PRINCIPLES OF WEED CONTROL

SS RANA
SR SCIENTIST
Weed?

- Weeds are recognized worldwide as an important type of undesirable economic pest.
- A plant growing out of place, that is a plant growing where it is not wanted, is common, accepted explanation of what a weed is.
- The definition given by WSSA appears to describe weeds more sufficiently, which states weed as a any plant that is objectionable or interferes with the activities or welfare of a man.
- Weeds are a concern of everyone and not just agriculturists.
- Weeds are a nuisance in crop production, forestry, aquatic ecosystem, public amenity areas, industrial establishments, grasslands etc.
Weeds know no boundaries.

Property lines, fences, and waterways do not stop them.

Wind, water, wild animals, birds, livestock, vehicles, and people can all contribute to the spread of noxious weeds.

Sometimes an innocent act can be the prime opportunity for these invaders to establish a new population.
Problematic Weeds

- 30,000 species of weeds have been listed in the world
- 18,000 species cause losses to agricultural production
- *Cyperus rotundus*, *Cynodon dactylon*, *Echinochloa crusgalli*, *Echinochloa colona*, *Eleusine indica*, *Sorghum halepense*, *Imperata cylinderica*, *Eichhornia crassipes*, *Portulaca oleracea*, *Chenopodium album*, *Digitaria sanguinalis*, *Convolvulus arvensis*, *Avena fatua*, *Amaranthus hybridus*, *Amaranthus spinosus*, *Cyperus esculentus*, *Paspalum conjugatum*, *Rottboelia exaltata* are the 18 world’s worst weeds.
- All of these weeds are found in India.
Types of weeds in crops

- **Grasses**
  - Cylindrical and hollow stem having nodes and internodes, family Gramineae, monocots

- **Sedges**
  - Triangular stem, no nodes and three leaves at the top, Cyperaceae family

- **Broadleaf weeds**
  - Broad leaves alternately arranged on stem, dicots
## Critical Period of CWC IN KHARIF VEGETABLES

<table>
<thead>
<tr>
<th>Crop</th>
<th>DAS</th>
<th>Crop</th>
<th>DAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato</td>
<td>20-40</td>
<td>French bean</td>
<td>20-30</td>
</tr>
<tr>
<td>Capsicum</td>
<td>20-40</td>
<td>Cucumber</td>
<td>30-45</td>
</tr>
<tr>
<td>Chillies</td>
<td>20-40</td>
<td>Bitter gourd</td>
<td>30-45</td>
</tr>
<tr>
<td>Brinjal</td>
<td>20-40</td>
<td>Colocasia/ginger/termeric</td>
<td>30-80</td>
</tr>
<tr>
<td>Okra</td>
<td>20-30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Critical Period of CWC IN RABI VEGETABLES

<table>
<thead>
<tr>
<th>Crop</th>
<th>DAS</th>
<th>Crop</th>
<th>DAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato</td>
<td>30-45</td>
<td>Carrot</td>
<td>20-60</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>30-45</td>
<td>Onion</td>
<td>30-75</td>
</tr>
<tr>
<td>Peas</td>
<td>30-45</td>
<td>Garlic</td>
<td>30-75</td>
</tr>
<tr>
<td>Cabbage</td>
<td>30-45</td>
<td>Beans</td>
<td>20-30</td>
</tr>
</tbody>
</table>
## Crop weed competition – root & leafy veg

<table>
<thead>
<tr>
<th>Roots</th>
<th>leafy</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Carrot- 20 to 60 DAS</td>
<td>• Celery 25-30 DAS</td>
</tr>
<tr>
<td>(Seedling stage)</td>
<td>• Amaranth 15-20 and 30-40 DAS</td>
</tr>
<tr>
<td>• Sweet potato 3-4 weeks</td>
<td>• Beet leaf 2-4 weeks or 20-30 DAS</td>
</tr>
<tr>
<td>after sowing</td>
<td>• Fenugreek 30 DAS</td>
</tr>
<tr>
<td>• Radish 25-30 DAS</td>
<td>• Parsley 50-90 DAS</td>
</tr>
<tr>
<td>• Turnip 30-45 DAS</td>
<td></td>
</tr>
</tbody>
</table>

IWM: Vegetables and field crops
## Critical Period of CWC in field crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>DAS</th>
<th>Crop</th>
<th>DAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>20-30</td>
<td>RICE (DR)</td>
<td>10-20</td>
</tr>
<tr>
<td>Rice(SP)</td>
<td>30-35</td>
<td>Chickpea</td>
<td>30-60</td>
</tr>
<tr>
<td>Rice(T)</td>
<td>30-35</td>
<td>Pigeon pea</td>
<td>15-60</td>
</tr>
<tr>
<td>Soybean</td>
<td>15-40</td>
<td>Green gram</td>
<td>15-30</td>
</tr>
<tr>
<td>Sesamum</td>
<td>15-40</td>
<td>Black gram</td>
<td>15-30</td>
</tr>
</tbody>
</table>
Crop losses due to agricultural pests

- Weeds: 37%
- Diseases: 22%
- Insects: 22%
- Others: 12%

Varshney and Raghuvanshi, 2010
Other losses

- Crop pests and diseases incidence
- Poor quality of agricultural produces like Food grains, Fodder, Milk and Wool etc.
- Human/Animal health problems
- Problems of water contamination
- Reduction in land value
- Though, weeds have many beneficial effects also
### %Yield loss due to weeds

<table>
<thead>
<tr>
<th>Crop</th>
<th>%</th>
<th>Crop</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>50-60</td>
<td>RICE (DR)</td>
<td>95</td>
</tr>
<tr>
<td>Rice (SP)</td>
<td>50-60</td>
<td>Rice (T)</td>
<td>40</td>
</tr>
<tr>
<td>Chickpea</td>
<td>30-60</td>
<td>Pigeon pea</td>
<td>30-50</td>
</tr>
<tr>
<td>Black gram</td>
<td>30-50</td>
<td>Green gram</td>
<td>30-50</td>
</tr>
<tr>
<td>Sesamum</td>
<td>40-60</td>
<td>Soybean</td>
<td>40-60</td>
</tr>
</tbody>
</table>
### Percent yield loss due to weeds

<table>
<thead>
<tr>
<th>Crop</th>
<th>%</th>
<th>Crop</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato</td>
<td>80-100</td>
<td>French bean</td>
<td>40-50</td>
</tr>
<tr>
<td>Capsicum</td>
<td>60-70</td>
<td>Cucumber</td>
<td>-</td>
</tr>
<tr>
<td>Chillies</td>
<td>60-70</td>
<td>Bitter gourd</td>
<td>-</td>
</tr>
<tr>
<td>Brinjal</td>
<td>80-100</td>
<td>Colocasia/ginger/termeric</td>
<td>50-80</td>
</tr>
<tr>
<td>Okra</td>
<td>40-60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IWM: Vegetables and field crops
## Percent yield loss due to weeds

<table>
<thead>
<tr>
<th>Crop</th>
<th>%</th>
<th>Crop</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato</td>
<td>60-82</td>
<td>Carrot</td>
<td>70-80</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>61</td>
<td>Onion</td>
<td>40-60</td>
</tr>
<tr>
<td>Peas</td>
<td>25-35</td>
<td>Garlic</td>
<td>40-70</td>
</tr>
<tr>
<td>Cabbage</td>
<td>61</td>
<td>Beans</td>
<td>40-50</td>
</tr>
</tbody>
</table>

IWM: Vegetables and field crops
Weed control

- Weed control is the process of limiting weed infestations so the crops could be grown profitably and other activities of man conducted efficiently.
Aim

- Manage the vegetation on land and water bodies in such a way as will encourage the growth of plants beneficial to humans and will suppress the remaining unwanted plants
- Indiscriminate application of control measures against plants is not the objective of weed control
Control v/s eradication

- Weed eradication is the complete removal of all live plant parts and seeds from an area.
- It is an expansive adventure since it costs more than that of the land.
- Besides complete elimination of all vegetation is not warranted as many of them are useful.
- Eradication of some noxious weeds such as Cuscuta and Lantana needed.
- Eradication should start when the weeds are small and limited in growth and spread.
Weed control v/s weed management

- Concept of weed management instead of control is important
- Weed control aims at putting down the weeds already present
- Weed management is a system approach whereby whole land use planning is done in advance to minimize the invasion of weeds in aggressive forms and give crop plants a very strong competitive advantage over the latter
- The systems approach is called integrated weed management (IWM)
Forces behind adoption of IWM

- Build up of previously minor species (perennials) into dominant levels because of repeated use of the same methods to control existing dominant species (annuals)
- Increasing concern over pesticide effects on human health and the environment and
- Development of resistant weeds
IWM-definition

- Management system of weed populations aiming to keep infestation levels below those causing economic injury by combining any two or more of preventive, cultural, chemical or biological methods.

- The definition implies that IWM is largely a decision making process involving 1) when to apply control measures with use of critical thresholds and 2) what combination will provide best control at greatest profits.
Long-term objective of IWM

- To avoid or reduce any adverse environmental impact of control methods and
- Prevent build up of any one weed species
Pre-requisite of a successful weed management programme

- One must gain knowledge of the biology of weeds under attack before choosing a system for their control
- The nature of weed problems must be surveyed in the target area
- Weed control measures must be planned for the whole farm and not just against weeds in a field
- Weed control system must follow up programme of weed prevention measures
Weed prevention

- Weed prevention comprises all measures which deny the entry and establishment of weeds in an area.
- All practices that help discourage the weeds from becoming a problem over time form the subject of weed prevention.
- Any physical or chemical method adopted with the main objective of not allowing the weeds to set viable seeds is to be considered as a part of weed prevention.
- Weed prevention reduces the farmers' efforts in controlling weeds later by physical, chemical or other methods.
- Weed prevention is essential against noxious weeds which once allowed to establish, become extremely difficult to control.
Important aspects of weed prevention

- Use of weed free crop seeds
- Avoid contamination of manure pits
- Keep non-cropped areas clean
- Prevent movement of weeds along with other farm resources
- Legal measures
Many weeds propagate by seed. Annuals are prolific seed producers (a few to one lakh/plant). Perennials produce less seeds.

Dormancy under unfavourable conditions and remain viable in soil for years. Weed seed bank ensure their progeny year after year. Under stress conditions they terminate their vegetative growth and ensure production of at least a few seeds before withering away.

Perennials propagate by rhizomes, root stocks, suckers, offsets, tubers, bulbs, bulbils.

Encroachment of new areas by wind dispersal.

Dispersal is also by farm produce, silage, dung and FYM with wind water, birds and man.
Vegetative propagules are disbursed by improper tillage. Man also spread certain weeds unknowingly eg. Water hyacinth and lantana.

Weeds are hardy and persistence.

Weeds differ in soil and climatic requirements; every soil is a seed bank.

Most of the weed seeds are distributed in 30 cm soil. Of these, only the ones present in the top 3-5 cm soil germinate at a time, while the deeper ones continue to be in a state of dormancy waiting for their turn to get into the top soil layer.

Weed seeds may germinate even after 100 years (extended longevity).
Propagation and dispersal of weeds contd.

- $C_4$ physiology of weeds help them confer advantages under field conditions (withstand high light intensity and high temperature; free of photorespiration)
- Classified: annual, biennial or perennial; woody or herbaceous; grasses, sedges or broadleaf (control measures are different)
- Climate, soil moisture, soil type and agronomic factors influence the growth of weeds (control strategies should be taken into consideration)
Crop-weed interference

- Weeds are better competitors with crops for light, nutrients, moisture and space (process of the survival of the fittest under vagaries of nature)
- Factors affecting weed-crop interference are
  - period of crop-weed competition (early stage is more critical)
  - effect of weed and crop densities
  - weed and crop species effects
  - cropping practices effects and
  - climate influences
Crop-weed interference—important aspects

- Increasing weed density reduces crop yield (sigmoidal relationship)
- Crop density also affects crop-weed competition. Increasing crop seed density in a community decreases weed growth (seeding vigour, canopy development, allelopathic effects, rooting depth and root volume etc).
- There are differences in both weeds and crops with regard to their competitive abilities.
- Some crop varieties also have allelopathic effects
- Cropping practices such as time and method of seeding, fertilizer application, irrigation etc have got influence on weed-crop interference.
- Adverse weather conditions like drought, incessant rainfall and extremes of rainfall put crops under stress without disturbing weeds.
Methods of weed control

- Good crop husbandry- ecological methods. Give advantage to the crop plants rather than weeds.
- Physical methods-conserves soil moisture and enhances aeration in heavy soils.
- Biological methods- environmental friendly, slow and climate dependent
- Chemical methods – not the substitutes but act as added production tools in agriculture. Should be economical and safe to man, animals and to rotation crops, free of interaction with herbicides applied to soil during the previous season and resistance to changes in weather
Good crop husbandry methods

- Proper crop stand
- Selective crop stimulation
- Proper sowing method
- Proper sowing time
- Crop rotation
- Stale seed bed
- Smother cropping
- Summer fallowing
- Minimum tillage
- Flooding and drainage
Physical methods

- Deep tillage - effective in controlling shallow rooted perennial weeds
- Soil solarization
- Mowing and cutting
Biological

- Insects, pathogens and fish
- Bio-herbicides - fungal preparations called myco-herbicides are used. They control only the weeds existing
- Noxious weeds like water hyacinth, alligator weed, Salvinia are controlled by classical approach
Herbicides

- Narrow spectrum and broad spectrum
- Soil acting and foliage acting
- Contact and translocated
- Residual or non-residual
- Soil sterilants and fumigants

Their use depends upon the type of weed flora and the requirements of weed control.
Herbicides – narrow and broad spectrum

- Narrow spectrum herbicides are to be used when the target weed is a big problem in a crop. Phalaris minor and Avena fatua are controlled by metoxuron and diclofop.

- Broad spectrum herbicides are used when there is a mixed weed flora.
Soil active herbicides are applied to make the fields weed free for initial 4-8 weeks. These herbicides inhibit germination of seeds, rhizomes, stolons and tubers e.g. alachlor, butachlor.

A foliage acting herbicide is applied to the weeds after their germination e.g. Paraquat, diquat, amitrole, MCPB. These are absorbed by foliage and are translocated to the other plant parts.
Contact and translocated herbicides

- Contact herbicides kill the plants by contact. Hence complete wetting of weeds is needed e.g. paraquat, propanil and diquat.
- Translocated herbicides kill plants when a portion is wetted. Hence, when perennial weeds are problems they are to be used e.g. glyphosate. Some herbicides like atrazine exhibit both contact and translocation action.
Soil sterilants

- Temporary soil sterilants (soil fumigants) are active up to 16 weeks. These are used for treatment of seedbeds and pot soil e.g. MB, metham and diazanet.
- Permanent soil sterilants are used in bacground in industrial and other non-crop areas e.g. Sodium chlorate, substituted ureas, symmetrical triazines, arsenicals and borates.
Pre and post emergent herbicides

- Pre-emergence herbicides are applied before the emergence of weeds. For effective working of these herbicides fine trash free soil tilth is the prerequisite. The soil should be adequately moist to induce weed seed germination and move the herbicide 1-1.5 cm deep into the soil in a uniform film. The land should be levelled and without any undulation.

- Post-emergence herbicides are to be applied after emergence of weed seedlings. They work effectively when there is uniform germination of weed seedlings in the soil. These herbicides are mostly non-residual e.g. paraquat and diquat.
Selectivity

- Herbicide selectivity is due to morphological features of plants such as waxy and narrow leaves which tend to repel aqueous spray liquids, depth protection in case of pre-emergence herbicides, innate physiological tolerance of plants to herbicides, rapid rate of metabolism and conjugation with the plants etc.
Granular formulations of herbicides are beneficial and preferred in crop like transplanted rice. They are safe to the crop because of their freedom from drift hazards and are non-selective to the standing crop than sprays since the granules bounce off the foliage. But granular herbicides require more moisture than spray liquids for activation. Only soil acting herbicides are used as granular formulations.
Rotational use

- Repeated use of the same herbicide in the same field is beset with problems of development of resistant weed species and races. The use of two or more herbicides in the form of either a rotation or a combination can obviate such chemoshifts in weed flora to a great extent.
Thanks