Final Technical Report Template

Final Technical Report

Non-Wetting Management Options for Growers in the Albany Port Zone – SCF Component (wetters)

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Intended for journal publication	**NO**
Results are incomplete	**NO**
Commercial/IP concerns	**NO**
Embargo date	**NO**

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Abstract

Forest gravels are notorious for having non-wetting topsoils but are otherwise well suited to high rainfall cropping. If non-wetting topsoils could be economically alleviated, growers would consistently produce more grain by sowing earlier. The aim of the Stirlings to Coasts component of the investment was to evaluate the effectiveness of soil wetters on forest gravels. A farm-scale trial was established at Tenterden in 2020 on highly non-wetting forest gravel. The replicated seeder width trial included 11 treatments over 200m long. In 2021, the grower sowed wheat directly over the 2020 canola plots without using wetter or engaging the Pro-Trakker. The main finding was that seed placement had a greater impact on canola germination and early biomass than the rate and placement of wetters in the first year (2020). Despite these findings, there were no differences in canola yields in 2020 or wheat in 2021. Canola seeded on-row or near-row had significantly greater early canola biomass than plots planted off-row, regardless of wetter application. The grains industry requires more research on wetting agents to determine the correct rate, application method and product for major soil types. The effectiveness of guidance systems for air-seeder bars needs to be independently evaluated over more crops and seasons to help growers make informed investment decisions.

Executive Summary

By 2021, growers in the Albany port zone will have updated knowledge on using soil wetting agents to effectively manage non-wetting forest gravel soils that apply to their situation.

Why was the work done?

Forest gravels are notorious for having non-wetting topsoils but are otherwise well suited to HRZ cropping systems. Forest gravels generally have high organic matter and are well suited to grow wheat, barley, canola and pulse crops in the appropriate soil pH. If germination issues associated with non-wetting topsoils could be alleviated, growers on these soils could produce even more grain by sowing crops earlier.

Mechanical soil amelioration on sandy soils is very effective and widely adopted by other growers in the Albany Port Zone (APZ); however, the process is slow and expensive. Mechanical options are not as well suited to forest gravels because of the rocks bought to the surface by ploughing etc. Soil wetting agents have been successful on forest gravels or gravelly loam soils, which has led to many growers installing liquid streaming systems on their seeding equipment. Questions still linger regarding the effectiveness of wetting agents due to inconsistent responses combined with the high cost of the products. Hence the interest in this project from growers and researchers alike.

Significant Results

The two most significant results were obtained in the 2020 season. Placement of wetting agent in the subsoil closer to the seed achieved significantly better germination and early plant biomass than wetter applied on the furrow above ground. Secondly, the seed placement in relation to last season's furrow had a more significant effect on canola germination and early vigour than the wetting agent treatments. Canola planted on or near last year's furrow had a significantly higher ground cover percentage than canola planted inter-row, regardless of a wetting agent treatment was applied or not. Despite observing differences in canola germination and early vigour in 2020, there were no significant differences measured in grain yields indicating the canola could compensate for lower plant numbers in some treatments.

In 2021, wheat was grown over the 2020 canola plots with the grower's standard agronomic package. No new wetter treatments were added so that we could determine if there was any residual benefit in the second year from the wetting agents applied in 2020. Satellite imagery was collected to analyse NDVI at different times during the 2021 growing season, but no significant differences were detected. There were no significant yield differences in 2021 between any treatments applied in 2020. This result confirms the recommendation that soil wetters be used every year on responsive soils. The 2021 season was exceptionally wet, and the expression of non-wetting was likely very low.

What was achieved?

Michael Webster, the grower host, found clarity on his strategy for treating non-wetting soils. They had previously set up the liquid application on their seeding bar that placed the SE14 wetter onto the furrow behind the press wheel. In 2020 we saw better responses to SE14 applied in the soil close to the seed rather than a surface application. Additionally, the improvement in canola germination from plants seeded near or on last year's furrow motivated Michael's family to purchase a Pro-Trakker hydraulic hitch for their bar so they could have better control of the seed location. The Pro-Trakker guidance system was used in 2021, although differences were hard to observe in the extremely wet season. Michael continues to work with SCF to validate the value of using wetting agents and the Pro-Trakker. In 2021, SCF helped Michael assess some new wetter products compared with SE14. The results of this demonstration are yet to be analysed. A similar trial was conducted by another SCF member at Manypeaks in 2021 on sandplain soil. The results of these farmer demonstrations will be shared with SCF members once the yields have been analysed.

Conclusions

The seed placement in relation to last year's furrow was enormously important for the canola germination in 2020. The improved canola germination and early biomass was the catalyst for Michael Webster to invest in a Pro-Trakker guidance system for his seeding bar in 2021. Placement of the SE14 wetting agent underground near the seed was significantly better than applying the same rate of SE14 on the furrow surface. There was no measurable benefit to the 2021 wheat crop from treatments used in 2020. Despite significant differences in plant germination and early biomass in the 2020 canola crop, the final grain yields were not significantly different to the untreated control. Even without yield increases from the wetter application in 2020, growers still valued the significantly improved plant germination and early biomass, which should translate to greater yields in seasons where water availability at grain filling is limited.

When and how can the industry benefit from the work done?

Our demonstration work highlighted the inconsistencies around soil wetter research in WA. The only way to gain more clarity is to conduct more scientifically valid demonstrations and trials. When wetting agents work, the differences are evident, encouraging growers to use the products on those soils. Other growers, particularly those on sandplain soils, are trying wetting agents in the hope they will gain some advantage. Mechanical soil amelioration is expensive and time-consuming, which rules those options out for some farming businesses. Applying soil wetting agents is still costly but cheaper than a mechanical option.

Recommendations for future actions

The longer-term implications of seeding on-row or near-row need to be explored. Is the 2020 canola result repeatable for different crops? Does soil and root disease build up over time? Do you still need a wetting agent when seeding on or near last year's furrow? Growers posed these questions to the SCF researchers throughout the project.

We could not detect a significant improvement in the 2021 yields associated with the treatment applied to the canola in 2020. However, 2021 was an exceptionally wet season at Tenterden, which would likely have masked any possible benefits from soil wetter applications. Trials over multiple seasons need to be conducted to account for seasonable variability and the effects on different soil types and environmental factors. Longer-term work needs to be completed to ascertain if there are improvements in soil wettability from prolonged use of wetting agents. Growers believed their soil wettability was improving year on year with wetter applications.

From the limited products we tried, SE14 from SACCOA was the best product on this soil type. However, there are more and more wetting agent products entering the market, and some independent analysis needs to be completed to help growers decide which products to use. There also needs to be more independent trial work looking at rates of soil wetter on different soil types. Given they are expensive, growers are always wanting to use the most economical product and amount.

Contents

Background

Over the past few years, grain growers in the Albany port zone (APZ) have found it more challenging to achieve good crop germination. Early growing season conditions have been very dry with below-average rainfall before June. Non-wetting expression is particularly nasty for growers with forest gravels, which rely on late summer and early season rains to alleviate the soil's non-wetting properties for plant germination. Non-wetting soils result in patchy and delayed crops, staggered weed germination, increased water erosion, and difficulty spraying crops with different growth stages. Growers are looking at cheaper alleviation rather than expensive mechanical soil amelioration to improve non-wetting soils.

Conventional methods of managing non-wetting soils involve mechanical disturbance of the soil structure to mix the non-wetting particles with wettable particles. Mechanical disturbance includes claying, deep ripping with inclusion plates, ploughing and spading. These are expensive to implement for grain growers; however, they usually have long-lasting results. Mechanical disturbance also has significant economic risk due to the cost and environmental risk from soil eroding winds. The SCF western R & D committee were especially keen to focus on wetting agents and their possible effects on local forest gravel soils.

Recent non-wetting mitigation options that have been explored include wetters, on-row seeding, near-row seeding and stubble retention. The range of wetting agents on the market is growing. Wetters can be placed on the seed, below the seed, in the seed contact zone or on the furrow surface. Previous research by Glenn McDonald (DPIRD) found that wetting agents will help crop germination and water infiltration at the end of the season, assisting grain filling. He also noted a long-term cumulative benefit of using soil wetters in paddocks. Anecdotally, growers have also observed an incremental benefit from applying soil wetters year after year.

This trial aimed to determine the best rate and placement of soil wetters for growers to mitigate non-wetting effects and achieve the best possible crop emergence without mechanical disturbance of non-wetting forest gravel soils.

Project objectives

Objective of the 2020-21 trial demonstration at Tenterden

By 2021, growers in the Albany port zone will have updated knowledge on using soil wetting agents to effectively manage non-wetting forest gravel soils that apply to their situation.

Grain growers in the HRZ around the Kendenup, Tenterden and Frankland River areas enjoy consistently high growing season rainfall and relatively mild temperatures during grain-filling, especially compared to the traditional Wheatbelt regions of WA. Growers in these regions have two main constraints to their cropping enterprises, one being waterlogging and the other being non-wetting topsoils. In this project, we tackled the non-wetting constraint.

Forest gravels are notorious for having non-wetting topsoils but are otherwise well suited to HRZ cropping systems. Although waterlogging is a problem, gravelly soils tolerate high rainfall better than most soils in WA. Forest gravels generally have high organic matter and are well suited to grow wheat, barley, canola and pulses, where the soil pH is 5 ($CaCl_2$) and above. If the germination issues associated with non-wetting topsoils could be effectively alleviated, growers in these regions would produce more grain on average by being able to establish crops earlier and achieve a more even crop.

Mechanical soil amelioration on sandy soils is very effective and widely adopted by some SCF members in the APZ; however, the process is slow and expensive. Most mechanical options are not as well suited to forest gravels because of the rocks hidden below the surface that would be bought up by ploughing etc. Soil wetting agents work well on forest gravels or gravelly loam soils, which has led to many growers installing liquid streaming systems on their seeding equipment. Questions still linger regarding the effectiveness of wetting agents due to a lack of consistency combined with the high cost of the products. New products are regularly entering the market, but growers are unsure of their efficacy. Hence the interest in this project from growers and researchers alike.

Methodology

In 2019 three trials were set up with Anthony and Murray Hall in West Kendenup. The trials looked at the effects of applying 2.0 litres of SE14 per tonne of seed to see if it assisted germination numbers in non-wetting soils on three crop types (canola, wheat and oats). The results of these three on-farm experiments have previously been reported. A copy of the 2019 report written for the Stirlings to Coast Farmers Annual Trials Review Booklet has been included in the appendix of this report.

2020-2021 Trial

A trial site was set up southwest of Tenterden for the 2020 season on a highly non-wetting forest gravel Soil. The demonstration had a strong cropping history, with barley grown in 2019 and only one pasture year in the seven seasons before that. The grower has used wetter in his system at seeding for the previous three years. The trial layout included 11 treatments, described in the list below, seeded in 200m long strips over three replicates. Soil samples from the three replicates were taken before sowing for MED testing to measure water repellency under field conditions. NB: MED stands for Molarity of Ethanol Droplet test- a measure of soil repellency. Staff also took soil tests and sent them to CSBP to determine the specific recommendations from BASF for their wetting agent product “Divine”. The Divine test returned three different suggestions for each replication. One recommended was no wetting agent, replicate two was a 20% Agri and 80% Integrate ratio and replicate three recommended a 100% Integrate ratio. Overall, we applied a 20% Agri and 80% Integrate to each replicate for the BASF Divine treatments.

A large proportion of the treatments involved the SACOA product SE14. The reason SE14 was selected was that local growers most commonly use it. The project aimed to investigate different placement effects with the seed or even directly on the seed. Research from Glenn McDonald indicates soils responsive to one wetter are often responsive to other wetters.

- Untreated Control
- 2 Lt/tonne SE14 directly on the seed
- 4 Lt/tonne SE14 directly on the seed
- 2 Lt/tonne SE14 behind press wheel
- 4 Lt/ha SE14 behind press wheel
- 2 Lt/tonne SE14 directly on seed and 1 Lt/ha behind press wheel
- 2 Lt/ha SE14 behind seed boot
- 4 Lt/ha SE14 behind seed boot
- 1 Lt/ha SE14 behind seed boot and 1 Lt/ha behind press wheel
- 2 Lt/ha SE14 behind seed boot and 2 Lt/ha behind press wheel
- 2 Lt/ha BASF Divine (80% integrate / 20% Agri) behind press wheel

The trial site was sown with 2.3 kg of 44Y90 IT canola using farm-scale equipment where possible. However, wetter treatments applied behind the seed boot needed a temporary 2m wide applicator attached to the seeder bar. Seeding occurred on the 6th of May 2021 after 25mm rainfall the day before, yet the seed was still placed into dry soil (See photo in appendices). Treatments applied behind the press wheel were done in 10.4m strips at a water rate of 50 l/ha. The treatments involving placement behind the seed boot were done in 2m strips using a water rate of 100 L/ha.

Plant counts were completed shortly after germination with ten counts per plot to mitigate the spatial variation within treatments. It was noted whether each plot was sown off- last season stubble rows, on-row or near-row where the seeder bar swayed on and off. Due to the high spatial variation seen during the season, drone imagery was used at the end of July to create an orthomosaic image of the trial site. Using mapping programs, the images' colour spectrum could be analysed to determine each plot's ground cover percentage.

To best account for the variation across plots, the 10.4 m plots were swathed and harvested by the grower. The yield maps to collect harvest information allowed for yield analysis of those treatments. For the remaining 2m wide and 10.3 m wide plots, a small-plot harvester was used to collect grain yields from a representative 27.3m length of each plot. A grain sample was also taken from these plots and analysed using CBH equipment.

The results from plant density and yield were analysed using the REML model with spatial analysis to account for paddock variability over the trial. The ground cover results could not be analysed spatially; however, they were statistically accounted for due to the significant difference from seed placement in proximity to last year's furrow.

2021 Method

In 2021, wheat was grown over the 2020 canola plots with the grower's usual agronomic practice minus wetting agents or engaging the newly installed ProTrakker. No new treatments were added because we aimed to see if there was any residual benefit in the second year from the wetting agents applied in 2020. Satellite imagery was collected to analyse the Normalised Difference Vegetation Index (NDVI) at different times during the 2021 growing season, but no significant differences were detected.

Harvest was completed with a plot header for all 33 plots in 2021. Plot length and grain weight were measured on the day of harvest, while grain quality was analysed at CBH in Albany three weeks later. Plot yields were calculated from the plot weight and the measured plot area. DPIRD biometrician Andrew VanBurgel analysed the grain yields in 2021.

Figure 1: Photo of the liquid delivery system used to apply soil wetting agents by Michael Webster and his family. The wetter is applied directly onto the seeding furrow behind the press wheel. The photo was taken by Nathan Dovey- Stirlings to Coast Farmers on the 6th of May 2021.

Location

NOTE: Where field trials have been conducted please include location details: Latitude and Longitude, or nearest town, using the table below (please add additional rows as required):

	Latitude (decimal degrees)	Longitude (decimal degrees)
Trial Site #1	-34.413005	117.465451
Nearest Town	Tenterden, WA	

If the research results are applicable to a specific GRDC region/s (e.g. North/South/West) or Agro - Ecological Zone/s please indicate which in the table below:

Research	Benefiting GRDC Region (can select up to three regions)	Benefiting GRDC Agro-Ecological Zone (see link: http://www.grdc.com.au/About-Us/GRDC-Agroecological-Zones) for guidance about AE-Zone locations	
Experiment Title	Western Region Choose an item. Choose an item.	☐ Qld Central ☐ NSW NE/Qld SE ☐ NSW Vic Slopes ☐ Tas Grain ☐ SA Midnorth-Lower Yorke Eyre ☐ WA Northern ☐ WA Eastern ☐ WA Mallee	☐ NSW Central ☐ NSW NW/Qld SW ☐ Vic High Rainfall ☐ SA Vic Mallee ☐ SA Vic Bordertown-Wimmera ☐ WA Central ☒ WA Sandplain

Results

2020 Results

Germination

The plant density analysis found two treatments with significantly higher plant numbers than the untreated control (UTC). These treatments were placed behind the seed boot rather than applied on top of the furrow (behind press wheel). Increasing the SE14 rate, from 2L/ha to 4L/ha, behind the seed boot had no significant increase in plant density, indicating that 2 L/ha of SE14 in 100 L/ha of water was sufficient to mitigate the non-wetting nature of this soil.

The placement of SE14 directly on the seed or behind the press wheel resulted in no significant difference in plant densities. The combination of SE14 behind the seed boot and the press wheel averaged higher plant densities than the control; however, they were not statistically significant. The plant densities in the BASF' Divine' and 'Integrate' combination treatment were not significantly different from the UTC.

The lower plant densities from the high rate of SE14 (4L/tonne) placed directly on the seed can be explained by the application method. At the high rate, the individual seed was observed sticking to each other and not flowing naturally in the air-seeder box. The reduced flow of grain and stickiness likely led to reduced seed numbers planted per row and probably reduced seed placement uniformity. If treatments applying wetter directly on the seed are to be tried again, we need to find a way to mitigate this problem.

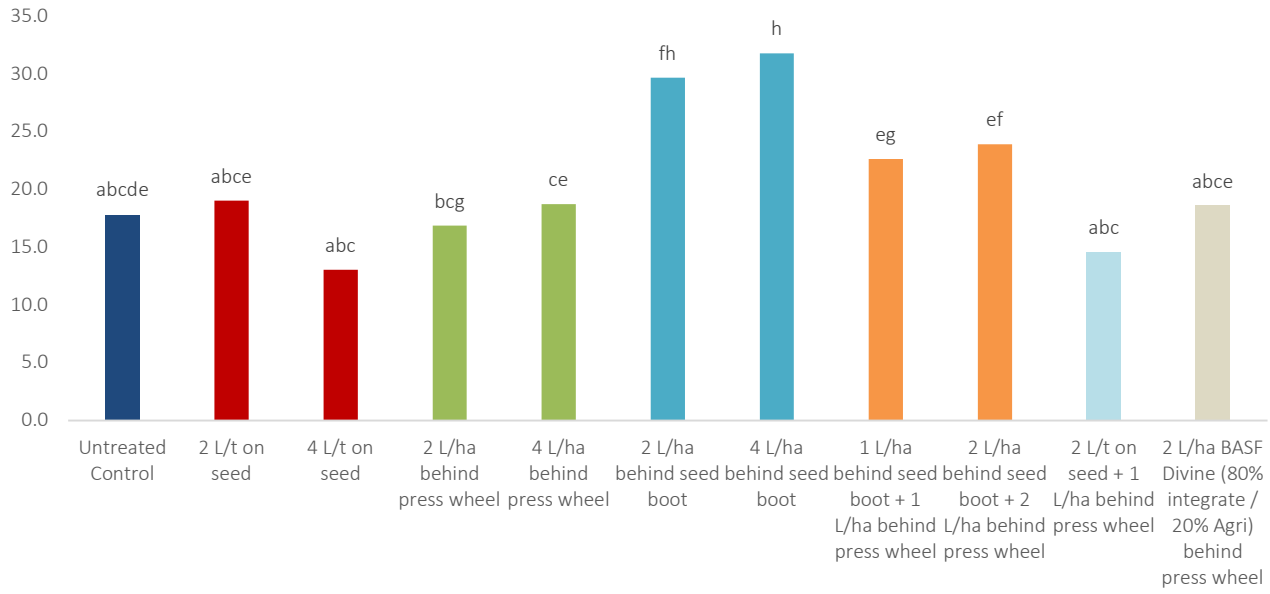

Figure 2: Plant density counts for different placements and rates of the soil wetters, SE14 and BASF Divine in a forest gravel at Tenterden WA in 2020. The vertical column represents the number of plants per m².

Early biomass

The plant establishment data was positively correlated to ground cover assessments taken on the 28th of July via drone imagery. The only two treatments that had significantly greater ground cover percentages on the 28th of July than the UTC were:

1. 4L/ha SE14 behind the seed boot and;
2. 2L/ha SE14 behind the seed boot

The 2L/ha SE14 behind the seed boot and 2L/ha behind the press wheel treatment was statistically equivalent to the 2L/ha SE14 behind the boot. However, it was not significantly higher than the UTC, despite having a 16% higher ground cover percentage.

The plant density and ground cover data indicate that 4 L/ha of SE14 behind the seed boot was the most effective mitigation strategy for non-wetting soils in this trial. Although, the high cost of applying 4L/ha may not be economical for some grain growers.

The ground cover results identified a significant difference between the seed placement in relation to the previous year's seeding furrow. The off-row seed placement resulted in a significantly lower ground cover than the near-row and on-row. The on-row placement had the highest ground cover percentage, although it was not significantly different to the near-row. The differences in canola establishment based on proximity to the previous season furrow is consistent with other research and field observations. Data from this trial suggest that seeding equipment that can consistently seed on or near the last season row is most beneficial to canola establishment and early season growth.

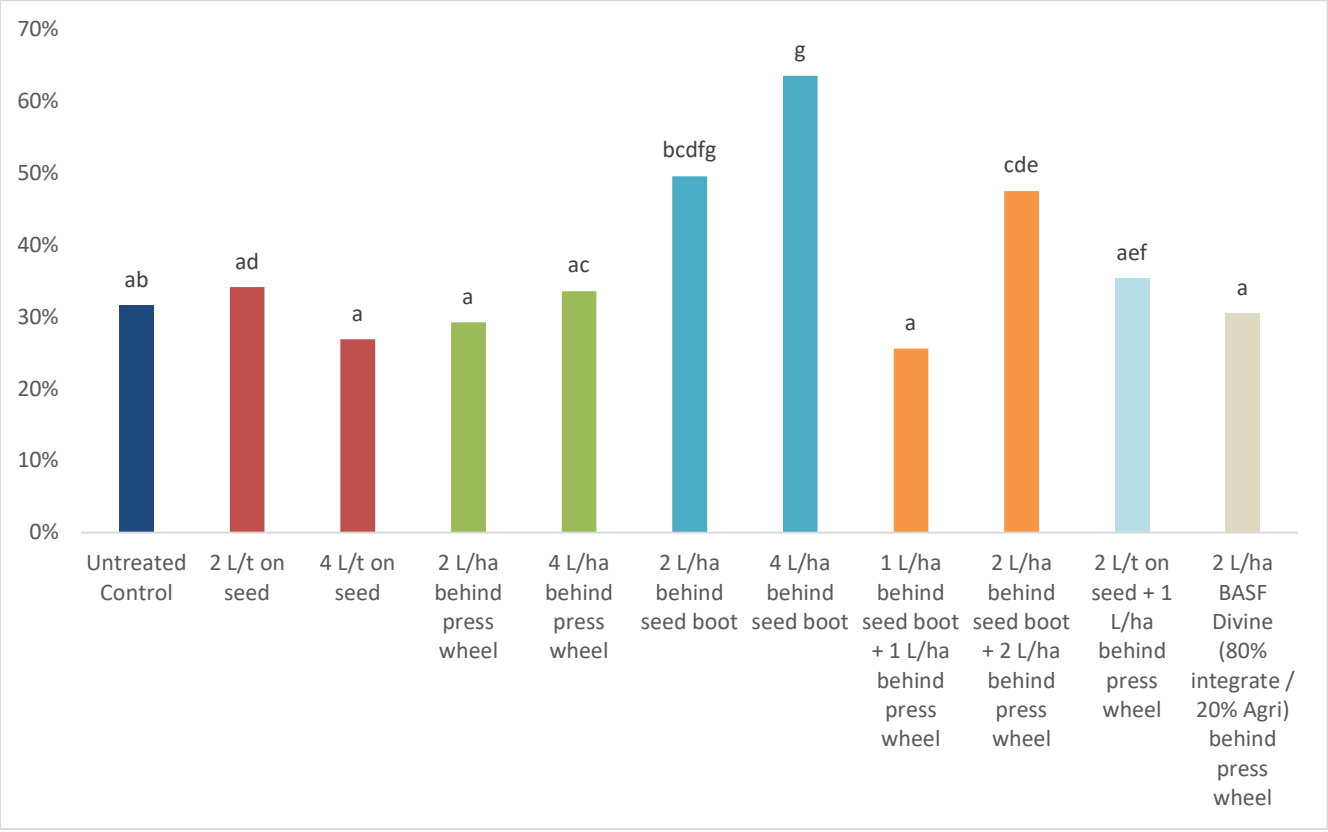

Figure 3: Ground cover for different placements and rates of soil wetters, SE14 and BASF Divine, in a forest gravel soil at Tenterden, WA. Percentages of ground cover were determined through calculations with drone imagery collected on 28/7/2020. Percentage ground cover is represented on the vertical axis.

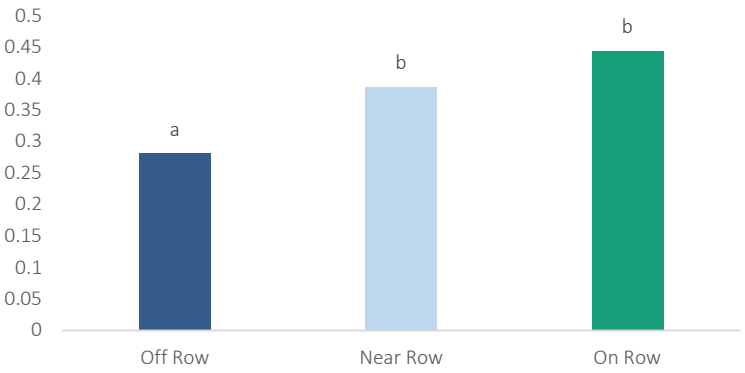

Figure 4: Percentage round cover for seed placement in proximity to last year's cereal furrow in a forest gravel soil type at Tenterden, WA. Percentage calculations were determined through drone imagery taken on 28/7/2020.

Grain Yields

The grain yields for the trial were analysed using analysis of variance (ANOVA). Initial results indicated no significant differences in grain yield between any treatments. When a spatial analysis model was used, significant differences were found, with the UTC yielding the highest. Three treatments grew significantly less grain yield than the UTC, and they were;

1. 4L/tonne SE14 applied directly to the seed
2. 2L/ha SE14 behind seed boot
3. 1L/ha SE14 behind seed boot and 1L/ha SE14 behind press wheel

Reviewing the three replicates that made up each treatment mean provided a plausible explanation for why the mean yields were significantly lower than the UTC. One of the three replicates for the 4L/tonne of SE14 applied directly to the seed was only 1.37t/ha, which reduced the average yield for the treatment. Likewise, the 1L/ha SE14 behind the seed boot with 1L/ha SE14 also placed behind the press wheel had one replicate that yielded 1.16t/ha. Each outlier was in plots where the air-seeder had randomly placed the seed off-row, explaining the poor result.

The 2L/ha of SE14 placed behind the seed boot also had one outlier that yielded 1.40t/ha. However, unlike the treatments mentioned previously, this plot was sown on-row, which means we have no explanation for the low yield. Out of the 33 plots in the trial, only six had yields of less than 1.5t/ha. The other three plots, not mentioned above, were in the following treatments:

1. 2L/ha SE14 behind the press wheel (1.16t/ha and seeded near-row)
2. 4L/ha SE14 behind the seed boot (1.08t/ha and seeded off-row)
3. 2L/ha BASF Divine/Integrate 80:20 mixture (1.13t/ha and seeded on-row)

Only one of the low-yielding plots mentioned above could be explained by being planted off-row. Without evidence to support another conclusion, we suspect the outlier plot yields could result from site variability or soil type.

Soil wetting trials on canola have traditionally struggled to determine significantly different grain yield responses between treatments. Canola plants have an excellent ability to compensate for lower plant numbers. Once canola plant densities are above a critical level, the plants increase vigour and heads

per pod. Previous work by M. Harries, M. Seymour & S. Boyce (2016) found that canola densities as low as ten plants/m^2 can yield 2.5 t/ha. They also noted as plant densities increased, so did grain yield. The highest yield in this trial was 2.14 t/ha, which suggests that plant density was not a limiting factor.

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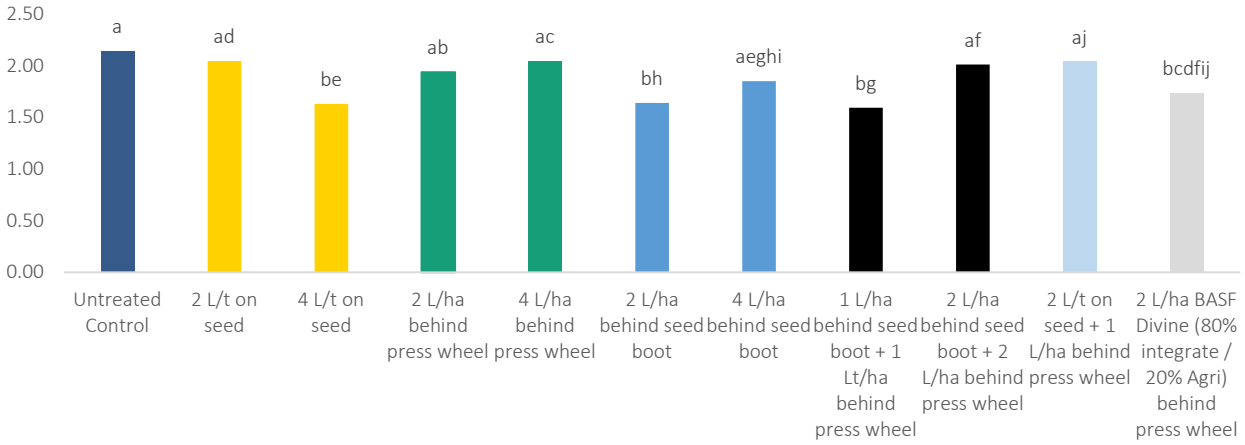

Figure 5: Grain yields of canola for different placements and rates of the soil wetters, SE14 and BASF Divine in a forest gravel soil at Tenterden WA in 2020. Grain Yield is represented on the vertical axis, and the units are t/ha.

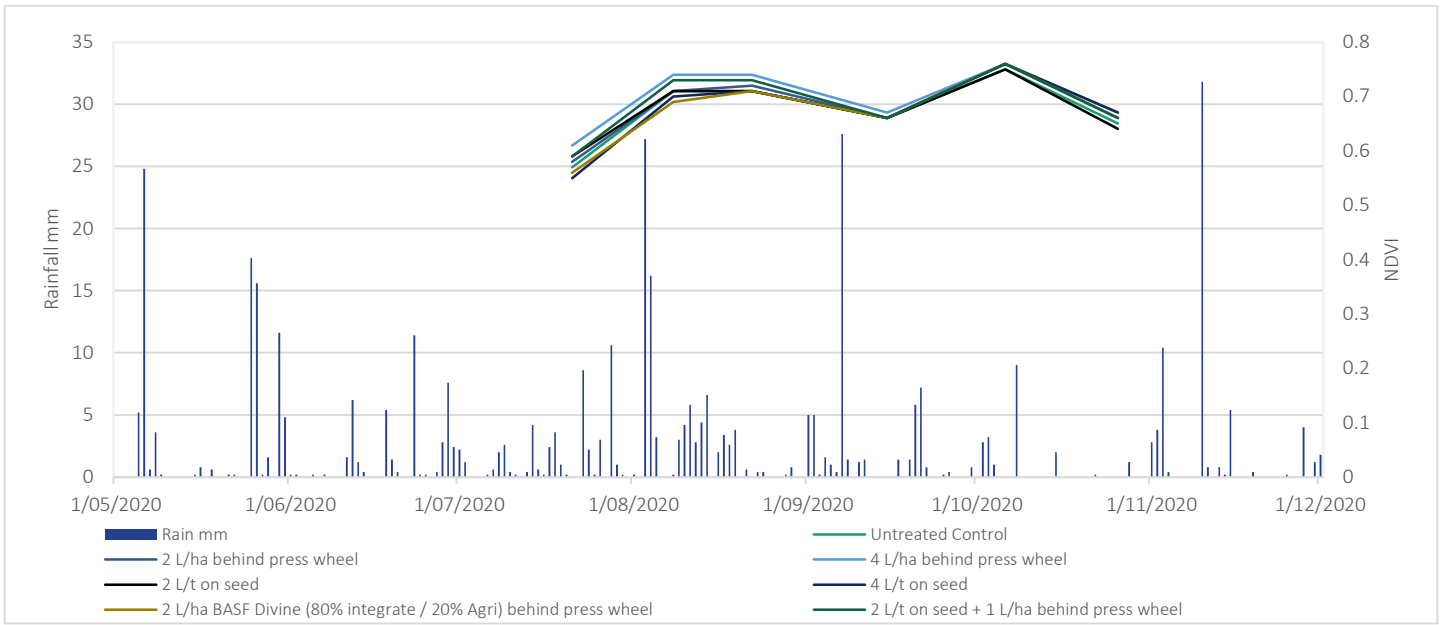

Figure 6: Rainfall and NDVI for different placements and rates of the soil wetters, SE14 and BASF Divine in a forest gravel at Tenterden WA in 2020.

Table 1: Results from the Molarity of Ethanol Droplet (MED) testing conducted by Phillip Mackie (SCF) in 2020. Replicate 1,2, and 3 represent a composite soil sample taken from each replicate within the trial demonstration site.

Molarity of Ethanol	Description of Severity	Replicate	Score
0	None	**1**	**3.4**
0.1-1.1	Low	**2**	**3.4**
1.1-2.3	Moderate	**3**	**3.6**
2.3-3.5	Severe		
>3.5	Very Severe		

The Molarity of Ethanol Droplet (MED) testing conducted before seeding in 2020 showed our trial site had topsoils that were rated severe or very severe for non-wetting expression. These results were not surprising to the farmer hosts who identified this paddock as one of the worst non-wetting paddocks on their Tenterden farm.

2021 Results

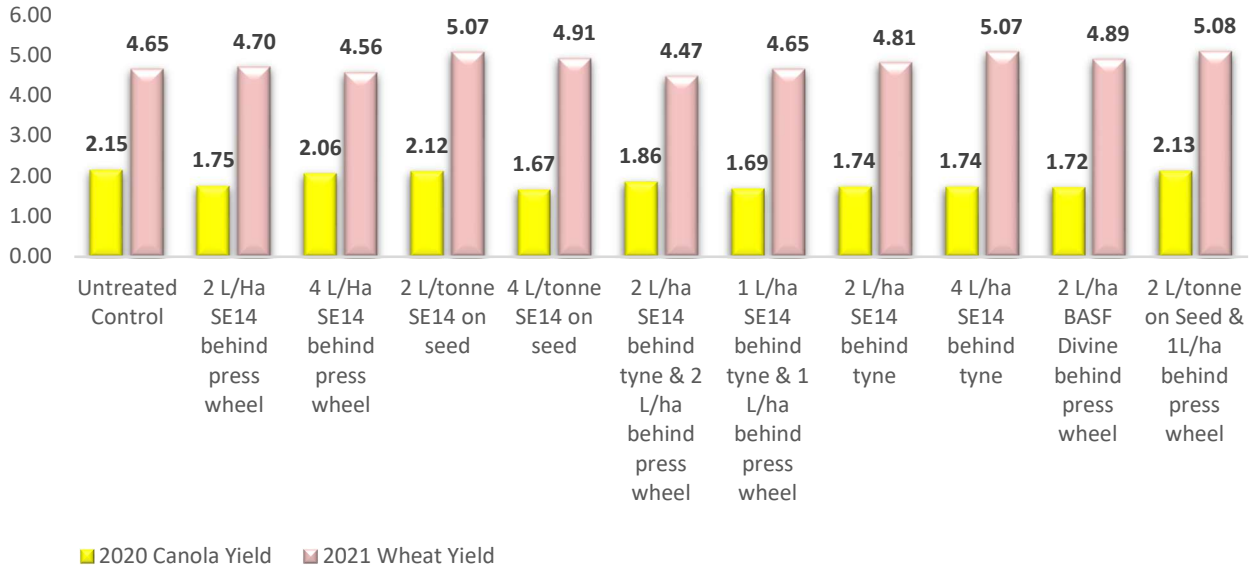

Figure 7: The Grain yields (t/ha) recorded in 2020 (canola) and 2021 (wheat) at the Webster/Beech non-wetting trial site in Tenterden. No statistical differences were measured between treatments in 2020 or 2021 (data not shown).

Table 2: Results showing 2020 (canola) and 2021 (wheat) yields plus the two years grain yields combined. Yields are recorded in tonnes per hectare (T/Ha).

Treatment	2020 Canola Yield (t/ha)	2021 Wheat Yield (t/ha)	Cumulative Yield (t/ha)
Untreated Control	**2.15**	**4.65**	**6.80**
2 L/Ha SE14 behind press wheel	1.75	4.70	6.45
4 L/Ha SE14 behind press wheel	2.06	4.56	6.62
2 L/tonne SE14 on seed	2.12	5.07	7.19
4 L/tonne SE14 on seed	1.67	4.91	6.58
2 L/ha SE14 behind tyne and 2 L/ha behind press wheel	1.86	4.47	6.33
1 L/ha SE14 behind tyne and 1 L/ha behind press wheel	1.69	4.65	6.34
2 L/ha SE14 behind tyne	1.74	4.81	6.55
4 L/ha SE14 behind tyne	1.74	5.07	6.81
2 L/ha BASF Divine behind press wheel	1.72	4.89	6.61
2 L/tonne on Seed & 1L/ha behind press wheel	2.13	5.08	7.21
Mean Yield of Trial (t/ha)	**1.88**	**4.81**	**6.06**

- There were no significant differences between wheat yields in 2021 from the wetting agent treatments applied in 2020.
- There were no residual yield benefits in 2021 from any wetting agent treatments applied in 2020.
- 698.4mm of rainfall (Decile 10) between April 1-October 30 at the West Kendenup DPIRD weather station, effectively removing the non-wetting soil constraint in 2021.

Figure 8: Harvesting the 2021 wheat demonstration trial at Michael Websters in Tenterden. Kelly Gorter (SCF) and Cameron Quenby (David Gray's Agronomist) look on. The photo was taken by Nathan Dovey (SCF) on the 15th of December, 2021.

Discussion of Results

2020 Trial at Tenterden

In 2020, only two wetting agent treatments had statistically higher canola germination than the UTC. These two treatments were 2L/ha and 4L/ha of SE14 behind the tyne. These results had two important outcomes. Firstly, SE14 was more effective when placed close to the seed behind the tyne compared to a surface application behind the press wheel. Secondly, the higher rate of 4L/ha did not significantly improve canola germination compared to 2L/ha of SE14. This shows that in responsive soil, 2L/ha of SE14 is enough to enhance canola establishment. This is an essential economic outcome because SE14 is an expensive product, and growers are loathed to apply more than needed.

The ground cover percentages of the canola plots were measured in late July 2020, and the results were consistent with the establishment data. However, only the 4L/ha of SE14 behind the tyne had significantly higher biomass than the UTC. The 2L/ha of SE14 behind the tyne had higher biomass than the UTC, but it was not statistically significant.

The differences in these treatments did not translate to the final grain yields of the canola. No treatments yielded significantly higher than the UTC in 2020. We think the canola compensated for differences in plant numbers because the plant populations were not low enough to be yield-limiting. The improved plant germination and early ground cover will have long-lasting agronomic benefits to growers through improved weed competition, but quantifying the benefit is complex and beyond this project's scope.

The most significant result from 2020 was the observations recorded regarding plant germination and early biomass compared to the seed placement in relation to last year's seeding furrow. The improvements in germination and early biomass from ‘on’ or ‘near-row’ placement convinced the grower to invest in a Pro-Trakker hydraulic hitch for his seeding bar to control their seed placement better. In the case of canola on a barley stubble, the seed placement ‘on’ or ‘near row’ was a more important factor than whether the treatment received a wetting agent or not.

In 2021, there were no significant yield differences between any of the treatments applied in 2020. This result was not unexpected since wetting agents are recommended to be used every year on responsive soils. The 2021 season was exceptionally wet, and the expression of non-wetting was likely very low. From the limited products we tried, SE14 from SACOA was the best product on this soil type. However, there are more and more wetting agent products entering the market, and some independent analysis needs to be completed to help growers decide which products to use. There also needs to be more independent trial work looking at rates of soil wetter on different soil types. Given they are expensive, growers are always wanting to use the most economical amount.

Unexpected results from the 2020 trial

In 2020, SCF researchers, in collaboration with Glenn McDonald (DPIRD), observed the distinct differences in germination based on the proximity to last year’s seeding furrow. Researchers detailed whether each plot was seeded, on last year’s row, just off last year’s row or in the middle of last season’s furrow. The data was then integrated into our statistical analysis by DPIRD biometrician Andrew VanBurgel, and the results were apparent.

The significant improvement in germination and early biomass from sowing close to last year's furrow was attributed to greater access to fertiliser and previous root channels. The existing root channels increase moisture penetration and provide the plant with preferred growth pathways. When sowing on last year's furrow, the plant can access unused nutrients from previous years combined with the fresh fertiliser applied in that season.

Conclusion

The project found that SE14 needed to be placed near the seed underground to increase the canola germination and early biomass. We tried to assess if combining applications behind the tyne and on top of the furrow would improve the wetting agent's (SE14) effectiveness compared to behind the tyne only or on top of the furrow only. Results were inconclusive, but site variability made it hard to determine statistical differences. The combination concept deserves further research to ascertain if it is a more efficient way to apply soil wetter.

Growers ultimately want yield gains that were not observed in either 2020 or 2021. The reasons for this have been examined in the report. Yield gains in the first year are more likely for crops other than canola, and perhaps more research in small plot trials would better determine significant differences than broad-scale trials. However, SCF has had collaborative discussions with fellow researchers, and they have also found it difficult to find significant differences in yields from using wetting agents like SE14.

In our two-year trial, we observed two clear outcomes that growers should note. Firstly, the placement of SE14 behind the seed-boot (underground) was much more effective in increasing canola germination and early biomass than a soil surface application behind the press wheel. We had discussions with SACOA (manufacturer of SE14), and they have reached the same conclusion in their own research over more trial sites and seasons. Secondly, seed placement in relation to last year's furrow had a massive impact on plant germination and early biomass growth. Seeding canola on or near row, regardless of the wetting agent treatment applied, had significantly higher early biomass than the off-row plots. The data generated in 2020 was convincing enough for our grower host to upgrade their seeding machinery with a Pro-Trakker hydraulic hitch. Utilising a ProTrakker may prove to be a cheaper and more effective solution to non-wetting soils in the long term than adding soil wetter every year.

Growers have anecdotally observed long term cumulative benefits from applying a soil wetting agents year on year. We attempted to measure this in the trial design, but the unusually wet 2021 season minimised the non-wetting expression making this hypothesis impossible to support with our trial results. This idea deserves further validation attempts since it would add utility to the SE14 investment made by growers.

Implications

Assessing the benefits of wetting agents is a difficult task because the response varies depending on the season, soil type and other environmental factors. Forest gravels are the most responsive to wetting agents, whereas, in different soil types, results are less certain. Some of our grower members (Stirlings to Coast Farmers) on sandplain soils are applying high rates of SE14 (4-5L/ha) out of desperation because outside of major soil amelioration (clay applications, delving etc.), they do not have a viable solution. Further fieldwork needs to continue to refine the application rates and responses in differing soil types. Many new products on the market also need to be assessed for efficacy and economic value.

Recommendations

Independent testing of new non-wetting products

SE14 by SACOA is the product most commonly used by growers in southern WA. Despite being perceived as being the best non-wetting product on the market, there are still many situations where the product does not give an economic response for growers. The lack of economic response is due to its high cost and uncertainty about which soil types the product will be effective. Growers have to test the product themselves, which is costly and inefficient. Growers need access to more independently generated soil wetter testing in their local environments.

Additionally, new products are being bought to market to challenge SE14's market share. Despite there not being enough research on the effectiveness of SE14's efficacy across all WA non-wetting soils, there is next to nil information on most new wetter products. Once again, growers are forced to test products themselves, which is slow, and data is poorly shared beyond small groups or even within individual companies.

There needs to be independent testing of new products on the market in different soil conditions. Growers are always sceptical of industry research conducted by companies that could potentially be biased. Growers would like to see an independent organisation like the GRDC or DPIRD conduct trials to guide grower choices. Some of the products on the market from companies appear to have very little of their own research that has been conducted in Australian conditions.

Economic Analysis of Air-Seeder bar guidance like Pro-Trakker

The data gathered from our Tenterden site suggested a Pro-Trakker on the air-seeder bar was going to be far more effective than using soil wetting products. Expanding the observations made in 2020 needs to be made to see if the substantial benefit is seen in other years on other soils and different cropping rotations. The grower host (Michael Webster) is keen to continue testing non-wetting solutions on his property because it is his number one soil constraint.

This type of assessment could be made by organising multiple on-farm demonstrations/trials with growers with the help of precision agriculture technologies. For example, growers that use wetting agents could leave untreated control strips in multiple paddocks and give researchers access to the harvest data to assess possible yield differences. This would not be a simple project, but it would be possible with collaboration between grower groups, technology providers and biometricians. The project's success would depend on the ability to collect a large enough data-set for analysis.

Multi-year analysis of soil wetting agents

The expression of soil wettability is dependent mainly on the seasonal conditions experienced, most notably the timing and amount of rainfall received. To accurately understand a soil wetters performance, the product(s) needs to be tested in multiple seasons to determine how effective it is on average. We recommend trying new products over numerous seasons to understand the economic returns for growers.

Appendix A.

Non-wetting management options for growers in the Albany port zone 2019

Key Points

- The lack of significance in plant count shows there were no adverse effects to the seed in the three crop types when wetter was seed coated prior to sowing.
- There were no significant improvements in yield from applying SE14 as a seed coating over the untreated control
- Water repellence was not likely an issue in the trials in 2019 as the site received adequate rainfall post-seeding and throughout the growing season.

Background

It is often difficult to identify which issue is the most constraining, with the added difficulty in some instances of multiple problems such as non-wetting soils, compaction, acidity, sodicity and transient salinity. This can make adoption decisions difficult when deciding which are the best management options when paddocks may have several constraints occurring at a local level. In the APZ, paddocks often have areas of non-wetting sands along with areas of exposed cap rock making the use of mechanical amelioration, such as one-way ploughs and other soil inversion tools difficult. A wrong decision in these soil types can have long term negative consequences and exposes soils to a variety of risks such as wind erosion.

Deep soil cultivation has been shown to reduce repellence on these soils but impacts on crop establishment and causes variability in productivity. Claying sandy soils has been relatively common in the APZ for the last 20 years. It has been highly effective at ameliorating non-wetting topsoils, reducing wind erosion and improving grain yields. However, time and cost of claying and incorporation is a large barrier to more wide-spread adoption. Local growers counter this by investing in small amounts of claying on an annual basis.

Non-mechanical management options such as soil wetters placed in-furrow at seeding are becoming a more common tool in alleviating non-wetting constraints on these soil types. Recent research by Geoff Anderson looked at the efficacy of seed coated wetters (as opposed to being applied in-furrow) saw an improved cereal establishment by up to 109% (Anderson et al. 2018).

The non-wetting management options for growers in the APZ project aims to improve the confidence in diagnostic methods for delineating and implementing practices to overcome non-wetting in most soil types, and to improve the confidence of growers in the decision making for improving soil productivity.

In 2019 three trials were set up with Anthony and Murray Hall in West Kendenup. The trials looked at the effects of applying 2.0 litres of SE14 per tonne of seed to see if it assisted in germination numbers in non-wetting soils on three crop types (canola, wheat and oats).

Results

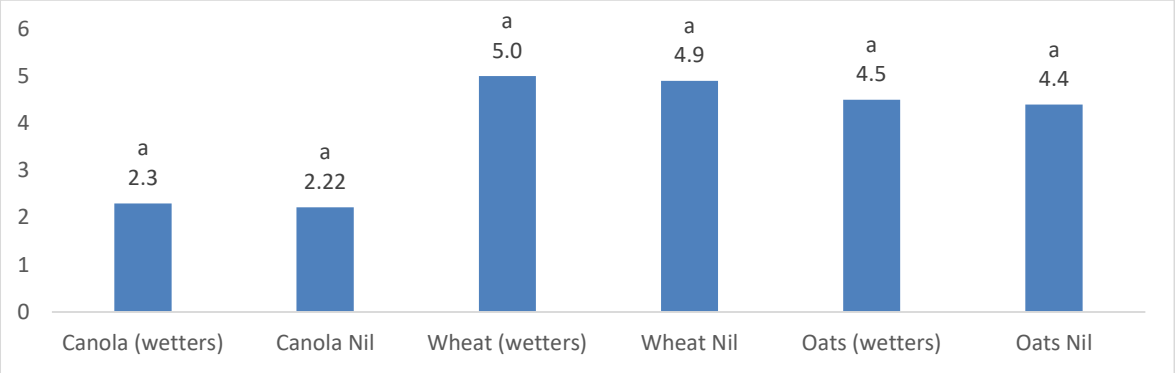

Figure 1 shows the yields (t/ha) of each crop type with a SE14 wetter seed coating and untreated control at Hall's Family Farm in West Kendenup in 2019

Table 1: displays grain quality from the canola with SE14 wetter seed coating and untreated control in 2019

Canola Grain Quality Average							
	Protein	**L Admix (g)**	**L Admix %**	**S Admix (g)**	**S Admix %**	**Moisture**	**Oil**
Canola (wetter)	20.20	2.83	0.57	4.23	0.85	4.23	46.23
Canola Nil	20.27	6.77	1.35	5.63	1.13	4.13	46.27

- There were no significant improvements in yield from applying SE14 as a seed coating over the untreated control in the canola, wheat or oats in 2019 Fig 1.
- Grain quality analysis in the canola trial shows there are no significant differences in protein, moisture or oil Table 1.
- There were no statistical differences in any treatments in plant counts (per m^2) that were collected from each of the crop and treatment types Fig 2.

- Plants were also divided into different growth stages to identify if more plants germinated on the first or second rains (Data not shown). Unfortunately, there were no significant differences observed for the three crops tested.

Crop Type and Treatment	July 5 2019 Ave plant count p/m^2		July 12 2019 Ave plant count p/m^2	
Canola (wetters)	43.3	a	56.1	a
Canola Nil	44.1	a	53.3	a
Wheat (wetters)	19	a		

Figure 2 Mean plant counts from one metre of planted row (1m/row) from Canola Wheat, and Oats from Anthony and Murray Halls property in West Kendenup. Canola plants were counted twice due to a staggered germination. Means followed by the same letter or symbol do not significantly differ (P=0.05, LSD)

Discussion

The main aim of applying the wetter directly to the seed in these trials was to aid in improving wetting of the seeding zone and help improve seed germination in both cereals and canola (Anderson et al. 2018). The lack of significance in plant count shows there were no adverse effects to the three crops with 2.0 litres of SE14 wetter applied directly to the seed before seeding. Generally, poor crop establishment on non-wetting soils occurs when crops are dry sown with limited rainfall pre- and post-seeding (Anderson et al., 2018). In 2019 despite the drier start to the season June through September achieved adequate rainfall at West Kendenup. Therefore, water repellence was less likely to be an issue in 2019 with greater than 65mm falling in June, July and August.

Anderson et al. 2018 stated that seed coating with wetters improved cereal establishment, which increases plan density and tillers, which is an important role in final yields. Despite no significant increases in yield or grain quality, the three trials had excellent yields, which indicates that water was not a limiting factor in 2019.

In 2020 two trials will be established, one with a steel-based amelioration (i.e. ploughing, ripping or other tillage machines) and anther trial with seed coating with wetter. Testing will be carried out to select sites with severely water repellent soils to investigate to impacted on crop establishment. Different rates of wetter will be added to the treatments in 2020.

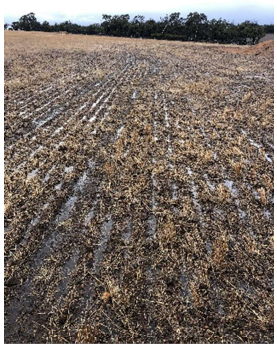

Figure 9: A photograph highlighting the non-wetting nature of the trial demonstration site hosted by Michael Webster in 2020 and 2021. The photo was taken on the 6th of May, 2021, the day after receiving 25mm of rainfall. The photo was taken by Nathan Dovey- Stirlings to Coast Farmers.

Glossary and Acronyms

Below is a sample Abbreviations and Acronyms list. Be sure to include on this page all abbreviations and acronyms that appear in the report

SCF	Stirlings to Coast Farmers Inc.
DPIRD	Department of Primary Industries and Regional Development
APZ	Albany Port Zone
HRZ	High Rainfall Zone
SE14	Moisture Retention Agent Produced by SOCOA
MED	Molarity of Ethanol Droplet Test -Measure of soil water repellency
CSBP	Australian Fertiliser and Chemical Company
CBH	Cooperative Bulk Handling
REML	Restricted Maximum Likelihood
ProTrakker	Precision guidance system that ensures the seeding tractor and seeder stay on the same path year after year via a hydraulic tow-hitch.
NDVI	Normalised Difference Vegetation Index
Divine Agri	Product from BASF (Chemical Company) to treat non-wetting soils
Divine Integrate	Product from BASF (Chemical Company to treat non-wetting soils

References

This section provides the information a reader would need to locate the articles, journals, and/or other publications referred to in the report.

file:///C:/Users/pmack/Downloads/Harries+Martin+Seeding+uniformity+and+canola+tield.pdf

Guidance systems a plus for on and edge-row sowing | Groundcover (grdc.com.au)

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