A Comparison of solarisation and secondary cultivations to control *Papaver dubium* L. in commercial poppy crops.

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ABSTRACT

This study compared the efficacy of soil solarisation treatments and secondary cultivations for the control of the most common wild poppy species, the long-head poppy (*Papaver dubium* L.) in plantings of commercial poppies in Tasmania. Results indicated a solarisation period of at least 20 days, or a secondary cultivation at 30 days, significantly (P = 0.05) reduced the total biomass of *P. dubium* occurring in the test plots. This failed to translate into increased yields of commercial poppy straw and seed. Surface soil temperatures achieved in this study only reached a maximum of 25^0C with the solarisation process responsible for an increase in temperature of up to 6^0C. Although these temperatures were not high enough to destroy weed seeds, it is argued that combined with sufficient moisture, they break dormancy and accelerate germination and emergence of weed seeds. Germinated seedlings either died while under the solarising film or once the film was removed.

KEY WORDS

Papaver, solarisation, poppy, weed, *Papaver somniferum* L., *Papaver dubium* L.

INTRODUCTION

Five species of wild poppies (*Papaver dubium* L., *P. hybridum* L., *P. argemone* L., *P. rhoeas* L., and *P. somniferum* spp. *Setigerum* L.) have been identified as weeds in commercial poppy crops in Tasmania (1). Competition from wild poppy species in poppy crops results in decreased commercial yields. Selective control of wild poppy species with herbicides is difficult due to both the weed and crop plants belonging to the same genus and having similar biochemical and morphological attributes. Initial laboratory and field based work established germination profiles for the wild poppy species occurring in Tasmania (1) and provided indications as to potential management options for wild poppies that required further study. This work also indicated the most common wild poppy species posing a weed threat to commercial poppy crops was *P. dubium*. The objective of this experiment was to determine the efficacy of two potential management options, solarisation or a second cultivation before planting (secondary cultivation), in controlling *P. dubium* in commercial poppy crops in Tasmania.

METHOD

The experiment was established on a commercial farm on red ferrosol soil type at Harford in Tasmania. Site preparation was undertaken by the grower as for the planting of commercial poppy crops with the final seedbed being worked to a fine tilth. Following the relevant solarising treatments (Table 1), and immediately prior to sowing, a Senior? push drill was used to place a banded application of 250kg/ha of 14:16:11 NPK fertiliser. The fertiliser was placed at a depth of 70 mm in the rows, spaced 150 mm apart to establish a plot measuring 5 m by 1.5 m. As each row of fertiliser was drilled another operator using a Planet Junior? push drill sowed a second banded application of poppy seed (900 g/ha) and lime-superphosphate (180 kg/ha) at 40-60mm. All poppies were hand thinned to approximately 100mm intra-row three weeks after sowing. Sampling blocks measuring 2 m by 1 m were marked within each plot and these areas were subsequently used for harvest and yield calculations.

Experimental plots were established as a randomised complete block design with four replicates for each treatment. A control consisted of a conventionally prepared and planted seedbed that was neither solarised or subject to secondary cultivation for the course of the experiment. Black polyethylene sheeting (classified as builder’s grade and approximately 0.5 mm thickness) was used as the solarising film. It was rolled onto the plots to be treated and then cut to size, and the edges secured by burial. Commercial poppies were sown into the solarised seed bed immediately after removal of the film. Secondary cultivations of the plots were made at the same time each of the solarising films were removed as a comparative treatment and were sowed at the same time. Soil temperatures were measured at one location within each plot using Hobo? dataloggers at 0-10 mm and 20-30 mm depth. All plantings were subject to a standard commercial crop herbicide regime.

Dry matter biomass measurement cuts were made using a 0.25m^2 quadrat at the completion of each treatment. Biomass cuts were oven dried at 65^{0}C for two days. At maturity, poppy capsules within the sampling blocks were hand picked. Capsules from each treatment were oven dried at 65^{0}C for two days. The dried capsules were then broken and seed collected and weighed. The remaining capsule shell was weighed and formed the straw component of the yield.

Table 1. Treatments and treatment codes for experiments.

Treatment	Code	Cultivated	Planted
Hand Weed	HW	21st August 94	25th August 94
Control- No solarisation	C0	21st August 94	25th August 94
20 days cultivation	C2	13th September 94	13th September 94
30 days cultivation	C3	23rd September 94	23rd September 94
49 days cultivation	C4	11th October 94	11th October 94
20 days solarise	S2	Nil	13th September 94
30 days solarise	S3	Nil	23rd September 94
49 days solarise	S4	Nil	11th October 94

RESULTS

Biomass measurements: A solarisation period of 20 days significantly (P = 0.05) reduced the biomass of *P. dubium*, but periods longer than this gave no significant additional benefit. A secondary cultivation did not significantly reduce biomass after 20 days but significantly reduced biomass at 30 days and 49 days. There was no significant gain in *P. dubium* biomass reduction between the 30 day and 49 day period.

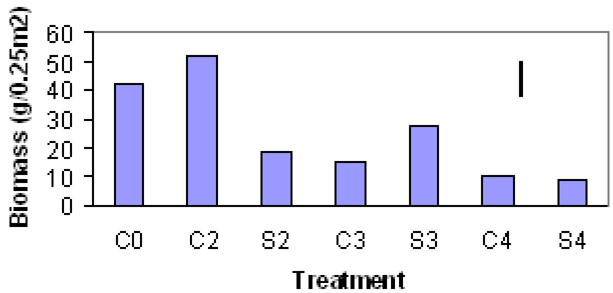

Figure 1. Mean biomass of *P. dubium* per quadrat at harvest under each solarising treatment of 20 (S2), 30 (S3), and 49 (S4) days compared with three second-cultivation intervals of 20 (C2), 30 (C3), and 49 (C4) days and an untreated control (C0). The vertical line indicate l.s.d at P = 0.05.

Straw/seed yield of commercial poppies under each treatment: The yield data collected for both commercial poppy straw and seed for each quadrat cut indicated there were no significant (P = 0.05) yield benefits due to solarisation or second-cultivation compared with the conventionally prepared and treated control. (Fig. 2).

Soil temperature increase due to solarisation: Surface soil temperature (0-10 mm) data indicated a minimum soil temperature of 3^0C and maximum soil temperature of 25^0C due to solarisation. Temperatures at depth (20-30 mm) indicated a minimum temperature of 5^0C and maximum temperature of 20^0C due to solarisation. These compared to the control plots where the surface soil temperature ranged from 2^0C to 19^0C and the minimum/maximum range at depth was 3^0C to 17^0C.

Table 2. Mean soil temperature increases due to solarisation over a 120 day period (August, September, October, and November 1994).

Soil depth	Min. Temperature (^{0}C)	Max. Temperature (^{0}C)
0-10 mm	1	6
20 – 30 mm	2	3

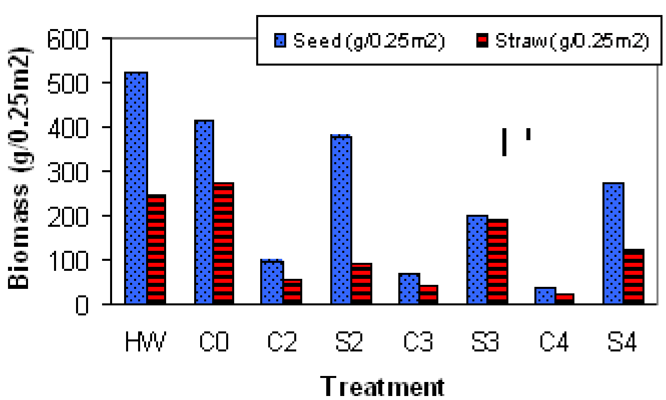

Figure 2. Mean Commercial poppy yield (seed and straw) under each solarising treatment of 20 (S2), 30 (S3), and 49 (S4) days compared with three secondary cultivation intervals of 20 (C2), 30 (C3), and 49 (C4) days and a conventionally prepared control (C0). A hand weeded (HW) treatment

is also included. The vertical line indicate l.s.d at P = 0.05. Lines indicate l.s.d at P = 0.05 for seed (left bar) and straw (right bar).

DISCUSSION

Biomass and secondary cultivation treatments both significantly reduced the biomass of *P. dubium* but this failed to translate into significant seed/straw yield gains in the commercial poppy yields. It is important to consider the solarising process in the context of climate conditions experienced at the trial site. Solarisation is referred to widely in the literature as being capable of controlling plant diseases and weed pests (2). Much work has been done in countries such as the USA and Israel (3) as to the potential of polyethylene mulches to control plant pests including weeds. However in these places, soil temperatures under the plastic mulch have been high enough to denature proteins and physically destroy weed seeds. Surface soil temperatures achieved in this study only reached a maximum of 25^{0}C with the solarisation process responsible for an increase in temperature of up to 6^{0}C. Although these temperatures are not high enough to destroy weed seeds, it is argued that combined with sufficient moisture, they break dormancy and accelerate germination and emergence of weed seeds. Germinated seedlings were spindly and chlorotic; they either died while under the solarising film or once the film was removed. This latter effect was possibly caused by rapid dehydration (Plate 1).

Secondary cultivations had little effect on *P. dubium* biomass at 20 days but significant decrease at 30 days. Waiting a further 19 days was no more effective than the 30 day treatment. This may indicate fewer P. *dubium* plants germinated in the later sowing periods. Bishop and Pemberton (1) indicated *P. dubium* has a single large germination flush rather than a staggered germination throughout the season; it is likely this flush occurred before the 30 day period had elapsed.

Plate 1. Exposed *P. dubium* seedlings emerged under the solarising film. These seedlings withered and died within a few hours of exposure.

CONCLUSIONS

Solarisation and secondary cultivation treatments in Tasmania have the potential to significantly reduce the biomass of *P. dubium* in commercial poppy crops although this may not translate into seed/straw yield gains. However by reducing *P. dubium* populations using these treatments, yield benefits may accrue to future poppy crops. Temperature measurements indicate the solarisation effect is unlikely to be due to the denaturing of the poppy seed but rather the premature breaking of *P. dubium* dormancy and forced germination under the solarising film. This results in the death of the *P. dubium* seedlings. Consideration needs to be given to the additional costs associated with solarisation treatments and additional cultivations given that there is no immediate yield benefit. Further investigation of impact on other weeds is recommended as well as comparative economic analyses.

ACKNOWLEDGMENTS

I would like to thank the following organisations for their financial support of this work: Horticultural Research and Development Corporation, Tasmanian Alkaloids Pty Ltd, GlaxoWellcome (Australia) Ltd, and the Department of Primary Industries, Water and Environment. Technical support provided by Brett Pemberton, Joanne Stagg, Craig Palmer, and Lars Dittmann is appreciated. Special thanks to Bill Cotching (DPIWE), Mark Boersma (DPIWE), and Tony Fist (Tasmanian Alkaloids Pty Ltd) for assistance in reviewing this paper.

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