The impact of stubble architecture on fallow efficiency and plant establishment.

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Stirlings to Coast Farmers are participating in a GRDC funded state-wide project investigating strip and disc seeding systems. The aim is to determine if there are benefits to strip and disc systems in the high rainfall zone (HRZ), where sowing rates, plant density, crop biomass and stubbles are routinely higher than wheatbelt cropping systems. The project will look beyond simply increasing fallow efficiency to measure and analyse several variables that arise from changes to stubble management and architecture over four years.

In this project, we will examine the impact of different stubble architecture across soil water dynamics, plant establishment and nutrient efficiency. Each treatment has been replicated twice at a paddock scale to provide observations and data that can be translated to real farming systems in the high rainfall zone (HRZ) of WA.

The project includes four stubble management x seeding implement treatments:

1. Draper front (standard cut height) + tyne seeder, (D(s)/T)

2. Stripper front + disc seeder, (S/D)

3. Stripper front + speed tillage + disc seeder, (S/st/D)

4. Draper front (high cut) + disc seeder. (D(h)/D

BACKGROUND

The manipulation of stubble architecture through harvester setup, strategic tillage, and seeder type is a key driver of fallow efficiency. In the wheatbelt, as well as in the more marginal cropping areas on the east coast, stripper fronts have become increasingly popular as growers seek to preserve more stubble residue and increase their fallow efficiency whilst increasing harvest productivity.

The basic philosophy of strip and disc cropping systems is that they will provide more stubble cover reducing soil moisture losses compared to the conventional draper and tyne practices of most WA growers. However, there is a lack of research on strip and disc systems in the HRZ, where stubble residues are much higher than the low-medium rainfall WA wheatbelt. The trial has been running for six months, and whilst this is a long-term project, there have been some notable results from the 2021/2 fallow period and this season so far.

FALLOW EFFICIENCY

Fallow efficiency is the measurement of the water stored in the soil at the end of the fallow period. This is a measurement of your starting balance plus the summer rainfall, minus all losses through transpiration, evaporation, runoff, lateral flows and losses through deep drainage. This is obviously a win for the WA wheatbelt, where dry summers are the standard. However, very little research has been conducted into increasing fallow efficiency and the impact of preserving high stubble loads in the HRZ. There can be consequences from keeping large volumes of stubble, such as increased disease burden and trash flow when seeding. Additionally, HRZ growers could be penalised rather than benefit from drastically increasing fallow efficiency because of waterlogging. Although penalties may not eventuate this season, this is something that will be monitored throughout the lifespan of the project.

Table 1: Average stubble height (cm) at the end of the 2021/2 fallow period.

Treatment	Stubble height
Draper front (standard cut height) + tyne seeder	16.5
Stripper front + disc seeder	64.1
Stripper front + speed tillage + disc seeder	0.0
Draper front (high cut) + disc seeder	26.6

2022 SOIL MOISTURE

Volumetric water content percentage (VWC%) was taken at the end of the fallow period in each plot. Soil cores were taken 12th of April, three days after the speed tilling was applied to the strip + speed till/disc plots. The results found that the stubble treatments with a greater stubble load had a higher soil VWC% at each depth interval (Figure 1). The site had 11.6mm of rainfall between the time of speed tilling and the soil coring. The rain event explains the relatively high and uniform VWC% at the shallowest depth interval of 0-10cm. However, once you measure deeper into the soil profile, you can see the different treatments changing the VWC%.

The stripper front/disc plots had the greatest VWC% at 10-30cm, with an average of 12.2%, while the draper (high cut) had a VWC% of 10.9. Interestingly the stripper front/speed tillage treatment had 3.3% less plant available water than the plots where the stubble remained intact. This is most likely due to the stubble increasing the infiltration rate and reducing the surface evaporation to allow the strip & disc plots to capture a greater percentage of the 11.6mm of rain that fell between the speed tilling and the soil coring. The standard draper front stubble treatment resulted in a significantly lower VWC% at 10-30cm and 30-50cm.

There is a potential for a yield penalty from the tilled plots given they will not receive an in-season water infiltration and ground cover benefit from the additional stubble cover. However, the rapid growth of the canola canopy and root system should minimise any differential that arises from stubble cover increasing water infiltration, as there are additional benefits such as improved plant establishment and less weed burden resulting from the tilling of the plots.

The three heavier stubble treatments improved the fallow efficiency, resulting in a greater percentage of plant-available water at seeding time, particularly at depth, compared to the standard draper cut. This could be a great benefit if the seasonal outlook were for below-average rainfall or if there is a prolonged period of dry weather. The early results show why some growers have utilised the strip and disc system in lower rainfall environments.

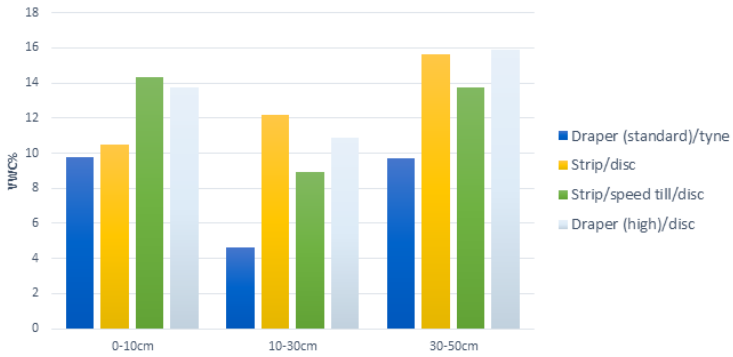

Figure 1: Average volumetric water content percentage for each stubble treatment recorded at the end of the 2021/2 fallow period, across three depth intervals.

Additionally, VWC% was recorded post-seeding by a TDR soil moisture probe on the 9th of May, 16 days after seeding. The TDR probe measures soil VWC% to a depth of 12cm. Like the 0-10cm soil cores, there was very little difference in the measured VMC% resulting from each stubble treatment. The VWC%s are lower across all treatments, which is expected given there was little rainfall for May up to that point. This probe will be used throughout the year to measure the long-term impact of the stubble treatments on the plant available water in the topsoil.

Table 2: Soil volumetric water content recorded by a TDR probe on the 9th of May.

Treatment	TDR Volumetric SWC (VMC%)
Draper front (standard cut height) + tyne seeder	6.47
Stripper front + disc seeder	6.36
Stripper front + speed tillage + disc seeder	8.82
Draper front (high cut) + disc seeder	7.89

PLANT ESTABLISHMENT

The impact of the stubble management by seeding treatments on plant establishment was relatively minor (Table 3). No statistically significant relationships existed between the stubble management treatments and plant establishment.

Table 3: Average canola plants per m2, measured on the 9th of May 2022.

Treatment	Average plants/m2
Draper front (standard cut height) + tyne seeder	26.1
Stripper front + disc seeder	25.8
Stripper front + speed tillage + disc seeder	28.4
Draper front (high cut) + disc seeder	28.9

WEEDS

As with plant establishment, there was no significant difference between the ryegrass densities and the seeding treatments (Table 4). However, the speed tilling treatment had reduced weeds (not significant) which is likely an effect of the soil disturbance or the greater spray efficiency from the incorporated stubble.

Table 4: Ryegrass numbers per m2 for each stubble treatment.

Treatment	Average Weeds/m2
Draper front (standard cut height) + tyne seeder	22.7
Stripper front + disc seeder	21.9
Stripper front + speed tillage + disc seeder	18.4
Draper front (high cut) + disc seeder	20.6

The high stubble loads had a negative impact on spray efficacy, with the two highest stubble loads having a significantly lower spray coverage than the tilled and standard stubble treatment (Table 5). Although the predominant weed was ryegrass, which is easily controlled in canola, the year-on-year effect of high stubble loads without tillage could increase the weed burden over time. The impact of stubble treatment on the weed burden will be continuously monitored over the 4-year project lifespan.

Table 5: Spray coverage percentage at ground level recorded during the second knock down spray prior to seeding.

	Draper Standard / Tyne	Stripper/ Disc	Stripper/ Till / Disc	Draper/High
Ground	12.27	7.32	13.72	8.62

CONCLUSION

The initial results show the wide and varying impact of stubble architecture on agronomic productivity and soil/water dynamics. Both positive and potentially negative flow-on effects have been recorded for each stubble management regime so far. It will be critical to observe how the differing stubble treatments impact crop development and, ultimately, any impact on grain yield. Given there has been little research into strip and disc systems in the HRZ, the continued monitoring of all the parameters will be necessary to form a complete picture of the suitability of strip and disc systems in the HRZ.

Figure 2: Demonstration of the Strip+Disc and Speed till (left) and Strip+Disk (right) treatments.

Figure 3: Demonstration of the Draper (standard) front + disc seeder (left) Strip+Disc and Speed till (right) treatments.

Figure 4: Demonstration of the Strip+Disc and Speed till (left) and Draper Hgih Cut + Disc (right) treatments.