Office Use Only	
Project Code	
Project Type	

FINAL REPORT 2024

Final reports must be submitted using the online application form at www.sagit.com.au with this Word document attached ***within two months*** after the completion of the Project Term.

PROJECT CODE	CAS4822
PROJECT TITLE	
On row sowing benefits on Yorke Peninsula – what are the drivers?	

PROJECT DURATION *These dates **must** be the same as those stated in the Funding Agreement.*						
Project start date	**1/07/2022**					
Project end date	**30/06/2024**					
SAGIT Funding	2022		2023		(year)	$

PRINCIPAL INVESTIGATOR *(responsible for the overall project and reporting)*		
Title:	**First Name:**	**Surname:**
Mr.	Sam	Holmes
Organisation:	**Central Ag Solutions Pty. Ltd.**	
Mailing address:		
Telephone:		**Email:**
Mobile:		

ADMINISTRATION CONTACT DETAILS *(responsible for all administrative matters relating to project)*		
Title:	**First Name:**	**Surname:**
Organisation:		
Mailing address:		
Telephone:		**Email:**
Mobile:		

PROJECT REPORT: *Please provide a clear description for each of the following:*

Executive Summary (200 words maximum)

Across two contrasting seasons, two replicated trials assessing crop response to applied P in either the on-row or off-row sowing position, and seven demonstration trials of sowing position have outlined significant yield benefits by sowing the crop on previous crop rows. These yield benefits have been observed for both Barley and Lentils and have translated to large PGM returns.

The mechanism of on-row sowing benefits in environments along coastal YP appear to be mainly attributed to lower surface salt levels in the soil at the on-row position. Other contributing factors could be higher starting moisture levels (these have been marginal) and lower background surface nitrate levels, important particularly for lentils.

Background and elevated soil salinity in the off-row sowing position hinders crop uptake and utilization of applied P in P deficient scenarios. The increase in salt around the seed causes emergence and early vigor effects which translates to reduced grain yields.

Salinity levels generated inherently or with fertilizer application cause greater issues with lentils compared to cereals (barley in this instance) and therefore the full benefit of overcoming lentil P deficiency is not fully obtained. SAGIT funded project ASO 03523 has supported these observations.

A detailed soil survey across coastal YP has demonstrated that around 40% of paddock zones would benefit from on-row sowing using Lentil salinity thresholds.

Project objectives

This project will aim to provide growers in coastal areas of Yorke Peninsula an understanding of the mechanisms leading to improved early crop vigor translating to increased grain yields from on or near row sowing.
Applicable areas where these soil characteristics and mechanisms exist will be surveyed and validated.

Project aims will be achieved by:
1) Demonstration of yield benefits from on or near row sowing of previous crop stubble lines under different phosphorus management programs through two replicated trials.
2) On-farm demonstration paddock trials (8) covering variations in soil type within paddock but across YP.
3) General survey of soil conditions that are present for 2022 on-row sowing vs interrow sowing across YP (50 paddocks).

Overall Performance

We believe we have achieved most of the project outcomes outlined above. The replicated trials were performed to a high standard with significant findings we believe to the industry.

Sean Mason, Agronomy Solutions was sub-contractor and assisted with trial assessments, data analysis including statistical, extension and communication activities and report writing.

We were unable to obtain grain yield data from the demonstration sites to due failures in machinery unfortunately. This is not uncommon in the precision agriculture space.

KEY PERFORMANCE INDICATORS (KPI)		
KPI	**Achieved**	**If not achieved, please state reason.**
Soil survey: 50 paddocks	Yes ☒ No ☐	
Implementation of 8 demonstration paddock scale trials	Yes ☒ No ☐	These were split across the two seasons: 2022/2023
Two replicated trials in 2022: P x sowing lines	Yes ☒ No ☐	
Progress report submitted to SAGIT	Yes ☒ No ☐	
Resowing of 2022 replicated field trials – residual effects	Yes ☒ No ☐	
Progress report submitted to SAGIT	Yes ☒ No ☐	
Final report submitted to SAGIT	Yes ☒ No ☐	
	Yes ☐ No ☐	

TECHNICAL INFORMATION (Not to exceed **three** pages)

Soil Survey:

50 paddocks were surveyed prior to the 2022 growing season along the western and eastern coasts of Yorke Peninsula with a selection of samples slightly more inland. In each paddock 0-10cm samples were taken either on 2021 sowing lines (labelled as On) or off/interrow 2021 sowing lines (labelled as Off) and fully characterized. Previously a document labelled 'Survey visual summary' was submitted to SAGIT which outlined locations of each sample and a comparison of important soil properties in on vs off row sowing positions. This document will be submitted again with the final report. Summary of results is presented in table 1 with simple one-way Anova analysis using sowing line as the single factor. Soil properties that generated an overall significant difference ($p < 0.05$) between sowing positions were Nitrate N (lower on), Colwell P (higher on) and salinity/EC (lower on). Benefits of on-row sowing have previously been allocated to increased soil moisture levels assisting establishment but while there was an overall increase in soil moisture (0.8%) in the on-row position it wasn't significant ($p < 0.05$) across the 50 paddocks.

In a snapshot of main on row soil drivers of yield importantly the soil survey revealed 24 paddocks (48%) had EC levels higher than the replicated field site labelled Anna Binna and 21 of these sites (42%) had soil salinity levels > 0.1 dS/m in the off-row sowing position compared to on row.

Table 1: Mean (50) comparison of selected soil properties in the off/interrow vs on/in row sowing position across coastal YP paddocks.

2021 Sowing line	pH CaCl2	Gravimetric moisture (%)	Nitrate - N (mg/kg)	Ammonium - N (mg/kg)	Soil Surface N (kg/ha)	Colwell P (mg/kg)	PBI	DGT-P (ug/L)	EC 1:5 (dS/m)
Off	7.72	10.1	60	2.4	87	41	131	60	0.50
On	7.69	10.9	27	2.1	40	55	140	74	0.33
P value	0.587	0.172	<0.001		<0.001	<0.001	0.315	0.196	0.022
LSD	NS	NS	8.53		12.3	7.65	NS	NS	0.138

Demonstration Sites:

A total of seven demonstration sites were established across western and eastern coasts of YP, three in 2022 and four in 2023. Growers were encouraged to run strips of crop sown in previous stubble lines in comparison with an adjacent run of crop sown on the interrow. The majority of demonstration sites were sown to lentils with one sown to barley and another sown to wheat in 2023. All demonstration sites were characterized by soil characteristics on and off row in two production zones (low vs high) as indicated by previous season NDVI or yield maps. Soil samples were segmented in three intervals (0-5, 5-10, 10-20cm) to check for stratification. Combined selected soil characteristics

from the demonstration sites demonstrate similar traits to the soil survey results (Table 2). In summary:

- Moisture is higher in the on-row sowing position particularly at the surface (0-5cm)
- Nitrate N levels are higher in the off-row position and concentrated at the surface (05cm)
- Soil salinity is concentrated at the surface but decreases in the on-row sowing position.
- Low production zones are linked to higher soil salinity in combination with lower available P levels.

We were able to access four of these demonstration trials early enough in the season to perform emergence counts and NDVI assessments at each GPS located zone in adjacent trial runs of on-row and off-row positions. All the data was taken in paddocks sown to lentils. We couldn't access a couple of trial sites due to quarry issues and accelerated growth stages in season 2023. Emergence counts were taken at 10 independent positions in each zone using 30cm rulers and 10 independent runs were performed at the width of the seeder. In summary two sites (site 2 in 22 and site 1 in 23) had significant positive benefits of on-row sowing in terms of emergence which translated to early biomass responses as measured by NDVI in both low and high production zones (Table 3). Site 1 in 2023 revealed a significant sowing x zone interaction. No positive benefits of Site 1 in 2022 were possibly due to very low lentil growth and site 2 in 2023 was allocated on relative low soil salinity levels < 0.3 dS/m.

Table 2: Mean selected soil characteristics from seven paddock demonstration sites for on and off-row sowing positions, at two depths (0-5, 5-10cm) taken in high and low production areas of the paddocks.

		Moisture	Nitrate - N	PBI	DGT-P	EC 1:5	Ece
Sample ID	Depth (cm)	%	mg/kg		µg/L	dS/m	dS/m
Off High	0-5	12.3	86	104	95	1.14	10.64
On High	0-5	13.8	49	112	125	0.53	5.11
Off Low	0-5	13.8	90	149	40	1.42	13.36
On Low	0-5	14.6	43	135	78	0.56	5.13
Off High	5-10	13.6	36	123	67	0.46	4.34
On High	5-10	13.9	21	123	78	0.26	2.34
Off Low	5-10	14.9	45	146	23	0.68	6.26
On Low	5-10	15.9	24	153	43	0.41	3.71

Table 3: Mean (10) lentil emergence counts and early biomass yields as assessed by NDVI for four demonstration sites assessing effects of on-row and off-sowing in designated low and high production zones of the paddock.

Site		2022 Site 1		2022 Site 2		2023 Site 1		2023 Site 2	
Zone	Sowing Position	Emergence	NDVI	Emergence	NDVI	Emergence	NDVI	Emergence	NDVI
High	Off	20.3	0.213	5.1	0.208	13.6	0.28	18.6	0.38
High	On	20.6	0.220	12.4	0.247	20.8	0.32	21.9	0.34
Low	Off	16.6	0.183	7.5	0.198	19.9	0.17	20.5	0.42
Low	On	19.0	0.198	10.6	0.220	18.6	0.21	23.5	0.42
	P value								
	Zone	0.03	0.004	0.777	0.071	0.08	<.001	0.21	<.001
	Sowing Position	0.241	0.154	<.001	0.005	0.01	<.001	0.03	0.02
	Zone x Sowing position	0.391	0.621	0.069	0.397	<.001	1	0.93	0.06
	LSD								
	Zone	2.352	0.016	NS	NS	NS	0.02	NS	0.02
	Sowing Position	NS	NS	2.235	0.02	2.29	0.02	2.76	0.02
	Zone x Sowing position	NS	NS	NS	NS	3.24	NS	NS	NS

Replicated Trials

Two replicated response trials were performed across two seasons assessing the response of barley and lentil to applications of P (as MAP) applied with the seed in either the 2021 seeding row position or interrow of the 2021 crop. Both sites were deficient in P as measured by DGT P in 2021 driven by high PBI values (163-167 at Anna Binna and 180-190 at Thiepvale) with the presence of Calcium Carbonate (see previous project progress report supplements). Sowing position did not have a significant effect on soil P properties, but the on-row sowing position had significantly higher soil salinity levels. Other significant effects were higher moisture (0.6-0.9%) and low soil Nitrate levels in the on-row sowing position. Five different rates of P were randomized across four replicate bays. The difficulty of generating on and off-row sowing lines with a small plot seeder meant that these were not randomized across bays but were randomized across rows. In 2023 Barley was sown on Lentils with the same sowing position x P rates at the moderate saline site called Anna Binna with Lentils sown on Barley at the high saline site labelled Thiepvale.

Summary of both site yield data with applied P either on-row or off-row is presented in Table 4. Both lentil and barley had significant yield gains associated with on row sowing compared to off row in each season. Barley yields also responded to applied P, although the interaction between sowing position and applied P was not significant. At the moderately saline site of Anna Binna the optimal P rate for the on-row sowing position was 20 kg P/ha which generated a combined yield increase of 1.42 t/ha; i.e. total yield of 6.01 t/ha at 20P vs 4.59 t/ha at 0P (Lentil + Barley combined yields). The optimal P rate in the off-row sowing position was > 50 kg P/ha generating a response of 1.64 t/ha (6.03 t/ha at 50P vs 4.29 t/ha at 0P) but lower P rates were ineffective. Difference in combined yield across the two seasons with P rate for sowing position ranged from 0.2-1.7 t/ha. There was no positive P effect in the off-row sowing position for Lentils. Similar trends were observed at the higher saline site (Thiepvale) with strong responses to P for the Barley phase in the on-row sowing position but no responses for lentils to applied P in either sowing position. Optimal P rates were 20 kg P/ha for both sowing positions with on-row sowing benefits ranging from 0.4-1.46 t/ha across P rates for combine barley and lentil yields.

Table 4: Mean grain yields for both sites with increasing P rates applied with the seed in either the on-row and off-row sowing position across two seasons with a lentil/barley or barley/lentil rotation.

Anna Binna: On Row EC 1:5 = 0.28, Off Row EC 1:5 = 0.45											
	2023 Sowing				2022 Sowing				Total		
Lentils (t/ha)	On	Off	Diff	Barley t/ha	On	Off	Ave P rate Barley t/ha	Diff	On	Off	Diff
0P	1.11	1.13	-0.02	0P	3.48	3.27	3.38 [a]	0.21	4.59	4.39	0.20
10P	1.30	0.97	0.33	10P	4.12	3.62	3.87 [b]	0.50	5.42	4.59	0.83
20P	1.42	0.75	0.67	20P	4.59	3.56	4.08 [b]	1.03	6.01	4.31	1.70
30P	1.05	0.64	0.41	30P	4.66	3.80	4.23 [b]	0.86	5.72	4.44	1.27
50P	0.85	0.93	-0.07	50P	4.94	5.10	5.02 [c]	-0.16	5.80	6.03	-0.23
Average t/ha Sowing	1.146*	0.884**			4.358[a]	3.87[b]					

$LSD_{p<0.007}$ Average sowing position lentils = 0.26 $LSD_{p<0.05}$ Average sowing position barley = 0.3

$LSD_{p>0.05}$ Average P rate lentils = NS $LSD_{p<0.05}$ Average P rate barley = 0.47

Interaction of sowing position x P rate was NS for both crops

Theipvale: On Row EC 1:5 = 1.24, Off Row EC 1:5 = 3.33												
	2023 Sowing				2022 Sowing				Total			
Barley (t/ha)	On	Off	Ave P rate Barley t/ha	Diff	Lentils (t/ha)	On	Off	Diff	On	Off	Diff
0P	1.50	1.31	1.40 [a]	0.19	0P	1.42	1.04	0.38	2.92	2.35	0.57
10P	2.04	1.82	1.93 [b]	0.23	10P	1.49	1.31	0.18	3.53	3.12	0.40
20P	2.67	2.26	2.47 [c]	0.40	20P	1.42	1.24	0.17	4.08	3.51	0.58
30P	2.51	2.32	2.41 [c]	0.19	30P	1.34	1.02	0.31	3.84	3.34	0.50
50P	2.90	2.26	2.58 [c]	0.64	50P	1.47	0.64	0.82	4.36	2.90	1.46
Average t/ha Sowing	2.32*	1.99**				1.42[a]	1.05[b]				

$LSD_{p<0.015}$ Average sowing position barley = 0.26
$LSD_{p<0.001}$ Average sowing position lentils = 0.185
$LSD_{p<0.001}$ Average P rate barley = 0.411
$LSD_{p>0.05}$ Average P rate lentils = NS
Interaction of sowing position x P rate was NS for both crops

Investment in new machinery aside there is very little expenditure associated with manipulating sowing lines to best capture soil conditions that could increase crop performance through reduced salinity effects, effective utilization of P fertilizer and potentially greater moisture. Large inputs in P fertilizer can be a large investment and therefore it is important to place the results outlined in Table 4 in terms of Partial Gross Margins (PGM) across the two seasons of rotations and cumulative inputs. At both sites large increases in PGM were observed with greater returns made from on-row sowing at the moderately saline site. Improved returns from P inputs were made in the on-row sowing position compared to off-row where you went backwards in PGM. At the higher saline site increases in PGM were both made by on-row sowing and P inputs, but this was mainly driven by the barley phase.

Table 5: Calculated Partial Gross Margins generated at each P rate by sowing position for combination of barley and lentil grain yields. Prices were set out to those applicable for the 2023 season with MAP of $1000/t, Barley at $350/t and Lentil at $800/t.

Anna Binna			
Applied P	PGM ($/ha) Barley 22/Lentil 23		
kg/ha	On Row	Off Row	Difference
0	$1,898	$1,848	$49
10	$2,147	$1,737	$410
20	$2,288	$1,452	$836
30	$1,921	$1,342	$579
50	$1,663	$1,767	-$104

Theipvale			
Applied P	PGM ($/ha) Lentil 22/Barley 23		
kg/ha	On Row	Off Row	Difference
0	$1,570	$1,214	$356
10	$1,780	$1,571	$209
20	$1,906	$1,650	$256
30	$1,795	$1,490	$306
50	$2,012	$1,169	$843

CONCLUSIONS REACHED &/OR DISCOVERIES MADE (Not to exceed **one** page)

Across two contrasting seasons, two replicated trials assessing crop response to applied P in either the on-row or off-row sowing position, and seven demonstration trials of sowing position have outlined significant yield benefits by sowing the crop on previous crop rows. These yield benefits have been observed for both Barley and Lentils and have translated to large PGM returns.

The mechanism of on-row sowing benefits in environments along coastal YP appear to be mainly attributed to lower surface salt levels in the soil at the on-row position. Other contributing factors could be higher starting moisture levels (these have been marginal) and lower background surface nitrate levels, important particularly for lentils.

Background and elevated soil salinity in the off-row sowing position hinders crop uptake and utilization of applied P in P deficient scenarios. The increase in salt around the seed causes emergence and early vigor effects which translates to reduced grain yields.

Salinity levels generated inherently or with fertilizer application cause greater issues with lentils compared to cereals (barley in this instance) and therefore the full benefit of overcoming lentil P deficiency is not fully obtained. SAGIT funded project ASO 03523 has supported these observations.

A detailed soil survey across coastal YP has demonstrated that around 40% of paddock zones would benefit from on-row sowing using Lentil salinity thresholds.

INTELLECTUAL PROPERTY

Not applicable

APPLICATION / COMMUNICATION OF RESULTS

Sean Mason presented these findings to an Elders agronomy meeting held at Waite campus on the 5th of February 2024.

Sam Holmes presented to the Mallala Ag Bureau on 10th April 2024

Sam Holmes presented to the Central Ag Solutions Grower Update on 10th April 2024

Sam Holmes presented recently at the 2024 SAGIT annual update.

Sean Mason use project data in a series of workshops (3) on EP held by Elders and supported through an MSF led FDF Extension and Adoption Project

As previously reported Sam Holmes ran tours of the trial site in 2023 to Nutrien Agronomists on the 6th September, Petersville Ag Bureau on the 20th September, Nutrien Minlaton Growers Crop Walk 15th September, Central Ag Solutions Grower Crop Walk on the 8th September.

In the 2022 year field inspection days were conducted through the season with Weavers, South Kilkerran and Petersville Ag Burea all attending at different times during the spring. There was also a field day for agronomists from South Australian Nutrien branches. Central Ag Solution also conducted a field day where farmers attended. Throughout the season approximately 125 farmers and agronomists attended the two replicated trial sites where discussions on the practicality and benefits were had.

While this activity doesn't fall in the project window, 2024 trial sites under the new project will be visited by the Independent Consultants Group in the last week of August where these project outcomes will be addressed.

With the complete two seasons of results, we will aim to communicate the results through farmer group compendiums in 2024.

POSSIBLE FUTURE WORK

There have been several questions raised from this initial project that we would like to answer and potentially have significant industry impact.

Briefly these are:

1) How long do residual on-row sowing benefits last? We have seen two season accumulation effects so far.
2) Fertilizer strategies for cereal/pulse rotation. We have shown that lentils are susceptible to induced salt through fertilizer applications so can we safely build up P reserves in the cereal phase for benefits in the lentil phase the following season?
3) Appropriate fertilizer placement strategies for overcoming P deficiency in moderately saline soils if on-row sowing isn't an option.

We are thankful to the continued support of SAGIT with co-funding from GRDC that these questions will be answered with trial work scoped out in the new investment CAS 05724 – Appropriate fertilizer strategies for on-row sowing in saline soils

On row sowing benefits on Yorke Peninsula – what are the drivers?

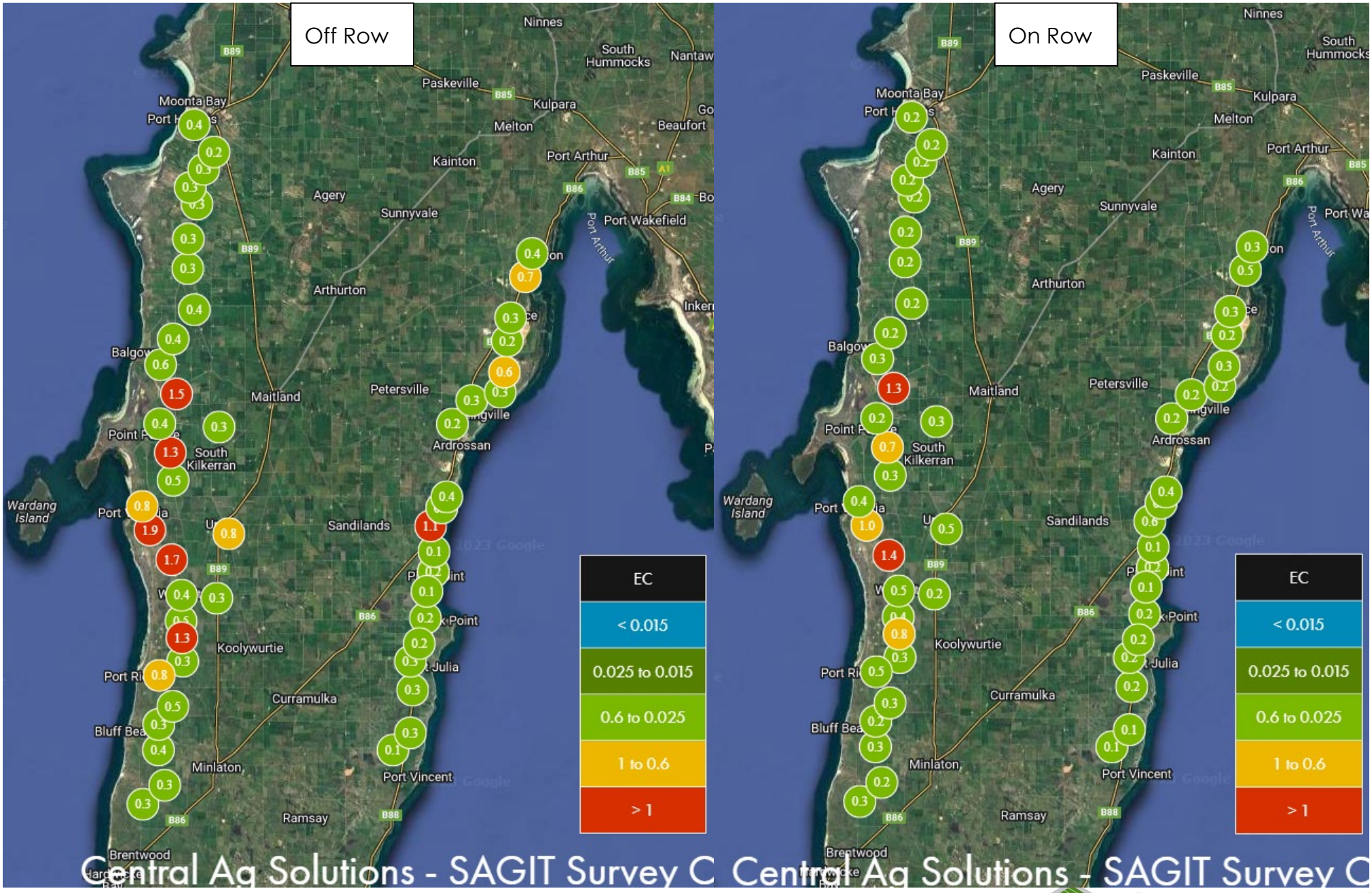
Summary of the survey results – on row vs off row characteristics of 50 paddocks on coastal YP

AGRONOMY SOLUTIONS CAPABILITY STATEMENT

Agronomy Solutions is a private, independent company providing agricultural research, education and advice in the area of soils and plant nutrition. Our service extends to industry, partner research organisations, universities, agronomists, advisers and growers.

The company endeavours to ensure that quality research outcomes and extension are delivered to improve the agricultural industries knowledge and integrity.

For further information on our recent work and capabilities please visit www.agronomysolutions.com.au


Off Row
On Row
EC
< 0.015
0.025 to 0.015
0.6 to 0.025
1 to 0.6
> 1
Moonta Bay
Paskeville
Kulpara
Melton
Beaufort
Kainton
Port Arthur
Agery
Sunnyvale
Port Wakefield
Arthurton
Balgowan
Maitland
Petersville
Ardrossan
South Kilkerran
Wardang Island
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Point Julia
Koolywurtie
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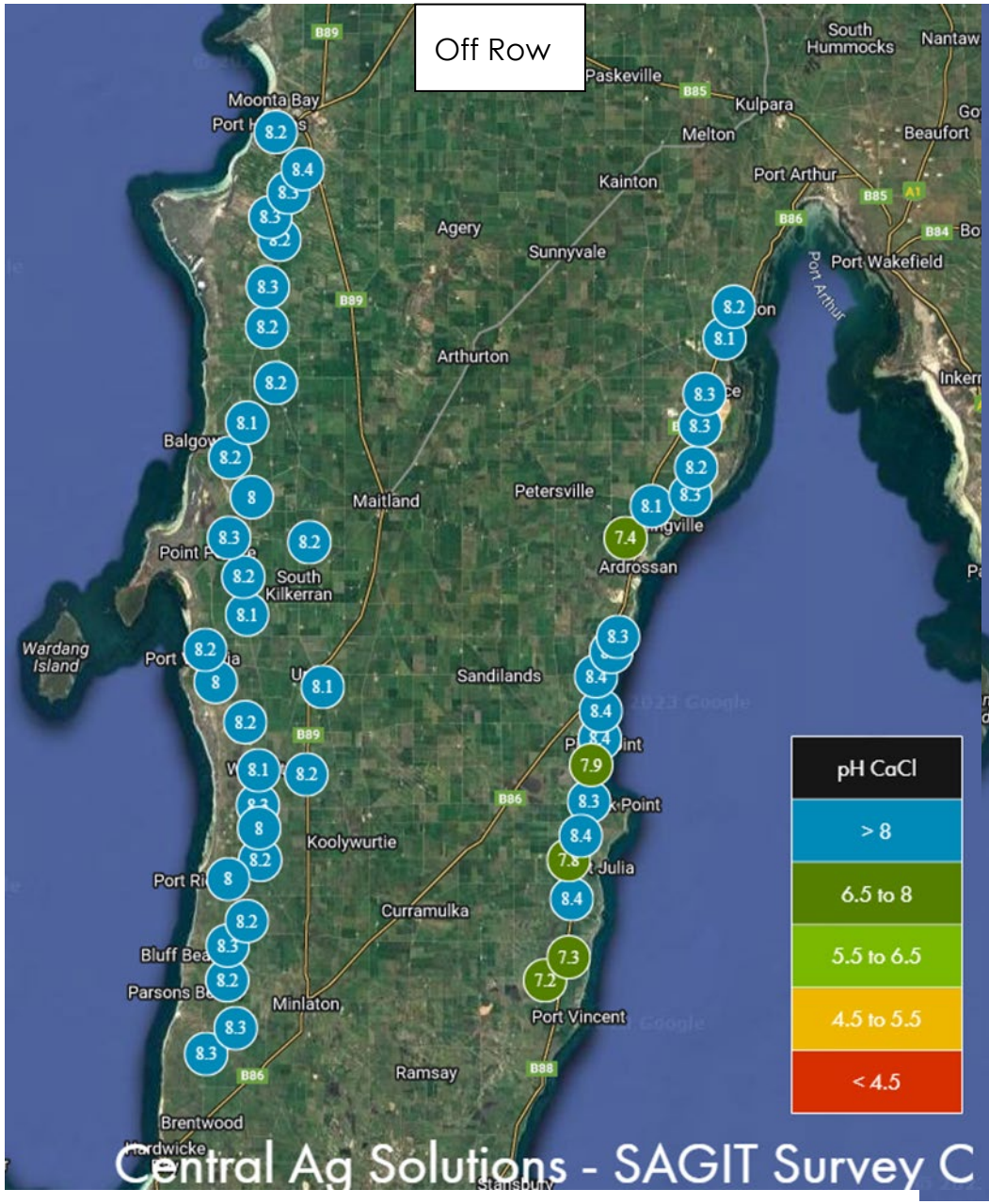
Minlaton
Port Vincent
Ramsay
Brentwood
Central Ag Solutions - SAGIT Survey C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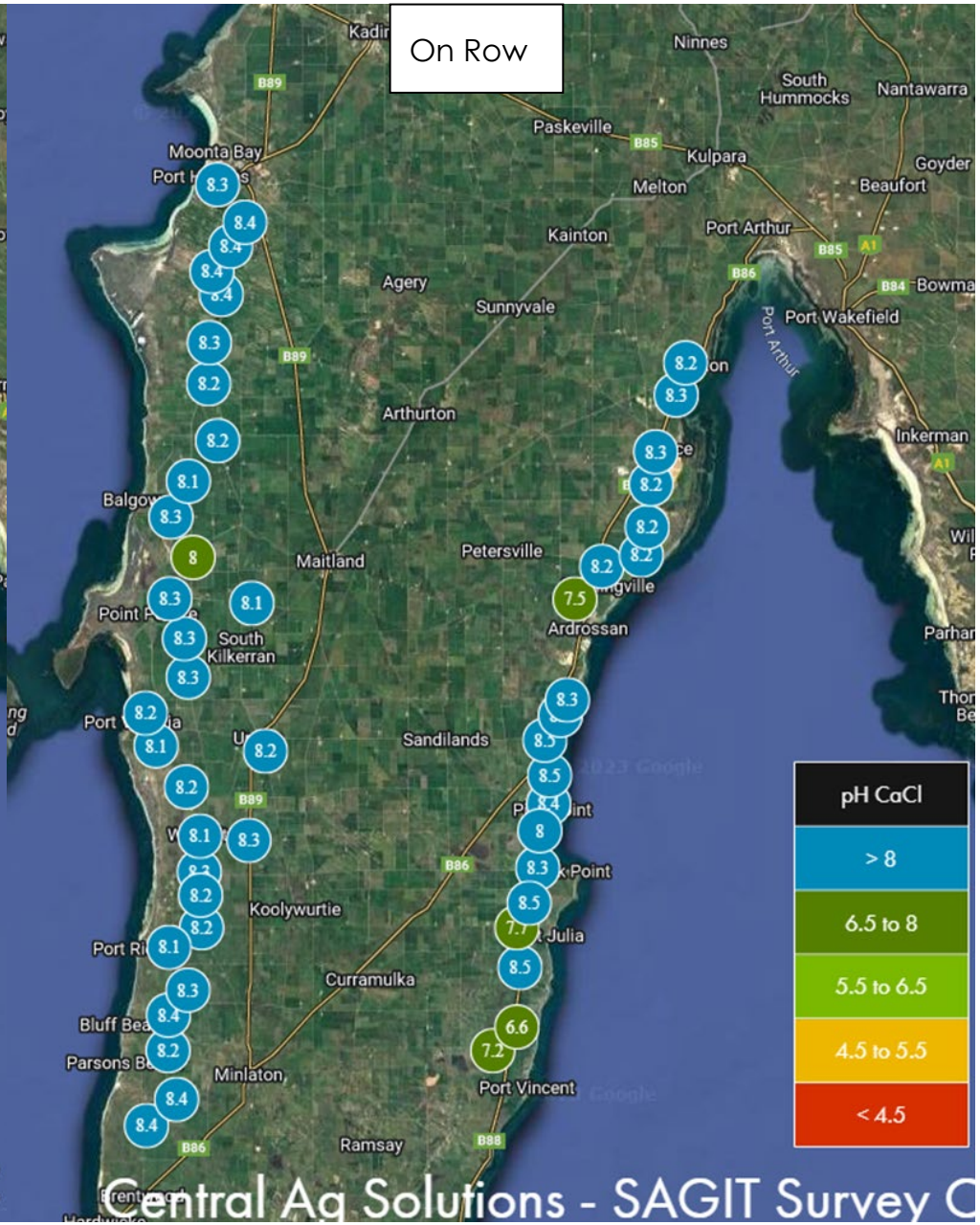
6.5 to 8
5.5 to 6.5
4.5 to 5.5
< 4.5
Central Ag Solutions - SAGIT Survey C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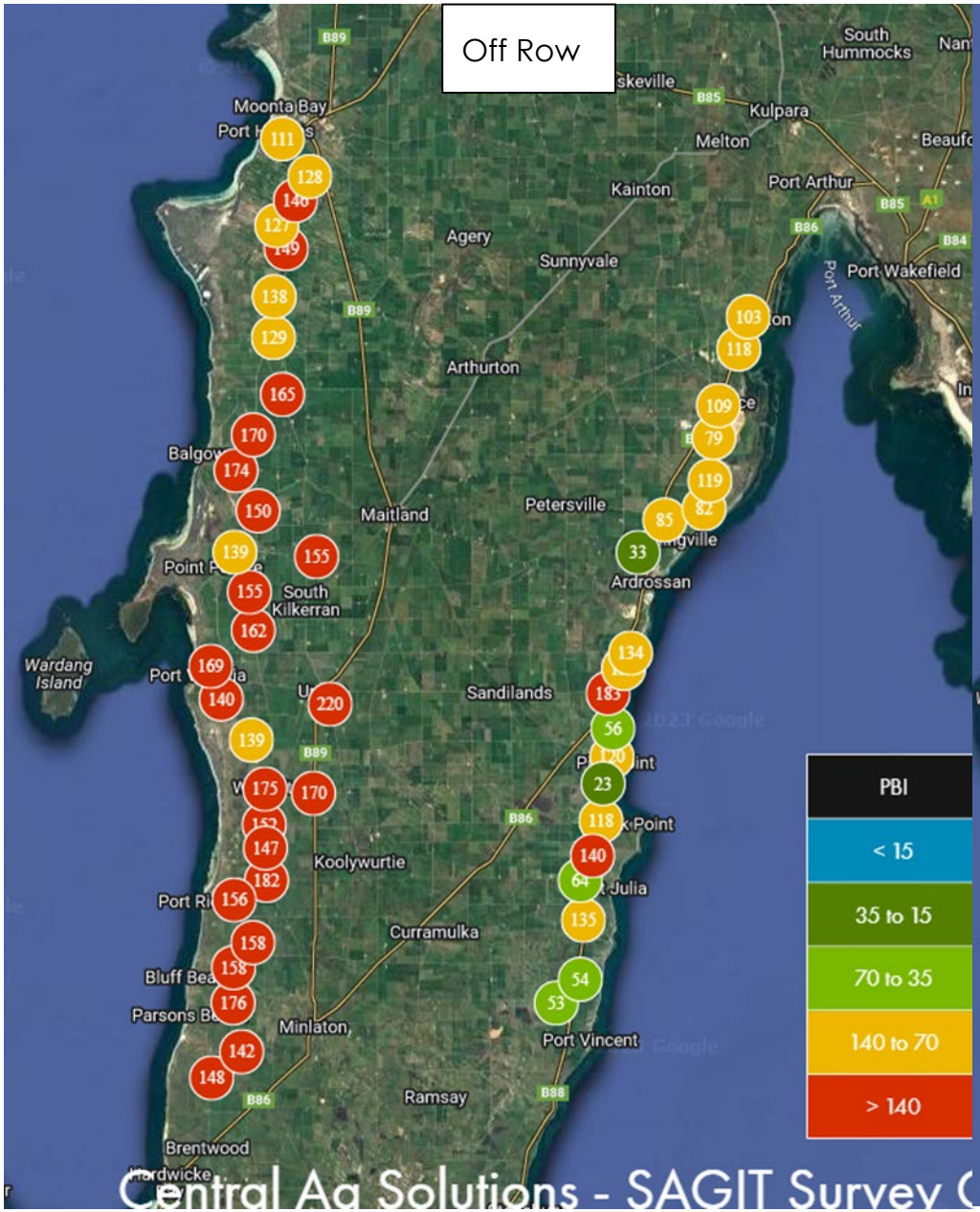
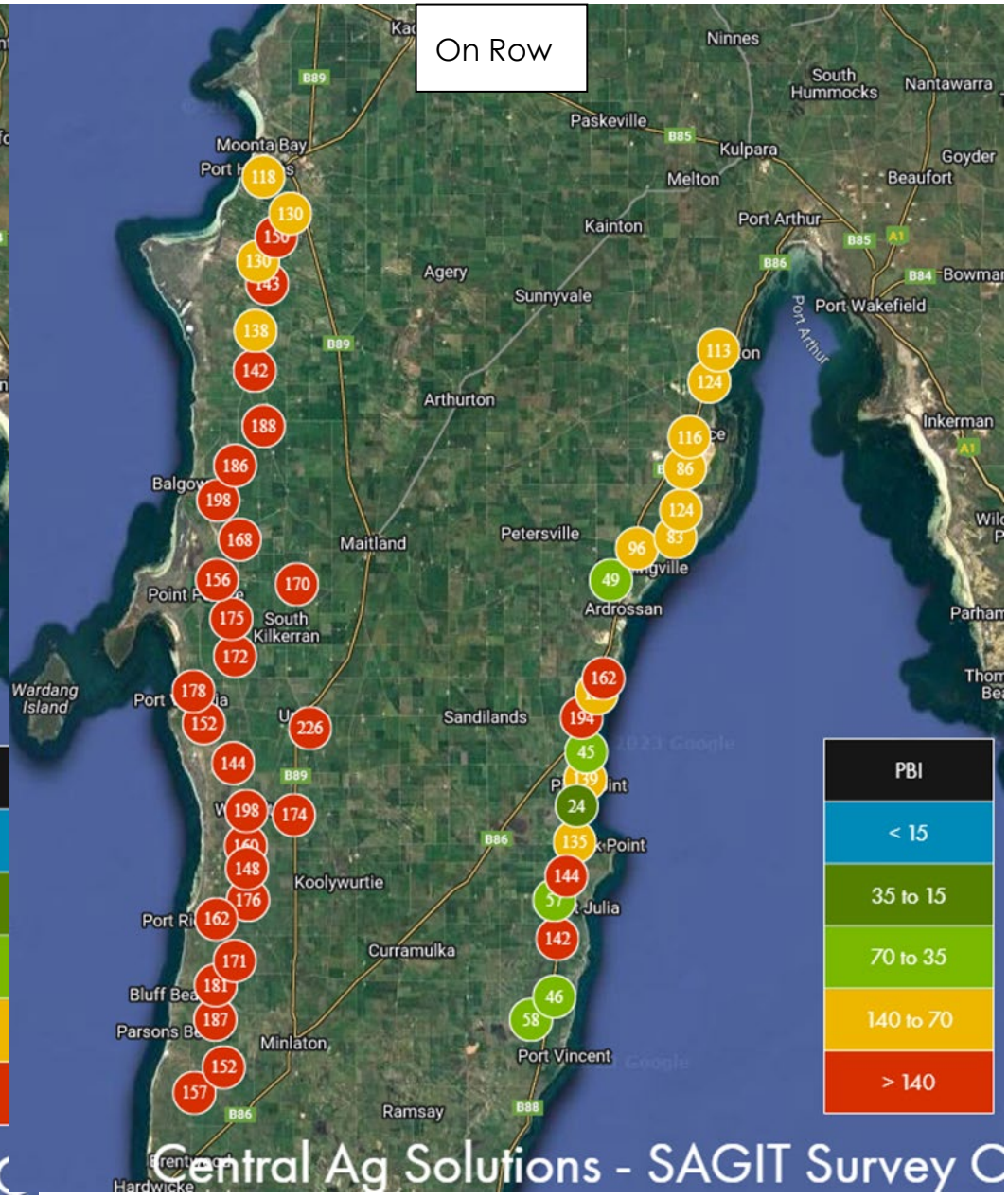
5.5 to 6.5
4.5 to 5.5
< 4.5
Central Ag Solutions - SAGIT Survey C


Off Row
PBI
< 15
35 to 15
70 to 35
140 to 70
> 140
Central Ag Solutions - SAGIT Survey


On Row
PBI
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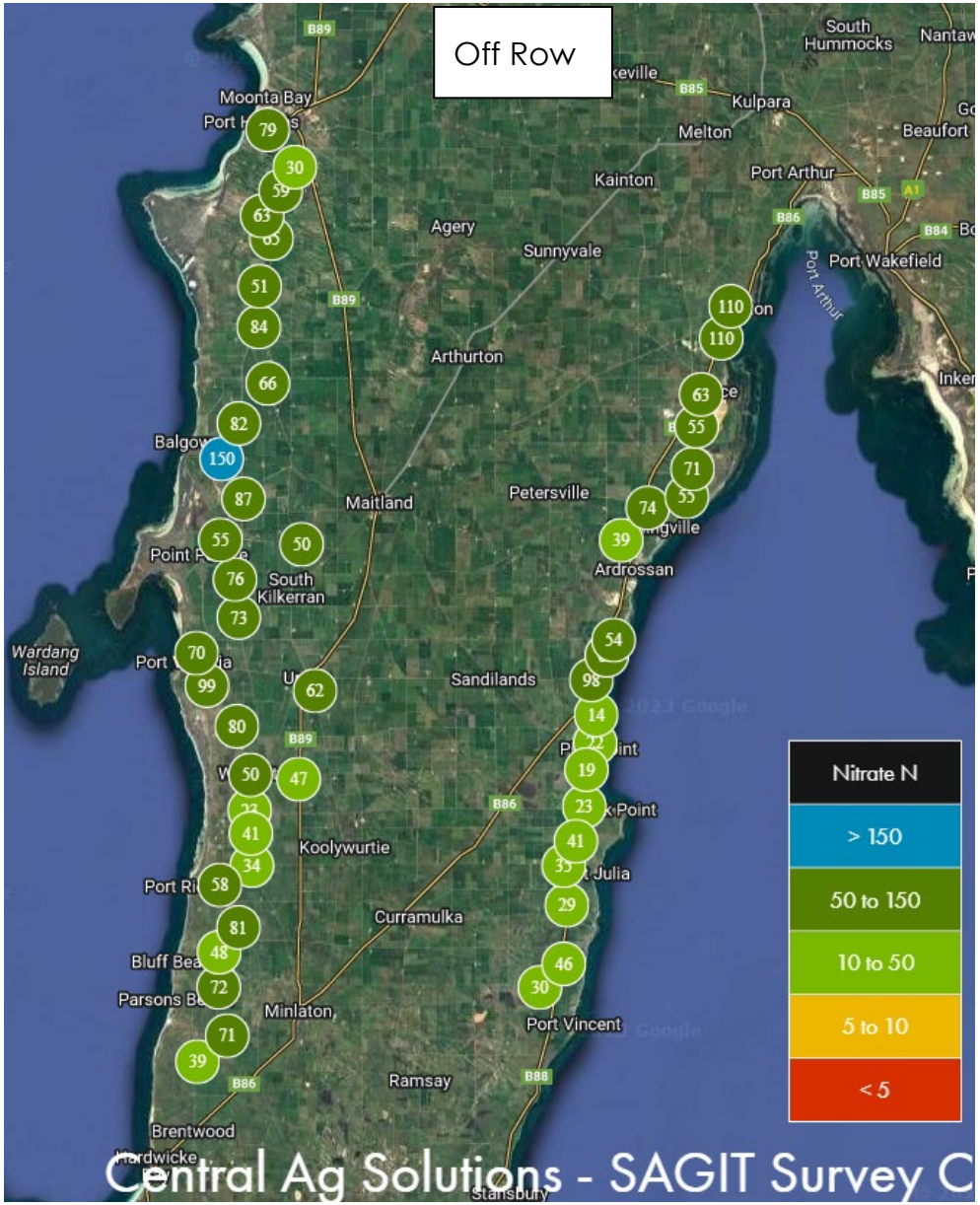
35 to 15
70 to 35
140 to 70
> 140
Central Ag Solutions - SAGIT Survey


Off Row
Nitrate N
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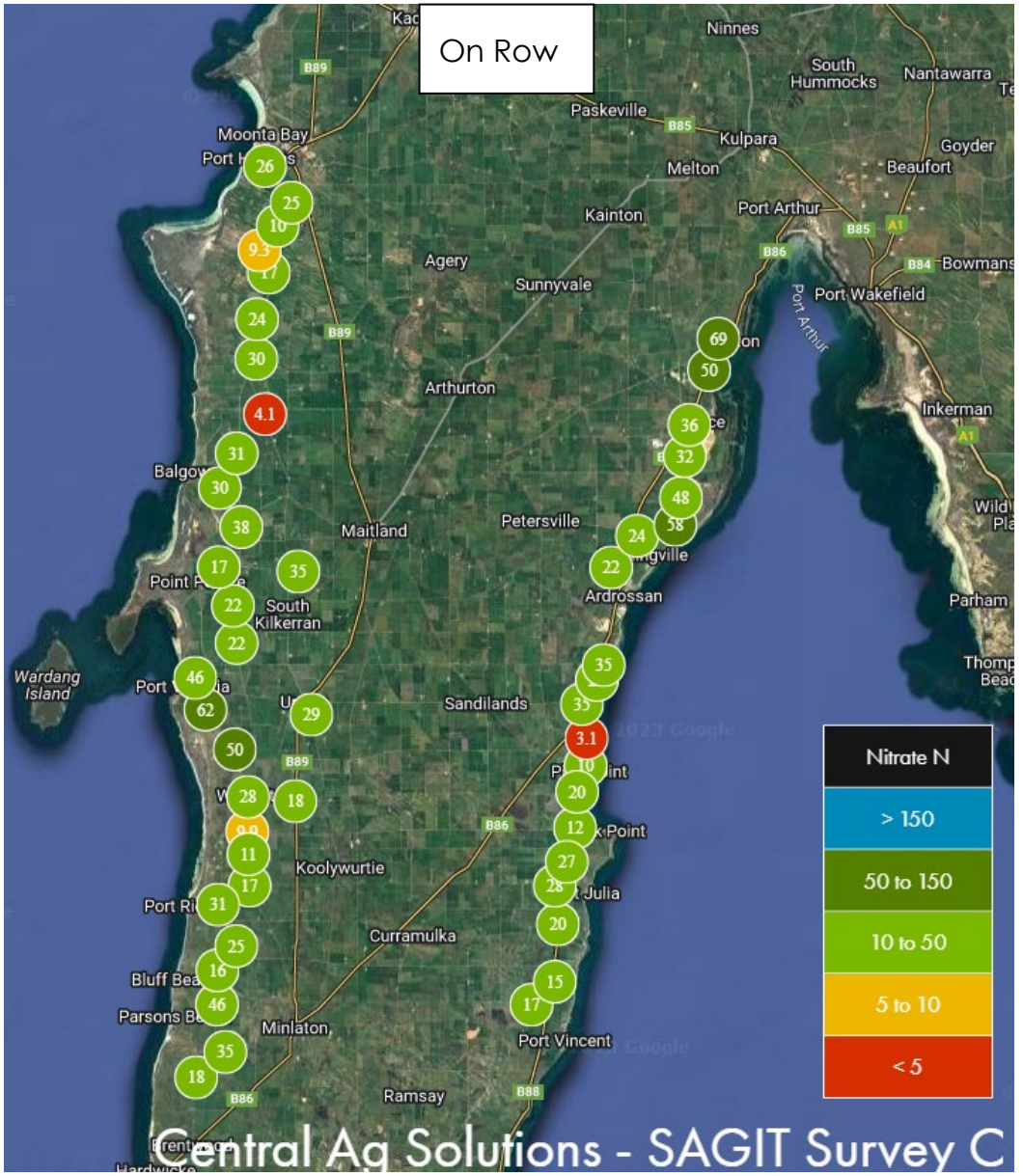
50 to 150
10 to 50
5 to 10
< 5
Central Ag Solutions - SAGIT Survey C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10 to 50
5 to 10
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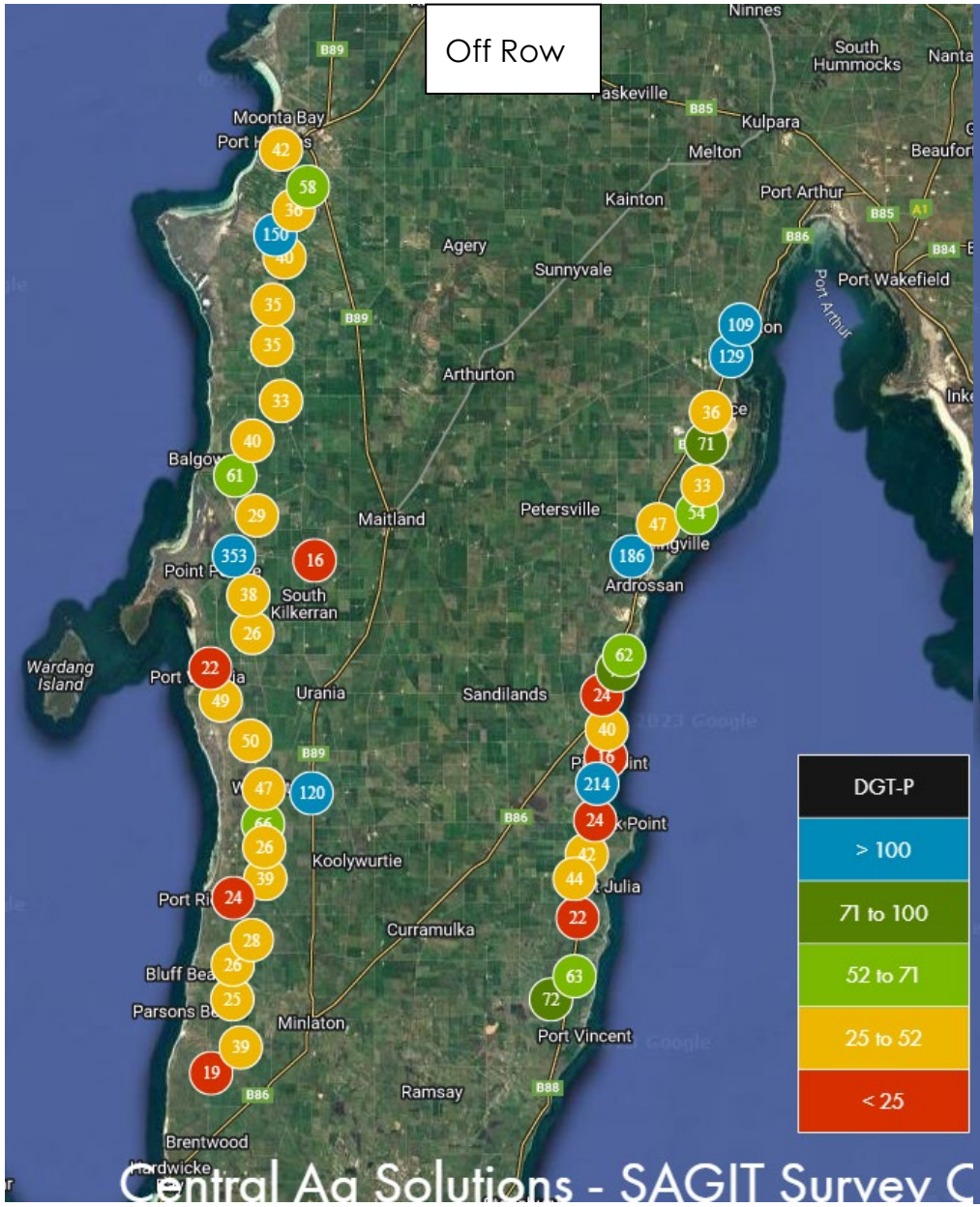
Off Row
DGT-P
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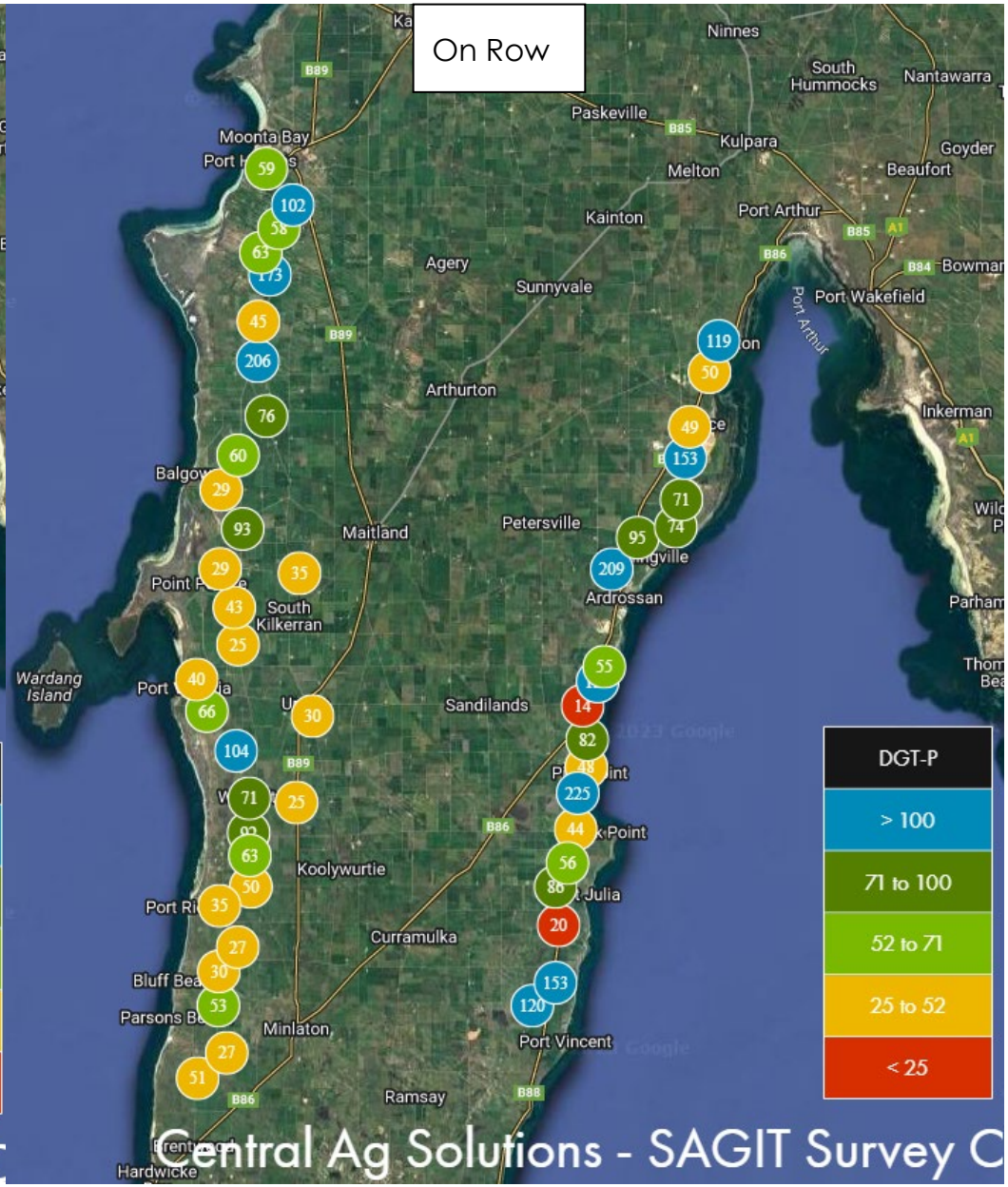
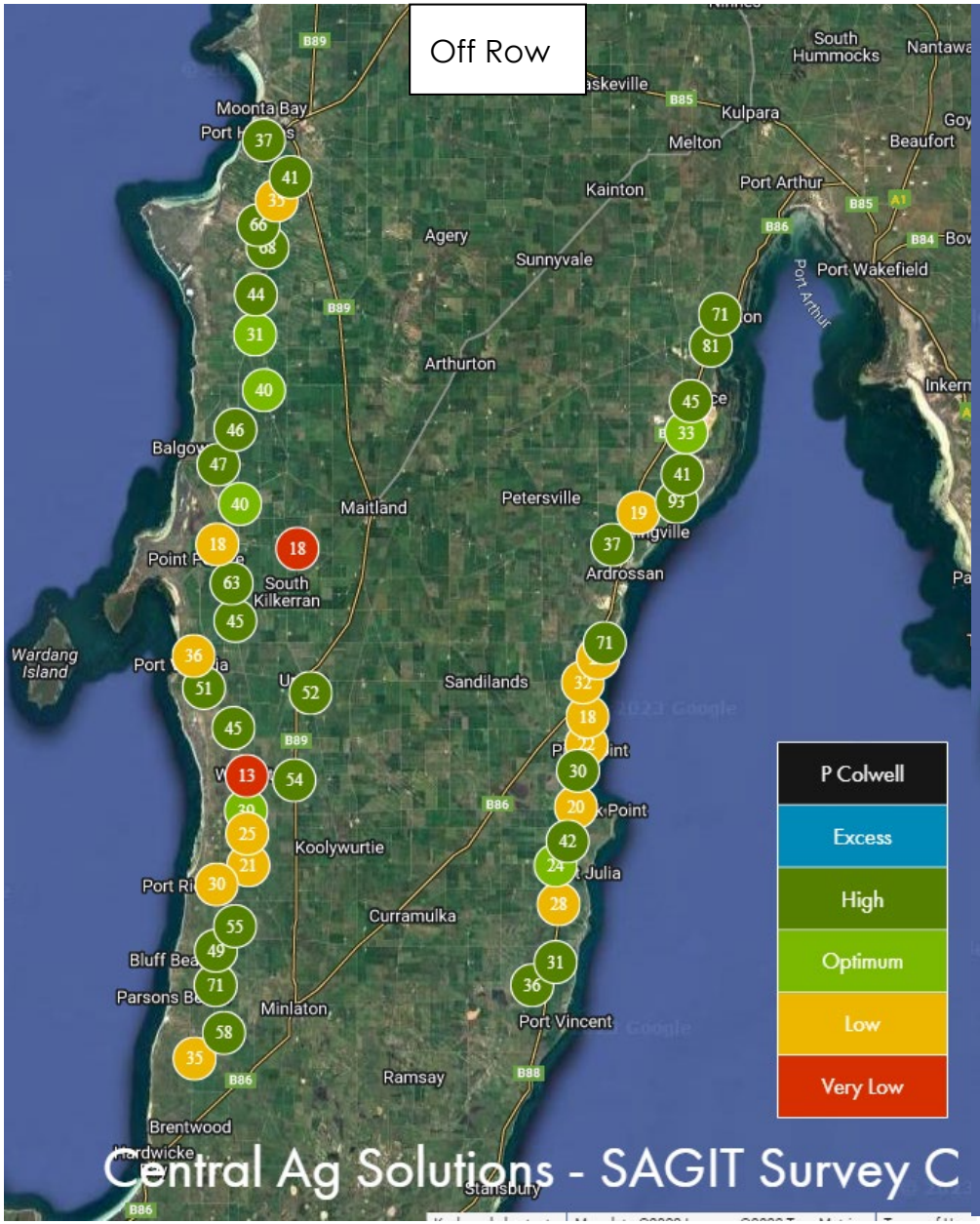
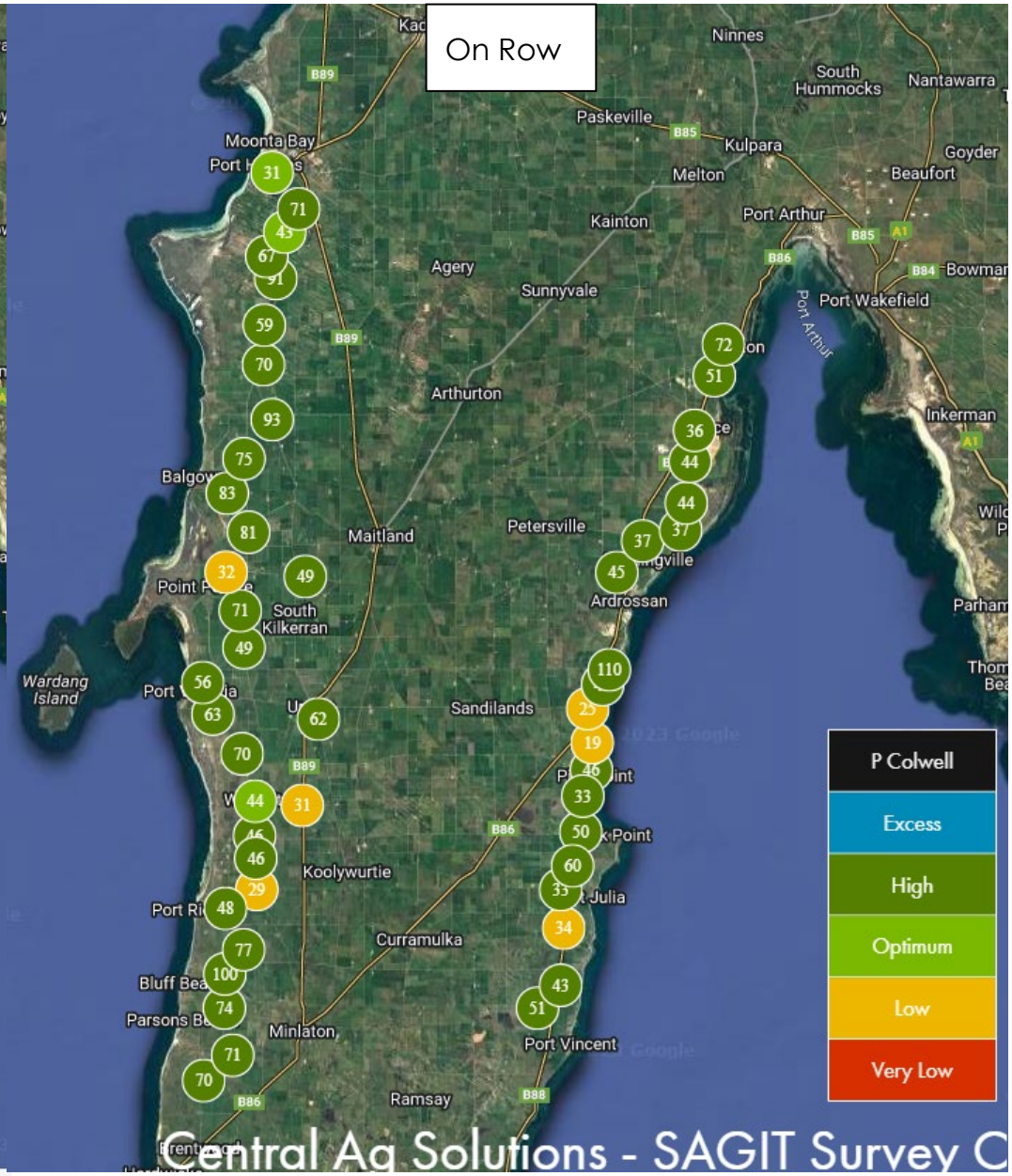
71 to 100
52 to 71
25 to 52
< 25
Central Ag Solutions - SAGIT Survey C


On Row
DGT-P
> 100
71 to 100
52 to 71
25 to 52
< 25
Central Ag Solutions - SAGIT Survey C


Off Row
P Colwell
Excess
High
Optimum
Low
Very Low
Central Ag Solutions - SAGIT Survey C


On Row
P Colwell
Excess
High
Optimum
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