Can nil disturbance seeding systems overcome water repellence in non-wetting gravels and other soil health issues over time?

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Key Points

- Three seeding systems, disc (slot), tyne and tyne-after-cultivation were tested over two seasons in a paddock with a long history of minimal soil disturbance. Soil water repellence, plant establishment and yield were compared.
- In the wet 2016 season, the effect of soil water repellence was minimal and soil disturbance caused by disc, tyne or tyne-after-cultivation did not significantly affect plant establishment or yield.
- In the dry 2017 season, plant establishment and yield of field peas was higher in the disc seeder treatment than the tyne or tyne-after-cultivation treatment.

Introduction

Growers and agronomists have observed a reduction in non-wetting and increase in plant establishment where disc seeders (slot seeding) are used, rather than tyne seeders. These observations reflect trials by Dr. Margaret Roper in Munglinup demonstrating that by not disturbing the soil, old root pathways are preserved and act as a conduit for water infiltration through the bio pores. These soil water pathways seem to persist well into the next season but are destroyed by the soil disturbance typically caused by tyne seeders.

SCF partnered with South Coast NRM and the GRDC to validate these observations of non-wetting soil improvement, using a paddock belonging to the Wood family at Kendenup, that has been continuously cropped for the last 18 seasons using a disc seeding system. SCF proposed to evaluate long-term nil disturbance seeding systems by re-applying conventional tyne seeding systems across parts of the paddock and measuring the effects on soil condition and crop performance.

The long-term nature of this trial is important as there is a lack of long-term farming systems studies, especially in WA, with almost all trials being discontinued before reaching 10 or more years of recorded measurements.

Trial Design

This trial tested three seeding treatments over two seasons, 2016 and 2017:

1. Nil disturbance – disc seeding
2. Tyne seeding- conventional one pass seeding
3. Maximum disturbance- scarifying the soil immediately before seeding with the tyne seeder

We then compared differences in soil water repellence, plant establishment and yield. Brad seeded canola in 2016 and field peas in 2017.

Figure 1: *Jeremy Wood disc (slot) seeding plots of field peas on May 2017. Soil conditions were marginal. The local area was experiencing decile 1 rainfall conditions at seeding time.*

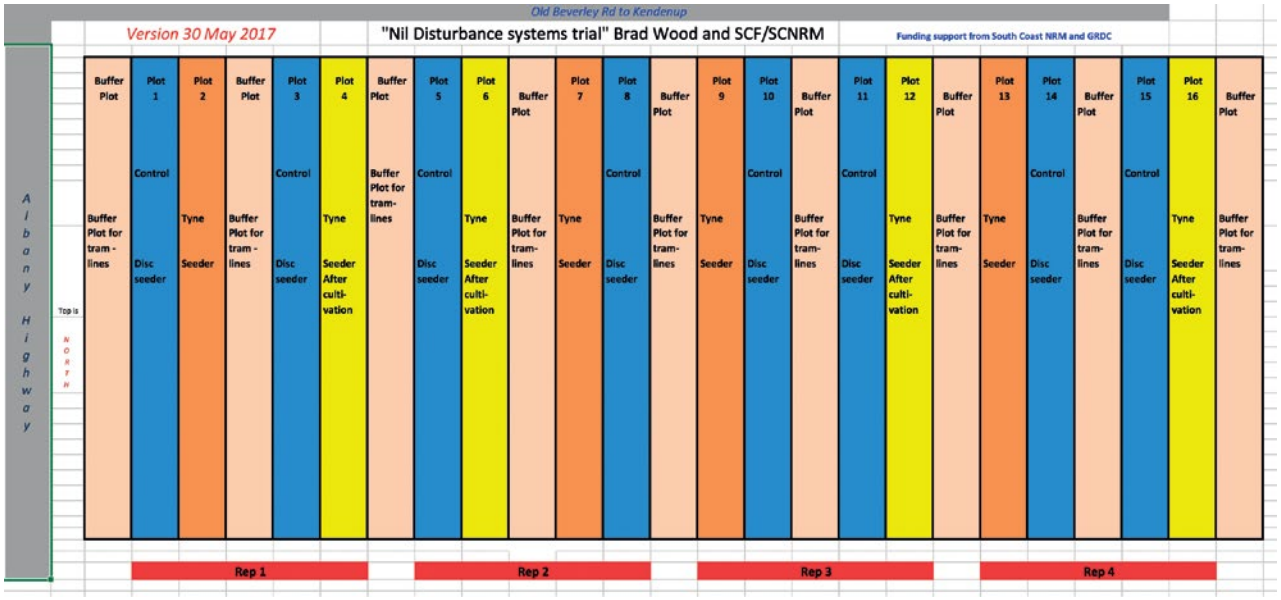

Figure 2: *Diagram of the trial layout showing the three treatments plus the buffer plots which are used by the farmer to apply herbicides and fertilisers.*

The plots were 10m wide by 250m long. Brad Wood used his Daybreak single disk seeder to seed the "control" disc treatment. Another local farmer, Ben Oldfield, was contracted to seed the "tyne seeder" and "tyne after cultivation" treatments. Brad Wood used his scarifier to plough the soil to a depth of 15cm immediately prior to Ben seeding with the tyne seeder for the "tyne after cultivation" treatment. All seeding treatments were completed on the same day; in 2016 canola was sown on May 13th and in 2017 field peas were sown on 1st June.

Buffer plots were included to allow inputs, such as fertilizer and herbicides, to be applied to the plots without wheel damage occurring in the treatment plots themselves. The Wood family are controlled traffic farmers (CTF) and this trial design allows them to maintain their tramlines without compromising the trial results.

After seeding all trial maintenance was performed by the farmer who applied the same inputs as the rest of the paddock. SCF conducted assessments on plant numbers established after seeding and yield at harvest using a weigh trailer.

Glenn McDonald (DPRID soil researcher) conducted soil testing over the site, including top soil water repellence measured using the Molarity of Ethanol Droplet (MED) test. The site averaged <2.5 for this test indicating severely non-wetting soils which is typical of the Forest Gravels in the Southern region.

The trial layout was determined after soil testing and mapping the paddock for high, medium and low productivity zones. These were based on yield map history, biomass imagery, targeted soil tests and soil mapping. The mapping was completed in Feb-March 2016 and Feb-March 2017.

Results

The trial was challenged in the first year (2016) with the soil water levels well above the field capacity of the Forest Gravel soil for three months of the growing season (Decile 9). Tillage treatments exacerbated the surface waterlogging, but the disc sown treatment was significantly more trafficable. The benefit of a long-term trial is, of course, being able to compare treatments over the full range of seasons. The second growing season (2017) was a stark contrast, with a very dry start (Decile 1) and plant establishment occurred under marginal soil moisture conditions. Plant establishment of the field peas was reduced in all of the tillage treatments (see results below). The drying topsoil in the seedbed was exacerbated by the tyne treatments in comparison to the disc seeding.

Plant count results

In the 2016 season there were good rains following seeding of canola on May 13th, which meant the expression of non-wetting, in this typical Forest Gravel, was minimal. The start of the 2017 was the other extreme with field peas sown into marginal moisture conditions in early June.

2016: Canola	
Nil disturbance treatment	34 plants/m^2
Tyne seeder treatment	41 plants/m^2
Tillage to 15cm soil depth immediately prior to tyne seeding	40 plants/m^2

2017: Canola	
Nil disturbance treatment	25 plants/m^2
Tyne seeder treatment	20 plants/m^2
Tillage to 15cm soil depth immediately prior to tyne seeding	17 plants/m^2

Figure 3: *Field peas on the 20th August 2017. There was improved plant establishment and biomass in the disc seeding treatment (on the right, averaging 25 plants/m^2) compared to tyne treatments (on the left averaging 20 plants/m^2).*

Harvest results

In 2016 there were no significant differences between the treatments (as marked by*) which was not an unexpected result due to a combination of factors (see below Table 1):

i. Treatments have longer term effects and are not expected to impact on crop performance in the initial years of the study

ii. Non-wetting in 2016 was not an issue, even in April, with a decile 10+ first half of the growing season.

iii. Canola is an indeterminate plant type and can compensate for lower plant densities. There were more than enough canola plants for its potential yield to be fulfilled.

In 2017 the yield of field peas in the disc seeding treatment was significantly higher (as marked by^) than the other treatments. This reflected the higher plant establishment in the disc seeder treatment in a tough, decile 1 season.

With just two seasons of results there are already differences measured in the seeding/disturbance treatments. The coming seasons with cereal and legume crops plus (hopefully) more moderate rainfall will provide a better understanding of nil disturbance seeding systems in Forest Gravel soils.

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Table 1: Table of the treatment average yields for 2016 (canola, decile 10) and 2017 (field peas, decile 1) (each having four replicates).

Year	Seeding system	Slot seeder (Disc)	Tyne seeder	Tyne seeder post cultivation
2016	Canola Kg/Ha	1959*	1956*	2034*
2017	Field peas Kg/Ha	1490^	1150	1080