



Sugar Research
Australia™



SRA Research Project - 2014-2018

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

2016 conclusions and feedback to participating
productivity services and growers



Trials on pre-emergent options to diuron

Trials on alternative pre-emergent options to diuron

The project aims to find an effective alternatives to pre-emergence with diuron which is currently a regulated chemical in Great Barrier Reef regions.

In 2015-16 three replicated trials were conducted in trash blanketed ratoons, from Mossman to Tully.

Table 1: Details of sites for trials on alternative pre-emergence options to diuron.

Trial site	1	2	3
Area	High rainfall, poorly drained	High rainfall, well drained	High rainfall
Location	Tully - Feluga	Mulgrave - Aloomba	Mossman - Daintree
GPS coordinates	145.950806°E 17.912223°S	145.919413°E 17.198605°S	145.380432°E 16.267988°S
Farmer name	Harkarn Singa Mavi	Greg Clarke	Bill Mackay
Farm and block number	3033 03	363 2B	5313A 4C
Cane variety and ratoon number	Q200 ^(b) 3 R	Q200 ^(b) 4 R	Q219 ^(b) 2 R
Soil type	Coom–Tully Seasonally wet soils requiring drainage or special management: Hydrosols	Liverpool (and wet variant) Deep sandy soils: Tenosols, Rudosols	Tully Friable non-cracking clay or clay loam soils: Dermosols, Ferrosols
Date and time sprayed	21/08/2015 (8:00am to 10:00am)	28/08/2015 (7:00am to 8:30am)	30/10/2015 (7:00 am to 8:20am)

Treatments

Table 2: Details of treatments in the three pre-emergent herbicides trials.

T	Treatment	Treatment description	Active	Rate kg or L/ha	Water rate L/ha
T1	Diu HR	Barrage full rate (as reference product)	diuron 468 g/L hexazinone 132 g/L	4	300
T2	Diu LR	Barrage low rate (as per new label)	diuron 468 g/L hexazinone 132 g/L	0.9	300
T3	Ima	Flame max label rate	imazapic 240 g/L	0.4	300
T4	Iso	Balance max label rate	isoxaflutole 750 g/kg	0.2	300
T5	Met	Clincher max label rate	metolachlor 960 g/L	2.7	300
T6	Ami	Amitron max label rate (still pending registration)	amicarbazone 700 g/kg	1.4	300
T7	Bob	Bobcat Imax max label rate	imazapic 25 g/L hexazinone 125 g/L	3.8	400
T1, T3, T4, T7	+ Par	Shirquat added to tank mix	paraquat 250 g/L	1.2	300

Measurements

Five to seven herbicide efficacy assessments were carried out in each trial.

Herbicide efficacy data have been calculated from photographic assessments and then statistically analysed.

Soil analysis (2015-16 results pending)

Trial 1 – Tully

Weather data

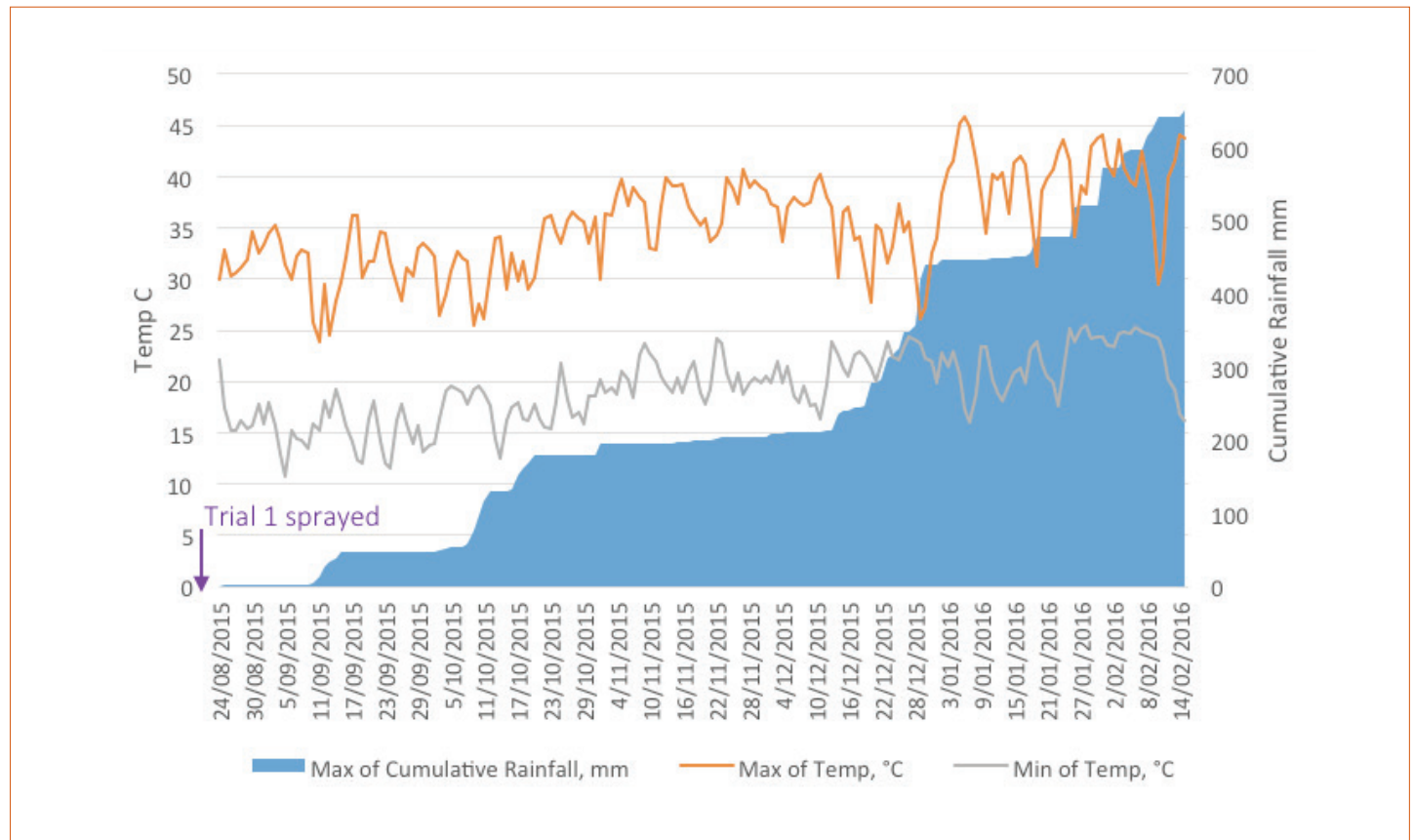


Figure 1: Minimum and maximum temperatures, cumulative rainfall and soil water content recorded at trial 1.

Weed population in the untreated controls

Two and a half months after harvest, the weed population in the untreated plots reached a maximum of 45% ground coverage. The weed population mainly consisted of grasses and broadleaf weeds. The main grass species were Guinea grass (new seedlings) and summer grass, the main broadleaf species were blue top and square weed and the main vine species was calopo.

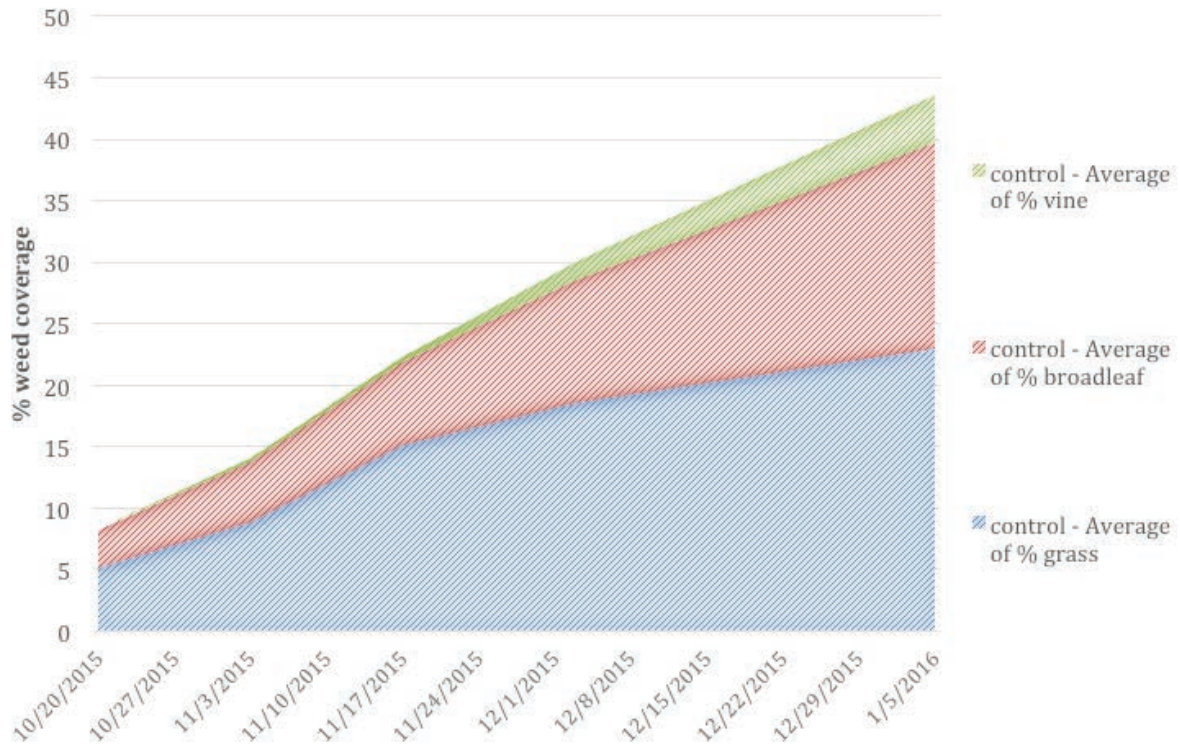


Figure 2: Average percentage of weed coverage in the untreated controls in trial 1.

Herbicide efficacy

A significant rain event occurred three weeks after spraying and successfully activated the pre-emergent herbicides as observable in Figure 3. Bobcat Imax (imazapic + hexazinone) was the most efficient herbicide to control the total weed population with an efficacy maintained at 85%, 137 days after application, despite a cumulative rainfall of 400 mm. Diuron + hexazinone high rate, imazapic and amicarbazone were also very efficient (not significantly different to imazapic + hexazinone) with efficacies above 70% during the assessment period. Isoxaflutole and diuron + hexazinone low rate were significantly less efficient than imazapic + hexazinone to control the total weed population with efficacies dropping under 70% between 74 and 88 days after application. Metolachlor was the least effective herbicide with efficacies under 40% throughout the assessment period.

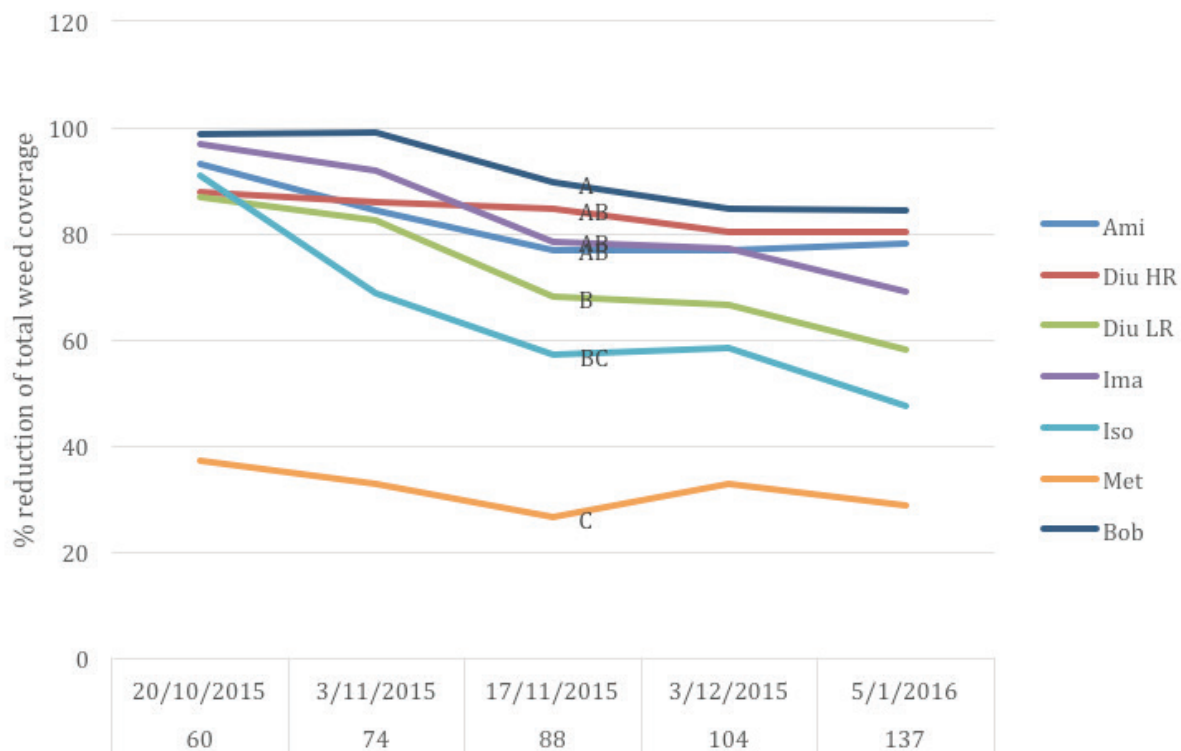


Figure 3: Mean of percentage reduction of total weed coverage compared to the adjacent untreated controls in trial 1. Similar letters are not significantly different.

Efficacy on grass coverage

Imazapic was the most efficient herbicide to control the grass population with efficacies above 90% during the assessment period.

This result was also observed in 2015 trials where imazapic was particularly effective against grasses like awnless Barnyard grass, Guinea grass and couch grass. Imazapic + hexazinone (similar rate per ha of imazapic) was not significantly different.

The other herbicides were less effective against grasses (efficacies ranging from 60 to 90%) without significant differences. The least effective herbicide was diuron + hexazinone low rate.

It is interesting to note that metolachlor efficacy against the grasses in this trial ranged between 60 and 80%. The product has proven ineffective in all previous trials against all weed categories. It seems that in specific circumstances the product remains effective against the grasses. Per label, metolachlor requires incorporation within 24 hours, which did not occur at this site.

Efficacy on broadleaf coverage

Diuron + hexazinone high rate and amicarbazone were the most effective herbicides against broadleaves with efficacies remaining at 100%, 137 days of application.

Imazapic + hexazinone was not significantly different with efficacies over 90% during the assessment period thanks to its hexazinone component.

Imazapic alone was far less effective on broadleaves with efficacies dropping under 60% after 88 days. This relatively rapid decrease in efficacy against broadleaves was also observed in 2015 trials.

Isoxaflutole efficacy dropped very rapidly (under 60% after 74 days). It was noticed in 2015 trials that it had a poor efficacy against square weed, which was confirmed again in this trial.

Trial 2 – Aloomba

Weather data

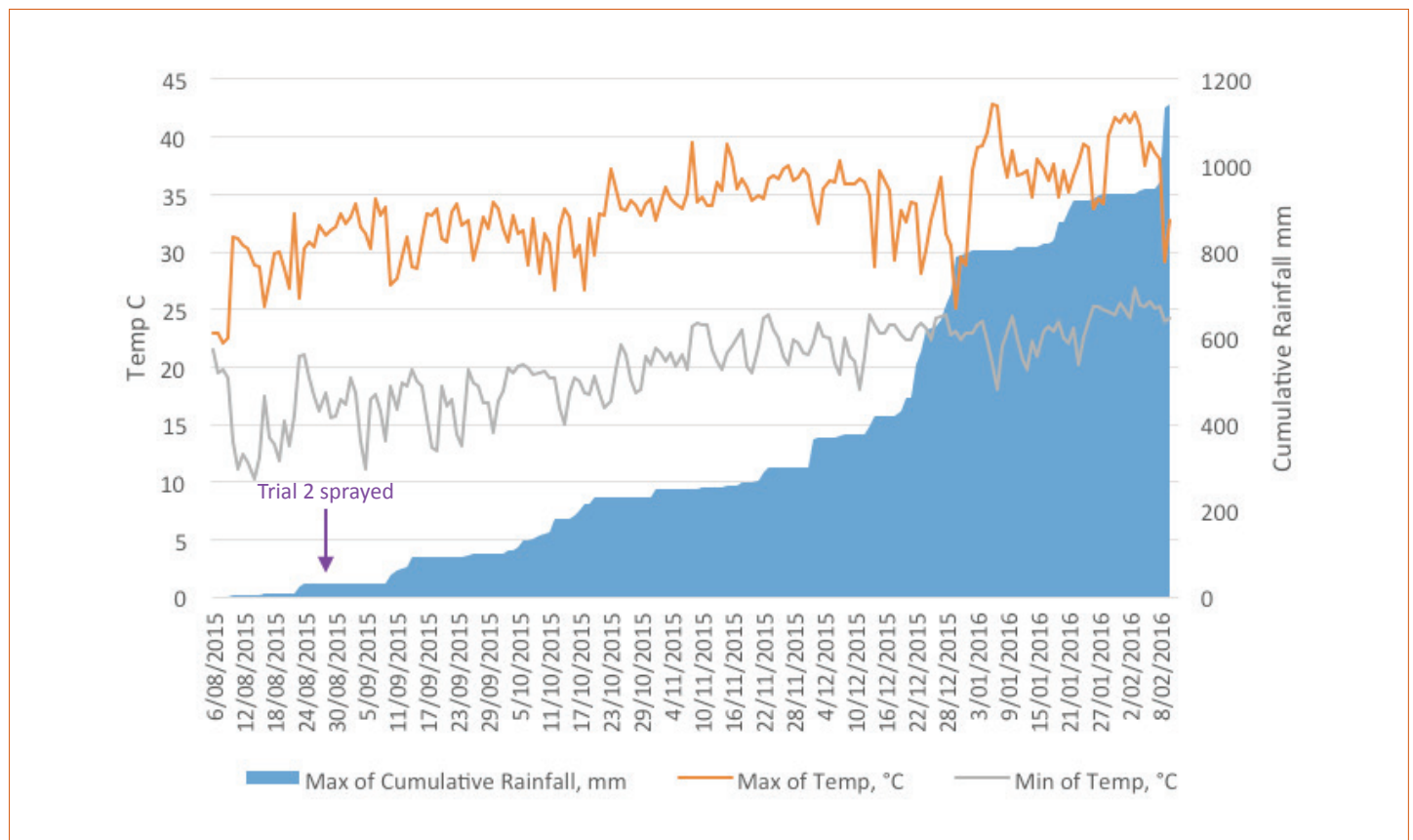


Figure 4: Minimum and maximum temperatures, cumulative rainfall at trial 2.

Weed population in untreated plots

Three months after harvest, the weed population in the untreated plots reached a maximum of 90% ground coverage. The weed population mainly consisted on grasses and broadleaf weeds. The main grass species were awnless Barnyard grass, summer grass and Guinea grass (new seedlings). Sour grass (new seedlings), crowfoot, couch grass and paspalum were also present. The main broadleaf species were blue top and spiny spider flower. Buddha pea, square weed, phyllanthus, joyweed and ludwigia were also present. The main vine species were pink convolvulus and balloon vine. The sedges species were mainly rice flat sedge and Navua sedge.

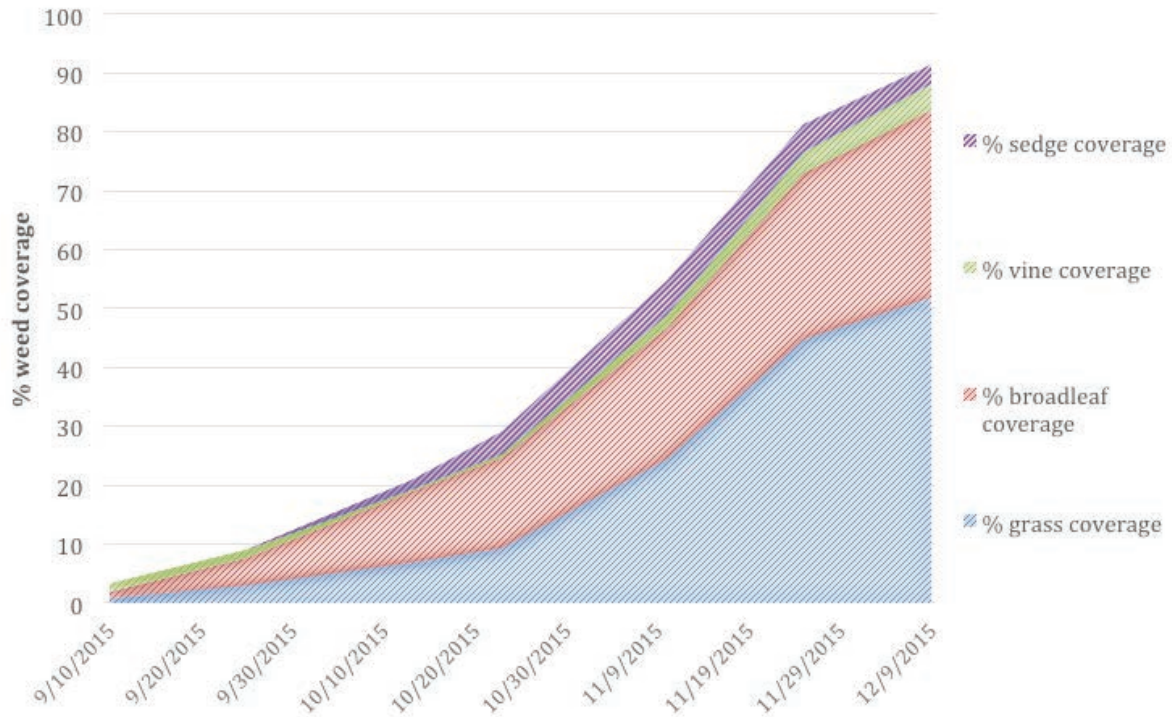


Figure 5: Average percentage of weed coverage in the untreated controls in trial 2.

Herbicide efficacy

A significant rain event occurred a few days before spraying triggering the germination of weed seeds under the trash blanket. The herbicides were sprayed over the trash and stayed locked in the trash until the following rain event occurred 10 days after application and incorporated the herbicides within the first cm under the soil surface. The young emerged weeds absorbed the herbicides through their shallow root systems, showed some phytotoxic symptoms and then died. This phenomenon can be observed in figure 6 where the efficacy at 13 DAT was relatively low for all herbicides but increased for the second assessment at 28 DAT.

Imazapic + hexazinone was the most efficient herbicide to control the total weed population with an efficacy still maintained at 70%, 89 days after application, despite a cumulative rainfall of 300 mm. Diuron + hexazinone high rate, imazapic, isoxaflutole and amicarbazone were also relatively efficient (not significantly different to imazapic + hexazinone) with efficacies above 60% until 74 or 89 DAT. Diuron + hexazinone low rate was less effective with efficacy dropping at 40% at 46 DAT.

Compared to trial 1, trial 2 was located on a lighter soil, with less binding properties, resulting in higher losses by leaching and runoff. The efficacies of all herbicides dropped more rapidly than in trial 1, despite a similar rainfall load and pattern.

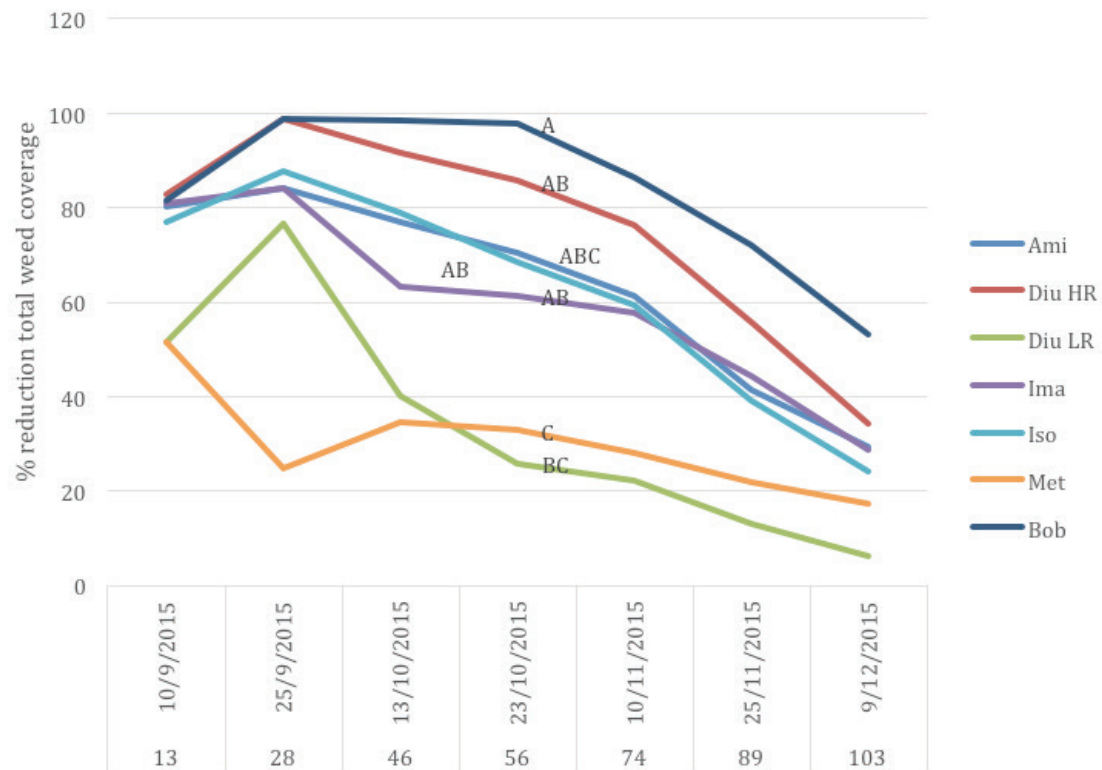


Figure 6: Mean of percentage reduction of total weed coverage compared to the adjacent untreated controls in trial 2. Similar letters are not significantly different.

Efficacy on grass coverage

Imazapic + hexazinone was the most efficient herbicide to control the grass population with efficacies above 80% during the assessment period.

The other herbicides seemed less effective against grasses (efficacies dropping under 60 % after 2 months) however only diuron + hexazinone low rate was significantly less effective than imazapic + hexazinone.

Amicarbazone performance against grasses seemed particularly low in this trial, which fits the manufacturer recommendations: amicarbazone mainly control broadleaves.

Again, metolachlor efficacy against the grasses in this trial ranged between 50 and 80% despite a delayed incorporation which usually does not suit this herbicide.

Efficacy on broadleaf coverage

Diuron + hexazinone high rate, imazapic + hexazinone and amicarbazone were the most effective herbicides against the broadleaves with efficacies remaining above 80% after 103 days.

Imazapic, isoxaflutole and diuron + hexazinone low rate seemed less effective with efficacies decreasing under 70% after 74 days, however the differences from the top treatments were not significant.

As observed in trial 1, the addition of hexazinone to imazapic in Bobcat Imax seemed to have improved the efficacy of the product against broadleaves.

Only metolachlor efficacy was significantly less effective than the best treatments with efficacies below 30% throughout the assessment period.

Efficacy on vine coverage

As there was only a limited amount of vine data collected, the results of the analysis need to be interpreted with caution.

Efficacies against the vines were low for all products (50% maximum).

Amicarbazone and diuron + hexazinone low rate were significantly more effective than metolachlor.

This result about amicarbazone confirms last year data.

Trial 3 – Daintree

Weather data

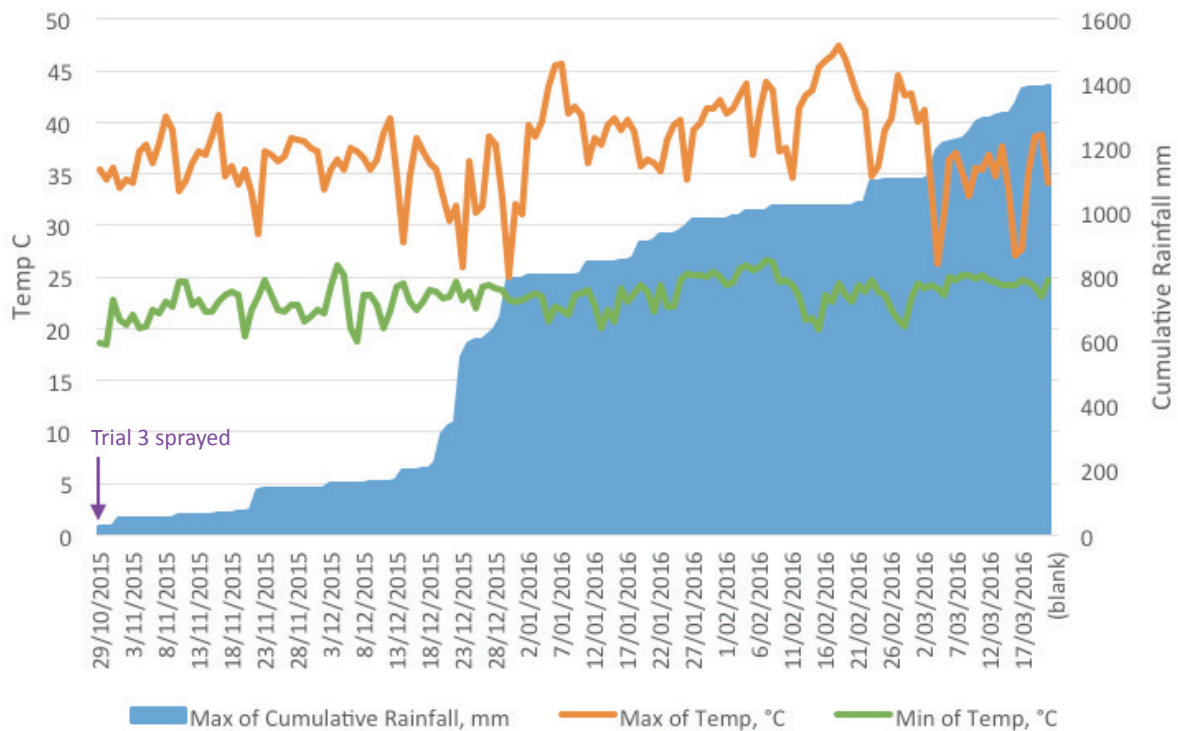


Figure 7: Minimum and maximum temperatures, cumulative rainfall at trial 3.

Weed population in untreated plots

Despite rainfall events occurring within 3 weeks of herbicide application, the weeds did not grow in the untreated plots, likely due to a thick trash layer and a limited seedbank (in contradiction to the grower's assumptions of a "weedy block" that was actually due to the presence of perennial sour grass). Three months after spraying, the weed population in the untreated plots reached only 5% coverage. Two and a half months later, the untreated plots reached a maximum of 20% ground coverage. The weed population mainly consisted on broadleaf weeds and grasses. The main broadleaf species were blue top and square weed. Ludwigia, sensitive weed and bacopa were also present. The main grass species were sour grass (new seedlings) and paspalums. Rushes were also present and counted as grasses. The main vine species was calopo.

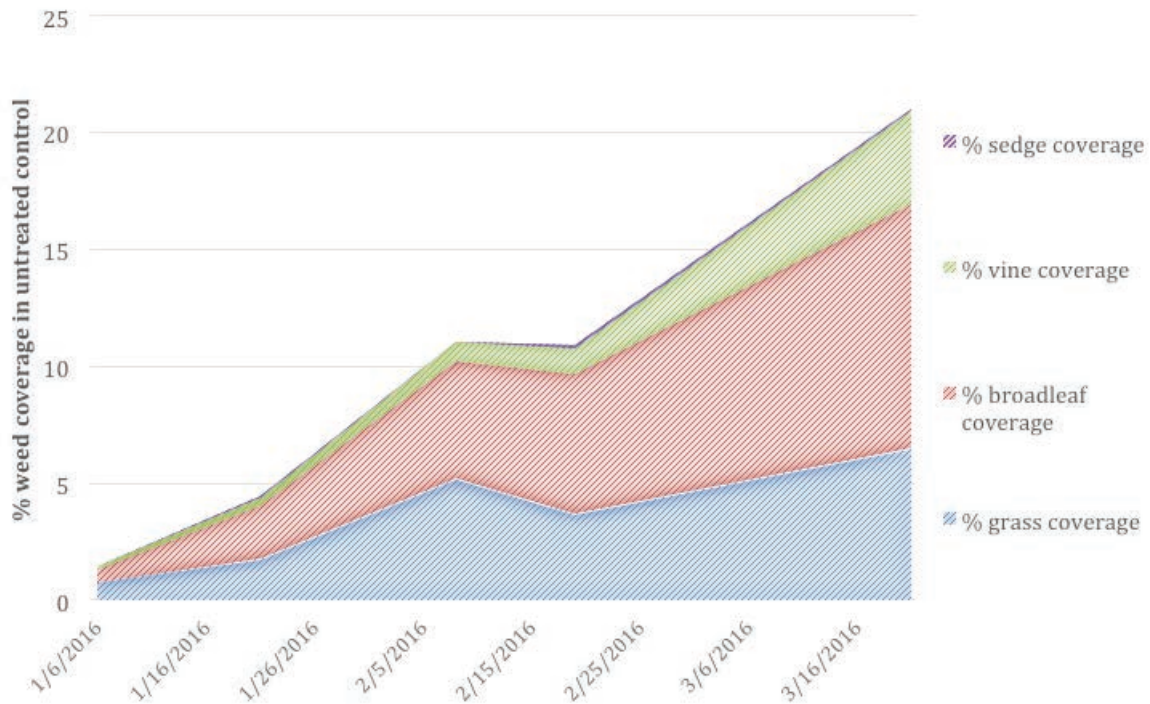


Figure 8: Average percentage of weed coverage in the untreated controls in trial 3.

Herbicide efficacy

Despite no weeds growing at the site for a couple of months, the rainfall events occurring within 3 weeks of herbicide application would have activated and positioned the herbicides within the first cm of the soil surface. The first assessment started more than 2 months after application.

The limited amount of data collected at the site makes it difficult for the analyses to discriminate between treatments. Only metolachlor appeared significantly less effective than all the other treatments, except imazapic.

All herbicides except metolachlor and imazapic maintained efficacies above 60%, 143 days after application.

Again imazapic + hexazinone appeared to be the most efficient herbicide in the trial.

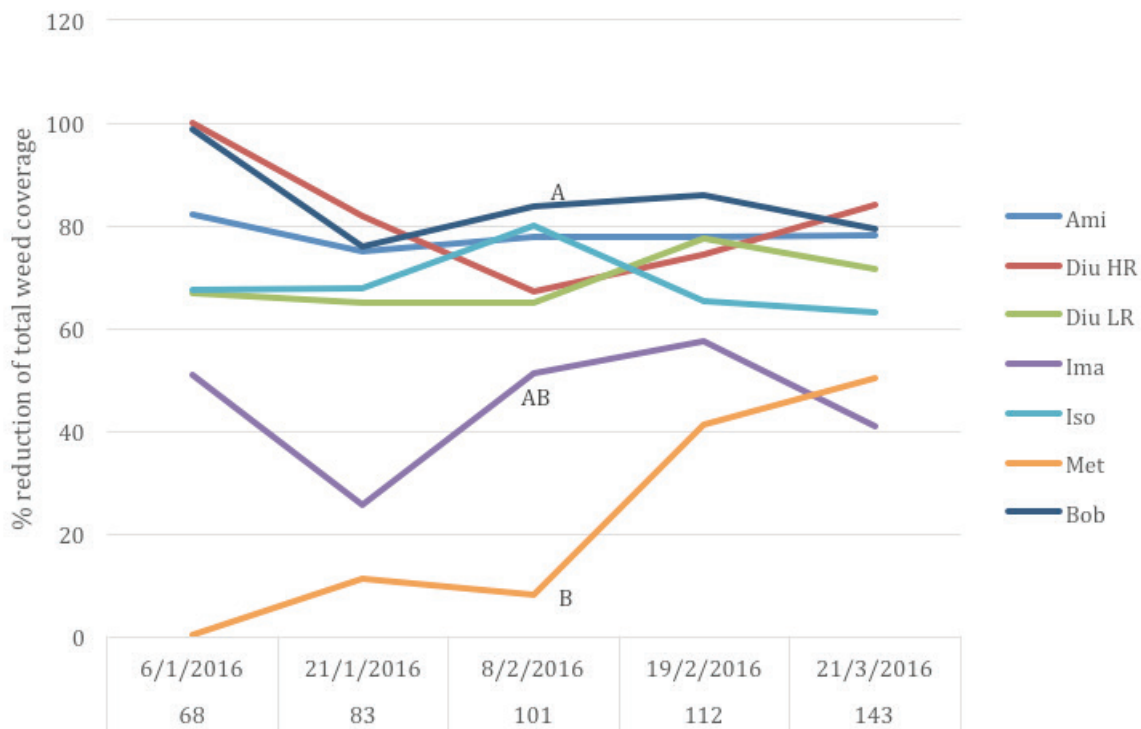


Figure 9: Mean of percentage reduction of total weed coverage compared to the adjacent untreated controls in trial 3.

Efficacy on broadleaf coverage

Diuron + hexazinone high rate, imazapic + hexazinone and amicarbazone were again the most effective herbicides against the broadleaves with efficacies remaining above 70% after 143 days.

Imazapic, isoxaflutole and diuron + hexazinone low rate seemed less effective with efficacies ranging between 40 and 70%, however the differences from the top treatments were not significant.

As observed in trials 1 and 2, the addition of hexazinone to imazapic in Bobcat Imax seemed to have improved the efficacy of the product against broadleaves.

Only metolachlor efficacy was significantly less effective than the best treatments with low efficacies throughout the assessment period.

Efficacy on vine coverage

As there was only a limited amount of vine data collected, the results of the analysis need to be interpreted with caution.

Imazapic + hexazinone and diuron + hexazinone high rate were more effective than amicarbazone against the calopo vine present at the site; however efficacies for amicarbazone were still high (75 to 89%).

General conclusion for pre-emergent trials and perspective for 2015-16

- Results were aligned with 2014-15 results.
- Diuron high rate + hexazinone was a very effective herbicide across all trial sites, regardless of the soil type and the weed composition. It had a particularly long period of efficacy regardless of the soil type and the rainfall amount when compared with other herbicides like imazapic and isoxaflutole. In 2014-15 dry conditions, diuron high rate + hexazinone was particularly stable during the very long drought period that preceded its incorporation, and was very efficient at controlling weeds after activation.
- Imazapic + hexazinone was the most efficient herbicide across all trial sites, regardless of the soil type and the weed composition. Like diuron + hexazinone high rate, it had a particularly long period of efficacy regardless of the soil type and the rainfall amount when compared with other herbicides like imazapic and isoxaflutole. The addition of hexazinone to imazapic is an effective complement to control a wider weed spectrum and extend its period of activity. The efficacy of the product was similar to diuron + hexazinone full rate. Imazapic + hexazinone was not tested in 2014-15 trials.
- Against broadleaves, amicarbazone was as effective as imazapic + hexazinone or diuron + hexazinone high rate, however its efficacy against grasses was quite low and short lasting, which was consistent with 2014-15 trials results.
- Imazapic performance varied in relation to the weed species present in the trials. It was particularly effective against the grasses but its efficacy against broadleaves was only short living. In 2014-15 trials, imazapic did not control well the legume vines (like calopo).
- Isoxaflutole performance varied in relation to the weed species present in the trials. It was more effective against the grasses than the broadleaves. Its main downfall was a short period of efficacy. In 2014-15 trials, isoxaflutole was particularly effective against legume vines (calopo), but controlled poorly the broadleaf square weed. Its efficacy was not limited by the soil type as suggested by the label and no phytotoxicity on cane was observed.
- Diuron low rate was more effective at controlling broadleaves than grasses; however, its period of efficacy was quite short. In 2014-15 trials, it was more effective against grasses and broadleaves than vines and did not perform well when its incorporation was overly delayed.
- Metolachlor efficacy was mediocre on broadleaves; however it had some relative efficacy against grasses in two trials. Its efficacy in all 2015 trials was extremely poor on all weed species, suggesting it remains an unsafe option to consider after harvest.

Perspective 2016-17

Carry out 5 demonstrations (strip trials) from Mossman to Tully to compare the efficacies of Balance, Balance + diuron, Flame, Flame + diuron, Bobcat Imax and knockdown only when applied after harvest on trash blanket. Organise field days at the site.

Trials on alternative post-emergent options to diuron to control perennial grasses

Trials on alternative post-emergent options to diuron to control perennial grasses

The project aims to find an effective alternative to spot spraying with diuron which is currently a regulated chemical in Great Barrier Reef regions. In 2015-16, two replicated trials were conducted in trash blanketed ratoons badly infested with Hamil grass in Aloomba and Garradunga.

Table 3: Details of sites for trials on alternative pre-emergence options to diuron.

Trial site	4	5
Area	High rainfall, well drained	High rainfall, well drained
Location	Mulgrave - Aloomba	South Johnstone - Garradunga
GPS coordinates	145.916031°E 17.197351°S	145.985516°E 17.482323°S
Farmer name	George Finden (Rob Rossi)	Chris Schmidt
Farm and block number	696, 25-2	363, 2B
Cane variety and ratoon number	Q208 ^{db} 2 R	Q200 ^{db} 4 R

Treatments

- T1 banded spray for asulam (sprayed on Guinea grass up to 40 cm tall), followed by two glyphosate applications in the inter-row using the shielded sprayer
- T2 diuron low rate + MSMA using Irvin leg (sprayed twice)
- T3 isoxaflutole low rate + paraquat using Irvin leg (sprayed twice)
- T4 isoxaflutole low rate + MSMA* using Irvin leg (sprayed twice)
- T5 isoxaflutole low rate + MSMA in the row*/glyphosate interrow using shield and its side nozzles (sprayed twice)
- T6 isoxaflutole low rate + MSMA in the row*/glyphosate interrow using DAF dual herbicide spray bar (sprayed twice)

* A label change /permit has been requested to register the application of isoxaflutole mixed with MSMA used as post-emergent

Application techniques



T2,T3 and T4

Octopus bar with two LD110 03 flat fan nozzles in the middle and 4 DG110 02 VP nozzles for the sides. Leg fitted to the SRA custom 6 tank sprayer.



T6

Dual spray bar with one AI110 025 nozzle in the centre (delivering glyphosate) and two Hardi 468021 E for the sides. Bar fitted to the SRA custom 6 tank sprayer with an additional tank and spray pump.



T1 and T5

Dual tank Weedseeker Shield sprayer: inside the shield equipped with two Albuz AVI OC80 01 nozzles on the side and one Agrotop Airmix 110 01 nozzle in the centre (the Weedseeker sensors were not used in this trial). Side nozzles were two flat fan 65 03E Teejet nozzles.

Measurements

Efficacy of post-emergent herbicides was achieved by rating the visual symptoms on cane and Hamil grass. In each plot, three ratings were given:

- phytotoxicity of the treatment on cane
- phytotoxicity of the treatment on Guinea grass in the row
- phytotoxicity of the treatment on Guinea grass in the interrow

Results were statistically analysed.

Cane yield for each treatment will be recorded and reported after the harvest, to assess the final phytotoxicity/competition impact of the treatment and perennial grasses on cane.

The location and size of each perennial grass stool was recorded in both trial sites before spraying herbicides in 2015. High precision GPS mapping equipment (Leica PS15 receiver and accessories, 2 cm accuracy) was hired from CR Kennedy in Cairns. After harvest, perennial grass stools location will be recorded again and compared with the first map to deduct the efficacy of the tested treatments.

Trial 4 – Aloomba

Weather data

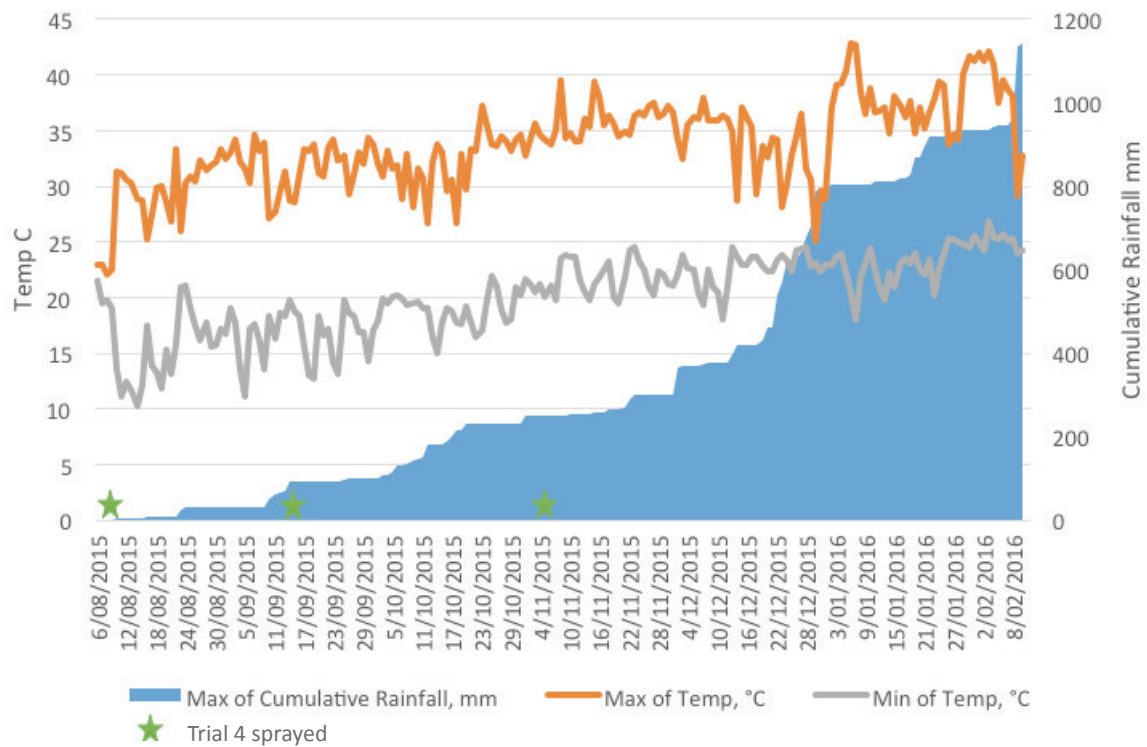


Figure 10: Minimum and maximum temperatures, cumulative rainfall at trial 4.

Herbicide efficacy on grass in the row

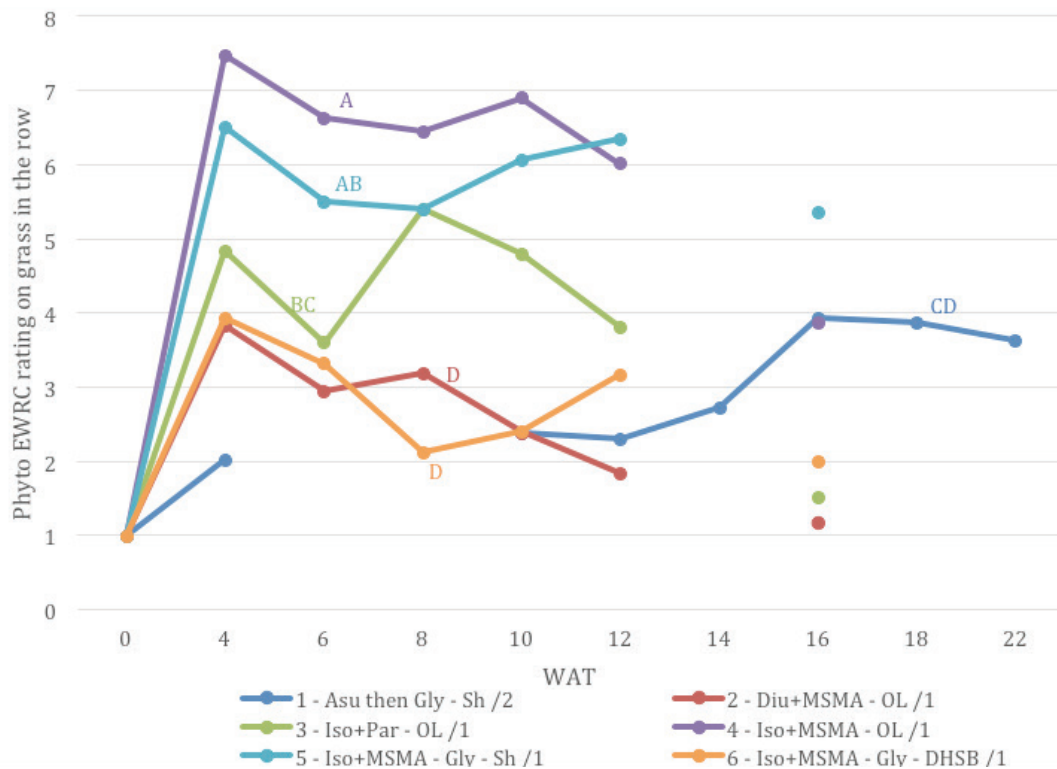


Figure 11: Mean of phytotoxicity rating on grass in the row at trial 4. Assessments date are based on number of weeks after the first spraying treatment. In this case the curve for T1 was actually recorded one month before the other treatments.

Trial 5 – Garradunga

Weather data

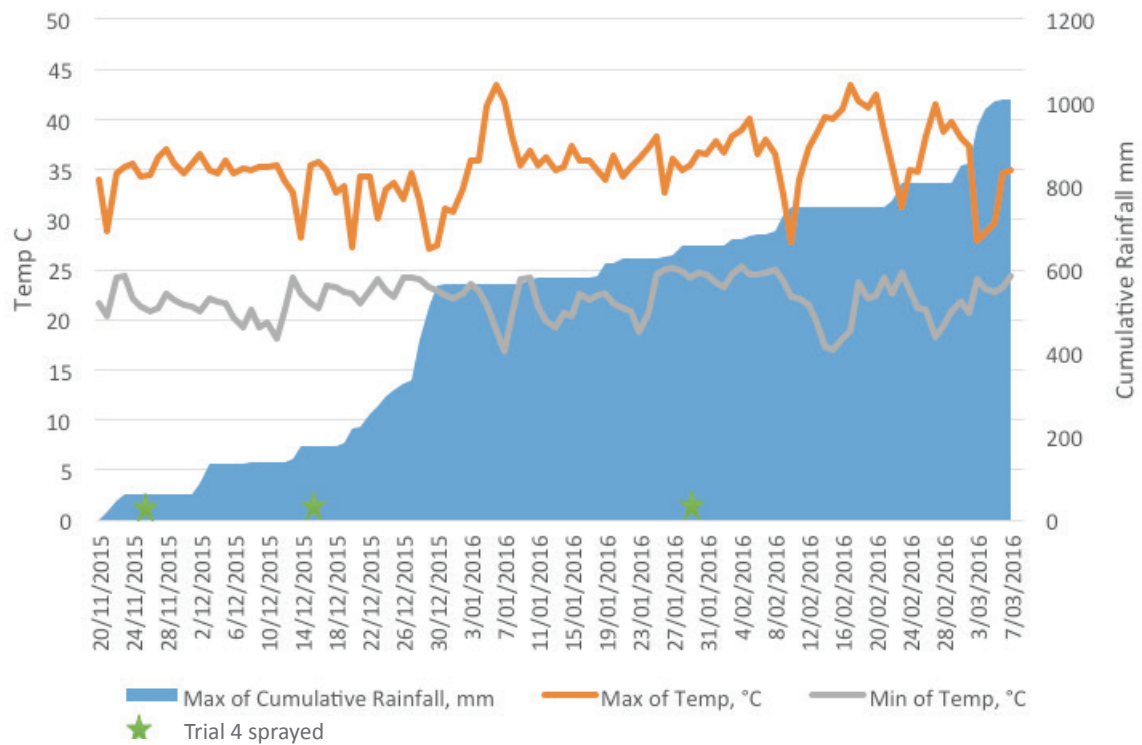


Figure 12: Minimum and maximum temperatures, cumulative rainfall at trial 5.

Herbicide efficacy on grass in the row

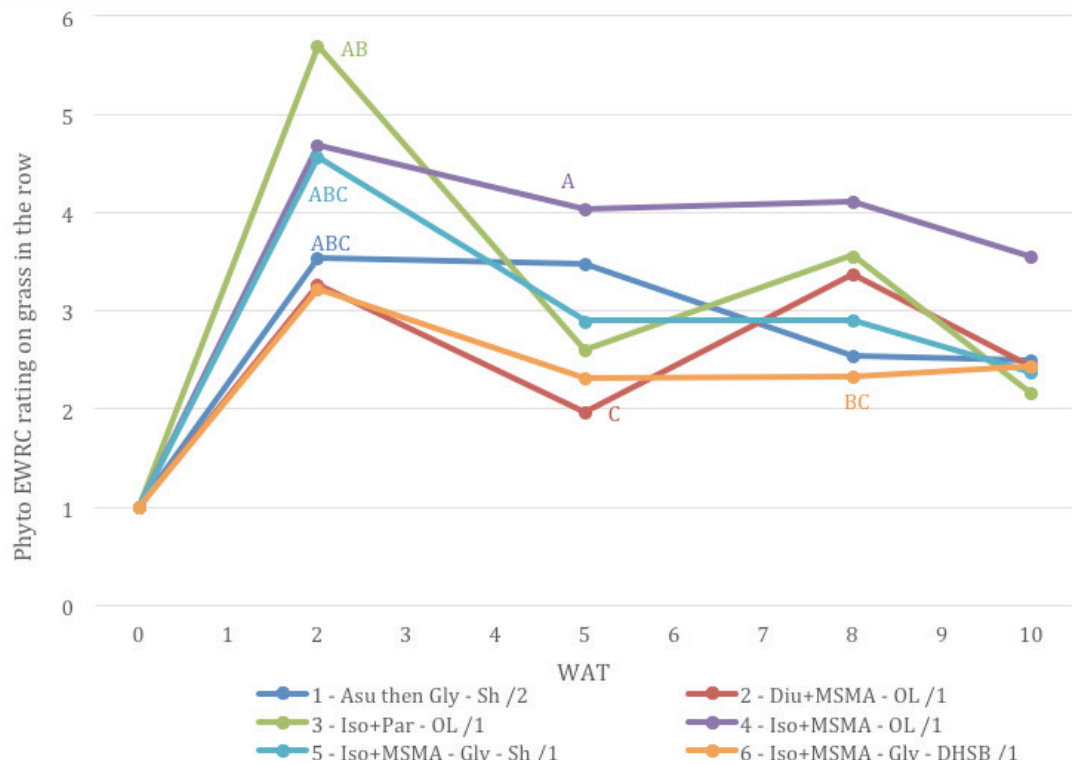


Figure 13: Mean of phytotoxicity rating on grass in the row at trial 5. Assessments date are based on number of weeks after the first spraying treatment. In this case the curve for T1 was actually recorded one month before the other treatments.

General conclusions for post-emergent trials

- None of the treatments tested resulted in full control of Hamil grass in the row.
- Phytotoxicity symptoms on grass in the rows were quite similar to phytotoxicity symptoms on cane, highlighting the fact the target weed had a similar susceptibility to these herbicides than cane; was nearly the same height as the cane; and was in the same location as the cane (in the cane row).
- The DSB was effective to control grasses in the interrow, but not in the row. The conservative set up and low height of the boom to avoid cane phytotoxicity damage from glyphosate also restricted the spray coverage of isoxaflutole + MSMA on grasses in the interrow. This result was consistent with 2015 trials.
- In trial 5 where asulam was applied in more humid conditions, it was moderately effective to slow down grass growth in the row. In trial 4, as in 2015 trials, asulam efficacy on perennial grasses was mediocre (as it was applied in dry conditions). Asulam was very safe on cane which is consistent with 2015 trials.
- The use of the glyphosate under shield was very effective to control the grasses in the interrow and safe on cane. The efficacy of the herbicide mix (isoxaflutole + MSMA) sprayed on the grasses in the row was highly correlated to the setup of the side nozzles. The higher the nozzles sprayed, the better efficacy on the grasses; on the other hand, it resulted in stronger phytotoxicity on cane. This result was aligned with 2015 trials results.
- The octopus bar was set up in a non-conservative manner, aiming high into the row canopy (50cm high). The most effective brew to control the grasses in the row and in the interrow using the octopus bar was isoxaflutole + MSMA which was also consistent with 2015 trials results. Grasses in the interrow were successfully controlled, whereas grasses in the row were only stunned and their growth slowed down despite a repeated treatment application. The impact on cane was also quite alarming with phytotoxicity symptoms lasting more than 8 weeks.
- Isoxaflutole + paraquat applied with the octopus bar was slightly less effective on the grasses (row and interrow) than the mix with MSMA, however its phytotoxicity on cane was comparable. This result was consistent with 2015 trials.
- Diuron + MSMA applied with the octopus bar was a softer option on cane; however it was also less effective to control the grasses in the row and in the interrow.

Perspectives for 2016-17

No directed spray method was satisfactory to control well establish perennial grasses.

Spot spraying remains the best option in terms of weed control and crop safety. The best herbicide options to control Hamil grass are glyphosate or isoxaflutole + MSMA only if a thorough spray coverage is achieved.

Project 2015815 (2016-2018) – “Field ready optimised precision weed identification and spray system” is looking at ways to develop an automatic spot sprayer that would discriminate weeds (including perennial grasses like Hamil or Guinea grass) from cane in the row.

Cover crop trials

Cover crop trials

Preliminary trials carried out in 2014-15 indicated that the most promising cover crop options were:

- cowpea alone
- cowpea and lablab (50%-50%)
- cowpea+lablab+millet (40%-40%-20%) for early weed competition with grasses
- high seeding rate
 - o cowpea 70 kg/ha
 - o cowpea 35 kg/ha + lablab 35 kg/ha
 - o cowpea 28 kg/ha + lablab 28 kg/ha + millet 10 kg/ha
- no use of herbicide

These treatments were compared in 2015-16 in full scale replicated trials that included different soil preparation practices and the associated sowing techniques.

Table 4: Details of cover crop trial sites.

Trial site	6	7
Area	High rainfall, well drained	Medium rainfall, poorly drained
Location	Craiglie - Port Douglas	Meringa - Mulgrave
GPS coordinates	145.46536°E 16.545254°S	145.798647°E 17.07444°S
Farmer name	Chris McClelland	John Ferrando
Farm and block number	5951, 2-1	0434, 5-1
Soil type	Clifton Red, yellow or grey loam or earth soils: Kandosols Strongly bleached gradational textured soils on alluvial fans.	Virgil Red, yellow or grey loam or earth soils: Kandosols Uniform or gradational textured red massive soils on high terraces.
Trash blanket level at planting	Medium	Very light
Row profile	Deep (and worsen by the wet conditions at planting)	Shallow
Soil preparation date	16/12/2015	18/02/2016
Sowing date	16/12/2015	26/02/2016
Spraying date on T4	03/02/2016	29/03/2016
Harvesting date	24/02/2016	11/05/2016

Treatments



To incorporate cover crop mixes into cane fallow farming practices, we faced the challenge to find a planter that can plant seeds of different sizes in a single mix.

We used the Baldan double disk seeder lent from Honeycombe Tolga which was able to plant a mix of two seed sizes thanks to the 2 separate boxes. This planter is typically used to plant rice.



When the trash blanket was too thick to operate the disk planter (like in the no-till zones in Mossman trial), it was decided to use a local soya bean planter that plants a row of bean on each side of the ex cane row through the trash.

To insure better ground coverage, we did three offset passes with the soya bean planter in an attempt to plant 6 rows of cover crop on the ex cane row.

The other inconvenient of the common soya bean planters was that it could handle only one seed size.

The mixes we wanted to test included very small millet seeds that could not be planted with this type of planter.

Table 5: Details of treatments in the cover crops trials.

Main treatment code	Soil preparation	Sub treatment code	Cover crop species	Type of seeder used in trial 6	Type of seeder used in trial 7
NT	No tillage	T1	Cowpea alone	Soya bean planter. Three passes, 12 rows on two wide beds. Used because of presence of trash blanket.	Baldan seeder. One pass, 17 rows over 3 m width The shallow row profile and the very light trash blanket allowed for the NT and ZT to be planted across the row profile with the Baldan seeder.
		T2	Cowpea + lablab		
		T3*	Cowpea + lablab + millet	Could not be planted with the soya bean planter.	
		T4	None		
ZT	Zonal tillage using a zonal rotary hoe	T1	Cowpea alone	Baldan seeder. One pass, 9 rows on two beds The seeder planted only on the raised bed because of the deep row profile.	
		T2	Cowpea + lablab		
		T3	Cowpea + lablab + millet		
		T4	None		
FT	Full tillage using a rotary hoe	T1	Cowpea alone	Baldan seeder. One pass, 17 rows over 3 m width.	
		T2	Cowpea + lablab		
		T3	Cowpea + lablab + millet		
		T4	None		

Measurements

Four to six assessments of weed coverage and cover crop coverage were carried out in each trial. Aerial parts were cut and weighted before the legume crop set seeds and the dry yield per ha was calculated. Nitrogen and carbon content in the residue were analysed at SRA laboratory.

Trial 6 – Port Douglas

Weather data

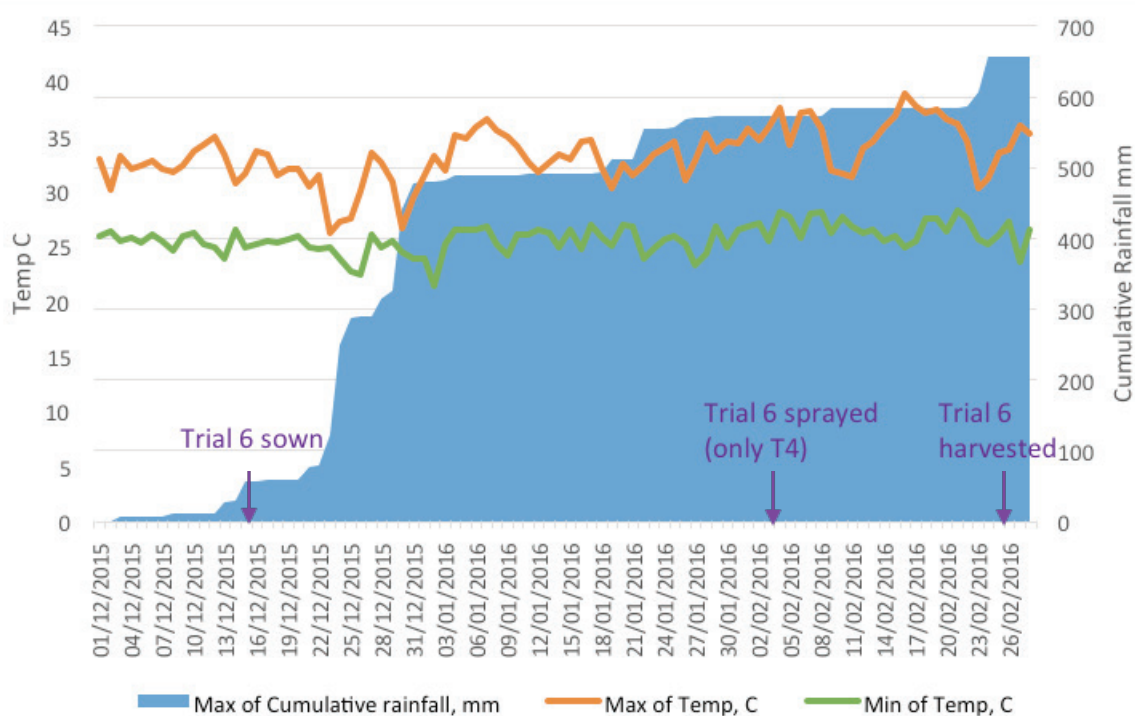


Figure 14: Minimum and maximum temperatures, cumulative rainfall at trial 6.

Weed coverage

The weed coverage was composed of awnless Barnyard grass, summer grass, crowsfoot, green summer grass, ludwigia, phyllanthus and red convolvulus in decreasing order of coverage. Expectedly the weed coverage in bare plots had the highest weed coverage (up to 80% until they were sprayed) without significant differences between farming systems. For the covercrop treatments, weed coverage results were opposite to the legume coverage results.

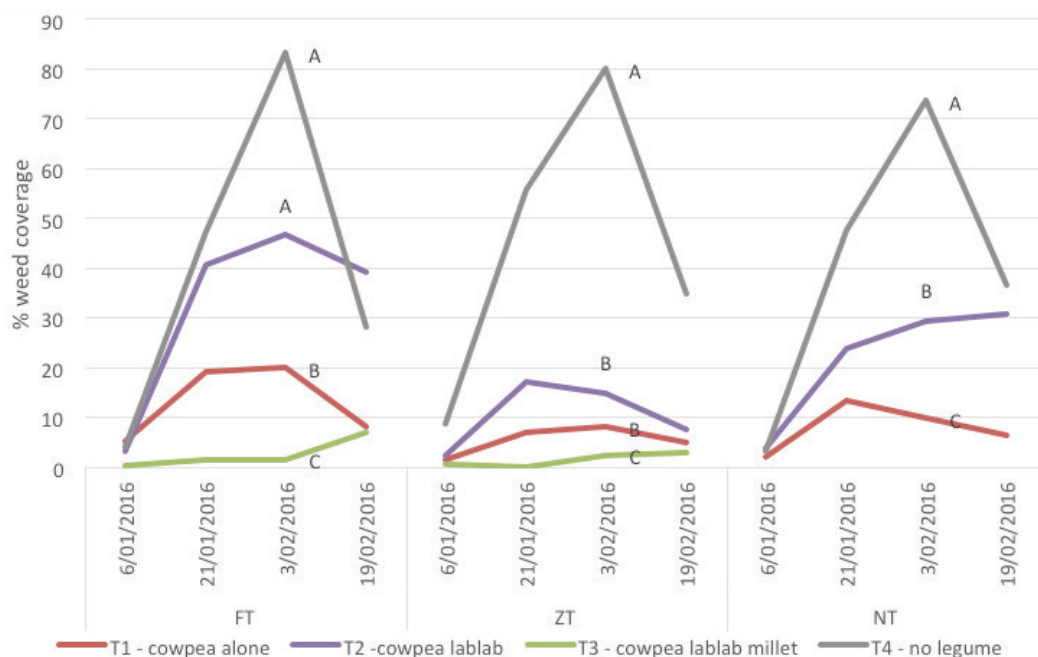


Figure 15: Percentage weed coverage in trial 6 for each cover crop mix on each farming system: Full till (FT), Zonal till (ZT) and No till (NT). Similar letters within a farming system are not significantly different.

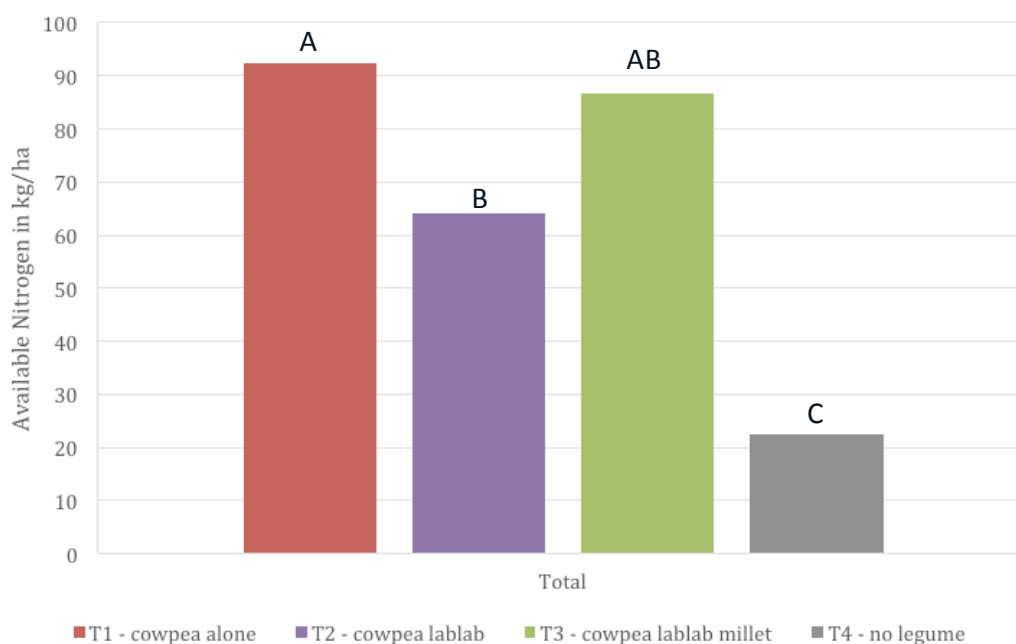


Figure 16: Available N in kg/ha.

Trial 7 – Meringa

Weather data

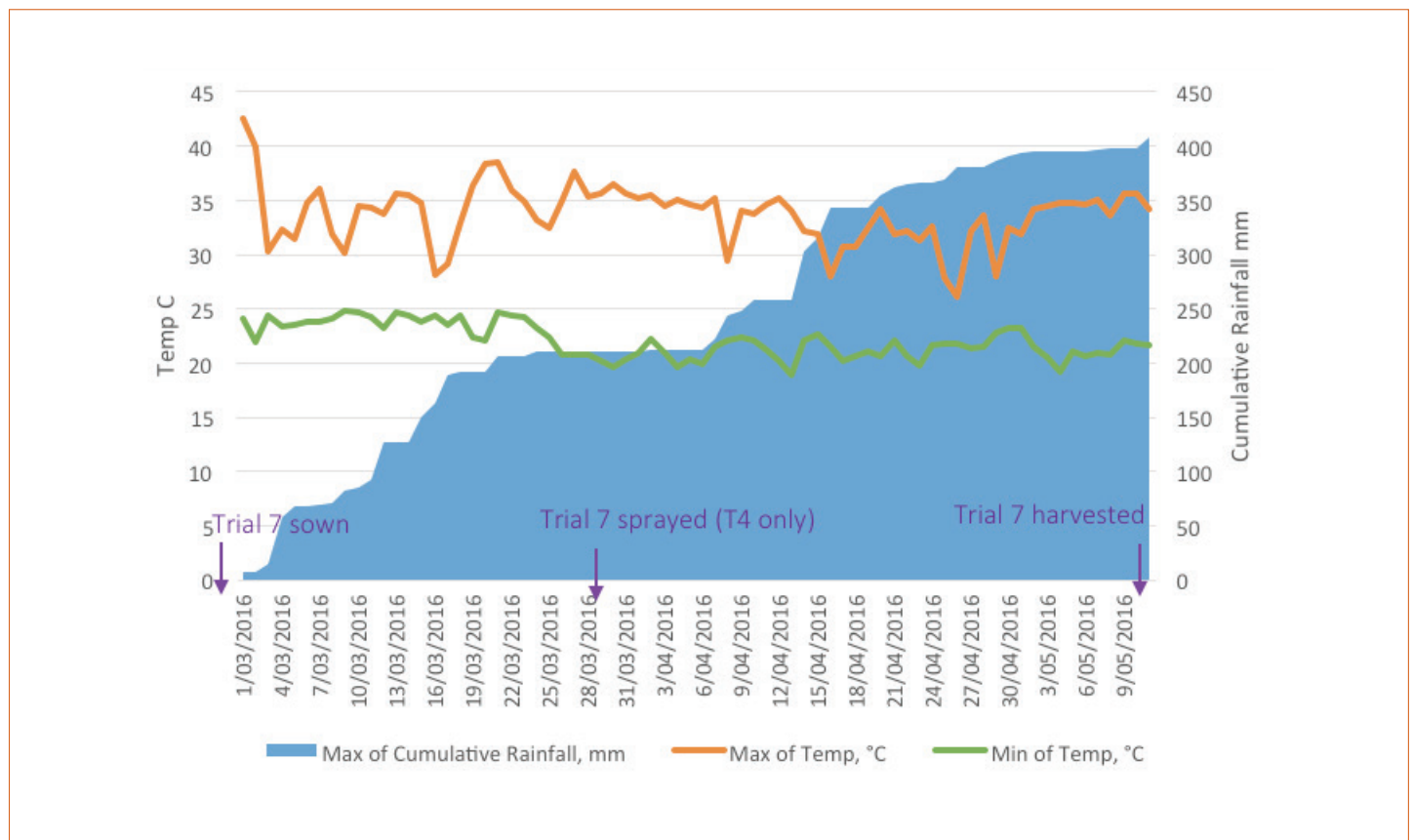


Figure 17: Minimum and maximum temperatures, cumulative rainfall at trial 7.

Weed coverage

The weed coverage was composed of spiny spider flower, passion fruit vine, blue top and green summer grass in decreasing order of coverage.

The No till treatment hosted the most weeds as small weeds were already present at time of sowing the legume.

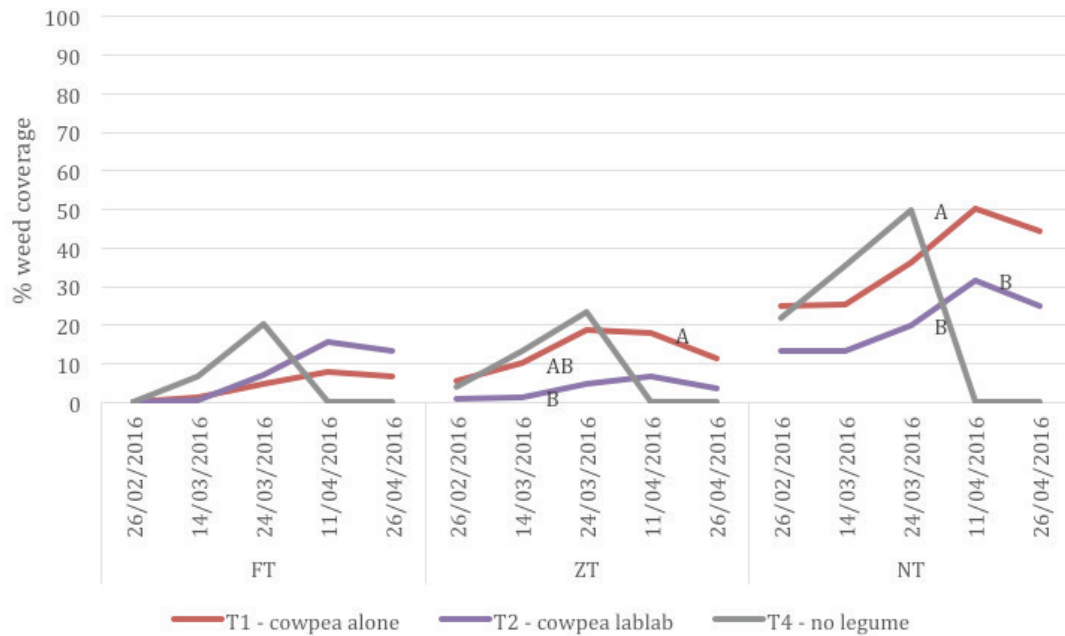


Figure 18: Percentage weed coverage in trial 7 for each cover crop mix on each farming system: Full till (FT), Zonal till (ZT) and No till (NT). Similar letters within a farming system are not significantly different.

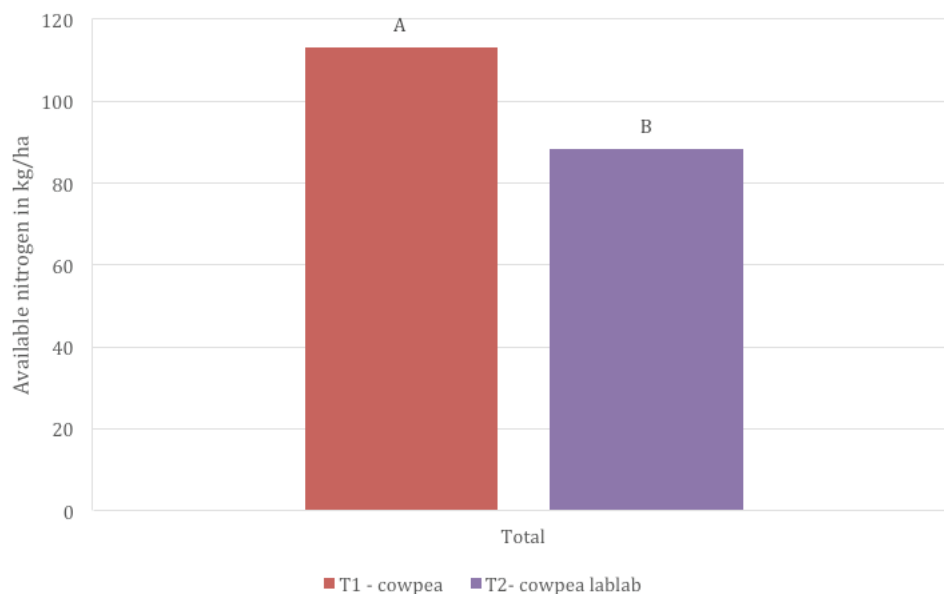


Figure 19: Available N in kg/ha.

General conclusions for cover crop trials

The three tillage systems were suitable for growing cover crops and cover crop mixes.

In very wet conditions (trial 6), the full tillage system was more challenging for mixes with Rongai lablab species whereas Ebony cowpea was fully adapted to extreme wet conditions. The weeds took advantage of the poor establishment of lablab in the cowpea + lablab treatment and reached 40% coverage, whereas in the cowpea alone treatment weeds only reached 20% coverage. Japanese millet also performed well in very wet fully tilled conditions (as long as there was no water logging). The early germinating millet outcompeted the weeds in the early stages after planting, while the legumes emerged and competed with the weeds a few weeks later keeping the weeds under 10% coverage. In drier conditions, very good results were obtained from both legume treatments keeping the weed coverage under 15%.

The zonal tillage was a more versatile option where all cover crops mixes performed very well both in very wet and drier conditions. The tilled bed area was easy to plant with a rice planter even if the interrow was too low for the planter to bury the seeds in trial 6. The use of millet that germinated even if spread on the ground surface, was a bonus in terms of weed control in the interrow. In trial 7, the rice planter could bury the seeds across the row / interrow section thanks to a lower bed profile, favouring the quick establishment of the legume species across the entire tested area. The cowpea + lablab mix reduced the weed coverage better than cowpea alone (7% versus 19%), highlighting the benefit of using cover crop blends with different growth pattern to achieve maximum weed suppression.



Above: Trial 6. Cowpea + lablab + millet in zonal till, 47 days after sowing.



Above: Trial 7. Cowpea + lablab in zonal till, 45 days after sowing.

For the no till system, the conditions were highly different between the two trials. Trial 6 had too much cane crop residue to use the rice planter and a soybean planter was used to sow 6 lines of legume seeds in the bed area. Even if this system prevented us to sow the millet seed, it gave good results for cowpea alone which maintained the weed coverage under 15% whereas cowpea+ lablab did not perform particularly well allowing the weed coverage to reach 30%. In trial 7, weeds just started to germinate when sowing in the no-till treatment, which gave the weeds an advantage against both cover crop treatments. Spraying must be done prior to sowing the cover crop in a no-till system to ensure no weeds are germinating!

Across all farming systems and in both trials, cowpea alone generated a higher biomass (5.2 t/ha in wet conditions and 6.3 t/ha in drier conditions) than the mix cowpea + lablab (3.7 t/ha in wet conditions and 4.7 t/ha in drier conditions). Literature reviews report that lablab generally yields less than cowpea in tropical wet conditions. The yield of the mix cowpea + lablab + millet in the wet trial was also high (4.6 t/ha). The addition of millet reduced the early weed establishment and allowed for better implementation of the cowpea + lablab mix when compared to the treatment without millet that had a bigger weed issue.

Available N (kg/ha) results were similar to the dry biomass, as the yield is the main driver of the total amount of nitrogen per hectare. 92 and 113 kg N/ha were supplied by the residues of cowpea alone in the wet and drier trials respectively; 87 kg/ha for the residues of cowpea + lablab + millet in the wet trial; and, 64 and 88 kg/ha for cowpea + lablab in the wet and drier trials respectively. These amount of nitrogen would need to be taken in consideration for the nutrition of the following plant cane.

Perspective for 2016-17

Monitor the weed population in plant cane after the different fallow crop treatments.

Implement new cover crop demonstrations in fallow, to confirm the most promising results (ie cowpea + lablab + millet , cowpea + millet in zonal, full and no till).