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MANURING OF PULSE CROPS FACT SHEET

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SOUTHERN REGION

MANAGING BROWN MANURE CROPS IN SOUTHERN NSW

Brown manuring of pulse crops is becoming an increasingly popular tool for weed management, particularly where there is herbicide resistance, and for boosting reserves of soil nitrogen for use by the following crop.

KEY POINTS

- Brown manuring can form part of a strategy to manage herbicide resistance.
- It boosts soil nitrogen while conserving moisture for the next crop.
- Cereal diseases, such as take-all and crown rot, can be reduced through use of break crops.
- The timing of spray application is determined by the target weeds.
- The value of a pulse needs to be considered in the context of the whole rotation.

PHOTO: LUKE GAYNOR

Pulses should be brown manured by either spraying out in early spring, to coincide with the critical growth stage of the weed, or waiting until plants reach peak biomass to maximise nitrogen fixation.

Brown manure cropping involves growing a pulse crop to spray out using a knockdown herbicide to prevent weed seed set and maximise nitrogen fixation. This is different to green manuring, where the crop and weeds are killed by cultivation.

There are three key reasons for brown manuring pulses – to help manage weeds, particularly if there is herbicide resistance present, to boost soil nitrogen and to conserve soil moisture for subsequent crops.

In crops where prevention of weed seed set is the primary aim, such as for herbicide-resistant annual ryegrass and wild oats, then it is essential to spray the knockdown herbicide before viable seed is set by weeds. Timing of herbicide application is determined by the growth stage of weeds rather that the pulse crop. Often a second knockdown herbicide application is necessary to kill surviving weeds, particularly those sheltered from the first spray by bulky pulse crops.

Brown manuring pulses can be used to maximise nitrogen fixation by delaying application of the knockdown spray until closer to crop maturity, or as it is reaching maximum dry matter production (see Figure 1). This approach relies on effective weed control and can double the nitrogen benefit of pulses.

Brown manuring pulse crops is becoming a more common practice, particularly in southern New South Wales, as cropping intensity increases and the frequency of pastures in rotations declines. Some growers in southern NSW have had difficulty in marketing pulses in recent years or have experienced damage to legume hay. These factors have influenced growers to consider including brown manured crops in a rotation, rather than leaving pulses out altogether.

For some grain growers, the perception is that the only viable cash break crop is canola. This has led to use of rotations of canola, wheat, canola, wheat or canola, wheat, wheat, which have accelerated development of herbicide resistance and increased the need for large volumes of applied nitrogen to maintain yield and grain protein.

Adoption of full stubble retention and wider row spacings have presented challenges for controlling grass weeds. This is due to reduced pre-emergent spray efficacy through stubble absorption and less crop competition for weeds, depending on the crop type and variety.

While there are doubts about whether continuous cropping sequences of only canola and wheat are sustainable in the medium or long term, brown manure crops are being used to address the immediate shortcomings.

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Advantages

The advantages of brown manure cropping include:

- Total, or near total, prevention of seed set in weeds.
- A weed, disease and pest 'break' for following cereals.
- For the next wheat crop, less disease as well as cost-savings in reduced nitrogen fertiliser requirements and seed dressings.
- Provision of organic N, which acts as a slow release form of nitrogen for following crops. A manure crop fixes about 25 kilograms of nitrogen per tonne of dry matter (DM), therefore the total nitrogen left for subsequent crops is in direct proportion to its growth.
- Nutrients are not exported from the paddock.
- It is possible to achieve a complete break from selective herbicides in the brown manure year.
- Water conservation, which is especially valuable if the following year is dry. This relies on maintaining good ground cover and weed control during the growing season and over summer before the next crop.
- Lower business risk with reduced cost of inputs and increased potential for higher quality product, such as H1 or H2 wheat, and hence a higher return.
- Extra nitrogen, with phosphorus and sulphur, can help retain and build soil carbon, which improves soil resilience, water availability and productive potential.
- Sowing canola after brown manure peas gives plants extra stored soil moisture and nitrogen, and extends wild oat seed set to two consecutive years, significantly depleting the seed bank. The two-year broadleaf sequence may provide crown rot control, while a one-year break does not. It may also provide a degree of take-all level reduction, enough to allow for mid-April sowing of the first wheat crop with minor root disease risk.
- A more sustainable farm and a stronger balance sheet through improved productivity without increased inputs, or even lowering inputs over time, and reducing risk.

Disadvantages

The major disadvantage of brown manuring compared with long fallowing is the cost of the pulse seed at about $25 to $30 per hectare plus the cost of sowing. To maximise nitrogen fixation, and hence maximise biomass, additional costs in fertiliser and herbicides may be required.

Decision-making

The role and management of pulses often revolves around weed burdens, particularly in southern NSW farming systems where brown manuring is becoming more common.

If weeds are a problem, grain growers can either brown manure to control herbicide-resistant weeds or crop-top for grain harvest. Crop-topping requires fast maturing pulse varieties since grain development ceases at the time of spraying.

If in-crop weeds can be managed, grain growers have a further two options: brown manuring much later to increase nitrogen fixation, or let the pulse crop mature through to grain harvest.

Weed control

To use brown manuring for weed control, pulse crops must be desiccated at or before the milky dough stage of the target weeds. This is usually at or before the flat pod stage of the pulse, well before the crop's peak dry matter production.

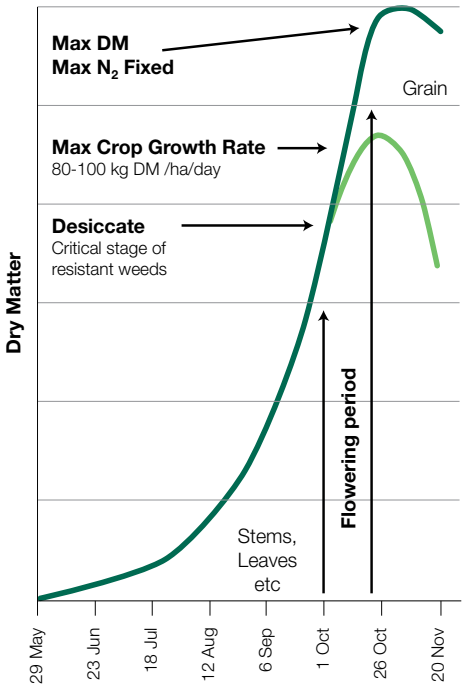
At this stage, the crop is growing at its maximum rate – about 80 to 100 kilograms of DM per hectare per day – and so the amount of nitrogen fixed will be reduced in proportion to its growth stage at desiccation.

Nitrogen fixation

The amount of nitrogen fixed by a pulse is directly linked to its dry matter production – approximately 25kg of nitrogen per tonne of DM. If a grower's main goal is to maximise fixed nitrogen, then the pulse should be manured close to its maximum dry matter. For a typical long-season field pea crop, such as the variety Morgan® sown at Wagga Wagga, NSW, in late May, this would mean desiccating at about the end of October (see Figure 1). Depending on the season and management, expected DM production ranges between 4-12t/ha, and can be even higher under ideal conditions.

However, when grain is harvested, nitrogen benefits are reduced in direct proportion to the N removed in the grain. For peas, this is about 36kg N/t of grain. Also, anything that reduces plant growth, such as disease, weeds, drought or sowing time, will directly reduce the nitrogen benefit.

Figure 1: Typical dry matter production of a Morgan® field pea – free of disease and weeds – sown in late May at Wagga Wagga, NSW.



Crop choice

The choice of a pulse manure crop needs to be considered in the context of a whole rotation and across an entire property. Vetch and field pea are common brown manure crops.

Early results from studies at Wagga Wagga show vetch to be the preferred choice for April sowing. However both vetch and field pea are equally suited to mid-May sowing. Sowing peas before mid-May greatly increases the risk of disease with no apparent improvement in dry matter production. The choice of field pea variety was not that important but delaying sowing to June significantly lowered maturity dry matter of all varieties.

Local choices are subject to rainfall and soil constraints, such as matching the soil type to the pulse crop. However the key points remain targeting maximum dry matter production and eliminating viable weed seed set.

Maximising biomass

Increased dry matter production means there will be more nitrogen fixed by a pulse crop. Research in 2012, and being repeated in 2013, is investigating how grain growers can maximise pulse biomass production through choice of crop and adjustments in sowing time.

The trial at Wagga Wagga by New South Wales Department of Primary Industries, in conjunction with CSIRO, Farmlink and GRDC, evaluated new pulse varieties in a brown manure system and their role in a crop sequence.

It compared three times of sowing – on April 20, May 9 and June 2 – and six pulse varieties including Morgan$^{\Phi}$, PBA Percy$^{\Phi}$ and PBA Hayman$^{\Phi}$ field peas; Morava$^{\Phi}$ vetch; plus Rosetta$^{\Phi}$ albus and Mandelup$^{\Phi}$ angustifolius lupins. Varieties were assessed in three areas – biomass production at the flat-pod stage, total biomass production close to maturity, and grain yield.

At the flat pod stage, biomass levels were highest in April-sown Morava vetch at 10t/ha (see Figure 2). But volumes decreased with each delay in sowing. Field pea did not show huge variation for biomass across all varieties and sowing dates and peaked at about 8t/ha. Lupin biomass was lowest in all sowing times but its April-sown plot was unfairly disadvantaged by hare grazing.

When assessed at maximum DM production, values peaked at between 12-14t/ha for April to mid-May sown peas and vetch with only small variations between varieties. However, DM production fell significantly when sowing later than mid-May (see Figure 3).

The trial results clearly outlined a question grain growers must consider when brown manuring – is it for weed control or maximising nitrogen fixation? If it is for weed control, then spray out the pulse in early spring at or before the milky dough growth stage of the target grass weeds. If not, then wait until plants reach peak biomass for maximum nitrogen fixation.

If targeting control of early flowering weed species, such as wild oats, then an early brown manure is critical. The crop must be sprayed out according to the flowering of the weed to gain maximum weed control.

Using the approximate rule of thumb of 25kg N fixed per tonne of DM, the best treatments in the trial potentially fixed more than 300kg/ha.

Figure 2: Biomass production at the 'flat-pod' stage of lupin, vetch and field pea over three sowing dates at Wagga Wagga in 2012.

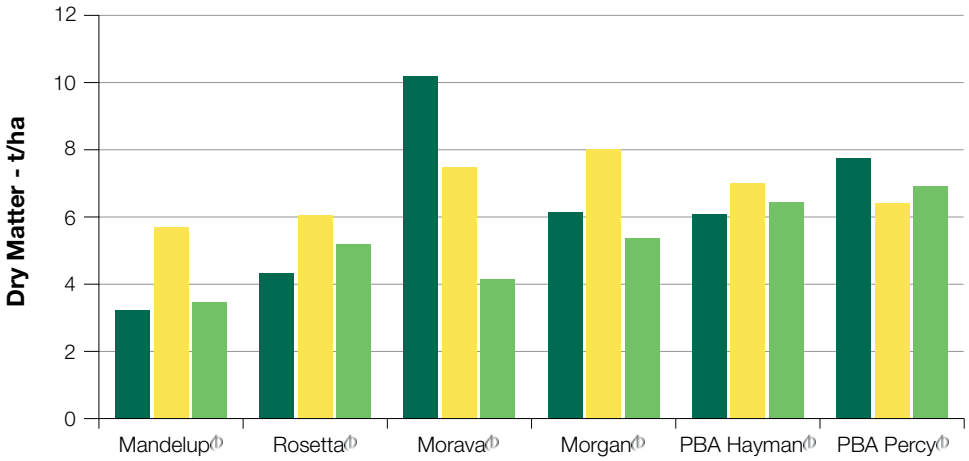
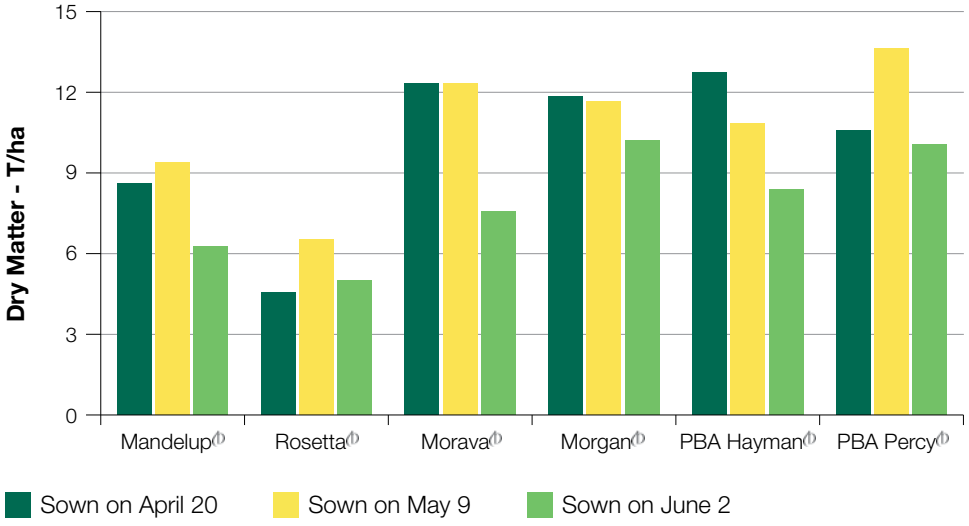


Figure 3: Biomass production at maturity of lupin, vetch and field pea over three sowing dates at Wagga Wagga in 2012.



Economics

Despite the manure phase being cash flow negative in the first season (ie. operating costs but no crop income), a crop production system involving a brown manured pulse will be more sustainable than continuous cropping.

Systems involving brown manure field peas have less production and financial risk compared to continuous cropping because of lower input and operating costs. Brown manuring is considered to be more resilient in dry years and more sustainable, reducing reliance on selective herbicides for weed control and artificial nitrogen for crop nutrition.

Economically, it is likely to be similar to mixed farming because of reduced reliance on artificial nitrogen for crop nutrition, and in addition, more ground cover maintenance. The GRDC Update Paper *Agronomics and economics of brown manure in continuous cropping systems* contains an economic analysis of the alternative farming systems (see Useful Resources).

Moisture conservation from a manure phase should not be under-estimated. The relatively small amounts of water conserved, compared with continuous cropping, have been the difference between profit and loss for subsequent crops in several recent seasons.

To gauge the true value of pulses in a rotation, the input costs and crop returns need to be considered over a whole rotation in terms of the revenue per hectare per year and per rotation sequence.

Every farmer has a different set of circumstances and the percentage of brown manure in a cropping system will vary from farm to farm. Whole farm financial analysis is an increasingly necessary tool. Gross margins may account for less than 50 per cent of the cost of doing business so should be used carefully, especially for forward projections.

FREQUENTLY ASKED QUESTIONS

Should I brown manure or crop-top?

Grain growers are currently using brown manuring to ensure they have an effective and complete weed kill and to allow an additional rotation of chemicals.

Crop-topping does have widespread application in similar weedy situations where resistance is a problem, allowing for both grain harvest and weed control at the critical growth stage of the weed. But its success depends on crop-topping at the critical stage of the weed and not when the crop is mature. This critical stage will vary depending on the weed species, for example, black oats will come out in head before ryegrass and so will require earlier crop-topping.

Ideally, the pulse crop should reach physiological maturity at the same time as crop-topping. Therefore, early maturing pulse varieties such as PBA Percy$^{\Phi}$, PBA Oura$^{\Phi}$ and PBA Pearl$^{\Phi}$ are better suited and suffer minimal yield loss when ryegrass is targeted. Earlier maturing field pea and lentil varieties are currently being developed by PBA breeding programs.

How can brown manuring fit into a continuous cropping system?

Farming systems that incorporate a brown manured crop can have lower input and operating costs compared with continuous cropping, which means less production and financial risk. Reliance on selective herbicides for weed control and artificial nitrogen for crop nutrition can be reduced. The value of brown manuring needs to be considered in the context of a whole rotation.

How do you choose a crop species and cultivar for brown manuring?

Crop species and cultivars that are most suited to brown manuring enable growers to maximise weed control and nitrogen fixation while minimising cost and risk. The main criteria to consider in selection includes:

- Cost and availability of seed.
- Matching soil type to pulse choice.
- Susceptibility to fungal diseases.
- Relative dry matter production at the time of spraying with the first knockdown herbicide.
- Competitiveness with target weeds, because the aim is to use little or no selective herbicides in the pulse crop.
- The degree of ground cover provided by the stubble to reduce wind erosion and conserve moisture for the following crop.

What chemicals are used in brown manuring?

To achieve maximum efficacy, brown manuring is based on a 'double-knock'. This includes early glyphosate application at full label rate for total weed control followed about two weeks later with paraquat application at full label rate for total weed control. Efficacy achieved is determined by the timing of the initial 'knock'. Grain growers should always follow label rates and instructions when applying chemicals.

Are there any problems sowing through brown manure residues?

There may be less issues going through manure residues than going through crop residues. Many growers who have adopted a brown manuring system use disc seeders. Alternatively, coulters in front of tynes on tyned seeders can minimise problems with pea mulch on the soil surface.

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GRDC PROJECT CODE

DAV00113

USEFUL RESOURCES

Agronomics and economics of brown manure in continuous cropping systems
Robert Patterson, 2012 Narrandera GRDC Adviser Update
www.grdc.com.au/Patterson2012-BrownManure

How pulse manuring fits our farm system
Mark Day, 2013 Temora GRDC Adviser Update
www.grdc.com.au/Day2013-PulseManuring

Pulses pay their way – a grower case study
Neil Schirmer, 2013 Temora GRDC Adviser Update
www.grdc.com.au/Schirmer2013-PulseCaseStudy

Incorporating a brown manure crop
David Gooden, GRDC *Over the Fence* video
www.grdc.com.au/OTF-BrownManure

Pulse trials aim to optimise brown manuring
Luke Gaynor, NSW DPI
www.grdc.com.au/GC105S-PulseTrials

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