SOUTHERN
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GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

FIELD PEA

SECTION 4

PLANTING

KEY POINTS | HAY, SILAGE, FORAGE, GREEN AND BROWN MANURE | PLANTING OVERVIEW | TIME OF SOWING | SOWING RATE AND PLANT DENSITY | SOWING DEPTH | ROW SPACING | SOWING EQUIPMENT | DRY SOWING | INOCULATION | CHECK FOR NODULATION | SEED TREATMENTS | FURTHER RESEARCH PROJECTS

Planting

Key points

- Ensure field pea is grown within the recommended window for your district. Time of sowing is a compromise between avoiding increased disease and frost risk from early sowing, and yield loss from late sowing due to high temperatures and/or dry conditions at flowering and pod-fill.
- Field pea is well suited to no-till, stubble-retention systems. Sow at the correct depth (3–5 cm) and avoid stubble clumping.
- Sowing can be dry; if weeds such as medics are not an issue and nodulation is assured. Be aware of blackspot risk with early sowing before seasonal opening rainfall.
- Sowing rate should be based on target plant density and will vary with seed size.
- Level paddocks are preferable, to make harvest manageable.
- Use Group E inoculant if there is likely to be a response to inoculation, such as in soils with pH ($CaCl_2$) less than 6, or if field pea hasn't been grown previously.

MORE INFORMATION

For more information: Field pea: Western NSW Planting Guide, https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/field-peas/field-peaf

Field pea is a hardy winter pulse that can provide economic gross margins for grain growers and flow-on benefits to the following cereal crop. Most field pea is grown for grain; however, some varieties are also increasingly being used for green/brown manure, forage or hay.

Hay, silage, forage, green and brown manure

Field pea can be made into good quality hay, which provides another market and weed control option. The crop can also be made into silage or ploughed in as green manure. Green manuring is the least profitable option and provides no significant yield benefit over hay or silage making to a following cereal crop. Profitability of hay or silage making will depend on accessing a secure market for the product.

Hay making is a valuable tool to prevent weed seedset in problem weeds, it can also be used to salvage a financial return from diseased, frosted or drought-affected crops. Cutting for hay effectively extends the fallow period and therefore can increase fallow moisture for subsequent cereal crops.

All pea varieties will make good quality hay, but varieties with rapid early growth and high dry matter production are best. To maximise dry matter, field pea should be sown in the early part of the sowing window.[1] However, sowing too early can result in blackspot becoming a major limitation to forage yield and quality.

A crop production system involving a brown manure legume such as field pea can be as profitable as continuous cropping or slightly less profitable, with lower production and financial risk due to lower operating costs.

Brown manure cropping involves growing a grain legume crop with minimal fertiliser and herbicide inputs to achieve maximum dry-matter production before the major weed species have set viable seed.

The grain legume crop is sprayed with a knockdown herbicide before seedset to kill the crop and weeds, ideally no later than the start of the crop's pod development to also conserve soil moisture.

A second knockdown herbicide is generally applied to achieve a 'double knock'. This is different to green manure where the crop and weeds are cultivated.

While vetch is a common brown-manure crop, early-sown field pea may be more competitive against weeds and potentially produce more dry matter. Higher dry-matter production should lead to higher nitrogen accumulation, and more stubble cover provides shading to reduce evaporation and reduce sunlight available to germinate weeds.

MORE INFORMATION

For more information: Brown manure legumes lower total crop risk, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-116-May-June-2015/Brown-manure-legumes-lower-total-crop-risk

Brown manure legume crops provide three major benefits over long fallows:

- competition for weeds (reducing knockdown herbicide use during the growing season);
- accumulation of soil nitrogen; and
- the maintenance of groundcover during the growing season and over the summer preceding the next crop.

The major disadvantage of brown manure pulse crops compared with long fallowing is the cost of the grain legume seed ($30 to $35 per hectare).[2]

1 L Jenkins, P Matthew, B Haskins, K Hertel, G Brooke, E Armstrong, D McCaffery, G Lane (2005) Field pea: Western NSW Planting Guide, NSW Department of Primary Industries, https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/field-peas/field-pea

2 R Patterson (2015) Brown manure legumes lower total crop risk, Ground Cover™, May-June 2015, GRDC, https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-116-May-June-2015/Brown-manure-legumes-lower-total-crop-risk

4.1 Planting overview

Field pea can be sown with machinery used for cereals. It is well suited to no-till, reduced-tillage and stubble-retention systems. Sow at the correct depth (3–5 cm) to ensure seed-to-soil contact for good emergence and improved safety to post-sow pre-emergent herbicides. Field peas sown between rows of standing cereal stubble are protected from wind erosion.

Field peas can be successfully dry sown if;

- problem weeds such as medic are not an issue;
- a level seed surface can be achieved before herbicide application; and
- nodulation is assured.

Sow into a friable soil ensuring good seed-to-soil contact. Retain adequate plant residue on the surface to protect the soil from erosion during growth and after harvest, and to reduce soil water evaporation in early growth stages. Retained cereal stubble does not affect field pea germination or growth, and can improve establishment on hard-setting, surface-crusting soils. The previous year's stubble can also offer an anchor for pea tendrils to grip, resulting in better standability at harvest. Stubble clumps however, can cause seed placement and harvesting difficulties. A flat surface assists harvest by ensuring clods or stones do not enter the harvester.

Sufficient moisture and a level soil surface must be present at application of some soil-active broadleaf herbicides for them to be fully effective and to avoid crop damage.[3] A ridged soil surface can cause problems if heavy rain falls between sowing and germination or after post-sowing herbicide application. The rain can wash the herbicide into the furrow and leave a concentrated band of chemical on top of the germinating seed, which can result in crop damage.

4.2 Time of sowing

Time of sowing is a compromise between:

- avoiding increased disease and frost risk from early sowing; and
- yield loss from late sowing due to high temperatures and/or dry conditions at flowering and pod-fill.

Sow at the later end of the recommended optimum for districts where disease and frost risks are high. Field pea can be sown dry, however consider:

- Blackspot risks
  - Early sowing increases exposure to blackspot spores over a longer period. Delay sowing 4 weeks later than the first rain. Early sowing may be possible if significant summer–autumn rains have fallen to release black spores from stubble. See Section 9 Diseases, Section 9.13 Ascochyta blight (AB) and Section 9.13.4 Management options.
  - Early sowing results in more vegetative growth and in longer-growing-season areas increased lodging can lead to increased risk of leaf disease.[4]
- Frost risks – choose later-flowering pea varieties (mid-spring) to avoid frost risk (e.g. Kaspa⏀). Semi-leafless varieties PBA Twilight⏀ and PBA Gunyah⏀ have been bred for shorter season climates or later sowings. They are more prone to frost if sown early. Semi-leafless types like Kaspa⏀ and PBA Gunyah⏀ have lodging resistance and reduced pod shattering.[5]

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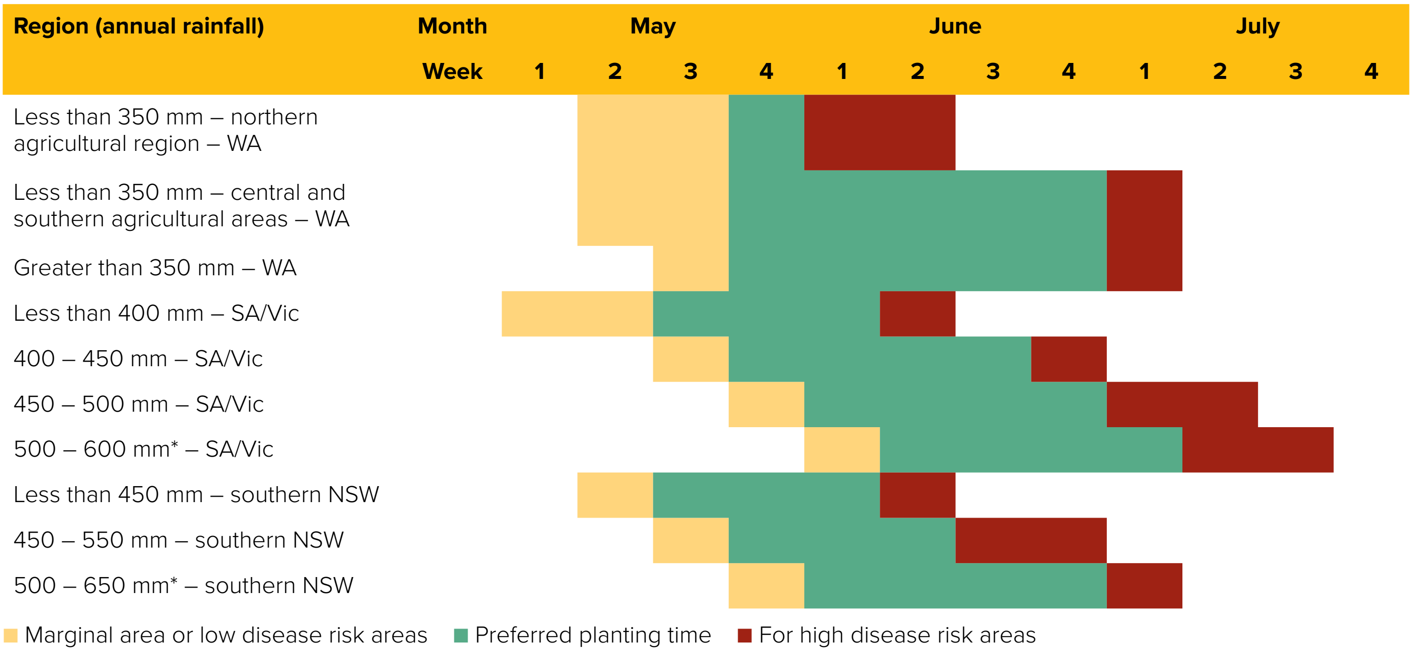
3 GRDC (2009) Field Peas: The Ute Guide, Southern region. GRDC, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/04/field-peas-the-ute-guide

4 GRDC (2009) Field Peas: The Ute Guide, Southern region. GRDC, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/04/field-peas-the-ute-guide

5 A Leonforte (2013) A study of salinity tolerance in field pea. University of Melbourne Australia, https://minerva-access.unimelb.edu.au/bitstream/handle/11343/38605/307726_PHD%20Thesis%20Antonio%20Leonforte.pdf?sequence=1

Table 1: Optimum sowing times for southern Australia.[6]



NOTE: Use Blackspot Manager to determine Blackspot risk with particular sowing dates each year. Sow later if Blackspot is a threat following a late break, or if frost is a risk.
* Preferred sowing time for spring-sown lentils is August-September

Source: GRDC (2009) Field Peas: The Ute Guide, Southern region. GRDC, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/04/field-peas-the-ute-guide

There are now a wider range of field pea varieties available, with differing maturities and some with better disease resistance and shatter-resistant pods. Growers should consider their preferred sowing window to minimise the risk of disease and frost, and select a variety that has a maturity to match. Any variety intended as a brown or green manure crop, or for hay, should be sown as early as possible within the recommended sowing window, to maximise dry matter production.[7] (See Table 2)

Trials conducted at Westmere in 2011 and 2012 investigated the adaptability of a range of field pea varieties to varying sowing dates, crop-topping and disease control. (See Section 10.2.1 Field trial.)

4.3 Sowing rate and plant density

Sowing rate depends on seed size, likely emergence and plant density required. Target densities tend to be lower with early sowing and higher if later sowing or on hard-setting soils when germination can be less due to emergence problems.

In most rainfall areas, varieties that are short to medium in height with lower vigour are very responsive to higher seeding rates, due to their lower biomass and the need for tendrils to intertwine to keep the crop upright in semi-leafless varieties.

The vigorous tall and medium types respond well to lower seeding rates and plant densities

4.3.1 Calculating seed rates

Field pea establishment targets can only be achieved by accounting for seed size, germination and sowing conditions when calculating sowing rates. Also, consider the seedbed condition and adjust accordingly. Use Table 3 to calculate the desired sowing rate based on target density, seed size, germination and potential establishment percentage of your seed.

6 GRDC (2009) Field Peas: The Ute Guide, Southern region. GRDC, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/04/field-peas-the-ute-guide

7 P Matthew, D McCaffery, L Jenkins (2017) Winter crop variety sowing guide 2017, NSW DPI Management Guide. NSW Government Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/winter-crop-variety-sowing-guide

FEEDBACK

Table 2: Field pea variety time of sowing guide.

Mallee	**April**			**May**				**June**				**July**		
PBA Coogee(D), PBA Hayman(D)		>	>	>	X	X	X	X	<	<	<			
Kaspa(D), Parafield, PBA Gunyah(D), PBA Oura(D), PBA Percy(D), PBA Twilight(D), PBA Wharton(D), Sturt		>	>	>	>	X	X	X	X	<	<			
Wimmera				**May**								**July**		
PBA Hayman(D)						>	X	X	X	X	<	<	<	
Kaspa(D), Parafield, PBA Coogee(D), PBA Gunyah(D), PBA Oura(D), PBA Percy(D), PBA Twilight(D), PBA Wharton(D), Sturt							>	X	X	X	X	<	<	<
North Central														
PBA Coogee(D), PBA Hayman(D)					>	X	X	X	X	<	<			
Kaspa(D), Parafield, PBA Gunyah(D), PBA Oura(D), PBA Percy(D), PBA Twilight(D), PBA Wharton(D), Sturt						>	X	X	X	X	<	<		
North east														
PBA Hayman(D)						>	X	X	X	X	<	<		
Kaspa(D), Parafield, PBA Coogee(D), PBA Gunyah(D), PBA Oura(D), PBA Percy(D), PBA Twilight(D), PBA Wharton(D), Sturt							>	X	X	X	X	<	<	
South west														
Kaspa(D), PBA Coogee(D), PBA Gunyah(D), PBA Hayman(D), PBA Oura(D), PBA Percy(D), PBA Twilight(D), PBA Wharton(D)						*	X	X	X	X	*			
South west (spring sowing)	**June**			**July**				**August**				**September**		
Above varieties for spring sowing				*	*	*	X	X	X	X	X	<	<	

> = earlier than ideal, X = optimum sowing time, < = later than ideal but acceptable * If conditions allow (e.g. raised beds, dry season, non-waterlogging paddocks).

Source: Victoria winter crop summary 2017, https://grdc.com.au/resources-and-publications/all-publications/publications/2017/03/nvt-victorian-winter-crop-summary

Table 3: Suggested plant density and seeding rate for field pea varieties.[8]

Field pea type	Variety	Average 100 seed weight (g)	Target plant density/m²			
			30	40	50	60
Tall scrambling	PBA Hayman⁽ᵈ⁾	13	–	65	81	–
	Morgan	18	68	90	–	–
	Sturt	19	71	95	–	–
	PBA Coogee⁽ᵈ⁾	20	–	100	125	–
	Parafield, PBA Percy⁽ᵈ⁾	23	86	115	–	–
Medium–tall semi leafless	Excell, Maki, PBA Pearl⁽ᵈ⁾, PBA Oura⁽ᵈ⁾, SW Celine⁽ᵈ⁾, Yarrum	22	–	110	138	165
Kaspa types	Kaspa⁽ᵈ⁾, PBA Gunyah⁽ᵈ⁾, PBA Twilight⁽ᵈ⁾, PBA Wharton⁽ᵈ⁾	22	–	110	138	–

Source: P Matthew, D McCaffery, L Jenkins (2017) Winter crop variety sowing guide 2017, NSW DPI Management Guide. NSW Government Department of Primary Industries, https://www.dpi.nsw.gov.au/about-us/media-centre/releases/2017/2017-winter-crop-variety-sowing-guide-now-available

Seedling rate for the target plant density can be calculated using germination percentage, 100 seed weight and establishment percentage.

Seedling rate (kg/ha) =

$$\frac{\text{100 seed weight (grams)\# x target plant population (per m}^2\text{) x 1000}}{\text{Germination \% x Estimated Establishment \%*}}$$

*Establishment percentage: 90–95% is a reasonable estimate, unless sowing into adverse conditions.

To determine your seed weight, weigh 100 seeds in grams.

Example

100-seed weight = 23 grams

Target plant density = 40 plants/m² (i.e. 400,000 plants/ha)

Germination % = 90%

Estimated establishment % = 95%

$$\frac{\text{Seeding rate (kg/ha) = 23 x 40 x 1000}}{\text{90 x 95}}$$

= 108 kg/ha

If you have seeds per kilogram from a laboratory test, this can be easily converted to 100 seed weight as follows:

$$\frac{\text{100 seed weight = 1000 x 100}}{\text{seeds per kg}}$$

Note: Optimum plant populations vary with the location grown, the variety sown and the pulse crop being sown.

8 P Matthew, D McCaffery, L Jenkins (2017) Winter crop variety sowing guide 2017, NSW DPI Management Guide. NSW Government Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/winter-crop-variety-sowing-guide

4.4 Sowing depth

Sow at a depth of between 3 and 5 cm. Adjust sowing depth based on the soil type and texture, and take into account depth of soil covering seed.

On friable clays, loams and lighter soils, sow deeper (>5 cm), but on hard-setting soils sow shallower (near 3 cm) to ensure establishment. On some well-structured, lighter soils it may be possible to sow deeper than normal if seeking subsoil moisture to maximise germination.[9] Do not sow dry or moisture-seek field pea at depth if uneven moisture is present, as crops will germinate unevenly, causing management difficulties such as herbicide timing. Crops sown later in the sowing window (e.g. due to a delay in sowing rainfall) should be sown shallower to improve germination under cold conditions.[10]

Rolling or harrowing after sowing or wind erosion can lead to an increased depth for seedlings to emerge.

Post-sowing herbicides can wash into seed rows from ridges if left unflattened after seeding.

4.4.1 Stubble retention

Field pea fit well into stubble-retention systems with no tillage, using the stubble as a supportive trellis (Photos 1 and 2).

Photo 1: *Trial demonstrating different heights of retained stubble to aid field pea growth and standability.*

Photo: Felicity Pritchard

9 GRDC (2009) Field Peas: The Ute Guide, Southern region. GRDC, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/04/field-peas-the-ute-guide

10 P Matthew, D McCaffery, L Jenkins (2017) Winter crop variety sowing guide 2017, NSW DPI Management Guide. NSW Government Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/winter-crop-variety-sowing-guide

FEEDBACK

VIDEO

Watch: Stubble Management
https://youtu.be/hjJ5HtyLluU

Watch GCTV15: Stubble height Pt. 1
https://youtu.be/XDTSbGcZxpM

and Stubble height Pt. 2
https://youtu.be/SglCa7vm1C0

Watch GCTV4: Burning for stubble retention.
https://youtu.be/BJjVmhYDv5c

Watch: Southern farm groups cutting through stubble issues.
https://youtu.be/pyC91wE-DBI

MORE INFORMATION

For more information, see: Profitable stubble retention systems for the high-rainfall zone,
https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2016/02/profitable-stubble-retention-systems-for-the-high-rainfall-zone

MORE INFORMATION

For more information, see Wide row pulses and stubble retention, Pulse Australia,
http://www.pulseaus.com.au/growing-pulses/publications/wide-rows-and-stubble-retention

Photo 2: *Trial demonstrating the difference between high (40 cm) stubble and low stubble (0 cm) on field pea height and standabilty.*

Photo: Felicity Pritchard

Retention of adequate plant residues on the surface is important to protect the soil from erosion both during growth and after harvest. This will not affect pulse germination and growth, and can improve establishment on hard-setting, surface-crusting soils. Sowing into cereal stubble reduces soil moisture losses from evaporation.[11]

4.5 Row spacing

Row spacing can be varied (15–45 cm), but the wider rows are only used if sowing into standing cereal stubble to minimise lodging at harvest and for intra-row herbicide application with shielded spayers. Medium to wide row spacing (25–36cm) suits trash clearance and intra-row weed control, and allows more air movement between rows to reduce blackspot disease risk. Row spacing greater than 45 cm is not a practical option for field pea in the southern region.

The height to bottom pods is often increased with increased row spacing or with higher seeding rates. Weed control can be more difficult with wider row spacing unless shielded sprayers are used.[12]

4.5.1 Wide row and stubble retention

Growers use wider seeding rows in pulses (and oilseeds) for a range of different reasons, largely driven by combinations of seeking consistency or stability of yield, disease control, fit in their system and general practicalities. However, row spacing should never be looked at in isolation, as it is only part of an overall system. Having stubble cover, preferably standing stubble, is an important component of a wider row system. For some growers the motivation to sow pulses in wider rows is to achieve better drought tolerance. Others are using it as a means to sow early, minimise foliar disease risk and achieve better early podset. Achieving better stubble flow during seeding, or better weed control through less soil disturbance, are also key drivers for many.

Wider rows are untested commercially for field pea.[13]

11 Pulse Australia, Chickpea Production: Southern and Western region, http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/southern-guide

12 GRDC (2009) Field Peas: The Ute Guide, Southern region. GRDC, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/04/field-peas-the-ute-guide

13 Pulse Australia (2016) Wide row pulses and stubble retention. Pulse Australia website, http://www.pulseaus.com.au/growing-pulses/publications/wide-rows-and-stubble-retention

MORE INFORMATION

For more information see Row placement strategies in break crop wheat sequence, GRDC Grains Research Updates, https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2013/02/row-placement-strategies-in-a-break-crop-wheat-sequence

4.5.2 Row placement for field pea as a break crop

Following a cereal crop, the break crop (pulse or oilseed) should be sown between the standing stubble rows. In the following year, the cereal crop should be sown directly over the previous season's break-crop row. Then in the next year of the rotation the break crop should shift back and be sown between the standing wheat rows. Finally, in the fifth year, the wheat crop again should be sown directly over the previous year's break-crop row.

There are two simple rules that need to be followed:

1. Sow break crops between standing wheat rows, which need to be kept intact.
2. Sow the following wheat crop directly over the row of the previous year's break crop.

By following these two rules it ensures the following:

- 4 years occur between wheat crops being sown in the same row space;
- a substantial reduction in the incidence of crown rot in wheat crops;
- improved germination of break crops, especially canola, not hindered by stubble;
- reduction in impact of viral infections in chickpeas from standing stubble; and
- improved protection for break-crop seedlings from standing wheat stubble.[14]

4.6 Sowing equipment

To be successful with pulses, seeders need to be equipped to cope with the larger-sized seed. If your seeder is not suitable, there are several options available.

The machine may be adapted by minor modifications such as:

- modifying the metering mechanism using manufacturer-supplied optional parts;
- modifying seed tubes to reduce blockages, particularly on older machines;
- modifying or replacing dividing heads on air seeders.

Most pulse seeding problems are related to seed metering and the transfer from seed meter to soil. These problems are caused by the large size of some pulses and the high seeding rates generally required.[15]

4.6.1 Rolling

Leaving a flat, firm soil surface free of sticks, stones and clumps is essential when growing most pulse crops. With field pea, rolling is helpful for herbicide application and to enable a flat soil surface at harvest. Rolling field pea is beneficial after sowing to aid harvestability where height to bottom pods is often low, particularly in lower-rainfall areas or late-sown crops. Rolling leaving a flat surface prevents post-sowing herbicide wash accumulating in furrows. Rolling also improves seed–soil contact in sandy non-wetting soils, although press-wheels normally achieve this.[16]

Rolling is often post-sowing pre-emergence. A rubber-tyre roller is best used when the soil is moist but not too wet or dry. Rolling post-emergence is not recommended in areas where bacterial blight disease is a risk. (See Section 9.14 Bacterial blight of field pea) If rolling is post-emergence, it is best done at the 3–5 node stage under warm conditions when plants are limp and well established. Avoid rolling when plants are just emerging as the young shoots can be damaged. Choose an afternoon on a warmer day to minimise crop damage.

14 A Verrell (2013) Row placement strategies in a break crop wheat sequence. GRDC Update Papers, 26 Feb 2013, https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Row-placement-strategies-in-a-break-crop-wheat-sequence

15 J Lamb, A Podder (2008) Grain Legume Handbook for the Pulse Industry. Grain Legume Hand Book Committee, https://grdc.com.au/grainlegumehandbook

16 Pulse Australia (2016) Southern Faba & Broad Bean – Best Management Practices Training

Avoid rolling 2 weeks before or after applying a post-emergent herbicide. Delay rolling until the crop has emerged if the soil is prone to hard-setting or crusting, or sandy or sloping ground prone to erosion.[17]

Photo 3: *Field pea need to be rolled to minimise dirt and stones entering the harvest sample.*

Photo: W. Hawthorne, formerly Pulse Australia

4.7 Dry sowing

Dry sowing is a means of getting crops sown on time in seasons with a delayed break. It allows:

- optimisation of all crop yields by sowing each one on time;
- sowing of more crop on time without the cost of increasing machinery size;
- the spread of labour requirements and operations;
- better handling of more trash while stubble is dry; and
- improved crop establishment under warm soil conditions.

A big risk of failure when dry sowing pulse crops is the survival of rhizobia and subsequent reduced nodulation. With field pea, a big risk with dry sowing is increased blackspot incidence if there have been no preceding rains to allow spore release (See Section 9.13.4 Management options).

The ability to control broadleaf weeds is another key factor to consider when dry sowing, as weeds may germinate with the pulse seed.

Paddock selection criteria apply for each pulse species. Consider soil pH, soil drainage and weed burden. The best results from dry sowing occur on freely draining, well-structured soils, but dry sowing has also been successful on other soil types. Avoid hard-setting or crusting soils and avoid sowing in front of a large rainfall event that may result in waterlogging of the crop and affect subsequent germination.

Major changes to seeding machinery for dry sowing are not required. You will need enough tyne break out pressure to penetrate the soil and maintain even seeding depth. Narrow seeding points with tungsten tips give better results and trash flow is often better when stubble is dry.

17 GRDC (2009) Field Peas: The Ute Guide, Southern region. GRDC, https://grdc.com.au/resources-and-publications/all-publications/publications/2009/04/field-peas-the-ute-guide

Ensure that the sowing boot is set up so the seed is dropped at the desired depth, but with some loose soil beneath it. Press-wheels or culti-packers are the better covering devices. They pack soil over the seed providing good seed–soil contact and do not create dust problems like covering harrows.

Start dry sowing at the beginning of the normal sowing window for that species and variety.

Row spacing, seeding rate and seed depth should all be maintained as for normal sowing. Place seed at the deeper end of the recommended range to reduce the risk of partial germination on light rain, and to maximise rhizobia survival. Row spacing can be increased to handle heavy stubbles with minimal reduction in yield.[18]

4.8 Inoculation

4.8.1 Rhizobia and nitrogen fixation

Symbiotic nitrogen fixation is the result of the mutually beneficial relationship between the pulse host and Rhizobium bacteria. These bacteria colonise legume roots soon after seed germination then form root nodules. Rhizobia live in the soil, on plant roots and in legume nodules, but only fix nitrogen when inside a legume nodule. Rhizobia in the nodules are dependent on the host plant for water, nutrients and energy, but in return supply the plant with available nitrogen for growth. This 'fixed' nitrogen is derived from the gaseous nitrogen in the air.[19]

Nitrogen fixation by legumes does not happen as a matter of course. Compatible, effective rhizobia must be present in the soil in which the legume is growing before nodulation and nitrogen fixation can occur. When a legume is grown for the first time in a paddock, it is highly likely that compatible, effective rhizobia will not be present. In such circumstances, the rhizobia must be supplied in highly concentrated form as inoculants.

A well-nodulated and productive crop of field pea will fix up to 150 kg of nitrogen/ha. Some differences have been measured among cultivars (Table 4). In general, tall-form, conventional leaf varieties (e.g. PBA Percy⫙ and PBA Coogee⫙) that produce more biomass will fix more N and leave more fixed N behind in the stubble because of their lower harvest index1, compared with shorter-form, semi-leafless varieties such as PBA Oura⫙ and PBA Twilight⫙. After grain harvest, more than 100 kg fixed N can remain in the stubble and roots of some varieties, which, when mineralised, becomes available to the following crop.

Photo 4: *Different forms of rhizobia: (from left) EasyRhiz® freeze-dried, Nodulator® granules, Alosca® granules, N-Prove® granules and Nodulaid® peat inoculant.*

Photo: M Denton, formerly Victorian DPI

18 D Carpenter (1999) Pulse Point 6: Dry sowing. NSW Agriculture and Grains Research & Development Corporation. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/157117/pulse-point-06.pdf

19 E Armstrong, D Holding (2015) Pulses: putting life into the farming system. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/558958/Pulses-putting-life-into-the-farming-system.pdf

Table 4: Estimates of fixed nitrogen(N) provided by different pea cultivars.

Cultivar	* Growth form	Fixed N (kg/t shoot DM)	Fixed N Grain, stubble and roots (kg/ha)	Fixed N Stubble and roots (lg/ha)
PBA Percy⊕	C-T	19	150	110
Parafield	C-T	18	154	107
PBA Coogee⊕	C-T	18	146	109
Kaspa⊕	SL-MT	17	145	91
Morgan	SL-T	17	143	99
PBA Pearl⊕	SL-MT	16	144	86
PBA Hayman⊕	C-T	16	150	127
PBA Gunyah⊕	SL-MT	16	139	79
PBA Oura⊕	SL-MT	16	130	78
PBA Twilight⊕	SL-MT	15	129	76
Wharton	SL-MT	15	124	84

Source: Unkovic *et al.* (2010)

4.8.2 Inoculant for field pea

Like bean, lentil and vetch, field pea is nodulated by *Rhizobium leguminosarum* bv. *viciae*. This species of rhizobia is produced and sold commercially as inoculant Groups E and F (Table 5).[20]

Table 5: Inoculation Group E and Group F.

Field pea and vetch	Strain: SUS303 (Group E)
Pisum sativum *Vicia species*	*Rhizobium leguminosarum* bv. *Viciae*
Faba bean, broadbean and lentil	**Strain: WSM1455 (Group F)**
Vicia faba *Lens culinaris*	*Rhizobium leguminosarum* bv. *Viciae*

Source: E Drew, D Herridge, R Ballard, G O'Hara, R Deaker, M Denton, R Yates, G Gemell, E Hartley, L Phillips, N Seymour, J Howieson, N Ballard (2014) Inoculating legumes: A practical guide. Grains Research & Development Corporation, https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

Two inoculant strains are provided for pea, bean, lentil and vetch to optimise nitrogen fixation potential of the different legume hosts. Group E (strain SU303) inoculant is preferred for field pea, but Group F (strain WSM1455) can be used in its place because it is only marginally less effective.

Field pea is not nodulated by the rhizobia that nodulate chickpea (Group N), lupin (Group G) or pasture legumes.

20 E Drew, D Herridge, R Ballard, G O'Hara, R Deaker, M Denton, R Yates, G Gemell, E Hartley, L Phillips, N Seymour, J Howieson, N Ballard (2014) Inoculating legumes: A practical guide. Grains Research & Development Corporation, https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

Photo 5: *Well-nodulated roots of field pea.*

Photo: Drew *et al*. (2014) https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

4.8.3 Inoculation in practice

Field pea will be responsive to inoculation if it (or bean, lentil or vetch) has not previously been grown in the paddock. Field pea is also likely to be responsive to inoculation on acidic soils because the rhizobia of these legumes are moderately sensitive to soil acidity. Pea rhizobia may be absent or their number may be suboptimal where soil pH ($CaCl_2$) is less than 6.0, even where there has been recent history of legumes that support pea rhizobia. See Table 6 for likelihood of response to inoculation.

VIDEO

Watch GCTV13: Legumes – Sowing Preparation
https://youtu.be/kcGu2CKwMS8

Table 6: Likelihood of response to inoculation for sown pea, faba bean, lentil and vetch.

High	• Soils with pH($CaCl_2$) below 6.0 and high summer soil temperates (>35°C for 40 days); OR • legume host (pea, faba bean, lentil, vetch) not previously grown
Moderate	• No legume host (pea, faba bean, lentil, vetch) in previous four years (recommended pulse rotation); OR • prior host crop not inoculated or lacked good nodulation.
Low	• Loam or clay soils with neutral or alkalin pH and a recent history of host crop with good nodulation

Source: Drew *et al*, (2014)

Inoculation of field pea is generally not necessary where well-nodulated pea (or bean, lentil or vetch) has been grown in the preceding 5 years and soil conditions are favourable to the survival of the rhizobia. Loam or clay soils with neutral or alkaline pH are favourable to the survival of pea rhizobia.

If paddock conditions and legume history indicate a likelihood of a response to inoculation (Table 6) then the following guidelines should be followed:

- Inoculate with AIRG-approved* inoculants ('Green Tick' logo).
- Use Group E inoculant for pea; Group F may be used in place of E.
- Do not expose inoculants to direct sunlight, high temperatures (>30°C), chemicals or freezing temperatures as they contain live bacteria.
- Always use inoculants before their expiry date has passed.
- Keep inoculants dry and cool. Reseal opened bags of inoculant and refrigerate; use resealed bags within a short time (days).
- Follow instructions on recommended rates of inoculation.
- Consider doubling the inoculation rate in very acidic soils or where pea, vetch, bean or lentil have not been grown previously. Start with a small batch of

seed to establish that it can be satisfactorily dried in order to avoid auger and seeder blockages.

- Always sow freshly inoculated seed as soon as possible, within 24 hours.
- When applying liquid or slurry inoculants, use clean, potable, non-chlorinated water and ensure the mixing tanks are free of toxic chemical residues.
- Do not mix zinc or sodium molybdate with liquid or slurry inoculants.
- Check the product label or contact the manufacturer for compatibility of inoculants with fertilisers and seed dressings.
- Ensure inoculants remain cool in transport and do not leave inoculants or inoculated seed in the sun.

*AIRG is the Australian Inoculants Research Group, part of the NSW Department of Primary Industries.

SARDI Hart trial data 2014 – Effect of rhizobia and other microbial inoculation treatments on field pea

Key findings:

The Hart Field Site in South Australia has a background of pea rhizobia that are numerous, but only moderately effective.

Inoculation treatment did not affect measured root parameters.

Some inoculation treatments increased shoot biomass and pod number, but not grain yield or grain N content.

The N benefit from the extra biomass residues was estimated to be 51 kg N/ha.

For details on the trial visit: http://www.farmtrials.com.au/trial/16967

4.8.4 Types of inoculant

A range of different inoculant formulations are available to Australian legume growers (Table 7). Inoculant for pea can be obtained as peat, freeze-dried or granular formulations.

Table 7: Inoculant formulations available to Australian growers.

Inoculant formulation	Composition
Peat	High organic matter soil, milled and irradiated, with rhizobia added in a nutrient suspension
Freeze dried	Concentrated pure cells of rhizobia following extraction of water under vacuum
Granular	Clay or peat granules impregnated with rhizobia
Liquid	Suspension of rhizobia in a protective nutrient solution
Preinoculated seed	Seed coated with polymers and peat inoculant

Source: G O'Hara, J Howieson, E Drew, R Ballard, D Herridge, G Gemmell, E Hartley, L Phillips, R Decker, M Denton, R Yates, N Seymour, N Ballard (2014) Inoculating legumes: A practical guide. Grains Research & Development Corporation, https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

The different formulations vary in the number of rhizobia they contain and so it is important that recommended application rates are followed.

Peat is the most commonly used formulation and provides reliable nodulation across a range of sowing conditions. Peat inoculants also provide some protection to the rhizobia where they are applied to seed treated with pesticides.

Freeze-dried inoculants should only be used where legumes are sown into moist soils. They provide a good option where liquid injection systems are used to deliver inoculant in-furrow.

FEEDBACK

MORE INFORMATION

For more information, see:

GRDC Inoculating legumes: A practical guide. https://grdc.com.au/resources-and-publications/all-publications/bookshop/2015/07/inoculating-legumes

The back pocket guide: inoculating legumes. https://grdc.com.au/resources-and-publications/all-publications/publications/2013/09/grdc-bpg-inoculatinglegumes

GRDC Fact Sheet Rhizobial inoculants. https://grdc.com.au/resources-and-publications/all-publications/factsheets/2013/01/grdc-fs-rhizobialinoculants

Granular inoculants can be used where separation between the rhizobia and pesticides or fertilisers is needed.[21]

4.8.5 Storing inoculants

For maximum survival, peat and freeze-dried inoculants should be stored in a refrigerator until used. Both types of inoculant can be kept for many months if stored correctly (4–10°C), but pay attention to the date of expiry and do not freeze inoculant. If refrigeration is not possible, store in a cool, dry place away from direct sunlight. Granules also need to be stored in a cool place out of direct sunlight. Opened peat inoculum packets are best discarded, but if resealed and kept cool can be used within a few days.

Discard the inoculant after the expiry date shown because the rhizobia population may have dropped to an unacceptable level.[22] [23]

4.8.6 Inoculum survival

Moist peat provides protection and energy while the unopened pack is being stored. Rhizobia can dry out and lose viability once applied to seed and not in moist soil. Granular inoculant forms may not dry out as quickly, and most peat inoculants now contain an adhesive which delays drying and increases survival of the rhizobia. Use a peat slurry mix within 24 hours and sow seed inoculated with peat slurry as soon as possible, or store for up to 3 days in a cool place, away from sunlight.

With non-peat-based inoculants, such as freeze-dried rhizobia, it is recommended that treated seed is sown within 5 hours of inoculation.

The rhizobia will survive for longer in granules than when applied to seed. Hence when dry sowing pulses, granular inoculant is preferred over peat and liquid injection methods.

Dry-dusting the peat inoculant into the seed box is not an effective means of either getting or keeping rhizobia uniformly on seed. Under some conditions, rhizobial death is so rapid where dry dusting is used that no rhizobia are alive by the time the seed reaches the soil.[24]

4.8.7 Inoculation methods

Inoculation with rhizobia is a numbers game: we aim is to get as many rhizobia as possible onto the seed or near the seed, to maximise the potential for nodulation. There will always be a loss of rhizobia, but by using appropriate methods these losses can be minimised to obtain effective nodulation. It is advisable to use high-quality inoculants, such as AIRG-approved ('Green Tick') products.

Peas have historically been inoculated with a slurry of peat inoculant onto the seed. But now rhizobia can also be purchased in a freeze-dried form suitable for application to seed or water injection into the soil, or granules that are sown at same time as the seed from a separate box.

Peat inoculants

Most peat inoculants for pea now contain a pre-mixed sticker, and only require the addition of water to make the slurry. When preparing the slurry do not use hot or chlorinated or saline water.

21 E Drew, D Herridge, R Ballard, G O'Hara, R Deaker, M Denton, R Yates, G Gemell, E Hartley, L Phillips, N Seymour, J Howieson, N Ballard (2014) Inoculating legumes: A practical guide. Grains Research & Development Corporation, https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

22 E Drew, D Herridge, R Ballard, G O'Hara, R Deaker, M Denton, R Yates, G Gemell, E Hartley, L Phillips, N Seymour, J Howieson, N Ballard (2014) Inoculating legumes: A practical guide. Grains Research & Development Corporation, https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

23 GRDC (2015) Field pea Northern Region GrowNotes™, https://grdc.com.au/GrowNotes

24 Pulse Australia (2016) Southern Faba & Broad Bean – Best Management Practices Training Course, module 2-2016

How to apply slurry to the seed:

- Through an auger – make sure the auger is turning as slowly as possible, to achieve effective mixing. Reduce the height of the auger to minimise the height of seed fall.
- Meter the peat slurry in, according to the flow rate of the auger (remember: 250 g packet per 100 kg of seed).
- Through a tubulator – similar to applying through an auger, except that the tubulator reduces the risk of damaging the seed. Its mixing ability is not as effective as an auger.
- In a cement mixer – only practical for small lots unless a cement truck is used.

Peat inoculant can also be injected as dilute, filtered slurry directly into the sowing furrow, with or below the seed.[25] Agitators and in-line filters may be necessary to avoid blockages to nozzles and capillary tubes. Typically, the peat inoculant is filtered and applied at low pressure in a water volume of 50–100 L/ha.

Dry-dusting the peat inoculant into the seed box is not recommended. This is not an effective means of getting good contact between rhizobia and seed. Attachment of the rhizobia to the seed can be very poor, and under some conditions rhizobial death is so rapid that no inoculant is alive by the time the seed reaches the soil.[26]

Freeze-dried inoculants

Freeze-dried inoculants can be applied to seed or delivered as a liquid into the furrow. Freeze-dried inoculants are not suitable for application to dry soils.

The rhizobia become active when the inoculant is reconstituted with liquid. The product comes with a protective polymer in a separate packet, which assists survival of the rhizobia. A 30 millilitre vial of inoculant will treat up to 500 kg of pea seed.

Treated seeds need to be sown into moist soil within 5 hours of application. Contact with seed-applied pesticides and fungicides must be avoided.

For liquid injection into the seeding furrow, add the inoculant suspension to 2 L of cool water containing the protective polymer. Add this solution to the clean spray tank and deliver at 50–100 L per hectare into the furrow.

Granular inoculants

Granular inoculants are applied as a solid product directly into the seed furrow, near the seed or below the seed. They avoid many of the compatibility problems that rhizobia have with fertilisers and fungicides. They also eliminate the need to inoculate seed before sowing. Granular inoculants are reported to be effective where dry sowing is practiced.

If granules are mixed with the seed, rather than applied separately, then distribution of both seed and inoculum may be uneven, causing either poor and uneven establishment and/or patchy nodulation. Granules should not be stored in seeding boxes overnight because they can settle or solidify and cause blockages.

25 J Brockwell, RR Gault and RJ Roughley (1982) Fact Sheet: Spray inoculating grain legumes. Available at www.ua.edu.au/legume-inoculation

26 Pulse Australia (2016) Southern Faba & Broad Bean – Best Management Practices Training Course, module 2-2016

Photo 6: *An 'after-market' third box fitted to a Flexicoil box to enable application of granular inoculums. Note that granular inoculums cannot be applied mixed with the seed (uneven distribution of seed and/or inoculums occurs). Rhizobia survival is severely jeopardised if granular inoculums are applied mixed with fertiliser.*

Photo: W. Hawthorne, formerly Pulse Australia

Granules contain fewer rhizobia per gram than peat-based inoculants, so they must be used at higher application rates. The size, form, uniformity, moisture content and rate of application of granules differ among products. Depending on product or row spacing sown, rates can vary from 2 to 10 kg/ha to deliver adequate levels of rhizobia.

Water injection

Water-injection methods can use peat, freeze-dried or liquid forms of inoculum. The inoculants are diluted with water in tanks mounted on tractors and applied through spray lines attached behind each planting tyne/boot (Photo 7). Agitators and in-line filters may be necessary, particularly for peat-based inoculum. Rates of inoculum need to be calculated for planting rates (kilograms of seed per hectare) and water volumes able to be carried. Typically, application rates are 50–100 L/ha.

Photo 7: *Spray line attached behind each planting tyne/boot dispense inoculants by water injection.*

Photo: Drew *et al.* (2014) Inoculating legumes: A practical guide. Grains Research & Development Corporation, https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

MORE INFORMATION

For more information, see

GRDC Inoculating legumes: A practical guide. https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

Inoculating legumes: the back pocket guide https://grdc.com.au/resources-and-publications/all-publications/publications/2013/09/grdc-bpg-inoculatinglegumes

GRDC Rhizobial inoculants Fact Sheet www.grdc.com.au/GRDC-FS-RhizobialInoculants

VIDEO

Watch GCTV17: Legume Nodulation – field sampling https://youtu.be/bfnBsEM64t0

Watch GCTV17: Legume Nodulation – sample preparation https://youtu.be/0VL7CIY-K9w

Watch GCTV17: Legume Nodulation – sample scoring https://youtu.be/Nd303SFITDk

Dry inoculation – a warning

This involves mixing packets of peat inoculum with the seed, or dusting it in the seed box. This method is not recommended because survival of the inoculum is low, and most of the inoculum is lost from the seed before and during planting. Increasing the rate of inoculant applied can partially help improve efficiency.[27]

4.9 Check for nodulation

It is important to determine how effective inoculant application has been and if the nodules are actively fixing nitrogen. By checking the number of nodules and their distribution on the roots, you can assess the effectiveness of the inoculum product used and the application method.

If you have not inoculated, it can still be helpful to assess nodulation of your pea crop, to assess whether inoculation may be needed in the future.

For pea, 50–100 pink nodules per plant after approximately 10 weeks' plant growth is an adequate level of nodulation (Photo 10). A strong pink colour inside the nodule indicates the rhizobia are actively fixing nitrogen for use by the plant (Photo 8).

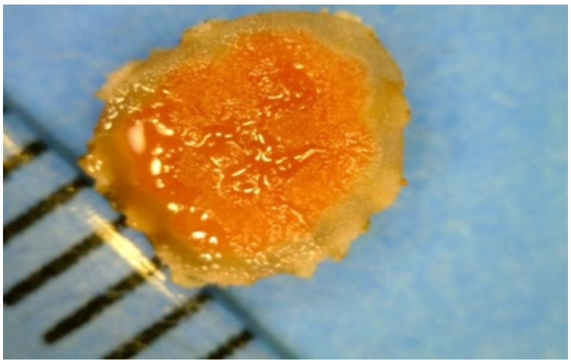


Photo 8: *A healthy, nitrogen-fixing nodule has a rusty red or pink centre.*

Photo: G Cumming, formerly Pulse Australia

4.9.1 Sampling and processing

At least 30 plants should be sampled, 10 at each of 3 locations, spaced 40 metres apart in the crop. Plants should be gently dug from the soil and the root system carefully rinsed in several changes of water before estimating nodule number. It is helpful to float the root systems in water on a white background (a cut down, clean chemical drum is easy to use).

4.9.2 Nodule number and distribution

Score each plant for nodulation. At least 50 pink nodules per plant is considered adequate (Photo 10). Separate plants into adequate and inadequate groups. If the adequate group contains more than 70% of the plants then inoculation has been successful.

27 GRDC (2015) Field pea Northern Region GrowNotes™, https://grdc.com.au/GrowNotes

Photo 9: *(Left) a well-nodulated field pea plant and (right) a poorly nodulated plant. Note the difference in green colour of the foliage.*

Photo: DPIRD

MORE INFORMATION

For more information on nitrogen fixation go to the GRDC Factsheet:

Nitorgen fixation of crop legume. https://grdc.com.au/Resources/Factsheets/2014/07/Nitrogen-fixation-of-crop-legumes-basic-principles-and-practical-management

Observe the pattern of nodules on the root system. Following inoculation, nodules on the main taproot clustered near the seed are a clear indication that nodulation occurred early. These are referred to as 'crown nodules'. If there are no crown nodules, but nodules on the lateral roots, then it is more likely nodulation has been delayed, indicating that there may have been issues with the inoculation process.

Nodules on both the crown and lateral roots indicate that inoculation was successful, and that bacteria have spread in the soil. This is the ideal situation, with the crown nodules providing good levels of N fixation early in the plant's growth, supported by the lateral root nodules, which may extend N fixation activity later into the season because they are less affected by drying of the surface soil.

Photo 10: *Well-nodulated roots of field pea showing active pink nodules.*

Photo: Liz Farquharson, SARDI

4.9.3 Nodule appearance

If necessary, cut or break open a few root nodules to check the colour. Very young nodules (after a couple of weeks' plant growth) are usually white because they still need to develop. However, in older plants (at 10–12 weeks growth when assessment is recommended) an abundance of white nodules may indicate the rhizobia in the soil that formed the nodules were poorly effective and they will not fix nitrogen (Photo 11). This is rare for field pea, but indicates that the crop should be inoculated next time it is grown. White nodules can also result from trace element deficiencies such as molybdenum.

Photo 11: *Field pea roots with active large pink nodules (pink arrows) and small white inactive nodules (white arrows). The white nodules indicate some of the rhizobia forming nodules were ineffective at nitrogen fixation.*

Photo: Drew *et al.* (2014) Inoculating legumes: A practical guide. Grains Research & Development Corporation, https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

Some nodules may appear green or grey inside. At the 10-week growth stage, this would likely indicate herbicide damage or that the plant has suffered water stress. These nodules are unlikely to recover N-fixation activity. However, later in the season, as plants approach flowering, the development of green pigmentation in the nodules occurs as a normal part of nodule maturation. Field pea nodules are indeterminate. This means they continue to grow and form lobed structures with distinctly different zones visible inside the nodule. With maturity, the section of nodule closest the plant root loses its pink coloration, turning grey or green. As long as the section of the nodule furthest from the root retains some pink tissue, the nodule remains actively fixing nitrogen.

If you have spent time and resources on inoculation, it is worthwhile to carry out this nodulation check, to determine whether your inoculation has been successful and is likely to provide N benefits. It may also indicate whether troubleshooting is required, or whether inoculation is needed in future.

4.9.4 Rating nodulation and nitrogen fixation

The amount of nitrogen fixed is strongly correlated with nodule rating (0 to 5) as detailed in the following photo standards (Figure 1).

When using this rating system, plants should be gently dug from the soil and the root system rinsed in water before scoring the level of nodulation.

Obvious signs of nodulation should be visible by 6 weeks after sowing (even in high soil nitrate situations).

- **Rate the level of nodulation using the photo standards provided** (Figure 1). This is based on nodule number and their position on the root system.
- **Observe the pattern of nodules on the root system.** Nodules on the main taproot clustered near the seed are a clear indication that nodulation occurred as a result of the inoculation process. These are referred to as 'crown nodules'.

If there are no crown nodules, but nodules on the lateral roots, then it is more likely that they have formed from native soil bacteria that are usually less effective in fixing nitrogen, even in field pea.

Nodules on both the crown and lateral branches indicate that inoculation was successful, and that bacteria have spread in the soil.

- **Inspect nodules for nitrogen-fixation activity.** The best method is to slice a few nodules open with a razor blade or sharp knife and look at their internal colour (see Figure 1).

Young nodules are usually white and still need to develop. White nodules can also indicate the wrong bacteria in the nodule and these will not fix nitrogen. Effective nodules are a rusty red or pink colour inside and these are usually actively fixing nitrogen. Effective red nodules can sometimes turn green when a plant comes under water, disease or other stress, or is suffering from nutrient deficiencies. These do not fix nitrogen, but they can change back to red and start fixing again if the stress is relieved without too much damage being done. Finally, black nodules are usually dead or dying. These are often seen as the crop matures, or after a crop has suffered severe waterlogging.[28]

4.9.5 Key for assessing nodulation in winter pulse crops

Figure 1 shows nodulation scores (0–5), based on nodulation number and distribution, where 0–1 is inadequate nodulation, 2–3 is adequate nodulation and 4–5 is good nodulation.

Score 0: taproot – absent, lateral – absent/few | **Score 1**: taproot – few/medium, lateral – absent | **Score 2**: taproot – medium, lateral – absent/low

Score 3: taproot – medium/high, lateral – low | **Score 4**: taproot – high, lateral – medium | **Score 5**: taproot – high, lateral – high

Figure 1: *Nodulation scores based on number and distribution of nodules.*

Source: TopCrop, Growers guide to assessing nodulation in pulse crops

28 TopCrop, Growers guide to assessing nodulation in pulse crops

FEEDBACK

Interpreting the impacts of the nodulation score:

- Where plant-available soil N is low, the crop relies heavily on good nodulation for its nitrogen supply. A score of 4–5 is desirable.
- Where plant-available N is high, nodulation may be partly inhibited and the crop will depend mainly on the soil to supply nitrogen.
- A high score indicates that the crop will yield well and conserve N for use by a following crop.

A low score suggests that the crop will yield poorly and deplete soil N.[29]

4.10 Seed treatments

An insecticide seed dressing is a simple and cost-effective way to protect emerging crops from insect attack in the early growth stages. Gaucho® 600 Red Flowable Seed Treatment Insecticide (imidacloprid) is registered as a seed treatment for early aphid protection to help control persistently transmitted viruses at the seedling stages. According to the label, Gaucho® seed treatment does not affect the viability of rhizobia when mixed with inoculant.

Seed treatments are also a cheap and effective method of suppressing some diseases, although growers need to be aware that the P-Pickle-T® seed treatment has caused phytotoxic responses in treated field pea, particularly in white and blue types.

Fungicidal seed dressing is part of an overall disease-management strategy protecting against certain root and leaf diseases. It can improve seed emergence, especially in wet winters. Downy mildew is best controlled by metalaxyl seed treatment, which will also provide protection from some other root rots such as Pythium. Thiram and thiabendazole fungicidal seed treatment can control seed-borne spores of blackspot and some root rots for up to 8–10 weeks after sowing and may improve yield. This is more likely to be economic in higher-risk situations such as early sowing.

If using both inoculum and seed dressing, apply the seed dressing first and then inoculate seed immediately before seeding. Do not mix inoculants and seed dressings together unless the inoculant's label specifies compatibility.

VIDEO

Watch GCTV13: Legumes – Inoculant Compatibility
https://youtu.be/gHBDSYeq0Ss

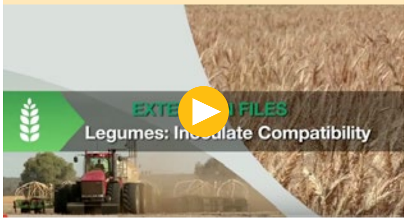


Table 8: Compatibility of different rhizobia groups with seed-applied fungicides and insecticides.

Inoculant group / crop	Fungicide type	Planting window of inoculated seed
E – pea, vetch	P-Pickel T Gaucho® 600 FL	6 hours 4 hours
F – faba bean, lentil	Gaucho® 600 FL P-Pickel T Thiram	24 hours 24 hours Compatibility not known
G – lupin	Rovral Thiram	6 hours 24 hours
H – soybean	not compatible with seed dressings	
N – chickpea	P-Pickel T Thiram Apron® XL 350 6 hours Gaucho® 600 FL	6 hours 6 hours 6 hours 6 hours
P – peanut	not compatible with seed dressings	

Information sourced from commercial product information guides (BASF and Novozymes)

Source: G O'Hara, J Howieson, E Drew, R Ballard, D Herridge, G Gemmell, E Hartley, L Phillips, R Decker, M Denton, R Yates, N Seymour, N Ballard (2014) Inoculating legumes: A practical guide. Grains Research & Development Corporation, https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

29 TopCrop, Growers guide to assessing nodulation in pulse crops

4.11 Further research projects

DAS00128 – Optimising nitrogen fixation of grain legumes - southern region

DAS00128 – Effect of rhizobia and other microbial inoculation treatments on field pea (https://www.farmtrials.com.au/trial/16967)