Seeding

Seed Quality

The best yields are produced by using quality seed with high germination rates. Sowing seed with low germination rates will produce a thin stand and lower yields.

Some pulses, such as peas, may have low germination rates because they have a high percentage of dormant seed. Others, such as lupins and broad beans, are easily damaged during augering. Harvest and post harvest seed damage can produce abnormal seedlings which germinate but do not develop further. *(See Plates in section 9)*

Seed borne diseases can lower germination levels.

Seed with poor germination potential or high levels of seed borne disease should not be sown. *(See Plates 7 : 11, 7 : 12 & 7 : 31*) The lower cost of this seed will be offset by the higher sowing rates needed to make up for the lower germination and the potential to introduce disease on to the property.

The only way to accurately measure the seed's germination rate and disease level is to have it tested.

Germination testing

Germination tests are done by seed testing laboratories. For beans, chickpeas, lupins, peas and vetch the sample size required is one kilogram for each 25 tonnes of seed. For lentils, take one kilogram for each 10 tonnes of seed.

Weed contamination testing

Sowing seed free of weeds cuts the risk of introducing new weeds. It also reduces the pressure on herbicides, especially with increasing herbicide resistance. Tests for purity of a sample can be conducted if requested, including the amount of weed seed contamination.

Disease testing

Seed borne diseases such as CMV in lupins and ascochyta blight in faba beans and lentils pose a serious threat to yields. Seed borne diseases can strike early in the growth of the crop when seedlings are most vulnerable and result in severe plant losses and hence lower yields.

Testing seed before sowing will identify the presence of disease and allow steps to be taken to reduce the disease risk. If disease is detected, the seed may either be treated with a fungicide before sowing or a clean seed source may be used.

For a disease test 1kg of seed is required, except for anthracnose where 2kg is needed.

Major Pathogens identified in seed tests

Test No.	Crop and pathogen	Disease	Reference
	CHICKPEAS		
1	*Botrytis cinerea*	Botrytis grey mould	P 7 : 2
2	*Ascochyta rabiei*	Ascochyta blight	P 7 : 3
3	*CMV*	Cucumber mosaic virus	P 7 : 6
	FABA BEANS		
4	*Botrytis fabae*	Chocolate spot	P 7 : 7
5	*Ascochyta fabae*	Ascochyta blight	P 7 : 8
6	*Ditylenchus dipsaci*	Stem nematode	P 7 : 10
7	*BBSV*	Broad bean stain virus	
	LENTILS		
8	*Ascochyta lentis*	Ascochyta blight	P 7 : 12
9	*Botrytis cinerea*	Botrytis grey mould	P 7 : 13
10	*CMV*	Cucumber mosaic virus	P 7 : 14
11	*AMV*	Alfalfa mosaic virus	P 7 : 14
	LUPINS		
12	*Phomopsis leptostromiformis*	Phomopsis stem blight Lupinosis	P 7 : 15
13	*AMV*	Alfalfa mosaic virus	P 7 : 17
14	*CMV*	Cucumber mosaic virus	P 7 : 17
15	*Colletotrichum lupini*	Anthracnose	P 7 : 19
16	*Sclerotium sclerotiorum*	Sclerotinia stem rot	P 7 : 16
	PEAS		
17	*Mycosphaerella pinodes*	Blight } Black	P 7 : 21
18	*Phoma medicaginis*	Foot rot } spot	
19	*Macrophomina phaseolina*	Charcoal rot } diseases	
20	*Pseudomonas syringae (pisi)*	Bacterial blight	P 7 : 23
21	*Ditylenchus dipsaci*	Stem nematode	P 7 : 27
22	*PSbMV*	Pea seedborne mosaic virus	P 7 : 27
	VETCHES		
23	*Botrytis fabae*	Chocolate spot	P 7 : 29
24	*Ascochyta pisi fsp viciae*	Ascochyta blight	P 7 : 28
25	*Ditylenchus dipsaci*	Stem nematode	P 7 : 30
26	*BBSV*	Broad bean stain virus	

The following laboratories will test for some or all of the above diseases:

SARDI Field Crops Pathology
GPO Box 379, Adelaide, SA 5001
Telephone (08) 8303 9360 Facsimile (08) 8303 9393
Tests: 1, 2, 4-6, 8-9, 12, 16, 18, 20, 21, 25

TASAG ELISA and Pathogen Testing Service
Dept. of Primary Industries & Water
13 St. John's Avenue, New Town, Tasmania 7008
Telephone (03) 6233 6845 Facsimile (03) 6278 2716
Tests: 10, 11, 13, 14, 22

Agwest Plant Laboratories
Department of Agriculture & Food Western Australia
3 Baron Hay Court, South Perth, WA 6151
Telephone (08) 9368 3721 Facsimile (08) 9474 2658
www.agric.wa.gov.au/agency/agwest/plantlabs
Tests: 1-17, 20-22, 26

Asure Quality Australia
3-5 Lillee Cresent, Tullamarine, Vic. 3043
Telephone (03) 8318 9000 Facsimile (03) 8318 9001
www.agriquality.com
Tests: 1-5, 8-11, 13-15, 19, 20, 23, 24

SGS Australia Pty. Ltd.
PO Box 549, Toowoomba Qld 4350
Telephone (07) 4633 0599 Facsimile (07) 4633 0711
Email: au.agritech.twb@sgs.com
Tests: 1, 2, 4, 5, 8, 9, 19, 23, 24

Inoculation

Pulses have the ability to "fix" their own nitrogen from the air via nodules on their roots if specific nitrogen fixing bacteria (rhizobia) are available. Different pulses need different strains of rhizobia, hence we tend to group them into 'inoculation groups'. Chickpea (group N) and lupin (group G) have very specific rhizobial needs.

Unless the right strain is present in the soil or has been supplied by adding a commercial inoculant at seeding time, effective root nodulation will not take place and little if any nitrogen will be fixed. These effects are not always immediately obvious above ground.

Rhizobia survive in soil, although they can be spread by wind, water, insects, animals, farm produce and implements. When the legume germinates they enter the plant's roots, multiply rapidly and form a nodule. *(See Plates 9 & 10, Section 3)*

Rhizobia numbers in soil vary greatly, increasing rapidly when their host legume plant is growing. Peak numbers generally occur immediately after a well nodulated legume crop, but numbers can then decline rapidly. Where the host legume plant is grown infrequently in the cropping rotation, re-inoculation can be beneficial. Use of a commercial inoculant will ensure that nodulation is prompt, nodules are abundant and that the strain of rhizobia forming the nodules is effective at fixing nitrogen.

Effective nodule formation *(See Plate 11, Section 3)*, and that all important "nitrogen fix," requires good growing conditions, the appropriate rhizobia and a host plant.

When to inoculate

If crops within an inoculum group have not previously been grown in the paddock to be sown, then seed of the crop should be inoculated immediately prior to sowing or a nodulation failure may occur. This is especially true for chickpea and lupin *(See Plates 12 & 13)*.

If the paddock has previously grown the legume (or one from the same inoculant group) the number of rhizobia remaining in the soil will be affected by the time since the legume was last grown, the type of rhizobia and soil pH and texture. Lupin rhizobia are most resilient and survive very well in low pH (down to pH 5 in water) sandy soils. If a well nodulated lupin crop has been grown in the previous four years, a response to inoculation is less likely. Pea and bean rhizobia (groups E & F) survive well in neutral to alkaline soils with good texture (loams or clays). They are also less likely to be responsive to inoculation on these soil types if they have been grown in the paddock in the previous four years. However, pea and bean rhizobia survive poorly in low pH sandy soils. Hence if soil pH is less than 6.0, the crop is best inoculated, especially on light textured soils. Less is known of the survival of chickpea rhizobia, so it is sensible to always inoculate.

If conditions for nodulation are likely to be adverse i.e. waterlogged, acid soils, or lighter soils, then it may help to use some starter nitrogen, e.g. M.A.P. or D.A.P. This will stimulate early root growth until the numbers of naturally occurring rhizobia build up and begin making nitrogen.

Inoculant groups

Inoculant packets are clearly labelled with the legumes they should be used on. The different packets contain different strains of rhizobia that have been carefully selected to optimise nitrogen fixation, so care should be taken to ensure the correct type is applied.

Group E:	Peas, vetches, tares, narbon bean, lathyrus, bitter vetch.
Group F:	Faba beans, broad beans, lentils.
Group G:	Narrow leafed lupins, albus type lupins, yellow lupins.
Group N:	Chickpeas.
Group Fenugreek:	Fenugreek

Inoculants include instructions on methods for storing and inoculating seed . . . read them. Group E and F crops can be more forgiving, so failure to inoculate will not necessarily lead to a total failure unless on acidic soils. This is not so with first time chickpea or lupin crops.

INOCULATION METHODS

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. For water injection the inoculant is mixed with water and applied at low pressure through tubes into each seed furrow. Using granules usually requires a third seed box as granules will shake out if mixed with seed and can lose viability if mixed with fertiliser.

Inoculant types

A diverse range of inoculant products with different methods of application are available now, including:

* Becker Underwood (NODULAID™) – Peat and liquid inoculants, applied as a slurry/powder/liquid to the seed or 'in furrow' to the soil and peat granular inoculants (NODULATOR™), to be applied 'in furrow' to the soil.

* New-Edge Microbials (EasyRhiz™) - Freeze-dried inoculants, made up into a liquid and applied to the seed or 'in furrow' by water injection into the soil.
* ALOSCA Technologies (ALOSCA®) – Dry clay (bentonite) granular inoculants, applied 'in furrow' to the soil.
* Brushmaster (Inoculeze™) – Peat inoculants in a 'tea bag' extract applied to the seed just before sowing using a special applicator
* Philom Bios Australia (N-Prove™)– peat-based inoculant, applied as a slurry/powder/liquid to the seed or 'in furrow' to the soil. Also available in 2008 are 'in furrow' granular formulations to be applied to the soil in the seed furrow.

Which inoculant type to use will depend on product availability, relative cost, efficacy, ease of use and machinery availability. Granular products vary and may be dry or moist, uniform, variable, powdery, coarse or fine.

Storing inoculants

For maximum survival the peat inoculant should be stored in a refrigerator at around 4°C until used. If refrigeration is not possible, store in a cool dry place away from direct sunlight. Granules and other forms also need to be stored in a cool place out of direct sunlight. Do not store an opened inoculum packet as it will deteriorate rapidly.

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

Inoculum survival

Moist peat provides protection and energy while the pack it is in is being stored, but rhizobia can dry out and lose viability once applied to seed and not in moist soil. Other inoculant forms may not dry out as quickly. Most peat inoculants now contain an adhesive which delays drying and increases the survival of the rhizobia.

Use the slurry mix within 24 hours. Sow inoculated seed as soon as possible or store for up to 3 days in a cool place, away from sunlight.

Lime pelleting is not normal for pulse crops, but if the inoculum is incorporated into lime pelleted seed, it may survive at cool room temperatures for up to a week.

If inoculated seed is sown into dry soil, the sticker assists in survival of rhizobia until rain, but inoculum viability rapidly diminishes with time and warm soil temperatures. Providing guidelines as to survival times are difficult, so it is best to sow as close to a rain front as possible. The rhizobia survive for longer in granules than when applied on seed. Hence when dry sowing pulses, granular inoculant is preferred over peat and liquid injection methods.

Nodulation failure after dry sowing of inoculated seed is more likely if the soil has no naturalised rhizobia present.

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 remain alive by the time the seed reaches the soil.

INOCULUM SLURRY

Most inoculants now contain a pre-mixed sticker. When mixing the slurry do not use hot or chlorinated water. Add the appropriate amount of the inoculant group to the solution and stir quickly. Mix into a heavy paste with a small amount of water prior to adding to the main solution. Read the inoculant label before adding any approved insecticides, fungicides, herbicides, detergents or fertilisers into the slurry. Add the inoculant suspension (slurry) to the seed and mix thoroughly until all seeds are evenly covered. A small amount of fine lime can be added after mixing is complete to help dry the seed and prevent tackiness. If adding lime use only calcite lime. Agricultural lime is too coarse. Do not use builders lime, hydrated lime or slaked lime as they will kill the rhizobia.

How to apply slurry to the seed:

1. In a cement mixer (practical for small lots only unless a cement truck is used).

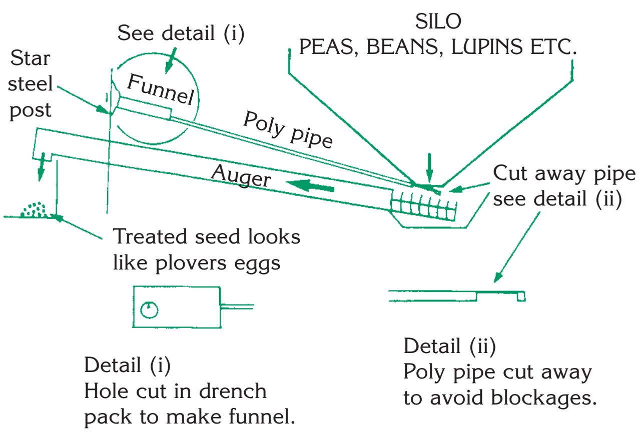
2. Through an auger *(See Plate 14)*;

   Make sure the auger is turning as slowly as possible. Reduce the height of the auger to minimise the height of seed fall. Perhaps add a slide, e.g. tin, to the outlet end of the auger to stop seed falling and cracking. Meter the slurry in, according to the flow rate of the auger (remember 250g packet per 100kg of seed). If the auger outlet is out of reach, e.g. under a field bin, then use some poly water pipe to run the slurry into the auger. A clean drench pack fixed to a dropper makes a good funnel into the poly pipe.

3. Through a tubulator:

   Similar to applying through an auger, except the tubulator reduces the risk of damaging the seed. Its mixing ability is not as effective as an auger.

FIGURE 3 : A



4. In the seed box (less desirable).

Partly fill the seed box, pour in the slurry and immediately mix thoroughly before the slurry runs to the bottom of the box. Partly fill again pour and mix. Continue to add and mix the seed and the slurry until the box is full. Experience is needed as too much water will cause bridging of seed in the box, or the inoculant will be washed off.

NEWER INOCULATION METHODS

In-furrow water injection

Injection of inoculants in water is becoming more common. It can be used where machines are set up to apply other liquids at seeding, such as liquid nitrogen. Water injection of inoculant requires at least 40 litres of water per hectare and is better with more. The slurry-water solution is sprayed under low pressure into the soil in the seed row during seeding. Benefits of the new inoculants over peat are that they mix more readily, and do not have the requirement for filtering out peat. Compatibility of the inoculant with trace elements is not yet known.

Granular inoculants

Granular inoculants are applied like fertiliser as a solid in the seed furrow or near to the seed and avoid many of the compatibility problems that rhizobia have with fertilisers and fungicides. They also eliminate the need to inoculate seed before sowing. Granulars may also be better where dry sowing is practiced.

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

INOCULANT QUALITY ASSURANCE

Legume inoculants sold to Australian farmers have to pass a rigorous quality assurance (QA) program. Cultures of inoculant are tested by the Australian Legume Inoculants Research Unit (ALIRU) to establish that the correct rhizobial strain is present and the viable cell number exceeds a minimum value.

Product	Viable rhizobia/g	Rate /ha	Rhizobia /ha	Expiry (months)
Peat	1×10^{9}	250g	3×10^{11}	12-18
Liquid	5×10^{9}	300ml	2×10^{12}	6
Granular	1×10^{7}	10kg	1×10^{11}	6
Freeze dried	1×10^{12}	0.15g	2×10^{11}	24

FERTILISERS

Molybdenum and cobalt are required for effective nodulation and should be applied as needed.

Soil phosphorus levels influence the rate of nodule growth. The higher the phosphorus level the greater the nodule growth.

Nitrogen fertilizers in small amounts (5 to 15kg N/ha) are not harmful to nodulation and can be beneficial by pushing out the early root growth to establish a stronger plant. M.A.P. or D.A.P. fertilizers can be used.

Excessive amounts of nitrogen will restrict nodulation and reduce nitrogen fixation.

Inoculated seed and acidic fertilizers should not be sown down the same tube. The acidity of some fertilizers will kill large numbers or rhizobia. Neutralized and alkaline fertilizers can be used.

Acid fertilizers are:
- Super phosphates (single, double, triple).
- Fertilizers with copper and/or zinc.
- M.A.P. also known as 11:23:0 and Starter 12.

Neutral Fertilisers are:
- Super lime.

Alkaline fertilizers are:
- D.A.P. also known as 18:20:0,
- Starter N.P.
- Lime.

A Warning

Caution should always be used when treating pulse seed with a fungicide. Some insecticide and seed treatments can also cause problems. Check the inoculant and chemical labels for compatibility of the inoculant and fungicide or insecticide seed treatments.

Pulses and fertilizer toxicity

All pulses can be affected by fertilizer toxicity. Lupins are especially susceptible. Higher rates of phosphorus fertilizer can be toxic to lupin establishment and nodulation if drilled in direct contact with the seed at sowing.

Drilling 10 kg/ha of phosphorus with the seed in 18cm row spacings through 10cm points rarely caused any problems. However, with the changes in sowing techniques to narrow sowing points, minimal soil disturbance, wider row spacings, and increased rates of fertilizer (all of which concentrate the fertilizer near the seed in the seeding furrow) the risk of toxicity is higher.

The effects are also increased in highly acidic soils, sandy soils and where moisture conditions at sowing are marginal. Drilling concentrated fertilizers to reduce the product rate per hectare does not reduce the risk.

The use of starter nitrogen eg. DAP, banded with the seed when sowing pulse crops has the potential to reduce establishment and nodulation if higher rates are used. On sands up to 10 kg/ha of nitrogen in 18cm row spacings can be safely used. On clay soils do not exceed 20 kg/ha of nitrogen in 18 cm row spacings.

Deep banding of fertilizer is often preferred for lupins, or else broadcasting and incorporating, drilling pre-seeding or splitting fertilizer applications so that lower rates or no phosphorus is in contact with the seed.

Pulses and herbicide damage

Pulses can be affected by application of some post emergent broadleaf and grass herbicides applied at label rates. Crop effects can be both a reduction in nitrogen fixation and lower yields. Lower rainfall regions with less than 250mm annual rainfall and with sandy calcareous soils are at most risk of experiencing herbicide damage. For example, a single application of some Group A grass herbicides to peas grown at Waikerie (Murray Mallee) in 2003 reduced nodulation by 50%, which resulted in a reduction in nitrogen fixation of around 50% and no N benefit to the system for the following crop. A significant reduction in nitrogen fixation can mean the difference between a positive and negative economic benefit from a pulse crop, particularly in these low rainfall environments.

The severity of herbicide effects on pulses varies with seasonal conditions and location. When considering pulses as an option in the low rainfall regions, growers should identify their prime reason for choosing a pulse in rotation. If weed and disease control are a priority, a potential decrease in nitrogen fixation may be less of a concern. Growers should adopt an integrated weed management approach to reduce weed populations on farm and spray strategically to reduce the number of herbicide applications required in a pulse crop.

Sowing and Handling Hints

The large size and awkward shape of many pulses means they need careful handling to prevent seed damage. The bigger the grain, the easier it is to damage. Seed grain, in particular, should be handled carefully to ensure good germination.

Whenever possible plan ahead so that handling can be kept to a minimum to reduce damage between harvest and seeding.

Handling bulk seed

Augers with screen flighting can damage pulses, especially larger seeded types such as broad beans. This problem can be partly overcome by slowing down the auger. Augers with large flight clearances will cause less damage to large grains.

Tubulators or belt elevators are excellent for handling pulses as little or no damage occurs. Cup elevators are less expensive than tubulators and cause less damage than augers. They have the advantage of being able to work at a steeper angle than tubulators. However cup elevators generally have lower capacities.

Augering out of the header should be treated with as much care as the rest of the handling and storage process because it has the same potential for grain damage.

Combine loaders, which throw or sling, rather than carry the grain can cause severe damage to germination.

Seeding equipment

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 *(see Plate 16)*.

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.

Broad beans in particular cannot be handled successfully by conventional combines and some airseeders may have to be modified to sow this crop.

Kabuli chickpeas can be sown with a standard airseeder or conventional combine but care should be taken as seeds tend to bridge over the outlets causing very uneven sowing. This difficulty can be eliminated by filling the box to only a third or a half capacity or by fitting an agitator.

Faba beans can also cause problems in some combines but airseeders with adequate metering rollers can sow them successfully as long as the airflow is adequate.

Combine seeders

Combines with fluted roller feeds such as Chamberlain, Connor Shea, old Napier and some Massey combines have few problems feeding seed of less than 15 mm down to the metering chamber.

Combines with peg roller and seed wheel feeds (newer Napier, Shearer, Chamberlain-John Deere) will seed grains up to the size of kabuli chickpeas without problems, providing adequate clearances are used around the rollers. Smaller faba beans can be metered with the more aggressive seed wheel system, but peg rollers are best replaced with ‘rubber stars’ for larger faba beans. Broad beans can be metered through the rubber stars but how efficiently combines sow these seeds is still in question.

Combines with internal force feed seed meters (Horwood Bagshaw, International Harvester) perform well on small seeds but cannot sow seed larger than 9mm because of bridging at the throat leading to the seed meter. The restricted internal clearance in this type of design can damage larger seeds.

Airseeders

Airseeders which use peg roller metering systems (Napier, Shearer) will handle grain up to the size of smaller faba beans without problems because of the banked metering arrangement. The optional rubber star roller will be necessary for larger seeds such as broad beans.

Airseeders using metering belt systems (Fusion, Alfarm, Chamberlain-John Deere, New Holland) can meter large seed at high rates with few problems.

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. Plate 16 shows a standard secondary distributor head (on the left) and a conversion to suit Connor Shea airseeders. The conversion head increased the bore from 23mm to 41mm. Four larger hoses replace the original eight while row spacings are increased from 150mm to 300 mm. This conversion allows large seeds such as beans to be sown easily.

Airseeders with large single fluted rollers cannot meter faba and broad beans bigger than 18 mm without modifications to the metering roller. The dealer is the best person to consult about possible modifications.

Significant levels of seed damage can be caused in airseeders by excessive air pressure, so be careful and use only enough air to ensure reliable operation.

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 fertilizer 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 to 50 percent higher, depending on conditions - because of the lower emergence levels. Yield is determined by final plant population rather than seeding rate.

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, ie 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.

Crop	General recommended sowing depth range*
Chickpeas	3-5cm
Faba beans	5-8cm
Lentils	2-6cm
Lupins	1-3cm
Peas	3-5cm
Vetch	3-5cm

* Note if applying a pre-emergent herbicide the deeper depth should be used

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. Generally lupins are least tolerant of deep sowing, lentils, peas, chickpeas and vetch are intermediate and beans the most tolerant.

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.

Sowing depth and herbicide interaction

Pulses can be more tolerant of some herbicides if shallow sowing is avoided. For example chickpeas and lentils are less affected by metribuzin applied either pre-sowing or post-sowing pre-emergent if they are sown deeper.

The actual depth of sowing will depend on the soil type. Herbicides leach deeper in sands than in clay soils. Some herbicides leach more than others, and heavy rain onto a dry soil surface, particularly on a sand, is worst.

Leaving the soil ridged (See section below), increases the risk of post-sowing pre-emergent herbicide washing into the furrow, especially on sands. As pre-sowing applications of herbicide may be less effective in the furrows, a split herbicide application is suggested to ensure effective weed control while avoiding the risk of herbicide damage.

Sowing depth, disease and herbicide interaction

Sowing depth of lupins can influence the incidence of root diseases. Shallow sowing will increase the damage caused by pleiochaeta root rot, particularly if the soil has been cultivated beforehand or lupins have been intensely grown in the rotation. Deep sowing will reduce the risk of pleiochaeta root rot, but increase the risk of hypocotyl rot.

The ideal compromise is to sow the lupin seed well below the soil surface, but into a furrow so that the seed is covered by a shallow layer of soil (eg by using press wheels). This way lupin seed is placed below the concentrated spore layer of pleiochaeta root rot, is not emerging through an excessive depth of soil, and so the risk of hypocotyl rot is minimised.

ROLLING

Leaving a flat, firm soil surface free of stumps, stones and clumps is essential when growing most pulse crops to enable a successful and trouble free harvest with minimal harvest loss and header damage. A flat soil surface at harvest becomes even more essential when crops are short in height at maturity due to low rainfall. Other reasons for rolling soils sown to pulses include leaving a flat soil surface for post sowing herbicide application (to prevent herbicides washing and accumulating in furrows), and to improve seed soil contact in sandy non wetting soils, although press wheels can do this job.

Rolling of paddocks sown to pulses in the past has generally occurred before crop emergence. However in recent years many growers have taken to post emergent rolling of their pulses. This is particularly common in peas and lentils but has also been used in other crops, although more sparingly and dependent upon soil type and conditions. Many pea and lentil growers have shifted to post emergent rolling due to:

- shoot damage occurring in crops rolled just as the crop is emerging
- greater ability to pick the right soil moisture conditions to achieve maximum burial of stones and clumps
- soils prone to hard setting or crusting which can lead to emergence problems if rolled pre-emergence
- greater erosion risk due to both wind and water where soils are rolled and plants haven't established, particularly on sloping soils.

Except that rolling can increase the risk of bacterial blight in peas.

Lentils and peas can be safely rolled post emergent. Trials on lentils in Australia and Canada show that there is no yield loss if rolled up to the 8th branching node stage. The safest time for rolling peas is when the crop is approximately 10cm high. Beans in high rainfall areas tend not to need rolling. In lower rainfall areas, where height to the bottom pod is considerably lower, rolling is often required. Experience of rolling beans post emergent is limited in southern Australia but generally early emergence is the preferred timing if it has to be done.

When rolling post emergent in pulses:

- avoid rolling during the period during which plants are just starting to emerge
- do not roll for 14 days after herbicide application and conversely don't apply sprays until for 14 days after rolling
- do not roll stressed or diseased plants
- the least amount of damage occurs when rolling the crop when it is limp ie in the mid afternoon
- avoid rolling straight after rain in heavier soil types.

Both rubber tyred and steel rollers can be used successfully although a lighter roller is preferred when rolling post emergent. However the choice of roller is largely dictated by soil conditions and the type of material being rolled. The heavier the roller the better the job of levelling heavy soil types and pushing rocks and sticks below the soil surface. Lighter rollers work well on sandier soils.

ROW SPACING

There is a trend towards wider row spacings for pulses. Trash clearance when sowing into stubbles, better foliar aeration for early disease control and the possibility of herbicide applications between the rows are some of the reasons.

However, it should be remembered that if the row spacing is doubled the seeding rate per row must be doubled if the same plant density is to be maintained. This is very significant for combine seeders or other seeders where there is one seed meter per row, but relatively unimportant in airseeders where one meter supplies all or part of a machine. Be aware of the changes for seeding rate calibrations.

Similarly for fertilizer rates, but remember also that the risk of toxicity to seed is increased when fertilizer is more concentrated in the seeding furrow. Sowing pulses into wider rows may require deep placement or side banding of the fertilizer.

Seeding Dates

Time of sowing is critical for all pulses.

Crops sown "on time" have an excellent chance of producing very high yields. However, the penalties for late sowing are high with potential yields declining rapidly as the season progresses. *(See Page 3 : 9)*

To achieve maximum yields critical management factors such as weed control and seed bed preparation must be planned to allow crops to be sown as close as possible to the "ideal sowing dates".

These ideal sowing dates should ensure that all pulse crops:

- finish flowering before they are subjected to periods of heat stress. (Generally when maximum day temperatures over a week average 20°C or more.) *(See Page 1 : 10)*
- flower over an extended period to encourage a better pod set and produce sufficient growth to set and fill an adequate number of pods.

But, sowing must not be too early, otherwise:

- flowering may be during a frost period
- growth may be excessive, resulting in the crop lodging while dramatically increasing the likelihood of fungal disease problems in the medium to high rainfall districts

- conditions at seeding time may not be suitable for controlling broadleaved weeds with recommended herbicides, resulting in weedy crops.

In other words there can be a significant difference between the optimum sowing time (for maximum potential yields) and the ideal sowing time (reducing yield loss factors).

The ideal seeding time for pulses depends largely on where the crops are being grown. Key factors include rainfall and the date of risk periods such as frost and critical heat stress. Soil type and fertility can also influence crop growth. With all pulses it is essential to have adequate soil moisture at seeding time.

In some areas the ideal sowing date will be a compromise. In other words optimum yields achieved by early sowing may have to be sacrificed, with sowing being delayed until risk factors have been reduced to an acceptable level.

Chickpeas:

Optimum Sowing Dates

SA/Vic
Rainfall less than 400mm – mid May to early June

Rainfall 400mm - 450mm – late May to early June

Rainfall 450mm to 600mm – late June to late July
Rainfall over 600mm – August to September

NSW
Southern and Central (red soils) – mid May to mid June

Central, Liverpool Plains, Moree/Narrabri – late May to late June

Walgett/Coonamble – early June to late June.

WA
low rainfall Northern (desi only) – mid April to late May
low rainfall Southern (desi only) – mid May to mid June

medium rainfall Northern – early May to Mid May

medium rainfall Southern – mid May to mid June

high rainfall Northern (kabuli only) – late April to late May

high rainfall Southern (kabuli only) – mid to late May

The availability of chickpea varieties resistant to ascochyta blight means that sowing times in southern Australia no longer need to be delayed to reduce the risk of ascochyta blight infection.

As with other pulses, any delay in sowing will result in reduced yield potential, but chickpeas appear to be less sensitive to seeding delays than other pulses. Avoiding frost or cool conditions during flowering is important. In areas with long growing seasons sowing time may also need to be delayed to avoid botrytis grey mould.

Chickpeas in eastern Australia are progressively later sown as you move further north.

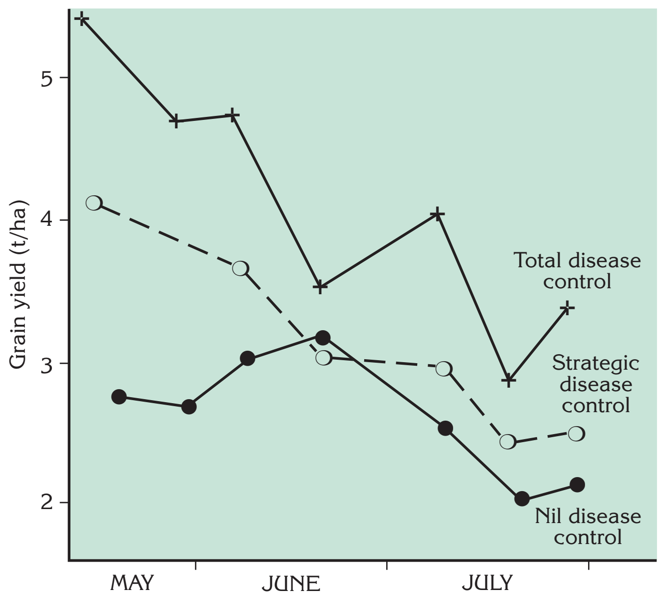
Because the kabuli varieties mature later than the desi varieties, they may need to be sown earlier than desis in some districts.

Chickpeas do not compete well against weeds and so pre-emergence broadleaf weed control is essential. Achieving good weed control is certainly more important than early sowing.

In the higher rainfall districts (over 600mm) where there is a long cool growing season, chickpea sowing dates can be delayed until August or September to avoid waterlogging and to reduce foliar diseases like ascochyta and botrytis grey mould.

FIGURE 3 : B

Grain yield of Fiord beans sown at different dates with different diseases control strategies at Struan



Faba beans:

Optimum Sowing Dates

SA/Vic

rainfall below 350mm – mid April to mid May

rainfall 350mm to 450mm – late April to late May

rainfall 450mm to 550mm – mid May to early June

rainfall 550mm to 650mm – late May to Mid June

rainfall above 650mm – early to late June

irrigation (less than 350mm) – mid May to mid June

NSW

Central, Southern – late April to late May
irrigation – late April to mid May

Liverpool Plains – late April to late May

Walgett/Coonamble – mid April to late April

Narrabri/Bogabilla – mid April to mid May

WA

rainfall less than 350mm – late April to mid May

rainfall 350mm to 450mm – early to late May

rainfall above 450mm – mid May to early June

YIELD LOSS: 250kg/ha for each week's delay

Early sowing produces the highest potential yields in beans, but requires greater attention to disease control, particularly for chocolate spot. Late sowing produces short, low yielding crops with less disease. Time of sowing is therefore a compromise with early sowing increasing the chance of high yield but also increasing the risk of disease *(See Figure 3 : B)*. Some varieties like Fiesta and Aquadulce broad beans respond less to early sowing because they do not set early pods under cool conditions.

In low rainfall areas faba beans must be sown early. Hot winds in spring cause beans to wilt, stop flowering and prematurely ripen. Compacted soils that do not allow root penetration exaggerate this effect.

Sowing also needs to be earlier on wetter areas, soils of lower fertility or acidic condition, or where excessively tall growth of beans is unlikely. Ultimately the use of varieties with resistance to chocolate spot will enable earlier sowing in most areas.

Sowing of beans into dry soil prior to the opening rains is a practice in some areas or years where sowing rains have not arrived, and it is a priority to get the beans sown to enable other sowing to occur when the rains do arrive.

Because there is limited post-emergence broadleaf weed control available in beans, achieving good weed control is important to consider in light of the desire for early sowing.

Lentils:

Optimum Sowing Dates

SA/Vic/NSW

rainfall less than 400mm – mid May to early June

rainfall 400mm to 450mm – late May to late June

rainfall 450mm to 500mm – late May to early July

rainfall 500mm to 600mm – early June to mid July

rainfall over 600mm – early August to mid September.

WA

rainfall less than 350mm – early May to mid May

rainfall 350mm to 450mm – mid May to mid June.

rainfall greater than 450mm – early to mid June

Sowing date with lentils needs to take the district and the variety being sown into account. If the variety grown is more susceptible to botrytis grey mould (eg Northfield), or in districts with milder winter temperatures where grey mould is a regular problem (e.g. coastal areas), sowing needs be delayed to reduce the disease risk.

Lentils are the quickest pulse to emerge, however early growth is slow. Lentils should not be sown too early as early sowing can result in a higher disease incidence (botrytis grey mould), juvenile lodging during flowering and early pod set, waterlogging and weed problems. The optimum time of sowing lentils is similar to field peas.

Late sown crops run the risk of being too short to harvest satisfactorily in many areas, along with the risk of high temperatures and dry conditions during flowering and pod fill reducing yields. Spring sowing is desirable in some higher rainfall areas, or areas with a long growing season.

Lupins:

Optimum Sowing Dates

WA

northern wheat belt - late April to early May

central and southern wheat belt– mid April to early May

southern coastal – early to mid May

SA/Vic

rainfall below 350mm – mid April to early May (later if a loam)

rainfall 350mm to 450mm – late April to early May (later if a loam)

rainfall 450mm to 550mm – mid to late May

rainfall above 550mm – late May to Mid June

NSW

low rainfall – mid to late April

high rainfall – late April to early May

YIELD LOSS: 180 kg/ha for each week's delay

Lupins are reputed to have the greatest requirement of all the pulses for early sowing as they need to take advantage of warmer temperatures for quicker seedling establishment, growth and nodulation. However, in some areas, sowing too early can result in excessive growth, lodging, and poor pod set, particularly on fertile soils. Late-sown lupins can be shorter and yield considerably less, especially on infertile soils. The risk of damage by wind erosion is greater in late sown lupins, especially if reduced tillage and stubble cover is not used.

Sowing after mid June is only worthwhile in areas with good soil fertility and an extended growing season, eg on shallow sands over clay in coastal areas.

Early sowing increases the risk of cucumber mosaic virus when infected seed is sown, especially with an early break to the season.

FIGURE 3 : C

Pea yield responses to time of sowing at different locations

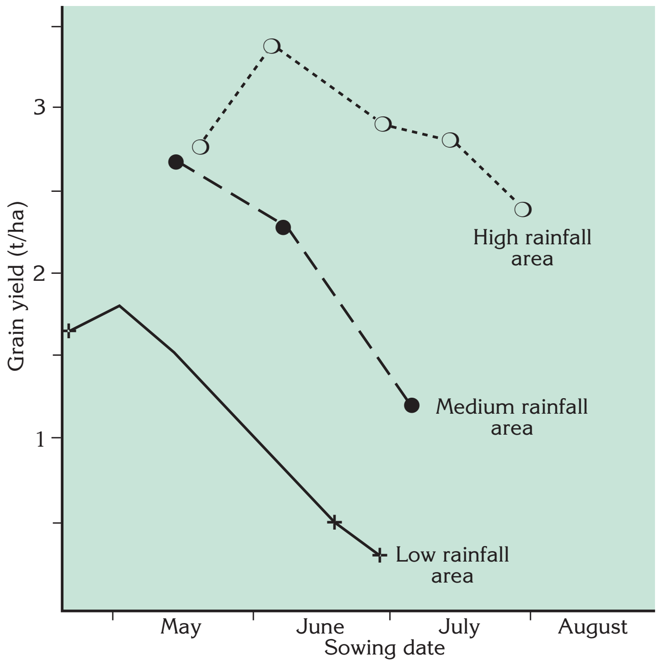
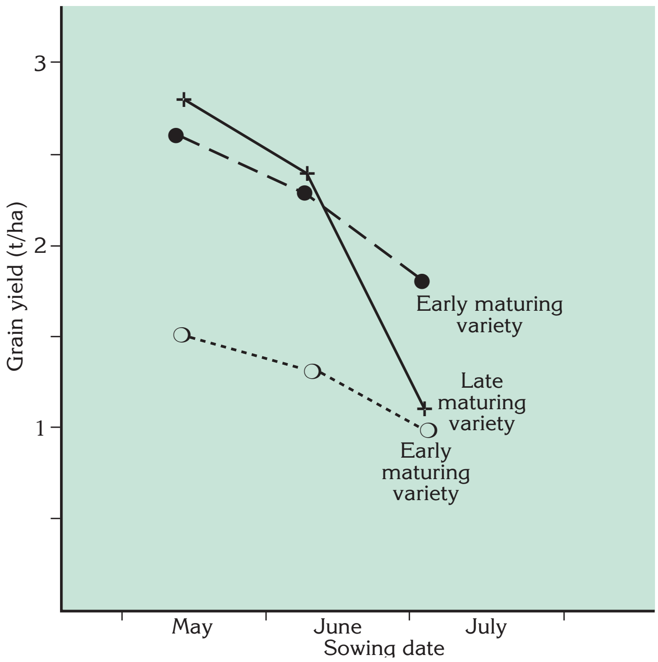


FIGURE 3 : D

Pea variety yield response to time of sowing



Peas:

Optimum Sowing Dates

SA/Vic

rainfall 350mm or less – early May

rainfall 350mm to 400mm – mid to late May

rainfall 400mm to 500mm – late May to late June

rainfall 500mm to 600mm – early June to early July

rainfall over 600mm – early August to mid Sept.

NSW

Western - mid to late May

Central – late May to early June

Eastern – early to late June

WA

Northern - rainfall less than 350mm – early May to late June

Southern - rainfall less than 350mm – early May to early June

Northern - rainfall greater than 350mm – mid May to late June

Southern - rainfall 350 - 450mm – mid May to late June

Southern - rainfall greater than 450mm – early to late June

YIELD LOSS: 170 kg/ha for each week's delay *(See Figure 3 : C.)*

Time of sowing with peas is a compromise. Early sowing increases the risk of leaf disease (particularly black spot) resulting from large spore releases from old stubble triggered by the opening rains and bulky crops with excessive foliage growth later in the season. The risk of frost damage is also increased. Sowing late runs the risk of high temperatures and dry conditions during flowering and pod fill.

Early and mid maturing varieties (eg Bundi, Excell Kaspa and Parafield) may be less sensitive to delays in sowing compared with the later maturing types (eg Alma). *(See Figure 3 : D)*. There is however the opportunity to off-set some of the yield penalties by increasing seeding rates when seeding of a semi-leafless variety is delayed (eg Bundi, Kaspa).

Vetch:

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.

Optimum Sowing Dates

SA/Vic

rainfall 375mm or less – early to late May

rainfall 375mm to 450mm – mid May to early June

rainfall 450mm to 600mm – early to late June

rainfall over 600mm – early August to mid September.

WA

rainfall less than 350mm – early May to late May

rainfall over 350mm – mid May to mid June

NSW

Western - mid to late May.

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

Dry Sowing

While dry sowing may fit in well with the sowing program there are a number of factors to consider before chosing this option:

- Paddock history of weed seed set and also the weed control options available in that pulse crop.
- The need for any inoculation of seed and survival of rhizobia in dry soil. Lupins and chickpeas have a greater reliance on applied rhizobia if they have never been sown before.
- Soil type
  - Ease of sowing into dry soil, soil tilth and the uniformity of depth of sowing.
  - Ability to get onto the paddock after rains but before emergence (for harrowing, rolling or spraying pre-emergent hebicides).
  - Clodiness of soil after sowing for herbicide application, harvesting.
- Additional levelling is required to flatten the ridges left, cover press wheel furrows or flatten clods
- Whether you have time to apply herbicides before crop emergence?
- Herbicide options:
  - Can you apply to dry soil or after the germinating rain?

- Pre-sowing application is often less effective because of dry soil.
- When spraying post sowing pre-emergence (PSPE) the soil surface may need levelling, especially where sowing with press wheels to reduce herbicide being washed into seed furrows by rain.
- Where PSPE herbicides are ineffective you may need rely on a post emergent herbicide as a salvage.

- Have you got other options for weed control and harvesting if it becomes too wet to spray or roll after the germinating rains and pre-emergent treatments cannot be carried out?
  - Crop emergence times differ (chickpeas and beans are slow, peas intermediate, lentils, lupins and vetch are quickest to emerge).
- Increased disease risk due to emergence soon after opening rains
  - Opening rains release very high amounts of blackspot spores so peas germinating on opening rains will be particularly vulnerable to high disease pressure if sown close to last year's stubbles or in a high risk situation.
  - A long growing season will lengthen the time the plant is exposed to diseases and hence the period it may need to be protected with foliar fungicides. Choose varieties with superior disease resistances or sow in low disease risk situations.

Seeding Rate

All seeds are not the same, some grow better than others. Before deciding on a seeding rate take a representative sample and have it sized and germination tested. *(See Page 3 : 1)*

Seeding rates can have a very significant effect on crop yields. But, be aware of the very large difference in seed size between individual pulse varieties.

When determining a seeding rate think "plant populations" and not just kilograms of seed per hectare. In other words the kilogram rate should be adjusted to achieve a target population of plants based on seed size and germination percentage.

Seeding rate can be calculated by these steps:

1. Decide on desired number of plants per square metre.
2. Weigh 100 seeds (in grams).
3. Obtain germination percentage from a seed test *(Page 3 : 1)*.
4. Estimate establishment likely during emergence (depends on conditions)
5. Seeding rate (kg/ha) =

$$\text{number of plants per square metre} \times \text{weight of 100 seeds (g)} \times \frac{1000}{(\%\ \text{germination} \times \%\ \text{establishment})}$$

For example - peas

For
1. 45 plants per square metre
2. 20 grams per 100 seeds
3. 80% germination
4. 90% establishment likely
5. Seeding rate = $\frac{45 \times 20 \times 1000}{80 \times 90}$

= 125 kg/ha

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

Chickpeas:

Seeding rates (kg/ha) for chickpeas will vary with the size of the seed being sown *(See Table 3 : 1)*. Plant populations should be between 35 per m^2 and 50 per m^2 for desi varieties. This means 100 to 130 kg/ha of Howzat, with an 85 percent germination test, but about 75 to 100 kg/ha of a smaller variety like Genesis 508.

The lower seeding rates ($35/m^2$) are suggested in north-eastern Australia, but the higher seeding rates ($50/m^2$) produce the highest yields in southern and western areas. Initial seed costs can be a limiting factor.

The plant density of kabuli chickpeas may need to be reduced to as low as 25 per m^2 to 35 per m^2 in areas with long cool growing seasons. This will reduce the density of the crop and help reduce the risk of foliar disease.

TABLE 3 : 1

SEEDING RATE (kg/ha) REQUIRED FOR TARGETED PLANTS/m² FOR A RANGE OF CHICKPEA VARIETIES AT 85% GERMINATION AND 95% ESTABLISHMENT

			required plants per square metre		
Example variety	type	seed wt (g/100)	25	35	50
Genesis 508	small desi	14	43	61	87
Howzat	medium desi	18	56	78	111
Kyabra	large desi	25	77	108	155
Genesis 090	small kabuli	27	83	117	167
Almaz	large kabuli	40	124	173	248

= targeted seeds/m²

Faba beans:

The size of beans can vary considerably, from 33 to 160g per hundred seeds depending on the type, variety and location it is grown *(See Table 3 : 2)*.

In most locations and rainfall areas, beans of all types have shown yield increases up to plant populations of 30 to 35 plant per m². This includes north-eastern areas through to southern areas, as well as WA where yields respond up to 45 per m². So to achieve maximum yields, seeding rates of up to 200 kg/ha for small seeded types and over 450 kg/ha for the larger seeded varieties would be needed. Sowing these high plant populations to maximise yields is unrealistic in some areas or with the bigger seeded types.

Growers also perceive a greater foliar disease risk with higher plant populations. Sowing rates used are therefore a compromise between seed costs, achieving a satisfactory plant stand for weed control, risk assessment and anticipated returns. Lower plant populations tend to be used in the lower rainfall areas. Under conditions of extremely early sowing (late April in southern areas), the optimum seeding rate for beans can be 20 plants per m², rather than the usual 30 to 35 plants.

Common rates to sow Fiord and Fiesta types in southern Australia are to target above 20 plants per m² in the medium and high rainfall areas (150 to 225kg/ha Fiesta, 100 to 150 kg/ha of Fiord). These rates being selected to reduce the severity of foliar diseases. In the low to medium rainfall areas 15 to 20 plants per m² is often used (150kg/ha Fiesta, 100kg/ha of Fiord). This is because of concern about moisture stress associated with the first hot winds. In WA where the season is shorter than the other states, 150 to 200 kg/ha is suggested (45 plants per m² for Fiord, 30 for Fiesta), with rates decreasing only in higher yielding or early sown situations.

Medium sized seed types like Manafest, Icarus or Aquadulce (if a medium rainfall area) should be sown at 15 to 25 plants per m², depending on rainfall and time of sowing.

The broad bean is sown at 8 to 12 plants per m² in high rainfall areas (about 200kg/ha) because higher rates are not necessarily cost effective or practical. Adequate plant numbers are needed to compete with weeds though. The use of small seed sizes graded out of broad beans to increase plant populations or reduce seed costs is unwise. The small seed has reduced vigour and yields. It will also be selecting a genetically smaller seeded line if continued.

TABLE 3 : 2

SEEDING RATE (kg/ha) REQUIRED FOR TARGETED PLANTS/m² FOR A RANGE OF FABA AND BROAD BEAN VARIETIES AT 85% GERMINATION AND 95% ESTABLISHMENT

			required plants per square metre			
Example variety	size	seed wt (g/100)	10	18	25	32
Fiord	average (35-55=range)	45	56	100	139	178
Fiesta	average (55-75=range)	65	80	145	201	258
Manafest	average (80-90=range)	85	105	189	263	337
Aquadulce	small (100-160=range)	100	124	223	310	396
Aquadulce	large (100-160=range)	150	186	334	464	594

= targeted seeds/m²

Lentils:

Lentil seeding rates will also vary with the size of seed sown, with a plant population of 100 to 120 plants per m² being desirable in most areas, but up to 150 per m² in WA or with spring sowing in high rainfall areas. Seed size can vary from 3.5 to 7.0 g per 100 seeds depending on variety and location grown *(See Table 3 : 3)*.

Excessively high seeding rates with lentils, particularly when sown early, can lead to disease problems, botrytis grey mould in particular.

Medium sized seeded types like Nugget are often sown at 50 to 65 kg/ha. Larger seeded types like Boomer and Matilda are sown at 70 to 85 kg/ha and Aldinga at 60 to 75 kg/ha. The small seeded types like Northfield and Nipper need to be sown at 40 to 55 kg/ha.

TABLE 3 : 3

SEEDING RATE (kg/ha) REQUIRED FOR TARGETED PLANTS/m² FOR A RANGE OF LENTIL VARIETIES AT 85% GERMINATION AND 95% ESTABLISHMENT

Example variety	type	seed wt (g/100)	required plants per square metre 100	120	150
Northfield, Nipper	small red	3.5	43	52	65
Nugget	average red	4.5	56	67	84
Aldinga	larger seeded red	5.3	66	79	98
Matilda	small green	5.5	68	82	102
Boomer	large green	6.5	80	97	121

= targeted seeds/m²

TABLE 3 : 4

SEEDING RATE (kg/ha) REQUIRED FOR TARGETED PLANTS/m² FOR A RANGE OF LUPIN VARIETIES AT 85% GERMINATION AND 95% ESTABLISHMENT

Example variety	type	seed wt (g/100)	required plants per square metre 30	45	60	75
Merrit, Tanjil	small seed	11	41	61	82	102
Merrit, Jindalee	average seed	14	52	78	104	130
Merrit, Wonga	large seed	17	63	95	126	158
Moonah	average seed	17	63	95	126	158
Quilinock	large seed	20	74	111	149	186
Luxor, Kiev Mutant	albus	32	119	178	238	297

= targeted seeds/m²

Lupins: *(See Table 3 : 4)*

With narrow leafed lupins there is less concern with plant population per se, since small lupin seeds can lack early vigour. Increased plant numbers can help to overcome the problem of using small seed with less vigour. The optimum yield with lupins is likely when there is a plant population of 45 to 60 plants per m². The higher plant populations are needed in the lower rainfall areas, contrary to what happens with peas and beans.

In WA the recommended sowing rate is 100kg/ha minimum. In eastern Australia it is suggested to be 75 to 100 kg/ha of 80 percent germinable seed. The rate should be adjusted proportionately for lower germinations. *(See Figure 3 : E.)*

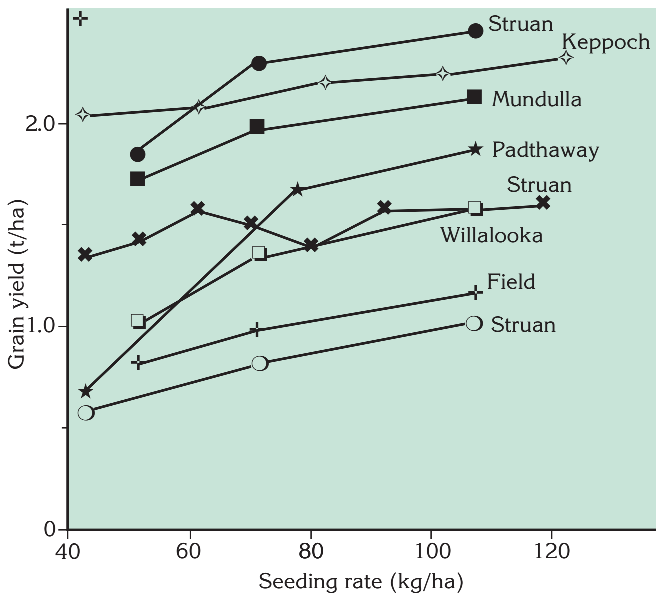
Use the higher rate if sowing is delayed or if the crop is expected to be weakened by low fertility or weed competition. The higher rate is also recommended in lower rainfall areas because the first flowers are the major contributors to grain yield.

Trials indicate yields are not depressed by high seeding rates. The newer lupin varieties (eg Mandelup, Jindalee, Wonga, Tanjil, Merrit,) respond better to increased sowing rates than the older varieties (eg Danja, Illyarrie) which had reduced poor pod set at the higher seeding rates.

Albus lupins are sown at about 160kg/ha (about 35 seeds per m²), their large seeds restricting the amounts sown *(See Table 3 : 4)*.

FIGURE 3 : E

Effect of seeding rate of lupins on the grain yield of lupins grown at various sites and years.



Peas:

The size of peas varies considerably depending on the variety and area in which it is grown. As well, the shorter types require a higher plant population compared with the tall conventional peas. Attention to plant population is therefore very important with peas *(See Table 3 : 5)*.

In most rainfall areas, varieties that are short to medium in plant height are very responsive to higher seeding rates, whereas taller types are less responsive. Varieties like Mukta, Excell, and Soupa show yield advantages when sown at densities higher than those used for tall conventional types like Parafield or Sturt.

With vigorous tall and medium type peas (eg Parafield, Sturt, Glenroy, Kaspa), seed rates of about 40 to 45 plants per m^2 (80 to 120 kg/ha) are suggested. In high rainfall areas plant densities can be reduced by around 20% to reduce bulky canopies and disease pressure. These rates generally apply across SA, Vic, NSW and WA. Plant densities below 40 plants per m^2 have frequently resulted in significant yield reductions particularly in low rainfall areas. In all areas seeding rates should be increased if seeding is delayed.

Pea varieties short to medium in height with lower vigour (eg Mukta, Soupa) should be sown at higher plant populations because of their low height and in the case of short semi-leafless types the necessity for the tendrils to intertwine to keep the crop upright. Plant populations of 65 plants per square metre are recommended for these varieties in all environments. The grain yield of medium to tall semi-leafless varieties like Kaspa and Excell has been found to be more responsive to increases in plant densities than tall conventional types like Parafield. In some environments and some seasons a 20% increase in seeding rate has resulted in a significant yield increase in Kaspa. Unlike in Parafield this increase in seeding rate has rarely resulted in a reduction in yield of Kaspa. In low rainfall environments a higher seeding rate can result in increased yield in Kaspa, this yield increase is not always economic due to increased seed costs. Rates as high as 70 to 80 plants per m^2 are suggested in Victoria for semi-dwarf, semi-leafless pea varieties like Kaspa, Excell and Snowpeak across all rainfall regions.

TABLE 3 : 5

SEEDING RATE (kg/ha) REQUIRED FOR TARGETED PLANTS/m² FOR A RANGE OF PEA VARIETIES AT 85% GERMINATION AND 95% ESTABLISHMENT

Example variety	type	seed wt (g/100)	required plants per square metre 40	50	60	75
Sturt	tall, small seeded	18	90	112	134	168
Parafield	tall, large seeded24	119	149	179	224	
Kaspa	medium, medium seeded	20	99	124	149	186
Moonlight	medium, large seeded.	25	124	156	187	233
Mukta	short, medium seeded	22	109	136	163	204
Bohatyr	short, large seeded	28	139	174	209	261

= targeted seeds/m²

Vetch:

Vetch optimum yield is achieved with a plant density of 40-50 plants per square metre, from a sowing rate of 30-40 kg/ha. Seeding rates for hay is 50-70 kg/ha and for grazing 50-70 kg/ha. When used for hay production, the ratio of vetch and cereal varies from 1:1 to 1:2 cereal-vetch mix. Seeding rate may be increased by 10-15% if sowing is delayed beyond late June. In higher rainfall areas, 50-60 plants per square metre is necessary, which equates to a sowing rate of 40-50 kg/ha. Seed size and germination percentage can vary. It is advisable to calculate your own seeding rate.

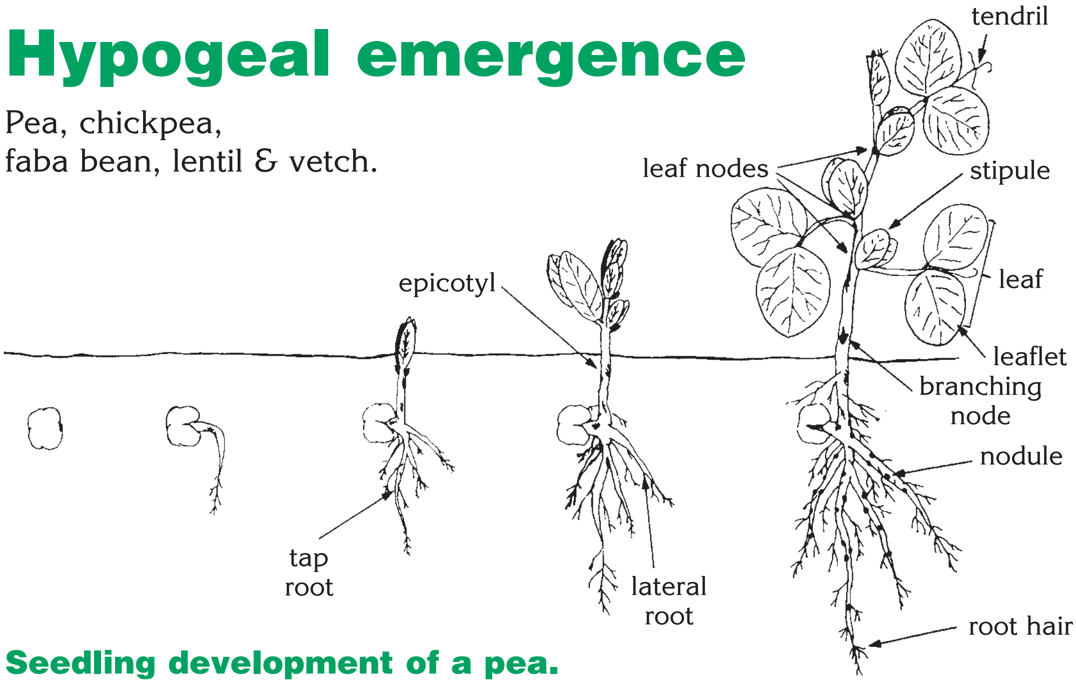
Seedling Development

Pulses are classed as either epigeal if the cotyledons appear above the ground or hypogeal if they remain below the ground.

Seedlings with hypogeal emergence are less likely to be killed by frost, wind erosion or insect attack as new stems can develop from buds at nodes, at or below ground level. In contrast, if an epigeal pulses is broken below the cotyledons, the plant will die as there are no buds from which to shoot.

Hypogeal emergence

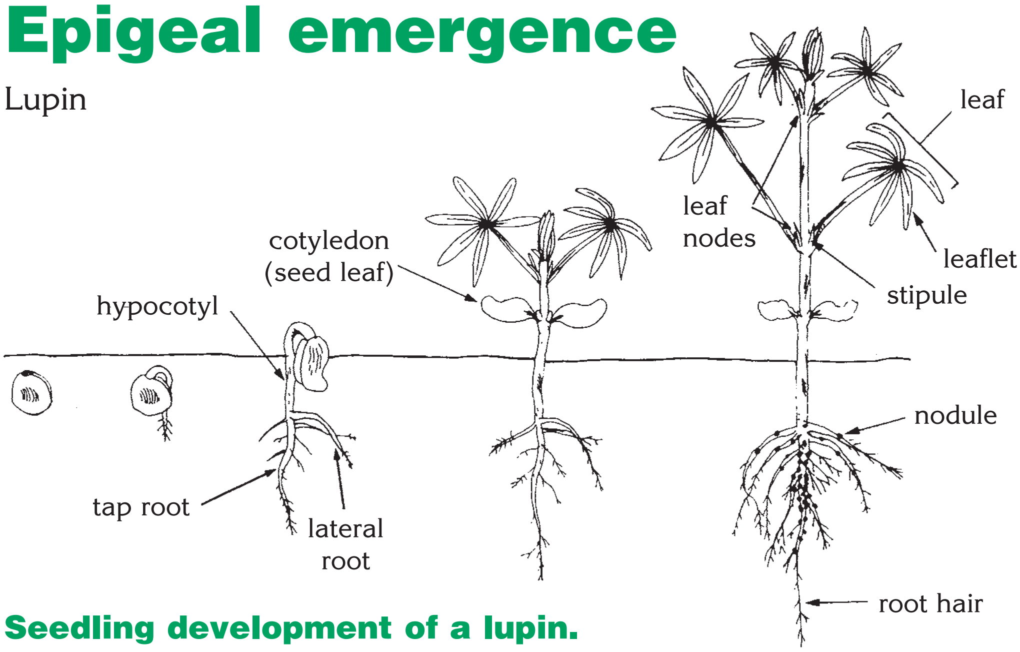
Pea, chickpea,
faba bean, lentil & vetch.



Seedling development of a pea.

Epigeal emergence

Lupin



Seedling development of a lupin.

Well nodulated grain legume plants . . .

Plate 9

Nodules can be clustered, mainly on the tap root, e.g. beans & lupins.

Plate 10

OR . . . spread across the root system, e.g. peas.

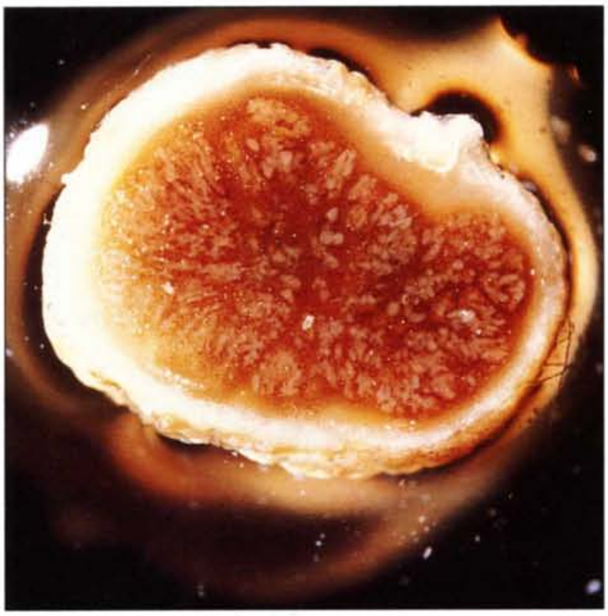


Plate 11

A healthy, nitrogen fixing nodule is pink inside. If the nodule is grey or green inside it is not fixing nitrogen.

Plate 12

The effects of inoculating are clearly shown; the middle strip was not inoculated.

Plate 13

In some cases nodulation failure can severely retard the crop, with the yellow plants eventually dying off.

Plate 14

Inoculating lupin seed through an auger. Don't forget to calibrate the amount of water required. (Too much means sticky seed.)

Plate 15

Lupins sown too deep (greater than 5cm). Note the stunted first true leaf.

Plate 16

Conversion heads, such as this one for a Connor-Shea airseeder, allow large seeds to be sown with ease.