Effect of pre-fallowing application of glyphosate on hoary cress (*Cardaria draba* (L.) Desv.)

D. M. Waterhouse
Horsham District Office, Department of Agriculture, Victoria 3400

J. E. Mahoney
Victorian Crops Research Institute, Horsham, Victoria 3400

Summary

Hoary cress (*Cardaria draba* (L.) Desv.) is a vigorous perennial weed with a deep spreading root system from which many aerial shoots are produced. Trials to evaluate the effect of glyphosate on hoary cress were conducted between 1978 and 1981. Glyphosate was used at four rates ranging from 0.36 to 2.16 kg a.i. ha^{-1} applied to pasture prior to fallowing in July and September 1978 (Experiment 1) and August 1981 (Experiment 2). Wheat was then sown the following June. Glyphosate at 0.54 kg a.i. ha^{-1} gave effective control of hoary cress when applied in August and this gave increases in grain yield in 1981, but not in 1979.

Introduction

Hoary cress (*Cardaria draba* (L.) Desv.) is one of the most serious perennial weeds infesting Victorian crops and pastures. It is a proclaimed noxious weed in Victoria, Queensland, South Australia, Western Australia, Tasmania and parts of New South Wales. It propagates by seeds, rhizomes and from severed root pieces, and can be effectively spread by frequent cultivation (Morgan, 1931).

Early attempts (1926–29) to eradicate this weed included regular cultivations (at least every 14 days for 2 years), spraying with arsenic pentoxide, and applications of common salt (NaCl) at rates of 6 to 74 t ha^{-1} (Morgan, 1931; 1934; Pemberton and Prunster, 1940). However, these methods were either unreliable, ineffective or impractical.

Since the 1940s, the use of phenoxy herbicides has provided some measure of control (Moore, 1953). For example, spraying four successive wheat crops at the post-tillering stage with 842 g a.i. 2,4–D amine ha^{-1} reduced the hoary cress population by 98% (Tuohey, 1969). Sowing infested land to pasture for 4 years also reduced weed numbers (Ferns, unpublished data), but for economic reasons this technique has not proved to be a practical solution.

In recent years hoary cress has become a more conspicuous problem in the Wimmera due probably to three factors: an increase in cropping intensity, a series of wet seasons (1978–81), and the reduced use of 2,4-D amine in cereals.

Following the successful control of another perennial weed soursob (*Oxalis pes-caprae* L.), by a pre-fallowing application of glyphosate (Mahoney, 1982) it was decided to evaluate this technique for hoary cress.

Methods

A site was selected at Greenland Dam 8 km north of Horsham on a friable grey clay soil (Ug 5.24) (Northcote, 1971) typical of the area where hoary cress is a problem. Experiment 1 commenced in 1978 while Experiment 2 was established in 1980 in immediately adjoining plots. A randomized block designed with three replications was used in both experiments. All plots measured 20 m x 3.5 m.

Experiment 1: 1978–79 Two herbicides were applied: glyphosate (360 g L^{-1}) at 2.16 kg a.i. ha^{-1} and 2,4-D amine (500 g kg^{-1}) at 0.85 kg a.i. ha^{-1}. Both herbicides were applied through Spraying Systems flat fan tee jet nozzles on a hand held plot sprayer in a volume of 112 L ha^{-1} at a pressure of 210 kPa. The herbicides were applied as a pre-fallowing application to undisturbed pasture in the season prior to cropping. The plots were then cultivated as necessary, with the exception of the chemical fallow treatments which received three applications of either glyphosate or 2,4-D amine. The chemical fallow treatments were cultivated prior to sowing in 1979.

Trifluralin (400 g L^{-1}) at 400 g a.i. ha^{-1} was applied 1 month prior to sowing to remove a number of broadleaf weeds. Wheat (c.v. Olympic) was sown at 80 kg ha^{-1}, with 110 kg ha^{-1} superphosphate, on 11 May 1979. The density of hoary cress was counted 12 weeks later in 10 quadrats each 0.25 m^2 per plot.

Experiment 1: recropped in 1981 After harvest of site 1 in December 1979, the area was left as a volunteer pasture until 18 August 1980 when it was again fallowed. Trifluralin (400 g L^{-1}) at 400 g a.i. ha^{-1} was applied 1 month prior to sowing. Wheat (c.v. Olympic) was sown at 80 kg ha^{-1} with 100 kg ha^{-1} superphosphate on 17 June 1981. The density of hoary cress was counted 10 weeks later in 10 quadrats each 0.25 m^2 per plot.

Table 1 (Experiment 1) The effect of pre-fallowing applications of glyphosate and 2,4-D amine in 1978 on hoary cress density and grain yield in 1979

Treatment (1978)		Hoary cress[3] Density m^{-2} (7.9.79)	Grain yield Dec. 1979 (t ha^{-1})
normal fallow – July		56.9 (1.76) ef	3.33 abc
late fallow – September		68.7 (1.84) f	2.92 cd
glyphosate[1]	July + cultivation	18.9 (1.28) b	3.53 ab
	August + cultivation	21.2 (1.33) bc	3.36 abc
	September + cultivation	9.2 (0.97) a	3.15 bcd
2,4-D amine[2]	July + cultivation	55.9 (1.75) ef	3.36 abc
	August + cultivation	46.4 (1.67) def	2.88 d
	September + cultivation	48.9 (1.69) ef	2.96 d
glyphosate (chemical fallow) (July, September, March)		14.6 (1.16) ab	3.60 a
2,4-D amine (chemical fallow) (July, September, March)		37.1 (1.57) cde	3.12 cd
L.S.D. (P = 0.05)		(0.23)	0.36

[1]all glyphosate treatments applied at 2.16 kg a.i. ha^{-1}

[2]all 2,4-D amine treatments applied at 0.85 kg a.i. ha^{-1}

[3]Figures within the same column followed by the same letter do not differ significantly (P > 0.05)

Figures in brackets refer to log (x + 1) transformation.

Table 2 (Experiment 1) The effect of pre-fallowing applications of glyphosate and 2,4-D amine in 1978 on hoary cress density and grain yield in 1981

Treatment (1978)		Hoary cress Density m^{-2} (27.8.81)	Grain yield Dec. 1981[3] ($t\ ha^{-1}$)
normal fallow – July		25.8	3.15 d
late fallow – September		19.7	3.29 cd
glyphosate[1]	July + cultivation	15.6	3.67 abcd
	August + cultivation	11.9	3.79 abc
	September + cultivation	9.5	4.15 a
2,4-D amine[2]	July + cultivation	25.6	3.50 bcd
	August + cultivation	22.0	3.75 abcd
	September + cultivation	31.2	3.67 abcd
glyphosate (chemical fallow) (July, September, March)		17.9	4.10 ab
2,4-D amine (chemical fallow) (July, September, March)		33.1	3.34 cd
L.S.D. (P = 0.05)		NS	0.54
(P = 0.01)			0.73

[1]all glyphosate treatments applied at 2.16 kg a.i. ha^{-1}
[2]all 2,4-D amine treatments applied at 0.85 kg a.i. ha^{-1}
[3]figures within the same column followed by the same letter do not differ significantly ($P < 0.05$).

Table 3 (Experiment 2) The effect of pre-fallowing aplications of four rates of glyphosate in August 1980 on hoary cress density and grain yield in 1981

Treatment (1980)	Hoary cress[1] Density m^{-2} (27.8.81)	Grain yield Dec. 81 ($t\ ha^{-1}$)
control (normal cultivation)	66.4 (1.82) c	2.96 b
glyphosate 2.16 L a.i. ha^{-1} + cultivation	4.1 (0.61) a	4.14 a
glyphosate 0.72 L a.i. ha^{-1} + cultivation	10.7 (1.03) b	4.18 a
glyphosate 0.54 L a.i. ha^{-1} + cultivation	11.4 (1.06) b	4.20 a
glyphosate 0.36 L a.i. ha^{-1} + cultivation	24.8 (1.39) b	3.67 ab
L.S.D. (P = 0.05)	0.36	0.72
(P = 0.01)	0.52	1.05

[1]figures within the same column followed by the same letter do not differ significantly ($P > 0.05$).
Figures in brackets refer to log (x + 1) transformation.

Experiment 2: 1980–81 Experiment 2 compared the effects of four rates (0.36, 0.54, 0.72 and 2.16 kg a.i. ha^{-1}) of glyphosate applied on 13 August 1980, with a normal cultivated fallow which was first cultivated on 18 August 1980 using a scarifier. All treatments were subsequently cultivated as necessary. Trifluralin was applied 1 month prior to sowing and the site sown on 17 June 1981. The density of hoary cress was counted 10 weeks after sowing using 10 quadrats each 0.25 m^2 per plot.

Results

Pre-fallowing treatments (Experiment 1)

All glyphosate treatments reduced hoary cress numbers by at least 62%, whereas the use of 2,4-D amine did not significantly ($P > 0.05$) affect the weed density (Table 1). Glyphosate applied in September resulted in the greatest reduction in hoary cress numbers. Applications of either herbicide in July and glyphosate in August and September did not affect grain yields significantly ($P > 0.05$) when compared with a normal fallow treatment, whereas yields were reduced by the August and September applications of 2,4-D amine and the late cultivation treatment.

Following the sowing of a second wheat crop on this site in 1981, there were no significant differences ($P > 0.05$) in the density of hoary cress plants (Table 2). However, there was a response in grain yield to two of the spray treatments carried out in 1978; significant ($P < 0.01$) increases in yield above that on normal fallow occurred on plots treated with glyphosate in September and those chemically fallowed with glyphosate.

Pre-fallowing application of four rates of glyphosate (Experiment 2)

Glyphosate at all rates resulted in significant reductions ($P < 0.05$) in the density of hoary cress followed by increases in grain yield (Table 3). The highest rate 2.16 kg a.i. ha^{-1} reduced the population of hoary cress by 93% and the lowest rate 0.36 kg a.i. ha^{-1} by 62%.

Discussion

The success of hoary cress as a weed is due in part to its ability to regenerate from root fragments and, hence, to spread by cultivation (Morgan, 1931). In both experiments all treatments, except those sprayed on the fallow in Experiment 1, received up to 10 cultivations during the fallowing and sowing operations. As all plots were cultivated lengthwise in succession, hoary cress root pieces may have been dragged from one plot to the next during cultivations. This may explain why no significant differences were measured in Experiment 1 in the crop in 1981 following a further 10 cultivations during the fallow period, even though effective control was visually apparent on the glyphosate treatments prior to fallowing in 1980.

In Experiment 1, the September application of glyphosate gave increased control of hoary cress — an 86% reduction when compared to 72% and 69% in July and August respectively but the improved weed control failed to produce an increased grain yield. In fact, the delay in fallowing outweighed the effect of the greater reduction in hoary cress numbers and resulted in poorer grain yields. This is consistent with the earlier findings of Rooney, Sims and Tuohey (1966) that to maximize grain yields the optimum time to fallow in the Wimmera is July–August. Consequently, all treatments in Experiment 2 were commenced in mid-August 1980.

The results of Experiment 2 demonstrate that glyphosate at rates as low as 0.54 kg a.i. ha^{-1} can give effective control of hoary cress. Smith and Lewis (1979) also found this to be an effective rate. While 0.36 kg a.i. ha^{-1} glyphosate reduced the density of hoary cress by 62%, this was insufficient to give a significant grain yield response. Glyphosate at 0.54 kg a.i. ha^{-1} would appear the optimum

economic rate as no further benefit was obtained using 0.72 kg a.i. ha^{-1} and while 2.16 kg a.i. ha^{-1} reduced hoary cress numbers by 93%, no additional increase in grain yield was obtained.

It is concluded therefore that the use of glyphosate at 0.54 kg a.i. ha^{-1} prefallowing is a viable technique for the long term control of hoary cress, with the possibility of subsequent increases in wheat yield.

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Glossary of terms

Damping-off – A disease that rots seedlings at soil level or prevents their emergence.

Dangerous Poison – A signal word used on pesticide labels that lets the user know the pesticide is highly toxic (Poison Schedule 7) and that extra care is required. The label also bears the instruction 'Read Safety Directions Before Opening'. Schedule 7 poisons are not available to householders and hobby gardeners.

Days to Harvest – The minimum number of days, established by law, between the final pesticide application and the harvest date – generally referred to as the 'withholding period'.

Decontaminate – To make safe, purify, make fit for use again by removing any pesticide from equipment or other surfaces as directed by a pesticide label, and agricultural authority, or the manufacturer of the pesticide.

Deflocculating Agent – An adjuvant which prevents the clumping together of particles (settling out) of solids in the suspension in the spray tank.

Defoliant – Any substance or mixture of substance causing the leaves or foliage to drop from a plant, with or without causing abscission.

Degradability – A chemical's ability to break down into less complex compounds or elements (usually in soil, water or other environmental component).

Degradation – A process by which a chemical is converted to another, usually less complex, compound. This process can be a result of the action of microbes, water, air, sunlight, or other agents.

Delayed Action – A response to a pesticide that does not occur for a considerable period after the treatment has been applied. The lack of an immediate response.

Deliquescent – Having the property of picking up moisture from the air to such an extent as to dissolve in this liquid: becoming liquid on exposure to air.

Density – Bulk Density: Mass of the material divided by the volume occupied under stated conditions of free pouring. Tap Density: Mass of the material divided by the volume occupied when compacted without pressure.

Deposit – The amount of pesticide remaining on the target immediately following an application.

Dermal – Through or by the skin; of or pertaining to the skin.

Dermal Toxicity – A measure of the poisonous effect of a pesticide to an animal or person when in contact with and absorbed through the skin. (Note: Dermal toxicity is the greatest hazard to people handling pesticides. Dermal exposure often occurs because a pesticide is spilled onto clothing and protective equipment or directly onto the skin. Be careful!)

Desiccant – Any substance or mixture of substances intended for artificially accelerating the drying of plant tissues. Usually used as an aid to harvesting.

Desiccation – Dehydration (removal of tissue moisture) by chemical or physical action. Chemicals which promote desiccation are called *desiccants.*

Detergent – A cleaning agent: a term usually reserved for chemicals used to clean a substance from a solid surface by an action other than by dissolving that substance.

Detoxify – To make harmless; to neutralize a poison; to remove a poisonous effect.

Diatomaceous Earth – A whitish powder – the skeletons of prehistoric micro-organisms (diatoms) used as an absorbent in the manufacture of pesticides.

Dicotyledon – A plant with two cotyledons – generally referred to as broadleafed plants. Having leaves with the veins like a net – unlike the leaves of grasses, lilies and palms where the veins run parallel to each other for the whole length of the leaf.

Diluent – A substance used to dilute a concentrated material to a usable or desirable strength. For dusts it can be something like talc, kaolin, or diatomaceous earth; for liquids it is usually water but can be diesel oil. Any gas, liquid, or solid material used to reduce the concentration of an active ingredient in a formulation.

Directed Application – Precise application to a specific area or plant organ such as to a row or bed or to the lower leaves and stems of plants.

Disease – A condition in which any part of living organism is abnormal; harmful deviation from normal functioning of physiological processes.

Dispersible Powder – A formulated powder intended for dispersion in water (or other liquid) for application. Also referred to as 'wettable powder'.

Dispersing Agent – An adjuvant that reduces the attraction between fine particles.

Distinguishing Name – The name to be used on the label and in promotional literature for the product (agricultural or veterinary chemical). It should include such descriptive words or phrases as are needed to distinguish the product from all others and to identify the purpose for which it is to be used.

Dormancy – A state of suspended development – inhibited germination of seeds or growth of plant organs.

Dormant – A state in which seeds or other plant organs temporarily stop growing.

Downwind – Direction *toward which* the prevailing wind is blowing.

Drift – The movement of pesticide droplets or particles by wind and air currents from the target area to an area not intended to be treated. The movement of spray particles beyond the intended target area.