2023 Chemical Field Study Report

Title: **Demonstrating effective management of late summer/early autumn germinating marshmallow (Malva parviflora) in southern Western Australia**

Trial number:

Project number: TAR2211-001SAX

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1.0 Summary

Climate data
Early rainfall across all three sites varied, there was little summer rain with the break of season arriving late March. Due to this there was a reduction in the summer marshmallow germination. Adequate rainfall was seen from March to September at all sites, however Newdegate only saw 6.8mm in May. The marshmallow targeted were Autumn germinations, where weeds were not as large as when they germinate in late summer. All sites had dense weed populations, but the actual plant size was small, meaning that there was likely an increase in efficacy of treatments. There were no significant heat or major frost events that would have influenced the results in 2023 but larger sized marshmallow plants should be targeted in the future trials to see if similar efficacy can be achieved.

Field Measurements
Three trial sites were selected looking at different methods of control for marshmallow in a variety of crop, pasture and knockdown settings.

1) The **Narrogin** site investigated the level of brown out control from a range of herbicides in a knockdown scenario over 49 days, with an emphasis on group 14 chemistry.
2) The **Kulin** site focused on in crop control of surviving marshmallow control using registered in-crop herbicides.
3) The **Newdegate** site investigated the control of marshmallow in a medic pasture. Often this is where populations set seed causing issues in the cropping phase. The sensitivity of medic to herbicides has often meant that control options are expensive or difficult to employ.

All sites followed a similar protocol with the treatments applied using a handboom and visual assessments made periodically, including brown out, control, and crop safety (% relative to the untreated control).

Narrogin
The Narrogin site found that the addition of a group 14 spike, in particular the new generation products such as Terrador and Voraxor resulted in the fastest level of adequate control, however all treatments achieved near total brown out by the end of the assessment period. This trial will be repeated in the 2024 season on larger marshmallow plants as this will provide a more accurate reading on the level of efficacy for these products.

Kulin
The Kulin site investigated marshmallow control with registered in-crop herbicides and assessed the level of brown out (%) and recovery after application. The trial was conducted on a fallow paddock as no cropped paddocks had adequate densities of surviving mallow plants for usable trial results. Registered in crop herbicides were used at commercial timings with the main difference being that there was no crop competition on any surviving weeds.
In the absence of crop competition, 1L/ha Quadrant© offered the highest level of control. Treatments containing carfentrazone had very fast brown out but soon recovered. Whilst no treatment provided total control of the marshmallow 28 days after application, it is thought that with the addition of a pre-emergent herbicide and crop competition that all products would sufficiently reduce weed seed set.

Newdegate
The Newdegate trial site demonstrated that there are a very limited number of herbicide options in medic pastures which restricts the tools which can be used to prevent populations blowing out in pasture phase. Results from this herbicide screening show that many of the options available will not provide sufficient control of marshmallow. However, high levels of control were able to be achieved with Raptor and Broadstrike with limited impact on the medic pasture.

All three trials provided options for controlling Autumn germinated marshmallow in different phases of the growing season or rotation. These results may differ when applied to larger, more established marshmallow plants. 2024 trials will be aimed at summer germinated marshmallow to verify whether the results from this series of trials apply to larger plant sizes. The findings from this project aim to equip growers with strategies to manage late Summer and early Autumn germinating marshmallow following best practice techniques.

2.0 Background

From Mediterranean origin, Marshmallow (Malva parviflora) was introduced in Australia 160 years ago and has since become a weed that often grows in pastures and un-arable locations of Western Australia. It's adapted to a wide range of environments but thrives in areas with an annual rainfall of 315-496mm. This along with an optimum germination temperature of 15-20^{o}C with minimal light requirement, makes the southwest one of its most dominant habitats in Western Australian cropping areas.

Control of marshmallow can prove difficult with the use of glyphosate alone on larger weeds being unsatisfactory and in pasture settings there are few options that won't affect the pasture negatively. Previous studies have found that marshmallow does not cross pollinate therefore reducing the genetic variation and ability to spread. It has been suggested that over the decades of broadacre farming the introduction of livestock has spread this weed through grazing the plant and spreading the seeds, which can lead to thick patches of marshmallow in sheep yards and concentrated parts of paddocks. Due to this being a dominant form of seed dispersal, livestock dominant and mixed cropping farms have the greatest challenges with controlling marshmallow, whereas full cropping systems have predominately successfully controlled this weed.

Assisting growers to gain a better understanding of the biology and ecology of marshmallow can assist with successful management of this weed. As marshmallow is hard seeded there is a requirement for a fluctuation in temperature for dormancy to release preventing any germination in false breaks or periods of drought. The weed also has an inability to be desiccated due to the seed coating being impermeable, therefore chemical, and biological control needs to be conducted early to ensure adequate eradication.

This project aims to not only assist growers in gaining a better understanding of the biology of marshmallow but also what the best practice is in terms of chemical control looking at efficacy and cost-effectiveness. The gaps in grower knowledge surrounding these points are what this project aims to overcome.

3.0 Objectives

This investment aims to provide growers with:

- A better understanding of the biology and ecology of marshmallow and how this information determines the success of management decisions for this weed in the short- and long-term.
- Best-practice techniques to manage late summer/early autumn germinations of marshmallow.
- Strategies to identify and manage late summer/early autumn germinated marshmallow escapees prior to sowing.

4.0 Experimental details - Narrogin

Site details

Location	Narrogin (Toolibin)
GPS co-ordinates	33° 1'0.32"S, 117°38'52.31"E
Soil description	
Soil pH	
Crop type	Pre seeding Knockdown (cereal)
Previous crop type/year	Pasture

Experimental design

Trial design type	Randomised Block Design
Replicates	4
Plot size (width x length)	2.5m x 12m

Target(s) description

Common name	**Scientific name**
Marshmallow	Malva parviflora

Product details

Product name(s)	Active ingredient(s) (ai)	Active concentration (g ai/kg or L)	Formulation type
Glyphosate®	Glyphosate	450g/L	SL (Soluble Liquid)
Sharpen®	Saflufenacil	700g/kg	(Water dispersible Granules)
Terrador®	Tiafenacil	700g/Kg	WG (Wettable Granule)
Hammer®	Carfentrazone-Ethyl	400g/L	EC (Emulsifiable Concentrate)
Goal®	Oxyflurofen	240g/L	EC (Emulsifiable Concentrate)
2,4-D Ester®	24, D present as the 2-ethylhexyl ester	680g/L	EC (Emulsifiable Concentrate)
Voraxor®	Saflufenacil Trifludimoxazin	250g/L 125g/L	SC (Suspension Concentrate)
Starane®	Fluroxypyr	333g/L	EC (Emulsifiable Concentrate)

Treatment list

Treatment		Rate		Application timing
		Product (g or mL/ha)	Active (g ai/ha)	
1	Untreated control	Nil	Nil	NA
2	1.2L/ha Glyphosate 570	Glyphosate	684g/ha	18th May 2023
3	1.2L/ha Glyphosate 570 + 20g/ha Sharpen + 1% Hasten	Glyphosate Saflufenacil	684g/ha 14g/ha	
4	1.2L/ha Glyphosate 570 + 20g/ha Terrdor + 1% Hasten	Glyphosate Tiafenacil	684g/ha 14g/ha	
5	1.2L/ha Glyphosate 570 + 25ml/ha Hammer	Glyphosate Carfentrazone-Ethyl	684g/ha 10g/ha	
6	2.4L/ha Glyphosate 570	Glyphosate	1368g/ha	
7	1.2L/ha Glyphosate 570 + 80ml/ha Goal	Glyphosate Oxyflurofen	684g/ha 19.2g/ha	
8	1.2L/ha Glyphosate 570 + 80ml/ha Goal + 400ml/ha Ester	Glyphosate Oxyflurofen 24, D present as the 2-ethylhexyl ester	684g/ha 19.2g/ha 272g/ha	
9	1.2L/ha Glyphosate 570 + 100ml/ha Voraxor + 1% Hasten	Glyphosate Saflufenacil Trifludimoxazin	684g/ha 250g/L 125g/L	
10	1.2L/ha Glyphosate 570 + 300ml/ha Starane 333	Glyphosate Fluroxypyr	684g/ha 333g/L	

Application details

Method	Spray application	**Start time**	3:55pm
Equipment	Handboom	**Finish time**	5:00pm
Nozzle type	Albuz AL-110 Air inducted	**Treatments applied**	9
Nozzle size	015	**Wind speed (km/hr)**	6.2
Number of nozzles	5	**Wind direction**	SE
Nozzle spacing (cm)	50cm	**Cloud cover (%)**	0
Height above target	50cm	**Relative humidity (%)**	34
Spray quality	M	**Temperature (°C)**	22.7
Spray volume (L/ha)	100	**Wet bulb**	5.6
Pressure (kPa)	2	**Dew present (Y/N)**	N
Ground speed(km/hr)	6km/hr	**Crop growth stage**	
Date	18/05/2023	**Target growth stage**	
Days after application	---		

Assessment details

Date	Days after application X (DAA - X)	Crop growth stage Zadok / BBCH / Description	Assessment type
25/5/2023	7DAA		% Brown Out Visual ratings and photos were taken on the 25/5, 1/6, 9/6, 23/6, 6/7. Photos were taken of the marshmallow using a square quadrant (0.36m²) at the same three points in each plot. The progression of the herbicide effect was captured using this method, and a numeric value was assigned. 0= no brown out 100%= no green material left Images show the UTC plots overtime to demonstrate growth habit, marshmallow size and density.
1/6/2023	14DAA		

9/6/2023	22DAA		
23/6/2023	36DAA		
6/7/2023	49DAA		By day 49 after spraying significant insect predation can be seen on mallow.

5.0 Experimental details - Kulin

Site details

Location	Kulin, WA 6365
GPS co-ordinates	32.62647°S, 118.52066°E
Soil description	Alkaline gray shallow loamy duplex
Soil pH ($CaCl^2$)	0-10cm- 5.8 20cm- 7.5
Crop type	Unsprayed Chem fallow – simulating in crop control of mallow survivors using cereal herbicides.
Crop variety	NA
Sowing date	NA
Harvest date	NA
Previous crop type/year	Pasture

Sowing details

Equipment	NA
Sowing rate (kg/ha)	NA
Row spacing	NA
Sowing depth	NA
Soil moisture at sowing	NA
Fertilizer details	NA

Experimental design

Trial design type	Randomised Plot Design
Replicates	Four
Plot size (width x length)	2.5m x 12m

Target(s) description

Common name	**Scientific name**
Marshmallow	Malva parviflora

Product details

Product name(s)	Active ingredient(s) (ai)	Active concentration (g ai/kg or L)	Formulation type
Aptitude®	Metribuzin Carfentrazone	375g/kg 90g/kg	WG (wettable granule)
MCPA Amine 750	MCPA	750g/L	SL (soluble liquid)
Condor®	MCPA Pyraflufen	375g/L 10g/L	SC (suspension concentrate)
Tigrex®	MCPA LVE Diflufenican	250g/L 25g/L	EC (emulsifiable concentrate)
Quadrant®	Bromoxynil MCPA LVE Picolinafen Diflufenican	240g/L 250g/L 10g/L 20g/L	EC (emulsifiable concentrate)
Howitzer®	Diflufenican MCPA LVE Bromoxynil	25g/L 250g/L 250g/L	EC (emulsifiable concentrate)
Affinity Force®	Carfentrazone	240g/L	EW (emulsion, oil-in-water)
Paradigm®	Halauxifen Florasulam	200g/kg 200g/kg	WG wettable granule
Priority®	Florasulam	200g/L	SC (suspension concentrate)
LVE MCPA 570	MCPA	570g/L	EC (emulsifiable concentrate)
Talinor®	Bromoxynil Bicyclopyrone	175g/L 37.5g/L	EC (Emulsifiable Concentrate)

Treatment list

	Treatment	Product (g or mL/ha)	Active (g ai/ha)	Application timing
1	UTC	Nil	Nil	NA
2	200g/ha Aptitude®+ 330ml/ha MCPA Amine 750	Metribuzin Carfentrazone MCPA	75g/ha 18g/ha 2475g/ha	1st August 2023
3	1.6L/ha Condor®	MCPA Pyraflufen	600g/ha 0.016g/ha	
4	1L/ha Tigrex®	MCPA LVE Diflufenican	250g/ha 25g/ha	
5	1L/ha Quadrant®	Bromoxynil MCPA LVE Picolinafen Diflufenican	240g/ha 250g/ha 10g/ha 20g/ha	
6	1/ha Howitzer®	Diflufenican MCPA LVE Bromoxynil	25g/ha 250g/ha 250g/ha	
7	100ml/ha Affinity Force® + 330ml/ha MCPA Amine 750	Carfentrazone MCPA	24g/ha 2475g/ha	
8	25g/ha Paradigm® + 0.5% uptake	Halauxifen Florasulam	5g/ha 5g/ha	
9	25ml/ha Priority® + 440 ml/ha LVE MCPA 570 + 0.5% uptake	Florasulam MCPA	5g/ha 250g/ha	
10	1.2L/ha Talinor® + 1% Hasten	Bromoxynil Bicyclopyrone	210g/ha 35g/L	

Application details

Method	Spray Application	**Start time**	11am
Equipment	Handboom	**Finish time**	11:30am
Nozzle type	Albuz AL-110 Air Inducted	**Treatments applied**	2-10
Nozzle size	015	**Wind speed (km/hr)**	24kmph
Number of nozzles	5	**Wind direction**	North
Nozzle spacing (cm)	50cm	**Cloud cover (%)**	20
Height above target	50cm	**Relative humidity (%)**	43
Spray quality	M	**Temperature (°C)**	20
Spray volume (L/ha)	100	**Wet bulb**	-
Pressure (kPa)	2	**Dew present (Y/N)**	N
Ground speed(km/hr)	6km/hr	**Crop growth stage**	n/a
Date	1st August 2023	**Target growth stage**	n/a
Days after application	-		

Assessment details

Date	Days after application X (DAA - X)	Crop growth stage Zadok / BBCH / Description *(Photos demonstrating UTC at each assessment date)*	Assessment type
7th August	6DAA	n/a	**Biomass** Biomass cuts were taken cutting 0.36m² of the untreated control treatments on the 7th of August. Biomass was weighed, dried, and weighed again to give t/ha value.
9th August	8DAA		**% Brown Out** Visual ratings and photos were taken on the August 9th, 17th and 29th. Photos were taken of the marshmallow using a square quadrant (0.36m²) at the same two points in each plot. The progression of the herbicide effect was captured using this method, and a numeric value was assigned. 0= no brown out 100%= no green material left
17th August	16DAA		
29th August	28DAA		

6.0 Experimental details - Newdegate

Site details

Location	Newdegate, WA 6365
GPS co-ordinates	-32.969012°S, 118.805623°E
Soil description	
Soil pH	-
Crop type	Regenerating Medic pasture
Crop variety	Various medic species (Santiago suspected) and volunteer wheat
Sowing date	NA
Harvest date	NA
Previous crop type/year	Wheat

Experimental design

Trial design type	Randomised Block Design
Replicates	4
Plot size (width x length)	2.5m x 12m
Boom width	2.5m
Boom nozzles	Air inducted 015 nozzles
Spray speed	
Water rate	100L/ha

Target(s) description

Common name	**Scientific name**
Marshmallow	Malva parviflora

Product details

Product name(s)	Active ingredient(s) (ai)	Active concentration (g ai/kg or L)	Formulation type	Batch no.
Raptor	Imazamox	700g/kg	WG	
Broadstrike	Flumetsulam	800g/kg	WG	
Buttress	2,4-DB	500g/L	SL	
Diuron	Diuron	900g/kg	WG	
Igran	Tebutryne	500g/L	SC	
Bromoxynil	Bromoxynil	200g/L	EC	

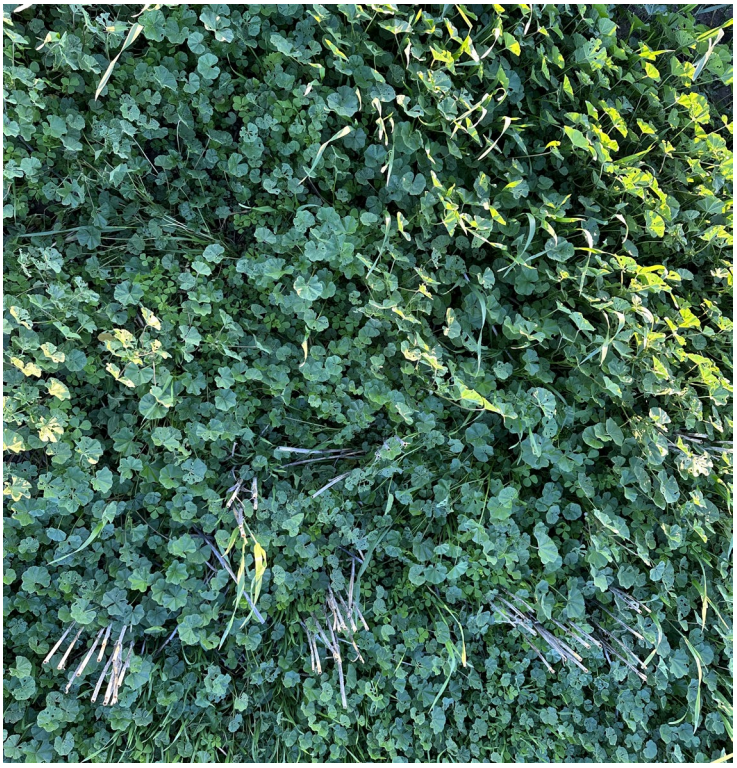
Treatment list

Treatment		Rate		Application timing
		Product (g or mL/ha)	Active (g ai/ha)	
1	Untreated control	Nil	Nil	NA
2	Raptor + 0.5% Hasten + 1% Ammonium Sulphate	40g	28	
3	Broadstrike + 0.5% Uptake	25g	20	
4	Raptor + Broadstrike + 1% Ammonium Sulphate + 0.5% hasten	40g + 15g	28 + 12	
5	Buttress + Broadstrike + 0.2% Wetter	1.5L + 25g	750 + 20	
6	Broadstrike + Diuron + 0.2% Wetter	25g +55g	20 + 49.5	
7	Broadstrike + Igran + 0.2% Wetter	15g + 0.5L	12 + 250	
8	Buttress	1.5L	750	
9	Bromoxynil (200)	1.5L	300	

Application details

Method	Boom Spray	**Start time**	4:45
Equipment	Hand Boom	**Finish time**	5:15
Nozzle type	Albuz AL-110	**Treatments applied**	All
Nozzle size	015	**Wind speed (km/hr)**	9.5
Number of nozzles	5	**Wind direction**	West
Nozzle spacing (cm)	50cm	**Cloud cover (%)**	50
Height above target	50cm	**Relative humidity (%)**	64
Spray quality	Medium	**Temperature (°C)**	13.2
Spray volume (L/ha)	100L/ha	**Wet bulb**	Adequate
Pressure (kPa)	220	**Dew present (Y/N)**	No
Ground speed(km/hr)	6	**Crop growth stage**	Various
Date	14/06/2023	**Target growth stage**	
Days after application	---		

Assessment details

Date	Days after application X (DAA - X)	Crop growth stage Zadok / BBCH / Description	Assessment type
30/06	16DA-A		Mallow Control + Medic Reduction. Photos of untreated control
11/07	27DA-A		Mallow Control + Medic Reduction. Photos of untreated control

26/07	42DA-A		Mallow Control + Medic Reduction. Photos of untreated control quadrant (0.36m^2)
28/08	75DA-A		Mallow Control. Photos of untreated control

7.0 Results & Discussion - Narrogin

The site was monitored for mallow control out to 49 days after spraying (49DAA). However, it was observed that after the 22-day (22DAA) assessment that grey banded weevil infestation spiked (observed by feeding damage highlighted in figure 1) reaching levels that provided near control of all sprayed plots by the 49DAA assessment. Results therefore highlight assessments of herbicide efficacy observed at 7DAA, 14DAA and 22DAA before the confounding influence of grey banded weevil was observed. Measurements ceased after 49 DAA due to near total control identified and the need for sheep to use the paddock for grazing by the trial host.

Measurements of brownout 7DAA and 14DAA highlighted that; treatments inclusive of the new generation group 14 products (Sharpen®, Terrador® and Voraxor®) all delivered significantly higher levels of brownout when compared to the untreated control, treatments exclusive of group 14 products and the older generation group 14 products (Hammer® and Goal®). Generally, these older group 14 products did result in significantly more brownout than treatments exclusive of a group 14 product. There was however an exception when 2-4,D ester was added to the mix which reduced the amount of brownout, giving equivalent results to the standalone glyphosate treatments 7DAA. At 14DAA this only applied to the higher rate (2.4L glyphosate 570).

Prior to the onset of grey weevil observation at 22DAA; all treatments inclusive of a group 14 product, (with the notable exception of the treatment including 2,4-D ester) gave equivalent levels of brownout. All other treatments gave equivalent control superior to the untreated control but poorer than those which contained group 14 products (again except for the treatment inclusive of 2,4-D ester). Glyphosate treatments were only able to provide in a reduction of 50% by 22DAA-a which would not be ideal in a green bridge, ground cover reduction scenario.

The results from this trial highlight that if rapid brownout is needed that the use of newer group 14 products should be employed. Of these newer group 14 treatments the most cost-effective solution was the use of Terrador® as a mixing partner. Results also highlighted a need to identify the influence of 2,4-D ester on the efficacy of group 14 products as efficacy was significantly reduced compared to the equivalent treatment without ester added. Further exploration of adjuvant selection with older group 14 products should also be considered as it may aid them in achieving comparable levels of rapid brownout to new group 14 products which demand premium adjuvants.

Figure 1: Feeding damage as a result of the grey banded weevil observed at the 36DA-A assessment timing

Table 1 Cost and brown out level (%) averages between 7DAA and 49DAA at Narrogin

Treatment		$/ha	% Brown out									
			7 DAA		14 DAA		22 DAA		36 DAA		49 DAA	
1	Untreated Control (UTC)	*$ -*	1	a	0	a	0	a	17	a	17	a
2	Glyphosate 570 (1.2L)	*$12*	11	ab	17	b	49	b	86	bc	93	b
3	Glyphosate 570 (1.2L) + Sharpen (20g)	*$20*	88	e	96	f	100	c	100	c	100	b
4	Glyphosate 570 (1.2L) + Terrador (20g)	*$15*	83	e	93	f	95	c	100	c	100	b
5	Glyphosate 570 (1.2L)+ Hammer (25ml)	*$25*	26	cd	59	e	82	c	98	bc	100	b
6	Glyphosate 570 (2.4L)	*$24*	13	b	30	bc	50	b	97	bc	100	b
7	Glyphosate 570 (1.2L) + Goal (80ml)	*$15*	53	d	54	de	84	c	99	c	100	b
8	Glyphosate 570 (1.2L) + Goal (80ml) + 2-4,D Ester (400ml)	*$18*	19	bc	36	c	57	b	96	bc	100	b
9	Glyphosate 570 (1.2L) + Voraxor (100ml)	*$19*	90	e	97	f	100	c	100	c	100	b
10	Glyphosate 570 (1.2L) + Starane (300ml)		21	bcd	43	cd	48	b	78	b	100	b
LSD 5% (P = 0.05)			11.97		15.3		19.64		15.28		11.76	
F Probability			<0.001		<0.001		<0.001		<0.001		<.001	
CV			6.1		14.5		26.1		8.5		4.6	

8.0 Results & Discussion - Kulin

Table 2 shows the progression of each herbicide treatment and the speed at which the effect was visible. Treatments with the active carfentrazone included (Aptitude® and Affinity force®) caused the fastest brown out but total control reduced with time as the plants were allowed to re-grow. The most effective treatment at 28 days after application (28DAA) was 1L/ha Quadrant®, although initially it took longer to show effect. The final control of Quadrant® was higher than Howitzer®, despite having the same herbicide groups and similar loadings of active ingredient. The main difference between these products is Quadrant® contains the active picolinofen which shows promise for future research. Treatments of 1.6L Condor®, 25g Paradigm® and 1.2L Talinor® provided poor control throughout the duration of the trial. Paradigm® did, however, demonstrate increasing relative efficacy at 28DAA indicating it may be slow to act. This trend was also noticeable in the Priority® + MCPA LVE mix. Consideration of how these products could be used as spikes is worthy of further research.

Finding a marshmallow site of adequate scale and distribution in crop proved difficult as marshmallow tends to grow in small dense areas, rather than entire paddock situations. Paddocks that are continually cropped or cropped regularly generally see less of a problem with marshmallow as herbicides applied in-crop combat the weed. If the weed is present, it is often isolated to small areas within a paddock. There are less control options in pastures, so it is generally a greater problem for livestock and mixed cropping producers.

The Kulin site was the only one in the wider trial group which didn't see any activity from the Grey Banded Weevil. Grey banded weevil is commonly found in marshmallow as this is the insects primary host plant. The Kulin site was free of weeds, stubble, and other marshmallow plants outside of the trial plots as the rest of the paddock was sprayed out. Future research could look at if the lack of vegetation in the remainder of the paddock helped to supress the pest.

Treatments containing carfentrazone provided the fastest brown out, but over time the marshmallow recovered which, may not have occurred in the presence of crop competition. The difference in final control between treatments 3 and 7 show there is some difference in the speed of rapid brownout between products of the same herbicide group, so product selection is important as the amount of active ingredient and type of crop safeners can vary.

This trial simulated an in-crop scenario but in the absence of pre-emergent chemistry and crop competition, the trialled treatments were less effective than what could be expected in a cropped situation. While some treatments provided strong suppression No treatment had total control of the marshmallow by 28DAA. By day 28 it was obvious that marshmallow in all plots survived so measurements of control ceased at 28DAA due to the grower needing the land to graze after this time and treatments had fully re-grown. The interaction with speed of control and crop competition is also worthy of future research as this interaction may result in higher levels of control.

Table 2: Brown out level (%) averages between 8DAA and 28DAA at Kulin and treatment cost.

		$/ha	% Brown out (8DAA)		% Brown out (16DAA)		% Brown out (28DAA)	
UTC	1	**$0**	0	a	0	a	0	a
200g/ha Aptitude®+ 330ml/ha MCPA Amine 750	2	$21 + $3.10= **$24.10**	71	f	78	f	46	de
1.6L/ha Condor®	3		23	d	24	b	20	b
1L/ha Tigrex®	4	**$10**	13	b	28	bc	41	de
1L/ha Quadrant®	5	**$22**	13	b	46	e	74	f
1L/ha Howitzer®	6	**$18.50**	29	e	41	de	50	de
100ml/ha Affinity Force®+ 330ml/ha MCPA Amine 750	7	$16 + $3.10= **$19.10**	78	g	81	f	55	e
25g/ha Paradigm®	8		9	b	29	bc	38	cd
25ml/ha Priority®+ 440 ml/ha LVE MCPA 570	9	$4.30 + $3.34= **$7.64**	16	c	34	cd	50	de
1.2L/ha Talinor®	10	**$30**	12	b	21	b	24	bc
		LSD 5% (P = 0.05)	3.591		8.651		14.97	
		F Probability	<0.001		<0.001		<0.001	
		CV	2.8		12.2		6.6	

9.0 Results & Discussion - Newdegate

Background

In the lakes area of Western Australia, marshmallow if often located on the alkaline soil types surrounding the salt lakes. Due to the alkaline nature of the soil, many legume-based pastures here are predominately medic based as opposed to sub clover which is dominant on the more acidic and lighter soil types throughout the Wheatbelt. The use of medics in these areas is beneficial both for grazing and the subsequent cropping phase. Medics are, however, generally much more susceptible to herbicides than sub clovers. This often restricts the amount of broadleaf manipulation which occurs. Options for controlling marshmallow have historically been limited which, can result in marshmallow plants escaping in the pasture phase and setting seed. This causes them to become an increasingly problematic weed in the subsequent crop phases. This trial seeks to identify herbicide options to control marshmallow in the medic pasture phase as this is where much of the seed set occurs.

Marshmallow Control

The mallow density was relatively even across the trial site with the first three replicates having very high densities. The group 2 (formally B) chemistries gave the highest levels of control with treatments inclusive of Raptor® (imazamox) reducing mallow populations by 90% at the end of the measurement period 75 days after application. At the same timing, treatments inclusive of Broadstrike® reduced populations by 75-80% which was not significantly different from the control achieved by Raptor®. The treatments of standalone Buttress® and Bromoxynil did not cause a large reduction in mallow numbers (17.5-30%)

This site was monitored out to 75 days after treatment. By this time there had been no new germination of mallow amongst the medic. The stronger treatments were very effective in suppressing the biomass and seed set of the mallow. In contrast the weaker treatments (eg Bromoxynil) only had minimal suppression of the marshmallow (see table 3 below). At this point the grower reintroduced livestock to the paddock and it was spray topped soon after.

Medic Safety

Most treatments had some impact on the biomass of medic. Ratings on the biomass of medic were taken from areas that had low levels of marshmallow in the plot but couldn't be completely free from the mallow or other broadleaf weeds. Broadstrike® had the least suppression of medic followed by Raptor®. The combination of Raptor® and Broadstrike® did increase damage slightly, though no Raptor® treatment resulted in a reduction greater than the untreated control. Treatments inclusive of Buttress® (2,4-DB) had a large reduction in biomass relative to the untreated control but no worse than Raptor® inclusive treatments. A similar result was observed with the Bromoxynil treatment, though it did result in significantly more reduction in the medic when compared to the standalone Broadstrike® treatment. Tebutryne which isn't registered for use in medic caused large amounts of damage and should never be used. It was included in this trial series to observe its potential use in a sub-clover situation.

Summary

The use of the group 2 products (Raptor® and Broadstrike®) provided not only the highest level of control of marshmallow but also the lowest level of reduction in the medic. Considerations need to be made with the choice of in-crop herbicides to reduce the reliance on group 2 chemistries in that phase, so they can be used in pastures. Preference should be given to their use in pasture due to the limitations of control options from other products as well as their potential to damage medics.

Table 3: Visual brown out control of marshmallow relative to the untreated control.

Treatment		Rate		Marshmallow control (%)	Marshmallow control (%)	Marshmallow control (%)	Marshmallow control (%)
		Product (g or mL/ha)	Active (g ai/ha)	16 DAA 30/06/2023	27 DAA 11/07/2023	42 DAA 26/07/2023	75 DAA 28/08/2023
1	Untreated control	Nil	Nil	22.5 a	12.5 a	12.5 a	10.0 a
2	Raptor + 1% Hasten + 1% Ammonium Sulphate	40g	28	57.5 bc	86.25 c	87.5 d	90.0 c
3	Broadstrike + 0.5% Uptake	25g	20	72.5 c	80.5 c	82.5 d	83.75 c
4	Raptor + Broadstrike + 1% Ammonium Sulphate	40g + 15g	28 + 12	65.0 c	85.5 c	87.5 d	91.25 c
5	Buttress + Broadstrike + 0.2% Wetter	1.5L + 25g	750 + 20	57.5 bc	72.5 c	70.0 cd	77.5 c
6	Broadstrike + Diuron + 0.2% Wetter	25g +55g	20 + 49.5	40.0 ab	68.75 bc	70.0 cd	81.25 c
7	Broadstrike + Igran + 0.2% Wetter	15g + 0.5L	12 + 250	27.5 a	51.25 b	56.25 c	75.0 c
8	Buttress	1.5L	750	20.0 a	12.5 a	12.5 a	17.5 ab
9	Bromoxynil (200)	1.5L	300	25.0 a	30.0 a	35.0 b	30.0 b
			LSD 5% (P = 0.05)	20.42	19.5	19.8	19.51
			F Probability	0.001	0.001	0.001	0.001
			CV	3.9	11.8	8.8	5.1

DAA#: days after application #

Table 4: Visual reduction of medic biomass (%) following applications of herbicide on the 14th June 2023

Treatment		Rate		Medic Reduction (%)	Medic Reduction (%)	Medic Reduction (%)
		Product (g or mL/ha)	Active (g ai/ha)	16 DAA 30/06/2023	27 DAA 11/07/2023	42 DAA 26/07/2023
1	Untreated control	Nil	Nil	15.0 a	10.0 ab	2.5 a
2	Raptor + 1% Hasten + 1% Ammonium Sulphate	40g	28	20.0 a	10.0 ab	15.0 abc
3	Broadstrike + 0.5% Uptake	25g	20	15.0 a	12.5 ab	12.5 ab
4	Raptor + Broadstrike + 1% Ammonium Sulphate	40g + 15g	28 + 12	15.0 a	22.5 bc	20.0 abc
5	Buttress + Broadstrike + 0.2% Wetter	1.5L + 25g	750 + 20	12.5 a	30.5 c	30.0 bcd
6	Broadstrike + Diuron + 0.2% Wetter	25g +55g	20 + 49.5	5 a	2.5 a	7.5 a
7	Broadstrike + Igran + 0.2% Wetter	15g + 0.5L	12 + 250	27.5 a	27.5 c	40.0 d
8	Buttress	1.5L	750	7.5 a	10.0 ab	30.0 bcd
9	Bromoxynil (200)	1.5L	300	15.0 a	30.0 c	33.75 cd
			LSD 5% (P = 0.05)	16.03	14.11	19.46
			F Probability	0.238	0.002	0.006
			CV	37.7	23.9	30.4

10.0 Conclusion

The three trials provided sound conclusions and recommendations that growers will be able to draw from and implement into their system. The Narrogin trial looking at marshmallow control in a knockdown scenario found that the addition of group 14 spikes increases the speed of control with the new generation group 14's (Terrador®, Sharpen® and Voraxor®) providing superior speed of brownout when compared to the older group 14 products (Hammer® and Goal®). All group 14 mixtures (except for the treatment inclusive of 2,4-D ester) gave high levels of control 22DAA.

The Kulin site looked at in-crop control of marshmallow and assessed the level of brown out (%) and recovery after application. In the absence of crop competition, 1L/ha Quadrant© offered the highest level of control. Treatments containing carfentrazone had very fast brown out but soon recovered. Whilst no treatment provided total control of the marshmallow at 28 days after treatment, it is thought that with the addition of a pre-emergent herbicides and crop competition that all products would perform better than demonstrated in this trial.

Finally, the Newdegate trial site demonstrated that there are a very limited number of herbicide options in medic which restricts the tools which can be used to keep marshmallow out of the medic pasture phase. Results from this herbicide screening show that many of the options available will not provide sufficient control of marshmallow. However, high levels of control were able to be achieved with Raptor® and Broadstrike® with limited impact on the medic pasture. Careful consideration will be needed as to how these products are used in rotations as both are group 2 chemistries. When selecting a product to use for marshmallow control pre-seeding or in crop, this will need to be considered. Having only one effective mode of action may potentially have issues with long term control of the weed if resistance were to develop so eradication of the weed by preventing seed set from problem paddocks should be the objective. This may involve targeted earlier spray topping in the pasture phase; however, this would require additional research into effective products and the timing of their applications.

11.0 Recommendations

11.1 Narrogin

The results from this trial indicate that the use of new generation group 14 products (Voraxor®, Terrador® and Sharpen®) is advised for the rapid brownout of marshmallow. However, if rapid brownout is not desired similar levels of control can be achieved 22DAA with older group 14 products (Hammer and Goal). We expect that spraying larger mallow plants will be harder to kill and will tease out greater differences between the new generation group 14 products and the old generation. Mallow plants controlled in this trial were small and in future trials, it would be recommended to apply the treatments to more mature marshmallow plants to see if the same interactions occur. The use of 2,4-D in a mixture with group 14 products should be explored with more scrutiny as there appeared to be a negative interaction in this trial. It is also worth exploring whether the use of adjuvants resulted in increased speed of brownout from the newer group 14 products over the older group 14 products. Future trials should pay close attention to the presence of grey banded weevil to remove it as a confounding factor for analysis. This may require an insecticide treatment to be applied across future trials.

11.2 Kulin

The 2023 in-crop treatments will be modified from learning outcomes for the 2024 trial design. Whilst Priority® + LVE MCPA only resulted in 50% brown out 28DAA and Howitzer® 50% 28DAA, further research into outcomes where these herbicides are mixed will be conducted. Carfentrazone treatments worked well but crop safety is a known issue which should be further studied in the 2024 trials. The use of Priority and picolinofen should be explored as a mixing partner due to their trend toward higher levels of efficacy. Trial designs in 2024 should explore these interactions as well as the impact of crop competition on final levels of control.

11.3 Newdegate

Medic pastures have a limited number of herbicide options, largely due to crop safety issues. Historically the options for broadleaf control in medic have been expensive and with often limited problematic broadleaf weeds have not been widely adopted. As a result, marshmallow has an opportunity to set seed in the pasture phase causing issues in the cropping phase. This trial indicates that the use of Group 2 (B) products in either Broadstrike® (flumetsulam) or Raptor® (imazamox) gives effective control of marshmallow in the medic pasture phase with minimal crop effect. If group 2's are being used in pastures to control mallow, an alternative control strategy should be employed in the cropping phase to reduce the risk of developing resistance. Due to the limitations in the number of available products for use in medic pastures. Future pasture research should identify whether there are spray topping strategies that could be effectively employed to reduce weed seed set.

12.0 Appendices

12.1 Appendix I: Trial details

Table 5: Brown out level (%) between 7DAA and 49DAA Narrogin. Red cells indicate where grey banded weevil accelerated % brown out.

			7 DAA	14 DAA	22 DAA	36 DAA	49 DAA
1	UTC	REP 1	3	2	2	0	0
		REP 2	0	0	0	0	0
		REP 3	0	0	67	67	67
		REP 4	0	0	0	0	0
		AVERAGE	**1**	**0**	**17**	**17**	**17**
2	1.5L Glyphosate 450	REP 1	15	18	13	12	70
		REP 2	5	5	18	73	100
		REP 3	12	18	63	100	100
		REP 4	13	27	100	100	100
		AVERAGE	**11**	**17**	**49**	**71**	**93**
3	1.5L Glyphosate + 20g Sharpen	REP 1	85	95	100	100	100
		REP 2	83	97	100	100	100
		REP 3	97	100	100	100	100
		REP 4	88	93	100	100	100
		AVERAGE	**88**	**96**	**100**	**100**	**100**
4	1.5L Glyphosate + 20g Terrador	REP 1	95	98	100	100	100
		REP 2	97	100	100	100	100
		REP 3	60	75	80	100	100
		REP 4	80	100	100	100	100
		AVERAGE	**83**	**93**	**95**	**100**	**100**
5	1.5L Glyphosate + 25ml Hammer	REP 1	28	60	77	90	100
		REP 2	8	20	62	100	100
		REP 3	15	63	90	100	100
		REP 4	53	93	100	100	100
		AVERAGE	**26**	**59**	**82**	**98**	**100**
6	3L Glyphosate 450	REP 1	15	42	35	88	100
		REP 2	8	8	15	100	100
		REP 3	23	43	50	100	100
		REP 4	5	25	100	100	100
		AVERAGE	**13**	**30**	**50**	**97**	**100**
7	1.5L Glyphosate + 80ml Goal	REP 1	35	55	60	98	100
		REP 2	41	72	87	100	100
		REP 3	22	60	100	100	100
		REP 4	17	28	90	100	100
		AVERAGE	**29**	**54**	**84**	**100**	**100**

8	1.5L Glyphosate + 80ml Goal + 400ml Ester	REP 1	23	37	65	87	100
		REP 2	5	10	10	97	100
		REP 3	13	23	52	100	100
		REP 4	35	75	100	100	100
		AVERAGE	**19**	**36**	**57**	**96**	**100**
9	1.5L Glyphosate + 100ml Voraxor	REP 1	90	98	100	100	100
		REP 2	93	100	100	100	100
		REP 3	85	93	100	100	100
		REP 4	90	97	100	100	100
		AVERAGE	**90**	**97**	**100**	**100**	**100**
10	1.5L Glyphosate + 300ml Starane	REP 1	8	20	22	73	97
		REP 2	15	18	0	40	100
		REP 3	33	53	72	100	100
		REP 4	28	78	100	100	100
		AVERAGE	**21**	**43**	**48**	**78**	**99**

Table 6. Brown out level (%) between 8DAA and 28DAA at Kulin

Treatment		Brown Out (%) - 8 DAA 09/09/2023								Brown Out (%) - 16 DAA 17/09/2023								Brown Out (%) - 28 DAA 29/09/2023							
1	Untreated control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0								**0**								**0**							
2	200g/ha Aptitude® + 330ml/ha MCPA Amine 750	70	75	65	70	70	70	75	70	80	75	70	65	80	80	85	90	40	50	30	30	40	40	80	60
		71								**78**								**46**							
3	1.6L/ha Condor®	25	20	25	20	20	25	20	25	25	20	20	30	25	20	20	30	30	30	10	10	30	20	20	10
		23								**24**								**20**							
4	1L/ha Tigrex®	10	15	15	10	10	15	15	10	20	20	35	30	20	25	40	35	35	40	60	70	20	50	35	20
		13								**28**								**41**							
5	1L/ha Quadrant®	10	10	10	10	10	10	20	20	40	30	60	65	40	45	40	50	80	70	80	90	60	80	60	70
		13								**46**								**74**							
6	1/ha Howitzer®	30	30	35	30	25	30	30	25	40	30	60	50	30	40	50	30	30	30	80	80	40	40	70	30
		29								**41**								**50**							
7	100ml/ha Affinity Force® + 330ml/ha MCPA Amine 750	80	75	80	85	80	70	80	70	80	75	80	80	75	85	90	80	70	40	40	35	50	60	70	75
		78								**81**								**55**							
8	25g/ha Paradigm®	5	10	15	10	10	10	10	5	40	30	50	30	20	10	30	20	30	30	50	20	60	40	50	20
		9								**29**								**38**							
9	25ml/ha Priority® + 440 ml/ha LVE MCPA 570	20	10	20	20	10	20	20	10	40	40	30	30	20	10	40	60	40	40	60	60	50	50	60	40
		16								**34**								**50**							
10	1.2L/ha Talinor®	10	10	10	10	10	15	15	15	20	20	30	20	10	15	40	15	30	30	0	10	20	10	60	30
		12								**21**								**24**							
LSD 5% (P = 0.05)																									
F Probability																									
CV																									

Table 7: % brown out control for marshmallow and % reduction on medic biomass at Newdegate site.

			30-Jun Mallow control %	30-Jun Medic reduction %	11-Jul Mallow control %	11-Jul Medic reduction %	26-Jul Mallow control %	26-Jul Medic reduction %	28-Aug Mallow control %
1	UTC	Rep 1	20	20	0	0	0	0	0
		Rep 2	20	20	20	20	30	0	20
		Rep 3	20	0	0	0	0	0	0
		Rep 4	30	20	30	20	20	10	20
		Average	**22.5**	**15**	**12.5**	**10**	**12.5**	**2.5**	**10**
2	40g Raptor	Rep 1	70	20	75	20	80	40	90
		Rep 2	50	20	90	0	90	0	90
		Rep 3	60	0	90	0	90	0	90
		Rep 4	50	40	90	20	90	20	90
		Average	**57.5**	**20**	**86.25**	**10**	**87.5**	**15**	**90**
3	25g Broadstrike	Rep 1	70	30	80	10	80	10	90
		Rep 2	70	10	80	10	80	0	80
		Rep 3	70	0	80	0	85	10	80
		Rep 4	80	20	80	30	85	30	85
		Average	**72.5**	**15**	**80**	**12.5**	**82.5**	**12.5**	**83.75**
4	40g Raptor + 15g Broadstrike	Rep 1	70	30	80	10	90	30	95
		Rep 2	70	20	80	10	90	0	90
		Rep 3	70	0	80	20	80	20	90
		Rep 4	50	10	90	30	90	30	90
		Average	**65**	**15**	**82.5**	**17.5**	**87.5**	**20**	**91.25**
5	1.5L 24db + 25g Broadstrike	Rep 1	50	0	60	30	60	20	70
		Rep 2	70	10	80	30	80	40	90
		Rep 3	60	20	70	30	80	30	70
		Rep 4	50	20	80	30	60	30	80
		Average	**57.5**	**12.5**	**72.5**	**30**	**70**	**30**	**77.5**
6	25g Broadstrike + 55g Diuron	Rep 1	20	0	65	0	60	10	70
		Rep 2	50	20	80	0	70	0	85
		Rep 3	40	0	60	0	70	0	90
		Rep 4	50	0	70	10	80	20	80
		Average	**40**	**5**	**68.75**	**2.5**	**70**	**7.5**	**81.25**
7	;g Broadstrike + 500ml Tebutryr	Rep 1	30	20	40	30	50	70	70
		Rep 2	20	30	50	30	50	40	60
		Rep 3	30	20	30	30	50	30	80
		Rep 4	30	40	85	20	75	20	90
		Average	**27.5**	**27.5**	**51.25**	**27.5**	**56.25**	**40**	**75**
8	1.5L 24db	Rep 1	50	20	20	20	20	50	30
		Rep 2	0	0	0	0	0	30	0
		Rep 3	0	0	0	0	0	10	0
		Rep 4	30	10	30	20	30	30	40
		Average	**20**	**7.5**	**12.5**	**10**	**12.5**	**30**	**17.5**
9	1.5L Bromoxynil 200	Rep 1	20	30	10	30	10	35	10
		Rep 2	50	10	50	20	60	30	60
		Rep 3	30	20	50	50	60	50	40
		Rep 4	0	0	10	20	10	20	10
		Average	**25**	**15**	**30**	**30**	**35**	**33.75**	**30**

12.2 Appendix II: Climate data

Data recorded at: 01/12/2023

Source: Buro of Meteorology (BOM)

Approximate distance from trial site (km): **Kulin- 30km**

Day	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1		0.2		7.2, 18		34, 8.6, 25.6						
2				0.4, 7		0.4, 2.4			2, 3	3.4	0.6	
3			0.4	22.5, 0.2				23.5, 27.8, 0.2	11.2, 12	1		
4							3.2, 11	8	7, 1.8, 1.2		0.2	
5		0.6			0.8	20.2, 4	2.6, 6	0.5	0.4, 1.6, 0.4			
6		0.8				25, 18.6, 10.8	0.2	0.7	1, 3.4, 1.8			
7					5.4	0.6, 0.2, 0.4	0.8					
8				20.8, 34.6	1, 0.2	0.2, 0.4	0.2	0.8				
9			1.2, 0.4	0.2		0.8, 0.2		5, 7				
10	1, 1.8			4.2	2.6, 0.2	3.4, 1	0.5	0.4	0.8			
11	0.5			42, 4, 3.8	1, 11, 1.2	4		8, 3.6				
12				0.2	0.2	0.5, 2		0.4				
13					4.2, 0.4	0.8, 0.2	1.2, 2.4	0.2	0.2		0.2	
14				7.5, 7	1.6, 2.8	1.4	0.5, 0.2	0.2	18, 25.2, 10.4		1.6	
15		0.2			1.4	0.2, 0.4		2.2	0.2, 0.2, 0.1			
16				0.8, 0.4		1.2, 5, 0.2		6, 8.2, 5.8	0.4			
17			0.6			1.2, 3		0.4, 0.2	0.4			
18												
19						2, 0.2	3, 11.2					
20						2.4, 2.4, 1.2	1.4					
21						2.8, 0.4, 2		0.8, 0.4				
22						0.2, 0.6	0.4				2	
23		0.2				3.4, 3.4			0.8		0.6	
24				1, 3	0.6, 1.6, 1.2	0.4						
25			0.8			0.4						
26			27, 28	6.6, 0.2		0.6, 5.2	5.4, 14.2		0.2			
27			31, 1.6, 9.4	1.2		3.4, 1	2				4, 0.6	
28			0.2			2						
29					1		2				7	
30					0.2		1					
31			2.2, 32		0.2		1.8, 0.6					
	1, 1.8, 0.5	0, 1.4, 0.6	33.2, 63.6, 38	72, 49.4, 71.4	7.6, 14.4, 6.8	77, 71.6, 60.6	18.2, 53.6, 24.2	42.9, 50.6, 50.6	26.6, 47.8, 29.3	0, 4.4	11, 2.6, 3.2	
						TOTAL	KULIN: 289.5 NARROGIN:361.2 NEWDEGATE: 285.2					

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12.3 Appendix 3: Survery:

1. **Where are you located?**
    - Varley
    - Kulin
    - Pingaring x 4
    - Lake Grace
    - North East Lake Grace
    - Presseville
    - Dunn Rock
    - East Wagin
    - Holt Rock
    - Wagin
    - South East Hyden/Little Italy
    - East Kulin/Jilakin
    - South Newdegate
    - Kukerin
    - Corrigin

2. **Do you have Marshmallow on your farm:**
    - Yes x 17
    - No x 1

3. **What percentage of your property has Marshmallow & has it increased over the last 10 years?**

Worse in wet years, hasn't increased in area

10 years ago (%)	, 3, 10, 5, 40, 5 acres, 2, 30, 20, 5, 10, 7, 2, 2, 20, 5	Today (%)	3, 10, 5, 40, 2, 40, 20, 2, 10, 5, 2,5, 20, 5

4. **What areas/paddocks/rotations have the highest densities and biggest issues with marshmallow?**
    - After pasture, clay.
    - Pastures with no/min stock.
    - Paddocks that have a high percentage of clay.
    - Late bank country
    - Gimlet clay highest, grey clay next
    - High gravel ridges
    - Heavy ground, shallow sand over clay
    - Very heavy granite/sheep yard
    - Heavy soil type- in pasture rotation
    - Heavy red soil x 3
    - Hard clay soils have the issues
    - Heavy country- no change in rotations
    - Where sheep camp, back of dams and paddocks near dams- sheep traffic etc.
    - See the odd one x 2

5. **Where is marshmallow the biggest problem? (rank your answer 1-3, 3 being the highest)**

Summer/Autumn: 2, 1, 2, 1, 1, 1

Pre-Sowing: 3, 3, 3, 3, 3, 2

In Crop/pasture: 1, 2, 1, 2, 2, 3

6. **Do you manage these paddocks differently?**

    Yes x 7

    No x 9

7. **What herbicide strategies do you use (in pasture, cereals (post em/ pre em) etc) and how effective are the (1= not effective 10=very effective)?**

Pre-Emergent (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

- Hammer, b power knockdown
- Hammer added to knockdown
- Hammer- 9
- Hammer- 10
- Goal/hammer- 9- as a knockdown
- Hammer- 7 & double knock
- Hammer- 9
- Gly + Hammer- 9
- Hammer- 6
- Terrador to gly- 10
- Hammer + gly is small- 8
- Hammer- 10
- Add Hammer to Glyphosate
- Add Gly- 8

Post Emergent (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

- Affinity, MCPA
- Don't target it, only in knockdown- x7
- Nail- 8

Pastures (1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

- Broadstrike, diuron, ecopar/amine
- Patch spray out, Hammer was effective
- Terrador
- Very difficult to control- x2
- An issue in pastures but don't really treat it
- Broadstrike + Diuron or Ecopar + MCPA Amine- 7

8. **Would you spend more money for a better control strategy?**
    - Don't need to.
    - Maybe- small patches- mostly ignore but regularly have survivors
    - No- not at current pressure
    - No- double knock plus hammer is working
    - Yes only if needed x5
    - No x 4
    - Yes x 5

Number of surveys: 18