Plantback to susceptible crops following application of picloram + triclopyr in north-eastern Australian fallow

Robert A. Annetts, Karen J. Kennedy and Christopher O. Love
Dow AgroSciences, PO Box 911, Kenmore, Queensland 4069, Australia

Summary The plantback period of Grazon™ DS (100 g L^{-1} picloram + 300 g L^{-1} triclopyr), when applied to fallow crop land with black cracking clay soils, to six winter and summer crops was investigated in six field trials carried out from 1999 to 2001 in northern New South Wales and southern Queensland, Australia.

Rotational crop, application rate, application timing and rainfall after application affected the plantback period of Grazon DS to the different rotational crops.

For an application of Grazon DS in fallow with a two month plantback period for recommended crops, at least 40 to 50 mm of rain is required to safely plant these crops. For a four month plantback period, at least 100 mm rain is required to safely plant these crops.

Keywords Plantback, fallow, picloram, triclopyr, black cracking clay soil, wheat, barley, chickpea, faba bean, canola, lucerne, sorghum, sunflower, cotton, soybean, mung bean.

INTRODUCTION

Conservation farming with retained stubble post-harvest and fallow weed control with herbicides has been widely adopted in northern Australia since the 1970s (Somervaille 1992). It aims to maximise water use efficiency and minimise soil loss, to provide sustainable systems for crop production.

Glyphosate, released by Monsanto in the 1970s, is a key tool to help weed control in these systems succeed. However, not all broadleaf weeds were susceptible to glyphosate alone, so tank-mixes with broadleaf herbicides were used for more cost-effective weed control (Wells 1999). Nowadays, due to the price decline of glyphosate, higher rates of glyphosate or the use of 'spikes' of more expensive broadleaf herbicides with glyphosate are used for control of hard-to-kill weeds in fallow.

The most common mixture has been glyphosate plus triclopyr for the control of melons. Grazon DS has recently been registered for the control of common sowthistle (*Sonchus oleraceus* L.), Polymeria (*Polymeria* spp.) and prickly paddy melon (*Cucumis myriocarpus* Naudin) in fallow.

Crop rotations are commonly used to make best use of stored soil moisture, break weed and disease cycles, replenish soil nutrients and maximise farm income by growth of highest return crops. Opportunistic cropping has meant sensitivity of crops to soil residues of broadleaf herbicides has become an important issue. Soil type, organic matter, soil water, soil pH and temperature, as stated by Appleby (1985), are all factors that affect the fate of herbicides in the soil.

Dow AgroSciences research over the last two years has aimed to determine safe plantback periods for summer and winter crops to different rates of picloram + triclopyr. A nine month plantback period is stated on the current Grazon DS fallow label for plantback to susceptible crops due to a review by Goring and Hamaker (1971) and findings from Marley (1980) that up to nine percent of applied picloram remains in the soil 7.4 months after applying 23.3 and 70 g ha^{-1} picloram (equivalent to 233 and 700 mL ha^{-1} Grazon DS) to a montmorillonitic clay soil. For enable greater use of Grazon DS to occur in fallow situations, more detailed work was required to determine if shorter plantback intervals could be obtained.

MATERIALS AND METHODS

A factorial trial design (six treatments × six timings) was used in a randomised complete block with three replications. Herbicide treatments were blocked by application timing with a plot size 3 m × 15 m to allow planting of six crops. Sites were located in the northern cropping belt at Breeza, NSW and Gatton, Queensland.

Treatments were applied with Azo precision gas powered sprayers or similar equipment, at spray volumes of 80–100 L ha^{-1} and pressures of 200–250 kPa via flat fan spray tips. Six rates of Grazon DS (0, 200, 300, 400, 600 and 800 mL ha^{-1}) were applied to bare soil to simulate worst case carryover situations. Applications were timed for nine, six, four, two and one month and one week pre-plant depending on the trial. Trial areas were maintained weed free with glyphosate sprays.

Crops were planted perpendicular to the line of spraying in all trials. Crops were generally grown dryland, however in very dry seasons irrigation was used to ensure crop establishment. Rainfall data from each trial site was collected.

Assessments Crops were assessed from one week after emergence to harvest, to determine effects of soil residues on crop establishment and vegetative growth. A scale of 0–100 was used for subjective visual assessment of symptoms where 100 = complete crop loss. In some trials crop emergence counts and visual emergence assessments were done. In these cases, the same rating scale was used. Visual injury ratings showed clear trends across trials, to give confidence in proposed plantback periods.

Safe plantback periods for particular herbicide rates and crops were determined by finding the time preplant when herbicides applied resulted in <2% average crop injury across three trials. Where injury was obvious, the previous 'clean' planting time was used as the safe period. Where there were variations in data across trials, the most conservative safe period was used. Data was analysed using analysis of variance.

RESULTS

Results from this series of plantback trials are summarised by rotational crop. Data from the four or eight weeks post-planting assessment is summarised across the three trials for each crop. Summer crop data from Trial 002014KK was not used as floodwater inundated the trial site on the planting date (14-Nov-2000) and herbicide residues may have been removed from the treated plots.

Within each table, the cells highlighted with shading represent the safe plantback interval to that particular crop for each rate of Grazon DS.

Wheat As shown in Table 1, it was safe to plant wheat into areas treated with Grazon DS at up to 800 mL ha^{-1} applied at least four months before planting and at up to 300 mL ha^{-1} prior to two months before planting. Crop injury at higher rates and at shorter intervals was unacceptable.

Barley As shown in Table 2, it was safe to plant barley into areas treated with Grazon DS at up to 800 mL ha^{-1} applied at least four months before planting and at up to 300 mL ha^{-1} prior to two months before planting. Crop injury at higher rates and at shorter intervals was unacceptable.

Chickpea As shown in Table 3, it was safe to plant chickpeas into areas treated with Grazon DS at up to 800 mL ha^{-1} applied at least six months before planting and at up to 200 mL ha^{-1} prior to four months before planting. Crop injury at higher rates and at shorter intervals was unacceptable. Crop recovery in areas of marginal injury was slow but showed that planting may be possible in areas treated with Grazon DS up to 300 mL ha^{-1} at least four months before sowing chickpea.

Table 1. Percent visual injury observed on wheat, 8 weeks after planting, following the application of Grazon DS in the fallow (mean of three trials).

Treatment	Rate mL ha^{-1}	Months before planting					
		9	6	4	2	1	0.25
Grazon DS	200	0	0	0	0	2	0
Grazon DS	300	0	0	0	0	3	0
Grazon DS	400	0	0	0	3	4	13
Grazon DS	600	0	0	0	1	4	0
Grazon DS	800	0	0	1	6	7	20

Table 2. Percent visual injury observed on barley, 8 weeks after planting, following the application of Grazon DS in the fallow (mean of three trials).

Treatment	Rate mL ha^{-1}	Months before planting					
		9	6	4	2	1	0.25
Grazon DS	200	0	0	0	0	2	0
Grazon DS	300	0	0	0	0	3	0
Grazon DS	400	0	0	0	3	6	15
Grazon DS	600	0	0	0	2	6	0
Grazon DS	800	0	0	1	5	7	18

Table 3. Percent visual injury observed on chickpea, 8 weeks after planting, following the application of Grazon DS in the fallow (mean of three trials).

Treatment	Rate mL ha^{-1}	Months before planting					
		9	6	4	2	1	0.25
Grazon DS	200	0	0	2	21	30	57
Grazon DS	300	0	0	4	33	36	80
Grazon DS	400	0	0	9	34	52	73
Grazon DS	600	0	0	11	63	69	97
Grazon DS	800	0	0	14	80	75	80

Table 4. Percent visual injury observed on faba bean, 8 weeks after planting, following the application of Grazon DS in the fallow (mean of three trials).

Treatment	Rate mL ha^{-1}	Months before planting					
		9	6	4	2	1	0.25
Grazon DS	200	0	0	0	16	28	53
Grazon DS	300	0	0	0	36	49	82
Grazon DS	400	0	0	4	48	67	84
Grazon DS	600	0	0	6	66	73	95
Grazon DS	800	0	0	12	82	82	83

Faba bean As shown in Table 4, faba beans were safe to plant into areas treated with Grazon DS at up to 800 mL ha^{-1} applied at least six months before planting

and at up to 300 mL ha^{-1} prior to four months before planting. Crop injury at higher rates and at shorter intervals was unacceptable.

Canola As shown in Table 5, canola was safe to plant into areas treated with Grazon DS at up to 600 mL ha^{-1} applied at least four months before planting and at up to 200 mL ha^{-1} prior to two months before planting. Crop injury at higher rates and at shorter intervals was unacceptable.

Winter lucerne As shown in Table 6, lucerne was safe to plant into areas treated with Grazon DS at up to 800 mL ha^{-1} applied at least nine months before planting and at up to 200 mL ha^{-1} prior to six months before planting. Crop injury at higher rates and at shorter intervals was unacceptable.

Sorghum As shown in Table 7, sorghum was safe to plant into areas treated with Grazon DS at up to 600 mL ha^{-1} applied at least two months before planting and at up to 300 mL ha^{-1} prior to one month before planting. Crop injury at higher rates and at shorter intervals was unacceptable.

Sunflower As shown in Table 8, sunflower was safe to plant into areas treated with Grazon DS at up to 800 mL ha^{-1} applied at least four months before planting and at up to 300 mL ha^{-1} prior to two months before planting. Crop injury at higher rates and at shorter intervals was unacceptable.

Cotton As shown in Table 9, cotton was safe to plant into areas treated with Grazon DS at up to 800 mL ha^{-1} applied at least six months before planting and at up to 200 mL ha^{-1} prior to four months before planting. Crop injury at higher rates and at shorter intervals was unacceptable.

Soybean As shown in Table 10, soybean was safe to plant into areas treated with Grazon DS at up to 800 mL ha^{-1} applied at least nine months before planting and at up to 200 mL ha^{-1} prior to four months before planting. Crop injury at higher rates and at shorter intervals was unacceptable.

Mung bean As shown in Table 11, mung bean was safe to plant into areas treated with Grazon DS at up to 800 mL ha^{-1} applied at least six months before planting and at up to 300 mL ha^{-1} prior to four months before planting. Crop injury at higher rates and at shorter intervals was unacceptable.

Table 5. Percent visual injury observed on canola, 8 weeks after planting, following the application of Grazon DS in the fallow (mean of three trials).

	Rate	Months before planting					
Treatment	mL ha^{-1}	9	6	4	2	1	0.25
Grazon DS	200	0	0	1	1	6	7
Grazon DS	300	0	0	0	4	12	23
Grazon DS	400	0	0	1	1	20	31
Grazon DS	600	0	0	0	15	30	33
Grazon DS	800	0	0	2	27	33	40

Table 6. Percent visual injury observed on winter sown lucerne, 8 weeks after planting, following the application of Grazon DS in the fallow (mean of three trials).

	Rate	Months before planting					
Treatment	mL ha^{-1}	9	6	4	2	1	0.25
Grazon DS	200	0	0	4	38	56	73
Grazon DS	300	0	2	4	61	80	97
Grazon DS	400	0	2	8	67	74	93
Grazon DS	600	0	2	15	86	91	100
Grazon DS	800	0	11	23	94	96	93

Table 7. Percent visual injury observed on sorghum, 8 weeks after planting, following the application of Grazon DS in the fallow (mean of two trials).

	Rate	Months before planting					
Treatment	mL ha^{-1}	9	6	4	2	1	0.25
Grazon DS	200	0	0	0	0	0	2
Grazon DS	300	0	0	0	0	1	5
Grazon DS	400	0	0	0	0	4	7
Grazon DS	600	0	0	0	0	1	19
Grazon DS	800	0	0	0	1	4	22

Table 8. Percent visual injury observed on sunflower, 8 weeks after planting, following the application of Grazon DS in the fallow (mean of two trials).

	Rate	Months before planting					
Treatment	mL ha^{-1}	9	6	4	2	1	0.25
Grazon DS	200	0	0	0	1	2	2
Grazon DS	300	0	0	1	0	23	5
Grazon DS	400	0	0	0	2	8	7
Grazon DS	600	0	0	0	3	8	19
Grazon DS	800	0	0	0	12	16	22

Summer lucerne Results for summer planted lucerne were very similar to winter lucerne in Table 6. For consistency, the plantback periods determined for winter lucerne will support all lucerne plantback claims.

DISCUSSION

Wells (1999) reported longer plantback periods for 40 g ha^{-1} picloram + 120 g ha^{-1} triclopyr (equivalent to 400 mL ha^{-1} Grazon DS) to wheat, barley, chickpea and faba bean than occurred in these trials. Very dry conditions prevailed in these early trials, which affected the breakdown of picloram in the soil.

The plantback period for Grazon DS at rates from 200 to 600 mL ha^{-1} to certain rotational crops on black cracking clay soils can be reduced from nine months to a shorter period, dependant on use of rate, temperature and rainfall.

Rainfall From the rainfall data gathered from the trial sites (Table 12), the following guidelines will ensure that the recommended plantback periods will be met. From an application of Grazon DS in fallow to a two month plantback period for recommended winter crops, at least 40 to 50 mm of rain is required to safely plant these crops. For a four month plantback period, at least 100 mm rain is required to safely plant these crops.

ACKNOWLEDGMENTS

Thanks are due to Peter Mesch, Mark Stavenuiter and Oscar Roach for their assistance with the trials at Breeza and Richard Chambers for assistance in editing this paper.

REFERENCES

Appleby, A.P. (1985). Factors in examining fate of herbicides in soil with bioassays. *Weed Science* 33 (2), 2-6.

Goring, C.A.I. and Hamaker, J.W. (1971). A review… the degradation and movement of picloram in soil and water. *Down to Earth* 27(1), 12-15.

Marley, J.M.T. (1980). Persistence and leaching of picloram applied to a clay soil on the Darling Downs. *Queensland journal of Agricultural and Animal Sciences* 37(1), 15-25.

Somervaille, A.J. (1992). Economics of fallow weed control. Proceedings of Economics of Winter Weed Control Seminar. Weed Society of Queensland, Darling Downs/Lockyer Branch, Toowoomba.

Wells, G. (1999). Herbicide plantbacks are shorter in northern Australia. Proceedings of the 12th Australian Weed Conference, Hobart, pp. 312-315.

Table 9. Percent visual injury observed on cotton, 8 weeks after planting, following the application of Grazon DS in the fallow (mean of two trials).

Treatment	Rate mL ha^{-1}	Months before planting					
		9	6	4	2	1	0.25
Grazon DS	200	0	0	0	2	8	7
Grazon DS	300	0	0	3	5	16	10
Grazon DS	400	0	0	4	12	24	12
Grazon DS	600	0	0	2	28	38	25
Grazon DS	800	0	0	9	51	50	68

Table 10. Percent visual injury observed on soybean, 8 weeks after planting, following the application of Grazon DS in the fallow (mean of two trials).

Treatment	Rate mL ha^{-1}	Months before planting					
		9	6	4	2	1	0.25
Grazon DS	200	0	0	1	6	18	58
Grazon DS	300	0	1	1	19	30	63
Grazon DS	400	0	2	3	23	34	78
Grazon DS	600	0	6	7	37	43	83
Grazon DS	800	0	5	14	43	49	87

Table 11. Percent visual injury observed on mung bean, 8 weeks after planting, following the application of Grazon DS in the fallow (mean of two trials).

Treatment	Rate mL ha^{-1}	Months before planting					
		9	6	4	2	1	0.25
Grazon DS	200	0	0	0	3	10	25
Grazon DS	300	0	0	1	8	34	40
Grazon DS	400	0	1	2	18	36	52
Grazon DS	600	0	1	2	43	49	78
Grazon DS	800	0	1	9	51	54	83

Table 12. Average rainfall statistics for winter trials planted during July/August, 2000 and 2001.

Trial No's. Location	002001KK, 994037RA, 012004KK Breeza, NSW and Gatton, Qld			
Application Timing (MBP)	Rainfall 2 wk prior (mm)	Time to first (days)	Amount first (mm)	Rainfall 4 wk after (mm)
Oct–Nov (9)	59.8	2	2.3	40.9
Jan–Feb (6)	13.0	4	10.2	49.8
Mar–Apr (4)	46.6	4	0.6	43.6
May–Jun (2)	16.7	8	4.6	16.6
Jun–Jul (1)	12.3	3	7.5	22.4
Jul–Aug (.25)	14.3	6	0.3	38.5