CONTROL OF AMARANTHUS (*AMARANTHUS POWELLII*) IN GREEN BEAN CROPS

A.C. Bishop, B.M. Pemberton and J. Stagg
Department of Primary Industry and Fisheries, PO Box 303, Devonport, Tasmania 7310, Australia

Summary Amaranthus (*Amaranthus powellii*) in green bean crops reduces crop yields and increases the chances of a processor by-pass due to harvest contamination. Spread is assisted by machinery and livestock such as sheep, presenting this weed as a priority farm hygiene issue. In Tasmania, current attempts at control of *A. powellii* in established bean crops has been largely unsuccessful. At the core of control difficulties is the lack of a registered selective herbicide strategy to control *A. powellii.*

Screening studies indicated a pre-emergence application of metolachlor at 2880 g ha^{-1} followed by a split application of bentazone at 960 g ha^{-1} (320 g ha^{-1} at *A. powellii* 2-leaf growth stage, 640 g ha^{-1} at *A. powellii* 4-leaf growth stage) selectively controlled *A. powellii* in green beans. Acifluorfen applied at 448 g ha^{-1} at *A. powellii* 2-leaf growth stage, or as a split application (224 g ha^{-1} at *A. powellii* 2-leaf, 224 g ha^{-1} at *A. powellii* 4-leaf) also selectively controlled *A. powellii* in green beans.

Improvements in farm hygiene practices were considered critical in reducing the spread of *A. powellii* in the first instance.

INTRODUCTION

Amaranthus (*Amaranthus powellii* S. Watson) is an annual spring germinating weed common in Tasmania. DPIF investigations (Bishop 1993) have indicated *A. powellii* was the worst competitive and contaminating weed of green bean crops and could not be effectively controlled. The incidence of *A. powellii* in green bean crops has increased in recent years and green bean producers said the problem was getting worse. Both growers and processors considered *A. powellii* a significant threat to the economic viability of the green bean industry in Tasmania. Once established in local patches the infestations spread rapidly. Spread is assisted by machinery and livestock such as sheep, presenting this weed as a priority farm hygiene issue.

A. powellii in green bean crops reduces crop yields and increases the chances of a processor by-pass. When the infested crop is harvested the *A. powellii* florets break from the plant and are picked up by the harvester along with the beans. The result is a contaminated harvest of beans that is both expensive and time consuming to clean. In Tasmania, current attempts at control of *A. powellii* in established bean crops has been largely unsuccessful. At the core of control difficulties is the lack of a registered selective herbicide strategy to control *A. powellii.*

The primary objective of this study was to identify an appropriate selective herbicide strategy to control *A. powellii* in green bean crops in Tasmania.

MATERIALS AND METHODS

The experiment was established at the Forthside Vegetable Research Station (FVRS), Tasmania on the 9 December 1994. Green beans (*Phaseolus vulgaris* L. cv. Montana) were sown into a prepared seed bed, previously drilled with band placed NPK (11:12:19) fertilizer, using a tractor mounted Fiona® seed drill. Beans were planted in rows 30 cm apart, the sowing operation consistent with local commercial establishment practices. As conditions were very dry, the site was irrigated with 20 mm of water shortly after sowing.

The experiment was designed and established as a complete randomized block design consisting of eight treatments (6 herbicide strategies + 1 handweed + 1 nil) replicated four times. Plots measured 2 m × 10 m. The herbicides tested are detailed in Table 1. The treatments applied along with their codes are listed in Table 2.

The site was irrigated throughout the season based on commercial crop recommendations.

Table 1. Details of treatments tested.

Herbicide active	Commercial product	Active	Low rate	High rate
Acifluorfen	Blazer®	224 g L^{-1}	1 L ha^{-1} (224 g ha^{-1})	2 L ha^{-1} (448 g ha^{-1})
Bentazone	Basagran®	480 g L^{-1}	1 L ha^{-1} (480 g ha^{-1})	3 L ha^{-1} (1440 g ha^{-1})
Metolachlor	Dual®	720 g L^{-1}	2 L ha^{-1} (1440 g ha^{-1})	4 L ha^{-1} (2880 g ha^{-1})

Quantity of active ingredient in dose is given in brackets beside the dose of the commercial product.

Table 2. Time of application for each treatment.

Code	Pre-emergence	AMA 2lf	AMA 4lf	AMA 6lf
S1	metolachlor (2880 g ha^{-1})	bentazone (480 g ha^{-1})	bentazone (960 g ha^{-1})	–
S2	metolachlor (2880 g ha^{-1})	–	bentazone (480 g ha^{-1})	bentazone (960 g ha^{-1})
S3	metolachlor (2880 g ha^{-1})	–	–	bentazone (1440 g ha^{-1})
S4	acifluorfen (448 g ha^{-1})	–	–	–
S5	–	acifluorfen (448 g ha^{-1})	–	–
S6	–	acifluorfen (224 g ha^{-1})	acifluorfen (224 g ha^{-1})	
HW	hand weeded			
Nil	no herbicides			

Post-emergence applications were based on the growth stage of *A. powellii* (AMA 2lf = 2-leaf, AMA 4lf = 4-leaf, AMA 6lf = 6-leaf).

Application timing of herbicide was based on the growth stage of the *A. powellii*. Herbicides were applied using a Kubota® tractor mounted 2 m width boom. Nozzles used were XR TeeJet® Fan 11003VP. The sites were monitored at 10–14 day intervals after the treatments were applied, and efficacy and phytotoxicity data were collected based on the EWRS scoring system.

The bean plants were harvested on 20 February 1995. Plants were removed from a one metre square buffered area within the plot. They were removed whole, roots cut off and discarded. The number of plants were counted and bean pods removed from the plant and weighed to determine crop yield. Remaining plant material was dried in a fan-forced oven at 35°C for 5 days, and then weighed to determine dry plant biomass.

Residue tests were conducted by Analchem Bioassay Pty. Ltd. on bean pods and plants.

Table 3. Yield data for green beans grown at FVRS.

Treatment	Bean yield (g m^{-2})	Bean plant no.	Plant biomass (g m^{-2})
S1	1545	30	217
S2	1333	29	245
S3	1424	33	267
S4	1588	35	272
S5	5928	33	228
S6	5580	32	284
HW	1802	32	284
Nil	1069	34	220
LSD (P=0.05)	144.78	–	–

RESULTS AND DISCUSSION

Bean yield The largest yields were obtained with treatments S5 and S6 (Table 3). Both treatments were post-emergence applications of acifluorfen. The yield of the green beans decreased significantly (P=0.05) when the dose was applied as a split application. However, even this treatment produced significantly (P=0.05) higher yields compared to the nil treatment (and compared to the bentazone post-emergent treatments). The decrease due to the split application could be due to the second application being applied at a later stage of *A. powellii* growth and consequently to a more mature bean crop. This reflects a need to minimize crop effects through early application of acifluorfen. S4, the pre-emergent application of acifluorfen, yielded significantly (P=0.05) less than its post-emergent treatments indicating the full potential of acifluorfen for weed control is only obtained when it is applied as a post-emergent spray.

Each of the treatments where metolachlor was applied as a pre-emergent application also showed significantly (P=0.05) higher increases than the nil treatment. The earlier split application of bentazone as a post-emergent spray yielded higher than the later split applications. Bentazone is known to be slightly phytotoxic to beans and must be used carefully. The negative yield effects may have been due to the extended effect of bentazone brought on by the split treatment. This was supported by the fact that a single dose of bentazone later in the season was not significantly (P=0.05) different to early split applications of bentazone.

The other yield parameters measured, bean plant number and biomass, showed no significant (P=0.05)

Table 4. EWRS efficacy scores for *A. powellii*.

Treatment	11 Jan	23 Jan	31 Jan
S1	2.5 (27 DAT)	2.5 (39 DAT)	1.5 (46 DAT)
S2	5.5 (27 DAT)	4.0 (39 DAT)	4.5 (46 DAT)
S3	5.5 (27 DAT)	5.5 (39 DAT)	2.5 (46 DAT)
S4	6.0 (27 DAT)	6.5 (39 DAT)	7.5 (46 DAT)
S5	1.0 (8 DAT)	2.8 (20 DAT)	2.5 (28 DAT)
S6	2.0 (8 DAT)	1.8 (20 DAT)	1.0 (28 DAT)
HW	1.0	1.0	1.0
Nil	1.0	1.0	1.0
LSD (P=0.05)	1.19	–	0.39

DAT refers to days after the first treatment.
1=healthy plant, 9=total kill, commercially acceptable <5.

Table 5. Phytotoxicity scores for green beans at FVRS.

Treatment	11 Jan	31 Jan
S1	2.0 (27 DAT)	2.0 (46 DAT)
S2	2.0 (27 DAT)	2.0 (46 DAT)
S3	2.0 (27 DAT)	2.8 (46 DAT)
S4	2.0 (27 DAT)	2.0 (46 DAT)
S5	3.3 (8 DAT)	2.0 (8 DAT)
S6	2.8 (8 DAT)	4.0 (8 DAT)
HW	1	1
Nil	1	1
LSD (P=0.05)	0.39	0.15

DAT refers to days after the first treatment.
1=healthy plant, 9=total kill, commercially acceptable <5.

difference between treatments and across sites. This indicated none of the treatments resulted in plant death, or reduction in plant size. The effects were confined to increases in bean yield, emphasising improvement in plant production probably due to decreased competition from *A. powellii* and other weeds.

Efficacy The most efficacious treatments were S5 and S6, the post-emergent acifluorfen treatments. Each of the metolachlor treatments were also effective in controlling *A. powellii*. This study demonstrated that metolachlor used in conjunction with bentazone results in a commercially acceptable level of control. The only commercially unacceptable treatment was the single application of acifluorfen as a pre-emergent application indicating its lack of suitability as a pre-emergent herbicide.

Phytotoxicity All treatments were commercially acceptable in terms of phytotoxicity (Table 5). Significant (P=0.05) differences within the scores indicated that the metolachlor treatments were the least phytotoxic followed closely by acifluorfen. Acifluorfen phytotoxicity is likely if it is applied late in the growth of the bean crop; the phytotoxicity scores showed an increase the later the application of acifluorfen was made. Early and strategically timed applications of acifluorfen appeared to overcome any phytotoxic problems.

Residues Nil residues were detected for most of the treatments tested with some exceptions showing trace residues. No acifluorfen was detected in the bean pod samples. Where pods and plants were tested together traces up to 0.03 ppm (at or near the limits of detection) were detected where 224 g ha^{-1} of acifluorfen was applied at the 4-leaf stage of *A. powellii*, or the days after application were reduced due to circumstances beyond our control. A trace of metolachlor was detected in only one replicate of one sample tested.

ACKNOWLEDGMENTS

This study was funded by the Horticultural Research and Development Corporation, Tasmanian Farmers and Graziers Association (Vegetable Growers Council), Edgell Birdseye Pty. Ltd., McCain Foods Pty. Ltd. and the Department of Primary Industry and Fisheries, Tasmania. The authors would like to thank Mr. Craig Palmer and Mr. Lars Dittmann for additional technical assistance, and Mr. Lyndon Butler and Mr. Frank Mulcahey for their advice and management of the crop at Forthside Vegetable Research Station.

REFERENCE

Bishop, A.C. (1993). The significance of Amaranths as weeds of crops in Tasmania. Abstracts 10th Australian Weeds Conference and 14th Asian-Pacific Weed Science Society Conference, Brisbane, Australia, 6–10 September 1993, p. 78.