Pak. J. Weed Sci. Res., 18: 477-483, Special Issue, October, 2012

WEEDSEEKER TECHNOLOGY CAN BE USED EFFECTIVELY IN WIDE-ROW CROPS IN DRYLAND BROADACRE FARMING SYSTEMS

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ABSTRACT

The adaptability and suitability of WeedSeeker technology for use in row crops in dryland broadacre farming systems has been determined from four field trials conducted in central Queensland in 2009-10. Inter-row post-emergence weed control efficacy and crop safety (tolerance) of glyphosate and or paraquat applied via tractor mounted shielded spray equipment fitted with detachable WeedSeeker units were measured in both chickpea and sorghum crops grown on 1 m rows. Good weed control with minimal lasting crop damage (for either crop or herbicide) supports the in-crop use of WeedSeeker technology particularly where it is used in conjunction with banded on-the-row residual pre-emergence herbicides. Economic benefits to farmers and safety to the environment can be maximised through the reduced physical amount of herbicide being applied particularly where this technology is employed in-crop as well as in the fallow where it is currently and mostly utilised. In-crop, WeedSeeker use will also facilitate the cost-effective application of the more expensive herbicide products that may be required for managing herbicide resistant weeds.

Key words: Banded herbicide, chickpea, in-crop use, sorghum, WeedSeeker.

INTRODUCTION

WeedSeeker technology uses advanced optics (infra-red) detection units to activate spray nozzles such that herbicide is only applied to a plant target and its immediate small surrounding area. Since weeds of cropping country are not often fence to fence, the technology offers large savings in the amount of chemical applied across a total area since spray nozzles are only operating when a plant is detected (cost-effective spot spraying but on a very large scale). Currently, in Australian farming systems WeedSeeker is being utilised mostly for fallow weed management using non-selective herbicides (Jameson, 2009).

The ability to use WeedSeeker in-crop with shielded booms will facilitate zonal weed management which could be considered a

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component of precision agriculture. Zonal weed management means residual herbicides can be precisely banded over the crop rows at planting (using conventional spray technology) and the inter-row zones can be treated post-emergence with non-residual products via WeedSeeker but only where weeds are present. The combination of the two technologies may result in a great reduction in the amount of all types of herbicide used without compromising good weed control. Banding is likely to result in 50-66% reduction (row spacing and bandwidth dependent) in physical amounts of residual herbicides applied; while WeedSeeker can result in up to 90% (weed density dependent) reduction in physical amounts of knock-downs applied.

Significant herbicide reductions represent large input costs savings to growers thereby improving farm profitability. WeedSeeker will also permit the cost-effective use of the more expensive herbicide products, thus facilitating greater herbicide mode of action rotation. This potential benefit will increase in importance as more weed species develop resistance to the cheaper and more often used chemistries. The reduction in the physical amount of herbicide applied across catchments will also reduce the risks to sensitive ecological habitats within the land and seascapes (eg. the Great Barrier Reef).

Research and development trials have been conducted in central Queensland during 2009/10 to evaluate the suitability and effectiveness of shielded WeedSeeker use in wide-row sorghum and chickpea using paraquat and glyphosate for the inter-row weed control. Two research questions were addressed – (a) does WeedSeeker with shields reduce the potential damage to crop when using non-selective herbicides compared to the same herbicides applied with shields but without WeedSeeker? And (b) does shielded WeedSeeker provide sufficient control of weeds in the inter-row when using non-selective systemic and contact herbicides?

MATERIALS AND METHODS

Four replicated randomised block trials (two chickpea and two sorghum) were undertaken in 2009 and 2010 on the DEEDI research block located at the Australian Agricultural College Emerald campus on a heavy alluvial clay soil type.

Chickpea (var. *Kyabra*) was planted in winter 2009 and 2010 on 1 m row spacing with target established populations of 300 000 plants/ha. In the 2009 trial, no residual herbicides were applied, however, in 2010 simazine (1 kg ai/ha) mixed with isoxaflutole (75 g ai/ha) was applied immediately post-planting as either a 50 cm wide band over the rows or as a blanket application (entire plot). In-crop, post-emergence herbicide treatments were applied before canopy closure and while weeds were small to medium in size. Glyphosate

(900 g a.i./ha) or paraquat (500 g a.i./ha) were applied using a shielded boom (mounted spray hoods that hang between the crop rows) with and without WeedSeeker technology attached. The tractor mounted boom spray operating details for all (chickpea and sorghum) trials are presented in Table 1, although details for the residual herbicide applications are not provided.

Sorghum (var. *Buster*) was planted early summer (2009-10 trial) and late summer (2010 trial) on 1 m row spacing with target established populations of 50 000 plants/ha. Residual herbicide (atrazine 2 kg a.i./ha) was applied as either a blanket at 21 days pre-plant or as a 50 cm band over the row immediately post-planting. Post-emergence in-crop herbicides were applied once the crop had established secondary roots and while the weeds were still small to medium in size. These post-emergence treatments included fluroxypyr (250 g a.i./ha), glyphosate (900 g ai/ha), paraquat (500 g a.i./ha) or glyphosate + fluroxypyr (900 g a.i. + 250 g a.i./ha) applied using the shielded boom with and without WeedSeeker fitted. Weed-free (hand-chipped) and weedy controls were included in all replicates in all trials.

All trials were irrigated within a week of planting to ensure incorporation of the residual herbicides and to assist with crop and weed emergences. All crops (except the 2009 chickpea trial) were mechanically harvested using a small plot Kew header.

Table-1. Boom spray details for all trials undertaken.

Year	Crop studied	Boom type	Nozzles used	Output (L/ha)
2009	chickpea	+ WeedSeeker	TP6503EVS	104
		nil WeedSeeker	DG110015	98
2010	chickpea	+ WeedSeeker	TP6503EVS	173
		nil WeedSeeker	DG110015	81
2009/10	Sorghum	+ WeedSeeker	DG8503	107
		nil WeedSeeker	DG110015	95
2010	Sorghum	+ WeedSeeker	80015EVS	142
		nil WeedSeeker	DG110015	93

Data Measurements

Visual weed control and crop injury ratings, as well as weed and crop biomass sampling was undertaken in all trials. However, insufficient weed pressure/density in both sorghum trials did not warrant detailed weed biomass sampling measurements. Crop yields were measured in 3 of the 4 trials. All data were subjected to analysis of variance using Genstat statistical package (11th Edition). LSD values are provided where the F probability tests were significant, unless otherwise indicated. For brevity, not all data sets are being presented.

RESULTS AND DISCUSSION

Impacts on the Weeds

The main weeds present in the chickpea crops included sow thistle (*Sonchus oleraceus*), African turnip weed (*Sisymbrium thellungii*), peppercress (*Lepidium* sp.) and prickly lettuce (*Lactuca serriola*). Very isolated infestations of bladder ketmia (*Hibiscus trionum*), boggabri (*Amaranthus mitchellii*), crownbeard (*Verbesina encelioides*), native jute (*Corchorus trilocularis*) and awnless barnyard grass (*Echinochloa colona*) occurred in the sorghum trials. Mean total weed densities were greater in winter (2-5 weeds/m^2) than in summer (0-0.5 weeds/m^2).

Key general findings

- WeedSeeker use with shields provided effective weed control in the inter-row using either glyphosate or paraquat (Tables-2, 3 and 4).
- Tendency for WeedSeeker to be slightly less effective than full spraying but the differences across the trials were not significant.
- Achieved ~90% or greater weed biomass reduction in the inter-row zone when using shielded WeedSeeker.
- Some form of on-the-row weed control is still necessary to minimise weed-seed production across the paddock.
- While banded on-the-row residuals with shielded WeedSeeker use in the inter-rows were very effective, overall weed management was slightly better when the residuals were blanket applied (Table-2). The blanket applied residuals tended to provide some assurance to the overall weed control.

Impacts on the Crops

Key general findings

- Application of glyphosate or paraquat via shields with or without WeedSeeker proved quite safe in both crops with neither herbicide being significantly more damaging than the other (Tables-2, 3 and 4).
- Any damage measured was minor (< 10% biomass reduction) and mainly transient. Greatest crop reduction was sustained in the untreated (weedy) controls and resulted from competition.
- Differences in levels of crop damage between ± WeedSeeker were not significant for either crop or herbicide, although WeedSeeker use tended to appear to be less damaging (since herbicide is being spot sprayed, there is much less exposure risk).
- Use of WeedSeeker and shields in crop is limited to the period prior to canopy closure; this will vary from crop to crop, and will be affected by row spacing. Wide-row (≥ 1 m) crops better

facilitate the use of shields. High clearance equipment may be needed for applications in "taller" crops.

- In the sorghum trials, an extra shield was required in front of the external-mounted WeedSeeker units (external to the spray hood) to push and lift the overhanging crop foliage from the path of the units and hood – overhanging foliage when detected by the units triggered the spray nozzles (unnecessarily).

Table-2. Weed and crop biomass, visual inter-row weed control and crop damage assessments and crop yield for the 2010 chickpea trial with and without WeedSeeker (WS) use in-crop.

Residual herbicide method#	In-crop treatment	Weed biomass (g/m²)	Weed control rating (0-5 scale)*	Crop biomass (g/m²)	Crop injury Rating (0-5 scale)*	Crop yield (t/ha)
blanket	+ WS paraquat	0	5	359	0.2	0.95
blanket	nil WS paraquat	0	5	375	0	0.86
blanket	+ WS glyphosate	7.3	4.2	406	0	1.21
blanket	nil WS glyphosate	0	5	434	0	1.03
banded	+ WS paraquat	22.3	2.5	288	0.3	0.94
banded	nil WS paraquat	8.8	3.8	328	0.3	1.02
banded	+ WS glyphosate	28.2	4.2	313	1	1.00
banded	nil WS glyphosate	12.3	4.7	311	0.5	1.04
nil	hand-chipped	13.0	3.3	349	0	0.81
nil	nil	108.0	0	278	0.3	0.59
	LSD (P = 0.05)	22.1	1.7	109	ns	0.26

* 0 – 5 visual assessment scales: for weed control, 0 = no control and 5 = 100% kill; for crop injury, 0 = no effects and 5 = crop death; #residual herbicide = simazine + isoxaflutole (1 kg + 75 g/ha) for both methods.

These data (presented in all Tables) demonstrate the safety and effectiveness of using shielded WeedSeeker in-crop (in sorghum and chickpea) for applications of paraquat or glyphosate to the emerged weeds within the inter-row. Overall weed management was enhanced when residual herbicide was applied at planting as a band over the crop row. While blanket applications of residuals at planting provided greater weed management assurance, their use via this method did not provide any reduction in the physical amount of residual chemical applied compared to when banded (100% of plot covered with blanket *cf*. 50% plot covered with 50 cm bands on the rows, where rows are 1 m apart). Growers will need to consider the trade-off in cost-savings versus the likely levels of weed control achievable for each situation

Table-3. Weed and crop biomass (actual and reductions) and crop yield pooled for main in-crop treatments only in the 2010 chickpea trial.

Main in-crop treatment	Weed biomass (g/m2)	% weed biomass reduction	Crop biomass (g/m2)	% crop biomass reduction	Crop Yield (t/ha)
+ WeedSeeker	14.4	87	342	0	1.02
nil WeedSeeker	5.3	95	362	0	0.99
LSD (P = 0.05)	9.8*	ns*	ns	ns	Ns
glyphosate	11.9	89	366	0	1.07
paraquat	7.8	93	337	0	0.94
LSD (P = 0.05)	ns	ns	ns	ns	Ns

*F probability value in the ANOVA was 0.06

Table-4. Crop yields (both trials) as well as crop biomass and inter-row weed control assessment (2010 trial only) for main in-crop treatments in sorghum. (Visual rating scale: 0 - 5, where 0 = no control and 5 = 100% kill)

Main in-crop treatment	2009/10 trial	2010 trial		
	Crop yield (t/ha)	Crop yield (t/ha)	Crop biomass (g/m^2)	Inter-row weed control rating (0-5 scale)
+ WeedSeeker	3.1	2.3	325	4.6
nil WeedSeeker	3.2	2.3	320	4.9
LSD (P = 0.05)	ns	ns	ns	0.2
fluroxypyr	3.6	2.4	323	4.6
glyphosate + fluroxypyr	2.9	2.2	316	4.8
glyphosate	2.9	2.3	319	5.0
paraquat	3.2	2.4	332	4.8
LSD (P = 0.05)	ns	ns	ns	0.3

Since the spot spraying of glyphosate or paraquat via WeedSeeker provided very effective weed control, it can be assumed that other herbicides with knockdown activity should behave similarly if applied in the same manner. However, crop safety responses may not be the same for all herbicides. Spot spraying of the more expensive chemicals, for example, the group A grass selectives, group I broadleaf selectives, glufosinate, and amitrole, may prove to be very cost-effective using shielded WeedSeeker technology in crop, although their use may not be registered for the situation or application method. But the ability to utilise these herbicides from different modes of action groups will assist in managing resistant weeds and or avoiding development of resistance in high risk weeds.

These small scale studies have shown that WeedSeeker used with shields is adaptable and suitable (effective and safe) for use in broadacre row cropping. However, before wider on-farm adoption can occur, further development work is needed to (a) make these herbicides and uses *legal*, and (b) adapt shielded WeedSeeker technology at the larger paddock scale using commercial size booms.

ACKNOWLEDGEMENTS

We are grateful for the research funding provided by the Fitzroy Basin Association, the Grains Research and Development Corporation, and the Department of Employment, Economic Development and Innovation (DEEDI) to undertake this work. We also thank the Central Queensland Sustainable Farming Systems Project and the Emerald DEEDI Research Facility - Australian Agricultural College for providing the staff, land and planting equipment resources for the trial work. Inputs from Scott Jameson and Kevin Bradley (Crop Optics Pty Ltd) into the adaptation of our experimental shielded boom and the commissioning of the fitted WeedSeeker technology is much appreciated.

WeedSeeker is patented spray technology owned by NTech Industries Inc. (a Trimble company), USA. The technology import and distribution licence within Australia is currently held by Crop Optics Pty Ltd, Tamworth, NSW.

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