

Chapter 3

General Methods of Weed Control

Weed control is essential to efficient and profitable agriculture; “good” farmers may lose 10-25% crop yield due to weeds and “poorer” farmers may lose 25-50% crop yield due to weeds

1. Approaches to weed management

- prevention - often most practical approach, not allowing a given weed species to infest an area

preventing the introduction, establishment, or spread of weed species in areas not currently infested

- control - management of weeds to minimize weed competition and provide greatest economic return from a crop; limiting seed infestations; living with what you have
- eradication - the complete removal of all live plants, plant parts, and seeds from an area; effective on a small scale but less effective on large areas; problem is seed in soil

2. Integrated programs

- IPM, IWM - popular terminology; integrated pest management/integrated weed management

use of two or more techniques to control a weed in a crop, e.g. prevention/control, etc.

3. Methods of weed control

- prevention

weed free crop seed - use certified crop seed; blue tag certified seed guaranteed to be 99% weed free but not 100%; some weed of certain species can be present in certified seed

Noxious weed seed are not allowed at all by federal law

A noxious weed is defined as any living stage of any plant of foreign origin that can injure directly or indirectly any agricultural or natural resource in the U.S.

Noxious Weed Act provides funds to prevent the introduction and spread of noxious weeds in the U.S.; popular terminology used today is “invasive weeds”
eliminate weeds from ditchbanks, etc. - also in other areas surrounding the cropland; avoid seed production and movement to crop area

irrigation water - control weed seed content of irrigation water; particularly a problem when irrigating from bayous, canals, etc.; seed dispersal in water

spot treat - best for minor weed infestation in the crop; easier to spot treat to prevent spread over larger area

avoid seed set - kill or remove plants prior to seed production at all costs

clean farm equipment - keep equipment clean of weed seed

hay - make sure hay and manure are free of variable seed; dairy operations with manure spreaders promote seed movement

custom harvesters - inspect custom harvesters and make sure they are weed free or that the person responsible will sign a contract making him liable for any infestation of new weeds on a farm (policy in Midwest)

prepare land lease contracts - makes the leaser liable for infesting the land with weeds

- cultural weed control - use of crop management practices to favor control of weeds

row spacing - rows originally wide to provide for cultivation (1730: horse-hoeing); advent of herbicides allowed for closer rows.

In general, under strong weed competition, close rows yield better than wide rows. However, an intermediate row, which allows for cultivation is usually the most consistent treatment.

Cold steel (cultivation with a implement) is inexpensive and consistent; also enhances aeration, water penetration

seeding rate - higher seeding rates usually enhance competitiveness of the crop. Must be sure that seedling rate and row spacing is not so high that yields under weed-free conditions are reduced.

Why? High population promotes intraspecific competition leading to smaller stalk diameter – more lodging, more disease potential

crop rotations - monoculture farming can cause a shift in weed population toward certain weeds, e.g. grass crops would have more grass weed problems and broadleaf crops more broadleaf weed problems

crop rotation would contribute to more effective long term weed control, i.e. johnsongrass easier to control in soybeans than in corn and broadleaf weeds easier to control in corn than in soybeans and cotton.

crop variety - a variety that grows more rapidly and is taller with a wider canopy architecture would be more competitive with weeds

an earlier maturity date may avoid problems with certain weeds and help to reduce seed production potential

soil pH/fertility - good soil pH usually results in improved herbicide performance; atrazine and simazine more efficient in pH greater than 6.2.

Some weeds tolerate acid soils; others alkaline. e.g. broomsedge

increased fertility improves competitiveness of the crop; crop yields are improved with fertilization even under weed conditions

planting date - use of varieties that can be planted early and that mature early will allow the crop to be harvested before weeds set seed

- mechanical weed control

hand pulling - good for annual weeds, but not as effective for perennial weeds – leaves underground plant parts undisturbed. Good for gardens and small areas.

hoeing - best method of weed control but expensive and labor intensive and hard to find “hoe hands” (people willing to do this); hand hoeing banned in California in 2004

mowing - effective on tall-growing plants with elevated growing points; prevents seed production; starves underground parts.

plants use carbohydrate reserves for regrowth after each mowing so mowing when root reserves are low is best (between full leaf development and flowering)

mowing will not control low growing weeds since you never remove enough of vegetation to stress plant or weeds that produce seed near the ground (turfgrass implications); most effective in pastures, roadsides, lawns, etc.

water management (flooding) - some plants are tolerant of anaerobic conditions (aquatic plants), but many are not

for success, roots and shoots of weeds must be covered for a long period so as to deprive weeds of air; management tool for red rice

smothering - use of nonliving material - mulch to exclude light from weeds; materials used include hay, woodchips, rocks, sawdust, pine needles, etc.

plastic mulch used in horticultural crops (tomatoes, bell peppers, etc.)

fire - pyric weed control

- a. flame cultivator in cotton - direct flame underneath the cotton row. The bark on the cotton plant protects the plant. You are burning the cambium layer thereby stopping movement of nutrients, water, carbohydrates.

Was a very popular technique to use in the '60's, fell out of favor due to the increased cost of propane.

Being used today. New flame cultivators have water cooled hoods around the flame.

- b. prescribed burning - controlled burning used in forestry situations. You want a slow burning, cool fire. You set a fire against the wind, which is cooler burning due to using less oxygen.

Excellent for destroying "under story" in forestry situations

Problems in Yellowstone National Forest – 1 million acres lost in 1988; in Northwest in 2000 (Montana, etc.)

tillage - principle method of weed control in agronomic crops.

Current cost to operate a tractor with implement across a field, \$7-8/A; effective in disturbing soil, killing young weeds, etc.

For tillage practices to be effective you have to do it often

Works best under dry conditions which prevent perennial weeds from reestablishing.

In the process you also deplete soil moisture which can be detrimental in sugarcane since cane establishment can be hindered

The trend is toward less tillage since herbicide costs are in many cases equal to or less than the cost of a tillage operation.

- biological weed control - control of a weed population by their natural enemies; maintain a weed population below the level of economic injury
USDA research unit in Stoneville, MS has sole responsibility for research in biological weed control agents.

The program has not been very successful from a practical standpoint, but this area of research has a high priority status for funding by USDA

control agents (biological) - insects, pathogens, fish, mammals, and birds

disadvantages

- a. complete control is difficult
- b. agent introduced must be specific to the host weed and not attack desirable species
- c. target pest must be a pest in general, some weeds in crops are ornamentals in cities; also the target could be aesthetically appealing such as wild flowers
- d. agent must be adaptable to the environment of the host
- e. one species is controlled often releasing others (herbicides are broader in spectrum)
- f. profit maybe limited - may sell only one time (inoculum in soil may provide control in subsequent years)

advantages

- a. excellent alternative in low cost areas such as rangelands, forests, aquatics
- b. environmentally sound - no contamination of ground water, steams, etc.
- c. relatively inexpensive when compared with other options in rangelands, forests, and aquatics

insects - success dependent upon:

- a. there must not be a natural enemy for the insect e.g. natural parasites
- b. environmental conditions must be conducive to development of the insect
- c. insect must be specific to the host and able to reproduce in sufficient numbers to control the weed
- d. the insect must be highly destructive to the weed and not attack the crop

Examples:

Moth Borer - highly specific to prickly pear

Flea Beetle - highly specific to alligatorweed

plant pathogens/fungi

- a. approach - classical approach is to inoculate weeds with a fungus and allow it to build up on the weed

in this system the fungus could occur naturally year after year; mycoherbicide [myco means fungus] a fungus that kills plants

- b. Collego, which contains the pathogen [*Colletotrichum* sp] was promoted to control northern jointvetch (*Aeschynomene virginica*) in rice; discuss the history of discovery (Dr. Roy Smith in Arkansas) and development

Collego did not have to go through the normal registration process like pesticides because the active ingredient was a naturally occurring pathogen.

Collego was marketed as a 2 component formulation: dry fungal spores + a liquid rehydrating agent.

Did not work in Louisiana. Louisiana had *Aeschynomene indica*, (indian jointvetch), rather than northern jointvetch. This points to the specificity of pathogens as weed control agents

- c. *Alternaria cassia* mycoherbicide for sicklepod control
Problems were: required high spray volume (40 gal. water/A), application just before sundown to take advantage of the dew period, and no screens in nozzles; this material was ineffective
- d. *Alternaria macrospora* mycoherbicide for spurred anoda
- e. *Puccinia* sp. (rust) causes red pustules on dock, morningglory

fish

- a. white amur (Arkansas grass carp) used to control weeds in waterways; this fish is a herbivore that grows to 100 lbs; meat is edible
- b. mud carp - bottom feeder that controls weeds by disrupting and uprooting plants

mammals - manatee (sea cows) used to control water hyacinth in British Guiana; goats for control of woody plants; sheep to remove weeds

birds - geese in cotton fields (standard practice before herbicides) eat johnsongrass rhizomes

- chemical weed control

based on selectivity of herbicides - a selective herbicide kills some plants without injuring others (e.g. atrazine and 2,4-D); a nonselective herbicide kills all plants (e.g. paraquat, Roundup)

selectivity dependent upon:

application rate - atrazine at high enough rate results in bare ground (changes selective herbicide to a non-selective)

application method - refers to where herbicide is placed in the soil relative to the crop, e.g., metribuzin in cane. Cane is planted 4 in. deep below the zone of where metribuzin penetrates

Prowl® surface applied safe to corn but incorporated can injure corn.

application timing - preemergence or postemergence; basis is difference in where herbicide is absorbed and how it is translocated

some herbicides are translocated in the water conducting tissue (xylem), some in the food conducting tissue (phloem), and some in both (will be covered later)

plant characteristics - differences in plant selectivity can also be due to differential herbicide uptake of foliar applied herbicides characteristic; a plant with a thick waxy cuticle (e.g. rubber plant) would prevent herbicide absorption into the leaf (water beads up on the surface)

Therefore, a nonselective herbicide maybe selective in this case.

herbicide uptake, translocation, and/or metabolism - elaborate and relate to a crop vs. weed

analytical techniques - work is done with radiolabeled compounds, e.g. carbon-14; ^{14}C is an unstable form (isotope) of carbon -12 and can be used as a marker or tracer. A carbon atom in the herbicide molecule is labeled with ^{14}C .

To look at uptake:

Apply radio-labeled material to plant tissue and wait 48 hours
 Sample parts of the plant (leaf where herbicide is applied, leaves above and below, and roots. Oxidize the plant parts to carbon dioxide, CO_2
 Look for $^{14}\text{CO}_2$ by counting radioactivity using a scintillation counter
 By following this approach, one can determine where and how much of the chemical moves in the plant

This technique can also be used to identify metabolites (breakdown products of the herbicide molecule)

4. Other weed science terminology

- preplant - applied prior to planting the crop
- preemergence - applied to the soil prior to emergence of the crop or weed
- postemergence - applied after emergence of the crop or weed

- postemergence overtop - applied after emergence of the crop or weed and overtop of both the weed and crop
- postemergence directed application - applied to a specific area such as below the crop foliage but on emerged weeds; PD = post directed; to use a PD treatment you must have a height differential between the crop and the weed with the crop larger; PD treatments are used often in cotton. They require special alignment or adjustment to the spray nozzles
- band - applied to a linear strip (area) on or along a crop row. Chemicals are usually banded to minimize cost, use less, e.g., 15 inch band on 30 inch row will reduce cost by 50%
- broadcast - applied over the entire field as one continuous sheet; a "blanket treatment"
- basal - applied to encircle the stem of a plant above or at ground level such that treatment of the foliage is minimal, used on woody plants
- at cracking - applied when the soil above the emerging crop begins to crack; in soybeans and peanuts, just as cotyledons (seed leaves with the new leaf between them) break through the soil is considered "at cracking".

The growing point of the plant is covered by the cotyledons. Application of herbicides at this stage does not harm the crop since it is protected by the cotyledons

Dynap® (dinoseb), a dinitro type herbicide, and Gramoxone®, (paraquat) herbicide are applied at cracking to peanuts. Dynap is no longer labeled.

- incorporated - to blend or mix the herbicide into the soil; this most often involves mechanical mixing with equipment (disk, tiller, rotary hoe, etc.)
- preplant incorporated - mixing or blending the herbicide into the soil mechanically prior to planting; PPI - preplant incorporated
- spot treatment - applied to only a restricted area of the field (spot)
- layby treatment - applied at or just after the last cultivation
- contact herbicide - kills on contact, not translocated within the plant, very fast acting, coverage of plant tissue is critical, e.g., MSMA (monosodium methanearsonate), Gramoxone Extra (paraquat), Basagran (bentazon), Stam (propanil)

a higher water volume per acre can sometimes enhance coverage of the plant tissue resulting in better control

- translocated herbicide - these herbicides work slower than contact herbicides since they require translocation within the plant to the site of action

coverage of the plant is not as critical with translocated herbicides e.g. Roundup (glyphosate), Fusilade (fluazifop), Scepter (imazaquin), etc. when compared with contact herbicides

- persistence - refers to length of time a herbicide remains active in the soil, i.e., providing weed control. A residue may be determined but level may be very low.

Persistence is positive to provide extended weed control but can be detrimental if the herbicide persists so long that it injures the following crop

- residual herbicide - one that persists in the soil over an extended time period; important for a herbicide to persist long enough to provide weed control but not long enough to result in injury to the following crop; recrop interval for herbicides is listed on the label
- activation - process of making a herbicide active; the herbicide must be in the soil-water interface (the soil solution) to be active. Herbicide may be activated by rainfall or by mechanical incorporation.

Incorporation will place the herbicide in the soil but moisture would still be needed (e.g. rainfall) for the herbicide to be in the soil solution