Report on Strip Till trial

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5 July 2021

Summary

There was no difference in radish seed yield (935 kg/ha) between strip till and full cultivation when sown during the spring of 2020. Initial radish growth in the strip till was slower than full cultivation with the radish being slightly shorter and with fewer flowering branches by 24 December.

Introduction

The standard preparation of many arable crops, including radish, generally involves moving the complete soil mass in the top 15 cm using plough, discs, and rippers etc. All of these tools create significant disturbance to soil aggregates in order to create a fine seedbed required for consistent seed to soil contact which provides even germination and emergence. However, many crops do not necessarily require a fine seed bed, and therefore can be established using reduced tillage techniques. These techniques have many benefits, including reducing soils disturbance and damage to soil aggregates, retention of soil moisture, and reduction of soil erosion. Strip tillage has been used to establish maize and other crops grown in wide rows where the in-between row space can be left undisturbed. Potential benefits include:

- Conserves energy during cultivation because only part of the soil is tilled,
- Reduces soil erosion because 50% soil remains covered with crop residue throughout the year,
- Conserves soil moisture because 50% of the soil surface area is covered with crop residue,
- Results in crop yields that are similar or higher, compared with other tillage systems
- Reduces expenses by eliminating some primary and secondary tillage

This experiment aims to investigate if the seed yield of radish can be maintained through the use of strip tillage compared with full cultivation. Radish seed crops are established in 50 cm row spacings, assuming 10 cm is required to create a fit for purpose seedbed, 80% of the soil could potentially be left undisturbed.

This report has three Sections:

1. Radish strip till trial
2. Handout for the Strip till Field day held on 17 December 2020
3. Case study based on interviews with six growers using strip-till;

1. **Radish strip till at Leeston**

Methods

The trial was located on Pooles Road near Leeston, Canterbury (43° 46’ 49.99”S; 172° 16’ 10.57” E). Previously the paddock had grown green feed oats planted 12 April and terminated with glyphosate on 17 August following grazing. The oats were grazed multiple times over winter leaving a layer of plant material covering the soil at the end of grazing. Base fertilizer was broadcast and incorporated in with cultivation or strip till. The trial had four replicates with paired plots of conventional tillage and strip till cultivation. The trial was sown in a European round radish with the female line, SPS11030FM and the males SPS11030M, in a ratio of 6 female rows and 2 male rows in 50 cm wide rows. The full cultivation area was disced, Maxi-Tilled for Treflan (active ingredient (a.i.) 480 g/L trifluralin herbicide) incorporation, base fertiliser applied and disced and ‘Cambridge rolled’ before planting. The strip tillage utilised a Kverneland Kultistrip machine with the first strip till pass on 1 September (Figure 1 handout), followed by a second pass on 10 September, then ‘Cambridge rolled’ before drilling. Treflan was applied to this area at the same time as full cultivation but not incorporated. Drilling used the same precision planter for both treatments targeting 9 seeds/m of drill row. Standard crop management was applied to both conventional and strip till radish by the grower for the rest of the season.

Pre-harvest, the crop was desiccated using 4.5 L/ha Reglone® (a.i. 200 g/L diquat) + 1.5 L/ha Uptake™ spraying oil on 4 April. The crop was combine harvested on 9 May with a Case IH, ‘Axial Flow’ combine.

Trial Layout and Design. Plots consisted of female beds (12 rows each 50 cm apart) flanked on one side by a male bed (four rows each 50 cm apart). Plots were the length of the field. The trial design was a randomized block design with four replicates.

Crop inputs. All crop inputs (fertiliser, fungicides and irrigation) were applied by the grower.

Assessments

Seedling counts. Radish seedling establishment was assessed on 23 October 2020, 5.5 weeks after drilling, by counting the number of radish seedlings in one metre of row at five locations per plot.

Weed assessments. Weed numbers were assessed in 1 m^2 quadrats on 24 December 2020 at five locations in each plot. The dominant weed was shepherd’s purse (*Capsella bursa-pastoris*).

Canopy height. Canopy height was assessed at five points per plot on 24 December 2020.

Flowering branches. The number of flowering branches per plant was counted *in-situ* on five plants per plot on 24 December.

Soil moisture. Neutron probes were placed in three places in each plot (24 probes) by Aqualink with weekly measurements made from 25 November 2020 until the week prior to harvest. Soil moisture was measured at five depths and summarised into three bands: 0-30 cm, 30-40 cm and 40 cm-60 cm.

Disease assessment. White blister disease (*Albugo candida*) was assessed on 26 February 2021 by counting the number of infections in 10 quadrats, each 1 m^2 per plot.

Seed harvest. The crop was machine harvested by the grower with a Case-IH, 'Axial Flow' combine on 9 May 2021. Each plot was harvested separately, a distance of 194 m by 3 m wide (one 6 row female bed) and the yield assessed by weighing the harvested seed in a weigh wagon. The machine dressed seed yield was calculated assuming a 20% seed dressing loss and adjusted to include the width of the area occupied by the male rows.

Results and Discussion

There was no difference in the number of seedlings established six weeks after planting or on weed density in late December between full cultivation and strip-till treatments (Table 1). At the start of flowering (24 December) the strip till plants were, shorter and had fewer flower branches (Table 1). This is in line with the grower's observation that the strip till was slower in growth than the fully cultivated. It is probable that the soil in the fully cultivated area was slightly warmer and thus allowed for better early season growth.

There were fewer white blister lesions in the strip-till treatment compared with full cultivation (Table 1), however the overall number of lesions was low suggesting the growers fungicide program was adequate to control the disease. However, none of these differences were adequate to result in seed yield differences between the two establishment practices with a mean yield of 935 kg/ha.

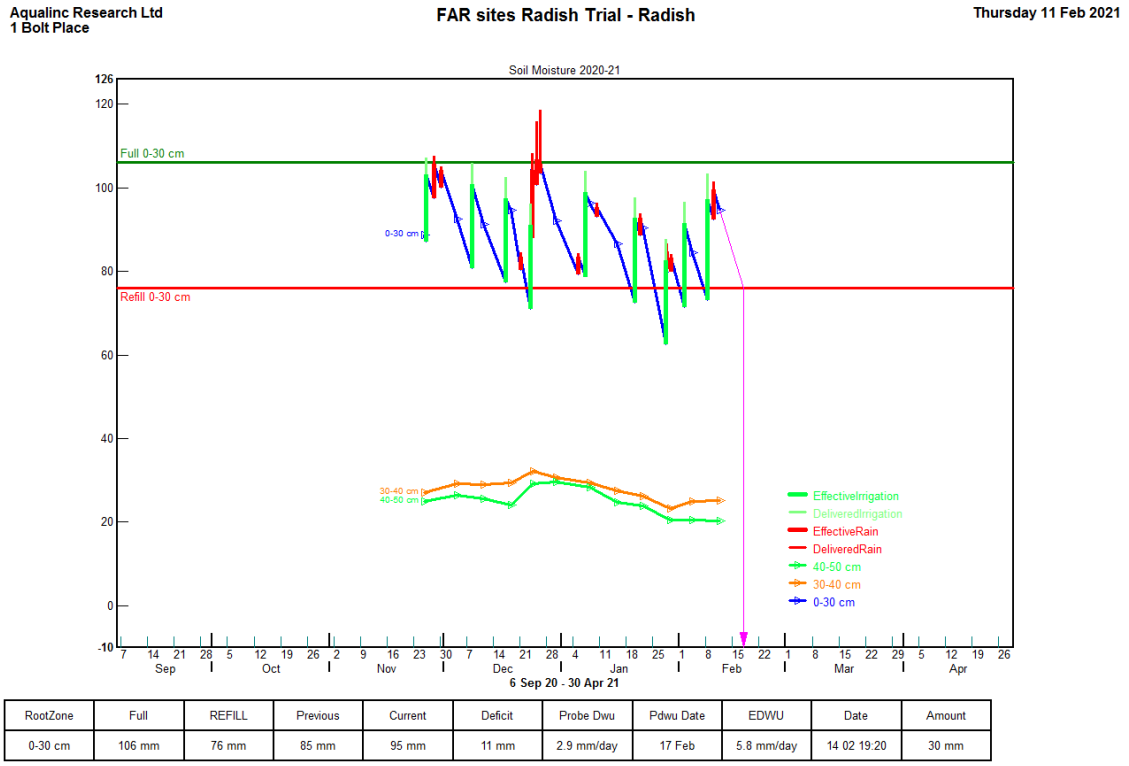
In this irrigated crop the average soil water deficit was slightly less (4 mm) in full cultivation. This was associated with a difference at the first readings (Table 2). The maximum deficits between the two establishment practices were not significantly different. The average weekly soil moisture readings are shown in Figure 1.

Table 1. Seedling numbers 5.5 weeks after sowing, plant height, weed density, number of flowering branches per plant, white blister lesions and seed yield for full cultivated and strip till radish seed crop at Leeston.

	Seedling (m^2)	Height (cm)	Weeds (m^2)	Flower branches (per plant)	White blister lesions (m^2)	Seed yield (kg/ha)
Treatments	23-Oct		24-Dec		26-Feb	9-May
Full	17.2	976	3.9	11.1	9.8	910
Strip-Till	16.5	835	2.9	8.7	7.4	960
LSD 5%	3.3	136	4.5	2.3	1.4	118
F. prob	0.52	0.046	0.53	0.048	0.011	0.184
Significance	NS	*	NS	*	**	NS

Table 2. Maximum and average soil moisture deficit 25 November – 16 February 2021 for full cultivation versus strip till radish seed production grown with irrigation at Leeston 2020/21.

	Max deficit (mm)	Avg deficit (mm)
Full	25.4	12.6
Strip	28.4	15.6
LSD 5%	8.0	1.4
F. prob	0.32	0.006



RootZone	Full	REFILL	Previous	Current	Deficit	Probe Dwu	Pdwu Date	EDWU	Date	Amount
0-30 cm	106 mm	76 mm	85 mm	95 mm	11 mm	2.9 mm/day	17 Feb	5.8 mm/day	14 02 19:20	30 mm

Figure 1. Soil moisture deficit (combined data for full and strip-till) for the growing season at Leeston 2020/21.

Conclusions

There was no difference in the seed yield.

Acknowledgements

David Birkett, the grower for hosting the trial and harvesting; Allister Holmes (Lincoln Agritech, and formally of FAR) for establishing the trial, Wadia (Diwakar Kandula), BioProtection Research Centre, Lincoln University for assistance with disease assessment; NZ Arable for weigh wagon yield assessments, James Taylor of South Pacific Seeds Ltd for crop management advice and support.

Strip tillage seed crop establishment – 17 February 2021

Courtesy of: David Birkett, Leeston and Stu Macauley, Altonbrook

Presenters: Allister Holmes (Lincoln AgriTech); John Evans (LandWISE)

Partners: Rural Professional Fund, Our Land and Water – National Science Challenge; Lincoln University - Prof. John Hampton

Strip till demonstration machine for 17 February: Simon Jackson, Power Farming, Ashburton, on loan from Josh Kingsbury.

Background

Tillage can be a valuable tool to dry out the soil, bury weeds or crop residue, and break up compacted soil. However, its stirring and shearing action stimulates microbial breakdown of beneficial soil organic matter and can also create very fine particles, which are prone to erosion and compaction. Reduced tillage establishment is another option and can help minimise soil degradation.

Reduced tillage

The establishment of crops using reduced tillage techniques is widespread internationally. Reduced tillage methods include no-till, reduced tillage, and strip-till.

Strip-till establishment:

- Conserves energy, because only part of the soil is tilled.
- Reduces soil erosion, because 50% of soil remains covered with crop residue.
- Releases less carbon into the atmosphere and maintains levels of soil organic matter.
- Warms the tilled strips in spring to promote seed germination and plant emergence.
- Conserves soil moisture, as 50% of the soil surface area is covered with crop residue.
- Results in crop yields that are similar or higher, compared with other tillage systems.
- Reduces expenses, by eliminating some primary and secondary tillage.

However, reduced tillage requires an additional capital investment, and insect pressures, particularly slugs, are greater.

Strip till, provides the benefits of cultivation (i.e. warmer, drier, and softer soils) with some of the advantages of no-till (i.e. retain more soil carbon, reduced risk of soil erosion, and greater soil water retention).

North Island strip-till successes

In strip-till trials carried out on heavy soils in Poverty Bay between 2000 and 2006, there was no significant difference in the yield of maize grain crops grown using full cultivation and strip-till establishment techniques. These results have been repeated in trials in Poverty Bay since 2017, and in Waikato since 2008. The Waikato trial has also shown that soil carbon reduced more slowly in no-till and strip-till systems than in fully cultivated systems.

Strip-till establishment is on the increase in North Island, with at least six new machines being used for the 2019 planting season. This is partly because of the findings of long-term trials showing no difference in yield, but also due to the clear and strong message from Environment Waikato and other regional councils that cultivation of paddocks near to waterways will be considered a high-risk activity due to the risk of soil sediment losses to waterways.

David Birkett radish strip till background

The trial has four replicates with paired plots of conventional cultivated and strip till. The paddock was ex green feed oats planted 12th April and terminated with glyphosate on the 17th August. The cover crop was grazed multiple times over winter leaving a layer of plant material covering the soil at the end of grazing. Base fertilizer was broadcast on, and incorporated in with cultivation or strip till. First strip till pass 1st September (Figure 1), followed by a second pass on the 10th September, then Cambridge rolled before drilling. Standard crop management applied to both conventional and strip till radish (Figure 2) for the rest of the season.

Fig. 1. Radish strips into stubble 1 September 2020 using a Kverneland Kultistrip machine

Fig 2. Radish establishing in strip till on 8 October 2020

Stu Macauley sunflower strip till background

59 ha established with strip till into a grazed annual species cover crop containing ryecorn, oats, annual ryegrass, crimson clover, peas, faba beans, lipons, phacelia, and buckwheat mix that was terminated with a Roundup + Hammer spray mix. Strip till was undertaken by Riverlea Contracting using a 6 m wide strip till between 15-18th October and the paddock was planted on 31st October with a high oleic oil sunflower (PureOil). The crop (Figures 3 & 4) was established using Stomp® herbicide (post-plant, pre-emergence) and Spata™ for springtail control.

Fig. 3 Strip till sunflowers with cover crop remnants

Fig. 4. Strip till sunflowers 5 Feb 2021

2019 Red beet seed crop - Simon Lochhead (Rakaia) strip-till background

A red beet crop was sown in April 2019 (Figures 5 & 6).

Fig. 5. Red beet crop being sown with a Kverneland Kultistrip machine.

Fig. 6. Red beet crop on 18 June 2019. Note the strip-tilled rows in between the residue of the previous ryegrass seed crop and the narrow band of cultivated soil at 50 cm row spacing. Some weeds are present in the cultivated strips.

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Strip-Tillage Case Study

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5 July 2021

Minimum tillage has become very popular in the New Zealand cropping system. Strip tillage is regarded as a minimum tillage system but can be hard to define as there are many different systems that all work slightly different to each other. Seedbed preparation to cultivate a narrow strip for seeding a crop while maintaining an uncultivated area has widely become the accepted definition. The objective of strip tillage is to form a seedbed condition in the row that is similar to that achieved by traditional cultivation that might include mouldboard ploughing and discing.

Strip tillage has allowed farmers to negate some of the problems associated with both direct drill and conventional tillage practices. Benefits of strip tillage provide adequate tilth for conventional planters to establish a variety of crops with out disturbing the entire paddock. Soil and wind erosion are greatly reduced by leaving a large area of the paddock uncultivated. Uncultivated soils maintain soil strength and increased soil health with the ability to maintain moisture that would be lost in conventional tillage system. The ability to graze live stock on paddocks during winter increases the profitability of the system. If soil can maintain its structure and not become degraded stock can be grazed during times it would not otherwise be possible.

The aim of this survey was to quantify what farmers who use strip tillage in their system receive from this practice. The different machinery in use on our farms and how this machinery is used. A telephone survey of six farmers across Canterbury that currently use strip tillage in their farm system was undertaken in May 2021, using a list of questions (Appendix 1) to gauge the different experiences and opinions of this practice.

Machinery options. Strip tillage equipment comes in a variety of models and cultivation arrangements. In our survey 2 commercial strip tillage machines were commonly used. The ***Kverneland Kultistrip*** which is a dedicated strip tillage system with changeable row spacing of 45 – 80 cm. Cultivation depth can be altered between 10-30 cm. Seed drilling is a separate operation. The ***Mzuri*** strip tillage drill is a multi-role tillage and seed drill. It has a pre-cultivating cutting disc and cultivating tyne to work the area to a level below the seed bed. Both machines are capable of band fertiliser application with granules of uniform size and offer many attachments to add extra capabilities. DAP (Di- Ammonium Phosphate) was preferred fertiliser at establishment, rates ranged from 150-250 kg/ha. The majority of respondents used pre-season soil tests to determine the fertiliser used and the applied rate.

Strip tillage has allowed farmers to cultivate into a previous season grass seed crop with minimal soil disturbance. This would previously involve more invasive cultivation technique to prepare a suitable seed bed. 100 percent of farmers surveyed noted this as a fundamental advantage when considering strip tillage over conventional minimal tillage systems.

Depending on what strip tillage system is used, dramatically changed the paddock management to produce an adequate seedbed. Respondence that use the Kverneland Kultistrip all agreed that to get a good seedbed it was imperative to spray out grass paddocks with herbicide. Typically, glyphosate is broadcast sprayed at least 6 weeks prior to cultivation. Only 1 respondent had used banded

herbicide application in the past. Pre-strip till sward termination with glyphosate allows the root mass to break down to allow soil shattering to produce an appropriate seedbed. The Mzuri system is generally different with most respondents answering that if the paddock is left sprayed off for too long the drill can kick out clogs which then need to be Cambridge rolled after seeding.
The number of cultivation passes needed to prepare a satisfactory seedbed is dependent on the soil condition and it is a risk to believe that strip till is only a one pass cultivation system.

A large range of crops were currently drilled with strip tillage but most are wide rowed seed crops such as:

- carrots,
- red beet,
- spinach,
- radish,
- sunflower,
- maize,
- kale and
- Chinese mustard.

Most respondents were relatively new to strip tillage, only using the technology for the past one or two seasons. One respondent had been using strip tillage for over 10 years.

Strip tillage has been proposed to offer many potential benefits for a multitude of different crops. The information received from the survey highlighted some key mutual benefits received from strip tillage amongst the growers. Maintaining soil structure and reducing compaction from live stock over winter was a very dominant response to the survey. Other proposed benefits strip tillage can offer were protecting soil biology and structure while reducing wind and water erosion. Reduction in compaction from reduced machinery passes on the paddock, less horsepower required as only a fraction of the total area is cultivated. All of which leads to a reduction in machinery running costs and carbon emissions.

To get the best out of strip tillage planning and preparation is key to a good strip tillage experience. Making sure all factors have been considered prior to cultivation will allow for good establishment. This is paramount for success. Understanding the potential problems before they arise will ultimately lead to a favourable strip tillage experience for example ‘increased slug pressure’. When relying on contractors a new range of problems exist, e.g. making sure the GPS lines up with drilling and the strip till is crucial. Problems have arisen from using different precision agriculture self-steer systems. This can result in the seed drilled outside or on the edge of the strip till.

The biggest limitation to using strip tillage is machinery cost. It is unrealistic to buy a strip till capable drill or cultivator especially on a smaller farm which has limitations on the variety of crops it can establish. As the practice becomes more widespread and more contractors are offering strip tillage, costs will reduce. It is important for users to understand that strip tillage is not a quick turnaround system so good planning and preparation is essential.

All of the farmers questioned in this survey replied that they would continue to use strip tillage in their farm operation. These farmers also commented that there is an adequate number of

contractors offering strip tillage and cost was not a draw back when all the potential benefits are considered.

Acknowledgement: FAR would like to thank all farmer who participated in the case study:

- James Thomas (Eiffelton, Ashburton District)
- John Evans (Wakanui, Ashburton District)
- Paul Taylor (Ashton, Ashburton District)
- Richard Peckitt (Pleasant Point, Timaru District)
- Simon Lochhead (Barrhill, Ashburton District)
- Stu Macaulay (Leeston, Selwyn District)

Appendix 1. Survey Questioner

1. What type of strip till system do you or your contractor use;
    a. Shank + coulter –
    b. Coulter only -
    c. Rotary hoe system -
2. Are you able to band fertiliser with your strip till unit?
3. If so,
    a. what fertiliser type do you use?
    b. what rate do you apply?
    c. how do you determine the fertiliser type and rate to be applied?
4. Do you do one or two passes with the strip till unit?
5. What is your herbicide practice prior to strip tilling?
    a. No herbicide used
    b. Herbicide applied across all the field
    c. Banded
6. What species have you grown with strip till?
7. Do you use a 'standard' or no-till planter when planting into strip till?
8. Does the planter apply a starter fertiliser?
9. If so,
    a. what fertiliser type do you use?
    b. what rate do you apply?
    c. how do you determine the fertiliser type and rate to be applied?
10. Does the planter have any unique technologies and if so what?
11. Which crops does strip till work best for you?
12. What year did you first try strip till?
13. What makes for a successful strip till experience?
14. Have you had any bad experiences and what went wrong?
15. What factors or advantages did you see from strip till?
16. Will you continue using strip till?
17. Other comments or thoughts?
18. What research is needed in strip till?
19. What crops/if any would you consider to establish with strip till that you don't already do?
20. What is your key driver when considering strip till over conventional cultivation?
21. What do you see as the biggest limitation/uptake to using strip till?
22. Are there enough contractors offering strip till?
23. Is cost of strip till compared to conventional tillage a limitation?