CottonInfo Extension Activity Report

Part 1 - Summary Details

CRDC Project Number: **CSD 2102**

CSD: **CSD 2102**

Project Title: Field demonstration Trial: Autumn cover crop Trial 2020-21

Project Commencement Date: 1/09/2020
Project Completion Date: 30/06/2021

Recognition of support: CottonInfo, acknowledges the financial assistance of the Cotton Research and Development Corporation to undertake this project, the trial co-operator, "Farm 1" Benerembah, farm manager for helping develop the methodology and hosting and conducting the operations of the trial. Also, the in kind assistance from Backpaddock with petiole testing and Precision Cropping Technologies for detailed statistical analysis is greatly appreciated.

Part 2 – Contact Details

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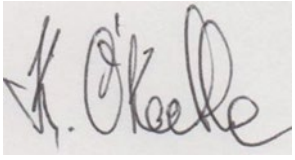

Date submitted: 15th July 2021

Part 3 – Final Report

Background

1. Outline the background to the project.

To encourage the use of cover crops for an optimised farming system.

Figure one shows a field at "Farm 1" Benerembah showing the cotton yield map in 2017/18, showing interesting variation in yield. Wheat was planted after cotton in May 2016 but due to a bogged planter the middle bays (Bays 2,3 & 4)did not get planted to wheat. Bay 5 did get wheat planted and due to a wet spring, it was harvested with yields of 5 t/ha. All stubble was incorporated. Bay 1 also did not get wheat sown, so was bare prior to the 2017/18 cotton crop. Itis showing a variety response as Sicot 746B3F was planted In Bay 1, while the other bays were Sicot 714B3F.

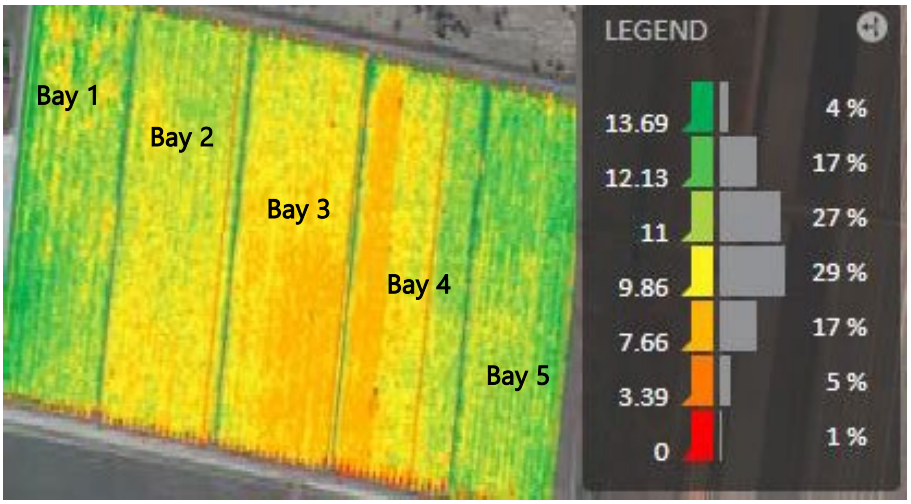

Figure1. Cotton yield map, "Farm 1" Benerembah 2018

After observing this response to having wheat in the rotation and having a lot of fallow ground during 2019 and 2020 a trial at “Farm 1” Benerembah was designed by the Farm Manager and Kieran O'Keeffe CottonInfo.

Trial aim: To see if an autumn cover crop of wheat or barley can improve yields in the following spring cotton crop in 2020/21.
Issues or problems to overcome: Due to water constraints many fields have been prepared for cotton planting but have been left follow during 2019. Fields still need to be kept clean using herbicides and cultivation during this time. A cover crop reduces weed competition and improves water infiltration for the following crop.
Innovation: Currently only a small percentage of cotton growers practice cover cropping due to a range of system constraints, but particularly the value of water. In southern NSW summer cropping is normally not practical due to low summer rainfall and high evaporation. Growers will normally grow a rotation crop (normally a cereal) after cotton taken through to harvest then 9 month fallow into cotton. This autumn timing of the cover crop potentially leads to improved soil health, wind protection from standing stubble leading to better establishment and potential increased cotton yields compared to a bare fallow.

Objectives:

1) To compare cotton yields between early autumn cereal cover crops and bare fallow

2) Investigate the use of yield maps in trial analysis

From the results of this trial there was no significant difference in cotton yields by including an autumn cover crop in the rotation system. There does appear to be some benefits to the cropping system with reduced herbicide costs, a slight buffering in seedbed temperatures (Figure 2), wind protection and improved soil tilth after pupae busting (Figure 9).

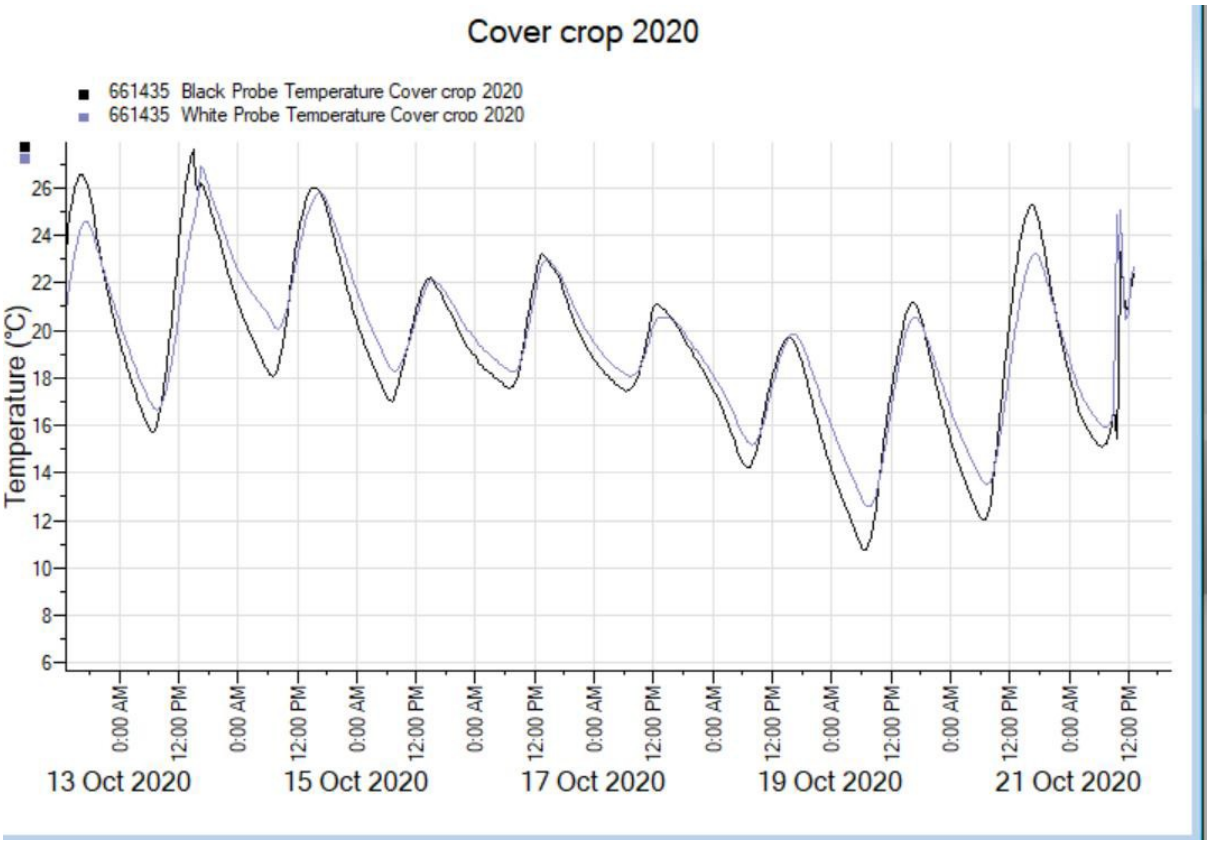

Figure 2. Soil temperatures at 10 cm deep during establishment. Black probe is bare treatment and White probe Is wheat stubble.

Methods

Detail the methodology and justify the methodology used. Include any discoveries in methods that may benefit other related projects.

- Four rollover bays selected at “Farm 1” Benerembah with a replicated andrandomised trial design (See Appendix 1).
- Planting date 1st March 2020 just before Autumn break, rain germination.
- Cover crop not to be sown 20 cm on edge of 1 m hill for plant line.
- Wheat variety Beckom, Barley La Trobe. Both sown at 50 kg/ha.
- Cover crop sprayed out mid-May at head emergence once enough cellulose in stem.
- Soil samples taken after cover crop (wheat, barley and bare) and analysed for N, P and K levels.
- Temperature tiny tag probes installed September 2020 to track soil temperatures on bare and cover crop plots.

- Soil samples taken just before cotton planting September 2020 and analysed for Nitrate N levels.
- Sicot 714B3F planted 4th October 2020.
- Petiole samples taken early squaring (See Appendix 1).
- Yield map and analysis of data May/June 2021.

Outcomes

The cover crop strips were sprayed out in mid-May when the crop was 50 cm high and heads were emerging (Plate 1). By early September most of the stubble had broken down and large cracks had formed in the hills (Plate 3). A roller was used to consolidate the cracks in the hills (Plate 2 & 4).

Plate 1: Wheat cover crop in early June after mid-May termination.

Plate 2: Rolling all treatments 2nd September 2020 to make a suitable seedbed.

Plate 4: Stubble cover break down by the start of September.

The soil N tests taken on the 2nd June 2020 and 22nd September 2020 confirmed the very high Nitrogen status of the trial site. It was interesting to observe the draw down as the cover crop grew and then the cycling back of the Nitrogen levels (see Figures 2, 3 and 4.)
From personal communication with advisors, it is not a common practice to find out Nitrogen levels before the cotton crop is planted. With extended fallows due to low water allocations, soil testing should be encouraged and factored into the coming seasons Nitrogen budget.

On an aside, a bay next to the trial had no applied Nitrogen for the season as other nutritional trials were in that bay. Interestingly, this bay ended up the highest yielding bay for the season! This bay is consistently a high yielding bay with minimal landforming effects.

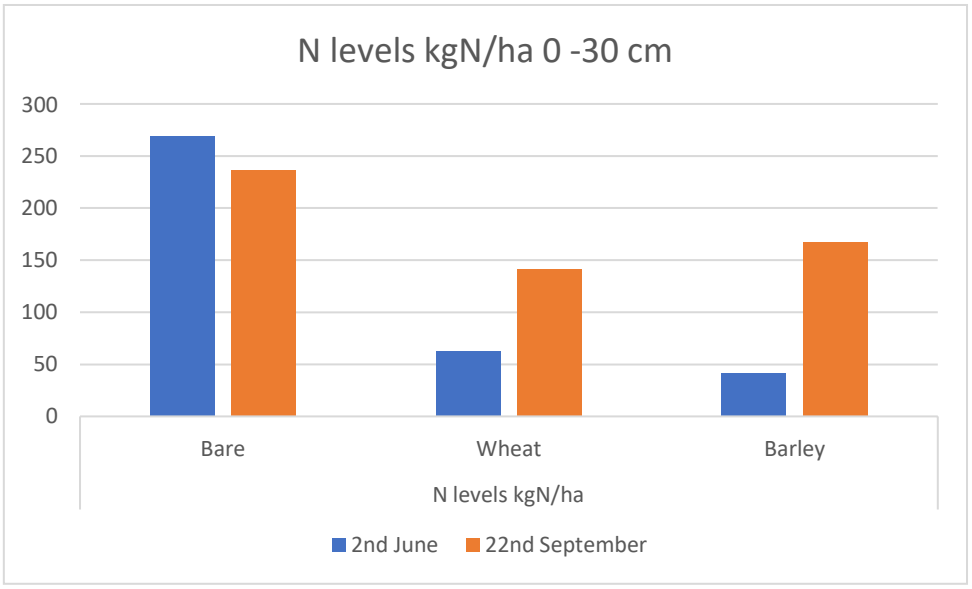

Figure 2. N levels (kgN/ha) 0 -30 cm

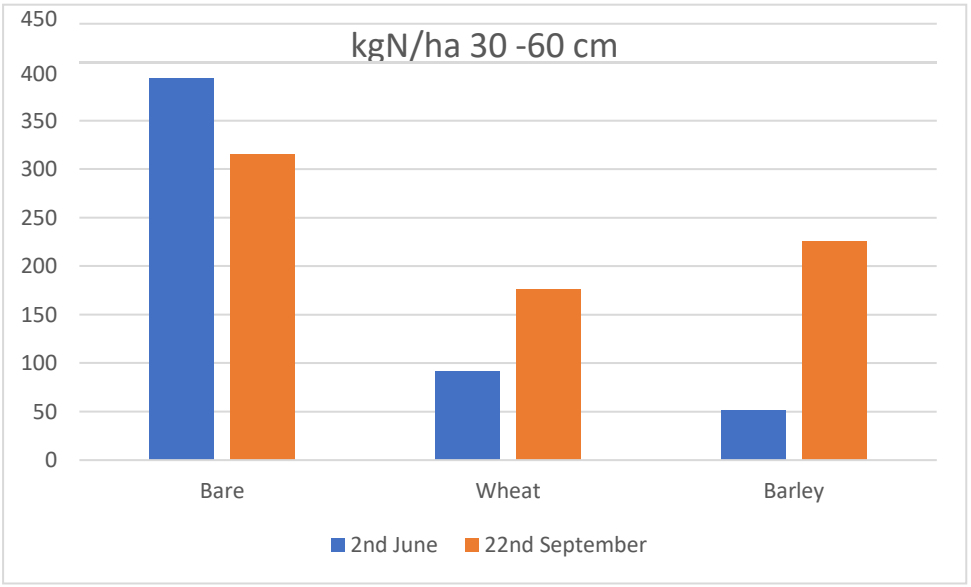

Figure 3. N levels (kgN/ha) 30 - 60 cm

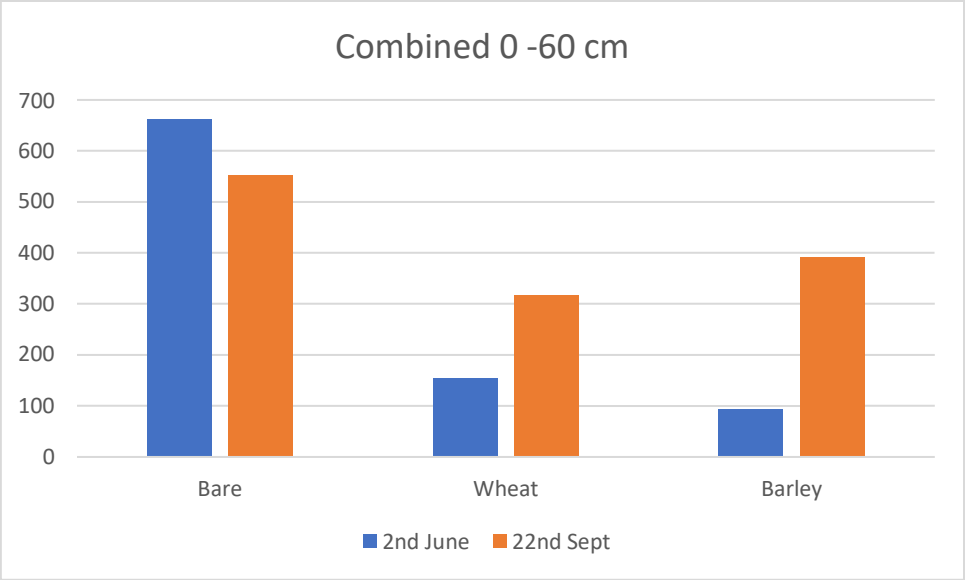

Figure 4. N levels (kgN/ha) 0 - 60 cm

The complete soil tests taken on the 18th June indicated good consistent Phosphorus levels (49 mg/kg) and Potassium levels (560 mg/kg) in the 0 -30 cm depth across all replicates. There was lower P levels in the 30-60 cm depth for Barley Rep 3 (13 mg/kg), Wheat Rep 3 (15 mg/kg) and Bare Rep 4 (12 mg/kg).

Results

Establishment and biomass

The replicates in the trial appeared to be very consistent for growth and development throughout the cycle of the crop. Establishment counts (Table 1) did not show any variation between treatments.

Rep	Bare	Barley	Wheat
1	12.3	11.6	12.5
2	12.6	11.1	12
3	13.3	12.9	11.4
4	13.2	12	11.3
Average	**12.85**	**11.9**	**11.8**

Planted 4th October at 17 seeds/m

Table 1. Establishment counts (plants/m)

However, biomass analysis by PCT did pick up significant growth differences between the treatments during the cotton crop cycle with the bare treatment

well in front. Cotton biomass growth was lower where there was more stubble cover (see Appendix 4).

Satellite images taken after cut out (Figure 5) did show a lot of variation in replicate 3 with a low growth patch. After discussion with the Farm manager the variation was not assigned to a treatment or irrigation effect but the effect of the initial landforming of the field In 2011 where a dam was filled in.

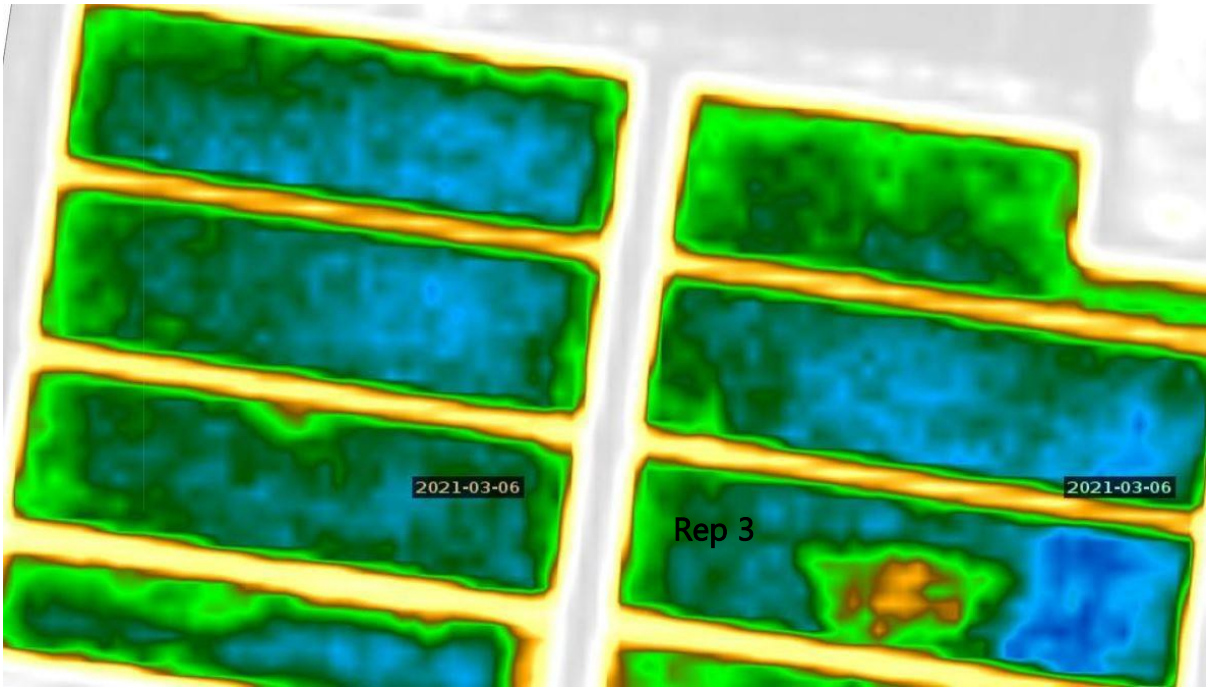

Figure 5. Satamap image of trial site 6th March 2021

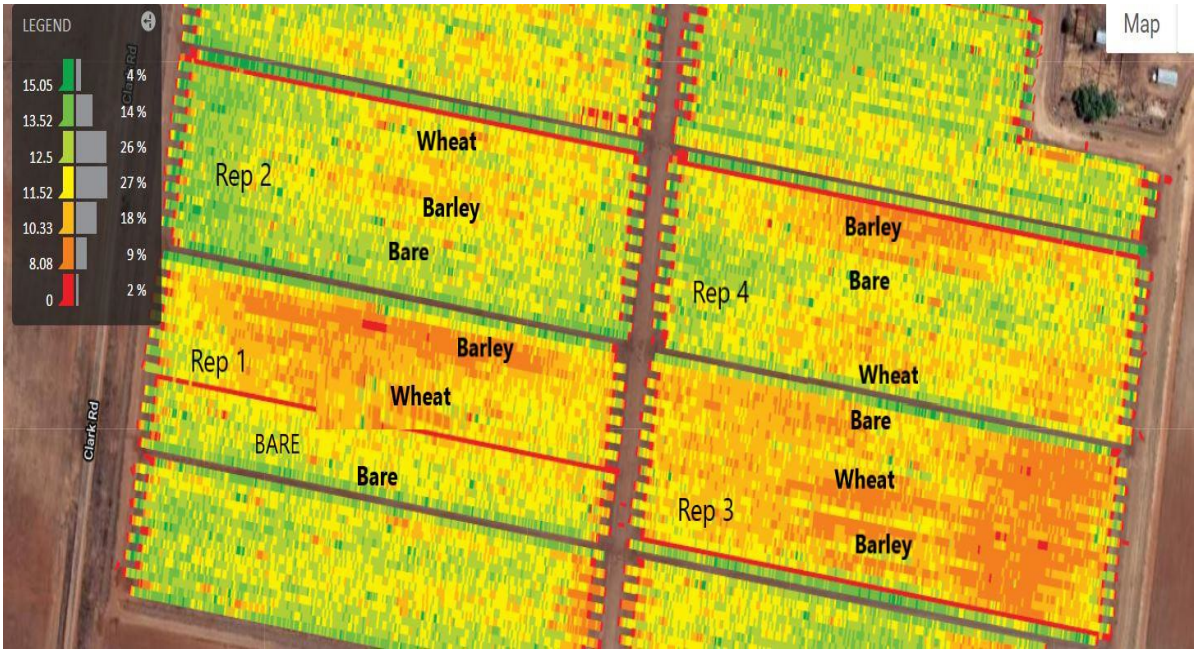

Figure 6. Yield map of cover crop site

The average yield for each replicate is provided in Table 1. No significant difference was found between treatments (See Appendix 2). However, there was a trend in increasing yield results with Bare>Wheat>Barley. This was a clear trend In three of the replicates. From a "trend" perspective which is often used in agriculture as it is so hard to get statistical differences, 3 out of 4 reps had bare fallow as highest yield and in those three reps, it was always fallow->wheat->barley (see Appendix 3).

Table 1. Statistical analysis of results

Treatment	Area (ha)	Min (b/ha)	Mean (b/ha)	Max (b/ha)	SD (b/ha)	CV (%)	DMRT
Bare rep 1	1.77	7.63	11.62	15.49	0.69	5.95	a
Bare rep 2	1.79	7.41	12.33	15.98	0.66	5.39	a
Bare rep 3	1.80	7.34	10.35	15.08	0.78	7.51	a
Bare rep 4	1.82	6.94	11.95	16.00	0.67	5.6	a
Barley rep 1	1.8	8.43	10.30	14.64	0.85	8.23	a
Barley rep 2	1.81	6.97	11.76	16.01	0.84	7.19	a
Barley rep 3	1.77	7.9	10.65	15.40	0.97	9.09	a
Barley rep 4	1.8	7.6	11.03	15.52	0.87	7.87	a
Wheat rep 1	1.82	7.26	10.96	15.05	0.74	6.79	a
Wheat rep 2	1.80	7.45	11.93	15.97	0.88	7.39	a
Wheat rep 3	1.82	7.32	10.20	14.58	0.79	7.70	a
Wheat rep 4	1.77	7.63	11.28	15.12	0.73	6.51	a

SD 0.79 b/ha CV 6.92% 5 % significance level P - value 0.44.

Treatments with the same DMRT letter do not significantly differ.

Biological activity in treatments

As a side activity of the cover crop trial, cotton strips (Figure 7) were placed in Rep 1 in early December and taken out every two weeks over a period of 2

month. The cotton strips were washed and dried then sent for analysis of tensile strength by Guna Nachimuthu, NSW DPI ACRI.

Figure 7. Cotton strips used in biological assessment.

The results (Figure 8) show an increasing trend in biological activity with the cover crop treatments with Wheat>Barley>Bare.

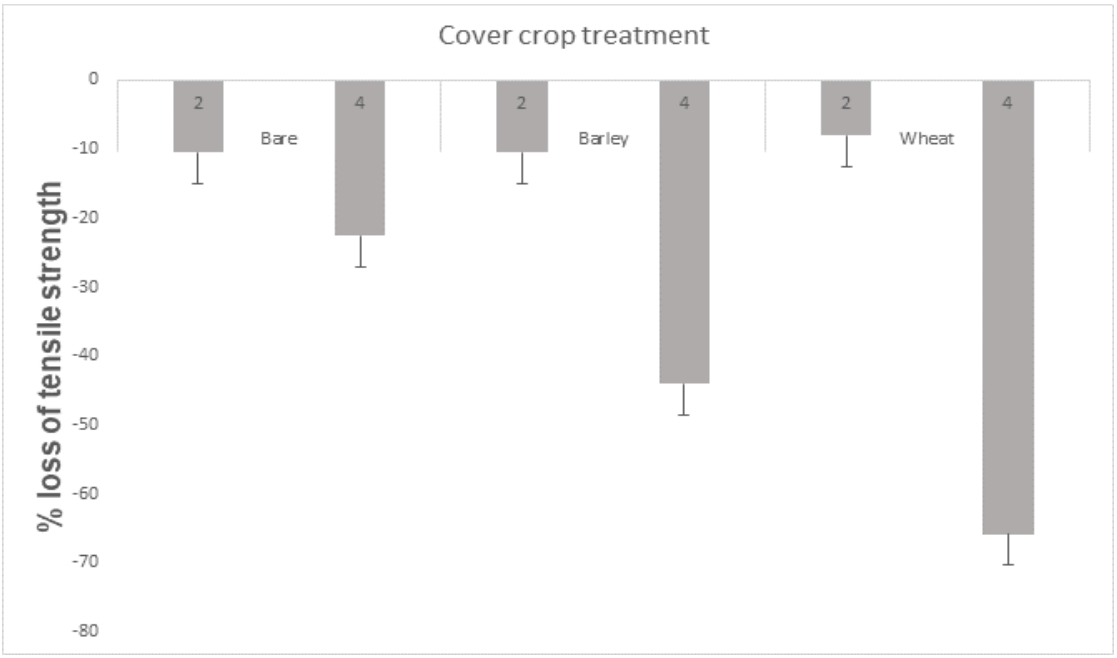

Figure 8. Assessment of biological activity in cover crop treatments.
Source Guna Nachimuthu, NSW DPI ACRI.

There was also a noticeable difference in soil condition after Pupae busting. Figure 9 shows Rep 1 Bare on the left and the Wheat treatment on the right. It will be interesting to see if any treatment effects are noticeable in the current wheat crop.

Figure 9. Photo of trial site after pupae busting.

Discussion

Although the statistical results show no significant difference in treatments there was a trend in yield results with Bare>Wheat>Barley.

The inclusion of an Autumn cover crop does however have a place in several cropping systems. For example, the use of standing stubble to reduce sprinkler impact on soil and sand blasting in spray irrigation systems. There is also the potential opportunity to grow a summer or winter cover crop after an increased area of irrigated Canola in 2021. Growing a full term break crop in the ex-canola field could help to increase the amount of mycorrhiza fungi available to the next cotton crop.

More flexible rotations are becoming common because of the variable nature of water availability in spring for irrigators. The trial site has now been sown to a 50 kg/ha wheat crop with four rows in the middle of a 2 m bed. The potential plant line on the shoulder for cotton has been left bare. This low input cereal crop planted in the correct window can be taken through to harvest if water does not become economically available in spring.

If water does become available and other suitable land is not available to the grower the cereal crop could be replaced with a back to back cotton crop. The percentage of Back to back cotton has significantly reduced in recent years in southern NSW due to lower water availability, increased disease risks and growers experiencing lower yield results in back to back fields. Back to back

cotton Is not the preferred option for most growers as they value the benefits of a full term break crop to repair compaction in fields and allow crop residues to recycle In the cropping system.

The use of yield maps in trial analysis is a relatively new technique available to researchers, commercial companies and growers. It does highlight how background variation in fields can influence the overall result. In agriculture because of the background influences on final yield (soil variations, cut and fill effects) site selection becomes critical to get a consistent comparison between treatments and it needs to be repeatable over several seasons. This will be a difficult task to get meaningful results with the overlay of variation as seen in Figure 10 from the 2018 and 2021 cotton crops. The complexity is highlighted in a recent discussion article by Emerson Nafziger from the University of Illinois.

[Does This Product Work? • farmdoc (illinois.edu)]

Figure 10. Yield map comparison between 2018 and 2021 of cover crop site

One solution to overcoming this variation in large scale on farm trials is to select a section of the bay that has a history of consistent yields and analyse that section for treatment effects. Growers should work closely with commercial research providers in the design and analysis of on farm trials (See Appendix 5).

Conclusion

From the results of this trial there was no significant difference in cotton yields by including an autumn cover crop in the rotation system. There does appear to be some benefits to the cropping system with reduced herbicide costs, a slight buffering in seedbed temperatures, wind protection and improved soil tilth after pupae busting.

As seen in Figure 1 at the start of this report, there are benefits to having a rotation crop in the cropping sequence (cotton/cereal/short fallow/ cotton) compared to the cotton/long fallow/cotton rotation. This needs to be researched and validated.

Take home messages.

- This trial found no significant difference in cotton yields by including an autumn cover crop in the rotation system, however, cover cropping is practiced for different reasons.

- When extended fallows occur due to low water allocations, soil testing should be encouraged and factored into the coming seasons Nitrogen budget.

- The benefits to having a rotation crop in the cropping sequence (cotton/cereal/short fallow/ cotton) compared to the cotton/long fallow/cotton rotation needs to be researched and validated.

- Careful site selection is a critical step in getting meaningful results from on farm trials. A solution to overcoming background variation in, large scale on farm trials, is to select a section of the bay that has a history of consistent yields and analyse that section for treatment effects. Growers should work closely with commercial research providers in the design and analysis of on farm trials.

Extension Opportunities

- Field walk 17th November – 30 attendees.
- CottonInfo Regional newsletter The Cotton tale

Appendix 1: Cover Cropping trial 2020 complete.

Appendix 2: Statistical analysis Field 07-08-2021.

Appendix 3: Trial analysis of replicates.

Appendix 4: PCD vs Treatment.

Appendix 5: Advice on setting up on farm trials

Advice from Nick Barton Precision Cropping Technology

When setting up trials, from our perspective, we suggest the following to growers/agronomists; some of the things in this list might not apply to certain trials (depends on what you are trying to measure)

- Dual EM survey to understand soil variability.
- Elevation layer plus slope/depression layers
- Historical yield data
- Historical vegetative imagery for both winter and summer cropping cycles – want an area that is consistent in both winter and summer cycles.
- Cut and fill data.
- Head ditch height (if using syphons) – watering times might change as you progress along a field, as head changes
- Multiple replicates
- Avoid fields where there have been previous trials that could Influence treatment effects.
- Generally, it is easier to manage a trial in a syphon field – bankless (at this stage) generally means the field has been recently developed (this style of irrigation layout is new) so cut-fill issues will certainly arise - syphon fields generally have less issue with cut-fill.
- Trying to put replicates into one bay if using bankless – might make management more difficult, but it is one way to reduce any variability due to cut-fill.
- Make the trial fit all operations i.e., if planter is 8m wide, the replicates probably need to be 24m wide to fit 4 passes of the picker and 3 passes of planter – but be careful if there are spray rigs passes that don't fit into the replicates as compaction can drop yield – 24m replicates generally work since planters fit (8 row or 12 row), pickers fit (either 4 row or 6 row) and spray rigs are generally 24m wide.
- We also do have suggestions for how to pick the trial, but this can be trial specific, depending upon what the treatments and trial layout end up being.