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Reduce crop weed seed numbers in the soil

DPIRD-85

There are various methods of weed control in the pre-sowing phase, including removing weed seed numbers in the soil, fallow, stubble, and by various methods.

This page covers some of the methods, including:

- Burning crop residues to reduce the surface seed bank of many weeds
- Encouraging insect predation of seed
- Inversion ploughing to bury weed seeds at a depth they can't germinate
- Autumn tickle to encourage earlier germination of weed seeds for destruction using a knockdown herbicide
- Delaying sowing to allow greater germination of weed seeds for destruction using a knockdown herbicide or cultivation, prior to crop sowing.

Burn stubble residues to destroy weed seeds

Burning crop residues can reduce the surface seedbanks of many weeds. Seeds close to the soil surface are more likely to be killed than seeds that have been buried. Residues of all crops can produce a sufficiently heated burn to kill weed seeds, provided there is adequate residue. A narrow windrow burns at a higher temperature, improves weed seed kill, and reduces the percentage of the paddock that is burnt. This will in turn reduce the area prone to wind erosion. It is illegal to burn in summer in Australia, but autumn burns effectively destroy weed seeds.

Image 1: A narrow windrow will burn at a higher temperature, improve weed seed kill, and reduce the percentage of the paddock that is burnt

Benefits

- In WA, burning windrows of wheat, canola, or lupin trash has been found to destroy 75% of wild radish seed and 98% of annual ryegrass seeds.
- Late autumn burning of crop residues may also kill emerged weed seedlings, including self-sown volunteers, such as wheat.
- Burning can stimulate weed germination of some weed species. Fire can be effective at stimulating germination of hard or dormant seeds, which allows for subsequent control with another tactic.
- Burning removes residues and thereby allows more effective incorporation of pre-emergent herbicides.
- Burning residues makes it easier to sow the subsequent crop, improves disease and pest management, and eliminates short-term nitrogen tie-up.

Issues to consider

- A high temperature burn that accounts for seasonal risks is the most effective.
- The area to burn should be prepared to ensure best placement of weed seeds on or just above the soil surface. Grazing should be avoided or reduced to ensure sufficient residue remains for the burn and weed seeds are not buried by trampling.
- Time burning to suit residue conditions and legislative requirements, noting it is illegal to burn in summer in Australia. Summer burns also increase the chance of erosion and reduce the efficiency of water conservation.
- The impact of burning depends on residue placement and quantity.
- Not all weed seed banks can be decreased by effective burning. Some weeds, such as wireweed, are not affected by burning and others benefit from burning.

Potential disadvantages

- Environmental concerns about carbon dioxide emissions, pollution, and respiratory health issues, like asthma.
- The risk of soil erosion following burning, especially a total residue burn.
- Adverse effects on soil fertility, organic matter, and soil structure, especially if burning frequently.
- Reduced soil water infiltration and increased evaporation and run-off due to crop residue removal.
- Reduced numbers of macro and micro-organisms, especially earthworms, and therefore reduced biopores.
- A shortened sowing window after rain.

Encourage insect predation of seed

Weed seeds provide a major component of many insect diets, which means weed seedbanks can be decreased naturally by encouraging insect (mainly ant) predation. Research has found that insect predation of annual ryegrass can significantly reduce seedbank numbers, with removal rates ranging from 0 to 100%, depending on the proximity of the seedbank to ant colonies. A study in the Western Australian grainbelt found that predation by insects was higher for annual ryegrass seed than wild radish seed. After 3 months, 81% of the original annual ryegrass seeds had been removed compared to 46% of wild radish.

Maximise insect predation

- Predation levels tend to be higher in situations close to 'refuge' areas, such as remnant vegetation or fence lines, and decreases with increasing distance from the refuge.
- Predation can be maximised by avoiding the overuse of broad-spectrum insecticides, which will decrease the number of 'friendly' insects in paddocks.
- Stubble can provide a refuge for predatory insects, but it also discourages heat-loving ant species, which prefer open spaces. Stubble type is also important. Compared to cereal, canola stubble can reduce the numbers of some ant species and consequently, the level of wild radish seed pod removal, particularly in early summer.
- Minimum tillage improves predation of weed seeds. Tillage, especially in heavy clay soil types, reduces ant populations. A cropping system that employs minimum soil disturbance is optimal. Soil disturbance during summer reduces seed predation by insects.

Inversion ploughing to bury weed seed

In suitable soil types, weed seed burial is an effective method of killing weed seeds, particularly if herbicide resistant weeds are problematic. Inversion ploughing is used to fully invert the soil to ensure weed seeds that were on or just below the soil surface are placed at a depth where they cannot germinate. This can be practiced every 8 to 10 years, with conservation tillage used in the intervening years. In WA, annual ryegrass seeds failed to establish and eventually died when soil was fully inverted to a depth of more than 20 cm using a specialist mouldboard plough fitted with skimmers. This single soil inversion event reduced annual ryegrass numbers by more than 95% at Katanning and Beverley, for a period of 2 years.

Benefits

- In suitable soil types, weed seed burial is an effective method of killing weed seeds.
- The burial of stubble results contributes to disease and insect control.
- Non-wetting soils are ameliorated.
- Nitrogen mineralisation occurs.
- Nutrient stratification (nutrients usually concentrated in the surface) in the soil is removed.
- Opportunities for the application of a soil ameliorant, such as lime, at depth.
- The resulting green manuring and incorporation of organic matter into the soil.

Issues to consider

- Inversion of windrows is a more effective weed control method than burning residues. Inversion ploughing of windrows will reduce weed numbers with minimal paddock disturbance, but weed seeds will remain in the inter-windrow area.
- Effective soil inversion relies on the appropriate soil type and is limited to soil types where there is sufficient topsoil to allow full inversion. Shallow duplex soils, where the clay is less than 15 cm deep, are unsuitable. It is also difficult to achieve the complete inversion needed for effective weed control in soils with many rocks and/or stumps.
- Soil inversion should be avoided where soils exhibit problems at depth, such as clay, sodicity, salinity, boron, magnesium, or manganese, as it may bring these problems to the surface. Growers should test soil where problems are suspected.
- Soil inversion is most effective in reducing weed seedbank numbers with limited dormancy. For species with dormant seeds, a reinversion in later years may bring viable seeds back to the surface.
- Careful timing of inversion ploughing will reduce the risk of wind and water erosion.
- Inversion ploughing is best performed just prior to sowing once the soil profile has become wet.

Autumn tickle

Autumn tickle, which is also known as an autumn scratch or shallow cultivation, stimulates weed seed germination by burying weed seeds to a depth of 1 to 3 cm. This ensures the seed has better contact with moist soil and is protected from drying out. An autumn tickle also encourages weed seeds to germinate earlier by changing their position from light to dark conditions or vice versa. This process will ultimately deplete weed seed reserves because weeds that germinate after an autumn tickle can be controlled. A delay between the tickle and seeding is necessary to give an opportunity for the weeds to germinate and then be killed using a knockdown herbicide. This may cause a yield penalty for some crops.

Image 2: An autumn tickle, or shallow cultivation, stimulates weed seed germination by burying weed seeds to a depth of 1 to 3 cm. This ensures the seed has better contact with moist soil and is protected from drying out

Benefits and issues to consider

- An autumn tickle can be conducted using a range of equipment, including tyned implements, skim ploughing, heavy harrows, pinwheel (stubble) rakes, dump rakes, and disc chains.
- A well-timed autumn tickle will promote earlier and more uniform germination of some weed species, for subsequent control with grazing or a non-selective herbicide.
- Post-cultivation erosion risk will be minimised when the tickle occurs closer to sowing.
- Soil type is critical for a successful autumn tickle. Poor candidates include light textured sand soils, non-wetting soils, and soils where moisture has trouble penetrating the profile. Where soils wet unevenly, weed seeds may be buried in pockets of dry soil. When the pockets become wet during the season, the seeds subsequently germinate and cause in-crop problems.
- Autumn tickling is best suited to weeds that are easily released from dormancy, such as annual ryegrass.
- Soil disturbance prior to sowing can reduce soil moisture, placing sowing at risk in a dry season.
- Soil disturbance prior to sowing can incorporate stubble and, as a result, significant amounts of soil nitrogen will be tied up by microbes that proliferate to degrade the stubble.
- In the early stages of no-till adoption, short-term nitrogen deficiencies are likely if stubble levels are high.

Delay sowing

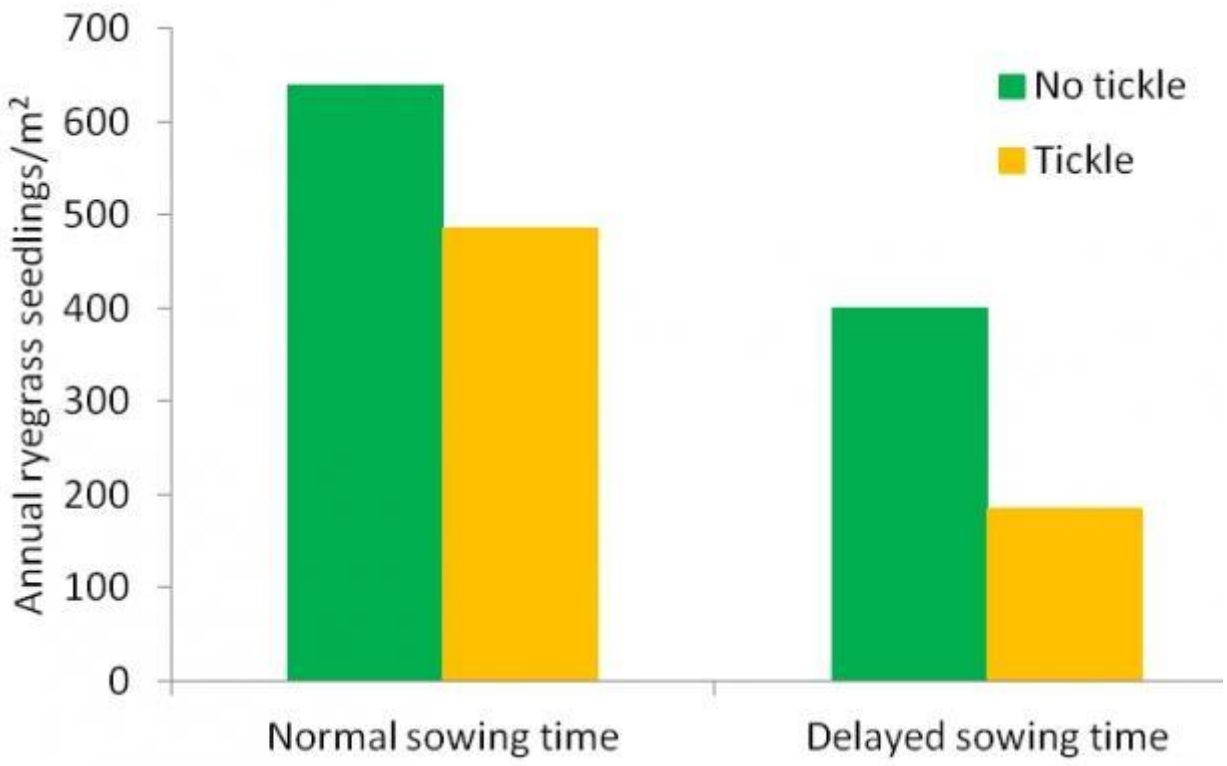
Delaying the sowing of weedy paddocks allows greater weed germination, which subsequently enables weeds to be killed prior to sowing using a non-selective herbicide or cultivation. The longer you delay sowing, the more weeds that will germinate. Delayed sowing (seeding) is where sowing occurs beyond the optimum time for yield benefit to maximise weed emergence. However, a yield penalty is experienced when sowing is delayed.

Delayed sowing can reduce early crop/weed competition via management of early germinating weeds prior to sowing. For this tactic to be successful, sowing must be delayed until the first flushes of weeds have germinated and are controlled. Up to 80% of annual ryegrass emergence occurs within 4 weeks of opening rain. Control of these seedlings will deplete the weed seedbank. Delayed sowing is used most for paddocks that are known to have problematic weed burdens.

Tactics for controlling weeds using delayed sowing include:

- targeting problem paddocks last. Paddocks with low weed burdens are given priority in sowing, with weedy paddocks left until later. This allows sufficient delay for the tactic to be beneficial on the problem paddock without interrupting whole-farm sowing.
- choosing a crop or cultivar with a later optimum sowing time to reduce the risk of yield penalty.
- seasonal conditions influencing delayed sowing opportunities. Delays to the start of the season will restrict the opportunity to wait for the first flushes of weed germination and subsequent pre-sowing control. If the season has a late break, consider excluding very weedy paddocks from the cropping program. This will allow for other weed management tactics to be employed in readiness for the following season.
- delayed sowing is very effective when used in conjunction with additional weed management tactics. A good weed management benefit is obtained when an autumn tickle is used with delayed sowing. See Figure 1 below for the impact of delayed sowing, 3 weeks after normal sowing time.

Figure 1 Impact of delayed sowing and autumn tickle on the number of annual ryegrass seedlings



More information

Refer to the department website at dpird.wa.gov.au for more information about the following:

- Crop weeds
- Managing crop weeds
- Herbicides
- Herbicide resistance

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