Control of *Emex* species

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Abstract
Highlights of the research carried out in Western Australia on the control of *Emex australis* from the early 1950s are briefly reviewed. A concise appraisal of the present state of knowledge is presented as a basis for proposals on future directions.

Introduction
In this paper I would like to briefly review some highlights of the doublegee control research that has been carried in Western Australia to this point in time, and propose directions for further research.

Scott and Beasley's (1996) bibliography of over 300 publications indicates the magnitude of world wide research that has been carried out on this plant, and although doublegee has had a high priority for research in this State, it still only represents a portion of that which has been completed.

Highlights up to 1970
- Geoff Pearce and others had developed reliable recipes for chemical control of doublegee in cereal crops.
- Pearce had demonstrated the benefit of an 'autumn tickle' used in conjunction with chemical control (IWM)?
- Pearce had also developed the 'Spray Graze Technique' for control in pastures, but because of stock management constraints with the technique, control was still unreliable for large areas of infested pasture.
- Some studies had been carried out on seed longevity and seedling emergence.

Research during the 1970s and early 1980s
The main aim of research during this time was to develop more reliable methods of doublegee control in subterranean clover pastures. Some highlights of this period are:
- Burnett (then with Bayer Australia) and Gilbey developed Tribunil® for use in pastures.
- Gilbey also developed 2,4-DB as alternative for use in pastures.
- The best sites for these herbicide evaluation trials were always in first year clover pastures following a cereal crop. Attempts to continue the studies beyond this year generally failed because the doublegee numbers were too low to detect significant difference between treatments.

These observations were supported by the results of sampling paddocks over several years on several research stations, for doublegee seeds in the soil. The results from 1974 (Table 1) indicate that more viable doublegee seed was found in the soil following a year of clover pasture, than that following a year of cereal crop.

Other highlights were :
- Seed longevity studies showed that dormant seed was more persistent in northern areas than the Great Southern (10% at Chapman after four years compared to less than 10% after one year at Katanning) and that viable seed could be detected after eight years at all sites.
- Depth of seedling emergence studies showed that few seedlings emerged from seed below 75 mm in the soil.
- Further paddock surveys in the mid 1970s showed maximum seedling numbers of over 900 plants m^{-2} at Wongan Hills, over 300 plants m^{-2} at Chapman and 50–80 plants m^{-2} in the Great Southern.
- In spite of the large number of products evaluated, no reliable chemical control method was developed for doublegee control in pastures.
- Collaboration with Ken Harley, Mic Julian and Paul Weiss of CSIRO lead to the first releases and evaluation of *Perapion antiquum*. This insect had not established successfully by the time John Scott joined the research group and continued the biological control research program.

Recent research highlights
- Dane Panetta and Rod Randall studied the emergence and survival of seedling cohorts.
- Panetta and Randall also studied the competitive effects of other pasture species on doublegee, and were developing a management strategy based on competition with pastures grasses when Dane transferred to Queensland.
- Gilbey by now working on weed control in lupins showed that doublegee can be controlled with pre-emergence applied simazine providing the crop is sown into moist soil. The size of the lupin crop in Western Australia, and the occurrence of late opening rains now dictates that large areas of lupins are sown dry and consequently doublegee control is often unsatisfactory.
- Bowran and Cooper developed metribuzin for post-emergence doublegee control in lupins, with supporting varietal tolerance data which showed that the varieties Gungurru and Merritt tolerated metribuzin better than other varieties, such as Danja.

The situation today
The present state of knowledge with respect to the control of doublegee can be summarized by the following:
- Reliable control can be achieved in cereal crops.
- Reliable control can be achieved in lupins, except for dry sown crops.
- Broadstrike® is now available for doublegee control in pasture, but it is yet to be demonstrated that there is a reliable method of control in pasture.
- All progress achieved in reducing soil seed populations under continuous cropping or pasture land use, is totally reversed by a change from one to the other. Up to 10 000 achenes m^{-2} have been recovered from soil at Wongan Hills following a year of pasture.
- The economic incentive for growers on broad area farming systems is not high enough for them to modify their farming systems for the sole objective of doublegee control.
- Eradication of doublegee has been demonstrated on a vineyard in Mildura, where the economic incentives in the dried fruit industry were high enough for the grower to adopt specific doublegee control strategies.
- Flexible control strategies have yet to be developed that are effective over various land uses.

Future directions
The main strength of doublegee is its ability to recover on the change from cultivation to non cultivation land uses and vice versa in broad area farming. This should be a target for further research.

It is also clearly an ideal candidate for integrated weed management by:
- cultural, chemical and biological control methods,
- rotations within farming systems and,

Table 1. Survey of doublegee seed in the soil following crop or pasture. Sampled in March 1974 (Gilbey 1977).

Site	Viable seeds m^{-2} after pasture	Viable seeds m^{-2} after crop
Avondale Research Station	2373	94
Wongan Hills Research Station	1062	433
Chapman Research Station	1431	261

• different farming systems.

There is a need to set priorities and targets for integrated weed management for the various land uses.

e.g. dried fruit industry
pulse crops
recreational areas
conservation areas

Separate IWM information packages are required for growers in the various land use categories. Preparation of this material would identify specific areas for further research. I believe that a team comprising of an industry liaison officer and a research officer working closely with growers, would lead to the most rapid advances in reducing the impact of doublegee in Australia.

References

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Dicamba control of *Emex australis*

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Abstract

Dicamba has long been used for the control of Polygonaceae weeds. The high efficacy against *Emex australis* is one of the major strengths of dicamba in southern Australia. The sulfonylurea group of chemicals also provides good control of *Emex*, however, there are two main benefits of using dicamba. Firstly, the very short plant back period of dicamba prevents the possibility of residue carryover into the next phase of the crop rotation. Secondly, the long term effects of continued use of Group B chemistry needs to be considered in terms of herbicide resistance. Rotation of herbicide groups is an essential component of Integrated Weed Management. The high efficacy of dicamba, in addition to these two factors, should favour the continued use of dicamba to control *Emex*.

Introduction

Dicamba was first discovered as a laboratory molecule in 1961 and registered for use in Australia in 1971. This initial registration was on primarily polygonaceous weeds, which remains the strength of dicamba in today's agriculture. Dicamba was used extensively for *Emex* control throughout Australia during the 1970s and early 1980s, prior to the discovery of the sulfonylurea (SU) chemistry. These chemicals were less expensive and provided control of a wider weed spectrum. Subsequently, the use of dicamba decreased. However, the use of dicamba for *Emex* control has been increasing during the mid-1990s due to factors that will be addressed in this paper.

Dicamba is a broad spectrum chemical that provides effective control of a number of annual, biennial and perennial broadleaf weeds. Plants absorb dicamba through the leaves, stems and roots and it accumulates at the areas of greatest metabolic activity.

At the site of activity, dicamba causes an imbalance in plant hormones, specifically auxin, thus interfering with cell elongation and nucleic acid and protein synthesis. The result is a disruption to normal metabolic and growth activities, and death of susceptible species. Due to its action as a disruptor of cell growth, dicamba is grouped with the phenoxy and pyridine herbicides in Group I.

Methods

Three protocols of dicamba/doublegee trials will be referred to in this paper. The first is a rate response determination, the second is a comparison with metsulfuron, and the third involves mixtures of dicamba and metsulfuron with glyphosate. Metsulfuron was selected for comparison because it is currently the most common post-emergent SU herbicide used for *Emex* control.

A hand held boom was used to apply the treatments in trials of the first two protocols (A and B below). The output from the boom was 100 L ha^{-1}. Plots were 3 m wide by 10 m long, with four replicates.

The third protocol (protocol C below) was designed and conducted by SBS Rural IAMA. A boom connected to a 4-wheel motorbike was used to apply the treatments. Compressed air was used as a propellent, at a spray volume of 50 L ha^{-1}. Plots were 3 m wide by 20 m long, with three replicates.

Protocol A. Rate response

A single trial was conducted during 1995 to determine a rate response curve for dicamba against doublegee. The *Emex* were at the two leaf stage when sprayed. The rates of dicamba (g a.i. ha^{-1}) used were 0, 40, 60, 80, 120, 160 and 320. The trial was sprayed under the following conditions; 13ºC, 70% relative humidity, no wind, overcast, dry leaves, and moist soil.

Assessments were made on percent efficacy at 35 DAT (days after treatment).

Protocol B. Metsulfuron comparisons

A single trial was conducted during 1995 to determine the comparative efficacy of low rates of dicamba and label rates of metsulfuron. The *Emex* were at the two leaf stage when sprayed. Rates of dicamba and metsulfuron were (g a.i. ha^{-1} of dicamba + g ha^{-1} of metsulfuron, respectively): 0+0, 60+0, 80+0, 0+3, 0+5, 60+3, 60+3, 80+3, and 80+5. The trial was sprayed under the following conditions; 12ºC, 80% relative humidity, no wind, clear sky, dry leaves, and moist soil.

Assessments were made on percent efficacy at 35 DAT.

Protocol C. Glyphosate mixtures

A single trial was conducted during 1992 to determine the comparative efficacy of dicamba and metsulfuron when mixed with glyphosate. The *Emex* had been transplanted by cultivation and were 15 to 30 cm in diameter. Rates applied were (mL ha^{-1} of glyphosate + g a.i. ha^{-1} of dicamba + g ha^{-1} of metsulfuron, respectively): 0+0+0,