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GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

VETCH

SECTION 3

PLANTING

INOCULATION | SEED TREATMENTS | TIME OF SOWING | TARGETED PLANT POPULATION | CALCULATING SEED REQUIREMENTS | SOWING EQUIPMENT

Planting

Key messages

- Vetch should be inoculated with Group E rhizobia, especially in paddocks where vetch has not been grown before.
- In Western NSW, Vetch should be sown in mid-March but timing will depend on whether the crop will be grazed or cut for hay.
- Vetch target population and seeding rate differ depending on end use.
- Vetch should be sown between 3–5 cm deep with good soil cover.
- Vetch can be normally drilled, whether sown alone or in combination with cereals or cereal/forage peas, and it can also be broadcast although this is rarely done

3.1 Inoculation

Key points:

- Group F rhizobia is recommended for vetch inoculation
- Do not mix inoculants with fungicides/insecticides. Make sure to check labels for compatibility.
- Take the time to choose an inoculant type that suits conditions and farming systems.
- It's important to see how effective the inoculum has been and what state of health the nodules are in. By checking the degree of nodulation you can assess the type of inoculum product you have used and the application technique employed to get the rhizobia where it needs to be; in the roots of the growing pulse.

Nitrogen fixation by legumes does not happen as a matter of course. Compatible, effective rhizobia must be 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 particular soil, it is highly likely that compatible, effective rhizobia will not be present. In such circumstances, the rhizobia must be supplied in a highly concentrated form as inoculants.

Vetch is able to add a large amount of nitrogen to the soil, which has benefits to following crops (Table 1).

Table 1: *The range of measures of shoot dry matter (DM) production and estimates of N2 fixation for 35 commercial pulse crops sampled in farmers' fields between 2001 and 2013. Mean values for each parameter and crop species are shown in brackets.*

Legume	Number of crops	Shoot DM	Shoot N fixed		
		(t DM/ha)	(%Ndfa)	(kg N/ha)	(kg N/t DM)
Faba bean	5	7.2–8.4	68–89	117–152	16–18
		[7.6]	[74]	[135]	[17]
Lupin	11	0.9–10.2	20–82	20–150	9–21
		[5.5]	[59]	[74]	[15]
Vetch	3	4.2–6.3	54–84	53–135	13–22
		[5.1]	[69]	[89]	[17]
Lentil	3	2.0–5.3	17–82	20–104	4–20
		[4.0]	[50]	[51]	[13]
Field pea	7	2.3–5.9	8–85	12–87	2–20
		[3.9]	[53]	[45]	[14]
Chickpea	6	0.8–5.2	24–87	13–66	7–17
		[2.9]	[67]	[34]	[13]
Median all crops			68	61	16

Source: GRDC

MORE INFORMATION

Legume effects on soil N dynamics - comparisons of crop response to legume and fertiliser N

For more information on vetch nitrogen fixation, see Section 1: Planning and paddock preparation, Section 1.3 Benefits of vetch as a rotation crop, Nitrogen fixation.

Grain legumes do not need additional nitrogen (N) if the seed is effectively inoculated at planting. Profitable production of pulses is dependent on successful nodulation of the crop, which supplies more than 60% of pulse crop nitrogen. [1] The biological process of nitrogen fixation, where rhizobia located in legume root nodules convert atmospheric dinitrogen (N_2) into ammonia (NH_3) for plant growth, is one of the great agriculture success stories. *Rhizobium* bacteria that have a symbiotic relationship with pulse crops 'infect' the plant roots, forming nodules that fix atmospheric nitrogen for the pulse crop to use while it is growing (Photo 1). This free source of nitrogen ensures a healthy plant and delivers excess nitrogen that reduces the risks of cereal production in subsequent years. Nitrogen fixed by the soil bacteria rhizobia symbiotically with Australia's pasture and pulse legumes, has a national benefit of close to $4 billion annually.

1 J Evans. (2005). An evaluation of potential Rhizobium inoculant strains used for pulse production in acidic soils of south-east Australia. *Animal Production Science*, *45*(3), 257–268.

Photo 1: *Nitrogen fixing nodules on a pulse plant.*

Photo: A Mostead, Source: GRDC

Residual nitrogen in the soil is decreased by crop growth (e.g. cereals) and nitrogen fixing crops like legumes and pulses can increase nitrogen in the soil. New technology has provided growers with several methods of applying the *Rhizobium* bacteria to the soil. Inoculation adds the most efficient N-fixing bacteria (rhizobia) for the type of legume to help maximise nodulation and N-fixing ability. A following cereal crop can also benefit from an effectively inoculated legume crop. Application of essential fungicides at planting is also possible using these new delivery methods without compromising the health of the rhizobium. [2]

Vetch should be inoculated with Group E rhizobia (*Rhizobium leguminosarum bv. viciae*).

Inoculation is important to all legumes, especially under planting situations where:

- soil has not previously grown the specific legume crop
- there has been a long time interval between the planting of successive legume crops
- soil erosion has removed or depleted bacterial populations
- levelling has exposed lower soil profiles that contain low bacterial populations.

Rhizobia types vary in their ability to persist in the soil until the host pulse crop is regrown. Vetch, pea and bean rhizobia (Groups E & F) survive well in neutral to alkaline soils with good texture (loams or clays). Vetch rhizobia survive poorly in low pH or sandy soils. The safest and lowest risk option is to always inoculate the crop, especially on light textured soils.

The cost of inoculation is lowand should be applied ever year, regardless of pulse history of the paddock . A benefit of inoculating a crop where rhizobia already exist is that an improved strain will be introduced which could result in better persistence for future pulse crops. Research continues to find more robust and efficient rhizobia strains for all pulse species. The strain used today in any group will be more advanced than those introduced to a paddock in the past. [3]

VIDEOS

WATCH: GCTV13: Legumes – Sowing preparation.

2 Pulse Australia. (2015). Australian Pulse Bulletin: Pulse inoculation techniques. http://pulseaus.com.au/growing-pulses/publications/pulse-inoculation

3 Pulse Australia. (2015). Australian Pulse Bulletin: Pulse inoculation techniques. http://pulseaus.com.au/growing-pulses/publications/pulse-inoculation

Rhizobia and acidic soils

After more than 100 years of legume cultivation, many Australian soils have developed substantial populations of rhizobia that are able to nodulate commonly grown agricultural legumes. However, suitable rhizobia may still be absent from the soil if the legume has not been grown previously or where the soil is not conducive to long-term rhizobial survival. Factors such as soil composition, water content, temperature and pH can influence plant and rhizobia growth and nodule establishment.

Soil acidity alone is responsible for significant losses in global legume production, resulting from impaired plant and rhizobia growth, and due to decreased nodule development and nitrogen fixation. Legumes species differ in their nodulation and growth response to acidic soil. Generally, nodule formation is more sensitive to soil acidity than other aspects of plant growth. Rhizobia for medic, lucerne and pea (including vetch, lentil and faba bean) are particularly sensitive to acid soils (Table 2). Their number may be sub-optimal or absent where soil pH is less than 6.0, even where there has been a recent history of legume host. In low pH soil, nodule formation has been reported to be reduced by more than 90% and nodule dry weight by more than 50% in species such as soybean and pea. Low pH conditions have also been shown to affect rhizobia attachment to root hairs and root colonisation, leading to reduced nodule formation. Soil acidity is widespread in the Northern cropping region, so soil testing, inoculation and monitoring of nodulation needs to be considered when growing vetch.

Table 2: *Sensitivity of key rhizobia to pH, where red is sensitive and green is optimal.*

Rhizobia	Host legume	pH 4	pH 5	pH 6	pH 7	pH 8
Rhizobium leguminosarum bv. viciae	Vetch					

Source: GRDC

Fortunately, acid tolerant strains of many rhizobia species have been isolated. The most effective means to improve nodulation under low soil pH conditions is to use acid-tolerant legume cultivars. Nodulation can be (but not always) achieved in acidic growth conditions as long as one of the symbionts is acid-tolerant. [4]

3.1.1 Application

Pulses have historically been inoculated with rhizobia onto the seed. But now rhizobia can be purchased in a form suitable to be applied with water into the soil, or as granules that are sown with the seed from a separate box. Rhizobia inoculants are available in a number of formulations (Figure 2):

1. moist peat, the traditional and most commonly used from of inoculant in Australia. Applied as a slurry directly to the seed or a diluted and filtered slurry directly injected into the seeding furrow.
2. granular, made from peat or clay. Applied directly into the seeding furrow using a separate bin on an airseeder.
3. liquid, a water-suspension of rhizobia. Diluted product is used for direct injection of inoculant into the seeding furrow into moist soil only, within six hours of mixing with water.
4. freeze-dried powder, a concentrate which is reconstituted prior to application. Allows for direct injection of inoculant into the seeding furrow or coating the seed immediately (less than five hours) prior to sowing into moist soil. [5]

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4 B Ferguson, M Lin, P Gresshoff. (2013). Regulation of legume nodulation by acidic growth conditions. *Plant signaling & behavior*, *8*(3), e23426.

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

Photo 2: *Forms of rhizobia (left to right): Easyrihiz freeze-dried, Nodulator granules, Alosca granules, N-Prove granules and peat inoculant.*

Photo: M. Denton, DPI Vic

Choosing an inoculant type

All types of inoculants will result in a well nodulated crop in good conditions but results may vary (Table 3).

Table 3: *Using different inoculant formulations.*

	Peat	Freeze-dried	Granular
Description	Finely ground sterilised peat containing a high density of rhizobia	Powder containing a very high density of rhizobia	Granules of peat or clay or a mixture; contain a lower number of rhizobia per gram
Storage	Winter legume inoculants – refrigerate at 4°C; summer legume inoculants – store in cool, dry place	Refrigerate at 4°C DO NOT FREEZE	Store in a cool and dry place away from direct sunlight
Common application	Mix with clean water to make a slurry, apply direct to seed. Can also be used in furrow.	Reconstitute with clean water and add protective compound. The liquid suspension is applied direct to seed or can be injected into the furrow	Granules are delivered in furrow at sowing. DO NOT allow granules to become moist during seeding as some products can cause blockages
Using additives	If used, ensure adhesive solutions are cooled before rhizobia are added. Generally NOT COMPATIBLE with mineral and organic fertilisers and pesticides; check manufacturer's guidelines	Generally NOT COMPATIBLE with mineral and organic fertilisers and pesticides; check manufacturer's guidelines	Check inoculant manufacturer's compatibility guidelines
Sowing	Best sown on day of coating into moist soil	Sow treated seed into moist soil within 5 hours of application	A third seeding box should be used to keep the granular formulation separate from fertilisers and pickled seed

Source: GRDC

When conditions are less than ideal, making the right choice becomes more critical (Table 4). Granules can vary and, depending on the product, may be dry or moist, uniform, variable, powdery, coarse or fine. The rhizobia bacteria need moisture to survive. When contained in the carrier; i.e. the peat material or the granule form, they will survive for up to 12 months when stored well. Read the expiry date before use.

However, once applied the survival rate is highly dependent on available soil moisture. This particularly applies to inoculum applied to the seed or to the soil as slurry. Dry soil conditions after sowing will kill off the rhizobia. Moisture will be needed within 2–3 days after sowing to maintain adequate numbers. If introduced rhizobia are essential for crop health, dry sowing should be avoided and caution should be used if sowing into a drying seed bed with a poor forecast for follow-up rain.

Granules by comparison are ideally suited to maintaining rhizobia numbers in dry soil for extended periods before rain arrives. The rhizobium is maintained within the granule which continues to protect it until the soil wets and the rhizobia can start multiplying. They are ideal to use if dry sowing is being considered. Additionally, they enable fungicides, which may be toxic to the rhizobia, to be applied the seed without causing a reduction in rhizobia numbers. [6]

Table 4: *Survival of rhizobia according to inoculant type and conditions at application.*

Inoculant type	Where inoculant should be applied	Survival in dry or drying soil*	Compatibility with seed applied fungicide	Time to sow after inoculation	Preparation or machinery requirements
Peat inoculums	Seed	Low	Some (check label)	24 hours	Pre-sowing/ Liquid applicator on seed
Freeze dried inoculums	Seed or in furrow (water inject)	Very low	No	Within hours	Pre-sowing
Granular forms	Seeding furrow or below seed	High	Yes	-	Separate seed box at sowing
In-furrow water injection	Seeding furrow or below seed	Very low	Yes	Within hours	Liquid applicator on seeder

*Survivial will depend on duration of dry conditions and soil pH.

Source: Pulse Australia

Always refer to the container label for inoculant application rates and check the inoculant's expiry date, and do not use old inoculant.

Likewise, keep inoculated seed in a cool shady place out of direct sunlight and treat enough seed for only one day's planting. Additionally, be cautious when using air seeders, as hot air in the distribution system may affect the inoculum. Temperatures greater than 30°C can kill the bacteria.

Seed coating in practice

- Rates of application; i.e. volumes and weights of formulation, water and seed, are given on inoculant packets
- Peat formulation is made into a slurry using clean potable water in a clean drum and mixing well
- For pasture seed, an adhesive is often added to the slurry

6 Pulse Australia (2015) Australian Pulse Bulletin: Pulse inoculation techniques. http://www.pulseaus.com.au/growing-pulses/publications/pulse-inoculation

- NOTE: Avoid fertiliser and pesticide residues and saline water
- Always grade seed first to remove pod debris and fine grain dust, which can block seeders
- Freshly prepared slurry is pumped from the drum (or poured) into the path of grain legume seed going up a slow-moving flighted auger into a grain bin
- Pasture seed, being small, can be coated in a concrete mixer or by mixing with a shovel on a concrete floor
- Most temperate pasture seed is best coated with fine lime (builders' and slaked lime should be avoided)
- Freeze-dried inoculant can be applied in the same way as peat slurry, as per manufacturer's instructions
- Allow slurry-treated seed to dry before filling air-seeders to prevent 'bridging' in the tank. [7]

The proven method of slurry inoculating the seed through an auger just prior to sowing still appears to be the cheapest and most reliable method (Photo 3). Alternative delivery methods using clay-based granules or water injection through micro-tubes are equally effective but considerably more expensive. These latter methods are best used when using sowing fungicide-dressed seed, to separate the rhizobia from the chemical.

Photo 3: *Inoculating seed through an auger. Don't forget to calibrate the amount of water required (too much will lead to sticky seeds).*

Source: GRDC

3.1.2 Compatibility with other major factors

Pesticides and fungicides

Rhizobia are living organisms. As a general rule, pesticides are toxic to rhizobia.

Almost all pulses require a fungicide applied to the seed to provide protection during early growth against foliar diseases. Occasionally an insecticide may also be needed.

Peat inoculants are also applied to the seed, bringing together two largely incompatible products. Mixing inoculum with a pesticide for seed treatment is possible with some products. Read the inoculum label to check for compatibility.

7 GRDC (2013) Inoculating legumes: the back pocket guide. http://www.agwine.adelaide.edu.au/research/farming/legumes-nitrogen/legume-inoculation/inoclegubackpocketguide.pdf

Applying the fungicide to the seed prior to the inoculum is a safer method to reduce the risk of rhizobia death. The fungicide can be applied at any time leading up to sowing. The inoculum is then applied immediately before sowing into moist soil. If in doubt, do not mix the inoculant and any pesticide.

Granular inoculants remove this risk because the rhizobia and the pesticide are not in contact. If you need to use a potentially toxic seed pesticide treatment, granular inoculant may be worth considering.

Always read the inoculant label or contact the manufacturer for up-to-date information on compatibility. [8]

Effect of fungicidal seed dressings on inoculum survival

While fungicide seed dressings reduce the longevity of the N-fixing bacteria applied to the seed (Table 5), the effect can be minimised by keeping the contact period to as short as possible.

Inoculate fungicide-treated seed as close as possible to the time of sowing.

Re-inoculate if not planted within 12 hours of treatment.

VIDEOS

WATCH: GCTV13: Legumes – Inoculant compatibility.

Table 5: *Compatibility of Group E rhizobia (for use in vetch) with seed-applied fungicides.*

Inoculant Group/crop	Fungicide type	Planting window of inoculated seed
Group E - Vetch	P-Pickle T	6 hours
	Gaucho® 600FL	4 hours

Source: GRDC

Trace elements

Rhizobia can be compatible with a few specific trace element formulations, but many are not compatible with rhizobial survival. Mixing inoculants with trace elements should only occur if the trace element formulation being used has been laboratory-tested against the rhizobial type being used.
Note the differences between inoculant types for a given trace element product, as well as differences between trace element products with a given inoculant.

3.1.3 Storing inoculant

Storing inoculant One of the main factors affecting the quality of legume inoculants is storage temperature. Legume inoculants contain live rhizobia. It is important to make sure they are kept in moderate temperatures (less than 30 °C and not frozen) away from sunlight and chemicals. Inoculant quality at the point of sale at the point of sale has been monitored.

Inoculants were purchased from retail outlets covering the grain cropping areas across Australia and the number of rhizobia in each packet or container counted. Temperatures and conditions of storage were recorded. Generally, rhizobial numbers in the inoculants remain high because the product at the point of manufacture had been prepared in a suitable carrier that prolongs rhizobial survival. However, numbers for the common legume host groups decline in rhizobial number when stored at ambient to high temperature compared to those stored at less than 10 °C (refrigerated). For the groups E, F, G, N and C there is a reduction of 22% or more in rhizobial numbers when the products are not refrigerated (Table 6). [9]

8 Pulse Australia. Pulse inoculation techniques. http://www.pulseaus.com.au/growing-pulses/publications/pulse-inoculation

9 E Hartley, G Gemell, J Hartley (2015) Use of quality legume inoculants to get the most from nitrogen fixation. NSW DPI. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/660496/Southern-NSW-research-results-2015.pdf

MORE INFORMATION

Pulse inoculation techniques

Inoculating legumes: a practical guide (GRDC)

Inoculating legumes: the back pocket guide (GRDC)

Rhizobia inoculants fact sheet (GRDC)

Maximising the nitrogen (N) benefits of rhizobial inoculation

Table 6: *Effect of retail storage temperature on rhizobial survival in peat inoculants.*

Legume	Inoculant group	Million rhizobia/g peat		
		Refrigerated <10°C	Ambient >20°C	Difference (%)
Vetch	E	831	614	-26

Source: NSW DPI

3.1.4 Assessing nodulation

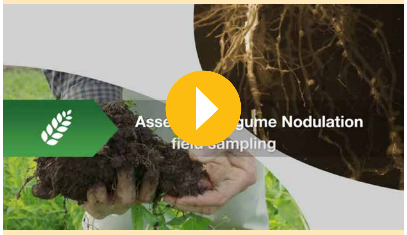
Vetch has a strong root system that develops nodules at an early stage; this provides sufficient nitrogen for the plants to use and accumulates significant amounts for the following crops (Photo 4).

Photo 4: *Vetch showing good nodulation.*

Source: Maarten Ryder

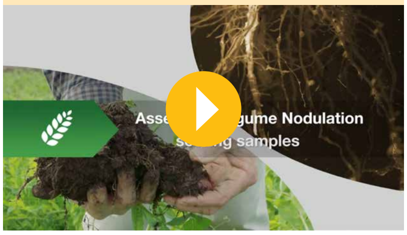
VIDEOS

WATCH: GCTV17: Legume nodulation — field sampling.



WATCH: GCTV17: Legume nodulation — sample preparation.

WATCH: GCTV17: Legume nodulation — sample scoring.

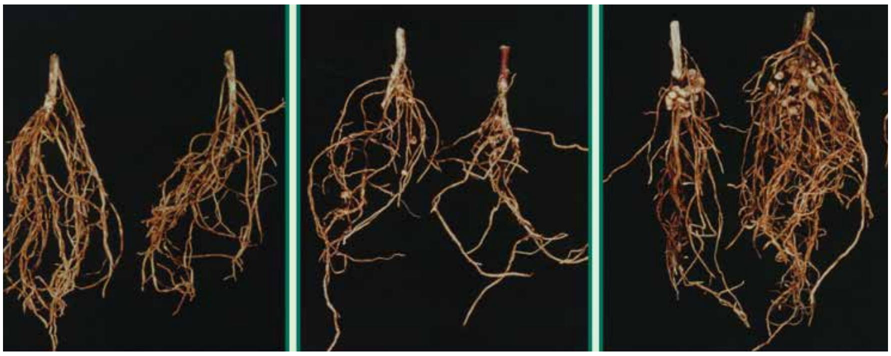


Do not assume that by applying rhizobia to the crop that the job is over. It's important to see how effective the inoculum has been and what state of health the nodules are in. By checking the degree of nodulation, you can assess the type of inoculum product you have used and the application technique employed to get the rhizobia where it needs to be; in the roots of the growing pulse. [10]

Nodules will have developed and be easily located from 8 to 10 weeks after sowing. Nodule assessment should occur any time from this point through to the end of flowering. For practical reasons, crops are more easily traversed when plants are young, and it is best to dig when the soil is moist and friable, allowing it to be easily crumbled from the roots.

To assess the effectiveness of crop nodulation and the health of nodules:

1. Carefully dig up 10 plants from each of several locations in the paddock and soak in bucket of water.
2. Locate nodules. A well-nodulated plant has nodules on the crown (where the root meets the shoot) and on the tap root and lateral roots.
3. Note their distribution, on the primary root and lateral roots.
4. Slice open a nodule. Check the colour inside the nodule. Is it pink/red or green or brown? Pink-coloured tissue indicates active N fixation.
5. Score 10 plants for nodulation and record (Photo 5).
6. Look at root health and structure. [11]



Score 0: taproot, absent; lateral, absent/few.
Score 1: taproot, few/ medium; lateral, absent.
Score 2: taproot, medium; lateral, absent/low.

Score 3: tap root, medium/ high; lateral, low.
Score 4: taproot, high; lateral, medium.
Score 5: taproot, high; lateral, medium.

Photo 5: *Photo guide to assessing legumes nodulation.*

Photos: A Gibson.

10 Pulse Australia. (2015). Australian Pulse Bulletin: Pulse inoculation techniques. http://pulseaus.com.au/growing-pulses/publications/pulse-inoculation

11 J Walker, K Hertel, P Parker, J Edwards (2011) Lupin growth and development. NSW DPI. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/516183/Procrop-lupin-growth-and-development.pdf

Nitrogen deficiency from nodule dysfunction can be caused by lack of Rhizobia, soil conditions, herbicide toxicity, or molybdenum or cobalt deficiency. Indications of poor nodulation are yellowing young leaves, yellow and/or stunted patches of plants, and lack of nodules on root systems.

If there is poor nodulation, check the inoculation strategy to ensure best management practices are followed. If both nodulation and plant performance are poor, reasons for poor nodulation need to be identified. Poor nodulation can cause 10–50% yield loss in pulse crops, as well as the lower potential nitrogen benefits to following crops. While a visual assessment will not indicate the actual level of nitrogen being fixed (only sophisticated scientific methods can do that) looking at the roots to determine if there has been a nodulation delay or failure is worthwhile.

Nodulation failure is difficult to remedy, except by adding inorganic nitrogen, which can be costly. Other possible remedies (if done immediately) include:

- In flood or sprinkler-irrigated fields, add slurry or liquid inoculant to the irrigation water
- Over-sow a granular inoculant close to the original sowing furrow. [12]

3.2 Seed treatments

It is recommended that, whenever possible, seed should be obtained from a source where the crop was free from disease. Seed treatments are a cheap and effective method for suppressing some diseases.

Fungicide use in vetch is not common, but if applied, then fungicides and principles of use are similar to those used in lentil and/or faba bean. Treating seed with products containing thiram plus thiabendazole (e.g. P-Pickel T® , Fairgro® Reaper TT®) will reduce seed infection, thereby protecting new seedlings from infection (Table 7). If infected seeds are sown untreated, botrytis seedling blight can reduce plant establishment during the growing season.

Table 7: *Pulse seed dressings 2017, Page 138, Table 69.*

Active ingredient	Fungicide group	Products	Active ingredient	Rate: (per 100 kg seed)
Thiram + Thiabendazole	M3 and 1	P-Pickel T® Fairgro® Reaper® TT	Thiram 360 g/L + TBZ 200 g/L	200 mL

Source: NSW DPI

3.2.1 Application

It is important for seed treatments to be evenly distributed on seed to ensure each seed gets an effective dose. This is enhanced for flowable seed treatments by dilution with water (refer to the label). Secondary mixing of treated seed through an auger assists to obtain even seed coverage. Correct calibration of the applicator and a consistent seed flow are critical for the recommended rate of seed treatment to be applied. [13]

3.3 Time of sowing

Time of sowing with vetch for grain production is often a compromise. Early sowing increases the risk of frost damage and leaf disease resulting from excessive foliage growth. Later sowing runs the risk of lower yields due to high temperatures and dry conditions during flowering and pod fill.

12 GRDC (2013) Inoculating legumes: the back pocket guide. http://www.agwine.adelaide.edu.au/research/farming/legumes-nitrogen/legume-inoculation/inoclegubackpocketguide.pdf

13 W Hawthorne, J Davidson, K Lindebeck (2011) Australian Pulse Bulletin PA 2011 #15: Pulse seed treatments and foliar fungicides. http://pulseaus.com.au/storage/app/media/crops/2011_APB-Pulse-seed-treatments-foliar-fungicides.pdf

MORE INFORMATION

Managing brown manure crops in southern NSW

Early sowing would be the preferred option for crops destined for hay, silage or green/brown manuring options where bulky plants are desired and frost damage is not an issue

Vetch should be sown between early-march l and the end of June, depending on break of the season (early March to May for feed/grazing end-use in lower rainfall regions). Data from ten years of trials indicate that earlier seeding times produced better yields compared with later seeding. [14]

Seeding rate may need to be increased by 10–15% if sowing is delayed beyond the optimum. [15]

3.4 Targeted plant population

Sowing rate affects plant establishment and is an important crop management decision. Sowing rate will vary depending on which legume is being planted, the region, the rainfall, the seed source and the sowing time.

In low rainfall areas, maximum dry matter and grain yields are obtained at plant densities of 50–60 plants per square metre (p/m^2). In areas with greater than 400 mm/year, plant densities of 70-80p/m^2 produced the highest yields (Table 8). [16]

For quality pastures or hay/silage use a mix of 2/3 vetch and 1/3 of rye grass or cereals (as a % of) the recommended rates for a particular area. [17]

Table 8: *Plant density and recommended seeding rates for vetch.*

End use	Common vetch varieties		Woolly pod vetch varieties		Purple vetch variety*	
	Plants density (plants per sq.m.)	Sowing rate (kg/ha)	Plants density (plants per sq.m.)	Sowing rate (kg/ha)	Plants density (plants per sq.m.)	Sowing rate (kg/ha)
Grain	40–60	40–50	40–50	25–40	40–50	25–40
Hay/ silage	50–70	50–60	50–60	30–45	50–60	30–45
Grazing	50–70	50–60	50–60	30–45	50–60	30–45
Green manure	60–70	55–65	60–70	45–50	5–60	30–45

* in Australia Popany is the only Purple vetch variety

Source: SARDI

3.5 Calculating seed requirements

The correct plant density is an important factor in maximising yield of pulse crops. To obtain the targeted density it is necessary not only to have quality sowing seed but also be able to accurately calculate seeding rates. It is surprising the difference a slight variation in seed size or germination makes to the seeding rate required to achieve a target plant density.

When sowing in areas with less than 350 mm of rainfall per year vetch for pasture, green manure or hay/silage should be

14 R Matic, S Nagel, G Kirby (2008) Common Vetch. Pastures Australia. http://keys.lucidcentral.org/keys/v3/pastures/Html/Common_vetch.htm

15 Day, T., Day, H., Hawthorne, W., Mayfield, A., McMurray, L., Rethus, G., & Turner, C. (2006). Grain legume handbook. *GRDC: Canberra, ACT.*

16 R Matic (2015) GRDC Final Reports: DAS00013 – Vetch variety improvement for Australian field crop farming systems. https://grdc.com.au/research/reports/report?id=268

17 R Matic, S Nagel, G Kirby (2008) Common Vetch. Pastures Australia. http://keys.lucidcentral.org/keys/v3/pastures/Html/Common_vetch.htm

Calculating 100-seed weight

To determine the 100-seed weight of a seed lot:

1. Take a representative sample of your seed lot. If it is ungraded, weigh out 50 to 100 g and remove damaged and split seed that would normally be discarded by grading.
2. Count out 200 seeds from each seed lot to be planted.
3. Weigh 200 seeds on scales accurate to 0.1 g.
4. Divide the weight by 2 to calculate the 100-seed weight.
5. Repeat four times from your sample.

3.5.1 Calculating seeding rate

Calculate a seeding rate based on a target plant population:

1. Decide on a target plant density
2. Calculate the 100-seed weight (see above)
3. Calculate the germination percentage of the seed lot (see Section 2, Section 2.3.2). Determine the establishment percentage. A realistic estimate of establishment is 80%. Take into account the likely field conditions (temperature, moisture, soil type, sowing depth, insects and disease).
4. Use the following formula to calculate seeding rate: Seeding rate for the target plant density can be calculated using germination percentage, 100 seed weight and establishment percentage (Figure 1).

Adjust sowing rates to take account of seed size, germination percentage and estimated establishment conditions.

$$\text{Seeding Rate (kg/ha)} = \frac{\text{100 seed weight\# x Target plant population* x 1000}}{\text{Germination \% x Estimated Establishment \%*}}$$

Example

100 seed weight = 21 grams

Target plant density = 25 plants/m^2 (i.e. 250,000 plants/ha)

Germination % = 95%

Estimated establishment % = 85%

$$\text{Seeding rate (kg/ha)} = \frac{21 \times 25 \times 1000}{95 \times 80}$$

= 69.08 kg/ha

#100 seed weight in grams from the variety characteristics table.
*Target plant population for your location (seek local advice)

Figure 1: *Seeding rate calculation – Desi chickpea example.*

Source: Pulse Australia

Seeding rates have been calculated for vetch based on the example above (Table 9). Seed size and germination percentage can vary so it is recommended that growers calculate seeding rate based on their seed.

Table 9: *Vetch sowing rates (kg/ha) based on 95% germination and 80% establishment.*

Variety	Seed weight (g per 100 seeds)	Seeding rate (kg/ha)				
		20	30	40	50	60
Morava⦇	7.82	20.58	30.87	41.16	51.45	61.74
Rasina⦇	6.92	18.21	27.32	36.42	45.53	54.63
Volga⦇	7.95	20.92	31.38	41.84	52.30	62.76
Blanchefleur	5.21	13.71	20.57	27.42	34.28	41.13
Timok⦇	6.88	18.11	27.16	36.21	45.26	54.32
Languedoc	6.74	17.74	26.61	35.47	44.34	53.21

Sowing depth

Sowing depths of pulses needs to be varied to take into account the crop type, soil type, herbicide used, the diseases likely to be present and the soil temperatures at sowing time; i.e. how long the crop will take to emerge. Lighter textured soils can be more prone to herbicide leaching in wet winters, hence deeper sowing in sandier soils is often recommended if applying a pre-emergent herbicide. The deepest sowings tend to be in sandy soil with warm soil temperatures and the shallowest sowings will be in heavy soils with cold soil temperatures, however there are exceptions.

Sowing depth is the key to uniform, fast emergence and establishment. Vetch should be sown at 3–5 cm and if applying a pre-emergent herbicide vetch should be sown at 5 cm. [18]

Avoid deep planting as seedlings can be weak. [19] and then be more prone to attack from insects and disease

There is a maximum depth at which the pulse crop can be safely sown to avoid poor establishment and lower seedling vigour. Sowing seed outside the suggested range above will delay emergence and slow seedling growth. Actual sowing depth should be shallower on clay soils and hard setting soils and deeper on sands. Vetch, lentils, peas and chickpeas have intermediate tolerance to deep sowing. Burying seed too deep to chase seed bed moisture for early sowing is not recommended, particularly as weed control, establishment and possibly nodulation is more likely to be poor. Deeper sowing may be needed in some districts to reduce the damage caused by birds and mice. [20]

For more information, see Section 4: Plant growth and physiology, Sowing depth section.

3.6 Sowing equipment

Key points:

- Tubulators or belt elevators are excellent for handling legumes as little or no damage occurs.
- On some airseeders the dividing heads may have to be modified because there is too little room in the secondary distributor heads to allow seeds to flow smoothly.

18 Day, T., Day, H., Hawthorne, W., Mayfield, A., McMurray, L., Rethus, G., & Turner, C. (2006). Grain legume handbook. *GRDC: Canberra, ACT*. https://grdc.com.au/__data/assets/pdf_file/0032/208886/chapter-3-seeding.pdf.pdf

19 CRDC. Comparative advantages/disadvantages of rotation crops with cotton. http://www.cottoninfo.com.au/sites/default/files/tools/CottonRotation/Rotation_chart_Page_1small.pdf

20 Day, T., Day, H., Hawthorne, W., Mayfield, A., McMurray, L., Rethus, G., & Turner, C. (2006). Grain legume handbook. *GRDC: Canberra, ACT*. https://grdc.com.au/__data/assets/pdf_file/0032/208886/chapter-3-seeding.pdf.pdf

- For vetch planting, maintenance and harvesting, farmers can use the same machines that are used for cereal crops (Photo 9). [21]

Photo 6: *Vetch inter-sown into cereal stubble.*

Photo: Stuart Nagel

Success with pulses may depend on the type of sowing equipment used because the large size of pulses can make sowing with conventional seeders extremely frustrating. If your seeder is not suitable for sowing a particular pulse (usually larger seeded types) in standard form 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 airseeders.

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 used.

Broadcasting pulses

If your sowing equipment is not able to cope with larger pulse seeds, it may be possible to broadcast the crop using a fertiliser spreader. The soil should be well ridged before broadcasting so that the seed will concentrate in the furrows. After broadcasting the soil should be worked shallowly with seeder and harrows or cultivator and harrows to cover the seed. When broadcasting, use a higher seeding rate than normal (20–50% higher, depending on conditions) because of the lower emergence levels. Yield is determined by final plant population rather than seeding rate. [22]

21 R Matic, S Nagel, G Kirby (2008) Common Vetch. Pastures Australia. http://keys.lucidcentral.org/keys/v3/pastures/Html/Common_vetch.htm

22 Day, T., Day, H., Hawthorne, W., Mayfield, A., McMurray, L., Rethus, G., & Turner, C. (2006). Grain legume handbook. *GRDC: Canberra, ACT.* https://grdc.com.au/__data/assets/pdf_file/0032/208886/chapter-3-seeding.pdf.pdf