CONSERVATION TILLAGE FARMING IN NORTHERN NEW SOUTH WALES AND QUEENSLAND WITH CHLORSULFURON [1]

D.C. POLLOCK and R.C. DAVIS

Du Pont (Australia) Ltd.,
P.O. Box 930,
North Sydney, N.S.W., 2060.

Summary. Three conservation tillage experiments based on the use of chlorsulfuron at 15 to 30 g ha^{-1} were installed during 1982 in northern N.S.W. and Queensland on soils ranging in pH from 6.0 to 8.0. In one experiment application was made during the winter cereal crop, while in the others treatments were applied in the fallow, one following a winter cereal and one following a summer crop. In all cases weed control during the fallow was assessed periodically; however only the latest evaluations recorded are presented in this paper. The trial on the pH 6.0 soil received two applications of chlorsulfuron in combination with glyphosate at 540 g ha^{-1}; the latest evaluation following each application is presented.

Chlorsulfuron at 15 g ha^{-1} provided good to excellent control of Caltrop *(Tribulus terrestris)*, Pigweed *(Portulaca oleracea)*, Black Pigweed/ Giant Pigweed *(Trianthema portulacastrum)*, Peppercress *(Lepidium spp.)*, Mintweed *(Salvia reflexa)*, Soft Roly Poly *(Salsola kali)*, Common Thornapple *(Datura stramonium)* and Rhynchosia *(Rhynchosia minima)* 91 to 203 days post-application. Common Sowthistle *(Sonchus oleraceus)*, Bladder Ketmia *(Hibiscus trionum)* and Prickly Paddy Melon *(Cucumis myriocarpus)* were well controlled for 105 days with chlorsulfuron at 22.5 g ha^{-1}. Liverseed grass *(Urochloa panicoides)*, Buffel grass *(Cenchrus ciliaris)* and Lovegrass *(Eragrostis spp.)* were not adequately controlled with chlorsulfuron.

Chlorsulfuron can be applied either in-crop for in-crop weed control followed by fallow weed control, or applied any time in fallow for winter cereal to wheat fallows and summer crop to wheat fallows. Longest term weed control is achieved in alkaline soils; the more alkaline the soil the longer the duration of weed control achieved from a single application of chlorsulfuron.

INTRODUCTION

Chlorsulfuron has been available in Australia since 1982 for the selective control of a broad spectrum of weeds in wheat *(Triticum aestivum)*, barley *(Hordeum vulgare)*, oats *(Avena sativa)*, triticale *(X Triticosecale spp.)* and rye *(Secale cereale)*. Application of chlorsulfuron for in-crop weed control may be made either pre-sowing incorporated by sowing for wheat and triticale only, or early post-emergence for all winter cereal crops. Use rates range from 11.25 to 18.75 g ha^{-1}.

[1]Trade name GLEAN®

Campion and Tichon (1981), and Ray (1981), reported that chlorsulfuron is absorbed by the plant through both its roots and leaves, and that it has both pre-emergence and post-emergence herbicidal activity.

The duration of herbicidal action of chlorsulfuron in the soil varies with soil conditions and plant species sensitivity. Hydrolysis is the main means of chemical degradation. The rate of hydrolysis is influenced by soil moisture, pH and temperature, with the most rapid breakdown occurring in soils of high moisture, low pH and high temperature.

As chlorsulfuron has both pre-emergence and post-emergence activity, coupled with its safety when applied pre-sowing to wheat and triticale, and its slower rate of hydrolysis in high pH soil, it would appear to have an important role to play in the further adoption of conservation tillage farming. The usefulness of chlorsulfuron in conservation tillage farming of the alkaline Wimmera soils has been reported by Swinnerton (1983) and Swinnerton and Davis (1984). Early work on the alkaline soils of northern N.S.W. and Queensland was reported by Fagan (1983).

The desirability and benefits of reducing the amount of soil disturbance in the cropping areas of northern N.S.W. and Queensland has been well documented by numerous researchers over at least the last decade. Rainfall in this area is summer dominant and often falls as thunderstorms of high intensity. Bare fallowed paddocks can be at great risk to soil erosion during these storms. Conservation tillage farming techniques are gradually being developed in these areas for the growing of winter and summer crops. The techniques revolve around protecting the soil surface from water and wind erosion, a minimal amount of soil disturbance, and maintaining the fallow as free of weeds as possible so the maximum amount of moisture can be stored in the soil for the next crop.

Fallow weed management in conservation tillage farming relies on the use of herbicides (as far as possible) in place of the traditional mechanical cultivations. To date foliar active herbicides have generally been used; however, several applications of one or more herbicides is often necessary to maintain an acceptably weed free fallow.

The wider adoption of conservation tillage farming techniques is dependant on farmers being convinced of the benefits from protecting their soil, the availability of suitable equipment, and the reduction of costs. If conservation tillage farming costs can be brought down to where crop establishment is clearly cheaper than with the traditional series of mechanical cultivations, adoption will be most rapid. One means of reducing costs is the use of soil active residual herbicides that provide prolonged periods of pre-emergence weed control. Such herbicides generally require fewer applications than foliar active herbicides to keep a fallow weed free, and thereby savings are made on application costs. They may also control a wider spectrum of weeds. Some soil active residual herbicides have the added advantage of being quite cheap.

Felton et al (1984) surveyed the main cereal areas of northern N.S.W. and found that many of the main problem weeds are summer growing species that occur in fallow. Observations of in-crop applications of chlorsulfuron at

11.25 to 18.75 g ha^{-1} have shown, in addition to extended control of some winter annuals through to harvest, control of some summer annuals beyond harvest into the fallow. These observations led to the fallow experiments in northern N.S.W. and Queensland reported in this paper.

MATERIALS AND METHODS

Three experiments representing different use situations were initiated in 1982 in northern N.S.W. and Queensland. Trial, treatment and agronomic details of these trials are detailed in Table 1. Chlorsulfuron was evaluated at 15, 22.5 and 30 g ha^{-1} in all experiments. In one experiment the chlorsulfuron treatments were applied in combination with glyphosate at 540 g ha^{-1}. In this same experiment, where the soil pH was 6.0, a second application was made. The herbicide treatments were applied using either a CO_2 pressurised small plot sprayer (Trial No. RJF/H7/82), a boom mounted on a utility (Trial No. RJF/H6/82) or a computer spray (Trial No. JBL/H4/82).

Table 1. Trial, treatment and agronomic details.

	Trial Number		
	RJF/H7/82	RJF/H6/82	JBL/H4/82
Location	Moree, N.S.W.	Crooble, N.S.W.	Moura, Queensland
Soil type	Black Earth	Black Earth	Grey Clay Loam
Soil pH	8.0	7.8	6.0
Chlorsulfuron applied	Feb. 12, 1982	Aug. 8, 1982	Oct. 27, 1982[a] & Jan. 26, 1983[a]
Use situation	to fallow pre-emergence	in-crop post-emergence	to fallow post-emergence
Plot size	0.004 ha	0.1 ha	0.195 ha
Replications	4	2	1

(a) in combination with glyphosate at 540 g ha^{-1}

Assessments of weed control for each trial were made at periodic intervals during the fallow. Weed efficacy assessments are expressed as weed biomass reduction on a 0 to 10 scale, where: -

0 = plot with highest level of infestation in the replicate in terms of weed biomass, and

5 = 50% reduction in weed biomass compared to the plot that scores "0" in the same replicate, and

10 = complete kill

RESULTS

Trial No. RJF/H6/82 evaluated the control of the fallow weeds Caltrop, Mintweed, Soft Roly Poly, Common Thornapple and Liverseed grass following the application of chlorsulfuron in-crop. While weed control was evaluated periodically throughout the fallow, data from the last assessment is presented in Table 2. Chlorsulfuron at 22.5 g ha^{-1} still provided good to excellent control of all the broadleaf weeds at this time; however, Liverseed grass was not controlled.

Table 2. Fallow weed control 203 days after an in-crop application of chlorsulfuron - Trial No. RJF/H6/82

Treatment	Rate (g ha^{-1})	Caltrop	Mintweed	Soft Roly Poly	Common Thornapple	Liverseed grass
Chlorsulfuron	15	8	8.5	8.5	7	0
Chlorsulfuron	22.5	8.5	8.5	9	8	0
Chlorsulfuron	30	9.5	9.5	10	9	2
Untreated Control	-	0	0	0	0	0

Trial No. JBL/H4/82 evaluated a fallow application of chlorsulfuron in central Queensland. The trial was installed soon after the preceding wheat crop was harvested. As there was established weed growth at application, glyphosate at 540 g ha^{-1} was tank mixed with the chlorsulfuron treatments to ensure a good "knockdown" of the existing weed growth. All treatments were applied a second time 91 days after the first, as Buffel grass and Lovegrass were not adequately controlled (required glyphosate), and on this lower soil pH site, broadleaf weed control was beginning to break and would have declined quickly (requiring chlorsulfuron) based from past experience and observations. Weed control results 91 days after the first application and 61 days after the second application are presented in Table 3. Chlorsulfuron plus glyphosate provided excellent long term control of Black Pigweed/Giant Pigweed, Pigweed, Caltrop and Peppercress, while Buffel grass, Liverseed grass and Lovegrass were not controlled.

Table 3. Fallow weed control following two fallow applications of chlorsulfuron - Trial No. JBL/H4/82

Treatment	Rate	91 days after first application						61 days after second application						
	(g ha^{-1})	BP	Pi	C	Pe	BG	LoG	BP	Pi	C	Pe	BG	LiG	LoG
Chlorsulfuron[(a)]	15	9	8	10	10	1	0	10	10	10	10	1	2	2
Chlorsulfuron[(a)]	22.5	9	9	10	10	2	1	10	10	10	10	1	2	2
Chlorsulfuron[(a)]	30	9	9	10	10	3	2	10	10	10	10	1	2	2
Untreated Control	-	0	0	0	0	0	0	0	0	0	0	0	0	0

(a) tank mixed with glyphosate at 540 g ha^{-1}

BP = Black Pigweed/Giant Pigweed; Pi = Pigweed; C = Caltrop; Pe = Peppercress; BG = Buffel grass; LiG = Liverseed grass; LoG = Lovegrass

Chlorsulfuron was also evaluated in a short fallow preceding a wheat crop (Trial No. RJF/H7/82). Application was made to a recently cultivated weed-free fallow approximately 3.5 months prior to sowing to wheat. A weed control evaluation made 105 days after application and just prior to sowing is presented in Table 4. Control of Common Thornapple, Rhynchosia and Caltrop was excellent with chlorsulfuron at 15 g ha^{-1} and above, while 22.5 g ha^{-1} and above was required for excellent control of Common Sowthistle and Bladder Ketmia. For similar control of Prickly Paddy Melon 30 g ha^{-1} of chlorsulfuron was required.

Table 4. Fallow weed control 105 days following a fallow application of chlorsulfuron - Trial No. RJF/H7/82

Treatment	Rate (g ha^{-1})	Common Thorn-apple	Rhynch-osia	Common Sowthistle	Bladder Ketmia	Caltrop	Prickly Paddy Melon
Chlorsulfuron	15	8.8	9	7.8	7.8	10	7.8
Chlorsulfuron	22.5	9	9.8	9	9	10	8
Chlorsulfuron	30	9.3	10	8.8	9	10	8.8
Untreated Control	-	0	0	0	0	0	0

DISCUSSION

The three experiments demonstrate that there is great flexibility in application timing when using chlorsulfuron for fallow weed control. It may be applied in any of the following situations for fallow weed control: -

1. Early post-emergence in-crop (winter cereal) giving fallow weed control after harvest;

2. Any time in the fallow of a winter cereal to wheat rotation,

3. Any time in the fallow of a summer crop to wheat fallow.

These fallows may be short or long term (up to 18 months in some cases) depending on the rotation and the desired mix of mechanical cultivation and chemical weed control.

Chlorsulfuron can be applied to the fallow either pre-emergence or early post-emergence to the weeds; however, when weeds are established best overall long term weed control is obtained when it is tank mixed with an appropriate foliar absorbed herbicide. The use of a suitable foliar absorbed herbicide is particularly important when grass weeds (e.g. Liverseed grass) are present at application, or if they become established after the broadleaf weeds have been controlled by chlorsulfuron. In a sorghum to wheat fallow, cultivation is usually necessary to control the regrowth sorghum. The application of chlorsulfuron is best made after this cultivation, and should coincide with the first germination of fallow weeds.

The experiments clearly indicate that chlorsulfuron has an important role in conservation tillage farming as it controls the major summer broadleaf weeds. Liverseed grass, Buffel grass and Lovegrass are not adequately controlled with chlorsulfuron.

The duration of weed control with chlorsulfuron increases with increasing soil pH. It is also longer in cold soils, and soils low in moisture. However, as broadacre cereal farmers can do little about regulating soil temperature and soil moisture, soil pH is the parameter that they can use to advantage. This feature is governed by the factors controlling the rate of chlorsulfuron hydrolysis. As chlorsulfuron is hydrolyzed slower in high pH soils, weed control is longest in these soils. The need to re-spray Trial No. JBL/H4/82 (where soil pH was 6.0) 91 days after application bears this out - control of Black Pigweed/Giant Pigweed and Pigweed with chlorsulfuron at 15 g ha^{-1} fell from 100% for both weeds at 54 days after the first application to 90% and 80% respectively 37 days later. This decline in control several months before the wheat crop was due to be sown (coupled with the heavy grass growth) dictated that the second application was necessary. In the other two trials, where soil pH was 7.8 and 8.0, weed control held up much longer. Chlorsulfuron therefore has greatest potential in conservation tillage farming of alkaline soils.

The ability to control winter broadleaf weeds in-crop, and also obtain control of the summer broadleaves beyond harvest following a single application of 15 g ha^{-1} chlorsulfuron is a major advantage of this herbicide. Likewise, the ability to apply chlorsulfuron at any time from the commencement of the fallow to just prior to sowing the next wheat crop, allows the farmer great flexibility in his conservation tillage farming program. Delaying the fallow application to 2 to 3 months, or even shortly prior to sowing the next wheat crop, allows some fallow weed control, followed by in-crop weed control.

In conservation tillage fallows it is desirable to retain stubble from the previous crop on the soil surface; however concerns are frequently raised as to its effect on herbicide performance. The effect of retained stubble on herbicide performance has been investigated by Fawcett and Herrman (1984). They report no loss in chlorsulfuron activity, under field conditions, when applied to soil surfaces with up to 6,000 kg ha^{-1} stubble, when compared to application to bare soil. In a more detailed study (J. Marley, personal communication, 1984) found that stubble residues of up to 3,000 kg ha^{-1} did little to increase the loss of herbicidal activity of chlorsulfuron over application to bare soil, but that losses, regardless of presence or not of stubble cover, were quite substantial if rainfall was not received within 10 days of application. Atrazine, cyanazine and metribuzin all suffered losses of a similar magnitude in cases of delayed rainfall.

CONCLUSIONS

Chlorsulfuron can play an important part in conservation tillage farming in the alkaline soils of northern N.S.W. and Queensland. It may be applied either in-crop for in-crop weed control followed by fallow weed control, or it may be applied at any time in fallow in both winter cereal to wheat, and summer crop to wheat rotations. If the wheat crop is followed by a sensitive rotational crop sufficient time for chemical degradation needs to elapse between the application of chlorsulfuron and the planting of a sensitive rotational crop. Plant-back periods are longest on very alkaline soils. An early fallow application of chlorsulfuron is less likely to restrict normal rotational crop options following the wheat crop.

Chlorsulfuron at 15 g ha^{-1} provided good to excellent control of Caltrop, Pigweed, Black Pigweed/Giant Pigweed, Peppercress, Mintweed, Soft Roly Poly, Common Thornapple and Rhynchosia 91 to 203 days post-application. Common Sowthistle, Bladder Ketmia and Prickly Paddy Melon were well controlled for 105 days with chlorsulfuron at 22.5 g ha^{-1}. Liverseed grass, Buffel grass and Lovegrass were not adequately controlled with chlosulfuron.

The possibilities for using chlorsulfuron to provide extended broad-leaf weed control in fallow are considerable. It may be possible to either eliminate, or significantly reduce in number, the applications of foliar ab-sorbed herbicides in fallow. This will provide an impetus for reducing the total herbicide cost component in conservation tillage farming, which should in turn lead to more widespread adoption of this farming system.

ACKNOWLEDGEMENTS

The authors wish to thank the University of Sydney Livingston Farm at Moree, Mr. D. Quast of Crooble and Mr. K. Anderson of Moura for making areas of their farms available for the trials, and for their kind assistance during the conduct of the trials. The authors thank their colleagues Mr. R.J. Fagan and Mr. J.B. Lancini for their valuable assistance in establishing and/or assessing the trials reported here.

LITERATURE CITED

Campion, J.G. and M. Tichon. 1981. Proc. 6th Aust. Weeds Conf. 2:1-6.

Fagan, R.J. 1983. Proc. No-Tillage Project Team Meeting, Agricultural Research Centre, Tamworth, N.S.W..

Fawcett, R.G. and T.N. Herrman. 1984. Project Report - Herbicides for Tillage Systems and Crop Production.

Felton, W.L., R.J. Martin and M.G. McMillan. 1984, Proc. Farming to Survive - Managing the Problems of '83 Meeting, Moree, N.S.W..

Ray, T.B. 1982. Pesticide Biochemistry & Physiology. 17:10-17.

Swinnerton, P.W. 1983. Proc. Weeds in Reduced Tillage Workshop, Victoria Crops Research Institute, Horsham, Victoria.

Swinnerton, P.W. and R.C. Davis. 1984. Proc. 7th Aust. Weeds Conf. p.