Final Report

Crop protection replacement for diuron in pineapple industry

Project leader:

Robert A. Vitelli B.Agr.Sc.

Delivery partner:

Bayer CropScience Pty Ltd

Project code:

ST15029

Project:

Crop protection replacement for diuron in pineapple industry ST15029

Disclaimer:

Funding statement:

This project has been funded by Hort Innovation, using the Pineapple research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Publishing details:

ISBN 978 0 7341 4651 9

Published and distributed by: Hort Innovation

Level 7
141 Walker Street
North Sydney NSW 2060

Telephone: (02) 8295 2300

www.horticulture.com.au

Content

Summary

The loss of diuron posed a threat to effective weed control in the pineapple industry and identifying a suitable replacement was a high priority for the Australian pineapple industry according to its Research and Development programme. The project ST15029 was established to generate sufficient efficacy, residue and crop safety data to allow for a submission for registration to the APVMA for Sencor® 480 SC Selective Herbicide (480 g/L metribuzin) and Balance® 750 WG herbicide (750g/kg isoxaflutole). The actives metribuzin and isoxaflutole were identified as candidates from the project entitled "Herbicide screening trial for Diuron replacement options for the pineapple industry", (HIA Project Number: PI 12004).

A total of eight residue test sites for two individual study plans were completed under Good Laboratory Practice (GLP) and ten efficacy/crop safety trials were completed in a range of geographical regions throughout the major pineapple growing regions in Queensland, over two cropping cycles (plant and ratoon). Trials were split using three cultivars (Smooth Cayenne, 73-50 and MD2) and two trials also investigated spray water volumes and tank mixtures. The residue and efficacy trial program were completed by Bayer CropScience Senior Development Specialists.

A summary of key findings includes:

- Sencor applied at 1.6 L/ha and Balance applied at 100 g/ha are effective in providing pre-emergent control of grass and broadleaf weeds in pineapple.
- The tank mixtures of Sencor plus Balance were numerically more efficacious than Sencor and Balance treatments applied alone and were comparable in weed control to the standard Uragan 800 WG (800 g/L bromacil).
- There was a trend to greater pre-emergent grass control for Sencor at 1.6 L/ha and a trend to lower pre-emergent control for Balance at 100 g/ha when applied at the low-water spray volume of 550 L/ha, compared to a high-water spray volume at 2410 L/ha.
- Sencor applied at 1.6 L/ha and Balance applied at 100 g/ha were physically and biologically compatible when tank mixed with Firepower® Herbicide applied at 800 mL/ha with Uptake™ Spraying Oil applied at 1 L/ha or when tank mixed with Uptake Spraying Oil at 500 mL/100 L.
- Sencor applied at 1.6 L/ha and 3.2 L/ha and Balance applied at 100 g/ha alone and as a tank mixture were safe to apply as a single spray up to 15 days after planting.
- Sencor and Balance caused unacceptable crop phytotoxicity when applied as two foliar sprays in the plant crop.
- Balance recorded higher crop phytotoxicity compared to Sencor when both were applied alone after two spray applications.
- The tank mixtures of Sencor at 1.6L/ha plus Balance at 100 g/ha and double rates (Sencor at 3.2 L/ha plus Balance at 200 g/ha) recorded greater crop phytotoxicity (crop discolouration) when compared to Uragan, after two spray applications and was not considered commercially acceptable.
- The double rates (Sencor at 3.2 L/ha plus Balance at 200 g/ha) also recorded more significant and often obvious phytotoxicity by impacting on the development of the pineapple crop. This resulted in greater biomass reduction and the lowest pineapple weights of all treatments, in 9 of the 10 trials.
- Sencor applied at 1.6 L/ha alone was the only treatment to be deemed safe to apply in ratoons following the plant crop harvest and was comparable to Uragan.
- In ratoons, it was apparent that herbicide applications must be made prior to the formation of suckers and slips/buttons.

Keywords

Pineapple, pre-emergent, weed control, diuron replacement, Sencor 480 SC, Balance 750 WG, metribuzin, isoxaflutole.

Introduction

Weeds in pineapple crops compete directly with the crop for sunlight, moisture and nutrients, interfere with spray penetration into the crop and often act as hosts for insect pests. Current weed management practices in pineapple are predominantly focussed on preventative measures using pre-emergent herbicides. Pre-emergent herbicides are designed to prevent weed establishment by killing the plant as it germinates and are primarily used immediately after planting. Post-emergent herbicides target weed populations after establishment has occurred and are aimed at the post-plant phase of the pineapple cycle. A tailored combination of pre and post emergent herbicides therefore remains an important strategy in reducing weed establishment and preventing the build-up of weed seed stores[4].

The Australian pineapple industry has relied on the use of the pre-emergent herbicides since the 1950s[5] and products containing diuron to effectively control weeds for many decades. In 2002 the Australian Pesticide and Veterinary Medicines Authority (APVMA) commenced a review of diuron based on environmental and human health concerns, specifically the potential for diuron to contaminate the marine environment through agricultural runoff and the possible toxicity of some impurities of diuron active constituents[4].

The APVMA concluded that using diuron at the originally approved rates of application presented a risk to aquatic ecosystems in most situations. The main risk is that in certain situations of use the concentration of diuron in water runoff following heavy or persistent rainfall may be high enough to cause significant harm to the environment, specifically aquatic plants[6].

Based on the outcomes of the diuron review, significant changes to the way diuron products could be used had been made with regional-specific restraints for pineapples introduced, including no-spray windows or time periods when diuron may not be applied. These time periods vary according to the climatic and geographic situations found on a regional basis[6]. The restrictions effectively ban the product from use in the pineapple industry as it cannot be used during some key planting windows.

The loss of diuron posed a threat to effective weed control in pineapples and identifying a suitable replacement was a high priority for the Australian pineapple industry according to its Research and Development programme. As a result, a screening trial was conducted at the Glasshouse Mountains district in south-east Queensland to evaluate the efficacy and crop safety of several commercially available herbicides for use in pineapples. The project entitled “Herbicide screening trial for Diuron replacement options for the pineapple industry”, (HIA Project Number: PI 12004), was designed to identify herbicides which warranted further investigation in terms of use patterns and application rates. In all, ten commercially available products were screened in the trial containing fourteen different treatments including the use of individual products and combinations of some of these products[4].

Evaluation based on efficacy and crop safety identified four products suitable for further investigation including Balance® 750 WG Herbicide (750 g a.i./kg isoxaflutole) and Soccer® 750 WG Herbicide (750 g a.i./kg metribuzin) and the combinations of these products[4]. Bayer CropScience Pty Ltd has subsequently ceased the production of Soccer in Australia and instead substituted with a different formulation of metribuzin, Sencor® 480 SC Selective Herbicide (480 g a.i./L metribuzin). The project ST15029 was established to generate sufficient efficacy, residue and crop safety data to allow for a submission for registration to the APVMA for Sencor and Balance herbicides.

Methodology

A) Efficacy/crop safety trial program

A total of 10 efficacy/crop safety trials were completed in a range of geographical regions throughout the major pineapple growing regions in Queensland (Table 1), with 6 trials completed over two cropping cycles (plant and ratoon). Trials were split using three cultivars (Smooth Cayenne, 73-50 and MD2) and 2 trials (QB05 and QB06) also investigated spray water volumes. The efficacy/crop safety trial program was completed by Bayer CropScience Senior Development Specialists. A list of products used throughout the trials are listed in Table 2.

Table 1: Summary of crop safety/efficacy field trials.

Protocol Number HD17AUSHM1 Trial number	Variety	Planting material	Queensland location
QB05	73-50	Tops	Elimbah
QB06	Smooth Cayenne	Tops	Elimbah
QB07	Smooth Cayenne	Tops	Mungar
QB08	73-50	Slips	Mungar
QC01	73-50	Tops	Beerwah
QE04	73-50	Tops	Rollingstone
QE05	MD2	Tops	Mutarnee
QF06	Smooth Cayenne	Tops	Yeppoon
QF07	MD2	Tops	Yeppoon
QF08	Smooth Cayenne	Tops	Yandaran

Table 2: Products used in the efficacy trials

Product	Form.	Ingredient	Conc.	Unit	Batch No.
Balance	WG	isoxaflutole	750	g ai/kg	PAHW000105
Sencor	SC	metribuzin	480	g ai/L	PHSF001448
Uragan	WG	bromacil	800	g ai/kg	15061112
Agral	SL	nonyl phenol ethylene oxide	600	g ai/L	AAC5G31041
Firepower	EC	haloxyfop-methyl	520	g ai/L	16RFA1003
Uptake	SL	paraffinic oil alkoxylated alcohol non-ionic surfactants	582 240	g ai/L g ai/L	1G16971100

<u>Trial Design</u>

The trials were conducted as Randomised complete block design using either 4 or 5 replicates (Table 3).

The plot size was 1 row/bed (1.32 to 1.5 m wide) x 7 to 10 m long.

Figure 1: Example of typical trial site: QB07 located at Mungar, Queensland with a 15 m buffer just prior to the commencement of the trial and spray Application A.

Water spray volumes ranged between 2096 to 2500 L/ha across all efficacy/crop safety trials, with a low water volume treatment applied at 550 L/ha included in trials QB05 and QB06 only, and coded as Applications D, E and F (Table 3).

Plant crop: An initial post-plant application of herbicides was applied as a broadcast foliar spray between 3 to 15 days after planting before planting material began to grow (Application A). A follow-up broadcast foliar spray (Application B) was applied at 54 to 71 days after application A (DAA) or Applications D and E for the low spray volume treatment in trials QB05 and QB06.

Ratoon crop: A broadcast foliar spray application was applied between 17 to 68 days after the plant crop had been harvested (Application C) or Application F for the low spray volume treatment in trials QB05 and QB06.

There were several consistent trial objectives across all trials with two additional objectives included for trials QB05 and QB06 where Sencor and Balance were also applied using a low spray water volume.

Trial objectives for all trials:

1. To compare Sencor at 1.6 and 3.2 L/ha for pre-emergence weed control in pineapple.
2. To compare Balance at 100 and 200 g/ha for pre-emergence weed control in pineapple.
3. To compare Balance and Sencor applied alone to tank mixtures of Sencor plus Balance for pre-emergence weed control in pineapple.
4. To compare Sencor, Balance and tank mixtures to the industry standard Uragan.
5. To evaluate the crop safety of Sencor, Balance and tank mixtures compared with the standard Uragan.

Additional objectives for trials QB05 and QB06

1. To compare Sencor at 1.6 L/ha applied at 2 water volumes (550 versus 2410 L/ha) for pre-emergence weed control in pineapple.
2. To compare Balance at 100 g/ha applied at 2 water volumes (550 versus 2410 L/ha) for pre-emergence weed control in pineapple.

Below is the list of treatments applied in the 10 efficacy/crop safety trials. There were 8 treatments common across all 10 trials. Two additional treatments were included in trials QB05, QB06, QB07 and QB08.

Treatments

No.	No.	Treatments	Product/ha	g ai/ha	Application code	Water spray volume range (L/ha)
1	1	Untreated				-
2	2	Sencor 480 SC	1.6 L	768	ABC	2096-2500
3	3	Sencor 480 SC	3.2 L	1536	ABC	
4	4	Balance 750 WG	100 g	75	ABC	
5	5	Balance 750 WG	200 g	150	ABC	
QB05 and QB06	6[1]	Sencor 480 SC	1.6 L	768	DEF	550
	7[1]	Balance 750 WG	100 g	75	DEF	
QB07 and QB08	6[2]	Sencor 480 SC + Balance 750 WG + Firepower 520 EC + Uptake Oil 822 SL	1.6 L + 100 g + 800 mL + 1 L/ha	768 + 75 + 416	AB	2375
	7[2]	Sencor 480 SC + Balance 750 WG	1.6 L + 200 g	768 + 150	AB	
6	8	Sencor 480 SC + Balance 750 WG	1.6 L + 100 g	768 + 75	ABC	2096-2500
7	9	Sencor 480 SC + Balance 750 WG	3.2 L + 200 g	1536 + 150	ABC	
8	10	Uragan 800 WG	4500 g 2200 g	3600 1760	AC B	

[1] Treatments applied only in trials QB05 and QB06.
[2] Treatments applied only in trials QB07 and QB08.
* Agral 600 SL applied at 12 mL/100 L was added as a tank mix to all herbicide treatments (Treatments 2 to 10) at Application B in trials QB05 and QB06 due to several weeds present at the time of application.
In trial QF06, treatment numbers 2 to 8 were all applied in a tank mix with Uptake Spraying Oil applied at 500 mL/100 L.

A summary of the spray application details, spray dates, spray intervals and harvest dates and intervals for the plant and ratoon crop are listed in Tables 3 and 4.

In 7 of the 10 trials, the herbicide treatments were incorporated with natural rainfall anywhere from 10 hours to 20 days after application with 6 to 13 mm of rainfall. In 3 trials, QE04, QE05 and QF08 the sites were irrigated using overhead sprinklers within one day of the first spray application (Application A). Only QF08 recorded the level of irrigation which equated to 11 mm (Table 3). Once the crop was established the irrigation lines were removed and the trial sites became dryland sites for the remainder of the trial.

Table 3: Summary of trial site and application details for crop safety/efficacy field trials for Applications A and B in the plant crop.

Trial No.	cv.	Irrigated /dryland (mm[1] - DAA[2])	Reps	Spray water volume (L/ha)	Crop Planted	Application A (DAP[3])	Application B (DAP)	Spray Interval (days)
QB05	73-50	Dryland (13 mm-4 DAA)	4	2410 & 550	19/7/16	29/7/16 (10 DAP)	28/9/16 (71 DAP)	61
QB06	SC	Dryland (6 mm-7 DAA)	4		2/8/16	16/8/16 (14 DAP)	12/10/16 (71 DAP)	57
QB07	SC	Dryland (8 mm-1 DAA)	4	2375	3/7/17	5/7/17 (2 DAP)	6/9/17 (65 DAP)	63
QB08	73-50	Dryland (10 mm-20 DAA)	4	2375	14/7/17	18/7/17 (4 DAP)	20/9/17 (68 DAP)	64
QC01	73-50	Dryland (10 mm-3 DAA)	5	2500	29/8/16	1/9/16 (3 DAP)	8/11/16 (71 DAP)	68
QE04	73-50	Irrigated/Dryland	4	2360	15/8/16	30/8/16 (15 DAP)	28/10/16 (73 DAP)	59
QE05	MD2	Irrigated/Dryland	4	2360	15/8/16	30/8/16 (15 DAP)	28/10/16 (73 DAP)	59
QF06	SC	Dryland (12 mm-10 hours)	4	2370	7/10/16	12/10/16 (3 DAP)	7/12/16 (59 DAP)	56
QF07	MD2	Dryland (12 mm-12 DAA)	4	2370	28/04/17	4/5/17 (6 DAP)	27/06/17 (60 DAP)	54
QF08	SC	Irrigated/Dryland (11 mm-0 DAA)	4	2096	7/9/16	15/9/16 (8 DAP)	25/11/16 (79 DAP)	71

[1] mm of rainfall or irrigation [2] DAA- Days after application A [3] DAP – Days after planting

Several trial sites did not reach a ratoon crop harvest (Table 4). In trial QB07, dry weather and damage from a severe hailstorm in October 2018 delayed the plant crop harvest until December 2019, almost 2.5 years after planting (Figure 2a). This resulted in the ratoon crop not being available for harvest until early 2021 which is at least six months passed the project end date of 30th June 2020.

In trial QB08, the site was damaged from the same hailstorm in October 2018. This caused the crop to experience natural flowering under stress, causing several different fruiting stages in the block with a majority as small unmarketable fruit. The grower decided to abandon the crop and subsequently ploughed in the site.

(a) **(b)**

Figure 2: Damage from October 2018 hailstorm in QB07(a) and QB08(b).

In trial QB06 the ratoon crop was commercially harvested (excluding the trial area, which was dumped in the field), without contact being made with Bayer.

In trial QC01, extended dry weather throughout 2019 adversely influenced this trial to the extent that the grower ploughed in the crop in mid-2019.

Table 4: Summary of trial site and application details for crop safety/efficacy field trials for Application C in ratoon crop and plant and ratoon crop harvest timings.

Trial No.	cv.	Plant Crop Harvest	Spray water volume (L/ha)	Application C	Days after plant crop harvest	Ratoon Crop Harvest
QB05	73-50	11/04/18 (560 DAB[5])	2410 & 510	03/05/18	24	2/03/20 (669 DAC[6])
QB06	SC	03/04/18 (538 DAB)	2410 & 510	20/04/18	17	1*
QB07	SC	02/12/2019 (817 DAB)	NA	2*		
QB08	73-50	29/01/2019 (496 DAB)	NA	3*		
QC01	73-50	12/09/2018 (673 DAB)	2400	24/10/18	42	4*
QE04	73-50	14/12/17 (412 DAB)	2106	20/02/18	68	29/11/18 (282 DAC)
QE05	MD2	14/12/17 (412 DAB)	2106	19/02/18	67	29/11/18 (283 DAC)
QF06	SC	03/04/18 (530 DAB)	2370	05/06/18	62	6/11/2019 (519 DAC)
QF07	MD2	03/01/19 (555 DAB)	2460	21/02/19	49	21/01/20 (334 DAC)
QF08	SC	11/10/17 (685 DAB)	2096	22/11/18	42	12/02/20 (447 DAC)

[1*] No sample collected. Crop destructed by grower without notice.
[2*] Application C was not applied as ratoon crop harvest will extend beyond project timeline to Feb-2021.
[3*] Site abandoned due to crop damage sustained from adverse weather conditions.
[4*] No sample collected. Crop destructed by grower in mid-2019 due to extended dry weather.
[5] DAB- Days after application B
[6] DAC- Days after application C

Assessments

i) Plant counts

In two trials, pineapple plant numbers were recorded by counting the number of living and/or dead pineapple plants within the plot area (QC01) or per 5 metres of row (QF07) (Table 7).

ii) Weed counts

In several trials a pre-spray weed count was made by counting the individual species or total number of grasses in the untreated control using either four quadrants, each 0.1 m^2, per plot or the entire plot (Table 7). All trials had additional weed assessments where individual weeds were identified and counted using either four quadrants, each 0.1 m^2, per plot or as total weed number counts for the entire plot. Within the reports, data is presented as weed numbers per unit of metre square and percent control (Abbott) is calculated relative to the untreated control. In several trials, an estimation of weed control per plot was calculated for each species or as a total of grass or broadleaf control relative to the untreated plots (Table 7).

The dominant grass and broadleaf weeds recorded at each trial site are presented in Tables 5 and 6. Please note that only percentage control of total grass and broadleaf weeds are presented within the Output section of the Final Milestone report.

Table 5: Summary of grass weeds recorded at each trial site.

Trial No.	Grasses	
	Common name	Scientific name
QB05	Summer grass Signal grass	*Digitaria ciliaris* *Urochloa subquadripara*
QB06	Summer grass* Crowsfoot grass* Coast button grass*	*Digitaria ciliaris* *Elusine indica* *Dactyloctenium aegyptium*
QB07	Green panic Paspalum*	*Panicum maximum* var. *trichoglume* *Paspalum dilatatum*
QB08	Green panic*	*Panicum maximum* var. *trichoglume*
QC01	Summer grass* Crowsfoot grass* Paspalum	*Digitaria ciliaris* *Elusine indica* *Paspalum dilatatum*
QE04	Crowsfoot grass* Green summer grass*	*Elusine indica* *Brachiaria subquadripara*
QE05	Guinea grass*	*Panicum maximum*
QF06	Barnyard grass* Summer grass*	*Echinochloa crus-galli* *Digitaria ciliaris*
QF07	Guinea grass Green Summer grass*	*Panicum maximum* *Brachiaria subquadripara*
QF08	Crowsfoot grass Vasey grass	*Elusine indica* *Paspalum urvillei*

* Data recorded allowed for statistical treatment comparisons.

Table 6: Summary of broadleaf weeds recorded at each trial site.

Trial No.	Broadleaf	
	Common name	**Scientific name**
QB05	Nil	Nil
QB06	Amaranth* Blackberry nightshade	*Amaranthus* spp. *Solanum nigrum*
QB07	Balloon Cotton Bush Praxelis Cobbler's peg Milkweed Phasey bean*	*Gomphocarpus physocarpus* *Praxelis clematidea* *Bidens pilosa* *Euphorbia heterophylla* *Macroptilium lathyroides*
QB08	Thick head* Blue top*	*Crassocephalum crepidioides* *Ageratum houstonianum*
QC01	Cobbler's peg Nutgrass	*Bidens pilosa* *Cyperus rotundus*
QE04	Pigweed*	*Portulaca oleracea*
QE05	Needle burr* Pigweed*	*Amaranthus spinosus* *Portulaca oleracea*
QF06	Nil	Nil
QF07	Slender amaranth Pigweed Blue top*	*Amaranthus viridis* *Portulaca oleracea* *Ageratum houstonianum*
QF08	Round-leaf cassia* Blue top	*Chamaecrista rotundifolia* *Ageratum houstonianum*

* Data recorded allowed for statistical treatment comparisons.

iii) <u>Crop safety</u>

At several assessment timings, crop effects (whole plot rating) were made using a combination of several parameters including:

Crop phytotoxicity, discolouration:

0 = No discolouration evident
10 = Negligible, discolouration barely seen
20 = Slight, discolouration clearly seen
30 = Moderate discolouration, recovery expected
40 = Substantial discolouration, some effects probably irreversible
50 = Majority of plants discoloured, highly likely irreversible effects
60 = Nearly all plants discoloured, mostly irreversible
70 = Severe discolouration
80 = Increasing level of discolouration
90 = Increasing level of discolouration
100 = Total discolouration of crop

A rating of 40 or above is generally commercially unacceptable

Crop biomass reduction:

0 = No damage evident
10 = Negligible damage,~ 10% biomass reduction or thinning
20 = Slight damage,~ 20% biomass reduction or thinning
30 = Moderate damage,~ 30% biomass reduction or thinning
40 = Substantial damage,~ 40% biomass reduction or thinning
50 = Majority of plants damaged, some necrosis and distortion,~ 50% biomass reduction or thinning
60 = Nearly all plants damaged, substantial necrosis and distortion,~ 60% biomass reduction or thinning
70 = Severe damage, substantial necrosis and distortion,~ 70% biomass reduction or thinning
80 = Very severe,~ 80% biomass reduction or thinning
90 =~ 90% biomass reduction or thinning
100 = Complete loss of plant (or) crop yield

Overall Crop safety rating:
1 = Excellent, no damage
2 = Good, very slight damage
3 = Satisfactory, damage still acceptable
4 = Marginal, damage usually no more acceptable
5 = Insufficient, damage unacceptable
6 = Not selective, total crop damage

iv) <u>Harvest</u>

A summary of the commercial harvests for the plant and ratoon crops are listed in Table 3 and 4. At each harvest and depending on the fruit size, between 5 to 16 mature fruit were randomly harvested per plot and weighed (Table 7). Data was analysed as an average fruit weight and calculating the relative percentage of each treatment was calculated by comparison to the untreated control.

Table 7: Summary of timing of weed, crop safety and harvest assessments across all trials.

Trial No.	Pineapple plant counts	Weed counts	Weed control as estimation	Crop safety assessments	Plant Crop Harvest	Ratoon Crop Harvest
QB05	-	Pre-spray -0 DAA/DAD 1 DAB/DAE 13 DAB/DAE	13 DAB/DAE	26 DAB/DAE 82 DAC/DAF	560 DAB (8 fruit)	669 DAC (10 fruit)
QB06	-	57 DAA/DAD 42 DAB/DAE	57 DAA/DAD 42 DAB/DAE	12 DAB/DAE 95 DAC/DAF	538 DAB (6 fruit)	1*
QB07	-	43 DAA 44 DAB	68 DAB	817 DAB	817 DAB (8 fruit)	2*
QB08	-	30 DAA	53 DAB	-	496 DAB (10 fruit)	3*
QC01	19 DAA 108 DAB	19 DAA 108 DAB	19 DAA	68 DAA 108 DAB 236 DAB 407 DAB 532 DAB 608 DAB 111 DAC 131 DAC	673 DAB (5 fruit)	4*
QE04	-	31 DAA 59 DAA	-	31 DAA 59 DAA 34 DAB 122 DAB 92 DAC	412 DAB (12 fruit)	282 DAC (16 fruit)
QE05	-	59 DAA 34 DAB	31 DAA	31 DAA 59 DAA 34 DAB 122 DAB 93 DAC	412 DAB (12 fruit)	283 DAC (16 fruit)
QF06	-	Pre-spray -0 DAA 48 DAA	-	48 DAA 57 DAB 519 DAC	530 DAB (15 fruit)	519 DAC (10 fruit)
QF07	149 DAB	25 DAA 54 DAA	-	25 DAA 149 DAB	555 DAB (16 fruit)	334 DAC (10 fruit)
QF08	-	Pre-spray -0 DAA 32 DAA 71 DAA	-	32 DAA 71 DAA 70 DAB	685 DAB (10 fruit)	447 DAC (10 fruit)

1* No sample collected. Crop destructed by grower without notice.
2* Application C was not applied as ratoon crop harvest will extend >8 months beyond project timeline to Feb-2021.
3* Site abandoned due to crop damage sustained from adverse weather conditions.
4* No sample collected. Crop destructed by grower in mid-2019 due to extended dry weather.

Data Management

Data generated in the trials was managed and statistically analysed within ARM (Agriculture Research Manager), a data management package used for planning, recording, evaluation and retrieval of trial data. All trial data analysed is compared using the Fisher's Least Significant Difference (LSD) test, except for trial QC01, where data was compared using Duncan's multiple range test, with statistical differences between treatments determined at the 5% or 10% level. When data violated the assumptions of ANOVA (homogeneity of variance and normality) data correction was conducted using either arcsine square root percent, square root or log transformations. Original plot means are presented in the results table for any transformed data. Treatment data means with the same letter do not significantly differ.

B) GLP Residue trial studies

A total of 8 residue test sites for two individual study plans (Table 8) were completed, under Good Laboratory Practice (GLP) to support registration, in a range of geographical regions, including dryland and irrigated farming operations, and split using three cultivars (Smooth Cayenne, 73-50 and MD2) with five trials completed over two cropping cycles (plant and ratoon) (Table 9). The residue trial program was performed by Bayer CropScience Senior Development Specialists.

i) Test sites

Table 8: Details of the two Study plans

Study Plan number: BCS-0527	**Balance 750 WG Herbicide**
Title: Determination of isoxaflutole residues in plant and ratoon crop pineapples following several applications of Balance 750 WG at rates of 100, 200 or 400 g/ha.	
Study Plan number: BCS-0528	**Sencor 480 SC Selective Herbicide**
Title: Determination of metribuzin residues in plant and ratoon crop pineapples following several applications of Sencor 480 SC at rates of 1.6 and 3.2 L/ha.	

Two GLP sites (Sites 5 and 8) had the ratoon crop commercially harvested (excluding the trial area, which was dumped in the field), without contact being made with Bayer. As a result, no residue data was obtained from the ratoon crop at Site 5 and 8.

The test site 6 located at Mungar near Maryborough was severely damaged by a hailstorm through the region on 14th October 2018. A sample from the plant crop was harvested in January 2019; however, the grower ploughed out the block and no ratoon crop can be harvested.

A detailed summary of the Study Plans BCS-0527 and BCS-0528 are shown in Table 9.

Table 9: Summary of GLP test site locations in Queensland and pineapple variety.

Test site	527 and 528-1	527 and 528-2	527 and 528-3	527 and 528-4
Location	Mutarnee	Rollingstone	Bungundarra via Yeppoon	
Soil type	Silty loam	Clay loam	Gravelly sand	Gravelly sand
Variety	MD2	73-50	MD2	Smooth Cayenne
Planting material	Tops	Tops	Tops	Tops
Environment	Field	Field	Field	Field
Planting date	15/08/2016	15/08/2016	28/04/2017	7/10/2016
Plot size	Bed area: 14.3 m^2 (10 m x 1.43 m) Sprayed area: 15.0 m^2 (10 m x 1.5 m)	Bed area: 8.33 m^2 (5 m x 1.66 m) Sprayed area: 7.5 m^2 (5 m x 1.5 m)	15.2 m^2 (10 m x 1.52 m)	Bed area: 13.2 m^2 (10 m x 1.32 m) Sprayed area: 15.2 m^2 (10 m x 1.52 m)
Test site	**527 and 528-5**	**527 and 528-6[1]**	**527 and 528-7**	**527 and 528-8**
Address	Yandaran	Mungar	Elimbah	
Soil type	Grey forest	Loam	Loam	Loam
Variety	Smooth Cayenne	73-50	73-50	Smooth Cayenne
Planting material	Tops	Slips	Tops	Tops
Environment	Field	Field	Field	Field
Planting date	17/10/2016	14/07/2017	2/08/2016	9/08/2016
Plot size	15.2 m^2 (10 m x 1.52 m)	Bed area: 10 m^2 (10 m x 1 m) Sprayed area: 12 m^2 (10 m x 1.2 m)	Bed area: 10 m^2 (10 m x 1 m) Sprayed area: 12 m^2 (10 m x 1.2 m)	Bed area: 10 m^2 (10 m x 1 m) Sprayed area: 12 m^2 (10 m x 1.2 m)

[1] Site abandoned after plant crop harvest due to crop damage sustained from adverse weather conditions.

ii) Residue trials - Application details

Plant crop: An initial post-plant application of herbicides was made within 3-46 days after planting, preferably before planting material began to grow (Application A). A follow-up spray (Application B) was applied at 34-64 days after application A (Table 10).

Ratoon crop: An application was be applied between 14-67 days after the plant crop had been harvested (Application C) (Table 10). Spray volumes ranged between 1917 to 2695 L/ha across the 8 sites.

Table 10: Summary of GLP test site application details.

Test Sites		527 and 528-1	527 and 528-2	527 and 528-3	527 and 528-4
Type of Application		Broadcast	Broadcast	Broadcast	Broadcast
Equipment Used		Application A and B: Motorised knapsack, 3 nozzle spray boom Application C: Makita motorised sprayer, 5 nozzle spray boom	Motorised knapsack, 3 nozzle spray boom	Makita motorised sprayer, 5 nozzle spray boom	Makita motorised sprayer, 5 nozzle spray boom
Spray Volumes Applied (L/ha)	**A**	2339 or 2352	2339 or 2352	2112 to 2257	2079 to 2369
	B	2339 or 2352	2339 or 2352	2162 to 2487	2145 to 2592
	C	1949 to 2088	2167 to 2406	2005 to 2343	1998 to 2127
Dates of Application (actual application timing)	**A**	30/09/2016 (46 DAP)	30/09/2016 (46 DAP)	3/05/2017 (5 DAP)	12/10/2016 (5 DAP)
	B	1/12/2016 (62 DAAA)	1/12/2016 (62 DAAA)	28/06/2017 (56 DAAA)	7/12/2016 (56 DAAA)
	C	19/02/2018 (67 days after plant crop harvest)	19/02/2018 (67 days after plant crop harvest)	21/02/2019 (48 days after plant crop harvest)	5/06/2018 (14 days after plant crop harvest)
Test Sites		**527 and 528-5**	**527 and 528-6**	**527 and 528-7**	**527 and 528-8**
Type of Application		Broadcast	Broadcast	Broadcast	Broadcast
Equipment Used		Makita motorised sprayer, 5 nozzle spray boom	Makita motorised sprayer, 4 nozzle hand boom	Makita motorised sprayer, 4 nozzle hand boom	Makita motorised sprayer, 4 nozzle hand boom
Spray Volumes Applied (L/ha)	**A**	2132 to 2225	2438 or 2567	2567	2438 or 2567
	B	1966 to 2237	2438	2182 or 2310	2310 or 2438
	C	1917 to 2162	N/A	2053 or2182	2182 to 2438
Dates of Application (actual application timing)	**A**	20/10/2017 (3 DAP)	18/07/2017 (4 DAP)	16/08/2016 (14 DAP)	16/08/2016 (7 DAP)
	B	23/12/2017 (34 DAAA)	20/09/2017 (64 DAAA)	12/10/2016 (57 DAAA)	12/10/2016 (57 DAAA)
	C	14/02/2018 (30 days after plant crop harvest)	N/A	5/07/2018 (30 days after plant crop harvest)	3/05/2018 (35 days after plant crop harvest)

DAAA = Days After Application A DAP = Days after planting
N/A – Not applicable

iii) Residue trials - Sampling details

A sample of 6 to 12 fruit were randomly selected from each plot at commercial harvest across all plant crops and at 5 of the 8 sites in the ratoon crop (Table 11).

Table 11: Summary of GLP test site sampling details.

Test Sites	527 and 528-1	527 and 528-2	527 and 528-3	527 and 528-4
Quantity of Test Sample Collected	12 fruit	Plant crop: 8 fruit Ratoon crop: 12 fruit	Plant crop: 10 fruit Ratoon crop: 6 fruit	Plant crop: 6 fruit Ratoon crop: 10 fruit
Sampling Dates (Timing)	14/12/2017 Plant crop (CH)	14/12/2017 Plant crop (CH)	4/01/2019 Plant crop (CH)	22/05/2018 Plant crop (CH)
Sampling Dates (Timing)	30/11/2018 Ratoon crop (CH)	30/11/2018 Ratoon crop (CH)	22/01/2020 Ratoon crop (CH)	7/11/2019 Ratoon crop (CH)
Test Sites	**527 and 528-5**	**527 and 528-6**	**527 and 528-7**	**527 and 528-8**
Quantity of Test Sample Collected	10 fruit	8 fruit	6 fruit	6 fruit
Sampling Dates (Timing)	15/01/2018 Plant crop (CH)	29/01/2019 Plant crop (CH)	5/06/2018 Plant crop (CH)	29/03/2018 Plant crop (CH)
Sampling Dates (Timing)	No ratoon crop samples[1]	No ratoon crop samples[2]	18/03/2020 Ratoon crop (CH)	No ratoon crop samples[1]
(green)	Harvest completed			
(red)	Harvest not completed			

[1*] No sample collected. Crop destructed by grower without notice.
[2*] Site abandoned due to crop damage sustained from adverse weather conditions.
CH = Commercial Harvest

iv) Residue trials – Preparation of the field test samples

For site 528-2 to site 528-8, representative portions of the whole pineapple fruit were ground in the presence of dry ice in a Robot Coupe food processor. A sub-sample of the processed material was stored in a 250 mL container in a freezer until analysed.

For site 528-1, the skin and flesh of the pineapples were separated for a representative number of fruit for each test sample and they were ground individually in the presence of dry ice in a Robot Coupe food processor. Sub-samples of the processed material of each test sample were labelled with the suffixes P (for the flesh sample) and F (for the flesh sample) and stored in 250 mL containers in a freezer until analysed.

The skin and flesh of 6 pineapples were weighed separately for 3 test samples and the proportions of the weights of flesh and skin to the whole fruit weight were then determined to calculate the concentrations of residues on a whole fruit basis. The mean percentages of flesh and skin weights are given in Table 12.

Table 12: Skin and flesh sample weights from test site 528-1.

Test site	Weight of flesh as a percentage of the whole fruit (mean)	Weight of skin as a percentage of the whole fruit (mean)
528-1	70.7 %	29.3 %

Outputs

Individual reports have been written for each of the efficacy and residue trials. The following data are taken from the individual trial reports.

The output section has been split into the following sections;

A) **Efficacy – Grass weed control**
B) **Efficacy – Broadleaf weed control**
C) **Crop safety – Plant crop:** consisting of crop discolouration, crop biomass reduction and yield.
D) **Crop safety – Ratoon crop:** consisting of crop discolouration, crop biomass reduction and yield.
E) **Residue studies**
F) **Conclusions**

A) Efficacy - Grass weed control

Not all assessment data is presented, only the total grass weed counts and percentage control of total grass weeds is presented to provide an overall summary of control across trials.

At three of the ten efficacy trial sites, very high grass weed pressure was recorded with between 9.5 and 48.0 weeds per square metre in untreated control plots (Table 13). Overall, Sencor 480 SC applied at 1.6 L/ha and Balance 750 WG applied at 100 g/ha, applied alone provided only moderate pre-emergence control (71% and 74%, respectively) of grass weeds when averaged across all 10 trials (Table 14). This result could be attributed to trials QB05, QF06 and QF08 which recorded emerged grass weeds at the time of the first spray application. In all three trials where the weeds were already emerged, no knockdown herbicide was applied which attributed to weed escapes and lower levels of control and the standard Uragan was more efficacious controlling emerged weeds. The double rates of Sencor at 3.2 L/ha and Balance 200 g/ha recorded higher levels of pre-emergence grass control when applied alone at 81% and 87%, respectively (Tables 13 and 14).

Overall, Sencor and Balance applied alone and in tank mixtures were effective in providing pre-emergent control of summer grass, crowsfoot grass, coastal button grass, paspalum, green panic and guinea grass (individual weed data not presented).

When comparing spray water volumes for Sencor and Balance across trials QB05 and QB06 there was a trend to greater pre-emergent grass control for Sencor at 1.6 L/ha (32% higher) and a trend to lower pre-emergent control for Balance at 100 g/ha (17% lower) when applied at the lower water volume of 550 L/ha compared to a water volume at 2410 L/ha, however, in both instances, differences were not statistically significant (P=0.05) (Tables 13 and 14).

The tank mix of Sencor at 1.6 L/ha plus Balance at 100 g/ha provided excellent pre-emergent grass control with an average of 93% achieved across the 10 trials (Figure 3 and Table 14). The tank mixture outperformed Sencor and Balance applied alone at the same rates by 22% and 19%, respectively. Across all trials the tank mixture of Sencor and Balance at 1.6 L/ha and 100 g/ha, respectively, was statistically equivalent to the standard Uragan, which recorded 99% average grass control across the 10 trials (Tables 13 and 14). The double rates of Sencor plus Balance at 3.2 L/ha plus 200 g/ha, respectively provided only a minor increase in percentage control (3% higher) compared to the lower rates when averaged across the 10 trials.

Sencor + Balance **Untreated control**

Figure 3: Trial QB06 cv. Smooth Cayenne. Example of grass weed control at 42 days after application B (DAB). Untreated control on right and Sencor at 1.6 L/ha plus Balance at 100 g/ha on the left following two spray applications.

Table 13: Summary of efficacy trial data for mean total grass weed counts.

Trial number				QB05[1]	QB06	QB07	QB08	QC01	QE04	QE05	QF06[1]	QF07	QF08[1]
Assessment Date				**11/10/2016**	**14/10/2016**	**20/10/2017**	**12/11/2017**	**20/09/2016**	**28/10/2016**	**01/12/2016**	**29/11/2016**	**27/06/2017**	**25/11/2016**
Assessment Interval				**13 DAB**	**2 DAB**	**44 DAB**	**53 DAB**	**19 DAA**	**59 DAA**	**34 DAB**	**48 DAA**	**54 DAA**	**71 DAA**
Sample Size				**1 m^2**									**2.5 m^2**
No.	Treatment	Rate	Appl. Code										
1	Untreated			3.94 a	9.53 a	0.28	0.275[2]	48.0 a	0.9 a	0.03	11.3 a	4.8 a	1.0
2	**Sencor**	**1.6 L/ha**	**AB**	**2.98 ab**	**0.33 d**	**0.00**		**14.6 b**	**0.0 b**	**0.00**	**11.7 a**	**1.1 b**	**0.8**
3	Sencor	3.2 L/ha	AB	0.84 bcd	0.05 d	0.00		7.2 b	0.1 b	0.00	5.0 ab	0.8 b	0.5
4	**Balance**	**100 g/ha**	**AB**	**1.20 bcd**	**2.28 b**	**0.10**		**5.4 b**	**0.5 b**	**0.00**	**8.9 a**	**1.2 b**	**0.0**
5	Balance	200 g/ha	AB	1.98 abcd	0.13 d	0.00		3.2 b	0.2 b	0.00	11.7 a	0.5 b	0.0
6	Sencor	1.6 L/ha	DE	0.45 bcd	0.55 cd	0.00		-	-	-	-	-	-
7	Balance	100 g/ha	DE	2.57 abc	1.93 bc	0.00		-	-	-	-	-	-
6	Sencor + Balance + Firepower + Uptake Oil	1.6 L/ha 100 g/ha 800 mL/ha 0.1 L/100 L	AB	-	-	0.00		-	-	-	-	-	-
7	Sencor + Balance	1.6 L/ha 200 g/ha	AB	-	-	0.00		-	-	-	-	-	-
6 or 8	**Sencor + Balance**	**1.6 L/ha 100 g/ha**	**AB AB**	**0.11 cd**	**0.05 d**	**0.00**		**1.2 b**	**0.0 b**	**0.00**	**4.5 ab**	**0.4 b**	**0.3**
7 or 9	Sencor + Balance	3.2 L/ha 200 g/ha	AB AB	0.05 d	0.00 d	0.00		1.2 b	0.0 b	0.00	5.5 ab	0.0 b	0.0
8 or 10	**Uragan**	**4.5 kg/ha 2.2 kg/ha**	**A B**	**0.00 d**	**0.00 d**	**0.00**		**3.2 b**	**0.1 b**	**0.00**	**0.0 b**	**0.0 b**	**0.0**
LSD P=.05				**tS**	**tS**	**ns**		**ns**	**0.4**	**ns**	**7.24**	**ns**	**ns**
LSD P=.10								**tS**				**0.0892**	**ns**
Treatment Prob(F)				**0.0249**	**0.0001**	**0.4363**		**0.0001**	**0.0014**	**0.1222**	**0.0235**	**2.61**	**0.1316**

AB – Applied using a spray water volume between 2000-2500 L/ha. DE – Applied using a spray water volume of 550 L/ha.
Means followed by same letter do not significantly differ (P=.05 or .10, LSD or Duncan's New MRT – QC01)
tS = Data transformed using y = SQRT (x + 0.5). Mean descriptions are reported in original data means and are not de-transformed.
[1] Grass weeds already emerged at the time of the first spray application A.
[2] Estimation of weed control conducted per plot relative to the untreated control. Weed count only made in untreated plot.
- Treatment not included in the trial

Table 14: Summary of efficacy trial data for mean percent control of total grass weeds at final weed assessment for each respective trial in the plant crop.

Target				Grass weeds percentage control										
Trial number				**QB05[1]**	**QB06[2]**	**QB07**	**QB08[2]**	**QC01**	**QE04**	**QE05**	**QF06[13]**	**QF07**	**QF08[1]**	**Average**
Assessment Date				**11/10/2016**	**14/10/2016**	**20/10/2017**	**12/11/2017**	**20/09/2016**	**28/10/2016**	**01/12/2016**	**29/11/2016**	**27/06/2017**	**25/11/2016**	
Assessment Interval				**13 DAB**	**42 DAB**	**44 DAB**	**53 DAB**	**19 DAA**	**59 DAA**	**34 DAB**	**48 DAA**	**54 DAA**	**71 DAA**	
No.	Treatment	Rate		Appl. Code										
1	Untreated				0	0	0	0	0	0	0	0	0	0	**0**
2	**Sencor**	**1.6**	**L/ha**	**AB**	**24**	**94**	**100**	**70**	**70**	**98**	**100**	**46**	**78**	**25**	**71**
3	Sencor	3.2	L/ha	AB	79	99	100	80	85	95	100	33	84	50	81
4	**Balance**	**100**	**g/ha**	**AB**	**70**	**86**	**64**	**83**	**89**	**54**	**100**	**18**	**75**	**100**	**74**
5	Balance	200	g/ha	AB	50	98	100	90	93	85	100	66	90	100	87
6	Sencor	1.6	L/ha	DE	89	92	-	-	-	-	-	-		-	91
7	Balance	100	g/ha	DE	35	86	-	-	-	-	-	-		-	61
6	Sencor + Balance + Firepower + Uptake Oil	1.6 100 800 0.1	L/ha g/ha mL/ha L/100 L	AB	-	-	100	93	-	-	-	-	-	-	97
7	Sencor + Balance	1.6 200	L/ha g/ha	AB	-	-	100	100	-	-	-	-	-	-	100
6 or 8	**Sencor + Balance**	**1.6 100**	**L/ha g/ha**	**AB**	**97**	**98**	**100**	**93**	**98**	**99**	**100**	**76**	**92**	**75**	**93**
7 or 9	Sencor + Balance	3.2 200	L/ha g/ha	AB	99	100	100	78	98	97	100	83	100	100	96
8 or 10	**Uragan**	**4.5 2.2**	**kg/ha kg/ha**	**A B**	**100**	**99**	**100**	**100**	**93**	**93**	**100**	**100**	**100**	**100**	**99**

AB – Applied using a spray water volume between 2000-2500 L/ha. DE – Applied using a spray water volume of 550 L/ha.

[1] Grass weeds already emerged at the time of the first spray application A.

[2] Estimation of weed control conducted per plot relative to the untreated control. Weed count only made in untreated plot.

[3] Percent control calculated using Henderson-Tilton as pre-spray counts were made across all trial plots.

- Treatment not included in the trial

B) Efficacy – Broadleaf weed control

Not all assessment data is presented, only the total broadleaf weed counts and percentage control of total broadleaf weeds is presented to provide an overall summary of control across trials.

Broadleaf weeds were present in eight of the ten efficacy trials. At 3 of those sites, moderate to high broadleaf weed pressure was recorded with between 5.0 to 11.0 weeds per square metre in untreated control plots (Table 15). Due to the sporadic pressure of the broadleaf weeds, statistical treatment effects were often not recorded at each trial site. Overall, there were few significant differences recorded between herbicide treatments across the trials. Sencor and Balance applied alone and in tank mixtures were effective in controlling amaranth, phasey bean, blue top, thick head, pigweed and needle burr and provided suppression of round-leaf cassia. There were numerical trends recorded for the control of praxelis in trial QB07 (individual weed data not presented).

Overall, Sencor at 1.6 L/ha and Balance at 100 g/ha, applied alone, provided good levels of pre-emergence control (91% and 83%, respectively) of broadleaf weeds when averaged across the 8 trials (Table 16). The double rates of Sencor and Balance (Sencor at 3.2 L/ha and Balance 200 g/ha) recorded higher levels of pre-emergence broadleaf control when applied alone, at 95% and 92% respectively (Tables 15 and 16).

In trial QB06 where only amaranth was recorded, Sencor and Balance were equally effective for the control of this weed (100% control), when applied using the low and high-water spray volumes of 550 L/ha and 2410 L/ha (Tables 15 and 16).

The tank mix of Sencor at 1.6 L/ha plus Balance at 100 g/ha provided a high level of pre-emergent broadleaf control with an average of 91% achieved across the 8 trials (Table 16). The tank mixture performed equal to Sencor applied alone but was 8% higher than Balance applied alone at the same tank mixture rates. Across all trials the tank mixture of Sencor at 1.6 L/ha and Balance at 100 g/ha was statistically equivalent to the standard Uragan, which recorded 99% average broadleaf control across the 8 trials (Tables 15 and 16). The double rates of Sencor plus Balance (Sencor at 3.2 L/ha plus Balance at 200 g/ha) provided greater control of broadleaf weeds (7% higher at 98%) compared to the lower rates when averaged across the 8 trials, though differences were not significant.

Table 15: Summary of efficacy trial data for mean total broadleaf weed counts.

Trial number				**QB06**	**QB07**	**QB08**	**QC01**	**QE04**	**QE05**	**QF07**	**QF08[1]**
Assessment Date				**23/11/2016**	**20/10/2017**	**12/11/2017**	**20/09/2016**	**28/10/2016**	**28/10/2016**	**27/06/2017**	**25/11/2016**
Assessment Interval				**42 DAB or DAE**	**44 DAB or DAE**	**53 DAB**	**19 DAA**	**59 DAA**	**59 DAA**	**54 DAA**	**71 DAA**
Sample Size				**1 m²**							**2.5 m²**
No.	Treatment	Rate	Appl. Code								
1	Untreated			0.13 a	11.0	5[2]	0.6	1.4 a	0.7 a	9.1	5.3 a
2	**Sencor**	**1.6 L/ha**	**AB**	**0.00 b**	**1.0**		**0.0**	**0.0 b**	**0.0 b**	**0.1**	**2.3 b**
3	Sencor	3.2 L/ha	AB	0.00 b	1.3		0.0	0.0 b	0.0 b	0.0	0.5 b
4	**Balance**	**100 g/ha**	**AB**	**0.00 b**	**4.5**		**0.0**	**0.0 b**	**0.0 b**	**1.8**	**2.3 b**
5	Balance	200 g/ha	AB	0.00 b	0.5		0.0	0.3 b	0.1 b	0.0	2.3 b
6	Sencor	1.6 L/ha	DE	0.00 b	-		-	-	-	-	-
7	Balance	100 g/ha	DE	0.00 b	-		-	-	-	-	-
6	Sencor + Balance + Firepower + Uptake Oil	1.6 L/ha 100 g/ha 800 mL/ha 0.1 L/100 L	AB	-	0.3		-	-	-	-	-
7	Sencor + Balance	1.6 L/ha 200 g/ha	AB	-	4.3		-	-	-	-	-
6 or 8	**Sencor + Balance**	**1.6 L/ha 100 g/ha**	**AB**	**0.00 b**	**3.8**		**0.0**	**0.0 b**	**0.0 b**	**0.0**	**1.5 b**
7 or 9	Sencor + Balance	3.2 L/ha 200 g/ha	AB	0.00 b	1.0		0.0	0.0 b	0.0 b	0.0	0.3 b
8 or 10	**Uragan**	**4.5 kg/ha 2.2 kg/ha**	**A B**	**0.00 b**	**1.0**		**0.0**	**0.0 b**	**0.0 b**	**0.0**	**0.0 b**
LSD P=.05				**tS**	**ns**		**ns**	**ns**	**0.13**	**ns**	**2.48**
LSD P=.10								**0.77**			
Treatment Prob(F)				**0.0001**	**0.2131**		**0.4520**	**0.0642**	**0.0001**	**0.4513**	**0.0063**

AB – Applied using a spray water volume between 2000-2500 L/ha. DE – Applied using a spray water volume of 550 L/ha.

Means followed by same letter do not significantly differ (P=.05 or .10, LSD or Duncan's New MRT – QC01)

tS = Data transformed using y = SQRT (x + 0.5). Mean descriptions are reported in original data means and are not de-transformed.

[1] Broadleaf weeds already emerged at the time of the first spray application A.

[2] Estimation of weed control conducted per plot relative to the untreated control. Weed count only made in untreated plot.

-	Treatment not included in the trial

Table 16: Summary of efficacy trial data for mean percent control of total broadleaf weeds at final weed assessment for each respective trial in the plant crop.

Target				Broadleaf weeds percentage control								
Trial number				**QB06[2]**	**QB07**	**QB08[2]**	**QC01**	**QE04**	**QE05**	**QF07**	**QF08[1,3]**	**Average**
Assessment Date				**14/10/2016**	**20/10/2017**	**12/11/2017**	**20/09/2016**	**28/10/2016**	**01/12/2016**	**27/06/2017**	**25/11/2016**	
Assessment Interval				**42 DAB or DAE**	**44 DAB or DAE**	**53 DAB**	**19 DAA**	**59 DAA**	**34 DAB**	**54 DAA**	**71 DAA**	
No.	Treatment	Rate	Appl. Code									
1	Untreated			0	0	0	0	0	0	0	0	**0**
2	**Sencor**	**1.6 L/ha**	**AB**	**100**	**91**	**100**	**100**	**100**	**100**	**78**	**62**	**91**
3	Sencor	3.2 L/ha	AB	100	89	100	100	100	100	84	90	95
4	**Balance**	**100 g/ha**	**AB**	**100**	**59**	**100**	**100**	**100**	**90**	**75**	**43**	**83**
5	Balance	200 g/ha	AB	100	96	100	100	78	100	90	71	92
6	Sencor	1.6 L/ha	DE	100	-	-	-	-	-		-	100
7	Balance	100 g/ha	DE	100	-	-	-	-	-		-	100
6	Sencor + Balance + Firepower + Uptake Oil	1.6 L/ha 100 g/ha 800 mL/ha 0.1 L/100 L	AB	-	98	100	-	-	-	-	-	99
7	Sencor + Balance	1.6 L/ha 200 g/ha	AB	-	61	100	-	-	-	-	-	81
6 or 8	**Sencor + Balance**	**1.6 L/ha 100 g/ha**	**AB**	**100**	**66**	**100**	**100**	**100**	**100**	**92**	**73**	**91**
7 or 9	Sencor + Balance	3.2 L/ha 200 g/ha	AB	100	91	100	100	100	100	100	90	98
8 or 10	**Uragan**	**4.5 kg/ha 2.2 kg/ha**	**A B**	**100**	**91**	**100**	**100**	**100**	**100**	**100**	**100**	**99**

AB – Applied using a spray water volume between 2000-2500 L/ha. DE – Applied using a spray water volume of 550 L/ha.

[1] Broadleaf weeds already emerged at the time of the first spray application A.

[2] Estimation of weed control conducted per plot relative to the untreated control. Weed count only made in untreated plot.

[3] Percent control calculated using Henderson-Tilton as pre-spray counts were made across all trial plots.

\- Treatment not included in the trial

C) Crop safety – Plant crop

In six of the ten trials an assessment of crop discolouration was conducted after the first spray application (application A in Tables 17 and 18), applied between 2 to 15 days after planting (Table 3). A visual assessment was made in the other 4 trials (QB05 to QB08), but no data was collected as there was no difference in visual symptoms between the herbicide treated plots and the untreated control. In two of the ten trials (QC01 and QF07), an estimation of biomass reduction was made after the first spray application A (Table 20). Across all trials, Sencor applied up to 3.2 L/ha and Balance applied up to 200 g/ha were safe to all pineapple cultivars when applied alone as a single spray application within 15 days of planting (Figure 4). There was some minor yellowing in several trials, however the level of crop discolouration was comparable to the standard Uragan (Figure 5, Tables 17 and 18). Symptoms appear from a chlorotic yellowing to a white bleaching and several leaf tips necrotic of younger and older leaves (Figures 4 to 6). The level of crop phytotoxicity increased across all trials, with greater crop discolouration following a second foliar spray applied between 54 to 71 days after application A (Table 3, Figures 4 and 5).

A: QF06 at 48 DAA **B: QF08 at 70 DAB**

Figure 4: Leaf symptoms in Smooth Cayenne following Sencor applied at the highest rate of 3.2 L/ha at 48 days after a single spray application A (DAA) in trial QF06 and after two spray applications in the plant crop in trial QF08 at 70 DAB.

A: QF06 at 48 DAA **B: QF08 at 70 DAB**

Figure 5: Leaf symptoms in Smooth Cayenne following Uragan applied at 4.5 kg/ha at 48 days after a single spray application A (DAA) in trial QF06 and after two spray applications (second application at 2.2 kg/ha) in the plant crop in trial QF08 at 70 DAB.

Figure 6: Typical plant symptoms showing chlorosis with bleaching of older and youngest leaves in the Sencor plus Balance tank mixture in the plant crop.

Sencor at 1.6 L/ha tank mixed with Balance at 100 g/ha was also safe when applied as a single spray application within 15 days of planting in the plant crop, with the level of crop discolouration comparable to Uragan across multiple cultivars (Tables 17 and 18). The double rate of Sencor plus Balance recorded significantly higher crop phytotoxicity compared to other herbicide treatments after a single plant crop spray in several trials including QC01, QE05, QF06 and QF08 in all three cultivars (Table 17).

Across all trials the level of crop discolouration increased when Sencor and Balance were applied alone or in tank mixtures after the second spray application, with the higher rates of each herbicide recording greater discolouration (Tables 17 and 18). Overall, after two spray applications, Balance recorded higher levels of crop discolouration and crop phytotoxicity (19% and 30%) compared to Sencor (10% and 15%), applied alone (Figure 7), when averaged across six trials (assessments after A and B applications Table 18). The tank mixtures of Sencor at 1.6 L/ha plus Balance at 100 g/ha, and at double these rates (Figure 8), also recorded greater crop phytotoxicity (27% and 50% crop discolouration respectively) when compared to Uragan (16% discolouration), after two spray applications.

Figure 7: Trial QE04 cv. 73-50: Very little crop phytotoxicity observed for Sencor applied at 1.6 L/ha after two foliar sprays in the plant crop at 34 DAB.

Figure 8: Trial QE04 cv. 73-50: Severe crop phytotoxicity for Sencor plus Balance applied at 3.2 L/ha + 200 g/ha, following two spray applications in the plant crop at 34 DAB.

Table 17: Mean crop discoloration in plant crop.

Assessment type				Percent crop discolouration											
Trial number				QC01		QE04		QE05		QF06		QF07		QF08	
Cultivar				73-50		73-50		MD2		Smooth Cayenne		MD2		Smooth Cayenne	
Assessment Date				08/11/2016	24/02/2017	28/10/2016	27/02/2017	30/09/2016	01/12/2016	29/11/2016	02/02/2017	23/11/2017		25/11/2016	03/02/2017
Assessment Interval				68 DAA	108 DAB	59 DAA	122 DAB	31 DAA	34 DAB	48 DAA	57 DAB	203 DAA[1]	149 DAB[1]	71 DAA	70 DAB
No.	Treatment	Rate	Appl. Code												
1	Untreated			0 d	0 d	0 d	0 d	0 d	2 c	3 b	5 e	3	3 c	0 b	18 b
2	**Sencor**	**1.6 L/ha**	**AB**	**4 cd**	**16 bc**	**1 cd**	**9 abc**	**0 d**	**5 c**	**0 b**	**3 e**	**1**	**9 bc**	**0 b**	**18 b**
3	Sencor	3.2 L/ha	AB	6 bcd	26 b	0 d	11 abc	0 d	15 c	0 b	15 d	3	6 c	0 b	15 b
4	**Balance**	**100 g/ha**	**AB**	**2 d**	**14 c**	**0 d**	**5 bcd**	**4 bc**	**45 b**	**0 b**	**23 cd**	**1**	**8 bc**	**3 b**	**18 b**
5	Balance	200 g/ha	AB	12 b	24 bc	3 abc	16 ab	5 b	55 ab	5 ab	38 b	1	10 bc	18 ab	38 b
6	**Sencor** **+ Balance**	**1.6 L/ha** **100 g/ha**	**AB** **AB**	**6 bcd**	**18 bc**	**4 ab**	**14 abcd**	**4 bc**	**48 b**	**0 b**	**28 c**	**4**	**18 ab**	**8 b**	**33 a**
7	Sencor + Balance	3.2 L/ha 200 g/ha	AB AB	24 a	50 a	4 a	23 a	8 a	73 a	10 a	88 a	4	23 a	23 a	43 a
8	**Uragan**	**4.5 kg/ha** **2.2 kg/ha**	**A** **B**	**10 bc**	**26 b**	**1 bcd**	**3 cd**	**3 c**	**16 c**	**0 b**	**20 cd**	**2**	**10 bc**	**3 b**	**20 b**
LSD P=.05				**6.2**	**9.5**	**tA**	**tA**	**2.5**	**21.1**	**tA**	**9.4**	**ns**	**10.9**	**ns**	**6.7**
LSD P=.10														**7.7**	
Treatment Prob(F)				**0.0001**	**0.0001**	**0.0044**	**0.0320**	**0.0001**	**0.0001**	**0.0127**	**0.0001**	**0.4114**	**0.0486**	**0.0519**	**0.0001**

[1] Replicates 3 and 4 were only applied as a single A application.

[2] Replicates 1 and 2 were applied twice as applications A and B.

Means followed by same letter do not significantly differ (P=.05 or .10, LSD or Duncan's New MRT – QC01)

tA = Data transformed using y = Arcsine square root percent (x). Mean descriptions are reported in original data means and are not de-transformed.

- Treatment not included in the trial

Table 18: Comparison of mean crop discolouration in plant crop after the first spray application A versus the second spray application B.

Target					**Percent crop discolouration**	
Assessment timing					**After application A**	**After application B**
No.	Treatment	Rate		Appl. Code		
1	Untreated				1	5
2	**Sencor**	**1.6**	**L/ha**	**AB**	**1**	**10**
3	Sencor	3.2	L/ha	AB	2	15
4	**Balance**	**100**	**g/ha**	**AB**	**2**	**19**
5	Balance	200	g/ha	AB	7	30
6	**Sencor** **+ Balance**	**1.6** **100**	**L/ha** **g/ha**	**AB** **AB**	**4**	**27**
7	Sencor + Balance	3.2 200	L/ha g/ha	AB AB	12	50
8	**Uragan**	**4.5** **2.2**	**kg/ha** **kg/ha**	**A** **B**	**3**	**16**

In trials QC01 and QF07, the number of dead plants were also assessed and only the double rate, Sencor at 3.2 L/ha plus Balance at 200 g/ha as tank mix, caused significant crop loss with higher numbers of dead pineapple plants after two foliar sprays applied in the plant crop (Table 19).

Table 19: Mean number of dead plants in plant crop.

Trial number					**QC01 (per plot)**		**QF07 (per 5 m row)**	
Assessment Date					**24/02/2017**		**23/11/2017**	
Assessment Interval					**108 DAB**		**203 DAA[1]**	**149 DAB[2]**
No.	Treatment	Rate		Appl. Code				
1	Untreated				0.0	b	0.5	0.5 b
2	**Sencor**	**1.6**	**L/ha**	**AB**	**0.2**	**b**	**0.0**	**0.5 b**
3	Sencor	3.2	L/ha	AB	0.2	b	1.5	0.5 b
4	**Balance**	**100**	**g/ha**	**AB**	**0.0**	**b**	**1.0**	**0.0 b**
5	Balance	200	g/ha	AB	0.4	b	0.5	1.0 b
6	**Sencor** **+ Balance**	**1.6** **100**	**L/ha** **g/ha**	**AB** **AB**	**0.4**	**b**	**0.0**	**0.5 b**
7	Sencor + Balance	3.2 200	L/ha g/ha	AB AB	10.8	a	2.0	8.0 a
8	**Uragan**	**4.5** **2.2**	**kg/ha** **kg/ha**	**A** **B**	**0.0**	**b**	**0.0**	**1.5 b**
LSD P=.05							**ns**	**2.2**
Treatment Prob(F)					**0.0001**		**0.1460**	**0.0008**

AB – Applied using a spray water volume between 2000-2500 L/ha.
[1] Replicates 3 and 4 were only applied as a single A application.
[2] Replicates 1 and 2 were applied twice as applications A and B.
Means followed by same letter do not significantly differ (P=.05, LSD or Duncan's New MRT – QC01)

In several trials, weed competition within the trial site impacted on the growth of the untreated control (Figure 3) and several herbicide treated plots throughout the plant crop cycle where weed control was lower. As a result, it was sometimes difficult in several trials to make accurate crop safety conclusions from the herbicide applications when based on estimates on crop biomass reduction and mean pineapple weights at the plant crop harvest. Nevertheless, some reference from the Sencor and Balance treatments can be made towards the industry standard herbicide Uragan to ascertain overall herbicide crop safety effects.

There were similar trends recorded for biomass reduction to that of crop discolouration. In QC01 and QF07, Sencor and Balance recorded no significant biomass reduction when applied alone relative to the untreated control and standard Uragan, after a single spray application (Table 20). However, following two spray applications the level of biomass reduction increased in the same trials, indicating some adverse crop effects when compared to the standard Uragan. Overall, Balance tended to record greater crop biomass reduction, and thus greater crop phytotoxicity, after the second spray application, compared to Sencor (Table 20).

When Sencor at 1.6 L/ha plus Balance at 100 g/ha were tank mixed, the level of crop biomass reduction trended higher and the mean pineapple weights lower compared to the standard Uragan, after two spray applications (Tables 20 and 21). In QF07 a single application of the Sencor plus Balance tank mix at the same rates, resulted in significantly higher biomass reduction compared to Uragan (18% and 5%, respectively), however this did not translate to any impact on pineapple weights with the tank mixture at the plant crop harvest (Tables 20 and 21).

The double rate of Sencor plus Balance tank mixture caused significant and often obvious phytotoxicity by impacting on the development of the pineapple crop. This resulted in an average 40% biomass reduction (Table 20) and the lowest pineapple weights of all treatments in 9 of the 10 trials (Table 21).

There were no obvious differences in crop safety between the low-water and high-water volume sprays in trials QB05 and QB06 for estimates of crop biomass reduction and mean pineapple weights (Tables 20 and 21).

Sencor plus Balance applied at 1.6 L/ha plus 100 g/ha was physically and biologically compatible when tank mixed with the post-emergent herbicide Firepower Herbicide (520 g/L haloxyfop-R-methyl ester) applied at 800 mL/ha with Uptake Spraying Oil at 1 L/ha for crop safety in pineapple cultivars Smooth Cayenne (QB07) and 73-50 (QB08) after a single spray application early in the plant crop (Tables 20 and 21). In QF06, all Sencor and Balance treatments were physically and biologically compatible when tank mixed with Uptake Spraying Oil at 500 mL/100 L after a single spray application in a Smooth Cayenne, early in the plant crop.

Table 20: Mean biomass reduction in plant crop.

Assessment type			Percent biomass reduction												
Trial number			QB05	QB06	QB07	QB08	QC01		QE04	QE05	QF06	QF07		QF08	Average % biomass reduction
Assessment Date			24/10/2016	24/10/2016	2/12/2019	12/11/2017	8/11/2016	24/10/2018	27/2/2017	27/12/2017	2/2/2017	23/11/2017		3/2/2017	
Assessment Interval			26 DAB/DAE	12 DAB	817 DAB	53 DAB	68 DAA	715 DAB	122 DAB	122 DAB	57 DAB	203 DAA[1]	149 DAB[2]	70 DAB	
No.	Treatment	Rate	Appl. Code												
1	Untreated			0 e	0	0	0 c	0 b	22 ab	0 d	0 e	3 c	0 b	0 c	0 d	2
2	**Sencor**	**1.6 L/ha**	**AB**	**12 cd**	**0**	**6**	**5 ab**	**0 b**	**2 d**	**11 c**	**10 de**	**0 c**	**5 b**	**23 b**	**3 cd**	**6**
3	Sencor	3.2 L/ha	AB	15 bcd	0	9	6 ab	2 b	16 abcd	5 cd	18 cde	3 c	0 b	10 bc	3 cd	7
4	**Balance**	**100 g/ha**	**AB**	**14 bcd**	**0**	3	**5 ab**	**0 b**	**30 a**	**4 cd**	**30 bc**	**3 c**	**0 b**	**3 c**	**10 c**	**9**
5	Balance	200 g/ha	AB	33 bcd	0	3	4 b	0 b	4 cd	33 b	60 a	25 b	3 b	20 b	23 b	17
6	Sencor	1.6 L/ha	DE	6 de	0	-	-	-	-	-	-	-	-	-	-	3
7	Balance	100 g/ha	DE	13 bcd	0	-	-	-	-	-	-	-	-	-	-	7
6	Sencor + Balance + Firepower + Uptake Oil	1.6 L/ha 100 g/ha 800 mL/ha 0.1 L/100 L	AB	-	-	0	4 bc	-	-	-	-	-	-	-	-	2
7	Sencor + Balance	1.6 L/ha 200 g/ha	AB	-	-	5	6 ab	-	-	-	-	-	-	-	-	6
6 or 8	**Sencor + Balance**	**1.6 L/ha 100 g/ha**	**AB AB**	**36 b**	**0**	**5**	**3 bc**	**2 b**	**16 abcd**	**38 b**	**38 b**	**16 b**	**18 a**	**25 b**	**23 b**	**18**
7 or 9	Sencor + Balance	3.2 L/ha 200 g/ha	AB AB	70 a	0	4	13 a	20 a	20 abc	70 a	73 a	88 a	18 a	55 a	45 a	40
8 or 10	**Uragan**	**4.5 kg/ha 2.2 kg/ha**	**A B**	**26 bcd**	**0**	**9**	**3 bc**	**2 b**	**10 bcd**	**3 cd**	**20 bcd**	**3 c**	**5 b**	**10 bc**	**8 cd**	**8**
LSD P=.05			tA	NA	ns	tA	3.9	0.4	tA	21.1	11.9	10.4	16	9.7	
Treatment Prob(F)			0.0275	1	0.2464	0.0001	0.0001	0.0001	0.0320	0.0001	0.0001	0.0177	0.0014	0.0001	

AB – Applied using a spray water volume between 2000-2500 L/ha. DE – Applied using a spray water volume of 550 L/ha.

[1] Replicates 3 and 4 were only applied as a single A application.

[2] Replicates 1 and 2 were applied twice as applications A and B.

Means followed by same letter do not significantly differ (P=.05, LSD or Duncan's New MRT – QC01)

tA = Data transformed using y = Arcsine square root percent (x). Mean descriptions are reported in original data means and are not de-transformed.

\- Treatment not included in the trial

Table 21: Summary of yield trial data in the plant crop.

Assessment type				Average fruit weight of single pineapple in untreated control and percentage relative to untreated control											
Trial number				**QB05**	**QB06**	**QB07**	**QB08**	**QC01**	**QE04**	**QE05**	**QF06**	**QF07**		**QF08**	**Average % relative to untreated control**
Assessment Date				**11/04/2018**	**03/04/2018**	**02/12/2019**	**29/11/2017**	**12/09/2018**	**14/12/2017**	**14/12/2017**	**21/05/2018**	**03/01/2019**		**11/10/2018**	
Assessment Interval				**506 DAB/DAE**	**538 DAB/DAE**	**817 DAB**	**496 DAB**	**673 DAB**	**412 DAB**	**412 DAB**	**530 DAB**	**609 DAA**	**555 DAB**	**685 DAB**	
No.	Treatment	Rate	Appl. Code	n = 8 fruit[1]	n = 6 fruit	n = 10 fruit	n = 10 fruit	n = 5 fruit	n = 12 fruit	n = 12 fruit	n = 15 fruit	n = 16 fruit		n = 10 fruit	
1	Untreated			1.39 kg[2]	1.26 kg	1.34 kg	1.08 kg	1.02 kg	1.71 kg	1.46 kg	1.22 kg	1.05 kg	1.17 kg	1.49 kg	**100**
2	**Sencor**	**1.6 L/ha**	**AB**	**89[3]**	**119**	**95**	**101**	**101**	**98**	**103**	**117**	**110**	**95**	**106**	**103**
3	Sencor	3.2 L/ha	AB	100	139	96	97	82	93	105	117	105	101	115	105
4	**Balance**	**100 g/ha**	**AB**	**88**	**110**	**98**	**102**	**87**	**85**	**96**	**117**	**95**	**96**	**102**	**98**
5	Balance	200 g/ha	AB	88	123	97	98	101	83	78	121	87	93	100	98
6	Sencor	1.6 L/ha	DE	97	115	-	-	-	-	-	-	-	-	-	106
7	Balance	100 g/ha	DE	98	108	-	-	-	-	-	-	-	-	-	103
6	Sencor + Balance + Firepower + Uptake Oil	1.6 L/ha 100 g/ha 800 mL/ha 0.1 L/100 L	AB	-	-	94	104	-	-	-	-	-	-	-	99
7	Sencor + Balance	1.6 L/ha 200 g/ha	AB	-	-	90	97	-	-	-	-	-	-	-	94
6 or 8	**Sencor + Balance**	**1.6 L/ha 100 g/ha**	**AB**	**93**	**128**	**96**	**100**	**91**	**90**	**87**	**113**	**91**	**111**	**106**	**101**
7 or 9	Sencor + Balance	3.2 L/ha 200 g/ha	AB	90	112	99	92	79	72	67	96	87	79	82	87
8 or 10	**Uragan**	**4.5 kg/ha 2.2 kg/ha**	**A B**	**103**	**129**	**98**	**110**	**105**	**92**	**92**	**141**	**87**	**81**	**109**	**104**

AB – Applied using a spray water volume between 2000-2500 L/ha. DE – Applied using a spray water volume of 550 L/ha.

[1] Number of fruit weighed per plot.

[2] Average weight of single fruit in untreated control plots.

[3] Percent relative to weight in untreated control.

- Treatment not included in the trial

D) Crop safety – Ratoon crop

In six of the ten trials, an assessment of crop discolouration was conducted after the ratoon spray, application C (Table 22), applied between 17 to 68 days after the plant crop harvest (Table 4). Sencor applied at 1.6 L/ha was regarded safe to all pineapple cultivars and averaged 6% plant discolouration across all trials (Figure 9 and Table 22). There were no adverse effects from Sencor applied at 1.6 L/ha using a low-water volume spray in trials QB05 and QB06. Sencor applied at 3.2 L/ha caused unacceptable phytotoxicity in one trial only, QB05 (Table 22).

Figure 9: Trial QE05 cv. MD2. No significant effects from Sencor applied up to 3.2 L/ha in the ratoon crop.

Balance applied alone at 100 and 200 g/ha recorded higher levels of plant discolouration in three of the six trials (Table 22). In QB06 the plant discolouration from Balance treatments were significantly higher than Sencor and the standard Uragan, with unacceptable damage recorded. The tank mixture of Sencor plus Balance also recorded unacceptable crop phytotoxicity from a single ratoon spray application in two of the six trials, in the cultivars 73-50 (QB05) and Smooth Cayenne (QB06).

In trial QB05, newly formed pineapple suckers appeared with a physical discolouration with symptoms ranging from a chlorotic yellowing to a white bleaching and with several leaf tips necrotic (Figure 10). Although the damage sustained with Sencor at 1.6 L/ha applied alone was deemed to be acceptable, it highlighted the importance of herbicide applications being made prior to the formation of suckers and slips/buttons in the ratoon crop.

Figure 10: Trial QB06 cv. Smooth Cayenne. Photo showing severe discolouration with Sencor at 3.2 L/ha plus Balance at 200 g/ha in ratoon crop on suckers and slips/buttons

Table 22 Summary of crop discoloration in ratoon crop.

Assessment type				Percent crop discolouration						
Trial number				**QB05**	**QB06**	**QC01**	**QE04**	**QE05**	**QF06**	**Average % discolouration**
Cultivar				**73-50**	**Smooth Cayenne**	**73-50**	**73-50**	**MD2**	**Smooth Cayenne**	
Assessment Date				**24/07/2018**	**24/10/2016**	**04/03/2019**	**23/05/2018**	**23/05/2018**	**06/11/2019**	
Assessment Interval				**82 DAC or DAF**	**95 DAC or DAF**	**131 DAC**	**92 DAC**	**93 DAC**	**519 DAC**	
No.	Treatment	Rate	Appl. Code							
1	Untreated			0	0 e	12	0	0	0	2
2	**Sencor**	**1.6 L/ha**	**ABC**	**20**	**0 e**	**10**	**0**	**3**	**0**	**6**
3	Sencor	3.2 L/ha	ABC	25	0 e	14	0	3	0	7
4	**Balance**	**100 g/ha**	**ABC**	**40**	**16 cd**	**22**	**0**	**0**	**0**	**13**
5	Balance	200 g/ha	ABC	50	24 ab	12	0	0	0	14
6	Sencor	1.6 L/ha	DEF	0	1 e	-	-	-		1
7	Balance	100 g/ha	DEF	35	12 d	-	-	-		24
6 or 8	**Sencor + Balance**	**1.6 L/ha 100 g/ha**	**ABC ABC**	**40**	**21 bc**	**16**	**0**	**0**	**0**	**13**
7 or 9	Sencor + Balance	3.2 L/ha 200 g/ha	ABC ABC	50	30 a	10	3	0	0	16
8 or 10	**Uragan**	**4.5 kg/ha 2.2 kg/ha 4.5 kg/ha**	**A B C**	**0**	**3 e**	**10**	**3**	**0**	**0**	3
LSD P=.05				**ANA**	**6.3**	**ns**	**ns**	**ns**	**ns**	
Treatment Prob(F)					**0.0001**	**0.6192**	**0.5828**	**0.5828**	**1.000**	

ABC – Applied using a spray water volume between 2000-2500 L/ha.
DEF – Applied using a spray water volume of 550 L/ha.
ANA – Analysis not applicable
Means followed by same letter do not significantly differ (P=.05, LSD or Duncan's New MRT – QC01)
\- Treatments not included in the trial

In trial QC01, Sencor applied at 1.6 L/ha was also safe to apply over the cultivar 73-50 in ratoon pineapples with comparable biomass reduction to Uragan (Table 23). Most of the other treatments trended to higher levels of crop biomass reduction. There were no clear trends for crop safety from the other trials for estimated crop biomass reduction or from mean pineapple weights recorded at the ratoon crop harvest (Table 24).

Table 23: Mean biomass reduction in ratoon crop.

Assessment type				**Percentage biomass reduction**				
Trial number				**QC01**	**QE04**	**QE05**	**QF06**	**Average % biomass reduction**
Assessment Date				**4/03/2019**	**23/05/2018**	**23/05/2018**	**6/11/2019**	
Assessment Interval				**131 DAC**	**92 DAC**	**93 DAC**	**519 DAC**	
No.	Treatment	Rate	Appl. Code					
1	Untreated			20 abc	5	0	16	10
2	**Sencor**	**1.6 L/ha**	**ABC**	**4 c**	**5**	**0**	**11**	**5**
3	Sencor	3.2 L/ha	ABC	20 abc	8	4	8	10
4	**Balance**	**100 g/ha**	**ABC**	**30 a**	**9**	**4**	**9**	**13**
5	Balance	200 g/ha	ABC	8 bc	0	4	9	5
6	**Sencor + Balance**	**1.6 L/ha 100 g/ha**	**ABC ABC**	**18 abc**	**9**	**6**	**5**	**10**
7	Sencor + Balance	3.2 L/ha 200 g/ha	ABC ABC	26 ab	10	3	10	10
8	**Uragan**	**4.5 kg/ha 2.2 kg/ha 4.5 kg/ha**	**A B C**	**10 bc**	**16**	**4**	**5**	**9**
LSD P=.05				**16.9**	**ns**	**ns**	**ns**	
Treatment Prob(F)				**0.0488**	**0.2255**	**0.8420**	**0.6178**	

ABC – Applied using a spray water volume between 2000-2500 L/ha.

[1] Replicates 3 and 4 were only applied as a single A application.

[2] Replicates 1 and 2 were applied twice as applications A and B.

Means followed by same letter do not significantly differ (P=.05, LSD or Duncan's New MRT – QC01)

\- Treatment not included in the trial

Table 24: Summary of yield trial data in the ratoon crop.

Assessment type				**Average fruit weight of single pineapple in untreated control and percentage relative to untreated**						
Trial number				**QB05**	**QE04**	**QE05**	**QF06**	**QF07**	**QF08**	**Average % relative to untreated control**
Assessment Date				**02/03/2020**	**29/11/2018**	**29/11/2018**	**06/11/2019**	**21/01/2020**	**12/02/2020**	
Assessment Interval				**669 DAC or DAF**	**282 DAC**	**283 DAC**	**519 DAC**	**334 DAC**	**447 DAC**	
No.	Treatment	Rate	Appl. Code	n = 10 fruit[1]	n = 16 fruit	n = 16 fruit	n = 10 fruit	n = 10 fruit	n = 10 fruit	
1	Untreated			0.83 kg[2]	0.79 kg	1.21 kg	1.06 kg	1.07 kg	1.67 kg	**100**
2	**Sencor**	**1.6 L/ha**	**ABC**	**111[3]**	**111**	**92**	**103**	**108**	**99**	**104**
3	Sencor	3.2 L/ha	ABC	108	105	92	96	106	107	102
4	**Balance**	**100 g/ha**	**ABC**	**102**	**95**	**90**	**102**	**98**	**90**	**96**
5	Balance	200 g/ha	ABC	96	111	97	101	100	92	100
6	Sencor	1.6 L/ha	DEF	105	-	-	-	-	-	105
7	Balance	100 g/ha	DEF	104	-	-	-	-	-	104
6 or 8	**Sencor + Balance**	**1.6 L/ha 100 g/ha**	**ABC**	**104**	**110**	**98**	**106**	**98**	**104**	**103**
7 or 9	Sencor + Balance	3.2 L/ha 200 g/ha	ABC	104	96	99	99	94	107	100
8 or 10	**Uragan**	**4.5 kg/ha 2.2 kg/ha 4.5 kg/ha**	**A B C**	**119**	**95**	**91**	**92**	**100**	**103**	**99**

ABC – Applied using a spray water volume between 2000-2500 L/ha.
DEF – Applied using a spray water volume of 550 L/ha.
[1] Number of fruit weighed per plot.
[2] Average weight of single fruit in untreated control plots.
[3] Percent relative to weight in untreated control.
- Treatment not included in the trial

E) Residue trial studies

A total of 8 residue test sites for two individual study plans (Tables 8 to 12) were completed, under Good Laboratory Practice (GLP), to support registration in a range of geographical regions including dryland and irrigated farming operations, and split using three cultivars (Smooth Cayenne, 73-50 and MD2) with five trials completed over two cropping cycles (plant and ratoon). Data obtained from these trials will be used for the APVMA submission for registration of Sencor 480 SC Selective Herbicide and Balance 750 WG Herbicide in pineapple as discussed and agreed with the APVMA.

F) Conclusions

1. Sencor 480 SC applied at 1.6 L/ha and Balance 750 WG applied at 100 g/ha are effective in providing pre-emergent control of grass and broadleaf weeds in pineapple.
2. The tank mixtures of Sencor plus Balance were numerically more efficacious than Sencor, and Balance treatments applied alone and were comparable in weed control to the standard Uragan 800 WG.
3. There was a trend to greater pre-emergent grass control for Sencor at 1.6 L/ha and a trend to lower pre-emergent control for Balance at 100 g/ha when applied at the low-water spray volume of 550 L/ha compared to a high-water spray volume at 2410 L/ha.
4. Sencor applied at 1.6 L/ha and Balance applied at 100 g/ha were physically and biologically compatible when tank mixed with Firepower Herbicide applied at 800 mL/ha with Uptake Spraying Oil applied at 1 L/ha or when tank mixed with Uptake Spraying Oil at 500 mL/100 L.
5. Sencor applied at 1.6 L/ha and 3.2 L/ha and Balance applied at 100 g/ha, alone and as a tank mixture, were safe to apply as a single spray up to 15 days after planting.
6. Sencor and Balance caused unacceptable crop phytotoxicity when applied as two foliar sprays in the plant crop.
7. The herbicide Balance recorded higher crop phytotoxicity compared to Sencor when applied alone after two spray applications.
8. The tank mixtures of Sencor at 1.6 L/ha plus Balance at 100 g/ha, and at double rates (Sencor at 3.2 L/ha plus Balance at 200 g/ha), recorded greater crop phytotoxicity (crop discolouration), when compared to Uragan, after two spray applications and was not considered commercially acceptable.
9. The double rates also recorded more significant and often obvious phytotoxicity by impacting on the development of the pineapple crop. This resulted in greater biomass reduction and the lowest pineapple weights of all treatments, in 9 of the 10 trials.
10. Sencor applied at 1.6 L/ha alone was the only treatment to be deemed safe to apply in ratoons following the plant crop harvest and was comparable to Uragan.
11. In ratoons, it was apparent that herbicide applications must be made prior to the formation of suckers and slips/buttons.

Outcomes

The outcomes of this project are for the 10 efficacy and crop safety trials and 8 GLP residue studies to support an application of registration to the APVMA of Sencor 480 SC Selective Herbicide and Balance 750 WG Herbicide as new pre-emergent herbicides for the Australian pineapple industry. The registration of both herbicides will provide the pineapple industry with tools to assist with the long-term management of weeds and serves as a replacement to diuron within the industry. This in turn will help reduce the reliance of the industry on permit applications to the APVMA.

The use of pre-emergent herbicides will continue to be the foundation of weed management in the pineapple industry and an important part of the production process. New weed management tools such as Sencor and Balance herbicides will contribute towards Australian pineapple growers maintaining current yields and quality, in turn preserving the profitability of their business.

Monitoring and evaluation

Not applicable

Recommendations

- Bayer CropScience will submit an application to the APVMA for the registration of Sencor® 480 SC Selective Herbicide and Balance® 750 WG Herbicide in pineapple during November 2020.
- The proposed Sencor use pattern will be the rates of 1.6 L/ha and 3.2 L/ha applied as a single broadcast spray for the pre-emergent control of weeds in the plant crop. Incorporation by rain or irrigation within 7 days after application of Sencor is necessary for best results. The higher rate should be used on heavier soils and for extended residual control.
- In the ratoon crop, the proposal will be for Sencor to be applied at 1.6 L/ha as a single directed or broadcast spray within 30 days of the plant crop harvest maximizing contact of the herbicide with the soil. A comment will be added indicating the application should not be made if the ratoon crop contains a high percentage of suckers or slips/buttons.
- The proposed Balance use pattern will be the rate of 100 g/ha to be applied as a single broadcast spray application for the pre-emergent control of weeds in the plant crop. The spray must be applied prior to weed emergence and immediately after planting or before planting material begins to grow roots or new leaves. Balance will not be recommended for the ratoon crop.

Refereed scientific publications

Not applicable

References

[1] Sanewski, G. and Newett, S., 2012. Industry Situation Statement Pineapple. Department of Agriculture and Fisheries, QLD.

[2] http://www.aussiepineapples.com.au/about/growing.html (10/02/2016)

[3] Growcom., 2012. Australian Pineapples 2011-2016. Produce Pathways for Growcom, the Pineapple Growers Advancement Group and Horticulture Australia Limited.

[4] Scott, C., 2013. Herbicide screening trial for Diuron replacement options for the pineapple industry. HIA Project Number: PI 12004. Horticulture Australia Limited.

[5] Broadley, R.H., Wassman, R.C. and Sinclair, E., 1993. Pineapple pests and disorders. Department of Primary Industries Queensland.

[6] https://apvma.gov.au/node/12511 - Diuron Chemical Review (July 2020)

Intellectual property, commercialisation and confidentiality

No project IP, project outputs, commercialisation or confidentiality issues to report.

Acknowledgements

The project is dedicated to Mr. Col Scott (1947-2018), former Agronomist with Golden Circle Cannery and from 2011 Agronomist with Tropical Pines Pty Ltd. Col instigated the project ST15029 following his screening trial conducted as part of the HIA Project Number: PI 12004. Col Scott was the nominated industry expert for this project and was generous with his time and assisted greatly, sharing his knowledge and providing guidance in the preparation of protocols and early assessments for the Sencor/Balance project. A friend and colleague who is sadly missed.

Col Scott

A warm thank you is also extended to the Australian pineapple industry growers who supported us with trials on their properties including the Accorsini and Pace families in North Queensland, Stevens family in Capricornia region, Steemson and Hawken families in the Wide-Bay district and Fullerton and Morgan families from the Glasshouse Mountains region. All the growers were generous with their time and providing advice on the trial design, results and positioning of the products. We would also like to acknowledge the input of: Shane Trainer, Andrew Ellis, Cate Moon, Andrew Reddie, Michael Rouch and Janet Mosbey from Bayer CropScience and Darren Westerhuis Quantum Ag, formerly Bayer CropScience and Mitchell Faint AgPD, formerly Bayer CropScience for their contribution to the project.

Appendices

No appendices attached