GROWING SUCCESSFUL BRASSICA CROPS – AND WHAT ABOUT FODDER BEET?

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Introduction

The Forage Brassica Development Group (FBDG) is a farmer-based organisation funded by the MAF Sustainable Farming Fund, Dairy NZ, Meat and Wool NZ and Pasture Partners. From 2006-2009 we conducted experiments, field days and workshops on brassica agronomy throughout NZ, with the main recommendations and conclusions being summarized in a booklet entitled 'Management practices for forage bassicas' by John de Ruiter *et al*. This booklet is the key reference for the paper I am presenting today.

Our experiences would suggest that the success or failure of a brassica crop is determined by the planning and preparation conducted in the month or so prior to sowing, sowing the crop in a husband like manner and finally what happens in the fortnight after sowing. A few timely rains can help, but consistent and reliable yields are the result of attention to detail: luck has very little to do with it.

In this paper I will therefore concentrate on establishment, but also yield assessment as in our experience the latter is often assumed or not taken seriously. Growers seeking information on other topics and issues especially cultivars and utilisation should refer to the booklet.

Crop establishment

Planning

Planning for brassica crops should include a long term strategy that considers crop sequences, maintenance of soil fertility and structure, weed and pest control as well as the requirements for feed supply.

Often the 'worst' paddock on the farm is chosen to grow a brassica crop because it is targeted for regrassing. Such paddocks may require high inputs of lime and fertiliser and adequate time for practises such as fallowing. The provision of adequate water, a suitable run-off and perhaps adequate drainage may also need to be addressed.

Conventional cultivation

The aim is to produce the desired seedbed at minimum cost and on time, with brassicas requiring a seedbed that is fine, firm, warm moist and free of weeds. Within this general aim there are several objectives of cultivation.

Bury plant material such as turf or crop residues. This is best achieved with a mouldboard plough set to a depth of about 25 cm. While some contractors prefer discs as they can cover large areas quickly, discs do not bury plant material and are best reserved for very steep (say > 15 degree) slopes or bouldery soils. Turf left on the soil surface is likely to harbour pests such as springtails and Nysius fly.

Reduce the bulk density to encourage root penetration.

Encourage mineralisation of plant nutrients especially nitrogen. Mineralisation may take several months under dry and or low fertility situations with a C/N ratio in excess of about 20/1.

Control annual and perennial weeds. Problem perennial weeds cannot be successfully controlled once the brassica crop is sown and are probably best controlled with herbicide prior to or during cultivation. Severe infestations of twitchy grass weeds such as couch or browntop may require two hits: spray out in late-summer and sown with Italian type ryegrass. Spray out a second time in spring before preparing to sow a brassica crop.

Consolidation is required in the latter stages of seedbed preparation usually in conjunction with moisture conservation described above. It is best achieved by the use of tyne harrows and a Cambridge roller often in combination. While power harrows are useful for producing a fine tilth on difficult soils and/or in wet seasons, they do not produce a consolidated seedbed and their over-use can destroy soil structure.

Subsoiling may increase yield up to 30% if there is restricted root penetration. Pay particular attention to headlands where extra compaction is likely to occur and tramline runs on cropping farms.

Direct drilling and coulter drilling

If executed correctly drilling should place the seed in contact with soil moisture to promote rapid uniform germination and emergence. Drilling also allows fertiliser and/or insecticides to be sown close to the seed for maximum benefit. The use of drills gives maximum control of seed placement while broadcasting of seed on to the soil surface provides minimum control, often resulting in mediocre crops. Drills use less seed than broadcasting but are slower and more expensive than broadcasting.

None of the intensive mixed cropping farmers that I know would ever contemplate broadcasting seed. Having said that, they would probably never contemplate milking cows either.

Direct drilling or no till is the drilling of seed into uncultivated soil without prior soil disturbance. It requires a complete kill of existing vegetation with 1-2 applications of herbicide before sowing. Under dry conditions the first spray should occur at least 2 months prior to drilling to conserve soil moisture, this practice being known as a chemical fallow.

Conversely on wet soils herbicide application can be delayed to avoid soils becoming too wet.

Higher rates of N fertiliser are required with direct drilling especially at sowing as there is little mineralisation compared with full cultivation (ref. para. Encourage mineralisation).

Pests such as springtails and slugs are much more prevalent with direct drilling and control is not negotiable.

Direct drilling requires specialist machinery of sturdy construction as it has to perform partial cultivation. It needs to have specialized coulters to aid soil penetration and create a favourable micro-environment in the soil slot. Finally these specialist machines require a competent and experienced operator.

There is some evidence to suggest that there is less soil pugging when grazing direct drilled crops than those sown after full conventional cultivation.

Comparison of conventional cultivation with direct drilling

Farmers consistently asked to FBDG to conduct experiments comparing conventional cultivation (CC) with direct drilling (DD). To be scientifically robust such a comparison needs to compare best practice methodology for both sowing methods. Farmers also asked us to investigate fertiliser usage. In the first two years the best that we achieved in the experiments that I was associated with was to compare awful CC with mediocre DD. In the final season (2008-2009) we got it right and these are the results that I shall present here. The first experiment involved growing Barkant turnips in the Waikato, while in the second we grew kale and swedes in Southland. These experiments also examined fertiliser placement for both sowing methods.

Waikato experiment, Barkant turnips

Host Farmer: Richard Henderson, 30 Henderson Road, Horsham Downs

Soil test results: pH 6.4, Olsen P 27, K = 14, Ca = 11, Mg = 32, Na = 8, SO_4 – S = 4, mineralisable N = 130 kg/ha

Site preparation

- Conventional cultivation (CC)

  The site was ex pasture

  6 Oct sprayed with Roundup @ 41/ha plus 60 g/ha Granstar

  10 Oct grazed and 2.5 t/ha of lime applied

  11 Oct mouldboard ploughed and rolled with tractor wheels

  3 Nov light power harrow and double Cambridge rolled prior to drilling

- Direct drilling (DD)

    As above but no cultivation

    28 Oct sprayed with Roundup at 81/ha plus Diazinon at 500 ml/ha

Sowing

Barkant turnips were sown on 3 November 2008 @ 2 kg/ha using Superstrike treated seed. CC plots were sown with a Taege drill, DD plots were sown by Greg Miller using a Cross-Slot drill.

Experimental design

- 24 plots
- Main plots
    - conventional cultivation
    - Direct drilling
- Sub plots - F1 no fertilizer
    - F2 DAP at 200 kg/ha banded under the seed
    - F3 DAP at 200 kg/ha broadcast on the soil surface
- 15 kg/ha Boronate was applied to whole area just prior to sowing

Crop management

- Slug out was applied at 10 kg/ha to all DD plots at sowing
- 3 Dec applied Tordon Max @ 1 L/ha, Centurion Plus @ 500 m/ha
- Perfekthion @ 350 ml/ha, 36 Kg N/ha applied to all plus fertiliser plots as urea
- 7 Jan applied Perfekthion @ 650 ml/ha

Yields

A 3 m^2 sample was harvested from each plot on 14 January 2009, weighed fresh and 3 representative plants removed to determine leaf/bulb ratio and dry matter content.

Table 1. Yields and yield components

				Kg DM/ha	
		Plants/m^2	**Leaf**	**Bulb**	**Total**
	F_1	52	4.5	5.2	9.7
Cult	F_2	60	6.9	5.1	11.8
	F_3	46	6.2	5.1	11.3
	F_1	36	4.9	4.9	9.8
Direct drill	F_2	34	4.9	5.1	10.1
	F_3	40	6.2	4.6	10.9

- The mean total yield of 11 t/ha in the cultivated plots was significantly higher than 10 t/ha from the No-till plots.
- Total yield was increased by fertiliser not affected by fertiliser placement.
- Yield differences were mainly due to differences in leaf yield as all treatments produced around 5 g/ha of bulb.
- More leaf DM was produced from banded fertiliser on cultivated plots than with No-till.
- Final plant populations were significantly higher in cultivated plots (52 plants/m^2) than No-till plots (37 plants/m^2).

Swedes and Kale, Southland

Host Farmer: Graeme Gardyne, Chatton, Southland.

Objective: Demonstrate best current practice in growing swede and kale crops in a fully replicated and randomised experiment.

Soil test results: pH 5.9, Olsen P 16, K 5, Ca = 9, Na 4, available N (15 cm depth) 262 kg/ha.

Site preparation

Conventional cultivation

- The site was ex pasture
- 4 Nov 2009 – sprayed with Roundup @ 41/ha plus 60 g/ha Granstar
- 7 Nov 2009 – grazed
- 20 Nov 2009 – mouldboard ploughed and power harrowed
- 24 Nov 2009 – Treflan applied at 2.5 1/ha and Lorsban at 500 ml/ha then power harrowed

No – till

As above but no cultivation.

- 24 Nov 2009 sprayed with Roundup @ 41/ha and 500 ml/ha Lorsban

Sowing

Aparima swedes and Sovereign kale were sown on 1 Dec 2008 using Superstrike seed. Kale was sown at 4 kg/ha in all plots, Swedes at 1.5 kg/ha in No-till areas and 0.8 kg/ha with the ridger.

In the cultivated treatments Swedes were sown with a ridger, and kale with a Taege drill. No till plots were sown by Alastair Henderson using a Cross – slot drill.

Experimental design

- Separate experiment for kale and Swedes, each experiment contained 24 plots
- Main plots
    - Conventional cultivation

- No – till or direct drilling – D/D

- Sub plots
  - F1 – no fertiliser
  - F2 – Triple superphosphate at 50 kg P/ha banded under the seed
  - F3 – Triple super phosphate at 50 kg/ha broadcast on soil surface

The entire experimental area received 15 kg/ha Boronate and 50 kg/ha of KCl just prior to sowing:

Crop Management

- Slug out was applied at 10 kg/ha to all No-till plots at sowing.
- 30 Jan 2009 – 70 kg N/ha of N as urea applied to F2 and F3 treatments in both kale and swede experiments.
- 7 Feb 2009 – Versatill @ 1l/ha and Tordon Max @ 1.5l/ha applied by helicopter to swede plots only.
- 2 Mar 2009 – 70 kg N/ha of N as urea applied to F2 and F3 treatments in both kale and swede experiments.

Yields

A 3 m^2 sample was harvested from each plot on 18 May, weighed fresh and a subsample of three plants removed to determine leaf/stem ratio for kale, leaf/bulb ratio for swedes and dry matter content.

Table 2. Yields and yield components - Kale

				Kg DM/ha	
		Plants/m^2	**Leaf**	**Bulb**	**Total**
	F_1	53	3000	7460	10460
Cult	F_2	50	3410	9690	13100
	F_3	47	3540	10210	13750
	F_1	42	3230	7090	10320
No till	F_2	38	3960	9660	13620
	F_3	41	3490	10230	13720

- Total yield not affected by sowing method.
- Fertiliser increased total yield by about 3t DM/ha.
- Yield increase from fertiliser mainly due to more stem.
- Total yield not affected by fertiliser placement.

Table 3. Yields and yield components - Swedes

			Kg DM/ha		
		Plants/m^2	Leaf	Stem	Total
	F_1	16	1710	10100	11810
Cult	F_2	17	2690	11450	14140
	F_3	16	2770	11410	14180
	F_1	35	1990	11460	13450
No till	F_2	32	2730	12620	15350
	F_3	32	3280	10230	13510

- Highest yield produced by the No-till with banded fertiliser, approx. 1 t DM/ha more than ridging.
- In the absence of fertiliser No-till produced approx. 1.5 t DM/ha more than ridging.
- These yield differences were mainly due to differences in bulb yield.
- No-till plots had double the plant population of ridged plots.

The main conclusion from these and other experiments is that there is usually little difference in yield between conventional cultivation and direct drilling, providing current best practice is conducted for both sowing methods. Our experience would also suggest that it is easier to cut corners with direct drilling leading to disastrous results.

The results from fertilizer experiments have been less consistent. Generally a starter fertilizer containing phosphate enhances seedling establishment which can also assist with weed control. This initial response is sometimes reduced or eliminated by final harvest especially in kale and rape crops which have a more vigorous scavenging root system than the bulb-type brassicas such as turnips and swedes. For this reason turnips and swedes are more likely to respond to banding fertilizer than broadcasting, but this may not always occur. Plant and Food Research is still conducting detailed experiments on the fertilizer requirements of brassicas.

Time of sowing and thermal time requirements

Given best husbandry practice described above, together with adequate moisture, time of sowing is one of the most influential yield driver (Scott and Pollock, 2003). Thermal time (^{o}C days) determines the rate of leaf appearance, the amount of light a crop intercepts, and therefore drives growth. As a guide, brassicas accumulate yield at about 1.10 t DM/ha per 100^{o}C days. Scott and Pollock (2004) using Invercargill as an example showed that a brassica crop sown on 1 December would experience around 1540^{o}C days by late May to give a yield potential of about 17 t DM/ha.

Finally, late sown crops never catch up because bare soil does note photosynthesise.

Yield assessment of brassicas

Accurate yield assessment of brassica crops is vital when rationing feed and has to involve more than guesswork. Brassicas are often grown on areas with high variability in soil type and aspect and a sufficient number of representative samples needs to be taken to account for this variability. Each sample should involve say 3 m^2 on each of five different areas in a paddock. A 1 m^2 quadrat can be made by bending a 4 m length of wire into a square or bending a 3.54 length of alkathene pipe into a circle that also covers 1 m^2. Alkathene off-cuts can be used to control unruly staff and dairy farmers' dogs.

After weighing the sample fresh, a representative subsample needs to be taken and oven dried to constant weight at 90°C. Thick kale stems and large swedes may take two days of drying even when cut into smaller portions. Dry matter % should not be estimated: a well grown crop of turnips may have a DM% of around 8% while a woody kale crop from a low fertility, dry site may have a DM% around 20. There are no shortcuts to measuring this figure especially if feed is being purchased.

What about fodder beet?

As there is some renewed interest in fodder beet I have been asked to comment on this crop as an alternative to brassicas. Firstly, fodder beet is not a brassica. Brassicas like swedes and kale belong to the brassica genus, beets belong to the species *Beta vulgaris* which contains mangels, fodder beet and sugar beet. Fodder beet is a cross between mangels and sugar beet aiming to combine the ease of harvest of mangels with the high DM and high sugar levels of sugar beet.

In the 1980's both Lincoln University and MAF carried out extensive research on beet's potential for methanol production, as the Arabs had the whole world over a barrel. This research (e.g. Martin 1986a, Martin 1986b, Martin *et al.* 1983) led to some conclusions:

- Beets are best grown on deep high fertility soils with irrigation.
- Yield is directly related to length of growing season: for Lincoln this means sowing in September for harvesting/grazing next autumn/winter.
- The crop takes 2-3 months for leaf canopy closure and is susceptible to weed invasion during this period. Chemical weed control is expensive and may not be completely effective especially in early sown crops or with perennial weeds. Fodder beet should be grown in clean paddocks. The crop needs a firm, fine, moist and uncompacted seed bed for good establishment.
- Crops need to be precision sown in 0.5m rows at 80,000 plants/ha.
- It sounds weird, but on some soils fodder beet responds to applications of sodium chloride (common salt). It also grows best with a ph of 6.0 or over, so lime applications are required at least the previous autumn if pH is less than this.

- Beets are susceptible to aphid borne viruses and will need insecticide applications if aphid numbers build up.

My own observations of fodder beet crops over the 2009-2010 growing season showed that there are still issues with plant establishment and spacing, some of which may be related to seed quality.

As for brassicas, be wary of extravagant yield claims. At Lincoln our yields averaged around 11 t DM/ha by early June. The highest published yields I have found were from Stephen (1982) who grew fodder beet crops yielding up to 24 t DM/ha at Ashburton Forks in Canterbury. These same crops yielded in excess of 15 t/ha of total sugars which makes fodder beet much trickier to feed than brassicas due to the risk of acidosis (Nichol *et al.* 2003).

Farmer experience (Lloyd McCallum, *pers comm*.) would suggest that cows should be wintered right through on either brassicas or fodder beet. Changing crops part way through winter means that the animals have to go through the 'time to adjust' process twice (Nichol *et al*. 2003) with subsequent loss in animal production.

In summary I would recommend that growers thinking of growing fodder beet should do their homework thoroughly, seek the best available advice and proceed with caution. It is a high technology, high risk crop so don't even think about it unless you are already consistently growing 15 t DM/ha plus brassica crops. Similarly forget fodder beet if you have already trashed your soil structure with several successive brassica crops.

References

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