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Integrated Weed Management

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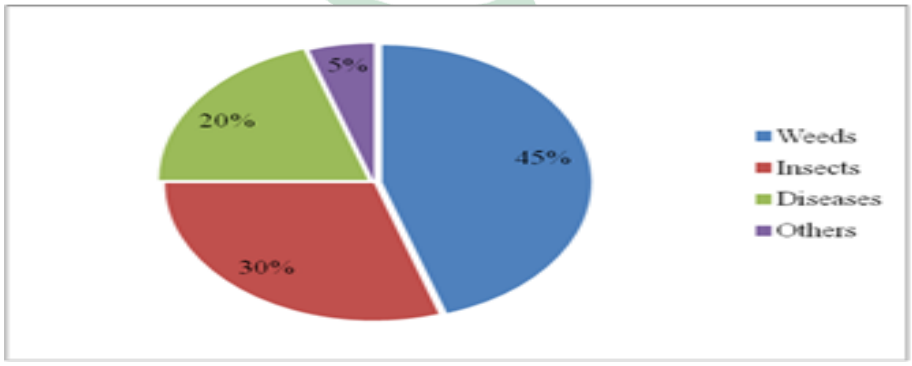
ARTICLE ID: 014

Introduction-

The agricultural growth rate has been slowed down in India and increased agricultural productivity is needed to meet the increasing needs of the growing population. In nearly all crops, low and static yield per unit area has become a typical aspect of Indian agriculture. In this backdrop, the required increase in food production can be realized only through vertical increases in productivity, as the possibilities of horizontal increase i.e., expansion of area are minimal. The vertical increase has got tremendous scope which can be achieved with better genotypes and providing farmer-friendly input technology. One such technology which has a potential to yield substantial increase in the production of food grains is proper weed management as weeds alone are known to account for nearly one third of the losses caused by various biotic stresses.

Economic losses due to weeds-

According to a recent study, weeds are responsible for nearly one-third of all oilseeds, half of all food grains, and an equal amount of pulses produced today. In India's arable agriculture alone, weed management costs almost Rs. 100 billion per year, according to conservative estimates. Depending on the crop, the degree of weed infestation, the plant species, and management measures, weeds can cause yield losses of up to 65 percent. As a result, weed control will continue to play an important part in meeting India's growing food and fibre demands.



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Yield loss due to weeds in some important crops

Crop	Yield loss range (%)	Crop	Yield loss range (%)
Rice	9.1 – 51.4	Sugarcane	14.1 – 71.7
Wheat	6.3 – 34.8	Linseed	30.9 – 39.1
Maize	29.5 – 74.0	Cotton	20.7 – 61.0
Millets	6.2 – 81.9	Carrot	70.2 – 78.0
Groundnut	29.7 – 32.9	Peas	25.3 – 35.5

Herbicide resistance in weeds-

Although herbicides have played an important role in increasing crop yields and overall production efficiency, overuse and repetitive application of herbicides from the same class can lead to herbicide-resistant weed biotypes. Though herbicides are not used as widely in India as they are in industrialised nations, the continued use of butachlor and isoproturon can lead to resistance in *Echinochloa colona* and *Phalaris minor*, respectively, posing a severe danger to the country's rice-wheat system's viability.

Weed flora shift –

The component of weed flora has varied due to changes in input availability and crop sequence. Reduced cultivation costs and better control of problem weeds like Phalaris minor in the rice-wheat system will result from the implementation of resource saving technologies such as zero tillage and bed planting. In addition, it may cause a shift in weed flora in favour of perennial weeds, as well as an increase in herbicide use. As a result, effective weed management strategies must be implemented**.**

Preventive strategies-

Preventive strategies normally do not target the present population and diversity of weeds in crop fields, but rather focus on preventing further introduction of weeds from various external sources/agents, as well as weed perpetuation in future years from existing weed stands in crop fields.

1. **Pure and clean crop seeds and seed certification** -Before sowing, thoroughly sieve the seeds to remove weed seeds, broken, shrivelled grains, and sick seeds. Make a thorough inspection of the seeds to ensure that no weed seeds are present. If it is

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impossible to separate the weed seeds from the crop seeds due to their comparable size, reject the lot for seed purposes and use certified crop seed instead.

2. **Well-decomposed FYM, compost, sewage and sludge-** Use well-decomposed FYM and keep the composting temperature between 65 and 90^0F 4-5 months. Chemicals such as acrocyanamide, SMDC (metham), DMTT (mylone), and ammonium thiocyanate can be used to treat FYM (synthetic urea). Before being applied to agriculture fields, sewage and sludge must be adequately cleaned to remove weed seeds.
3. **Prevent movement of weeds through machinery etc. -** Before moving harvesters, seed cleaners, hay balers, and other farm instruments out of the contaminated region, clean them. Use gravel, sand, and dirt from weed-infested areas sparingly. Weed seeds, tubers, and rhizomes of perennial weeds are checked in nursery stock. Allow no live stock to be moved from weed-infested areas to clean areas.
4. **Keep non crop area clean -** Keep weeds out of irrigation and drainage channels, fence lines, road sides, fence corners, and other non-cropped areas. Prevent mature seeds from spreading to the main land.
5. **Use vigilance-** A farmer should inspect his farm on a regular basis for unusual new weeds. As a result, when a new weed species is discovered, it should be prevented from establishing. So that it doesn't add to the weed flora already present.
6. **Follow legal & quarantine measures-** Quarantine should be strictly enforced. To control the interstate and international transportation of noxious weeds, legal measures are required.
7. **Physical (Mechanical & Manual) Methods**
   - ✓ **Hand hoeing and weeding-** Removal of weeds either manually or by using tools like khurpi or sickle, when weeds grown up to some extent and the method is effective against annuals and biennials and controls only upper portion of the perennial. *Convolvulus arvensis* which has shallow root system can be controlled.
   - ✓ **Digging-** 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. They can be eliminated by digging with crowbar or Pick axe etc.

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- ✓ **Mowing and cutting-** Mowing is cutting of uniform growth from the entire area up to the ground level. Cutting is the topping/cutting of the weeds little above ground level. It is done with help of axes and saws. It is mostly practiced against brushes and trees.
- ✓ **Dredging and Chaining-** Mechanical pulling of aquatic weeds along with their roots & rhizomes from the mud is known as dredging. In case of chaining, a very big & heavy chain is pulled over the bottom of a ditch with tractors along with embankments of ditch.
- ✓ **Burning and Flaming-** It is cheapest method to eliminate the mature unwanted vegetation in non-cropped areas and range lands. Flaming is used in western countries for selective weed control in crops like cotton, onion, soybean and fruit orchards. It is the momentary exposure of green weeds to as high as 1000^{o}C from flame throwers to control in row weeds.
- ✓ **Soil Solarization-** It is effective against weeds which are produced from seeds. Covering the soil with transparent, very thin plastic sheets of 20-25 mm polyethylene (PE) film during hottest part of summer months for 2-4 weeks. This increases the temperature by 10-12 ^{0}C over the un-filmed control fields.
- ✓ **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: Pre plant tillage helps in burying the existing weeds.
- ✓ **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. E.g.- Polythene sheets, natural materials like paddy husk, ground nut shells, saw dust etc. The efficiency of polythene sheet is more (more polythene) if it is applied in continuous sheet. It is effective against annual weeds and perennial weeds.
- ✓ **Flooding-** Flood kills weeds by excluding oxygen from their environment. Flooding is a worldwide crop husbandry method of controlling weeds in rice fields.

8. **Cultural Methods**

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- ✓ **Proper crop stand and early seedling vigour-** Lack of adequate plant population is prone to heavy weed infestation, which becomes, difficult to control later. Therefore, practices like a). Selection of most adopted crops and crop varieties b). Use of high viable seeds c). Pre plant seed and soil treatment with pesticides, dormancy breaking chemicals and germination boosters d). Adequate seed rates are very important to obtain proper and uniform crop stand capable of offering competition to the weeds.
- ✓ **Selective crop simulation-** Vigorous crop plants compete better with weeds as they close the ground very quickly. Selective simulation can be achieved by a) application of soil amendments like gypsum or lime may correct the soil conditions in favour of crop. b) manures and fertilizers application of proper kind in adequate quantities improve the crop growth. c) Inoculation of crop seeds with suitable nitrogen fixing and phosphorous solubilising organisms may help in selective simulation of some crops e.g. Legume crop and non legume weed. Selective simulation in wide row crops like maize, sugarcane, cotton can be achieved by foliar application of nutrients.
- ✓ **Proper planting method-** Any planting method that leaves the soil surface rough and dry will discourage early growth. In summer, furrow planting of crops reduces the weed problems. Because in this method irrigation water restricted initially to the furrow only. In transplanted crops farmers get opportunity to prepare weed free main field.
- ✓ **Planting time-** Peak period of germination of seasonal weeds coincides with crop plants. So little earlier or later than normal time of sowing is beneficial by reducing early crop weed competition. For example, using photo insensitive varieties we can make adjustments with regarding to time of planting.
- ✓ **Crop rotation-** Growing of different crops in recurrent succession on the same land is called as crop rotation. Monocropping favours persistence and association of some weeds. Crop rotation is effective in controlling of crop associated and crop bound weeds such as *Avena fatua* in wheat and *Cuscuta* in lucerne. The *Orobanchae sp.* In mustard can be controlled by crop rotation.

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- ✓ **Stale Seedbed-** This is achieved by soaking a well-prepared field with either irrigation or rain and allowing the weeds to germinate. These weeds are controlled by using contact herbicides like paraquat and by mechanical methods then sow the crop.
- ✓ **Smother crop / Competitive crop-** This crop germinates very quickly and develop large canopy, capable of efficient photosynthesis within short period. They possess both surface and deep roots. Competitive crop covers the ground quickly than non competitive crop. e.g., Cowpea, Lucerne, berseem, millets.
- ✓ **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 main crop.
- ✓ **Minimum tillage-** Deep and frequent tillage may be useful for some reasons but it serves to bring more of dominant weed seeds and rhizomes to the soil surface. Zero tillage completely avoids burying of weed seeds and reduces persistence of annual weeds but it induces vigorous growth of perennial weeds.
- ✓ **Summer fallowing-** 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. In the month of April, May and June farmers expose their lands to sun in order to control many soil born pests, including weeds. Roots, rhizomes and tubers of shallow rooted perennials like Bermuda grass and nut sedge.

9. **Chemical method -** Common salt, ash etc. have been used for centuries to control weeds on roadsides, fence rows & pathways. A real breakthrough in selective weed control was achieved In 1945, with the discovery of 2,4-D & MCPA in USA & England independently by P.W. Zimmerman and A. E. Hitchkock. Both 2,4-D and MCPA were found highly selective for cereals and phytotoxic to broad leaved weeds. In Agriculturally developed countries, herbicides form over 45% of the total pesticides used. In India, share of herbicides is only 8% of the total pesticides consumed.
10. **Allelopathy as a Weed Management-** Allelopathy is a natural process that can be used in crop production as a tool for biological weed management. Allelochemicals

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could be utilised to develop new methods to tackle weed resistance to herbicides. White mustard seed germination was entirely suppressed by sunflower extracts (*Sinapis alba* L.). *Phalaris minor* Retz., *Chenopodium album* L., *Coronopis didymus* L., *Medicago polymorpha* L., and *Rumex dentatus* L. were all inhibited by an annuionone derived from aqueous extract of sunflower (cv. Suncross-42 leaves).

11. **Biological Methods-** Insects, herbivorous fish, other animals, disease organisms, and competitive plants are all used to inhibit their growth. Weeds cannot be eradicated using biological management methods, although the number of weeds can be controlled. This strategy does not work for all sorts of weeds. The best targets for biological control are introduced weeds. Two significant examples of early period biological weed control are the control of *Opuntia spp.* (prickly pear) in Australia and lantana in Hawaii with particular insect bioagents.

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	i)*Zygogramma bicolorata* ii)*Epiblema strenuana* iii) Conotrachelus sp.	India Australia Australia	Leaf eating beetle Stem galling insect Stem galling insect
Rumex spp.	i) *Uromyces rumicis* ii)*Gastrophysa viridula*	USA USA	Plant pathogen Beetle
Tribulus terrestris	*Microlarinus lareynii and M. lypriformis*	USA	Pod weevil

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Cirsium arvense	*Septoria cirsii*		Plant pathogen
Cyperus rotundus	*Bactra verutana*	India, Pakistan, USA	Shoot boring moth
Echinochloa spp. (In rice fields)	i)*Emmalocera sp.* ii) *Tripos spp*	.	i)Stem boring moth ii) Shrimp

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.
Luboa-2	Colletotrichum gloesporiodes Spp. Cuscuta	Cuscuta

Conclusion

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. This strategy is more effective since any weeds that are left over from one method can be controlled with another. As a result, this technique aids in the reduction of seed bank status in the field. Many difficulties, such as shifts in weed flora and the development of resistance in weed plants, can be prevented by using this strategy. The requirement of the day is for an integrated weed control strategy, and this

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method must be promoted in order to achieve long-term respite from these unwelcome plants. Integrated weed management approach is environmentally friendly as farmers are not entirely dependent on herbicides.