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GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

VETCH

SECTION 2

PRE-PLANTING

VETCH FOR FEED GRAIN | VARIETAL PERFORMANCE AND RATINGS YIELD | PLANTING SEED QUALITY

Pre-planting

Key messages

- Caution needs to observed with vetch if lentils are part of the future cropping rotation. No contamination of vetch seed can be found in lentils for marketing purposes.
- Grain and hay/silage from common vetch varieties can be used to feed ruminants without limit.
- The grain can also be used in up to 20% of the ration with cereal grains in a diet for pigs.
- Vetch in crop rotations is an excellent tool to reduce problem weeds, diseases and insects.
- Vetch is one of the best crops to improve soil fertility and contribute to increase yield and protein content in following crops. [1]

2.1.1 Vetch for feed grain

Vetch is a very good source of crude protein of 27.8%. It has high digestibility of dry matter and is high in metabolisable energy. In variety choice, consider yield and adaptation to the area, disease resistance, grain quality, marketability, and proximity to receival point.

Grain vetch for ruminants is considered similar to field peas, but much smaller in size. Grain vetches are not generally recommended for monogastrics. There is evidence that bitter vetch is a suitable grain for ruminants, but use in monogastrics should be treated with caution. Grain supply of bitter vetch is very limited.

Lamb feeding experiments using Morava⚘ and Rasina⚘ (< 0.65% toxin in grain), showed extremely good growth. There are no issues arising from using vetch grain as a mix with cereal grains or pure to feed lambs. Inclusion of 50% and 70% vetch grain in a feed ration enabled lambs to reach target weights of 42–46 kg/head 7–11 days earlier than the control ration of pure barley grain. [2]

Common vetch is not recommended for young pigs, but can be included with caution at levels up to 35% when fed to 35–40 kg pigs without depressing performance.

Grain from common vetches can be used without limit in rations together with cereals to feed ruminants, or in cereal grain mix for pigs. [3]

Grain from woolly pod vetch varieties CANNOT be used to feed any livestock.

1 R Matic, S Nagel, G Kirby. Vetch productions and use in Australian Farming systems. Mallee Sustainable Farming. http://www.msfp.org.au/wp-content/uploads/Vetch-productions-and-use-in-Australian-farming-systems.pdf

2 R Matic (2011) GRDC Final Report: New vetch varieties for grain and hay production for Australian Farmers. https://grdc.com.au/research/reports/report?id=1446

3 R Matic, S McColl (2013) Which vetch is my farming system? Online Farm trials. http://www.farmtrials.com.au/trial/16634

Table 1: *Proximate composition and energy content of minor legume species in comparison to Field Peas.*

Component	Field Pea*	Common vetch*	Narbon Bean*	Dwarf chickling**	Grass Pea*	Bitter vetch*
Crude protein%	23.2	27.8	24.2	24.1	27.3	21.8
Ash g/kg	24.9	24.9	27.7	28	24	25.6
Fat g/kg	11.2	8.6	7.6	6	15	12.3
Crude fibre g/kg	59.4	51.0	115.3	63	73	51.0
ADF g/kg	93.3	74.0	142.6	96	85	
NDF g/kg	132.6	219	287.6	219	142	
Lignin g/kg	5.3			2	11	
Oligosaccharides %	3.53	3.45	3.37			
Phytate %	0.59	0.66	0.74	0.81	0.5 - 1.1	
Tannins %	0.37	0.64	0.72	0.46	0 - 0.8	
TIA mg/g	1.29	2.40	0.29	0.19	1.7 - 4.4	
CTIA mg/g	1.60	2.25	2.05	0.31	0 - 2.3	
Lectins dilut	4.00					
Energy MJ/kg##				18.7	19.0	
GE	18.8	18.7	16.2			
DE - sheep	-	16.0	-			
DE - pigs	14.5	-	-			
ME – sheep	11.4	12.0	-			
ME - poultry	-	-	12.0			
AME - poultry	11.5	-	-			

Source: Petterson et al (1997) ** Source Handbury and Hughes (2000, 2003) # Source Farhangi et al (1996). B. Mullan and K. Jae Cheol personal communication. ## GE is gross energy, DE is digestible energy, ME is metabolisable energy

Source: Pulse Australia

2.1.2 Vetch for forage

Forage vetches are used for hay, green manure or mid to late winter feed for grazing. Information gathered from district agronomists, farmer advisors, seed distributors and field days indicate that over 65% of vetch production is used for hay/silage. [4] Vetch hay is a very rich source of protein and metabolisable energy and is highly digestible for all ruminants. Australian dairy farmers are increasingly adopting vetch hay as one of the main forage sources to increase milk production. Vetch hay or silage has been reported to have increased milk production per cow by more than 12% compared with meadow/grass or cereal hay (Photo 1). [5]

Vetches are not suited to close grazing. They are climbing plants, with their growing points situated well above ground level. The type of grazing management required will largely be governed by whether the vetch is sown by itself, or in a mix with cereals such as oats. [6]

Common vetch varieties have some resistance to grazing after 15 nodes (30 cm high) till the start of flowering. Regrowth is dependent significantly on rain or available moisture after grazing.

All current common vetch varieties are palatable for grazing and for hay.

4 R Matic (2007) Improved vetch varieties for fodder production. Rural Industries Research and Development Corporation.

5 R Matic, S McColl (2013) Which vetch is my farming system? Online Farm trials. http://www.farmtrials.com.au/trial/16634

6 DAF (2011) Vetches in southern Queensland. DAF QLD. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/pastures/vetches

Morava⚘ and Rasina⚘ are resistant to rust and ascochyta and can be grazed at any time. Languedoc and Blanchefleur are susceptible to rust and ascochyta. Do NOT graze a crop if rust occurs as rust can cause abortion in pregnant cows and sheep. [7]

Ability to spread

It is not possible for vetch to be spread by animals or birds. When animals ingest the grain it breaks down completely. If soft seeded varieties are sown, any residual seed that may germinate in the following crop can be easily controlled with broadleaf herbicides. [8]

Photo 1: *Common Vetch (Morava⚘) cut for hay.*

Photo: Stuart Nagel

Common vetch crops may be harvested at different stages depending on the quality of the forage required. As the plant matures, dry matter digestibility (DMD), leaf matter and crude protein (CP) decrease, and neutral detergent fibre (NDF) and acid detergent fibre (ADF) increase. As the plant matures, DMD, leafiness and CP decreases and NDF and ADF increase. Just before flowering the nutritive value of vetches is at its best. Trials from 2002 – 2006 found that the best ratio between yield and nutritive value of hay/silage is at 50/50 flowers/pod stage (Table 2). [9]

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

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

9 R Matic (2007) Improved vetch varieties for fodder production. Rural Industries Research and Development Corporation.

Table 2: *Vetch hay analysis.*

Year	No. of samples		Crude Protein CP (%)	Dry Matter digestibility DMD (%)	Metabolise energy (MJ/kg DM)	Neutral detergent fibre NDF (%)
2002	28	Mean	25.8	65.4	9.7	41.6
		Range	(19.2–29.8)	(49.3–72.8)	(7.1–11.2)	(32.8–56.2)
2003	36	Mean	24.9	67.8	9.5	42.8
		Range	(16.3–27.3	(52.1–78.3)	(8.1–12.4)	(30.8–58.6)
2004	45	Mean	26.5	68.9	9.8	44.2
		Range	(15.2–29.9)	(57.1–75.6)	(8.4–11.6)	(32.2–52.4)
2005*	52	Mean	15.8	52.8	9.5	42.6
		Range	(9.2–18.2)	(40.8–58.6)	(6.8–11.2)	(37.4–48.6)
2006	64	Mean	28.4	68.4	10.4	43.4
		Range	(21.4–32.1)	(48.8–74.2)	(7.8–12.2)	(32.1–58.8)
Mean			24.3	64.7	9.8	42.9

Source: RIRDC

Purple varieties including Popany need to be cut at flowering/before the pod set stage. In these stages the balance of nutrition value of hay/silage is at its highest for each species.

Common vetches can be cut late, when pods contain seeds and still be fed to all ruminants, without any problem, but purple vetch grain cannot be used to feed any livestock even when still in pods.

Different forage varieties are better adapted to different rainfall zones (Table 3).

Table 3: *Vetch hay/silage/grazing and green manuring variety selection based on rainfall (mm).*

<350	350–400	400–450	450–600	>600
Rasina(þ	Rasina(þ	Morava(þ	Morava(þ	Capello(þ
Blanchefleur	Morava(þ	Rasina(þ	Popany	Haymaker(þ
Cummins	Cummins	Popany	Capello(þ	Morava(þ
Morava(þ	Popany	Capello(þ	Haymaker(þ	Popany
Volga(þ	Blanchefleur	Haymaker(þ	Timok(þ	Timok(þ
Timok(þ	Volga(þ	Volga(þ	RM4(þ	RM4(þ
RM4(þ	Timok(þ	Timok(þ		
	RM4(þ	RM4(þ		

Source: SARDI

2.1.3 Anti-nutritional factors

Some vetches contain neurotoxins, mainly BCA (beta-cyanoalanine) and other anti-nutritional factors. Hence vetches can only be used in limited quantities for monogastrics (if at all), and contamination by wild vetches (tares) or other species may exacerbate the problem. Inactivation of BCN by autoclaving does not improve the digestibility of amino acids or digestible energy.

MORE INFORMATION

[Pulses nutritional value and their role in the field industry]

[Using pulses for forage]

[Progress towards reducing seed toxin levels in common vetch]

Anti-nutritional factors in bitter vetch include *L. canavanine*, trypsin inhibitor, catechin and a special lectin. The bitterness in bitter vetch needs to be removed by leaching with boiled water before it could be considered for humans or monogastrics. [10]

Breeding to reduce vetch toxins

Common vetch is well adapted to the low rainfall areas of southern Australia however, the seed contains high levels of the toxin, γ-glutamyl-β-cyanoalanine, which limits its use. Reducing the concentration of this toxin may allow greater marketing options and help develop vetch as a viable alternative grain crop for low rainfall areas. The genetic control of seed toxin level, and cotyledon colour were studied with the aim of developing low toxin lines of vetch with distinctive seeds. More than 3000 accessions from major international collections have been screened for seed toxin level. Using conventional breeding methods, it appears that seed toxin concentration can be reduced to about 0.3–0.4%. The work has shown that it is feasible to use conventional breeding methods to develop low toxin lines of vetch, which can then be used as a viable alternative source of protein in poultry diets. [11]

2.2 Varietal performance and ratings yield

Table 4 provides information on the most important selection/recommended criteria for planting for grain and hay, maturity, shattering resistance and hard seed percentage for each variety.

Table 4: *Varietal characteristic of vetch varieties.*

Variety	Maturity	Yield potential		Flower colour	% of pod shattering	% of hard seeds
		Grain	Dry matter			
Common Vetch Varieties (*Vicia sativa*)						
Blanchefleur	Mid	High	Mod	White	5–10	5–10
Cummins	Mid-early	High	Mod	White	5–10	5–15
Morava(b)	Late	High	High	Purple	0	0
Rasina(b)	Early-mid	High	Mod	Purple	0–2	0
Volga(b)	Early	V. high	High	Purple	0–2	2–5
Timok(b)	Mid	High	V.high	Purple	0–2	0–2
Purple Vetch (*Vicia.benghalensis*)						
Propany	Very late	Low	High	Purple	20–30	5–10
Woolly pod vetches (*VIcia villosa* subsp.)						
Haymaker(b)	Late	Low	Very high	Purple	5–10	20–30
Capello(b)	Late	Low	Very high	Purple	5–10	15–20
RM4(b)	Mid	Moderate	Very high	Purple	2–5	2–5

Source: SARDI

2.2.1 Common Vetch (*Vicia sativa*)

Common vetches are an annual pasture/forage/grain legume, extremely palatable at all growth stages, from early green shoots, as dry matter/hay or silage through to seedpods and seeds over summer.

It has very high feed values for animals as green plants and dry matter as well as grain. Herbicide tolerance; no differences between these varieties to registered

10 W Hawthorne (2006) Pulses nutritional value and their role in the feed industry. Pulse Australia Pty Ltd. http://www.pulseaus.com.au/storage/app/media/using_pulses/2006_Pulses-Feed-value-livestock.pdf

11 D Chowdhury, M Tate, G McDonald, R Hughes (2001) Progress towards reducing seed toxin levels in common vetch. The Regional Institute. http://www.regional.org.au/au/asa/2001/5/c/chowdury.htm

herbicides to control broad leaf weeds. Also, no differences between varieties to registered herbicides for grass weed control.

Languedoc

This is an early flowering and maturing variety recommended for low rainfall areas although its can lodge severely making harvest difficult under certain conditions. Languedoc generally exceeds Blanchefleur's grain yield in areas with less than 350 mm rainfall. Its hard seed content is generally around 5–10% and it is highly susceptible to rust. Languedoc grains possess 1.0–1.6% of anti-nutritional level (BCN).

Blanchefleur.

Prior to the release of Morava(b, Blanchefleur had been the preferred grain variety in areas above 350 mm rainfall in SA. Blanchefleur has mid maturity, white flowers and reddish brown/mottled seed with orange cotyledons. Blanchefleur is very susceptible to rust. It is well suited to medium to high rainfall areas where rust is not a regular problem. Both vetch and lentils are on the prescribed grain list of AQIS due to the vetch-lentil substitution issue, this has meant export markets of orange cotyledon varieties like. Blanchefleur are limited to small bird seed markets in Europe and seed for grazing and green manure crops only. Blanchfleur grains possess 0.9–1.6% of anti-nutritional level (BCN).

Cummins

This is a mid to early maturing, white flowering variety selected from Languedoc. It is well adapted to medium to low rainfall areas where it generally yields higher than Blanchefleur. Cummins is susceptible to rust and moderate susceptible to Ascochyta blight. Cummins possess similar percentage of BCN to Blanchefleur.

Morava(b

Morava(b is a rust resistant late flowering vetch variety with 100% soft seeds, develop in 1998 by SARDI's Australian National Vetch Breeding Program (ANVBP). Grain yield is superior to other vetches in the high rainfall areas and to Blanchefleur, Languedoc and Cummins in all other areas in the presence of rust. It is larger seeded and more resistant to shattering than other vetch varieties. The BCN levels of Morava(b are 0.65%, which is 50% lower than Blanchefleur and Languedoc. Morava(b produces higher herbage yields than all other common vetch varieties. Morava(b is later flowering and maturing than Blanchefleur and grain yield will be reduced in environments with dry finishes.

Rasina(b

Rasina(b is soft seeded vetch from the ANVBP, developed in 2006. Rasina(b replaces Languedoc, Blanchefleur and Cummins in low to medium rainfall areas for grain production. Rasina(b is 5–10 days earlier than Blanchefleur and 10 to 15 days earlier than Morava(b. A significant advantage over Languedoc, Blanchefleur and Cummins is Rasina(b resistance to rust and is slightly more tolerant to ascochyta blight and Botrytis. However, Rasina(b is not expected to replace Morava(b in higher rainfall districts or for hay production. The level of anti-nutritional factors is 0.6 to 0.8 compared to 0.9 to 1.6 in Blanchefleur and Languedoc, respectively. Rasina(b possesses a distinctive uniform dark brown speckled seed coat with dark beige cotyledons. Rasina(b is a PBR variety

Volga(b

Developed in 2012 by SARDI's Australian National Vetch Breeding Program (ANVBP), Volga(b is high yielding grain/seed variety for low and mid rainfall areas. It is particularly suited to shorter season areas where the growing season finishes sharply. Volga(b has good initial establishment, is rust resistant, and earlier flowering and maturing than Blanchefleur and Rasina(b. It will improve the reliability of vetch and economic production in crop rotations especially in low and mid rainfall areas, 330 to 380 mm per year. Earlier maturing equates to earlier nodule development. Volga(b has high grain and herbage yields and is well adapted to all areas where vetch is currently grown. Volga⁽ᵎ⁾ is well suited to situations where the season finishes sharply (dry September & October, a common issue in many low to mid rainfall areas) because of its early flowering and maturing characteristics. It can be successfully grown in many Australian soil types; from non- wetting sand to heavy clay loam with pH 5.8 – 9.4, like other common vetch varieties. Volga⁽ᵎ⁾ is moderately susceptible to ascochyta blight, whereas Morava⁽ᵎ⁾ is susceptible. The early maturity of Volga⁽ᵎ⁾ may limit yield potential relative to longer growing season varieties like Morava⁽ᵎ⁾ in high rainfall areas. Toxin levels in the grain are around 0.54% lower compared to Morava⁽ᵎ⁾ at 0.65% and Blanchefleur 0.95%. Volga⁽ᵎ⁾ seed size is very similar to Morava⁽ᵎ⁾ seeds (100seeds weight 7.82 g). See data in following tables. Volga⁽ᵎ⁾ is a PBR variety

Timok⁽ᵎ⁾

Developed in 2012 by SARDI's Australian National Vetch Breeding Program (ANVBP), was bred to complement Morava⁽ᵎ⁾ in mid/high rainfall areas for grain/seed and especially for hay/silage production. Timok⁽ᵎ⁾ yielded more grain than Rasina⁽ᵎ⁾, Morava⁽ᵎ⁾ and Blanchefleur by 9%, 18% and 21%, respectively over five years at five sites in SA. Timok⁽ᵎ⁾ has better initial establishment than Morava⁽ᵎ⁾, and will improve the reliability of vetch and economic production in crop rotations especially in mid and high rainfall areas, 350–450 mm/yr. Morava⁽ᵎ⁾ will still be the preferable variety for hay/silage in rainfall areas with greater than 450 mm per year. Timok⁽ᵎ⁾ is high yielding, highly rust resistant common vetch variety, moderately susceptible to ascochyta blight, susceptible to botrytis, has good early establishment, and is a soft seeded variety. Timok⁽ᵎ⁾ matures between Rasina⁽ᵎ⁾ and Morava⁽ᵎ⁾ (100–105 days from seeding to full flowering). Timok⁽ᵎ⁾ is very well adapt for grain production in rainfall areas >380 mm/yr, and dry matter production is similar to Morava⁽ᵎ⁾ in high rainfall regions (>400 mm), but 19% higher than Morava⁽ᵎ⁾ in low to medium rainfall regions (330–380 mm). Timok⁽ᵎ⁾ is multipurpose variety--can be used for grain, hay/silage, grazing or green/brown manure. Toxin levels in the grain are around 0.57%. Seed weight is 6.88 g per 100 seeds, similar size to Rasina⁽ᵎ⁾ 6.92 g/100seeds. See data in following tables. Timok⁽ᵎ⁾ is a PBR variety. [12]

2.2.2 Woolly pod vetches

Woolly pod vetch can be used as a pasture plant, hay/silage and green manuring crop (Photo 2).

Photo 2: *Woolly pod vetch in NSW.*

Photo: Stuart Nagel.

12 SARDI (2017) 2017 Sowing Guide, South Australia. GRDC, SARDI. http://www.nvtonline.com.au/wp-content/uploads/2017/01/SA-sowing-guide-2017_lo-res.pdf

Capelloᶲ and Haymakerᶲ

Woolly pod vetches are lower in grain yield compared with common vetches, but are much higher in dry matter production than common vetch varieties in rainfall areas >450 mm/yr. Grain from these varieties cannot be used to feed any livestock. Also, these varieties can only be grazed from the 10-node stage to podding stage. It is not recommended that grazing occur earlier and also once plants begin to develop seeds in pods. These two varieties are very good for hay/silage production in areas >400 mm of rainfall annually. Haymakerᶲ and Capelloᶲ are selected soft seed varieties from Namoi. In last few years these two varieties have become prone to hard/dormant seeds. Both varieties are owned by Heritage Seeds.

RM4ᶲ

This variety was selected by Australian National Vetch Breeding Program. RM4ᶲ is high producer of dry matter, has very good early establishment, moderately resistant to ascochyta blight, and susceptible to botrytis, soft seed variety (>94%); emerged in 15–20 days on the field; earlier in maturity by 10–15 days than Haymakerᶲ or Capelloᶲ, significantly higher in dry matter production in mid/low rainfall areas (400–650 mm/yr. RM4ᶲ is multipurpose variety- that can be used for hay/silage, grazing, green/brown manure or for seeds. RM4ᶲ can be successfully grown, like other woolly pod varieties in many Australian soil types, like other vetches is excellent for soil fertility/structure and nitrogen fixation, graze from 10 nodes up to finish flowering, for hay/silage, cut in full flowering for the best balance of feed value. RM4ᶲ performs better in grain productions than other woolly pod varieties when season finishes sharply. Herbicide tolerance: RM4ᶲ was not sensitive to any herbicides recommended/registered for use in woolly pod vetch varieties. Insect pests: RM4ᶲ is susceptible in early growth stages to redlegged earth mite and lucerne flea, like other woolly pod vetch varieties. Also, RM4ᶲ is susceptible to blue green and cowpea aphids from early growth through to pod maturity, as well as to native budworm during pod formation and filling. Grain from this variety, like other woolly pod vetches, cannot be used to feed any livestock. RM4ᶲ is a PBR variety and can be sourced from Heritage Seeds. [13]

Namoi

Namoi woolly pod vetch (*Vicia villosa* ssp. *dasycarpa* cv. Namoi) is a self-regenerating legume that was originally introduced from Turkey in 1951. It was further developed at the University of Sydney's Plant Breeding Institute at Narrabri into a useful and adaptable legume that can be grown throughout the state. It is an annual which grows from autumn to spring, and does well on many soil types and in varying climates.

Namoi been used on the North-West Slopes and in central and southern NSW as a pioneer species when developing new country. It is also very useful when rehabilitating old cultivation areas. Namoi is often sown with winter cereal fodder crops to increase protein levels in the fodder.

This cultivar is sprawling and weak-stemmed, with purple, pea-like flowers. It will grow through and over associated plants to produce a dense, intertwined sward as shown in the photo on the right.

The plant flowers profusely from late spring to early summer, producing many two-seeded to five-seeded pods. The seeds are:

- fairly large (26,500 seeds/kg);
- about half the size of field peas;
- high in protein.

Early growth, particularly from winter sowings, is very slow. The young, almost fernlike, prostrate runners are weak and easily damaged by grazing.

Namoi is adapted to a wide range of soils varying from heavy basalts to granites, but the soil must be at least moderately fertile for satisfactory production. It responds

13 SARDI (2017) 2017 Sowing Guide, South Australia. GRDC, SARDI. http://www.nvtonline.com.au/wp-content/uploads/2017/01/SA-sowing-guide-2017_lo-res.pdf

MORE INFORMATION

Namoi woolly pod vetch

well to added phosphorus and sulfur in fertilisers when soils are low to moderate in fertility. [14]

Table 5 provides dry matter yield for woolly pod and purple vetch varieties tested between 2011–2014 by the Australian National Vetch Breeding Program.

Table 5: *Dry matter as a percentage of Capello⚖ in field trials in SA between 2011–2014.*

Variety	Dry matter (t/ha)	% of Capello⚖
Cappello	6.23	100.0
Haymaker⚖	6.26 (2009–12)	100.4
RM4⚖	6.71	107.7
Mean yield	6.4	
Purple Vetch Variety		
Popany	5.28 (2009–12)	84.75

Source: SARDI

2.2.3 Purple Vetch (*Vicia benghalensis*)

Popany

Popany (*V. benghalensis*) is purple vetch. Grain yield is significantly lower than yields from common vetch varieties. But, seeds are smaller than seeds from common vetch varieties therefore the seeding rate are lower at approximately 30–35 kg/ ha. Grain from this variety can be used as a bird feed in mix with other recommended grains. Popany is a late maturity variety, >125 days from seeding to podding. It is a good variety in mid to high rainfall areas for hay/silage. Popany, possesses 5–10% hard seeds. This variety is resistant to rust but susceptible to ascochyta and botrytis grey mould. Seed coat is black with distinctive white hilum. [15]

2.3 Planting seed quality

Key points:

- All seed should be tested for quality including germination (high germination – above 80%) and vigour (AA test). Use large, graded seed.
- If grower retained seed is of low quality then consider purchasing registered or certified seed from a commercial supplier and always ask for a copy of the germination report.
- Careful attention should be paid to the harvest, storage and handling of grower retained seed intended for sowing.
- Calculate seeding rates in accordance with seed quality (germination, vigour and seed size). [16]

Seed quality at sowing can have a major impact on crop performance and resulting yield at the end of the season - particularly in pulse crops. Seed size, quality and germination varies between varieties, from year to year, from paddock to paddock and should be checked for each seed line to be used.

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 may have low germination rates because they have a high percentage of dormant/hard seed or from damage during augering. Harvest and post-harvest

14 NSW DPI. Namoi Woolly pod vetch. http://www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/species-varieties/namoi-woolly-pod-vetch

15 SARDI (2017) 2017 Sowing Guide, South Australia. GRDC, SARDI. http://www.nvtonline.com.au/wp-content/uploads/2017/01/SA-sowing-guide-2017_lo-res.pdf

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

seed damage can produce abnormal seedlings which germinate but do not develop further.

Seed quality is important for good establishment. Early seedling growth relies on stored energy reserves in the seed. Good seedling establishment is more likely if the seed is undamaged, stored correctly and from a plant that has had adequate nutrition.

Test any retained seed for germination, vigour and disease. Do not keep seed from severely diseased crops.

Check the seed analysis certificate for germination percentage and purity before purchase. Legislation requires that only the minimum germination test must be supplied on the label with certified seed. Be sure to ask for the seed analysis certificate and any disease testing for the seed lot being purchased.

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 can 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 1 kg of seed is required, except for anthracnose where 2 kg is needed. [17]

Grower retained seed

Grower retained seed may be of poor quality with reduced germination and vigour, as well as potentially being infected with seed-borne pathogens.

Seed quality may be adversely affected by several factors including:

- Early desiccation resulting in high levels of green immature seed and smaller seed size (affecting both germination and vigour).
- Cracking of the seed coat if the seed is exposed to several wetting and drying cycles. As the seed coat absorbs moisture it expands and then contracts as it dries. This weakens the coat increasing the risk of mechanical damage during harvesting and handling operations.
- Mechanical damage can result in reduced germination and vigour and increased susceptibility to fungal pathogens in the soil at sowing (exacerbated if establishment is delayed into cold wet soils).
- Delayed harvest due to wet weather can lead to increased (i) Native budworm damage; (ii) mould infection, and (iii) risk of disease.
- Harvesting at a moisture content more than 15% can lead to problems with moulds and fungal pathogens colonising on the seed coat during storage.
- Harvesting at a moisture content under 10% can result in mechanical damage to the seed coat and/or seed splitting, which is compounded each time the seed is handled.
- Poor (temporary) storage in the rush to get harvest done in wet weather can reduce viability of the seed resulting in poor germination and emergence.

17 Day, T., Day, H., Hawthorne, W., Mayfield, A., McMurray, L., Rethus, G., & Turner, C. (2008). Grain legume handbook. *GRDC: Canberra, ACT.*

VIDEOS

WATCH: GCTV16: Extension Files – Retained Pulse Seed.

- Seed-borne diseases all reduce the viability of the seed (germination and vigour). Crop establishment is reduced and any surviving infected seedlings act as an inoculum source to initiate disease infection within the new crop. [18]

NOTE: Do not use grain for seed of pulse crops harvested from a paddock that was desiccated with glyphosate. Germination, normal seedling count and vigour are affected by its use. Read the glyphosate label.

2.3.1 Seed germination and vigour

Seed with poor germination potential or high levels of seed borne disease should not be sown. Seed borne diseases can lower germination levels.

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.

Always do a germination test on seed and adjust the sowing rate accordingly. Sowing quality seed is critical to achieving adequate plant density and high yields.

Germination tests can be done by seed testing laboratories or at home. For vetch, the sample size required is one kilogram for each 25 tonnes of seed. [19]

Calculating germination percentage

To calculate the germination percentage of a seed lot.

1. Using a graded seed lot, count out 100 seeds from each lot to be planted, including the damaged seeds.
2. Use a flat tray about 30 cm square and 5 cm deep (a nursery seedling raising tray is ideal). Place a single sheet of paper towel in the bottom to cover the drainage holes and fill with clean sand, potting mix or freely draining soil. (NOTE: If you don't have a tray the test can be done in any sort of self-draining container or in a cool part of the home garden.)
3. Take the 100 seeds (including the damaged ones) and sow 10 rows of 10 seeds (the rows make it easier to count the seedlings). Seeds should be sown at a normal seeding depth of 2 to 3 cm (Photo 3). (NOTE: Place the seeds on top of the sand or soil and push them in with a piece of dowel or a pencil and cover with more sand.)

18 L Jenkins, K Moore, G Cumming. Pulse Australia. Chickpea: High Quality seed. http://www.pulseaus.com.au/growing-pulses/bmp/chickpea/high-quality-seed

19 Day, T., Day, H., Hawthorne, W., Mayfield, A., McMurray, L., Rethus, G., & Turner, C. (2008). Grain legume handbook. *GRDC: Canberra, ACT.*

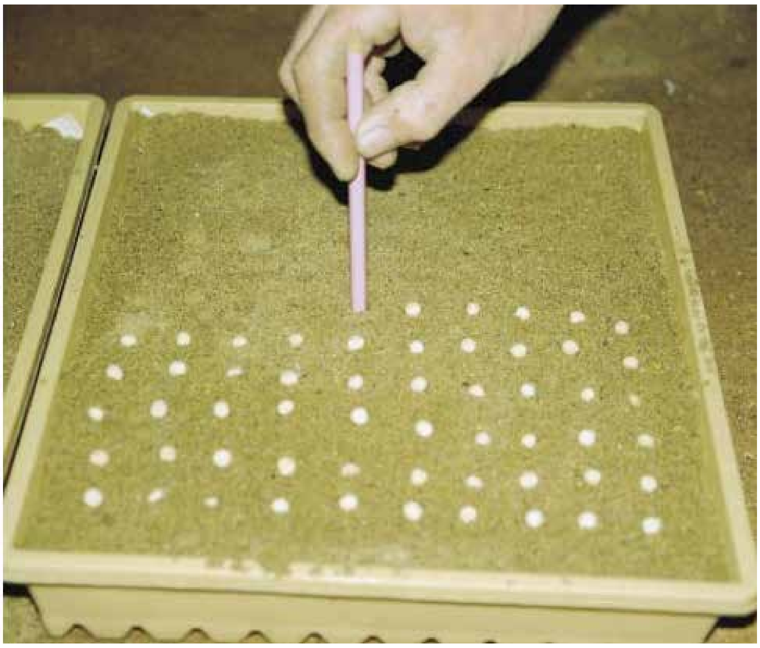


Photo 3: *Setting up a germination test in a seedling raising tray. Place 100 seeds on top of the sand and push them in 2–3 cm deep before covering.*

Photo: Di Holding, Source: NSW DPI

4. Water gently with a spray bottle. Keep moist (not wet). Overwatering will result in fungal growth on the seeds and may cause seed rot and affect normal germination.
5. Count the seedlings after 7 to 10 days, when the majority of seedlings are up. Do not wait until the late ones emerge. (These ones are damaged or have low vigour.)
6. Only normal seedlings should be counted - those with both cotyledons (seed leaves) present.
7. Calculate your germination percentage (e.g. if you count 83 normal seedlings, then your germination percentage is 83%).
8. Repeat four times. [20]

Results of this test will inform sowing rates. For more information on sowing rates, see Section 3: Planting – section 3.6 Calculating sowing rate.

MORE INFORMATION

Germination testing and seed rate calculation

Seed dormancy in Vetch

Seed dormancy

Vetch species and subspecies were assessed for dormancy in greenhouse trials in 1999. Common vetch (*Vicia sativa*) and Purple vetch (*V. benghalensis*), V. ervilia and V. articulata had no impermeable seeds. Almost all the Woolly pod vetch (*V. villosa*) accessions had a high level of impermeable seeds ranging from as low as 10% to a high of 60%. Some subspecies of common vetch (*V. sativa ssp nigra, V. sativa ssp sativa*) had higher levels of impermeable seeds ranging from 50–95%. [21]

2.3.2 Seed size

The larger the seed, the larger the endosperm and starch reserves. Although seed size does not alter germination, larger seeds emerge earlier and faster than medium and small seeds. This is because larger seeds germinate more rapidly and their roots are longer than those of smaller seeds. With adequate moisture, medium-sized seeds

20 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

21 O Modisa (1999) Seed dormancy in vetch (Vicia species). University of Melbourne. https://minerva-access.unimelb.edu.au/handle/11343/114553

will emerge in 5 or 6 days. Seed size is usually measured by weighing 100 seeds. The result is known as the 100-seed weight.

The 100-seed weight varies among varieties and from season to season. Therefore, sowing rates should be altered according to seed weight to achieve the desired plant population.

Seed grading is a good way to separate good-quality seed of uniform size from small or damaged seeds and other impurities such as weed seeds. Grading is important when sowing into soils with marginal moisture or when sowing depth is uneven. Seed size and vigour are particularly important following drought years, when there is more small seed. Not only does seed size affect seedling vigour, it can also affect sowing rate.

For more information, see Section 3: Planting, Calculating seed rate.

It is recommended that both the germination test and seed size test be done on several lots of seed (i.e. at least twice) to get a more accurate assessment of the sample.

2.3.3 Seed storage

Pulses exposed to weathering before harvest deteriorate more quickly in storage. Most pulse seed should only be stored for 12 months, although longer storage periods are possible with high quality seed provided both grain moisture and temperature within the silo can be controlled. Rapid deterioration of grain quality occurs under conditions of high temperature/moisture and with poor seed quality including weathered, cracked and diseased seed.

Pulses harvested at 14% moisture or higher must be dried before going into storage to preserve seed germination and viability. As a general rule, every 1% rise in moisture content above 11% will reduce the storage life of pulse seed by one third.

High temperatures in storage will cause deterioration in grain viability. Temperatures of stored pulse grain should not exceed an average of 25°C and preferable the average temperature should be below 20°C. In general, each 4°C rise in average stored temperature will halve the storage life of the grain. [22]

IN FOCUS

Seed dormancy and storage in vetch.

Low temperature storage (5°C) reduced the level of impermeable seeds in most species. The seed moisture was increased under low temperature storage and this resulted in higher germination. This type of storage is not suitable for long term storage but can be used if the relative humidity is reduced to about 0%. High temperature storage reduced seed moisture and encouraged seed impermeability. Fluctuating temperature of 22/11°C reduced the proportion of impermeable seeds.

Storage environment also played an important role in the development of impermeable seeds in Vicia. Dry conditions imitated by desiccator reduced seed moisture and resulted in higher levels of impermeable seeds. Seed storage under laboratory conditions had no effect on the proportion of impermeable seed. [23]

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

23 O Modisa (1999) Seed dormancy in vetch (Vicia species). University of Melbourne. https://minerva-access.unimelb.edu.au/handle/11343/114553

For more information, see Section 13: Storage.

2.3.4 Safe rates of fertiliser sown with the seed

Be wary that all pulses can be affected by fertiliser toxicity. The risk of fertiliser toxicity can be reduced by increasing the spread of seed and fertiliser in the row, reducing in-furrow fertiliser rates or separating seed and fertiliser bands.

Soil testing, including deep nitrogen and sulfur testing, is especially important following wet summers as the loss of nutrients by water-logging, leaching and summer weeds, may or may not be balanced by higher release of mineralised nutrients from the warm, moist soils. Where soil nutrient status is low, and soil moisture is high, there is the opportunity to use higher rates of fertiliser at seeding to meet the needs of the crop. While placing fertiliser in the seed row is an effective practice, germinating seeds are susceptible to damage by fertiliser. Care must be taken to create space between seed and fertiliser, especially with high fertiliser rates and under wide row spacing. If row spacing is increased but the fertiliser rate per hectare remains constant, then the amount of fertiliser in each row increases. The narrow seed spread typically created by disc seeders can also increase the potential for seedling damage by fertiliser.

The separation of seed from fertiliser is three-dimensional – along, across and down the furrow. The concept of seed bed utilisation (SBU) has been used to address this issue.

Factors to consider when selecting fertilisers and rates

Fertiliser type

All fertilisers are relatively concentrated chemical compounds that can affect delicate germinating seeds in a couple of ways.

Osmotic effect - In chemical terms fertilisers are salts and can affect the ability of the seedling to absorb water by osmosis. Too much fertiliser (salt) near the seed and desiccation or 'burn' can occur. However, fertilisers vary in salt index or burn potential depending on composition. As a general rule, most common nitrogen and potassium fertilisers have a higher salt index than phosphorus fertilisers.

Efficiency enhancers - Some strategies to enhance fertiliser efficiency, such as the use of polymer coatings or urease inhibitors will slow the rate of ammonia production and make these products less likely to cause crop damage.

Soil type and environment

Soil conditions that tend to concentrate salts or stress the germinating seed increase the potential for damage. So, the safe limit for in-furrow fertilisation is reduced with lighter soil texture (sands) and in drier soil conditions. It is also reduced when environmental conditions such as cool temperatures induce stress and/or slow germination. These can result in prolonged fertiliser-seed contact, increasing the likelihood of damage. Good rain immediately after sowing can reduce the potential for damage as salts are diluted and ammonia is dissolved, which reduces the concentrations around the seed.

Machinery configuration

The type of sowing point and seed banding boot used and the spacing between the drill rows both affect the concentration of fertiliser near seed and the likelihood of damage.

Increasing seed bed utilisation (SBU) using seeding systems - When high SBU seeding systems were combined with high seed rate, the grain yield and crop/weed competition were both maximised. Practical options to achieve a high SBU include fitting paired row seeding boots to existing tillage systems, using greater soil disturbance ribbon sowing systems, or reducing row spacing. When tyne-based systems are used to achieve high SBU, stubble clumping is typically increased and uniformity of seeding depth decreased.

Row spacing - If the same fertiliser rate is used with different row spacings, then the amount distributed along each seeding row will increase as row spacing becomes wider. For example, the rate of fertiliser applied in a 30 cm row is basically double that of a 15 cm row. To avoid this increased fertiliser concentration in wide-row systems the safe rate of in-furrow fertiliser decreases as row spacing increases (Table 6).

Table 6: *Approximate safe rates of P with canola seed if seedbed has good soil moisture (at or near field capacity). These values can be applied to vetch.*

	25 mm (1') seed spread[2]			**50 mm (2') seed spread[2]**		
Fertiliser Type	Row spacing			Row spacing		
	180 mm (7')	229 mm (9')	305 mm (12')	180 mm (7')	229 mm (9')	305 mm (12')
	SBU[3]			SBU[3]		
	14%	11%	8%	29%	22%	17%
DAP (18:20:0)	8	6	5	17	13	10
MAP (10:22:0)	10	8	6	21	16	12
Triple Super (0:20:0)	27	21	15	55	42	33
Single Super (0:9:0)	15	12	9	31	24	18

2 Width of seed spread must be checked under field condition. Width of spread varies with air flow, soil type, moisture level, amount of stubble and other soil conditions.

3 SBU is the amount of the seedbed over which the seed/fertiliser has been spread. These models are yet to be confirmed and are a guide only – use half these rates in dry soil

Source: GRDC

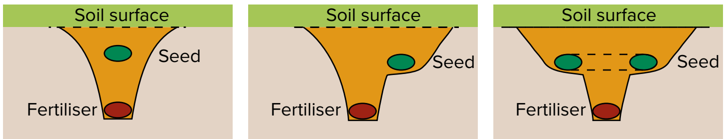
Seedbed utilisation - The concept of SBU has been used to help quantify this issue. SBU is simply the seed/fertiliser row width divided by the seed row spacing, that is, the proportion of row space occupied by the seeds. The wider the lateral seed spread, for a specific row spacing, the greater the SBU. As SBU increases, so does the safe rate of in-furrow fertilisation. The greater the lateral scatter of seed and fertiliser in the seed band or row (along, across and to depth) the more fertiliser that can be safely applied with the seed. The type of planting equipment and seed opener influences the closeness of seed-fertiliser contact (Table 7). For example, minimal lateral spread is achieved by many disc openers, with lateral spread generally increasing with share width. Double shoot/ribbon seeding openers, where seed is spread across a wider furrow, achieve the greatest lateral spread. When the lateral seed spread = share width = row spacing, a 100 per cent SBU is achievable.

Table 7: *Differences in seed bed utilization for a range of seeding points and boot combinations.*

Seeding point	**Common seed spread (mm)**	**% seed bed utilization (SBU)**		
		Row spacing (mm)		
		150	**225**	**300**
125 mm share	65	43	29	22
65 mm share	46	31	20	15
Single side band opener	36	24	16	12
Spear point	25	17	11	8
Inverted T	25	17	11	8

Source: GRDC

Openers with split banding systems can separate the seed and fertiliser laterally and vertically (Figure 1 A, B and C). The greater the angle of the fertiliser boot to the seed boot the greater the vertical separation potential between the seed and fertiliser. The width of spread must be checked under field conditions. It may vary with air velocity, ground speed, seeding depth and soil conditions. Along with seeding system crop type, fertiliser and environmental conditions must still be considered. Table 6 shows the safe rates of fertiliser urea for canola. Seedbed moisture content is also an important factor, and damage is more likely with dry soils rather than moist soils. If the soils are dry or borderline, then rates should be at least halved from those in Table 6. [24]



A. Single outlet with centre banding
Pros: Sub-seed soil disturbance, fertiliser separation banded at depth.
Cons: High draft and breakout force required compared with tillage at seeding depth, seed placement quality variable.

B. Single outlet with side banding
Pros: Sub-seed soil disturbance, fertiliser separation banded at depth, improved seed placement, good moisture transfer to seed.
Cons: High draft and breakout force required, potentially higher soil and residue disturbance.

C. Dual outlet paired row and ribbon sowing systems
Pros: Sub-seed soil disturbance, fertiliser separation, good seed placement except over centre section, higher seed-bed utilisation.
Cons: High draft and breakout force required, higher soil and residue disturbance influencing seeding depth uniformity.

Figure 1: *Three arrangements of split seed and fertiliser banding with tillage below the seeding point that illustrate the different types of seed and fertiliser separation achieved.*

Source: GRDC

MORE INFORMATION

Care with fertiliser and seed placement – GRDC Factsheet

24 GRDC (2011) Fertiliser Toxicity – Fact sheet: Care with fertiliser and seed placement. https://grdc.com.au/__data/assets/pdf_file/0019/203635/fertiliser-toxicity.pdf.pdf