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STATUS OF WEED SCIENCE IN AUSTRALIA – PROSPECTS AND CHALLENGES

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ABSTRACT

Weeds are estimated to cost in excess of AUD$4 billion every year in Australia. National coordination of weeds research, extension and education aims to reduce weed impacts in both natural and agro-ecosystems. Research is in progress to improve detection and management of new weed incursions as well as develop new control tactics. For more than 30 years selective herbicides have effectively controlled agricultural weeds but now herbicide resistance, concerns about chemicals in the environment, and the lack of new herbicidal products threatens the sustainability of chemical weed control. The integration of cultural control tactics such as diverse crop rotations, crop competition, cover crops, and physical weed control with chemicals aims to improve the efficiency of weed management in agriculture.

Key words: Weed incursions, impacts, herbicide resistance, cultural control, collaboration, national coordination, Cooperative Research Centre for Australian Weed Management.

Weed Incursions and Impacts

Weeds are a major constraint to agricultural and natural ecosystems in Australia and are estimated to cost the economy in excess of AUD$4 billion every year in lost production and control costs (Jones *et al*. 2000). Weeds reduce the yield and quality of agricultural produce, cause human and animal health problems (e.g. toxicity, cause rashes, stings or injury by spines, severe respiratory problems), and in natural ecosystems reduced biodiversity (numbers and species of animals and plants) and amenity value.

Australia has many well established weeds. Over the last 200 years since the arrival of Europeans more than 28,000 foreign plant species have entered Australia either by accident or intentionally for pasture, horticulture or for ornamental reasons. More than 2,500 species have become naturalised. Between 1971 and 1995, nearly 300 plant species established as weeds (Groves, 1998). Despite Australia's relative isolation and strict quarantine systems, the risk of new weed incursions remains high due to international tourism, mail, air and sea traffic.

Early detection and eradication of new weed incursions has a relatively low cost compared to the on-going cost of managing a well established weed, i.e. prevention is much cheaper than cure. Australia has developed a national approach to anticipating, detecting, and eradicating potential new weeds (Pheloung, 2002). This is based on: effective surveillance; provision of weed risk assessment guidelines for importation of plant species (a sound science-based decision-support system to assess the potential weed risk of a plant); and an adequately resourced national infrastructure to enable

eradication. Weed risk potential is determined by a number of criteria including biological traits, distribution, ease of control, weed status (Pheloung, 2001).

There is considerable discussion on the feasibility of eradication versus containment of a new incursion. For an eradication program to be undertaken at a national level, four basic criteria must be met regarding the weed: accurate identification; a potentially serious weed; eradication must be feasible; and the benefit-cost of eradication must be high. The effective response to a new incursion will depend on accurate monitoring of the current distribution, adequate quarantine measures to prevent further spread, and effective control measures to enable eradication.

Weed impacts on natural ecosystems are difficult to quantify (compared to agricultural systems) due to a number of reasons including:

- detection is difficult in remote locations,
- measuring impacts is hard,
- limited control options; and
- Inadequate resources for monitoring.

Despite these problems a concerted effort is in place to overcome these difficulties. Mmanagement options to lessen the impacts of weeds on biodiversity in natural ecosystems include: enhanced risk assessment of introductions of non-agricultural plants for their potential as environmental weeds; prevention of sale of known environmental weeds by nurseries; enhancement of biological control effort for environmental weeds; and re-vegetation programs using competitive, non-invasive native species.

Half of the cost of weeds in Australia occurs in agricultural systems. For more than 30 years selective herbicides have effectively and economically controlled agricultural weeds but now herbicide resistance, and concerns about chemicals in the environment has led to a need for more efficient use of herbicides and reduced inputs. In addition, conservation farming systems with stubble retention have exacerbated the spread of herbicide resistance due to greater dependency on chemicals for weed control. Conservation farming is being promoted in Australia to conserve soil, water, fuel and time. Certain weed species favour conservation farming compared to systems using stubble burning and tillage, eg. *Bromus* spp. and *Vulpia* spp. And glyphosate resistance in *Lolium* is spreading (Pratley et al 1996; Heap 2006). Other species that require soil disturbance to germinate, eg. *Fumaria* spp. can still be a problem within the cropping rows in low-disturbance, no-till systems.

Adoption of genetically modified varieties with herbicide tolerance has been widely promoted but is very limited due to public concern about potential human health and environmental risks. These factors and the lack of new herbicidal products threaten the sustainability of chemical weed control and increase the risk of greater future weed impacts in agricultural systems.

Nationally Coordinated and Collaborative Research, Extension and Education

In response to these developments, the Cooperative Research Centre for Australian Weed Management (Weeds CRC) was established in 1995 as a nationally funded collaborative initiative to reduce the risks of current and new weed incursions through coordinated research, education and information delivery. The Weed CRC has five key objectives:

- to reduce the influx of new weeds from abroad and to more effectively manage new incursions already in Australia, and to do so without unduly affecting access to new species of beneficial plants for Australian agriculture and horticulture;

- to reduce the costs of weed to primary industry while improving the sustainability of agriculture by novel integration of agronomy, weed-competitive crop cultivars, agricultural engineering, biological control, and smart herbicide use;
- to protect the integrity of Australia's landscapes and natural ecosystems through the use of multi-disciplinary approaches, including biological control, grazing, fire, herbicides, and vegetation management;
- to develop and implement a strategy to ensure effective communication of weed research to the broader community; and
- to train the next generation of researchers, administrators, and advisers in all areas of weed management (including postgraduate and honours students).

The Weeds CRC collaborative partners include universities, Federal and State agencies as well as industry support. Funds for the CRC program come from the Federal government as well as the CRC partners.

The Weeds CRC has had the following major impacts on weed management in both Australia and overseas:

- elevated the profile of weeds and provided economic estimates of impacts leading to increased and more efficient R&D support;
- led the world in the development of weed risk assessment guidelines for importation of plant species;
- developed a national approach to anticipating, detecting and managing potential new weeds;
- developed new non-chemical control tactics including biological controls;
- played a very significant role in demonstrating the importance of integrating weed management tactics that target weed populations over long time-frames in agricultural and natural ecosystems;
- increased the number of people trained in weed science; and
- provided a network that accelerates the rate of information exchange and delivery resulting in adoption of improved weed management.

Integrated Weed Management in Cropping Systems

The Weeds CRC has undertaken research to facilitate the integration of herbicides with cultural control tactics such as diverse crop rotations, crop competition, cover crops, and physical weed control is essential to maintain efficacy of important selective herbicides as well as glyphosate. Weeds persist in crops because they adapt to and thrive in our cropping systems. To reduce weed impacts and persistence in crops and pastures we need to understand their biology and ecology and how they respond to different control tactics and farming practices. To manage weeds effectively it is necessary to employ a wide range of different controls throughout the life-cycles of the weeds, i.e. from seedling emergence to seed-set. This requires varied cropping/pasture rotations and flexibility in the use of control options. Knowledge of weed growth and developmental patterns, seed dormancy and timing of seedling emergence is essential to ensure accurate timing of control operations.

Diverse crop rotations are integral components of improved weed management systems (Anderson, 2003). Weeds tend to associate with crops that have similar life cycles, eg. *Avena* spp. and

wheat. Rotating crops with different life cycles can disrupt development of weed-crop associations. Different planting and harvest dates of diverse crops provide opportunities for producers to prevent either weed establishment or seed production.

Crop competition is an important and cost-effective tactic for enhancing weed suppression and optimizing crop yield. This can be done through agronomic manipulation or breeding for strong competitive ability (Lemerle *et al*. 2001). The competitive characteristics of crop plants include rapid emergence, root development, height, canopy closure, high leaf area index, and profuse tillering or branching. Choosing a strongly competitive crop species or cultivar requires no additional cost to farmers apart from some extra planning. Cereals are generally more competitive than pulses, and oilseeds are intermediate. Increasing crop density and reducing row spacing increases crop competitive ability with weeds. Nitrogen fertilizer placed as below the crop seed rather than broadcast can increase crop competitive ability of several weed species. Opportunities exist to use biotechnology to develop bio-herbicides, and to breed for strong crop competitive ability.

Cutting crops or pasture for hay and silage or grazing by livestock can play an important role in reducing weed seed carryover. It is important to know the timing of weed flowering and seed set in relation to timing of cut for silage or hay, also consider weed re-growth for these techniques to be effective. Green (or brown) manuring is economical to reduce high weed population densities, especially of herbicide-resistant weeds. Cover crops such as rye (*Secale cereale*), oat (*Avena sativa*), barley, mustard (*Brassica* spp.), and sweetclover (*Melilotus officinalis*) contain allelopathic compounds that inhibit weed germination and growth (Weston, 1996). These allelopathic chemicals are released by the living plants or from decaying crop residues. Living cover crops also suppress weeds by competing for resources and their decaying residues inhibit weeds through physical, biotic and allelopathic interactions. Cover crops that establish quickly and have high biomass production are well suited for weed management. A disadvantage is that they utilize water and nutrients otherwise available to subsequent crops. Current research in Australia is continuing to explore opportunities to utilize the allelopathic properties of both weeds and crops to develop 'natural' herbicides, and take advantage of allelopathic crops to suppress weeds.

Research is examining opportunities to physically control weeds by strategic cultivation, and using new remote sensing technology for site-specific or precision weed management. Advances in seeding machinery to improve crop establishment need to be developed for a wide range of crops and environments.

In summary, recent nationally coordinated research has improved our knowledge and capacity to reduce weed incursions to Australia, and better manage existing infestations in both agricultural and natural ecosystems.

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More information is available about the Weeds CRC on www.weeds.crc.org.au

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