Can effective weed management be obtained by grouping species by life cycle? Case studies from the cotton industry II

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Summary Individual weed species have different life cycle characteristics and these differences often require specific management strategies. Despite this, identification of commonality in key life cycle parameters between different species may increase the effectiveness of weed management strategies.

This growth cabinet study examined the development of 19 weed taxa and two cotton cultivars. Phenological development was assessed using a day degree relationship that had previously been validated for cotton. The trial was conducted under a 12 h light regime at 35°C and 12 h dark regime at 25°C until 690 day degrees after cotton emergence. In general, the weeds examined had rapid seedling leaf development and a shorter vegetative period than cotton. Some taxa emerged earlier than cotton, while others produced seeds before flowering in cotton. The results indicated that while early season post-emergence weed control in cotton crops will be important in managing the weeds examined, more attention should be paid to pre-emergent cotton weed control. To reduce seed set, targeted management of certain weed species such as *Amaranthus macrocarpus* Benth., *Echinochloa colona* (L.) Link, *Ipomoea lonchophylla* J.M.Black, *Trianthema portulacastrum* L. and *Urochloa panicoides* P.Beauv. during their early growth is needed.

Keywords Thermal development, *Hibiscus trionum*.

INTRODUCTION

Weeds result in significant economic loss in the Australian cotton industry, with estimates of up to \$400 ha^{-1} when yield losses and control measures are considered (Taylor and Walker 2002). Research into the biology and ecology of troublesome weed species has resulted in the development of successful integrated weed management systems for some of these species, including *Cyperus* spp. (Charles 2002), *Ipomoea lonchophylla* J.M.Black and *I. plebeia* R.Br. (Charles 2006a,b), *Polymeria longifolia* Lindl. (Johnson 2000), *Salvia reflexa* Hornem. (Charles and Roberts 2006) and Malvaceae species such as *Hibiscus trionum* L. (Johnson 2003).

More than 200 weed species are known to be present on Australian cotton farms (Johnson and Hazlewood 2002). Management of this large suite of species is difficult because of knowledge gaps in the biology and ecology of many of these weeds, despite recent research (Johnson 2006). This paper reports on growth cabinet studies conducted to ascertain the biological development of 19 weed taxa and two cotton cultivars to determine if commonalities in key life cycle parameters could be identified and management strategies improved. Since variability in life cycle parameters within a species also exists (Johnson 2003), this paper examined the influence of population source on key life cycle parameters in three taxa of *H. trionum*.

MATERIALS AND METHODS

Thermal development in cotton crops can be determined by calculating the number of day degrees after planting into a suitably moist soil and under non water limiting conditions as per the equation: Day degrees = ((Maximum daily temperature − 12) + (Minimum daily temperature − 12))/2. Cotton development is stalled at temperatures below 12°C. This trial was conducted under a 12 h light regime at 35°C and 12 h dark regime at 25°C until 690 day degrees after cotton emergence (ca. six days before cotton flowering at 800 day degrees).

This study assumed that the thermal development of weed species used in this study followed the cotton relationship (above), and that weed development was unaffected by day length. Neither assumption has been validated.

Weed seeds were generally collected from populations located in north-western New South Wales (NSW) and south-eastern Queensland (Qld). The populations of *H. trionum* used are listed in Table 1. A discussion of differences between these taxa can be found elsewhere (Johnson *et al.* 2003, 2004).

Appropriate dormancy breaking treatments were applied before sowing seeds into 10 cm pots filled with grey cracking clay. Excess seedlings were removed to ensure one vigorous seedling in each of five replicates. The cotton cultivars were chosen to represent differences in cultivar life cycle and maturity. The parameters measured included emergence (cotyledons visible above the soil surface), third true leaf fully

Table 1. *Hibiscus trionum* taxa collected from various locations within their geographic range.

Variety	Parent population location
var. *trionum*	Jimbour (Qld) – Northern Narrabri (NSW) – Central Trangie (NSW) – Southern
var. *vesicarius* (yellow centre flower type)	Jimbour (Qld) – Northern Narrabri (NSW) – Central Trangie (NSW) – Southern
var. *vesicarius* (red centre flower type)	Emerald (Qld) – Northern Jimbour (Qld) – South eastern St George (Qld) – South western

expanded (all leaves counted for grasses), first floral bud (larger than 3 mm diameter) and seed development (green seed present, and mature seed shed). All parameters (except emergence) were assessed relative to the average emergence date for the weed.

RESULTS

Emergence Five weed taxa emerged 1–2 days before the earliest cotton cultivar, Sicot 80. In order of emergence these included *Sesbania cannabina* (Retz.) Pers., *Amaranthus macrocarpus* var. *pallidus* Benth. and *Echinochloa colona* (L.) Link. Six weed species emerged at least one day after the cotton cultivar Sicala 40. In order of emergence these included *I. plebeia*, *I. lonchophylla*, *Bidens subalternans* DC., *Anoda cristata* (L.) Schltdl., *Abutilon theophrasti* Medik. and *S. reflexa*. There was no clear trend in *H. trionum* populations of the three taxa with respect to cotton emergence.

Early seedling growth Most weed taxa reached the third true leaf fully expanded stage before the two cotton cultivars. The most rapid of these in order were *Urochloa panicoides* P.Beauv., *B. subalternans*, *A. macrocarpus* var. *macrocarpus* Benth., *S. cannabina*, *E. colona*, *Solanum nigrum* L. and *I. lonchophylla*. With the exception of the grasses with only three leaves counted, a number of weeds developed early leaves more rapidly than cotton. Very few taxa developed more slowly than both cotton cultivars, but these included *A. cristata* and one population each of *H. trionum* var. *trionum* L. and *H. trionum* var. *vesicarius* Hochr. from Trangie in central NSW. Seedlings of *H. trionum* var. *trionum* and var. *vesicarius* from Jimbour populations (from south-eastern Qld) developed three true leaves significantly earlier than both cotton cultivars. In comparison, third true leaf development within these taxa was significantly delayed in more southerly populations from Narrabri and Trangie.

Floral initiation and seed development With the exception of three weed species, all taxa developed floral buds before the two cotton cultivars, that is these taxa had a shorter vegetative period. This occurred within 550 day degrees (up to 30 days). The three exceptions were *B. subalternans*, *I. plebeia* and *Malva parviflora* L. Seedlings of *H. trionum* developed floral buds significantly more quickly in more southerly (var. *trionum* and var. *vesicarius* – yellow centre flower type) or easterly (var. *vesicarius* – red centre flower type) populations.

Although only one species produced mature seed within the trial period (*U. panicoides* at 577 day degrees), four other species produced green seed, these being *A. macrocarpus* var. *pallidus*, *E. colona*, *I. lonchophylla* and *Trianthema portulacastrum* L.

DISCUSSION

Although individual weed species have different life cycle characteristics, the growth cabinet studies indicated that there were commonalities in key life cycle parameters. Accordingly, there is considerable potential to manage early emerging weed species before cotton emergence with non-selective knockdown or residual herbicides, particularly after irrigation at planting. The potential for management is greater if weed emergence occurs before cotton planting after rainfall or irrigation.

Rapid early vegetative growth of all weeds indicated that attention should be directed to early season post-emergent weed management via herbicide applications in-crop and inter-row cultivation. Such attention will help achieve successful management, as weed seedlings are often easier to kill than larger plants.

The rapid reproductive development of nearly all weed taxa where floral buds developed within 30 days is a reason for concern. Such rapid development has been observed in spring, summer and autumn in the field and glasshouse situations in varieties of *H. trionum*, *A. cristata* and *A. theophrasti* (Johnson 2003). Another concern is the production of seed in some species during the relatively short trial period. It is crucial therefore that a suite of integrated weed management techniques be used to prevent weed reproduction, including targeted chipping, and using the methods for early-season control outlined above. Reducing weed seed production will help lessen problems in future years.

This study also illustrated considerable differences in vegetative and reproductive development within *H. trionum*. Life cycle differences were evident between the different varieties and flower types (Table 1), as well as between populations of the same variety or flower type that were sourced from different geographic areas. This was also reported earlier in other glasshouse and field research (Johnson 2003, Johnson *et al.* 2004). In particular, the expansion of the third true leaf was significantly delayed in southern populations of var. *trionum* and var. *vesicarius* (yellow centre flower type) when compared to northern populations of the same variety. Conversely, southern populations of all *H. trionum* varieties and types developed flower buds earlier than northern populations. When developing management strategies, it is therefore important to consider the differences in the life cycle of populations within the same species (variety and flower type).

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