Weed control options for pasture cropping systems in the West Midlands of Western Australia

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Abstract
The West Midlands region of Western Australia combines high rainfall (350 to 650 mm) with deep sandplain soils. Growers in this region have been adopting summer-active perennial grasses on sandy, low fertility soils to reduce erosion and lift livestock production. Pasture-cropping has also been trialled but uncertainty about weed control options is one factor limiting adoption. In 2011, twenty commonly used cereal, lupin and canola herbicides/mixtures were sprayed across a two year old subtropical pasture (mix of panic, Rhodes and signal grass) to identify options that could be used to control crop weeds without jeopardizing the persistence of the perennial pasture base. It was found that the broad range of pre- and post-emergent herbicides applied (22 June) were well tolerated by the semi-dormant perennials. However, glyphosate (540 g/L) at 2 and 4 L/ha and Select® (a.i. Clethodim 240 g/L) at 750 mL/ha killed some plants. Of note was the good tolerance to the triazine group of herbicides (simazine and atrazine); this could enable lupin and possibly canola to be pasture cropped over subtropical pastures. In addition, the triazine plus knockdown treatments appear to conserve soil moisture as perennial grasses remained green and actively grew until December; thus removing winter annual weeds from subtropical pastures might enable farmers to finish lambs on green feed.

Key Words
Herbicide tolerance, subtropical grasses, EverCrop project

Introduction
The West Midlands region in Western Australia has a high proportion of sandy soils which are susceptible to wind erosion, and marginal for continuous crop production (Van Gool *et al.* 2008). Over the past decade, farmers in this region have been adopting subtropical perennial species in an effort to stabilize fragile soils, reduce groundwater recharge and provide out-of-season fodder for grazing enterprises (Moore *et al.* 2009; Ward 2006). Because subtropical perennials become dormant during winter, there may also be scope to adopt pasture cropping systems (Finlayson *et al.* 2012). Pasture-cropping is an agricultural production system where annual crops are sown into 'live' perennial pastures with crops either used for grain or forage (Badgery and Millar 2009). The system exploits a separation in the growth period of winter-active crops and summer-active C4 grasses. This system has proved successful across native perennial grasses in several grain producing regions in eastern Australia (Millar and Badgery 2009); however, pasture cropping is a relatively new technology in WA, especially across subtropical perennial pastures.

Over the past 4 years, the Future Farm Industries CRC's EverCrop project has been working with innovative growers to evaluate and refine pasture-cropping systems in WA (Ferris *et al.* 2010). The central element of this project is on-farm adaptive research which includes identifying issues, opportunities and research needs. Uncertainty about crop performance, competition for water and the sensitivity of subtropical grasses to herbicides were some of the issues raised as potential constraints to the adoption of pasture cropping in the Northern Agricultural Region of WA (Dolling *et al.* 2010). This paper evaluates the sensitivity of subtropical grasses to a range of knockdown and in-crop herbicides commonly used to control weed in annual crops. Companion papers present trial results on crop yields and water dynamics when pasture cropping over subtropical perennials (Ward *et al.* 2012); and perceived advantages and disadvantages of pasture cropping in WA (Barrett-Lennard *et al.* 2012).

Methods
The trial was implemented (2011) across an established, subtropical-grass pasture about 20 km west of Three Springs, WA. The perennial pasture had been sown in 2009 with a commercial mix of Gatton panic (*Megathyrsus maximus*), Rhodes grass (*Chloris gayana*) and Signal grass (*Urochloa decumbens*). Knockdown and commonly used in-crop herbicide treatments were selected based on feedback from EverCrop Local Adaptation group growers and agronomists.

Twenty herbicide treatments (Table 1) were sprayed across the subtropical grass pasture on the 22nd of June in still, sunny conditions. Plots were 3 m by 20 m, including the unsprayed control, and there were three replicates per treatment. Sheep were removed a month prior to spraying and there was a full germination of annual weeds (mostly capeweed and annual grasses). The treatments were rated visually every two to four weeks from July to October, using a scale from zero (no damage) to 10 (complete plant death). Only data from 2 July, 4 August and 3 September is presented here. Herbicide damage was difficult to assess in September and October due to the prolific growth of annual weeds in some treatments. Analysis of variance (GENSTAT) was based on a simple split-plot model for repeated measurements (5 assessment dates, 21 treatments, 3 blocks).

Results

The knockdown treatments and Select® caused the greatest initial damage to the subtropical grass pasture (see Table 1 for active ingredients, rates and damage scores). Select® at 750 mL/ha and glyphosate (540 g/L) at 2L/ha and 4 L/ha also caused some plant death. Upon closer inspection, initial damage in these treatments appeared to be greater for Rhodes grass than for panic and signal grass; however, this difference became less noticeable with time as Rhodes grass resumed active growth (sent out runners) about a month earlier than the panic or signal grass.

By August, there was minimal visible damage (if any, relative to the unsprayed control) for the various Sprayseed® treatments and grass selective options for controlling brome and barley grass in cereal crops (Atlantis® and Monza®). The triazine herbicides (atrazine, metribuzin and simazine) applied in mixture with other herbicides also appeared to be safe; as were the broadleaf selective treatments (2,4-D, Lontrel®, Jaguar®, Tigrex® Velocity®).

With the onset of warm spring conditions (September), glyphosate (540 g/L) treatments limited to 1 L/ha recovered well; however, glyphosate at 2 L/ha and 4 L/ha (in particular) and Select® at 750 mL/ha did not recover to the same extent due to some plant death. The broad spectrum knockdowns mixed with other herbicides (i.e. triazines or triasulfuron) were the most effective treatments (based on visual observations) for removing annual weeds from the perennial pasture. The Sprayseed®-simazine and glyphosate-atrazine treatments, in particular, were virtually weed free in spring, remained green longer and produced more subtropical grass biomass than the weedy unsprayed control.

Discussion

There are two possible factors reflected in the damage scores (Table 1). The average damage scores reflect the initial (negative) impact due to the herbicide, and possibly a subsequent (positive) response due to the removal of competition by annual weeds. This trial has not attempted to tease apart these two factors; it is simply a trial ascertaining the initial and final consequences of applying different herbicides in winter to established subtropical grass pastures. Although the subtropical grasses did not appear to grow over the winter period (Jul-Aug), the damage scores indicate that they are not completely dormant. The initial damage caused by the knockdown herbicides/mixtures, and the ‘dim’ herbicide Select®, is therefore not surprising. However, damage may have been less were perennials grazed hard before spraying.

Viable grain crops are dependent on good weed control and there is considerable knowledge among growers on knockdown and in-crop weed control options. In the context of pasture cropping, there are additional considerations: the impact of herbicides on the longer term productivity and persistence of the perennial pasture base, and the role that herbicides might play (in some situations) to suppress perennial plants, and minimise competition between annual and perennial species. This trial has shown that the most widely grown subtropical pastures in the Northern Agricultural Region (panic, Rhodes and signal grass mix) are tolerant of herbicides commonly used in cereal and lupin crops; robust rates of glyphosate, Select® and other ‘dims’ may be an exception. Useful tolerance to a range of herbicides was also reported by McCormick *et al.* (2011). Sprayseed® and glyphosate treatments provided some suppression of the perennial pasture. This might be useful to minimise interspecies competition during crop establishment in years with early autumn rains. The impact was more sustained for glyphosate, especially at higher rates; however, this is likely to come at a cost to perennial persistence, as glyphosate (540 g/L) at 2 and 4 L/ha killed some plants. Thus Sprayseed® is a safer knockdown than glyphosate on established perennial grasses, particularly where plants are small, sparse or under other stresses.

This research has identified herbicides that might be use to control weeds when pasture cropping across subtropical perennial grasses for grain production. Of note is the useful tolerance to knockdown herbicide mixtures commonly used to produce grain crops. Tolerance to Sprayseed®-simazine and glyphosate-atrazine, not only provide effective weed control options for Lupin and Canola crops respectively, but might also be used in a pasture situation to extend the winter growing season by removing annual weeds to conserve soil moisture for additional growth in spring.

Table 1. Damage scores for subtropical grass plots 1, 2 and 3 months after spraying with different herbicides/mixtures (0=no damage, 10=complete plant death).

Herbicide treatment		Rate/ha	Assessment date		
Common name	**Active ingredient**		**5 Jul**	**4 Aug**	**3 Sep**
Powermax®	Glyphosate as potassium salt (540 g/L)	1 L	7.3	5.7	1.7
Powermax®	Glyphosate as potassium salt (540 g/L)	2 L	8.0	7.3	2.2
Powermax®	Glyphosate as potassium salt (540 g/L)	4 L	8.2	8.2	4.2
Sprayseed®	Paraquat (135 g/L) + Diquat (115 g/L)	1 L	5.5	0.5	2.8
Sprayseed®	Paraquat (135 g/L) + Diquat (115 g/L)	2 L	6.5	3.5	0.3
Sprayseed®	Paraquat (135 g/L) + Diquat (115 g/L)	4 L	6.5	2.3	0.0
Powermax® + Logran B® + Trifluralin	Glyphosate as potassium salt (540 g/L) Butafenacil (200 g/kg) + Triasulfuron (500 g/kg) Trifluralin (480 g/L)	1 L 50 g 2 L	7.8	4.5	1.0*
Sprayseed® + Logran® + Trifluralin	Paraquat (135 g/L) + Diquat (115 g/L) Triasulfuron (750 g/kg) Trifluralin (480 g/L)	2 L 40 g 2 L	5.8	2.5	0.7*
Sprayseed® + Simazine	Paraquat (135 g/L) + Diquat (115 g/L) Simazine (500 g/L)	2 L 1.5 L	5.8	2.2	0.0*
Powermax® + Atrazine (sprayed separately)	Glyphosate as potassium salt (540g/L) Atrazine (500 g/L)	1 L 4 L	5.3	5.0	1.0*
Ally® (DC Trate 0.2%)	Metsulfuron-methyl (600 g/kg)	7 g	2.0	1.3	4.3
Atlantis® (Hasten® 1%)	Mesosulfuron-methyl (30 g/L)	330 mL	4.8	0.7	2.2
Velocity® (Hasten® 1%)	Bromoxynil (210 g/L) + Pyrasulfotole (37.5 g/L)	1 L	4.7	0.8	1.7
Lontrel®	Clopyralid (300g/L)	300 mL	2.8	0.5	0.7
Amine 625	2,4-D as dimethylamine salt (625 g/L)	1 L	0.2	1.2	1.3
Tigrex®	Diflufenican (25 g/L) MCPA as iso-octyl ester (250 g/L)	750 mL	2.0	0.3	1.3
Jaguar® + LVE MCPA	Bromoxynil (250 g/L) + Diflufenican (25 g/L) MCPA as ethylthexyl ester (600g/L)	750 mL 500 mL	4.3	1.3	0.0
Monza® (Bonza® 2%)	Sulfosulfuron (750 g/kg)	25 g	2.5	0.3	2.0
Brodal® + Metribuzin	Diflufenican (500 g/L) Metribuzin (750 g/kg)	200 mL 100 g	3.8	0.0	0.3
Select® (Supercharge® 0.75%)	Clethodim (240 g/L)	750 mL	6.5	9.0	7.5
LSD (P=0.05)			1.86 (1.63 if same trt level)		

* On 25 October, perennial grass biomass was greater in these treatments than the weedy unsprayed control.

Conclusion

Results from this preliminary study indicate that there are several herbicides and knockdown mixtures which have the potential to safely control common crop weeds in well established subtropical perennial pastures. Thus pasture cropping across subtropical grasses should not be constrained by the lack of safe herbicide options for in-crop weed control. However, further work is required to evaluate the sensitivity of individual species and young stands (less than 1 year after establishment) to herbicides, and the degree of damage when plants are actively growing (e.g. after an early break of season). Such information could mean the difference between a successful long-term pasture-cropping system and failed pasture.

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