

Integrated Weed Management

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What is IWM?

Integrated Weed Management (IWM) is the planned implementation of diverse weed management tactics aimed at rapidly depleting the soil seedbank and preventing further seed set/recruitment. IWM aims to manage today's weed problems in a manner that reduces the potential for weed problems in the future. There are five key principles in developing an IWM plan:

- Know the weed spectrum and aim for maximum weed control.
- Stop seed set, actively manage the seedbank and control survivors to prevent replenishment.
- Monitor and respond to the success of your control tactics.
- Treat weed flushes with a diversity of in-crop and fallow management tactics.
- Don't automatically reach for glyphosate – think longer term.

An IWM program uses a range of weed control tactics in combination, so that ALL weeds are controlled by at least one tactic in the weed management system. In short, IWM is about NOT relying on only one or two methods of weed control alone, and in particular it does

not involve relying only on herbicides. When developing an IWM program, think strategically about how you can best utilise all available weed control methods in cotton, in rotation crops and in fallows. A short term approach to weed management may reduce costs for the immediate crop or fallow, but may not be cost effective over a five or ten year cropping plan. Over this duration, problems with species shift and the development of herbicide resistant weed populations are likely to occur where weed control has not been part of an integrated plan. Herbicide resistant weed populations are becoming increasingly common in NSW and Queensland.

Why use IWM in cotton systems?

Effectively managing weeds using an integrated weed management program for the entirety of the cropping rotation will reduce:

- Rate of shift in weed spectrum towards more herbicide tolerant weeds.
- Risk of selecting herbicide resistant weeds and so prolong the useful life of each herbicide.
- Future weed control costs by reducing the number of weed seeds in the soil seed bank.
- Competitiveness of weeds and improve crop productivity each year.

Although all of these outcomes are important, reducing the risk of developing herbicide resistant weeds is critical. Throughout the world 185 weed species have developed resistance to different herbicides. Thirty-six weeds have developed resistance to herbicides in Australia. In northern NSW populations of 4 common grass weeds – awnless barnyard grass, liverseed grass, windmill grass and annual ryegrass (also occurring in southern NSW) – and one broad leaf species, flax-leaf fleabane have developed resistance to glyphosate. Weeds with resistance to multiple herbicide modes of action are also occurring more frequently. The following tactics should be used to develop an integrated weed management strategy for your farm to help prevent the development of herbicide resistance.

IWM tactics in cotton

Key weeds are identified

Ensure that weeds are correctly identified before deciding upon a response. Refer to Weed Identification Tool.

Monitoring

Monitoring fields before weed control is implemented, enables the best control option to be used. Scouting should be repeated to assess efficacy post-treatment.

For IWM strategies to be effective in preventing resistance, weeds that survive an herbicide must be controlled by another method before they set seed. Weeds may need to be closely examined, as some are capable of setting seed while very small. For information on key weeds refer to the Weed Growth and Development Guide in WEEDpak.

BEST PRACTICE

- Herbicides are applied according to label directions and the pesticides act.
- Good farm hygiene is practised to minimise entry of new weeds.
- Key weeds identified and weed burden assessed annually. Weed strategies are targeted to managing problem weeds.
- Fields scouted regularly to assess weed pressure and efficacy of control measures.
- Herbicides are applied at the ideal weed and crop growth stages.
- Weeds that survive a herbicide application are controlled using an alternative mode of action prior to seed set.
- Key weeds and management practices that are at risk of glyphosate resistance are identified through use of a risk assessment tool.

Identify and closely monitor areas where machinery such as pickers and headers breakdown. Weed seeds are often inadvertently released when panels are removed from machines for repairs.

Weed scouting in non-crop areas of the farm is a valuable source of information for planning future weed management strategies.

Field records

For all fields, maintain records of weed control methods and their effectiveness after every operation. Consider the records from past years in this year's decisions, particularly in relation to rotating herbicide modes of action. Repetitive use of the same mode of action group over time is closely associated with the evolution of herbicide resistance. In addition, records are useful in terms of crop rotations and plant back periods.

The spring tickle

The spring tickle uses shallow cultivation in combination with a non-selective, knockdown herbicide. The aim of the spring tickle is to promote early and uniform germination of weeds prior to sowing to ease weed pressure in-crop. Some weed species are more responsive to the spring tickle than others. Highly responsive weeds include bellvine and annual grasses such as liverseed grass and the barnyard grasses.

The spring tickle may be used in conjunction with pre-irrigating to maximise the emergence and control of weeds prior to crop emergence.

Double knock

The double-knock technique is a fallow weed control tactic that is being used widely in southern states to manage hard to control weeds such as herbicide resistant annual ryegrass. When executed well, the double-knock tactic will provide 100% control. In cotton systems there are several ways the technique can be applied to improve control of weeds such as flaxleaf fleabane and simultaneously reduce the risk of resistance developing in other key weed species such as liverseed grass and awnless barnyard grass. More recently the term double-knock has evolved to include the sequential application of two herbicides with different modes of action in a narrow time frame (3–14 days). When using two herbicides, the basis of the double-knock is to apply a systemic herbicide, allowing sufficient time for it to be fully translocated through the weeds, then return and apply a contact herbicide, from a different mode of action group, that will rapidly desiccate all of the above ground material, leaving the systemic product to completely kill the root system. Most commonly glyphosate is followed with a Group L product. The optimum time between the treatments is dependent on the weed targets. Small, rapidly growing grasses respond best when the second application occurs 3–5 days after the first. When slightly larger fleabane is the target, separate the applications by 7–10 days.

Herbicide tolerant crops are grown according to licence requirements

Herbicide tolerant cottons allow the use of non-selective herbicides for summer weed control in-crop. Incorporating this tactic into the IWM strategy allows for more responsive, flexible weed management. Weeds need only be controlled if and when germinations occur, meaning herbicide application can be timed to have maximum impact on weed populations. In relatively clean fields the reliance on residual herbicides for in-crop management is reduced. In fields known to have heavy weed burdens, using the non-selective together with residual herbicides can achieve very high levels of control. Avoid using the same herbicide to control successive generations of weeds. Use the weed control threshold calculation tool to assist with timing of Roundup Ready application.

Prevent weed establishment

Where cotton is grown in rotation with crops such as winter cereals or maize, retain stubble cover from these rotation crops for as long as possible. Stubble cover reduces weed establishment and encourages more rapid breakdown of weed seed on the soil surface.

Protect yield potential

Young cotton is not a strong competitor with weeds. The critical times when weed competition can cause yield loss are provided in the Cotton Pest Management Guide for a range of weed densities and weed types. Irrespective of the type of weeds, early season control is critical to prevent yield loss. The higher the weed population and the more competitive the weed, the longer into the season weed control is required.

Control survivors and late germinations

Use a range of selective controls – inter-row cultivation, lay-by herbicides, chipping and spot spraying – to prevent seed set in weeds that survived early season tactics or have germinated later in the season.

For a range of reasons, situations will occur when some weeds escape control by herbicides:

- Some tap-rooted annual and perennial weeds, such as fleabane and bindweed may have relatively little leaf area and survive most herbicide applications;
- Stressed weeds are much harder to kill with herbicides;
- Missed strips due to nozzle blockages or equipment failure;
- Insufficient coverage due to high weed numbers;
- Applying the incorrect rate; and
- Interruptions by rainfall are just a few reasons why weeds escape control.

If herbicide resistant individuals are present, they are likely to be among the survivors. It is critical to the longer term success of any IWM strategy that survivors not set seed.

Inter-row cultivation

Inter-row cultivation can be used to prevent successive generations of weeds from being targeted by post-emergent herbicides. Cultivating when the soil is drying out is the most successful strategy for killing weeds and will reduce the soil damage caused by tractor compaction and soil smearing from tillage implements.

Manual chipping

Manual chipping is ideally suited to dealing with low densities of weeds, especially those that occur within the crop row. Whilst this is an expensive option, perhaps it should be costed not just to this crop, yet also to subsequent crops.

Spot spraying

Spot sprayers may be used as a cheaper alternative to manual chipping for controlling low densities of weeds in crop. Ideally, weeds should be sprayed with a relatively high rate of herbicide from a different herbicide group to the herbicides previously used to ensure that all weeds are controlled.

Crop rotations

Rotation crops enhance IWM by:

- Introducing herbicide options not available in cotton.
- Producing stubble loads that reduce subsequent weed germinations (it is important to remember stubble loads and their impact on emerging cotton plants).
- Varying the time of year non-selective measures can be used and the time of year that crop competition suppresses weed growth.
- Rotation between summer and winter cropping provides opportunities to use cultivation and knockdown herbicides in-fallow at all times of the year.

Bury seed of surface-germinating species

Use strategic cultivation to bury weed seeds and prevent their germination. Some weed species, such as common sowthistle (milk thistle) and flaxleaf fleabane, are only able to germinate from on or near the soil surface (top 20 mm).

Good farm hygiene is practiced

To minimise the entry of new weeds into fields, clean down boots, vehicles, and equipment between fields and between properties. Pickers and headers require special attention. Eradicate any new weeds that appear while they are still in small patches. Monitor patches frequently for new emergences.

Irrigation water can be a source of weed infestation with weed seeds being carried in the water. While it is not practical to filter seeds from the water, growers should be on the look out for weeds that gain entry to fields via irrigation. Control weeds that establish on irrigation storages, supply channels and head ditches.

Critical success factors in IWM

Timely implementation of tactics

Often the timeliness of a weed control operation has the largest single impact on its effectiveness. Herbicides are far more effective on rapidly growing small weeds, and may be quite ineffective in controlling large or stressed weeds. Cultivation may be a more cost-effective option to control large or stressed weeds, but additional costs can be avoided through being prepared and implementing controls at the optimum time.

Rotate herbicide groups

All herbicides are classified into groups based on their mode of action in killing weeds. Rotate herbicide groups whenever possible to avoid using the same group on consecutive generations of weeds. When this is unavoidable, use other methods of weed control in combination with the herbicide and ensure no weeds survive to set seed. The cotton industry is very fortunate to have registered herbicides in the majority of the mode of action groups.

Herbicides applied according to label directions

Herbicides are a principal component of most IWM strategies so it is important that they are used in the most effective manner possible. When reading the herbicide label check:

- That the Rate you are about to use is right for the growth stage of the target weeds Always use a robust rate and aim for maximum control of the weeds present.
- Whether a wetter or crop oil is required to maximise herbicide performance.
- That your Application set up is consistent with the label – water volume, droplet spectrums, operating pressure.
- For additional, specific information regarding appropriate weather conditions for spraying.

Consider other aspects of crop agronomy

Most agronomic decisions for cotton have some impact on weed management. Decisions such as cotton planting time, pre-irrigation versus watering-up, methods of fertiliser application, stubble retention and in-crop irrigation management all have an impact on weed emergence and growth. The influence of these decisions should be considered as part of the IWM program.

Resistance

Resistance is now a real issue for the cotton industry with glyphosate resistant weeds being detected in both irrigated and dryland cotton situations. Cotton growers and managers now more than ever need to ensure that they have sound IWM strategies in place to manage the risk of herbicide resistance especially given the reliance of the industry on Roundup Ready Flex® technology for weed control in-crop as well as, the high reliance on

glyphosate for fallow weed management. The cotton growing regions are closely aligned with the northern grains region. Across this area, there are 18 weed species that have developed resistance to at least one herbicide mode of action. Most recently, liverseed grass, windmill grass, awnless barnyard grass and fleabane have been confirmed as being glyphosate resistant, while feathertop Rhodes grass is very difficult to control with standard rates of glyphosate.

Development of herbicide resistant weed populations has been most strongly associated with cropping systems where there is minimal or no use of tillage and where there is only limited rotation between summer and winter cropping. It is essential that growers follow the industry's best management practices and are proactive in preventing the development of herbicide resistance.

Refer to www.myBMP.com.au

Looking for the early signs of resistance

Resistance genes can be present at very low frequencies in weed populations before the herbicide is first applied. Using the herbicide creates the selection pressure that increases the resistant individuals' likelihood of survival. The underlying frequency of resistant individuals within a population will vary greatly with weed species and herbicide mode of action. Resistance can begin with the survival of one plant and the seed that it produces.

Early in the development of a resistant population, resistant plants are likely to occur only in small patches. This is the critical time to identify the problem. Options are much more limited if resistance is first diagnosed over large areas.

Many of the symptoms of herbicide resistance can also be explained by other causes of spray failure. Evaluate the likelihood of other possible causes of herbicide failure. Start by taking the self assessment (see table). The more questions to which you have confidently answered 'Yes', the more a further investigation of possible resistance is warranted. If you have answered 'Yes' to most of these questions, including questions 9–11 on field history, take action;

- Collect samples and send for testing.
- Remove surviving plants from the field to limit the amount of seed going into the soil seed bank.
- Develop a management plan for continued monitoring of the sites and the use of alternative weed control strategies.

Phenoxy

Cotton is extremely sensitive to phenoxy and other Group I herbicides via off target application and through poorly decontaminated booms. To help reduce off target drift damage it is essential that you identify your cotton fields on the cottonmap website. This map will be used by spray contractors, resellers, agronomist and neighbours to identify crops.

Decontaminating spray rigs and tanks is VERY important for cotton.

Self assessment – for possible herbicide resistance: Y/N

1.	Was the rate of herbicide applied appropriate for the growth stage of the target weed?
2.	Are you confident you were targeting a single germination of weeds?
3.	Were the weeds actively growing at the time of application?
4.	Having referred to your spray log book, were weather conditions optimal at the time of spraying so that herbicide efficacy was not compromised?
5.	Can the weed patch be related to a previous machinery breakdown (such as a header) or the introduction of weed seeds from a source such as hay?
6.	Are you confident the suspect plants haven't emerged soon after the herbicide application?
7.	Is the pattern of surviving plants different from what you associate with a spray application problem?
8.	Are the weeds that survived in distinct patches in the field?
9.	Was the level of control generally good on the other target species that were present?
10.	Has this herbicide or herbicides with the same mode of action been used in the field several times before?
11.	Have results with the herbicide in question for the control of the suspect plants been disappointing before?

If you suspect herbicide resistance and require further information please refer to the *Cotton Pest Management Guide*, available on the Cotton CRC website or discuss with your agronomist.

These guidelines are a brief version of the Integrated Weed Management Guidelines for Australian Cotton II.

For more information the following resources and tools are available at https://www.mybmp.com.au/auth_user/grower_tools_and_resources.aspx

- WEEDpak
 - Weed Identification Web Tool
 - Herbicide Damage ID Web Tool
 - Herbicide Resistance Risk Assessment Tool
- Cotton Map – <http://www.cottonmap.com.au/>



Look for the early signs of resistance. (Photo: Graham Charles, NSW DPI)