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WEED MANAGEMENT 2. physical weed management

Key points

- Physical weed management should be **proactive rather than reactive**.
- The techniques used must be based on the weed's lifespan, method of propagation, germination requirements, morphology, and interaction with crop.
- Physical weed management involves *planning* and consideration of the whole farm design, including rotations; soil nutrients and structure; crop, pasture and livestock choices; cultivation; sowing, planting and related techniques; mechanical weeding and hand weeding.
- Cultivation is the main means of direct weed control but a major consideration is that cultivation has a detrimental effect on soil structure.
- After **primary cultivation** to prepare the seedbed, **secondary cultivation** to control the annual weeds can be undertaken.
- Secondary cultivation includes false and stale seedbeds.
- For a **false seedbed**, prepare the seedbed, leave until weeds germinate, then shallow cultivate to kill the weeds before planting the crop.
- Two or more false seedbeds can be used before the crop is planted, if time allows.
- The **stale** seedbed technique involves killing the weeds without disturbing the soil – create the seedbed, but delay planting so the weeds can be killed with a steam or flame weeder just before crop emergence.

Charles Merfield presented a seminar to the Canterbury Organic Growers group on physical weed management. These techniques are suitable for conventional as well as organic farmers.

Weed lifecycles and biology

The techniques used to manage weeds must be based on their lifespan, method of propagation, germination requirements, morphology and interaction with crop. Weeds usually "match" the crop they are in e.g., permanent pasture will have perennial weeds rather than annual, and annual crops will have annual weeds which germinate quickly after disturbance. Annual species usually have huge seed output and must be controlled before seed is set. Some weeds are not a problem during crop growth but control is necessary because they can be a nuisance at harvest e.g., clover in onions.

The "big picture"

Physical weed management involves not just machinery but consideration of the "big picture" – the whole farm design. This includes:

1. rotations,
2. soil nutrients and structure,
3. crop, pasture and livestock choices,
4. cultivations,
5. sowing, planting and related techniques,
6. mechanical weeding,
7. hand weeding.

Costs increase as you move down this list; it is therefore imperative to sort out weed issues as early on as possible, e.g., if an early germinating weed is a problem in a particular paddock, consider organising your crop rotation so that a late sown crop will be grown there. This will give you time to control the weed with several false or stale seedbeds before the crop is planted.

1) Rotations Rotations should be flexible, and include crops that have different planting dates, rooting habits, volume and type of top growth, length of production, cultivation requirements, harvesting requirements, weeding requirements, and should include green manures, cover crops and livestock.

2) Soil conditions Soil nutrients, pH, structure, and drainage should be at optimal levels so the crop is as competitive as possible against weeds.

3) Crop, pasture and livestock choice The pasture phase of the rotation needs to be as vigorous as possible, with minimal bare ground to help prevent weed germination and growth. Perennial weeds, such as dock and Californian thistle, can be a problem in pasture. Pasture species that can compete with them are lucerne and chicory.

Crop variety can also make a difference to weed management. Choose cultivars that have rapid establishment and growth, and that have a prostrate or leafy habit. Cereal varieties with long stalks can more successfully shade out annual weeds than short ones.

4) Cultivation Cultivation is the main means of direct weed control. A major consideration is that

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cultivation has a detrimental effect on soil structure. Minimising the number, depth and energy involved in each cultivation is crucial to minimising damage. A spring loaded tine weeder for example requires less energy and will cause less damage to the soil than a PTO powered implement.

Most weed seeds can only successfully emerge from the top 5 cm of soil and for most crops, only the top 5-10 cm of soil needs to be cultivated for seed establishment. Cultivation to a greater depth leads to mixing of the soil, especially with ploughs or rotary hoes which can bring up previously dormant weed seeds and harms the soil and its flora and fauna.

Compaction from tractor traffic is very detrimental and can lead to huge yield losses. Minimising the weight of the tractor and machinery and sticking to permanent tramlines can reduce the effect. Soil type and soil moisture level is also important: clay soils are very prone to compaction whereas sandy soils are much less so, and damp soils will compact more than dry ones.

Cultivation approaches for perennial weed problems

i) Weeds with tap roots – docks are usually killed if the root is destroyed to a depth of 10 cm or more by an undercutter bar, ploughing, rotary hoeing or a combination of these. A fallow can also be used – the field can be shallow cultivated (to 3-6 cm) every time the weeds produce above-ground growth. This can be very effective but is hard on the soil and takes the land out of production.

ii) Shallow creeping weeds – e.g., twitch. Don't cultivate below the creeping roots but top work to bring roots to the surface. Sheep can very effectively clean up roots and a warm nor-wester can help desiccate. Repeat surface cultivation with spring-loaded tines.

iii) Deep creeping weeds – e.g., Californian thistles. These weeds call for a zero tolerance approach and should be attacked before they become a major problem. If present in pasture, repeated mowing can control; in cropland, deep ripping or subsoiling can break up deep roots. When subsoiling, use another implement first to break up the first 20 cm before going to about 40 cm with the subsoiler. It is crucial to overlap passes to ensure all the roots are broken up. Also ensure soil conditions are suitable – soil must be dry enough to shatter. Make a test run with the subsoiler then dig a hole where the subsoiler has passed to check that the soil has shattered not smeared. The hole is also useful to check the depth of the thistle roots.

Lucerne and chicory are deep rooting species feeding in the same soil zone as Californian thistles and can provide effective competition. A vigorous pasture with these species can provide good control.

Cultivation to control annual weeds in cropland

After **primary cultivation** (e.g., with a grubber, rotary hoe etc.) to prepare the seedbed for growing a crop, *secondary cultivation* to control the annual weeds can be undertaken. Keep the depth of cultivations within the emergence depth of seeds – this rarely exceeds 5 cm. The aim is to encourage as many weed seeds to germinate as possible and without doing too much damage to soil structure.

Secondary cultivation includes false and stale seedbeds – both these weed control techniques begin with cultivation to produce a good seedbed that will promote weed germination. Then, for a **false seedbed**, leave the seedbed until weeds germinate, then shallow cultivate to kill the weeds, then plant the crop. If time allows, two or more false seedbeds can be used before the crop is planted.

The **stale seedbed** technique involves killing the weeds without disturbing the soil – that is, create the seedbed, then delay planting the crop so the weeds that emerge before the crop can be killed just before crop emergence with a flame or steam weeder. In both false and stale seedbeds it is important that good germination conditions exist; if dry, irrigation should be used if it is available.

Tine weeders can be used for false seedbeds in broadacre situations and roller/cutters are suitable in horticultural situations. Rollers give good depth control for the undercutter bar. Both these pieces of machinery are fast, not PTO driven, and therefore involve low capital outlay.

Blind harrowing – for large seeded crops that can be drilled more deeply, blind harrowing can be used. This involves drilling the crop, waiting till weed seeds emerge, then shallow cultivating. The crop then emerges into a cleaner seedbed. These techniques cost time and money but are less expensive than controlling weeds later, or having a reduced yield.

5) Sowing, planting etc. Sowing rate can be increased by 5-10% to compensate for losses due to tine weeding. Alternative spacings for broadacre crops can be used, e.g., row width can be doubled to 30 cm with the sowing rate per meter row doubled – this ensures sowing rate per ha remains the same and the wide row means there is enough space for an interrow hoe. Another option is to overdrill crops such as cereals at 90^{o} to minimise the amount of bare ground available for weeds to germinate. For row crops such as vegetables, try to standardise row widths so weeding machinery (e.g., interrow hoe) does not need to be altered when moving from one crop to the next.

6) Mechanical weeding Weeding machines are most effective at killing weeds up to the time the weeds have two true leaves; once weeds are bigger than this the percentage of weeds killed decreases significantly. Weeds are most effectively killed in hot, dry conditions and most machines work better with fine, stone-free beds. An exception is the spoon weeder which works better in coarser tilths or where there are soil caps, which it breaks up effectively.

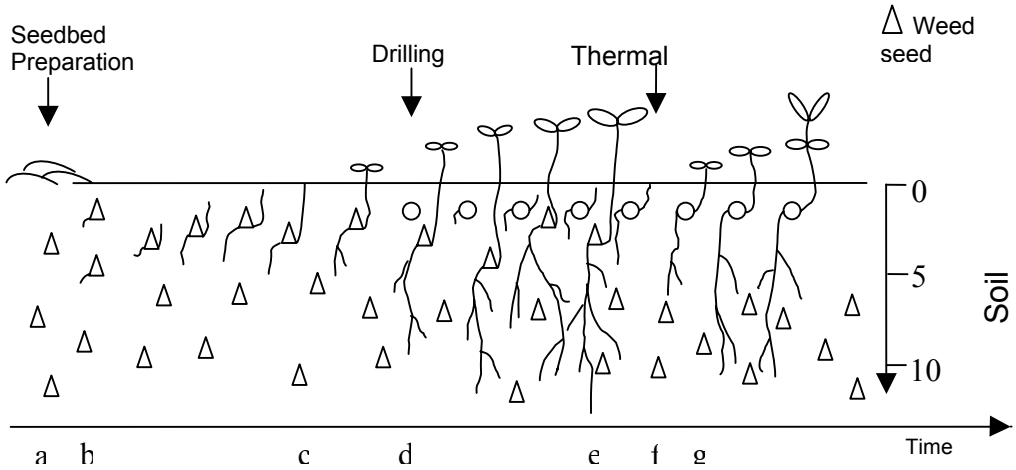
i) Broadacre machinery: is designed to go over the crop without causing too much damage, e.g., tine weeders. These are designed for larger, deeper seeded crops with flexible stems, e.g., peas and cereals. They can efficiently flick out small annual weeds but are less effective against grass weeds and ineffective against established weeds. Forward speed needs to be quite fast – up to 8 km/hr to get the most effective kill. Crops at later growth stages need to be weeded more slowly to minimise damage.

Spoon weeders have a number of flat, thin spokes forming a wheel which is driven around by contact with the ground. The "spoon" at the end of the spoke lifts a cone of soil and weeds and throws it into the air. There is less coverage than with a tine weeder but can punch through a capped soil.

ii) Interrow weeders: A range of interrow weeders is available including steerage hoes, brush weeders (good for wet conditions), basket weeders (no use in stony soils), rotary-hoe hoes (rotovators), rolling cultivators and potato ridgers.

More detail, and information on individual weeders, is available in the publication "Organic Weed Control – A Practical Guide". This is available from Charles Merfield's website: www.merfield.com – go to research, then look down the list for the report Organic Weed Management.

A stale seed bed (stale because the seedbed is no longer freshly cultivated at the time of crop planting/sowings): Seedbed is prepared (a), weed seeds in top 5 cm of soil germinate (b-c), crop is sown (d), weed seedlings emerge (c-e), immediately prior to crop emergence (g) weed seedlings are killed by thermal weeder (f), crop emerges (g).



A false seed bed (false because the first seedbed is not the true seedbed because it is destroyed by re-cultivation): The seedbed is prepared (a), weed seeds in top 5 cm of soil germinate (b-c) and then emerge (c-d), the soil is then re-cultivated (f) with the minimum disturbance necessary to kill weed seedlings, the crop is then sown (f) germinates and emerges (g).