Lecture -16

WEED MANAGEMENT IN HORTICULTURAL CROPS

Traditional vegetable-growing areas are usually situated adjacent to waterways, flood plains, river deltas, marsh zones, and, if herbicides are used, their environmental impact and usage conditions must be taken into account. Another aspect related to the complexity of herbicide use is its soil persistence that can seriously affect the next crops in the rotation as a result of soil residues or carryover. Vegetable rotations are very fast and intensive in many places, and herbicide toxicity can affect the next crop if the cycle of the previous crop is short enough.

We have to consider all these aspects, as well as consumer concerns on the probable presence of pesticide residues in fruit, leaves and roots of these crops and the strict limitations for marketing and export that can invalidate the hard labour and endurance of many workers. Therefore, a careful use of herbicide is compulsory, and good field practices must be followed, especially when recognition of a labelled production is desired. There is a great interest in the integration of tilling practices with chemical control because of the reduction of the herbicide impact and the cost of hand-labour.

SEED BEDS

Many vegetables are grown in seed beds to develop suitable seedlings for transplanting in the field. Soils dedicated to seed beds are usually light, with good tilth, and fertilized to obtain a good plant emergence. Seed beds are usually flood-irrigated and plastic-protected. Here we add some possibilities for weed management.

STALE SEED BEDS

Stale ('false') seed beds are sometimes used for vegetables when other selective weed-control practices are limited or unavailable. Basically, this technique consists of the following:

1. Preparation of a seedbed 2-3 weeks before planting to achieve maximum weed-seed germination near the soil surface.
2. Planting the crop with minimum soil disturbance to avoid exposing new weed seed to favourable germination conditions.
3. Treating the field with a non-residual herbicide to kill all germinated weeds just before or after planting, but before crop emergence.

SOLARIZATION

Soil solarization is a broad-spectrum control method, simple, economically feasible and environmentally friendly. It is an effective method for the control of many weeds. It does not affect soil properties and usually produces higher yields (Campiglia *et al.* 2000). There are also

some disadvantages in its implementation. For example, previous irrigation is a requirement, (or frequent and abundant rain) and the soil must be kept solarized (non-producing) for a period of at least one month. Results are often variable, depending on weather conditions. Cold (high latitude) or cloudy places are usually not suitable for implementing solarization. Some species can tolerate solarization (e.g. deep rooted perennials: *Sorghum halepense, Cyperus rotundus, Equisetum* spp. and also some big weed seeds such as legumes).

The soil must be clean, surface-levelled and wet, previously to being covered with a thin (0,1-0,2 mm) transparent plastic sheet and very well sealed. The soil must be kept covered during the warmer and sunnier months (30-45 days). Soil temperatures must reach above 40° C to exert a good effect on weed seeds.

After solarization the plastic must be recovered, and the use of deep or mouldboard tillage must be avoided. This system is more suitable for small areas of vegetables, but it has been mechanized for extensive areas of tomatoes. Soil solarization is widely used under plastic greenhouse conditions.

CHEMICAL CONTROL IN SEED BEDS

There are even less registered herbicides for seed beds than for planting crops. Herbicide treatments under plastic cover are always hazardous and careful application should be carried out. Under plastic, high levels of moisture and elevated temperature are common and plants grow very gently. Selectivity could be easily lost and phytotoxicity symptoms may occur, while sometimes they are just temporary. The effects are often erratic. The best way to deal with it is to be prudent and make some trials before a general treatment.

Selective pre-emergence and early post-emergence herbicides for vegetable seedbeds

a) Pre-emergence		
Herbicide	**Dose (kg a.i./ ha)**	Crop
Clomazone	0.18 - 0.27	Pepper, cucumber
DCPA	6.0 - 7.5	Onion, cole crops, lettuce
Metribuzin	0.15 - 0.5	Tomato
Napropamide	1.0 - 2.0	Tomato, pepper, eggplant
Pendimethalin	1.0 - 1.6 1.0 - 2.5	Onion, garlic Lettuce
Propachlor	5.2 - 6.5	Onion, cole crops
b) Post-emergence (crops with at least 3 leaves)		
Clomazone	0.27 -0.36	Pepper
Ioxinil	0.36	Onion, garlic, leek

Linuron	0.5 - 1.0	Asparagus, carrots
Metribuzin	0.075 - 0.150	Tomato
Oxifluorfen	0.18 - 0.24	Onion, garlic
Rimsulfuron	0.0075 -0.015	Tomato

DIRECT-SEEDED AND TRANSPLANTED CROPS

WEED IDENTIFICATION

Dicotyledons (most broad-leaf weeds) and monocotyledons (e.g. grasses) are the two main plant types. Weed grouping has a significant impact on the potential for management. The more closely related a weed is to the host crop, the harder it will be to manage.

Weed and crop family groupings (monocotyledons - 'M')

Family	**Weed examples**	**Related crops**
Apiaceae	slender celery (*Ciclospermum leptophyllum*) Australian carrot (*Daucus glochidiatus*)	celery, carrot, parsley
Amaranthaceae	amaranths (*Amaranthus* spp.)	Chinese amaranthus
Asteraceae	billygoat weed (*Ageratum* spp.) sowthistle (*Sonchus oleraceus*) cobbler's pegs (*Bidens pilosa*) fleabanes (*Conyza* spp.) parthenium (*Parthenium hysterophorus*) potato weed (*Galinsoga parviflora*)	lettuce, artichokes
Brassicaceae	wild turnip (*Brassica tournefortii*) wild radish (*Raphanus raphanistrum*) turnip weed (*Rapistrum rugosum*) shepherd's purse (*Capsella bursa-pastoris*) peppercress (*Lepidium* spp.) lesser swinecress (*Coronopus didymus*)	cabbage, cauliflower, broccoli, brussels sprouts, Chinese cabbage
Chenopodiaceae	fat hen (*Chenopodium* spp.)	beetroot
Convulvulaceae	bell vine (*Ipomoea plebia*) bindweed (*Convolvulus erubescens*)	sweetpotato
Euphorbiaceae	caster oil plant (*Riccinus communis*) caustic creeper (*Euphorbia drummondii*)	cassava

Fabaceae	rattlepod (*Crotalaria* spp.) vetch (*Vicia monantha*) medics (*Medicago* spp.)	peas, beans
Liliaceae (M)	onion weed *(Nothoscordum gracile)*	onion, garlic
Malvaceae	small-flowered mallow (*Malva parviflora*) sida (*Sida* spp.) bladder ketmia (*Hibiscus trionum*) anoda weed (*Anoda cristata*)	okra, rosella, cotton
Solanaceae	apple of Peru (*Nicandra physalodes*) nightshades (*Solanum* spp.) thornapples (*Datura* spp.)	tomato, potato, capsicum, eggplant

CROP ROTATION

Crop rotation is the programmed succession of different crops during a period of time in the same plot or field. It is a key control method to reduce weed infestation in vegetables. Crop rotation was considered for a long time to be a basic practice for obtaining healthy crops and good yields. At present, however, crop rotation is gaining interest and is of value in the context of integrated crop management. Classically, crop rotations are applied as follows:

- Alternating crops with a different type of vegetation: leaf crops (lettuce, spinach, cole), root crops (carrots, potatoes, radish), bulb crops (leeks, onion, garlic), fruit crops (squash, pepper, melon).
- Alternating grass and dicots, such as maize and vegetables.
- Alternating different crop cycles: winter cereals and summer vegetables.
- Avoiding succeeding crops of the same family: *Apiaceae* (celery, carrots), *Solanaceae* (potato, tomato).
- Alternating poor- (carrot, onion) and high-weed competitors (maize, potato).
- Avoiding problematic weeds in specific crops (e.g. *Malvaceae* in celery or carrots, parasitic and perennials in general).

Examples of crop rotations are as follow (Zaragoza *et al.* 1994):

In temperate regions: Pepper - onion - winter cereal

Melon - beans - spinach - tomato

Tomato - cereal - fallow

Lettuce - tomato - cauliflower

Potato - beans - cole - tomato- carrots

Melon - artichoke (x 2) - beans - red beet - wheat - cole

In tropical regions: Tomato - okra - green bean

Sweet potato - maize - mung bean

Introducing a fallow in the rotation is essential for the control difficult weeds (e.g. perennials), cleaning the field with appropriate tillage or using a broad-spectrum herbicide. It is also important to avoid the emission of weed seeds or other propagules.

Mixed cropping

Growing two or more crops at the same time and adjacent to one another is called mixed cropping, or intercropping. The advantages are a better use of space, light and other resources, a physical protection, a favourable thermal balance, better plant defence against some pests and fewer weed problems because the soil is better covered. Sometimes the results are less productive than cultivating just one crop alone. Some examples are:

In temperate regions

- lettuce + carrots;
- cole crops + leeks, onion, celery, tomato;
- maize + beans, soya.

In tropical regions

This technique is very well adapted to the traditional agricultural system:

- maize + beans + squash,
- tomato + pigeon pea,
- sugar cane + onion, tomato.

PREVENTIVE MEASURES

It is necessary to avoid the invasion of new species through the use of clean planting material and to prevent seed dispersal on the irrigation water, implements and machines. A written record of the weed situation in the fields is very useful. Another aspect is to impede perennial weed dispersal (or parasitic weeds) through the opportune use of treatments and tillage and the use of drainage tillage to prevent propagation of some species that need high moisture levels. *(Phragmites* spp., *Equisetum* spp., *Juncus* spp.) It is also necessary to scout the field edges to prevent invasions.

LAND PREPARATION AND TILLAGE

Suitable land preparation depends on a good knowledge of the weed species prevalent in the field. When annual weeds are predominant (Crucifers, *Solanum,* grass weeds) the

objectives are unearthing and fragmentation. This must be achieved through shallow cultivation. If weeds have no dormant seeds (*Bromus* spp.), deep ploughing to bury the seeds will be advisable. If the seeds produced are dormant, this is not a good practice, because they will be viable again when they return to the soil surface after further cultivation.

When perennial weeds are present, adequate tools will depend on the types of rooting. Pivot roots *(Rumex* spp.) or bourgeon roots *(Cirsium* spp.) require fragmentation and this can be achieved by using a rotovator or cultivator. Fragile rhizomes (*Sorghum halepense)* require dragging and exposure at the soil surface for their depletion, but flexible rhizomes *(Cynodon dactylon*) require dragging and removal from the field. This can be done with a cultivator or harrow.

Tubers (*Cyperus rotundus)* or bulbs (*Oxalis* spp.) require cutting when rhizomes are present and need to be dug up for exposure to adverse conditions (frost or drought). This can done with mouldboard or disk ploughing. Chisel ploughing is useful for draining wet fields and reducing the infestation of deep-rooted hygrophilous perennials (*Phragmites, Equisetum, Juncus).*

MULCHING MATERIAL

The use of plastic mulching is very popular in many vegetable-growing areas. A non-transparent plastic is used to impede the transmission of photosynthetic radiation through the plastic to the weeds so that the development of weeds is then arrested.

CHEMICAL WEED CONTROL

The best approach to minimize inputs and to avoid any environmental problems is to apply herbicides in the crop row to a width of 10-30 cm. Many herbicides are effective in the control of perennial weeds. Sometimes a combination of two herbicides having a different weed-control spectrum may be used. Mixtures of different herbicide are possible to achieve better efficacy, but previous trials are necessary. Their foliar activity is enhanced by adding a non-ionic surfactant or adjuvant. The use of any herbicide in vegetables requires previous tests to verify its effectiveness in local conditions and selectivity to available crop cultivars.

In general pendimethalin 3.3 l/ha or Fluchloralin at 2 lit/ha or metolachlor 2 l/ha as pre-emergence herbicide is recommended for most of the vegetable crops, followed by one hand weeding 30 days after transplanting.

Selective herbicides for weed control in vegetable crops

Herbicide	**Dose kg a.i./ha**	**Treatment moment**	**Crops**

Alachlor	2.4	Post emergence	Brassica crops, onion
Ethalfluralin	0.8-1.7	Pre Plantation	Tomato, pepper, beans, squash
Linuron	0.50-1.25	Pre emergence	Carrot, artichoke, asparagus, faba bean
Metribuzin	0.10-0.35	Pre/Post emergence	D.s. tomato, carrots, peas
Oxifluorfen	0.36-0.48	Pre/Post emergence	Onion, garlic, cole crops
Oxifluorfen	0.24-0.48	Pre Plantation	Tomato, pepper
Pendimethalin	1.32-1.65	Pre Plantation / pre-plant incorporated	Artichoke, cole, lettuce, leek, pepper, tomato, onion, green peas
Rimsulfuron	7.5-15(g)	Post emergence	Tomato
Trifluralin	0.59-1.44	pre-plant incorporated	Beans, carrots, celery, cole crops, artichoke, onion, pepper, tomato

HAND WEEDING

Apart from chemical weeding, one hand weeding is done 30 days after transplanting.

BIOLOGICAL CONTROL

Myco-herbicides are a preparation containing pathogenic spores applied as a spray with standard herbicide application equipment. Eg: a weevil for the aquatic weed salvinia, rust for skeleton weed, and a caterpillar (*Cactoblastis* sp.) to control prickly pear.