



Queensland
Government



Sugar Research
Australia



Developing an alternative herbicide management strategy
to replace PSII herbicides in the Wet Tropics area

SRA Research Project 2014050

Demonstrations – 2016



Introduction:

The project

Diuron is currently considered one of the more environmentally sensitive herbicides used in Australian sugarcane production. Restrictive label conditions of use has encouraged growers to seek alternative herbicide strategies.

Banded application of pre-emergent herbicides has also been promoted as one way of reducing the total volume of pre-emergent herbicides applied to cane fields.

These demonstrations describe the results of different spray strategies for late cut ratoons in the Wet Tropics (Gordonvale and Innisfail). Herbicides applied on late cut ratoons have a greater risk of being lost due to the increased probability of rain soon after application.

Limiting pre-emergent herbicides to a band applied over the drill offers a way to reduce the volume of these herbicides subject to loss, however this strategy cannot be recommended carte blanche.

Spray strategies should be site specific.

Conclusions from a number of spot-spraying demonstrations are also discussed.



Project funding was provided by SRA and the Queensland Government.

Demonstration 1:

Late cut ratoon weed management strategies for the Wet Tropics

Location

Gordonvale, North Queensland

Main weeds present

This site had a moderate weed pressure with major weeds being:

Vines	<ul style="list-style-type: none"> • Red convolvulus (<i>Ipomoea hederifolia</i>) • Balsam pear (<i>Momordica charantia</i>)
Grasses	<ul style="list-style-type: none"> • Crowsfoot grass (<i>Eleusine indica</i>) • Guinea grass (<i>Panicum maximum</i>)
Broadleaf	<ul style="list-style-type: none"> • Electric weed, also called Spiny Spider Flower or Wild Rose (<i>Cleome aculeata</i>)

- Dry conditions during spring and early summer can delay weed germination:
 - > Pre-emergent herbicides immediately following harvest may not be necessary in these conditions.
- For later spraying, closer to out-of-hand crop stage, decide whether a knockdown only herbicide is suitable or whether you need to add a pre-emergent: especially if vines are likely to germinate after spraying.
- Non-selective knockdown herbicides can be either CONTACT (e.g. Paraquat 250, Basta®) or SYSTEMIC (e.g. Weedmaster® Argo®):
 - > Ensure good coverage especially with contact herbicides
 - > Systemic herbicides need active weed growth to ensure good translocation
 - > Spray when weeds are small to get coverage onto growing tips and to avoid injury to cane.



Spray strategies



All weed management strategies included three separate spray activities from spike/3-4 leaf stage to established cane growth stage:

- **Spike to 3 leaf stage:** Pre-emergent herbicides band sprayed over drills only. Five different pre-emergent mixes were used. The logic for this strategy is that weeds, especially grasses, within the row are the hardest to kill and cause the most competition. An early pre-emergent applied to only the rows reduces the total volume of pre-emergent herbicides applied and the cost per hectare.
- **Spot-spraying of Guinea grass stools when cane reached approximately 50 cm stalk length:** Three different spot-spray mixes were evaluated. Spot-spraying strategies are included as Demonstration 3 *Spot-spraying post-emergent strategies for perennial grasses*.
- **Established cane prior to out-of-hand growth stage:** Spraying of emerged weeds with or without the addition of a residual, focusing on the effectiveness of different herbicide strategies for the row and inter-row.



Summary of each spray strategy (excluding the spot-spray)

Strategy	1 st spray Pre-emergent straight after harvest (banded) 22/11/2016	2 nd spray Knockdown with or without pre-emergent 18/1/2017
1	Bobcat® i-maxx + Paraquat 250	Weedmaster® Argo® + Valor® 500 (spike rate) (inter-row) Mentor® 750 + Amicide® Advance 700 (row)
2	Balance® 750 WG + Barrage + Paraquat 250	Weedmaster® Argo® (inter-row) MCPA (row)
3	Flame® + Barrage	Mentor® 750 + MCPA
4	Balance® 750 WG + Paraquat 250	Basta®
5	Flame® + Paraquat 250	Weedmaster® Argo® + Valor® 500 (inter-row) MCPA (row)
6	nil	Weedmaster® Argo® + Flame® (inter-row) Mentor® 750 + Decoy® 400 (row)


Strategy 1

Spike to 3-leaf crop stage		Established cane – prior to out-of-hand crop stage	
Spray objective Kill small existing weeds and provide residual protection to rows only until out-of-hand spray.	Spray objective Control germinated weeds and keep clean until canopy closure.		
	Equipment used DAF dual spray bar (see Dual Circuit Spray Rig)		
Bobcat® i-maxx (3.8 L/ha) + Paraquat 250 (1.2 L/ha) 400 L/ha water rate	Inter-row Weedmaster® Argo® (3 L/ha) + Valor® 500 (100 g/ha) 80 L/ha water rate	Row Mentor® 750 (2 kg/ha) + Amicide® 700 (700 mL/ha) 300 L/ha water rate	
			
30 days after spraying		38 days after spraying	
<p>The early pre-emergent band did not provide any benefit as it did not rain until more than 1 month after spraying. Unsprayed inter-rows remained as clean as the sprayed rows.</p> <p>As it did not rain soon after spraying, the pre-emergent did not have any impact on existing Guinea grass stools located in the rows.</p>		Inter-row Weedmaster® Argo® mixed with the spike rate of Valor® killed existing weeds in the inter-row. However a subsequent flush of weeds, especially Balsam pear, germinated. Vines germinating from inter-row spread into the canopy. (Valor® at this rate has no residual activity). Row Mentor® plus Amicide® had good knockdown on existing Balsam pear, but Mentor® did not give good pre-emergent control of Balsam pear. It did prevent the germination of other weeds.	
Cost: \$54/ha (banded)		Cost: \$52/ha	
Conclusions: The early banded pre-emergent could have been left out (insurance policy). The combination spray to established cane was not a very effective strategy. Vines germinated in the inter-row after the knockdown was applied as Mentor® did not give good pre-emergent control of Balsam pear germinating in the row.			



Strategy 2

Spike to 3-leaf crop stage		Established cane – prior to out-of-hand crop stage	
Spray objective Kill small existing weeds and provide residual protection to rows only until out-of-hand spray.		Spray objective To see if a non-selective knockdown to the inter-row and a broadleaf selective knockdown to the row provides adequate weed control.	
		Equipment used DAF dual spray bar	
Balance® (200 g/ha) + Barrage (900 g/ha) + Paraquat 250 (1.2 L/ha) 400 L/ha water rate		Inter-row Weedmaster® Argo® (3 L/ha) 80 L/ha water rate	Row MCPA (930 mL/ha) 300 L/ha water rate
			
30 days after spraying		38 days after spraying	
<p>The early pre-emergent band did not provide any benefit as it did not rain until more than 1 month after spraying.</p> <p>Unsprayed inter-rows remained as clean as the sprayed rows.</p> <p>As it did not rain soon after spraying, the pre-emergent did not have any impact on the Guinea grass stools located in the rows.</p>		Inter-row Weedmaster® Argo® killed existing weeds in the inter-row. However a subsequent flush of weeds, especially Balsam pear, germinated. Vines germinating from inter-row spread into canopy. Row MCPA alone did not effectively control existing Balsam pear, but did control other broadleaf weeds and convolvulus vines. A new flush of weeds, including vines was apparent one month after spraying.	
Cost: \$32/ha (banded)		Cost: \$18/ha	
Conclusions: The early banded pre-emergent could have been left out. The combination spray to established cane was not an effective strategy. Vines germinated in the inter-row and row soon after the knockdowns were applied. Additionally MCPA alone had poor knockdown of Balsam pear.			



Strategy 3

Spike to 3-leaf crop stage	Established cane – prior to out-of-hand crop stage
Spray objective Kill small existing weeds and provide residual protection to rows only until out-of-hand spray.	Spray objective Combine a pre-emergent that also has early post-emergent action with a broadleaf knockdown spray across both row and inter-row area.
	Equipment used Octopus leg
Flame® (400 mL/ha) + Barrage (900 g/ha) + Paraquat 250 (1.2 L/ha) 400 L/ha water rate	Mentor® 750 (2 kg/ha) + MCPA (930 mL/ha) 300 L/ha water rate
	
30 days after spraying	38 days after spraying
<p>The early pre-emergent band did not provide any benefit as it did not rain until more than 1 month after spraying. Unsprayed inter-rows remained as clean as the sprayed rows.</p> <p>As it did not rain soon after spraying, the pre-emergent did not have any impact on the Guinea grass stools located in the rows.</p>	<p>The combination of Mentor® plus MCPA gave good knockdown of all existing weeds including Balsam pear.</p> <p>Mentor® did not prevent new Balsam pear from germinating, but it did prevent other weeds from germinating.</p>
Cost: \$19/ha (banded)	Cost: \$35/ha
Conclusions: The early banded pre-emergent could have been left out. Mentor® did not give good pre-emergent control of Balsam pear. An alternative pre-emergent applied to both rows and inter-rows, such as Flame® would have given better pre-emergent control of Balsam pear.	



Strategy 4

Spike to 3-leaf crop stage	Established cane – prior to out-of-hand crop stage
Spray objective Kill small existing weeds and provide residual protection to rows only until out-of-hand spray.	Spray objective Apply a non-selective knockdown across the whole inter-row and row area with octopus legs. No pre-emergent herbicide applied. Evaluate the weed pressure subsequent to this knock-down application.
	Equipment used Octopus leg
Balance® (200 g/ha) + Paraquat 250 (1.2 L/ha) 400 L/ha water rate	Basta® (3 L/ha) 300 L/ha water rate
	
30 days after spraying	38 days after spraying
<p>The early pre-emergent band did not provide any benefit as it did not rain until more than 1 month after spraying.</p> <p>Unsprayed inter-rows remained as clean as the sprayed rows.</p> <p>As it did not rain soon after spraying, the pre-emergent did not have any impact on the Guinea grass stools located in the rows.</p>	<p>Basta® was effective against weeds that were fully covered by the spray.</p> <p>Balsam pear and red convulvulus that had started climbing in the cane canopy were out of spray reach and were not killed.</p> <p>A new flush of weeds, particularly Red convulvulus and Balsam pear germinated soon after the knock-down was applied.</p> <p>At this particular site, cane suffered from phytotoxicity after the application of Basta®. This situation is rare and likely to have been caused by the rain event that occurred 2 to 3 hours after spraying.</p>
Cost: \$23/ha (banded)	Cost: \$41/ha
Conclusions: The early banded pre-emergent could have been left out. Basta® should not be chosen when vines that cannot be reached by the spray coverage are present.	

Strategy 5

Spike to 3-leaf crop stage		Established cane – prior to out-of-hand crop stage	
Spray objective Kill small existing weeds and provide residual protection to rows only until out-of-hand spray.		Spray objective Using spray hoods, assess weed control using a non-selective knockdown in the inter-row and a broadleaf selective knockdown for the rows.	
		Equipment used Spray hoods with side nozzles	
Flame® (400 mL/ha) + Paraquat 250 (1.2 L/ha) 400 L/ha water rate		Inter-row Weedmaster® Argo® (3 L/ha) + Valor® 500 (100 g/ha) 80 L/ha water rate	Row MCPA (930 mL/ha) 300 L/ha water rate
			
30 days after spraying		38 days after spraying	
<p>The early pre-emergent band did not provide any benefit as it did not rain until more than 1 month after spraying. Unsprayed inter-rows remained as clean as the sprayed rows.</p> <p>As it did not rain soon after spraying, the pre-emergent did not have any impact on the Guinea grass stools located in the rows.</p>		Inter-row Weedmaster® Argo® with Valor® as a spike killed existing weeds in the inter-row. However a subsequent flush of weeds, especially Balsam pear, germinated. Vines that germinated from inter-row spread into the canopy. Row MCPA did not effectively control Balsam pear, but did control other emerged broadleaf weeds. New grass and vine germinated after the knockdown spray.	
Cost: \$10/ha (banded)		Cost: \$28/ha	
Conclusions: The early banded pre-emergent could have been left out. The knock-down only sprays for the rows and inter-rows did not give lasting control due to subsequent flushes of germination. MCPA alone is not efficient to control Balsam pear. A second pass with either a high-rise spray rig or aerial application using 2,4-D and fluroxypyr (i.e. Decoy®, Starane® Advanced) was needed to clean up broadleaf weeds, especially vine.			

Strategy 6

Spike to 3-leaf crop stage		Established cane – prior to out-of-hand crop stage	
Spray objective Do not spray any herbicide to see what weed pressure there is. Is an early pre-emergent necessary?		Spray objective Using spray hoods, assess weed control using a non-selective knockdown mixed with a pre-emergent in the inter-row and a broadleaf selective knockdown mixed with a pre-emergent herbicide that also has early post-emergent action for the rows.	
		Equipment used Spray hoods with side nozzles	
nil	Inter-row Weedmaster® Argo® (3 L/ha) + Flame® (300 mL/ha) 80 L/ha water rate	Row Mentor® 750 (2 kg/ha) + Decoy® 400 (650 mL/ha) 300 L/ha water rate	
			
30 days after spike stage		38 days after spraying	
No pre-emergent was applied to either the row or inter-row areas. Very low weed germination.		Inter-row Weedmaster® Argo® killed existing weeds in the inter-row while Flame® prevented new germination of the weed species present in this block. Row The knockdown action of Mentor® plus Decoy® gave good knockdown control of existing Balsam pear. The pre-emergent action of Mentor® did not prevent new germination of Balsam pear, but was effective on other weeds.	
Cost: \$0/ha		Cost: \$45/ha	
Conclusions: Not applying an early pre-emergent at spike stage did not result in increased weed pressure and was the best option in 2016 for this block. Mentor® was not the best choice of pre-emergent due to the presence of Balsam pear. Flame® was a more effective pre-emergent for the type of weeds present at this site.			

Herbicides used on this site

Herbicide action	Product name	Active ingredient(s)
Knockdown	Amicide® Advance 700	2,4-D 700 g/L
	Basta®	glufosinate ammonium 200 g/L
	Decoy® 400	fluroxypyr 400 g/L
	MCPA® 750	MCPA 750 g/L
	Paraquat 250	paraquat 250 g/L
	Weedmaster® Argo®	glyphosate 560 g/L
	Valor® 500 WG (as a knockdown spike)	flumioxazin 500 g/kg
Pre-emergent	Balance® 750 WG	isoxaflutole 750 g/kg
	Barrage	diuron 468 g/kg, hexazinone 132 g/kg
	Bobcat® i-maxx	imazapic 25 g/L, hexazinone 125 g/L
	Flame®	imazapic 240 g/L
	Mentor®	metribuzin 750 g/kg

Conclusions

In this demonstration, the early band spray of pre-emergent was not necessary and the best choice was not to spray just after harvest. If band spraying is being considered to reduce the amount of residuals applied to a block, it is important to carefully consider the weed pressure, the type of weeds in the block, the amount of trash and the weather forecast as a band application may not even be necessary.

For the late treatment, none of the selected treatments provided acceptable weed control across the whole row/inter-row area. This was because Balsam pear was a dominant weed and had already started to climb into cane rows. Balsam pear required both knockdown control at time of the last spray and also residual control after that spray.

In this situation, because of the need to apply a late pre-emergent to both the row and inter-row areas, equipment such as octopus legs or droppers are the best option as long as they are used before the vines climb into the cane canopy. Suitable mixtures sprayed with octopus legs that should give both knockdown and residual control of the weeds present on this site include:

Starane™ Advanced (1 L/ha) + Flame® (300 mL/ha):	\$31/ha
Basta® (1-3 L/ha) + Flame® (300 mL/ha):	\$21-\$48/ha
Spray.Seed® 250 (1.2-1.6 L/ha) + Flame® (300 mL/ha):	\$20-\$24/ha
Atrazine 900 (2.2-3.3 kg/ha) + Valor® 500 (560-700 g/ha):	\$114-\$147/ha
Spray.Seed® 250 (1.2-1.6 L/ha) + Bobcat® i-maxx (2.9-3.8 L/ha):	\$71-\$93/ha

Again, spray should be applied whilst the growing tip of vines is still within the spray zone. If Balsam pear vine is already climbing in the cane canopy, it would be more effective to spray with a high-rise that targets vines with side nozzles using 2,4-D + Starane for example, and droppers that target the inter-row and the base of the row. Mixtures such as Flame® + SpraySeed®, Bobcat® i-maxx + Spray.seed®, Valor® + atrazine can be used for the droppers. This demonstration illustrates the need to assess each cane block individually; knowing what weeds are likely to be present and what herbicide(s) will give adequate control.

Demonstration 2:

Mid – late ratoon weed management strategies for the Wet Tropics

Location

Garradunga (Innisfail)

Main weeds present

This site had a moderate weed pressure with major weeds being:

Grasses	<ul style="list-style-type: none"> • Hamil grass (<i>Panicum maximum</i>) • South African pigeon grass (<i>Setaria sphacelata</i>) • Couch (<i>Cynodon dactylon</i>) • Para grass (<i>Brachiaria mutica</i>)
Broadleaf	<ul style="list-style-type: none"> • Blue top (<i>Ageratum conizoides</i>)
Vine	<ul style="list-style-type: none"> • Calopo (<i>Calopogonium mucunoides</i>)

- Growth of existing Guinea/Hamil grass stools can be retarded by pre-emergent herbicides, provided good soil moisture and incorporation by rainfall/irrigation occurs.
- Where moderate to heavy weed pressure is anticipated after harvest, ensure product selection is effective against the range of weeds present; to avoid follow-up sprays for species not controlled.
- For later spraying close to out-of-hand crop stage, decide whether a knock-down herbicide is suitable or whether you need to add a pre-emergent herbicide: especially if vines are likely to germinate after spraying.
- Be aware of forecast rain that could lead to run-off and/flooding: most pre-emergent herbicides can be rendered ineffective by heavy rain or flooding.



Spray strategies




Weed management strategies included either two or three separate spray activities from spike/3-4 leaf stage to established cane growth stage plus spot-spraying:

- **Spike to 3 leaf stage:** Pre-emergent herbicides blanket sprayed. Five different pre-emergent mixes were used.
- **Spot-spraying of Guinea grass stools** when cane reached approximately 50 cm stalk length – 3 different spot-spray mixes were evaluated. Spot-spraying strategies are included as Demonstration 3 *Spot-spraying post-emergent strategies for perennial grasses*.
- **Follow-up spray for calopo where required.**
- **Established cane prior to out-of-hand growth stage:** Spraying of emerged weeds with or without the addition of a residual, focusing on the effectiveness of different herbicide strategies for the row and inter-row.




Summary of each spray strategy (excluding the spot spraying)

Strategy	1 st spray Pre-emergent straight after harvest 27/9/2016	2 nd spray Knockdown for calopo vine where needed 11/11/2016	3 rd spray Knockdown with or without pre-emergent 20/12/2016
1	Bobcat® i-maxx + Paraquat 250	Kamba® 500	Weedmaster® Argo® + Valor® 500 (inter-row) Balance® 750 WG + Basta® (row)
2	Balance® 750 WG + Barrage + Paraquat 250	Not required	Mentor® WG + Basta®
3	Flame® + Barrage + Paraquat 250	Kamba® 500	Balance® 750 WG + Basta®
4	Balance® 750 WG + Paraquat 250	Not required	Weedmaster® Argo® (inter-row) Mentor® WG + Basta® (row)
5	Flame® + Paraquat 250	Kamba® 500	Mentor® WG + Basta®
6	nil	Agtryne MA	Basta®




Strategy 1

Spike to 3-leaf crop stage	Stooling	Established cane – prior to out-of-hand crop stage	
Spray objective Kill small existing weeds and provide residual protection until out-of-hand spray.	Spray objective Control calopo vine that the initial pre-emergent herbicide failed to control.	Spray objective Using DAF dual sprayer, control weeds using a non-selective knockdown in the inter-row and a non-selective knockdown mixed with a pre-emergent for the row.	
Equipment used Boom	Equipment used Octopus legs	Equipment used DAF dual sprayer	
Bobcat® i-maxx (3.8 L/ha) + Paraquat 250 (1.2 L/ha) 400 L/ha water rate	Kamba® 500 (560 mL/ha) + Activator® (125mL/100L) 300 L/ha water rate	Inter-row Weedmaster® Argo® (3 L/ha) + Valor® 500 (100 mL/ha) 80 L/ha water rate	Row Balance® 750 (150 g/ha) + Basta® (3 L/ha) + Activator® (25 mL/100L) 300 L/ha water rate
			
42 days after spraying	4 days after spraying	34 days after spraying	
Good pre-emergent control of grasses and broadleaves but only moderately prevented calopo germination. Bobcat® i-maxx retarded growth of Guinea grass stools (good rainfall incorporation soon after spraying) which was an additional benefit to its pre-emergent activity.	Sufficient calopo germinated after the pre-emergent spray to warrant a specific spray to prevent it growing up into the cane. Kamba® was an effective but slow acting knockdown with no effect on subsequent calopo germinations.	Inter-row All existing weeds were controlled. The addition of Valor® at the spike rate did not seem to give extra benefit. Row Basta® was very effective as a knockdown on all existing weeds. Flooding two weeks after spraying reduced the performance of all pre-emergents.	
Cost: \$83/ha	Cost: \$20/ha	Cost: \$66/ha	
Conclusions: Bobcat® i-maxx was effective on all weeds except calopo. Anticipated weed pressure following harvest was sufficient to justify the early pre-emergent spray. The presence of calopo vine indicated that a boom applied pre-emergent was justified. After about six weeks after the initial spray a late spray was necessary to control the emerged calopo. Twelve weeks after the initial spray, the late spray strategy of splitting the row/inter-row sprays did control existing weeds both in the row and inter-row. Flooding of the site for approximately one week duration caused the application of a pre-emergent to the rows to be short lived. In this case the application of a late pre-emergent was wasted.			


Strategy 2

Spike to 3-leaf crop stage	Stooling	Established cane – prior to out-of-hand crop stage	
Spray objective Kill small existing weeds and provide residual protection until out-of-hand spray.	Spray objective No follow up control for calopo was needed as there was low calopo pressure in this treatment.	Spray objective Control weeds using a non-selective knockdown mixed with a pre-emergent applied across both inter-row and row.	
Equipment used Boom		Equipment used Octopus legs	
Balance® 750 (200 g/ha) + Barrage (900 g/ha) + Paraquat 250 (1.2 L/ha) 400 L/ha water rate		Mentor® WG (2 kg/ha) + Basta® (3 L/ha) + Activator® (25 mL/100L) 300 L/ha water rate	
			
42 days after spraying		34 days after spraying	
Good pre-emergent control of weeds. Only a few calopo germinated. Unlikely that the addition of Barrage at this low rate gave much benefit compared to Balance® alone. Balance® plus Barrage retarded growth of Guinea grass stools (good rainfall incorporation soon after spraying) which was an additional benefit to its pre-emergent activity.		Very good knockdown control of all weeds present at time of spraying. Mentor® also has early knockdown activity. Flooding two weeks after spraying reduced the performance of all pre-emergents.	
Cost: \$53/ha		Cost: \$75/ha	
Conclusions: The early applied pre-emergents gave good control of germinating weeds. By about twelve weeks, there was enough germination of a range of weeds to justify a late spray. Basta® with Mentor® gave very good knockdown control of all weeds present. Any potential pre-emergent effect from Mentor® was largely reduced by the extended flooding. In this case the application of the late pre-emergent was wasted.			




Strategy 3

Spike to 3-leaf crop stage	Stooling	Established cane – prior to out-of-hand crop stage
Spray objective Kill small existing weeds and provide residual protection until out-of-hand spray.	Spray objective Control calopo vine that the initial pre-emergent herbicide failed to control.	Spray objective Control weeds using a non-selective knockdown mixed with a pre-emergent across both the inter-row and row.
Equipment used Boom	Equipment used Octopus legs	Equipment used Octopus legs
Flame® (400 mL/ha) + Barrage (900 g/ha) + Paraquat 250 (1.2 L/ha) 400 L/ha water rate	Kamba® 500 (560 mL/ha) + Activator® (125mL/100L) 300 L/ha water rate	Balance® 750 (150 g/ha) + Basta® (3 L/ha) + Activator® (25 mL/100L) 300 L/ha water rate
		
42 days after spraying	4 days after spraying	34 days after spraying
The early re-emergent spray provided good pre-emergent control of weeds except for calopo. Flame® plus Barrage retarded growth of Guinea grass stools (good rainfall incorporation soon after spraying) which was an additional benefit to its pre-emergent activity.	Sufficient calopo germinated after the pre-emergent spray to warrant a specific spray to prevent it growing up into the cane. Kamba® was an effective but slow acting knockdown with no effect on subsequent calopo germinations.	Basta® was very effective as a knockdown on all existing weeds. Prolonged flooding two weeks after spraying largely reduced the effectiveness of all pre-emergent used on the site.
Cost: \$31/ha	Cost: \$20/ha	Cost: \$70/ha
Conclusions: Flame® plus the low Barrage rate was less effective than Balance® for controlling germination of calopo, straight after harvest. A second selective vine spray was necessary to control calopo. By about twelve weeks, there was enough germination of a range of weeds to justify a late spray. Basta® gave very good knockdown control of all weeds present. The prolonged flooding meant that any pre-emergent applied at the late spray was ineffective. In this case that late applied pre-emergent was wasted.		


Strategy 4

Spike to 3-leaf crop stage	Stooling	Established cane – prior to out-of-hand crop stage	
Spray objective Kill small existing weeds and provide residual protection until out-of-hand spray.	Spray objective No follow up control for calopo was needed.	Spray objective Using the DAF dual sprayer, control weeds using a non-selective knockdown only in the inter-row and a non-selective knockdown mixed with a pre-emergent herbicide that also has early post-emergent action for the rows.	
Equipment used Boom		Equipment used DAF dual sprayer	
Balance® 750 (200 g/ha) + Paraquat 250 (1.2 L/ha) 400 L/ha water rate		Inter-row Weedmaster® Argo® (3 L/ha) 80 L/ha water rate	Row Mentor® WG (2 kg/ha) + Basta® (3 L/ha) + Activator® (25 mL/100L) 300 L/ha water rate
			
42 days after spraying		34 days after spraying	
Other than a few calopo germinating, Balance® gave effective pre-emergent control of weeds present, up until about twelve weeks after spraying. Balance® retarded growth of Guinea grass stools (good rainfall incorporation soon after spraying) which was an additional benefit to its pre-emergent activity.		Inter-row All existing weeds were controlled by Weedmaster® Argo®. Row Basta® was very effective as a knockdown on all existing weeds. Mentor® also has some early post-emergent knockdown activity. Prolonged flooding two weeks after spraying largely reduced any pre-emergent effect.	
Cost: \$39/ha		Cost: \$59/ha	
Conclusions: Balance® gave good pre-emergent control up until about twelve weeks after spraying There was enough subsequent germination of a range of weeds to justify a late spray. Both Weedmaster® Argo® and Basta® plus Mentor® gave very good knockdown control of all weeds present. The pre-emergent activity of all the pre-emergents applied at this late spray was largely reduced by the extended flooding. In this case the application of a late pre-emergent was wasted.			

Strategy 5

Spike to 3-leaf crop stage	Stooling	Established cane – prior to out-of-hand crop stage
Spray objective Kill small existing weeds and provide residual protection until out-of-hand spray.	Spray objective Control calopo vine that the initial pre-emergent herbicide failed to control.	Spray objective Control weeds using a non-selective knockdown mixed with a pre-emergent across both the inter-row and row.
Equipment used Boom	Equipment used Octopus legs	Equipment used Octopus legs
Flame® (400 mL/ha) + Paraquat 250 (1.2 L/ha) 400 L/ha water rate	Kamba® 500 (560 mL/ha) + Activator® (125mL/100L) 300 L/ha water rate	Mentor® (2 kg/ha) + Basta® (3 L/ha) + Activator® (25 mL/100L) 300 L/ha water rate
		
42 days after spraying	4 days after spraying	34 days after spraying
Flame® was slightly less effective for pre-emergent control of calopo than Balance®. Other weed species were effectively controlled up until about twelve weeks after spraying. Flame® retarded growth of Guinea grass stools (good rainfall incorporation soon after spraying) which was an additional benefit to its pre-emergent activity.	Sufficient calopo germinated after the pre-emergent spray to warrant a specific spray to prevent it growing up into the cane. Kamba® was an effective but slow acting knockdown with no effect on subsequent calopo germinations.	Basta® plus Mentor® provided very good knockdown control of weeds. Any pre-emergent activity was largely reduced by extended flooding 2 weeks after spraying.
Cost: \$16/ha	Cost: \$20/ha	Cost: \$75/ha
Conclusions: Because of the presence of calopo, Balance® would have been a better choice than Flame® for the early pre-emergent and may have circumvented the need for a second knockdown spray specifically for calopo. The late spray of Basta® plus Mentor® was very effective for knockdown control of all weeds present at time of spraying. Flooding two weeks after spraying meant that any pre-emergent activity was largely lost. In this case the late applied pre-emergent was wasted.		

Strategy 6

Spike to 3-leaf crop stage	Stooling	Established cane – prior to out-of-hand crop stage
Spray objective Do not use an early pre-emergent herbicide; rely on later applications of knockdowns.	Spray objective Control weeds especially calopo vine that was becoming a problem.	Spray objective Control weeds using a non-selective knockdown only across both the inter-row and row.
	Equipment used Octopus legs	Equipment used Octopus legs
	Agtryne MA (4 L/ha) + Agral® (200 mL/100L) 300 L/ha water rate	Basta® (3 L/ha) + Activator® (25 mL/100L) 300 L/ha water rate
 <p>Unsprayed weed pressure after 42 days</p>	 <p>4 days after spraying</p>	 <p>34 days after spraying</p>
Germination of Hamill grass, sour grass, couch, green pigeon grass and particularly calopo demonstrated that an early applied pre-emergent herbicide would have been a better strategy.	Agtryne MA effectively controlled the existing calopo (Agtryne MA by itself provides only broadleaf/vine control). Agtryne MA is very fast acting.	Basta® gave very good knockdown control of all weeds present at time of spraying.
Cost: \$0/ha	Cost: \$74/ha	Cost: \$46/ha
Conclusions: Weed pressure on this site was sufficient to warrant both an early and late spray. An appropriate early applied pre-emergent herbicide would have prevented early competition and given control of most weed species up until out-of-hand stage. The knockdown herbicide Basta®, gave very good control of weeds present at the late spraying.		

Herbicides used on this site

Herbicide action	Product name	Active ingredient(s)
Knockdown	Agtryne MA	terbutryne 275 g/L, MCPA 160 g/L
	Basta®	glufosinate ammonium 200 g/L
	Kamba® 500	dicamba 500 g/L
	Weedmaster® Argo®	glyphosate 560 g/L
	Valor® 500 WG (as a knockdown spike)	flumioxazin 500 g/kg
Pre-emergent	Balance® 750 WG	isoxaflutole 750 g/kg
	Barrage	diuron 468 g/kg, hexazinone 132 g/kg
	Bobcat® i-maxx	imazapic 25 g/L, hexazinone 125 g/L
	Flame®	imazapic 240 g/L
	Mentor®	metribuzin 750 g/kg

Conclusions

Weed pressure on this site justified both an early pre-emergent herbicide boom sprayed soon after harvest and a late applied knockdown herbicide.

A large flooding event about two weeks after the late applied (20/12/2016) pre-emergents, demonstrates the risk in late applied pre-emergent herbicides. It is likely that most of the late applied pre-emergents applied at this site were lost in floodwaters; giving little to no pre-emergent benefit as well as contributing to pesticide loads in floodwaters.

Of the pre-emergent herbicides used, Balance® gave the best early pre-emergent control, especially for calopo vine. Other pre-emergent herbicides not tested on this site, like Valor®, may also have given similar vine control.

Kamba® 500 and Agtryne MA are both systemic broadleaf knockdowns and provided excellent control of calopo, when the initial pre-emergent spray failed to give adequate control.

For a late-applied knockdown strategy, Basta® applied as a directed spray was a very effective knockdown for weeds present at out-of-hand stage, and could be used for weeds both in the row and inter-row zones, at an indicative cost of \$46/ha. It must not be sprayed on cane growing tips.

Dual circuit spray rigs

Dual circuit spray rigs have one spray circuit to supply side nozzles directed onto the row or cane drill and another circuit to feed a centre nozzle(s) directed to the inter-row only. Each circuit operates from its own spray tank, allowing different herbicides to be applied simultaneously to the row and inter-row.

Dual circuit spray systems can utilise spray shields or hoods or be unshielded. The DAF dual sprayer is unshielded with one centre nozzle operating at low pressure, high volume, very coarse droplet spectrum to avoid spray drift.



Above: DAF dual circuit sprayer – image on the right demonstrates two different circuits in operation using dye in the side nozzle circuit.



Above: Spray hood system utilising two spray circuits.

Demonstration 3:

Spot-spraying post-emergent strategies for perennial grasses

Evaluation of spot-spraying strategies for Guinea and Hamil grass was carried out during 2016 at East Barron, Mossman, Gordonvale and Innisfail.

Historically, spot-spraying relied mainly on herbicides containing diuron plus hexazinone, such as Velpar® K4™ DF® (no longer available), Barrage and Bobcat® combi WG.

Alternative spot-spraying mixes tested were

Products	Active ingredient	Rate	Estimated cost/100 L spray volume
Barrage + BS 1000	diuron/hexazinone + wetter	1 kg/100 L 500 mL/100 L	\$21
Balance® + Daconate® + Agral	isoxaflutole + MSMA + wetter	50 g/100 L 1 L/100 L 100 mL/100 L	\$27
Bobcat® i-maxx + Activator®	imazapic/hexazinone + wetter	1 L/100 L 125 mL/100 L	\$22
Rattler® 400 + Diurex® 900 + Wetspray® 1000	asulam + diuron + wetter	2 L/100 L 500 g/100 L 200 mL/100 L	\$44
Weedmaster® Argo®	glyphosate	1.35 L/100 L	\$10

- All the spot-spray mixes successfully killed established Guinea grass stools.
- Volume of spray applied is critical:
 - > Up to 200 mL for 30 cm high stools and up to 1 litre for stools one meter high
 - > Lower volumes caused a burn-off of foliage but stools regrew, requiring additional spot-spraying
 - > A Spray Turbo 400 handgun with a 2.5 mm ceramic jet delivering up to 5 L/minute at 2.5 bar was effective.
- Over-spray onto cane foliage will cause crop injury
 - > Glyphosate will kill cane and is not recommended for spot-spraying in-crop
 - > Bobcat i-maxx (imazapic/hexazinone) showed the most phytotoxicity of the other mixes.





Barrage + Activator®



Balance® + Daconate® + Agral



Bobcat® i-maxx + Activator®



Weedmaster® Argo®



Rattler® + Diurex® + Wetspray® 1000

