for plant pathogens.

(E) Chemical methods

Common salt, ash etc. have been used for centuries to control weeds on roadsides, fence rows & pathways. A great breakthrough in selective weed control was accomplished in 1945, with the development of 2,4-D & MCPA in USA & England independently by P.W. Zimmerman and A. E. Hitchkock. It was discovered that MCPA and 2,4-D are both extremely selective for cereals and phytotoxic to weeds with broad leaves. Over 45% of all pesticides used in agriculturally developed nations are herbicides. Herbicide usage makes to only 8% of all pesticide use in India.

(F) Allelopathy as a Weed Management

Inter-weed-competition determined by allelopathy can be manipulated in the natural control of weeds. Natural compounds released by some platns inhibit or prevent the grouth of nearby plants. Merigold flowering plant is found to suppress the growth of parthenium. Thistle exudation inhibits the growth of oats. Wheat, oats & peas suppress the growth of *Chenopodium album.*

Conclusion

The aim of weed management is to find best effective methods or techniques that can be used to make cropping systems prohibitive to the emergence and establishment of weeds. Integrated weed management is a science-based decision-making approach that includes multiple weed control methods rather than relying on a single method to reduce weed populations below an economic threshold. Therefore, the best approach is to integrate the cropping system and weed control blueprint into a sustainable comprehensive system that is economically and environmentally viable.

References

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