Final report

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Assess green waste streams from urban areas in sugarcane production systems in tropical Queensland

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Assessing green waste streams from urban areas in sugarcane production systems in tropical Queensland

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Abstract

The National Landcare funded project sort to improve soil health and yields of sugarcane farms through the use of organic green waste from urban areas. Trials were established in the Herbert and Burdekin cane growing regions to assess the possible benefits of using green waste streams from urban areas to improve soil health and condition, improving financial returns to farmers, while addressing waste and negative environmental issues for regional councils.

There were specific challenges that need to be addressed when using green waste streams from regional councils like: impurities and contaminants found in the products, the viability of handing, processing, and transporting such material. The cost of transporting a low bulk density product currently makes it cost prohibitive to transport such products any considerable distances.

The research work undertaken by this project has identified potential opportunities where green waste organic waste streams can be used in a sugarcane production system.

Introduction

Soil farmed under sugarcane for long periods of time are known to have poor soil health, due to long periods of monoculture agricultural production with low organic inputs. Consequently, these soils have low soil carbon levels which result in poor soil structure, low water holding capacity and nutrient contents. In addition, sugarcane soils generally have low levels of micro-, meso, and macro- organisms and have a disproportionately high level of non-beneficial and parasitic organisms. The overall result of these poor soil conditions is that sugarcane productivity is negatively impacted and both grower and miller profitability is reduced.

The local governments of Hinchinbrook, Townsville and Burdekin receive large amounts of green waste from urban gardens, that is mostly buried in land fill with only small volumes being used on local gardens and none being used in combustion processes to generate energy. These organic materials generally breakdown and release large volumes of greenhouse gases such as nitrous oxide and methane to the atmosphere.

The project has demonstrated that green waste material from local governments could be effectively used in a sugarcane farming system, however the quality of the green waste needs to be managed to ensure that contaminants like plastics, asbestos, concrete, metals (including heavy metals) and other impurities are excluded from the final product that makes it on farm.

Materials and methods

Collection and processing of green waste materials

The three regional councils (Hinchinbrook, Townsville and Burdekin) collect large amounts of green waste material from the community and local businesses in their respective shires annually.

Photo 1. Above left- green waste material received by Hinchinbrook Shire council at its Warrens Hill waste station.

Photo 2. Above right- HCPSL Board member Gino Zatta (left) and HCPSL Extension Agronomist Richard Hobbs (right) inspecting composted green waste at the Townsville City Council Harvey's Range waste station.

Photo 3. Below left- Windrows of ground green waste at the Townsville City Council Harvey's Range waste station.

Photo 4. Below right- Tub ground green waste waiting shipment to the Herbert region from the Townsville City Harvey's Range waste station.

All three regional councils collect green waste materials at their waste disposal stations. Green waste can be contaminated with cement, asbestos, plastics, metal objects, heavy metals, and other foreign objects. Regional councils attempt to remove contaminants on receival; however, some loads need to be rejected and diverted into land fill. "Clean" green waste is stock pilled until there is sufficient material to be ground down to an average particle size of 50m, by a tub grinding unit. The mulched material was pasteurised to kill weeds and held on site for a period of time until required for dispatch.

Before dispatching of the ground green waste from the Shire Council sites the material was assessed for nutrient content, impurities and contaminants. Refer to appendix 1 and 2 for examples of reports from the studies undertaken for the product provided from Townsville City Council.

The ground green waste material from the 3 regional council sites was transported from the waste station to farm by truck.

Photo 5 (above left)- Loading of the green waste from the Burdekin Shire Council.

Photo 6 (above right)- The green waste received from Townsville City Council (note contaminants in the green waste).

Trial site preparation treatment applications and cane planting

Prior to applying all treatments in the trial blocks, soil was sampled for soil nutrients present to allow for nutrient balances to be created for each treatment.

Treatments were applied using various spreading equipment in the Herbert and Burdekin sugarcane growing areas. Photo 7 is the green waste product being spread at the Pace, Bambaroo site and photo 14 at one of the Burdekin sites. All application equipment was calibrated for each product before applications were undertaken.

Photo 7 (above)- Application of green waste at the Pace, Bambaroo site.


Photo 8 (above left)- Application of the green waste at the Pace, Bambaroo site.

Photo 9 (above right)- Loading the green waste into the spreader.


Photo 10 (above left)- Green waste applied to the field before incorporation at the Pace, Bambaroo site.

Photo 11 (above right)- The green waste and mill mud/ash applied to the field at the Zatta, Bambaroo site.

Photos 12 and 13 (above). Incorporating green waste at the Pace, Bambaroo site.

Photo 14 (below) Application of green waste in the Burdekin.

Photo 15 (below left)- Mixing green waste and mill mud in the Burdekin to make compost before application using a compost turner.

Photo 16 (below right)- Sugarcane planting at the Bambaroo site.

To allow for the ameliorant products to break down, the paddocks were left fallow for three to four months before being planted in March-April 2020 (in the Burdekin) and for 6-7months in the Herbert. At the Pace, Bambaroo site a mounded legume cover crop was established across all treatments prior to the onset of the “wet season”. The legume crop was incorporated into the soil prior to cane planting.

In the Burdekin, four trial sites were established across a variety of soil types, including sandy-loam Delta soils of Kilrie and Burstalls and heavier clay soils of Groper Creek and Giru; in the Burdekin area. The green waste was spread in two different methods: spreading then incorporation at a rate of 200m3/ha and banding into Vs at a rate of 70m3/ha. Other treatments included straight mill mud, mixed mill mud and green waste, green waste, and Easy N fertiliser, decomposed Hymenachne water weed, and compost composed of bagasse, cow manure, chicken manure and mill mud. Treatments were replicated within a site.

In the Herbert, two trials and 2 demonstration sites were established. The Pace, Bambaroo site was located on a clay soil, while the Zatta site was established on a sandy loam soil. Treatments included at the Herbert sites were:

Pace, Bambaroo site:

- Control
- Green waste @ 25 t/ha
- Poultry biodigester 9 t/ha
- Mill mud/ash @ 95 t/ha

Zatta, Bambaroo site:

- Control
- Mill mud/ash @ 75 t/ha
- Mill/ash @ 15 t/ha
- Green waste @ 15 t/ha
- Green waste @ 30 t/ha + mud/ash @ 30 t/ha + lime @ 5 t/ha
- Green waste @ 15 t/ha + lime @ 5 t/ha

All Herbert treatments were banded to the cane row area. Treatments were replicated within a site.

The planting dates for the Herbert and Burdekin replicated trials are as follows:

Burdekin:

Kilrie site- May 2020

Groper Creek site- May 2020

Burstalls, Kalamia site- May 2020

Haughton site- May 2020

Herbert:

Pace, Bambaroo site- 19/7/2020

Zatta, Bambaroo site- 7/6/2021

Both the demonstration sites at Wilmar, Orient and Chiesa, Blackrock sites were sodic saline clay loam soils with high exchangeable sodium percentages (ESP) greater than 20% and high electrical conductivities (EC values). Because sodic and saline areas are randomly distributed across a paddock, areas of high ESP or EC values were treated and there were left untreated areas within the same field. These sites are non-replicated and planted in 2021.

Sugarcane was planted in the Burdekin using a furrow planter and, in the Herbert, using a mound at the Zatta, Bambaroo site or double disc opener planter at the Pace, Bambaroo site. The sugarcane was planted on the treated band of each sugarcane row.

Harvesting and data collection

The trials were harvested using conventional sugarcane harvesters in both districts. Each plot consisted of greater than 28t of cane, which is required by the sugar mill to obtain a mill CCS (commercial cane sugar) figure; this data was used to calculate t/sugar/ha. The following data was collected at harvest: cane yield, CCS, cane fibre percentage (for the Herbert trials only) and any other visual observations.

Photo 17. Harvesting the Zatta, Bambaroo trial in 2020.

Measuring soil health

To investigate the possible benefits of this trial, SRA were partnered , to road test their Soil Health Toolbox as part of their Soil Health Project. They utilized this toolbox at all four sites and undertook in-depth biology sampling at one of the sites.

It is proposed to sample the Herbert sites in 2023 to measure the long-term effects on soil health through a Soil CRC project. These results will be made available to the National Landcare program at a later date.

Results and discussion

Burdekin results

Burstalls/ Kalamia- plant cane

Treatment	TCPH	CCS	TSPH
Control	170.4	14.2	24.2
Greenwaste	169.7	13.7	23.3
Water weed	173.4	13.9	24.2
Compost	177.7	13.4	23.9
Greenwaste + water weed	177.2	13.7	24.3

Burstalls/ Kalamia- 1st ratoon cane

Treatment	TCPH	CCS	TSPH
Control	170	14.2	24.2
Greenwaste	170	13.7	23.3
Water weed	173	13.9	24.2
Compost	178	13.4	23.9
Greenwaste + water weed	177	13.7	24.3

Kilrie- plant cane

Treatment	TCPH	CCS	TSPH
Control	154.05	13.87	21.37
Green waste	157.66	13.8	21.75
Mill mud	158.77	13.73	21.80
Green waste + Easy N	162.27	13.75	22.30

Kilrie- 1st ratoon cane

Treatment	TCPH	CCS	TSPH
Control	154	13.9	21.4
Green waste	158	13.8	21.8
Mill mud	159	13.7	21.8
Green waste + Easy N	162	13.7	22.3

Haughton- plant cane

Treatment	TCPH	CCS	TSPH
Control	198.4	11.6	23.0
Green waste	201.2	11.1	22.4
Mill mud	200.8	11.5	23.1
Green waste + Mill mud	191.7	11.6	22.2

Haughton- 1st ratoon cane

Treatment	TCPH	CCS	TSPH
Control	198	11.6	23.0
Green waste	201	11.1	22.4
Mill mud	201	11.5	23.1
Green waste + Mill mud	192	11.6	22.2

Groper Creek- plant cane

Treatment	TCPH	CCS	TSPH
Control	146.42	13.52	19.8
Green waste	131.74	13.76	18.13
Mill mud	143.4	13.77	19.74
Compost A	138.2	13.48	18.62
Compost B	145.54	13.57	19.75

Groper Creek- 1st ratoon cane

Treatment	TCPH	CCS	TSPH
Control	146	13.5	19.8
Green waste	132	13.8	18.1
Mill mud	143	13.8	19.7
Compost A	138	13.5	18.6
Compost B	146	13.6	19.7

Pace, Bambaroo- plant cane

Treatment	TCPH	CCS	TSPH
Control	80.0	14.36	11.48
Green waste @ 25t/ha	87.5	14.3	12.47
Mill mud/ash @ 95t/ha	86.2	13.35	11.84
Poultry Biodigester @ 9t/ha	83.9	13.5	11.3

Pace, Bambaroo- 1st ratoon cane

Treatment	TCPH	CCS	TSPH
Control	135.16	13.58	18.36
Green waste @ 25t/ha	141.97	13.55	19.25
Mill mud/ash @ 95t/ha	124.99	12.4	15.52
Poultry Biodigester @ 9t/ha	141.58	13.22	18.74

Zatta, Bambaroo- plant cane

Treatment	TCPH	CCS	TSPH
Control- Lime @ 5t/ha	129.22	13.65	17.63
Mill mud @ 75t/ha	140.86	12.9	18.17
Mill mud/ash @ 15t/ha	143.88	13.2	18.99
Green waste @ 15t/ha + Lime @ 5t/ha	135.82	13.1	17.79
Green waste @ 15t/ha + Lime @ 5t/ha + Mill mud/ash @ 30t/ha	133.94	13.10	17.55
Green waste @ 15t/ha	134.86	13.65	18.41

Soil health benefits

The SRA Soil Health Extension Toolkit was used to calculate gravimetric moisture, volumetric moisture using bulk density % and penetration depth of the soil.

Groper Creek site:

Harvest date- 24/8/22 Sample date- 29/8/22

Treatment	Gravimetric moisture %	Volumetric moisture using bulk density %	Penetration depth (cm)
Control- top	8.108108	10.23115	4.51
Control- bottom	10.70336	13.2626	
Green waste- top	9.230769	12.50474	4.93
Green waste- bottom	10.30393	13.16787	
Mill mud- top	6.074074	7.768094	8.61
Mill mud- bottom	13.50826	13.16787	
Compost A- top	6.329114	7.578628	6.94
Compost A- bottom	14.18376	15.06252	
Compost B- top	5.782575	7.104964	4.54
Compost B- bottom	17.67029	16.95718	

Kilrie site:

Harvest date- 28/9/22 Sample date- 28/9/22

Treatment	Gravimetric moisture %	Volumetric moisture using bulk density %	Penetration depth (cm)
Control- top	6.362922	7.673361	6.75
Control- bottom	8.177905	10.79955	
Green waste- top	3.961196	4.64191	9.19
Green waste- bottom	7.900677	9.94695	
Mill mud- top	7.092199	9.473285	5.98
Mill mud- bottom	6.911765	8.904888	
Green waste + Easy N	6.68626	8.62069	6.95
Green waste + Easy N	8.464849	11.17848	

In the Herbert trials high levels of mycorrhizal fungi populations were observed where the green waste treatments were applied, when compared to the untreated areas.

Photo 18. Mycorrhizal fungi observed in the green waste material applied in the Herbert.

Application issues

One of the significant challenges transporting the green waste to farm was the low bulk density of the product, hence impacting on pay load capacity and cost to transport the product. An example was for the truck used to cart to the Pace and Zatta, Bambaroo sites was a 24 cubic meter trailer which could carry only 6.6t of product.

Photo 19. Truck transporting the green waste to the Zatta, Bambaroo site.

Conclusions

Burdekin

Overall, there were no significant trends that could be seen between any of the trial sites Individually there were significant differences between treatments, however these did not translate when compared to the other trial sites. The different sites all yielded different results when comparing green waste to control. Different treatments did better in different areas within the Burdekin. A site and treatment that was of particular interest was Kilrie, where the Greenwaste + Easy N performed much better than all the other treatments. There is no clear evidence to suggest why this could be, further investigation is needed to draw conclusions. It is theorised that the green waste plots will perform better in the coming years as the materials are given a chance to break down and become available to the plants.

These trials requires more years of study and possibly more trial sites to draw any definitive conclusions. BPS and the participating growers are interested in further investigating the progress of the trial sites beyond the life of this project.

Herbert

At the Pace, Bambaroo site the green waste treatment had the highest cane yield (t/ha) and tonnes of sugar/hectare. All treatments compared to the control treatment had higher cane and sugar yields, expect the poultry biodigester treatment in plant cane that had the lowest sugar yield.

At the Zatta, Bambaroo site the control treatment had the lowest cane yield compared to all other treatments. The green waste treatment @ 15t/ha had the highest sugar yield.

In the Herbert application of any ameliorant had a positive impact on cane yield. This may be attributed to increases in soil moisture and an increase in soil carbon. Both Herbert sites had low organic soil carbon levels less than 1% at the commencement of the trials. The Herbert sugarcane growing region is rainfed, when compared to the Burdekin area which is flood irrigated, making moisture holding capacity more critical in the Herbert region.

HCPSL and the participating growers are interested in further investigating the progress of the trial sites beyond the life of this project.

Impacts on CCS

Lower CCS levels occurred at most sites where mill mud or mill mud/ash treatments were applied at rates greater than 75t/ha wet weight. This finding aligns with the research undertaken by Larsen et.al (2022).

Compared to the control treatments across most sites and across years there was a reduction in CCS levels when a soil ameliorant was applied, except at the Groper Creek and Haughton, Burdekin sites.

Further research is required to investigate the reason why CCS levels have declined when compared to the control treatments when soil ameliorant is applied.

Soil health benefits

The Burdekin data showed no significant differences for gravimetric moisture, volumetric moisture using bulk density % and penetration depth of the soil based on the tests using the SRA Soil Health Toolbox.

In the Herbert trials high levels of mycorrhizal fungi populations were observed where the green waste treatments were applied, when compared to the untreated areas. The increase in the populations could be attributed to the increase in organic matter being present.

At the Wilmar, Orient and Chiesa, Blackrock sites improvements in cane growth was observed in the sodic and saline areas within a cane block. This could be attributed to the increase in water holding capacity, increase in organic carbon levels and improvements in general soil structure (which was visually observed) at both sites.

As earlier indicated in the report further studies concerning the long-term impact of the soil ameliorants will be assessed in 2023 through a Soil CRC project. The findings will be made available to National Landcare when they become available.

Challenges going forward

Shire Councils will continue to have issues with the collection, handling and disposal of green waste from their waste collection sites. The low bulk density of green waste makes it expensive to transport product any considerable distance because high truck payloads cannot be achieved. Based upon this study it will not be viable to transport green waste to farms outside of a 50km radius from the waste station site; hence making it unviable for Townsville City Council to supply green waste to the sugarcane industries in the Herbert and Burdekin sugarcane growing regions. There are opportunities for both Hinchinbrook and Burdekin Shire Councils to investigate options to dispose of green waste in their respective districts.

Shire Councils in sugarcane producing districts will also be competing with mill mud and mill ash from sugarcane mills, being supplied to farmers in terms of cost of product delivered on farm. Hence shire councils may need to consider subsidising the cost to disposed of green waste in some districts to prevent this product entering landfill. Because sugar in a low-price commodity crop, it maybe worth shire councils consider value adding to the green waste or supplying the product into higher value crop industries like tree crops and horticulture.

The other significant challenge faced is the contaminants and impurities found in green waste products. The nations farms are not the dumping grounds for contaminated green waste products, so specific attention is required to ensure that these products are free of contaminants and impurities. To ensure that green waste is “clean” Shire Councils will need to physically separate products entering their waste station sites and provide education of the general public of the issues.

There are some opportunities for Shire Councils and the sugarcane industry to work together to better utilised green waste streams into the future. These opportunities should be undertaken on a case-by-case basis when it is feasible to do so.

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