FINAL REPORT

For Public Release

Part 1 - Summary Details

CRDC ID: **CRDC 1904 - Aquatill**

Project Title: **Are chemical or mechanical crop termination tactics more effective for cotton crop termination in a multi herbicide tolerant gene stack system?**

Project Start Date:01/07/2018 **Project Completion Date:**30/06/2019

Research Program: 1 Farmers

Part 2 – Contact Details

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Date submitted: Annabelle Guest

Part 3 – Final Report

Background

1. Outline the background to the project.

The use of water jet water cutting in industry and the background to this project have been well documented in the preceding project, DAQ 1703 under the leadership of Dr Paul Grundy, Queensland Department of Agriculture and Fisheries (DAF).

An extract of the report from this project report is presented below:

Ultra-High Pressure Water Jet technology has a number of industrial applications in product manufacturing. The technology uses water pumped through specialised nozzles at ultra-high pressures (50,000-60,000 psi) to create a high powered jet that can be used to very accurately cut through a broad range of materials ranging from steel to carrots. Researchers from the South Australian No Till Farmers Association (SANTFA) have been investigating the potential for this UHP Water Jet technology, termed AquaTill, to be retro-fitted to planting equipment for the purpose of cutting through fallen stubble that would otherwise obstruct the passage of the planting tynes through the soil surface. Compared to a standard cutting disc fitted to many planters for this purpose, AquaTill provides the advantage of cleanly cutting through stubble, eliminating the occurrence of trash 'hair pinning' during the planting operation.

Demonstrations of AquaTill in northern NSW by the SANTFA at field days during 2016 piqued the curiosity of a number of cotton growers who expressed an interest in seeing this technology tested for its potential to be used as an alternative method of cotton termination for traditional root cutting.

Root cutting is a commonly deployed crop destruction technique whereby two opposing and overlapping discs are drawn at ground level through the crop and used to cut through the main stem below the cotyledon nodes. Ineffective root cutting can occur when equipment is either not well set up or when in-field conditions are variable (un-even ground or stones), resulting in a percentage of plants that are not severed below the cotyledons and consequently grow back as ratoons, presenting a significant challenge for farm hygiene.

The use of AquaTill technology to cut through the main stem at ground level offers an alternative method to the use of metal discs. The addition of herbicide might also provide a technology fail-safe in that any plants not effectively severed below the cotyledons might still be destroyed.

To test the potential application of AquaTill technology as an alternative technique for root cutting, proof of concept experimentation was undertaken at 'Keytah' west of Moree. This work was a joint effort by Mr Greg Butler – SANTFA and Mr Darren Hart of Keytah with financial and intellectual support provided by the Queensland Department of Agriculture and Fisheries (DAF) through CRDC projects DAQ1502 and DAQ1703. These results have been separately reported.

In this project, CRDC 1904, two small plot replicated field trials were conducted in dryland cotton crop residue to determine repeatability of the results obtained from the previous season's proof of concept work. An improved ground engagement tool (Aquatill Injecticide) was developed by Dale Foster, NDF Narromine as an in-kind contribution to the project. A manufacturer of Fluroxypyr, Titan AG, has also contributed through provision of chemical product and consultant support of registration requirements for the development of this project. The aim of the 2018 field trials was to demonstrate repeatability of the results achieved from the proof of concept trials in the previous season's work and to generate data

for registration of Fluroxypyr applied through ultra high pressure water nozzles for control of cotton ratoons.

Objectives

Milestone 1.
Are chemical or mechanical crop termination tactics more effective for cotton crop termination in a multi herbicide tolerant gene stack system?

Milestone Description:

1.1 Chemical and mechanical cotton crop termination tactics are compared and evaluated for compliance with Resistance Management Plan requirements.

Performance Indicator:
Two replicated field trials are conducted in 2018 dryland crop residue consisting of treatments fluroxypyr 1.0 and 0.5 L/ha in three water volumes for example 113, 63 and 31 L/ha. A standard (commercial farm practice) and an untreated area included.

Two replicated small plot field trials were conducted in 2018/19 near Narrabri, NSW in commercial dryland cotton crop residue. One trial was conducted in standing cotton stubble at "Camus", property of Gourley Pastoral Company, Edgeroi, while the second trial was conducted at the University of Sydney commercial farm "Llara" in mulched cotton crop residue.

The treatments evaluated in both trials were water only, Fluroxypyr at 0.5 and 1.0 L/ha applied in volumes of 113, 63 and 31 L/ha. An untreated control was also included. Water volume applied was regulated by tractor speed. Commercial farm practice at Camus consisted of double cropping the field with field peas, then broadacre spraying the crop residue with paraquat over the summer fallow period as required after rainfall. The fieldpea crop provided little groundcover and failed due to dry conditions. Commercial practice at "Llara" consisted of over the top spray applications of Fluroxypyr and paraquat (not in the trial area) as required after rain.

Milestone Description:
1.2 Field trial outcomes used to form recommendations for AquaTill system to achieve commercialisation

Performance Indicator:
Field trial outcomes are used to form recommendations for AquaTill system to achieve commercialisation

The first area of recommendation provided was to NDF around the ground engagement tool. To further the project, feedback was provided to NDF around the prototype ground engagement tool and the modifications required to enhance accuracy in guiding the nozzle along the cotton row. The ground engagement tool was commercially named AquaTill Injecticide at this point. It was proposed that a multi row unit would be developed for the 2019 project. It was then determined that the label use pattern for Fluroxypyr 400 would need to be amended to accommodate treatment through water jet cutting equipment and that a permit would be required to treat larger scale areas than is covered under the general trial permit. The decision was then made to refine the ground engagement tool as a single row unit until a label permit was granted for the use pattern of

Fluroxypyr. The project is continued in 2019 as part of CRDC 1937 - Opportunities in dryland cotton with Bollgard3, with 3 further trials established. A meeting between the project partners DCRA, SANTFA, Titan Ag and and NDF is proposed in the next few weeks to determine the way forward for continued development. The project team resulted from an NLP2 grant application made by SANTFA for development of ultrahigh pressure water cutting in sugarcane, cotton, cereals and woody weeds which was supported by CRDC. The grant application was unsuccessful. SANTFA has since secured some funding for development of the technology in all four areas through a smaller NLP grant.

Methods

Two replicated field trials were established on the 26th July 2018 at "Llara" Narrabri and on the 27th July at "Camus" Bald Hill Road, Edgeroi. Both sites were established in conventional cotton refuge. The site at "Llara" comprised of mulched cotton stubble after picking while at "Camus" the cotton crop residue was standing plant residue post stripping. The standing stubble was chosen to accommodate the double crop after dryland cotton scenario, where the desired system is to pick cotton, plant winter crop (field peas or chickpeas), apply residual herbicide then slash cotton crop residue prior to the winter crop being too high. The desirability of using Aqua-Till in this scenario is to provide flexibility in timing of operations. The mulched site was selected as per alternative commercial practice, which is to slash or mulch cotton crop residue within 4 weeks of picking as required under the Resistance Management Plan, then leaving the field fallow until the next crop in the rotation is planted.

The treatments applied at both sites were Fluroxpyr 400 at 0.5 and 1.0 L/ha in volumes of 132, 66 and 32 L/ha. These volumes were selected based on the previous season's work and to determine if there was a response in ratoon control to water volume used. The lower the water volume used, the greater the efficiency gain at treatment time. An untreated check (essentially a conventional commercial treatment) and a water only treatment were included at both sites. The water only treatment was included to demonstrate the efficacy of adding Fluroxypyr over water only, a result of the previous season's work. A ground engagement tool for holding the nozzle on the plant row was provided by Dale Foster, NDF (Figure 2) and the treatments were applied by Greg Butler from SANTFA using water jet cutting technology consisting of a Flow pump (Figure 1) using a pressure of approximately 50 000 psi through a 008 sapphire orifice nozzle.

Figure 1 Flow Pump

Figure 2 Ground Engagement tool

Figure 3 Standing cotton crop residue treated at Camus (Blue Hills) Site

Efficacy assessments of ratoon control were conducted in mid-November, mid -December and early February by counting the number of regrown plants in each plot that were cut at treatment but had regrown. Those plants within the row that had been missed by ground engagement tool were excluded for the assessment purposes. Timing of the first assessment was delayed due to lack of rainfall during winter and spring limiting regrowth stimulation.

Results

Control of Cotton Ratoons

Results were variable and inconsistent due to the extremely dry conditions experienced over spring and summer 2018/19. Only 70 mm of rainfall was recorded over the trial duration (July 18 to February 19) at "Camus" while 140 mm was recorded at "Llara". Control of cotton ratoons held until mid-December at both sites, and achieved 88% to 94% at Camus (Blue Hills) (Figure 4) and 55% to 89% at Llara (Figure 5). Well below average rainfall over the summer period delayed the final assessment until February where regrowth was recorded in all treatments. At the Llara site, more robust control resulted where the 1 L/ha rate of Fluroxypyr was applied compared to the 0.5 L/ha rate, however, there was no impact of water volume this rate was applied in. The same trend was seen at the Camus site.

At the "Llara" site, Fluroxypyr 1 L/ha applied through the AquaTill gave more robust control than water only at the final assessment but there were no significant treatment differences.

Fluroxypr at both 0.5 and 1 L/ha applied through the AquaTill gave equivalent but significant control (Table 1) compared to the untreated control or commercial regime which at "Camus" phenoxy herbicide applied over the top of standing stubble. There was no significant increase in control gained from adding Fluroxypyr compared to water only through the AquaTill at this site.

Factorial analysis of chemical rate and spray volume and the interaction between these factors showed no significant interactions at either site (Tables 2 and 4) .

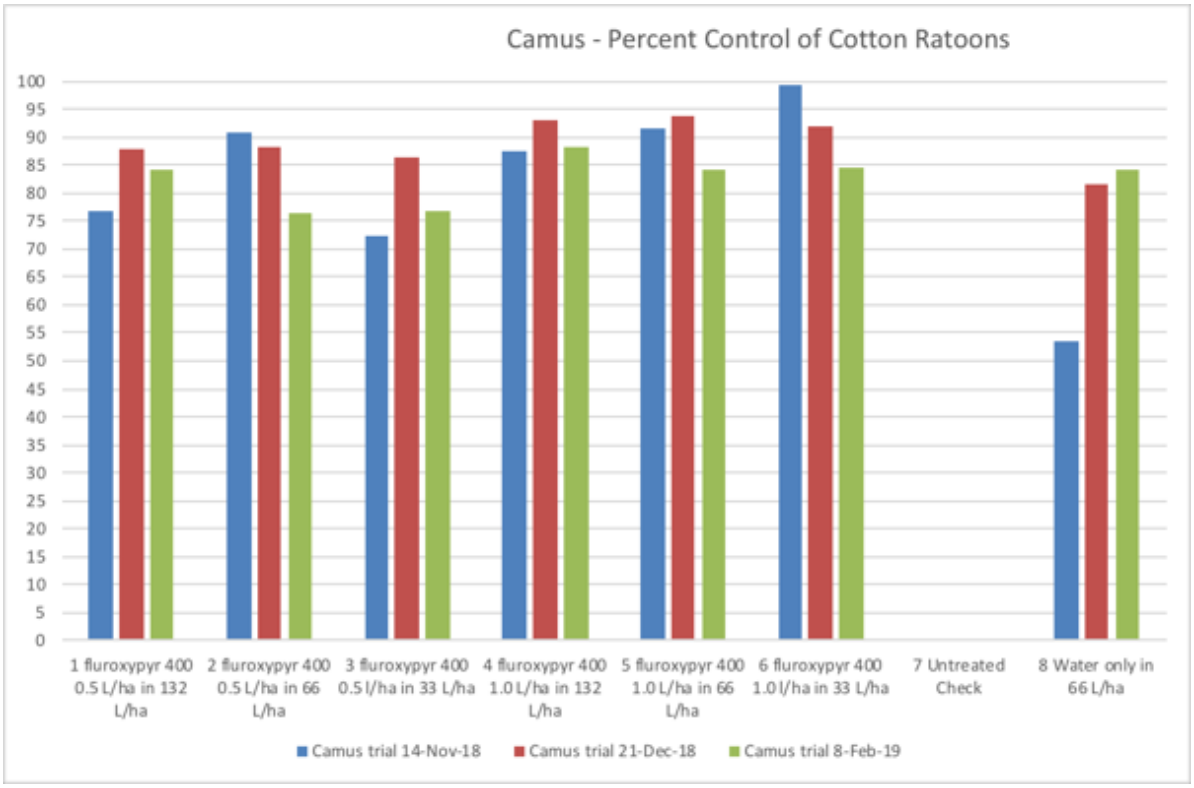

Figure 4 Percent Control of Cotton Ratoons compared to Untreated at "Camus" (Blue Hills) Site

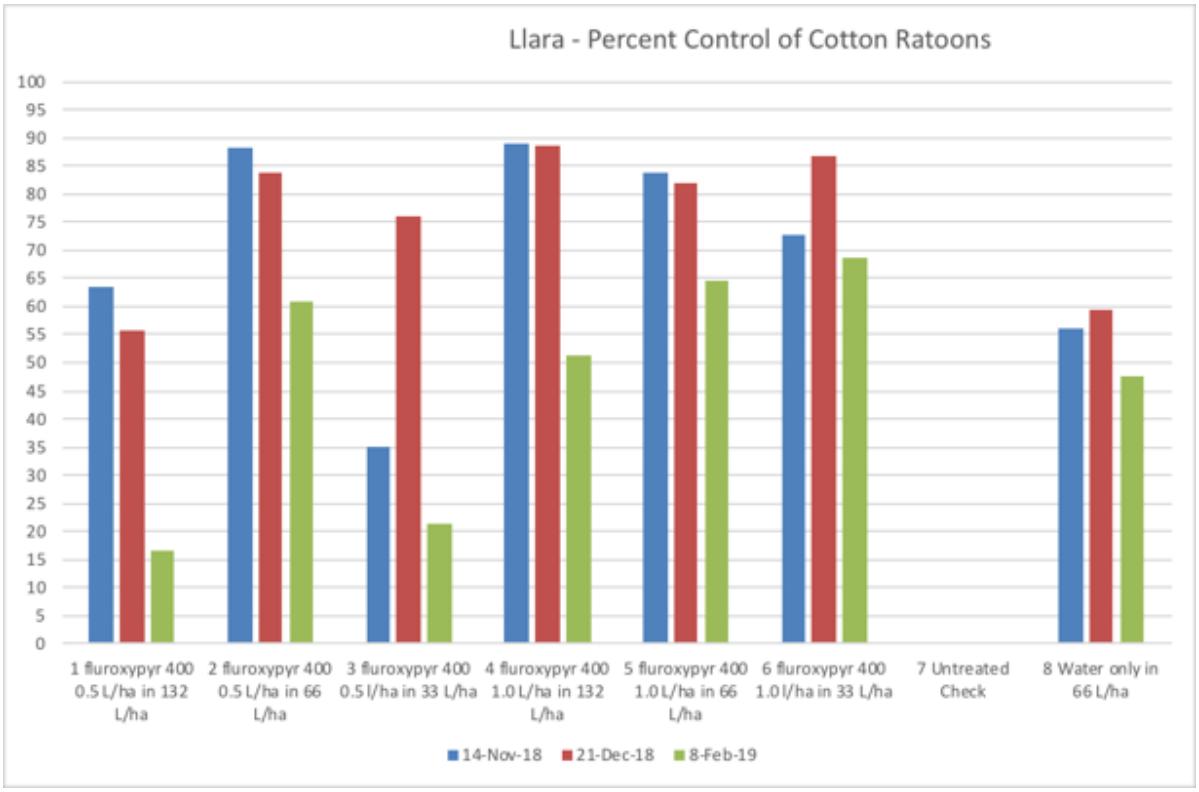

Figure 5 Percent Control of Cotton Ratoons – "Llara" PBI site

Table 1 ANOVA statistical Analysis “Camus” (Blue Hills site) Number of Ratoons per Metre and percent Control Compared to Untreated

Pest Code				GOSHI	GOSHI	GOSHI	GOSHI	GOSHI	GOSHI
Pest Scientific Name				Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>
Pest Name				American uplan>	American uplan>	American uplan>	American uplan>	American uplan>	American uplan>
Crop Code				GOSHI	GOSHI	GOSHI	GOSHI	GOSHI	GOSHI
Crop Scientific Name				Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>
Crop Name				American uplan>	American uplan>	American uplan>	American uplan>	American uplan>	American uplan>
Assessment Date				Nov-14-2018	Dec-21-2018	Feb-8-2019	Nov-14-2018	Dec-21-2018	Feb-8-2019
Part Assessed				PLANT -	PLANT -	PLANT -	PLANT -	PLANT -	PLANT -
Assessment Type				COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
Assessment Unit				m	m	m	m	m	m
Collection Basis, Unit				50 ROWm	50 ROWm	50 ROWm	50 ROWm	50 ROWm	50 ROWm
Trt No.	Treatment Name	Rate	Rate Unit	Appl Code	1	3	5	2	4	6
1	fluroxypyr 400	0.5	l/ha	A	1.9 bc	5.4 b	6.9 b	1.9 bc	4.4 b	5.7 b
	High volume			A				(76.7%)	(87.7%)	(84.1%)
2	fluroxypyr 400	0.5	l/ha	A	0.7 bc	4.3 b	8.6 b	0.7 bc	4.2 b	8.4 b
	Medium Volume			A				(90.9%)	(88.2%)	(76.5%)
3	fluroxypyr 400	0.5	l/ha	A	2.2 abc	5.9 b	9.6 b	2.2 abc	4.9 b	8.3 b
	low volume			A				(72.5%)	(86.3%)	(76.7%)
4	fluroxypyr 400	1.0	l/ha	A	1.0 bc	2.7 b	4.6 b	1.0 bc	2.5 b	4.2 b
	High volume			A				(87.6%)	(93.1%)	(88.3%)
5	fluroxypyr 400	1.0	l/ha	A	0.7 bc	2.4 b	6.1 b	0.7 bc	2.3 b	5.6 b
	Medium Volume			A				(91.7%)	(93.7%)	(84.2%)
6	fluroxypyr 400	1.0	l/ha	A	0.1 c	3.2 b	5.8 b	0.1 c	2.9 b	5.6 b
	low volume			A				(99.2%)	(91.8%)	(84.4%)
7	Untreated Check				8.0 a	38.7 a	37.5 a	8.0 a	35.6 a	35.7 a
								(0.0%)	(0.0%)	(0.0%)
8	Water only			A	3.7 ab	7.2 b	6.0 b	3.7 ab	6.5 b	5.6 b
								(53.7%)	(81.7%)	(84.2%)
LSD P=.05					2.60 - 5.83	8.66 - 16.73	8.96 - 14.67	2.60 - 5.83	6.63 - 24.58	8.17 - 22.46
Standard Deviation					5.37t	7.13t	6.27t	5.37t	0.33t	0.28t
CV					70.89t	46.74t	35.1t	70.89t	41.54t	29.8t
Replicate F					2.818	2.433	1.791	2.818	2.472	1.443
Replicate Prob(F)					0.0667	0.0949	0.1797	0.0667	0.0914	0.2585
Treatment F					2.941	7.339	6.898	2.941	4.232	3.651
Treatment Prob(F)					0.0290	0.0002	0.0003	0.0290	0.0052	0.0098

Table 2 Factorial Analysis “Camus” (Blue Hills) site Number of Ratoon per Metre and percent Control Compared to Untreated

Pest Code			GOSHI	GOSHI	GOSHI	GOSHI	GOSHI	GOSHI
Pest Scientific Name			Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>
Pest Name			American uplan>	American uplan>	American uplan>	American uplan>	American uplan>	American uplan>
Crop Code			GOSHI	GOSHI	GOSHI	GOSHI	GOSHI	GOSHI
Crop Scientific Name			Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>
Crop Name			American uplan>	American uplan>	American uplan>	American uplan>	American uplan>	American uplan>
Assessment Date			Nov-14-2018	Dec-21-2018	Feb-8-2019	Nov-14-2018	Dec-21-2018	Feb-8-2019
Part Assessed			PLANT -	PLANT -	PLANT -	PLANT -	PLANT -	PLANT -
Assessment Type			COUNT	COUNT	COUNT	COUNT	COUNT	COUNT
Assessment Unit			m	m	m	m	m	m
Collection Basis, Unit			50 ROWm	50 ROWm	50 ROWm	50 ROWm	50 ROWm	50 ROWm
Trt No.	Treatment Name	Rate Appl Rate Unit Code	1	3	5	2	4	6
TABLE OF A (Rate of Treatment) MEANS								
1	fluroxypyr 400	0.5 l/ha A	1.5 a	5.2 a	8.3 a	1.5 a	4.5 a	7.4 a
2	fluroxypyr 400	1.0 l/ha A	0.5 a	2.7 a	5.5 a	0.5 a	2.5 a	5.1 a
LSD P=.05			1.35 - 1.79	3.28 - 3.77	4.39 - 4.98	1.35 - 1.79	2.70 - 3.43	3.75 - 4.97
Standard Deviation			5.42t	6.04t	6.12t	5.42t	0.34t	0.30t
CV			98.16t	53.27t	40.40t	98.16t	52.50t	34.91t
TABLE OF B (Spray Volume) MEANS								
1	High volume	A	1.4 a	3.9 a	5.7 a	1.4 a	3.3 a	4.9 a
2	Medium Volume	A	0.7 a	3.3 a	7.3 a	0.7 a	3.1 a	6.9 a
3	low volume	A	0.8 a	4.4 a	7.6 a	0.8 a	3.8 a	6.8 a
LSD P=.05			1.36 - 2.66	3.44 - 5.15	4.88 - 6.39	1.36 - 2.66	2.71 - 5.32	4.09 - 6.33
Standard Deviation			5.42t	6.04t	6.12t	5.42t	0.34t	0.30t
CV			98.16t	53.27t	40.40t	98.16t	52.50t	34.91t
TABLE OF A (Rate of Treatment) B (Spray Volume) MEANS								
1	fluroxypyr 400	0.5 l/ha A	1.9 a	5.4 a	6.9 a	1.9 a	4.4 a	5.7 a
1	High volume	A						
2	fluroxypyr 400	1.0 l/ha A	1.0 a	2.7 a	4.6 a	1.0 a	2.5 a	4.2 a
1	High volume	A						
1	fluroxypyr 400	0.5 l/ha A	0.7 a	4.3 a	8.6 a	0.7 a	4.2 a	8.4 a
2	Medium Volume	A						
2	fluroxypyr 400	1.0 l/ha A	0.7 a	2.4 a	6.1 a	0.7 a	2.3 a	5.6 a
2	Medium Volume	A						
1	fluroxypyr 400	0.5 l/ha A	2.2 a	5.9 a	9.6 a	2.2 a	4.9 a	8.3 a
3	low volume	A						
2	fluroxypyr 400	1.0 l/ha A	0.1 a	3.2 a	5.8 a	0.1 a	2.9 a	5.6 a
3	low volume	A						
LSD P=.05			2.20 - 2.72	5.13 - 7.16	7.25 - 8.97	2.20 - 2.72	4.06 - 7.26	6.04 - 9.38
Standard Deviation			5.42t	6.04t	6.12t	5.42t	0.34t	0.30t
CV			98.16t	53.27t	40.40t	98.16t	52.50t	34.91t

Table 3 ANOVA statistical Analysis “Llara” PBI site Number of Ratoon per Metre and percent Control Compared to Untreated

Pest Code				GOSHI	GOSHI	GOSHI	GOSHI	GOSHI	GOSHI
Pest Scientific Name				Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>
Pest Name				American uplan>	American uplan>	American uplan>	American uplan>	American uplan>	American uplan>
Crop Code				GOSHI	GOSHI	GOSHI	GOSHI	GOSHI	GOSHI
Crop Scientific Name				Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>
Crop Name				American uplan>	American uplan>	American uplan>	American uplan>	American uplan>	American uplan>
Assessment Date				Nov-14-2018	Dec-21-2018	Feb-8-2019	Nov-14-2018	Dec-21-2018	Feb-8-2019
Part Assessed				PLANT -	PLANT -	PLANT -	PLANT -	PLANT -	PLANT -
Assessment Type				COUNT	COUNT	COUNT	CONTRO	CONTRO	CONTRO
Assessment Unit				m	m	m	%UNCK	%UNCK	%UNCK
Collection Basis, Unit				50 ROWm	50 ROWm	50 ROWm	50 ROWm	50 ROWm	50 ROWm
Trt No.	Treatment Name	Rate	Rate Unit	Appl Code						
					1	3	5	2	4	6
1	fluroxypyr 400 High volume	0.5	l/ha	A A	3.3 abc	12.8 ab	22.8 a	3.3 abc (63.3%)	13.2 ab (55.7%)	23.0 a (16.7%)
2	fluroxypyr 400 Medium Volume	0.5	l/ha	A A	1.1 c	4.8 bc	10.8 a	1.1 c (88.3%)	4.8 bc (83.8%)	10.8 a (60.9%)
3	fluroxypyr 400 Low Volume	0.5	l/ha	A A	5.9 ab	7.3 bc	21.8 a	5.9 ab (35.1%)	7.2 bc (76.0%)	21.7 a (21.3%)
4	fluroxypyr 400 High volume	1.0	l/ha	A A	1.0 c	3.4 c	13.4 a	1.0 c (88.9%)	3.4 c (88.7%)	13.5 a (51.2%)
5	fluroxypyr 400 Medium Volume	1.0	l/ha	A A	1.4 bc	5.4 bc	9.8 a	1.4 bc (83.9%)	5.4 bc (81.9%)	9.8 a (64.5%)
6	fluroxypyr 400 Low Volume	1.0	l/ha	A A	2.5 bc	3.9 bc	8.7 a	2.5 bc (72.7%)	3.9 bc (86.8%)	8.7 a (68.5%)
7	Untreated Check				9.0 a	23.7 a	26.3 a	9.0 a (0.0%)	29.8 a (0.0%)	27.6 a (0.0%)
8	Water only			A	3.9 abc	12.1 ab	14.5 a	3.9 abc (56.2%)	12.1 ab (59.5%)	14.5 a (47.5%)
LSD P=.05					3.75 - 6.54	8.57 - 16.39	18.53 - 20.50	3.75 - 6.54	8.49 - 20.37	19.74 - 21.63
Standard Deviation					0.31t	0.32t	0.33t	0.31t	0.32t	0.34t
CV					52.66t	34.04t	27.65t	52.66t	33.51t	28.35t
Levene's F					0.596	0.262	0.597	0.596	0.226	0.51
Levene's Prob(F)					0.752	0.962	0.751	0.752	0.975	0.816
Replicate F					1.319	1.527	0.498	1.319	1.659	0.480
Replicate Prob(F)					0.2973	0.2416	0.6880	0.2973	0.2094	0.7004
Treatment F					2.645	2.687	1.055	2.645	3.275	1.049
Treatment Prob(F)					0.0434	0.0431	0.4299	0.0434	0.0186	0.4352

Table 4 Factorial Analysis “Llara” PBI site Number of Ratoon per Metre and percent Control Compared to Untreated

Pest Code	GOSHI	GOSHI	GOSHI	GOSHI	GOSHI	GOSHI
Pest Scientific Name	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>
Pest Name	American uplan>	American uplan>	American uplan>	American uplan>	American uplan>	American uplan>
Crop Code	GOSHI	GOSHI	GOSHI	GOSHI	GOSHI	GOSHI
Crop Scientific Name	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>	Gossypium hirs>
Crop Name	American uplan>	American uplan>	American uplan>	American uplan>	American uplan>	American uplan>
Assessment Date	Nov-14-2018	Dec-21-2018	Feb-8-2019	Nov-14-2018	Dec-21-2018	Feb-8-2019
Part Assessed	PLANT -	PLANT -	PLANT -	PLANT -	PLANT -	PLANT -
Assessment Type	COUNT	COUNT	COUNT	CONTRO	CONTRO	CONTRO
Collection Basis, Unit	50 ROWm	50 ROWm	50 ROWm	50 ROWm	50 ROWm	50 ROWm
Trt Treatment Rate Appl No. Name Rate Unit Code	1	3	5	2	4	6
TABLE OF A (Rate of Treatment) MEANS						
1 fluroxypyr 400 0.5 l/ha A	2.9 a	7.7 a	17.6 a	2.9 a	7.8 a	17.6 a
2 fluroxypyr 400 1.0 l/ha A	1.6 a	4.2 a	10.5 a	1.6 a	4.2 a	10.5 a
LSD P=.05	1.83 - 2.23	3.72 - 3.85	9.08 - 10.95	1.83 - 2.23	3.75 - 3.85	9.09 - 10.98
Standard Deviation	0.31t	0.27t	0.33t	0.31t	0.27t	0.33t
CV	61.17t	33.14t	28.15t	61.17t	33.09t	28.12t
TABLE OF B (Spray Volume) MEANS						
1 High volume A	1.9 a	6.7 a	17.5 a	1.9 a	6.9 a	17.6 a
2 Medium Volume A	1.2 a	5.1 a	10.3 a	1.2 a	5.1 a	10.3 a
3 Low Volume A	3.9 a	5.4 a	13.9 a	3.9 a	5.4 a	13.8 a
LSD P=.05	2.58 - 2.60	3.83 - 5.97	10.37 - 14.38	2.58 - 2.60	3.89 - 5.97	10.44 - 14.37
Standard Deviation	0.31t	0.27t	0.33t	0.31t	0.27t	0.33t
CV	61.17t	33.14t	28.15t	61.17t	33.09t	28.12t
TABLE OF A (Rate of Treatment) B (Spray Volume) MEANS						
1 fluroxypyr 400 0.5 l/ha A 1 High volume A	3.3 a	12.8 a	22.8 a	3.3 a	13.2 a	23.0 a
2 fluroxypyr 400 1.0 l/ha A 1 High volume A	1.0 a	3.4 a	13.4 a	1.0 a	3.4 a	13.5 a
1 fluroxypyr 400 0.5 l/ha A 2 Medium Volume A	1.1 a	4.8 a	10.8 a	1.1 a	4.8 a	10.8 a
2 fluroxypyr 400 1.0 l/ha A 2 Medium Volume A	1.4 a	5.4 a	9.8 a	1.4 a	5.4 a	9.8 a
1 fluroxypyr 400 0.5 l/ha A 3 Low Volume A	5.9 a	7.3 a	21.8 a	5.9 a	7.2 a	21.7 a
2 fluroxypyr 400 1.0 l/ha A 3 Low Volume A	2.5 a	3.9 a	8.7 a	2.5 a	3.9 a	8.7 a
LSD P=.05	3.89 - 4.53	7.06 - 8.51	16.36 - 21.31	3.89 - 4.53	7.07 - 8.79	16.48 - 21.30
Standard Deviation	0.31t	0.27t	0.33t	0.31t	0.27t	0.33t
CV	61.17t	33.14t	28.15t	61.17t	33.09t	28.12t

Summary of Results:

- Results were variable and inconsistent across both trials due to very dry conditions
- Control approached 85% to 90% before regrowth was stimulated between December and February at both sites
- Substantial regrowth occurred in all treatments between December and February at both sites but particularly at the Llara site which received double the rainfall of the Camus site (140 mm compared to 70 mm)
- 1 L/ha rate of Fluroxypyr gave more robust residual control than 0.5 L/ha regardless of application volume.
- All 1 L/ha fluroxypyr treatments gave significant control compared to the untreated in Nov and Dec, no significant differences were seen in February at the Camus (Blue Hills) site. All treatments gave statistically significant control compared to the untreated at the Llara (university of Sydney) site at all assessments.
- All 1 L/ha fluroxypyr treatments gave numerically higher control compared to the water only in Nov and Dec, no significant differences were seen in February

Recommendations:

- Fluroxypyr - continue 2019 trials with higher rates 1-2 L/ha to aim for longer residual control
- Water volume - continue 2019 trials with lower water volumes as no effect of volume was observed
- Ground engagement tool - continue to modify to enhance robustness to rows and aim to construct a multi row unit when the single row unit is robust
- Timing - treat cotton closer to picking when plants are more like to be metabolising than when frosted and no active growth is visible.
- Crop type - Ensure 2019 trials are conducted in conventional refuges as this is the area identified where ratoon control is the most difficult to achieve
- Methodology - aim to nick plant stems rather than cut them through completely as this is when regrowth was most often observed

Figure 6 "Llara" site at treatment (mulched)

Figure 7 "Camus" site at treatment (standing)

Figure 8 "Llara" 14 Nov 18 – Untreated plot right

Figure 9 "Camus" 14 Nov 18 treated plot (planted with field peas

Figure 10 'Llara" site 21 Dec 18

Figure 11 "Camus" site 21 Dec 18

Figure 12 "Lara" site 8 Feb 19

Figure 13 Camus site 8 Feb 19

Outcomes

2. Describe how the project's outputs will contribute to the planned outcomes identified in the project application. Describe the planned outcomes achieved to date.

The efficacy data produced in the trials will be collated and submitted to the APVMA to obtain a large scale permit for this use pattern and application method of fluryoxypyr. A permit will be applied for to treat larger sale areas with a multi row machine in 2020. The aim of the data is to support a label claim pending further results produced in the following project CRDC 1937 where more efficacy data will be generated

A project team consisting of Greg Butler SANTFA, Annabelle Guest DCRA, Andrew Ericson Titan AG, Dr Geoff Smart regulatory consultant, Dale Foster NDF and 1-2 proposed growers with support from CRDC is proposed. This team will progress the project with the aim of achieving commercialisation when enough data is generated for a label claim for the Fluroxypyr use pattern.

3. Please describe any:-

a) technical advances achieved (eg commercially significant developments, patents applied for or granted licenses, etc.)

Further modification of the ground engagement tool is needed and will be undertaken by Dale Foster from NDF Narromine. This is encompassed in project CRDC1937 in which further trials are currently underway. Another machinery manufacturer TTQ Industries based in Toowoomba has expressed interest in commercialisation of this technology. A multirow machine is planned for when a large scale trial permit becomes available.

b) other information developed from research (eg discoveries in methodology, equipment design, etc.);

A commercial standard treatment eg mulching followed by herbicide, or over the top herbicide only, needs to be assessed in future trials to determine the control of ratoons achieved by the Aqua-Till application method compared to the commercial standard treatment. The commercial goal for crop termination through Aquatill is to achieve 90 to 95% ratoon control. Current commercial treatment regimes achieve around 85% control as indicated by grower observation, concurred with by Bayer CropScience,

c) required changes to the Intellectual Property register.

No changes to the IP register are required

Conclusion

AquaTill technology is showing promise as the preferred method of cotton crop termination, particularly in dryland situations. This is because crop termination can be achieved in accordance with the Resistance Management Plan requirements with minimal soil disturbance therefore minimising moisture loss from the system. The ability to leave crop residue standing will enhance rainfall capture which is pivotal in dryland farming systems. The flexibility provided around timing of operations ie slashing of crop residue is another advantage using AquaTill for crop termination will provide.

Further exploration of rates of Fluroxypyr and refinement of application equipment are required to progress the technology towards commercialisation. These aspects of development are progressing through project CRDC 1937 and through formation of a project development team.

Extension Opportunities

Demonstrations of the AquaTill technology in 2016 and 2017 were held (dedicated field walk at Keytah in June 2017). Growers and consultants have witnessed application to trials and the results from this project were presented as part of the University of Sydney GRDC and CRDC inaugural summer crop field day held on 28 March 2018. Further extension activities will be held as the ground engagement equipment develops.

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Further research is progressing through project CRDC 1937 with a further three field trials currently in progress

9. A. List the publications arising from the research project and/or a publication plan.

Results from the continuing project (CRDC1937) will be extended through publication in the Cottongrower Magazine when the 2019 trial results are available. A presentation is planned for the 2020 Crop consultants Association cropping solutions seminar.

B. Have you developed any online resources and what is the website address?

No online resources developed

Part 4 – Final Report Executive Summary

Ultra high pressure water jet cutting is widely used in industry for cutting through steel, glass and food items such as meat. It's use in agriculture can be many and varied including liquid coultering to sow through cereal stubble, in woody weed control, cutting through sugar cane residue and for cotton crop termination at the end of the season.

As the cotton industry moves further into multi-gene stack herbicide tolerant cotton, fewer herbicide options are available to control volunteer ratoons which are problematic in wet seasons. The current commercial industry standard of mulching and root cutting does not always provide effective control of ratoons and creates soil disturbance losing moisture.

The benefits of water jet cutting (AquaTill) in dryland systems are twofold. There is no soil disturbance reducing soil moisture loss as occurs through conventional tillage crop destruction methods such as root cutting and crop residue can be left standing at the end of the season, winter crop planted and cotton crop residue later removed providing flexibility around timing of operations. The technology is compatible with the current Resistance Management Plan which doe not require pupae busting if defoliation occurs prior to the end of March.

Initial work evaluating proof of concept for water jet cutting for cotton termination produced in project DAQ 1703 was promising using water alone through the system, however, the ratoon control achieved was not long lasting. Later, Fluroxypyr was added which enhanced and lengthened the control achieved. The initial work was done in good soil moisture conditions and proof of concept was demonstrated.

The aim of this project was to replicate the results from the previous season under different geographical and soil moisture conditions with the long term goal of producing data to support large scale demonstration and a path to commercialisation for AquaTill technology for cotton termination.

Two field trials were conducted in conventional dryland cotton crop residue in the spring and summer of 2018-19. Fluroxypyr at 0.5 and 1.0 L/ha was applied through the water jet at volumes of 32, 66 and 132 L/ha and ratoon control assessed over the following months.

Very dry conditions at treatment in late July 2018 persisted into the spring and over summer limiting regrowth and causing variable results. Robust control was achieved by the 1 L/ha rate of Fluroxypyr regardless of water volume. The treatments broke at the final assessment made in February.

Further development of the ground engagement tool and higher rates of Fluroxypyr were recommended for the subsequent project CRDC 1937 in which three further field trials are currently underway. A project team to develop a path to commercialisation has been formed as a result of this project.

Commercialisation of waterjet cutting AquaTill will provide growers with a minimum soil disturbance option for cotton crop termination thus conserving moisture and maximising ground cover contributing to a more sustainable farming system. Increased flexibility around timing of operations is an added benefit.