

APPLYING THE CRITICAL PERIOD FOR WEED CONTROL IN THE FIELD

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Sunflowers in cotton at the start of November mimicking an infestation of large broad-leaf weeds.

Introduction

The critical period for weed control is a concept that relates the yield reduction caused by weed competition to an economic threshold. It establishes a period at the start of the season when weeds do not need to be controlled as they cause no economic loss, and a period at the end of the season when weeds again cause no economic loss. These periods define the middle, critical period for weed control, in which weeds must be controlled to reduce yield losses.

The relationships which define the critical period are affected by weed species, weed density and the economic threshold chosen.

The critical period for weed control

Experiments were conducted at the ACRI at Narrabri over the past 4 seasons to define the critical period for weed control for irrigated cotton in Australia. These experiments used sunflowers, mung beans and Japanese millet to mimic the competition from a large broad-leaf weed such as thornapple, a medium sized broad-leaf weed such as bladder ketmia and a grass weed such as barnyard grass.

Relationships for these weeds at two densities are shown in Figure 1. The curves show the competitive effects of weeds that emerge with the crop and are subsequently controlled (maroon line) and weeds that emerge after the crop and are not subsequently controlled (brown line).

At the densities shown, the large broad-leaf weeds had the greatest effect on the crop, suppressing yield by up to 100% when not controlled. The medium broad-leaf and grass weeds had less effect, with 79% yield reduction from season-long competition of 40 grass plants per metre of cotton row.



Japanese millet at 40/m row in cotton at the end of December mimicking a heavy infestation of a grass weed.

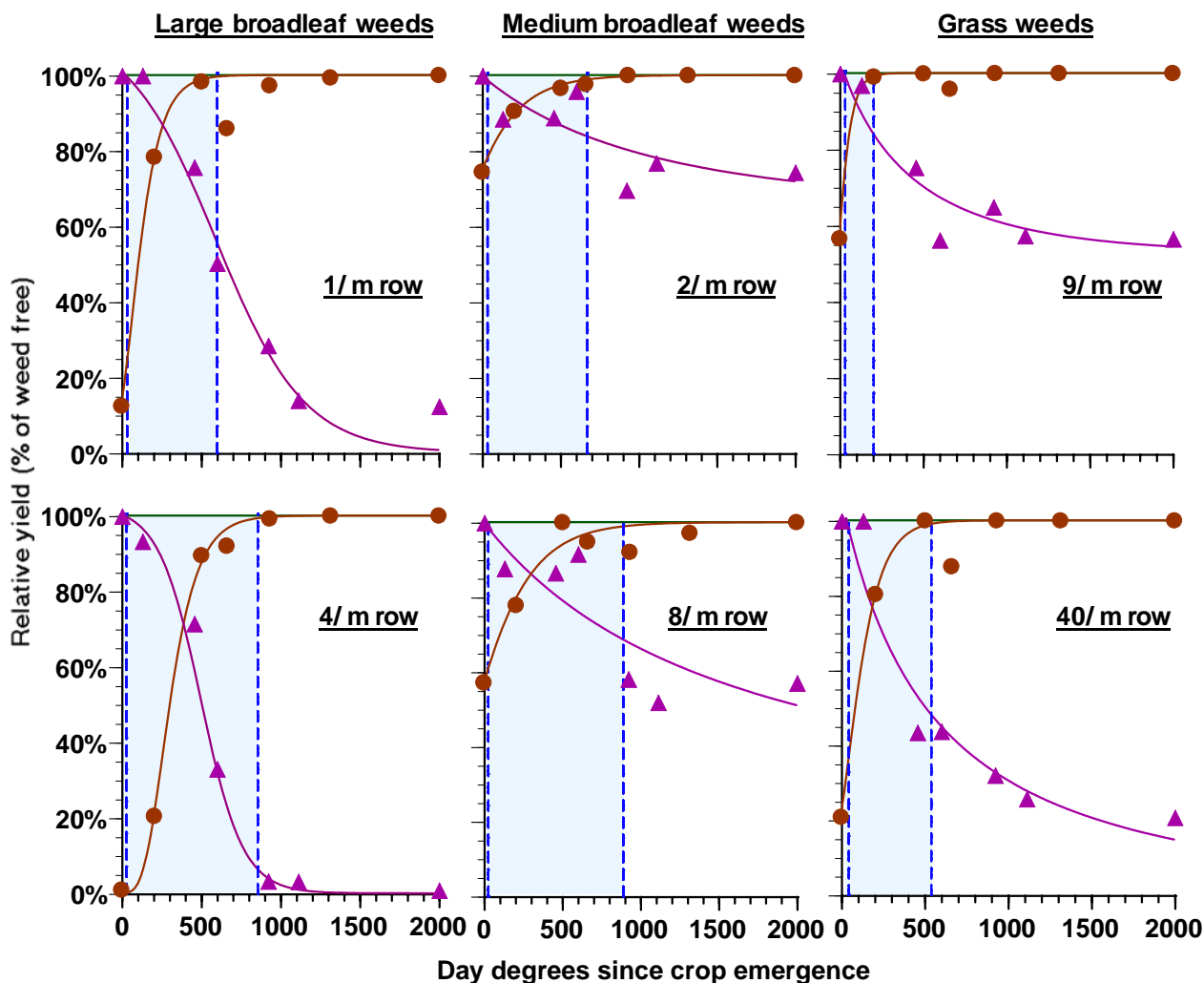


Figure 1. Yield relationships for weeds competing in irrigated cotton. Data for large and medium broadleaf and grass weeds are shown. Weed densities are indicated on each figure. The critical period for weed control at a 1% yield threshold is the shaded blue area in each figure. This area is determined by where the curves in each figure cut the chosen economic threshold, which in this example is at 1% yield loss (99% yield).

The critical periods for weed control defined by these weed competition relationships are dependant on the economic threshold chosen. As an example, results for a 1% yield threshold are indicated in Figure 1 by the shaded blue areas in each figure. These areas are defined by where the maroon and brown lines cut the economic threshold, and determine the start and end of the critical period in day degrees on the bottom axis.

Figure 1 shows that the critical period for weed control at a 1% economic threshold for one large broad-leaf weed/m row starts 30 day degrees after crop emergence and continues till 598 day degrees. In other words, at one large weed/m row, if weed control starts later than 30 day degrees after crop emergence, a yield loss of greater than 1% will occur. Conversely, large broadleaf weeds that emerge at up to 1/m row later than 598 day degrees after crop emergence cause less than a 1% reduction in crop yields. Consequently, controlling these weeds that emerge later than 598 day degrees after the crop can't be justified on the

basis of the yield reduction they will cause. They may still need to be controlled, however, as they may interfere with harvesting and may produce a seed load that leads to increased weed problems in later seasons. A layby application of a residual herbicide may be the best option at this point in the season.

The length of the critical period for weed control increases with increasing weed density, climbing from 598 day degrees after crop emergence for 1 large broad-leaf weed/m row to 854 day degrees for 4 weeds/m. The start of the critical period declines slowly as weed density increases, decreasing from 30 day degrees at 1 large broad-leaf weed/m to 26 day degrees for 4/m.

Predicting the critical period for weed control

These data were put together to produce relationships to predict the start and end of the critical period of weed control for any density of these weeds. The relationships predict that for any density of weeds, the maximum critical period is 996 day degrees post crop emergence (Table 1). Weeds that emerged later than 996 day degrees after crop emergence didn't cause more than 1% yield loss, regardless of their type or density.

The start of the critical period for weed control was fairly insensitive to weed density, declining from 43 day degrees at the lightest density of grass weeds.

The length of the critical period was much shorter for the grasses compared to the broad-leaf weeds at the same densities. Season long competition from fewer than 3 grass weeds/m causing less than 1% yield loss. Consequently, control of fewer than 3 grass weeds/m row can't be justified on the basis of yield loss alone. However, failure to control grasses at this density early in the season will lead to problems later in the season with harvesting difficulties and lint contamination. Not controlling grass weeds will result in seeds being added to the seed bank. This seed may germinate following the next rainfall or irrigation event, resulting in greatly increased weed problems later in the season or in subsequent seasons.

Table 1. The predicted start and the end of the critical period for weed control for a range of weed species and densities.

Weed density (weeds/m row)	Critical period (day degrees)	
	Start	End
Large broad-leaf weeds		
0.1	31	130
0.2	31	230
0.5	30	427
1	30	598
2	29	747
4	26	854
Medium broad-leaf weeds		
0.1	31	92
0.2	31	169
0.5	30	336
1	30	503
2	29	668
4	26	800
Grass weeds		
2	-	-
3	42	61
4	42	80
8	42	148
16	40	258
32	37	410

Other weeds, such as the vines, may have little impact on yield at low densities but can cause major difficulties for harvesting. Low densities of some weed species may also be problematic as they may harbor pests or diseases, or have the ability to rapidly spread if not controlled. Controlling a low density of small weeds may make a lot more sense than trying to control a heavy density of large weeds later in the season.

Using the 'critical period for weed control' data set

The critical period for weed control data will be a valuable tool for managing weeds in cotton into the future. However, the current data is very preliminary and should be viewed with caution. Other research has shown that the results of this type of research can be site and season specific, meaning that different results might be obtained in other seasons and in other cotton areas.

Future research in this project will cover a number of additional points, including developing data sets for mixed populations of real weeds, testing the findings in other regions and developing more robust weed competition assessment tools. Weed densities are never uniform in the real world, and staggered weed germinations can make for difficult decisions. Developing a weed management guide based on measurements such as weed and crop leaf area may give much more robust guidelines than the current findings simply based on weed density.

Nevertheless, these preliminary findings can be used to guide weed management decisions, especially in Roundup Ready Flex® and Liberty Link® cotton crops where over-the-top broad-spectrum herbicides are available. The results firstly indicate that weed control should be commencing early in the season, soon after weed emergence, when light rates of herbicide give good control on small, susceptible weeds. Weeds should not be allowed to grow unchecked in the hope of being able to control multiple weed germinations with a single, high rate herbicide application later in the season.

Secondly, the duration of the weed control period is influenced by weed species and density, but may extend until well into the season in dirtier fields. Weed control may have to be maintained until mid- to late-January, depending on the region and the season. Conversely, weed control with an over-the-top herbicide in relatively clean fields may be largely cosmetic and not justified on the grounds of competition alone. Controlling these weeds with inter-row cultivation or a lay-by herbicide later in the season would be a better option. This is especially the case in fields that are not going back to cotton.

Avoiding herbicide resistance and species shift

One of the biggest concerns with adopting a system which relies largely on a single weed control tool is the development of species shift and herbicide resistance. This is a potential issue for systems such as a Roundup Ready Flex cotton system where few other inputs might be used.

An obvious strategy might seem to be to limit the number of Roundup Ready applications, using maximum rates to control big weeds. This is not advisable for two reasons. Firstly, the critical period for weed control work shows that this strategy will lead to large yield losses. Secondly, using a lesser number of applications of a heavy herbicide rate will not necessarily reduce selection pressure compared to multiple applications of lighter rates on small weeds. The issue is not how many applications are made per season, but whether successive generations are exposed to the same selection pressure.

There are three keys to successfully adopting a low input weed control system. These are:

- Ensuring the herbicide will control all weeds at the rate used,
- Ensuring successive generations of weeds are not exposed to the same herbicide, and
- Ensuring all weed escapes are controlled using a different management tool **before they set seed.**

High yielding cotton crops can be grown for many years into the future if these strategies are adopted.