SOUTHERN
FEBRUARY 2018

GRDC

GROWNOTES

VETCH

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Start here for answers to your immediate vetch crop management issues

What do you want to grow – forage, manure or grain?

Which variety matches your end use and environment?

What are the rotation issues?

What are the weed control options?

Should you conserve or harvest for grain?

What are the market options?

VERSATILE VETCH

Three key species suited to different environments and end uses.

CLIMATE

Vetch suits Mediterranean or cool temperate environments.

Rainfall = 250mm

SOIL

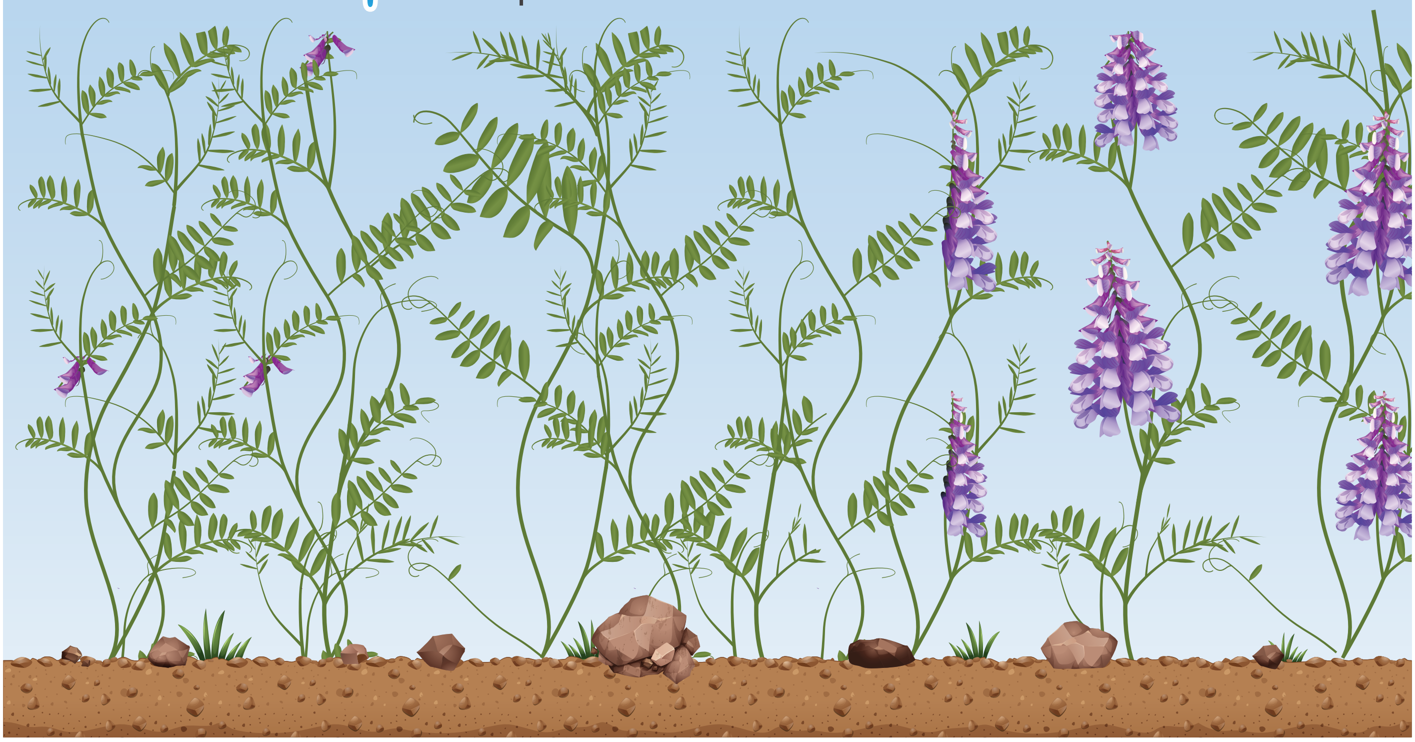
Moderate to high-fertility soils with good drainage and low frost potential at flowering.
Moderate salinity – pH 5.2 to 8.2.

USE

High-protein forage or grain legume for livestock (species dependent) or manure crop returning nitrogen and organic matter.

ROTATION ROLE

Provides a disease break for cereals and oilseeds, option for grass-selective herbicides, excellent nitrogen fixation (50–150 kg/ha depending whether harvested as grain or manure), boosts soil biology.



ISBN: 978-1-921779-26-8

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Introduction

Key points

- **Vetch is a versatile, high-production, low-input crop**
- **It can be used for grazing, forage, green or brown manure, grain for livestock or for seed**
- **It is more tolerant of acidic soils than most grain legumes, except lupin**
- **It brings many benefits to cropping and mixed-farming rotation, including nitrogen fixation and control options for resistant weeds**

IN FOCUS

Versatile vetch

Unlike other grain crops grown in Australia, vetch is not grown for human consumption. Grain from some species is used for animal feed. The other reasons for growing vetch are to produce seed that can be sown for green manure crops, which fix nitrogen and provide a control option for weeds, or for the production of grazed and conserved forage.

Determining why vetch is being grown is an important starting point in the selection and management of vetch crops.

1.1 What is vetch?

Vetch (*Vicia* species (sp.)) is a winter-growing, multi-purpose, annual legume. It produces a scrambling vine, climbing by means of branched tendrils, which can grow as a dense pure stand to about 80 cm, or will trellis on cereals or canola with which it can be grazed, ensiled or conserved as hay.

Vicia sp. is a genus of about 140 species of flowering plants commonly known as vetches. Bitter vetch (*Vicia ervilia*) was one of the first crops grown in the Middle East, about 9,500 years ago. *Vicia* sp. is in the biological family Fabaceae, the same as true pea and lentil, and is a close relative of the pulses faba bean (*Vicia faba*) and narbon bean (*Vicia narbonensis*)[1].

Vetch is classified as large-seeded pasture legume that can be used for forage, fodder and a nitrogen-fixing green manure. All Australian Common vetch varieties are suitable for grain to be used as high-protein feed for all ruminants and a limited amount in pig rations (see Table 1). Grain from most species of vetch cultivated in Australia is unsuitable for human consumption (see Section 1.4 Markets).

The species of vetches bred and grown in Australia are:

- Common or grain vetch – *Vicia sativa*
- Purple vetch – *Vicia benghalensis*
- Woolly pod vetch – *Vicia villosa* subspecies *dasycarpa* and *eriocarpa*

Common vetch is the most versatile of the vetch species as it can be grown for early grazing, green or brown manure, conservation as silage, hay, dry grazing and as grain.

Key characteristics[2]

- Mature plants are erect to 80 cm, with square stems branching from the base resulting in a tangled mass. Stems have longitudinal ridges.
- Cotyledons do not emerge.
- Leaf pairing, shape and hairiness vary with variety.
- Flower from August to November.
- Flower colour and size varies with variety (see Photo 1).
- Pods are flattened, to 50 mm long and 12 mm wide.
- Seed colour is light to dark brown, orange to beige when split. Hilum (seed scar) is the same colour as seed coat.

1 Vicia. Wikipedia, https://en.wikipedia.org/wiki/Vicia

2 GRDC. Weed ID: The Ute Guide App, https://grdc.com.au/resources-and-publications/app

Photo 1: *(From left) two examples of Common vetch and one of Woolly pod vetch. Common vetch is the most versatile of the vetch species as it can be grown for early grazing, green or brown manure, conservation as silage, hay, dry grazing and as grain. Woolly pod vetch cannot be grown for grain but produces large volumes of dry matter.*

Photo: Emma Leonard, AgriKnowHow

1.1.1 Hard seed

Namoi vetch (*Vicia villosa* ssp. *dasycarpa*) was developed in NSW in the late 1960s for grazing. Its ability to grow on a wide range of soil types increased the grazing capacity of poorer sandy soils. It is a hard-seeded variety, which means not all seed germinates the year after seed shed. Hard seed can lead to unwanted germinations of vetch in other parts of the rotation and gave vetch a reputation as a weed species in crops.[3] This reputation still exists, although it can be managed with newer varieties and by minimising seed set.

New varieties of vetch have a much higher proportion of soft seed, which will germinate on late summer rainfall and with less carryover of hard seed into future years.

Self-sown vetches from hard-seeded varieties can cause admixture problems in pulse crops. Even soft-seeded varieties can cause problems in subsequent pulse crops if germination and control has not occurred before sowing the following crop. Vetch contamination in lentil creates a major marketing problem because it is difficult to clean vetch seed out of lentil grain and vetch is unacceptable in international food markets.

Common vetch is also known as 'tare' and it may be referred to by this name when considered a weed rather than a crop.

Vetch can be controlled with herbicides in cereal and canola crops but control in pulses is much less reliable. If there is concern over unwanted in-crop germinations of vetch in other parts of rotations, varieties with a zero or low proportion of hard seed should be sown.

3 B. Bull, A Mayfield (1992) Growing Vetch – out of print

1.2 Why grow vetch?

Vetch can be grown for forage, green or brown manure or grain. No other legume offers the same degree of versatility as vetch. Cereal yields are generally higher following vetch, irrespective of whether it was for forage, green manure or grain.

For example, in trials in NSW, soil nitrogen increased, weeds decreased and direct drilling was easier following a vetch hay crop. In these trials, wheat yield and protein after vetch hay increased by 25% and 1.8% respectively, compared to cereal-on-cereal.

Generally vetch is a low-input crop, often requiring no additional fertiliser inputs after seeding, but it can require applications of herbicide, insecticide and fungicide (see Section 5 Growth stages, Section 6 In-crop management – pests and Section 7 In-crop management – disease).

1.2.1 Forage

Vetch is highly palatable to sheep and cattle at all growth stages but care should be taken not to overgraze during early growth stages otherwise the crop will not produce bulky regrowth (see Section 5 Growth stages).

Capable of producing a large amount of biomass (5–10 t/ha dry matter), but this is dependent on rainfall and sowing date. For example, in trials in Upper Eyre Peninsula that recieved 237 mm of growing season rainfall the average yield across 3 common and 1 woolly pod vetch crop of different maturities was 3.19 t/ha of biomass at flowering for crops sown 5 May and 2.35 t/ha for those sown 28 May. Yields increased to 4.45 t/ha and 3.17 t/ha for the respective sowing dates by maturity. Vetch can provide excellent grazing or be conserved as high-protein silage or hay.

Vetch can be successfully grown for forage in combination with cereals, particularly oats, and with canola.

Vetch hay is higher in protein than cereal hay and provides similar nutrition to medic and lucerne hay (Table 1). Dairy farmers report vetch hay or silage can increase milk production per cow by more than 12% compared to grass or cereal hay.[4]

Photo 2: *Vetch can produce a large amount of biomass that is highly palatable to sheep and cattle. If overgrazing is avoided, especially at early growth stages, several grazings can be achieved.*

Photo: Emma Leonard, AgriKnowHow

4 R Matic (2007) Improved vetch varieties for fodder production. AgriFutures Publication No 07/123, https://agrifutures.infoservices.com.au/downloads/07-123

Table 1: Feed quality of vetch forage compared to forage from other grain crops.

	Metabolisable energy (MJ/kg DM)	Crude protein (%)	Dry matter digestibility (%)
Vetch hay	8.0–11.0	12.0–20.0	60–70
Field pea hay	5.1–12.5	4.5–23.1	38–82
Medic hay[1]	7.8–9.7	14.0–24.0	58.0–71.4
Lucerne hay[2]	9.0	More than 19.0	More than 65.0
Cereal hay	7.5–9.0	6.0–12.0	55–75
Field pea straw	6.0–7.0	Less than 5.0	35–50
Cereal straw	5.0–6.5	Less than 4.0	35–50

Source: Vetch the Ute Guide, (2010) Primary Industries and Resources South Australia, via B Ashton (2013) Feed analysis results Eyre Peninsula, Sheep Consultancy Services. http://www.sheepconsultancy.com.au/Technical/FEED%20analysis%20EP%20Current.pdf and M Lattimore (2008) Producing Quality Lucerne Hay. RIRDC Publication No. 08/101. https://rirdc.infoservices.com.au/downloads/08-101

1.2.2 Grain

Grain can be harvested with a conventional grain harvester. Harvesting should be relatively early as seed shatter can be an issue with some varieties (Section 2, Table 1 and Table 2).

In trials in south-eastern Australia, vetch grain yield has averaged 2–2.75 t/ha grain (Section 2, Table 1). Production varies by season and rainfall region and yields are generally similar to field pea in the same environment but with lower establishment costs.

The grain of Common vetch is a valuable protein source in livestock diets. It contains 280–300 g/kg crude protein, 16–19 g/kg lysine and 14–15 megajoules/kg of energy. It can be used without limit in the diet of ruminants and up to 20–25% (depending on variety; Section 2, Table 1) of the diet of pigs[5].

Table 2: Comparison of break crops in low-rainfall regions – grain yield (kg/ha) for each trial site and as an overall average across all sites.

Legume	Loxton flat	Loxton sand	Waikerie flat	Waikerie sand	Average
Albus lupin	0.28	0.14	0.02	0.30	0.18
Narrow-leaved lupin	0.71	0.60	0.20	0.49	0.50
Kabuli chickpea	0.43	0.22	0.05	0.45	0.29
Desi chickpea	0.55	0.30	0.09	0.77	0.43
Faba bean	0.83	0.55	0.29	0.46	0.53
Field pea	0.58	0.71	0.16	1.21	0.66
Lentil	0.96	0.64	0.48	0.82	0.72
Canola	0.52	0.69	0.20	0.66	0.52
Vetch	0.77	0.86	0.19	0.69	0.63
P value	<0.001	<0.001	<0.001	<0.001	<0.001
lsd (5%)	0.12	0.19	0.09	0.09	0.23

Source: Comparing break crop performance on sandhills and flats in the SA Mallee (2016), Mallee Sustainable Farming. http://www.msfp.org.au/comparing-break-crop-performance-in-the-sa-mallee

5 Proceedings of Nutrition Society of Australia (2002) 26 Victorian Institute of Animal Science, Werribee

MORE INFORMATION

Web resource: Green manure calculator – http://www.soilquality.org.au/calculators/green_manure

1.2.3 Manure crop

A green vetch crop can be worked into the soil with cultivation equipment to boost organic matter content. More commonly the vetch crop is brown manured by desiccating using a knockdown herbicide to kill both the vetch and weeds and allowed to decompose over the fallow period before being worked into the soil at sowing.

Its production of large volumes of biomass makes vetch a good green or brown manure crop. This is because vetch returns large amounts of organic matter to the soil, which in turns boosts biological activity. Add to this its ability to fix nitrogen (see Table 3) – it provides the ideal manure crop. There are three key reasons for manuring legumes:

- management of weeds, particularly if they are herbicide-resistant;
- to boost soil nitrogen; and
- to conserve soil moisture for subsequent crops.

The main disadvantage of a manure crop compared to a non-cropped fallow is the cost of establishment (seed plus sowing) and herbicides. Despite the manure phase being cashflow-negative in the first season, a crop production system involving a manure crop can be more economic than continuous cropping.

To gauge the true value of legumes in a crop sequence, the input costs and crop returns need to be considered over the whole crop sequence in terms of net income per hectare per year.[6]

Photo 3: *Vetch being grown with safflower as a manure crop. The vetch provides bulk to out-compete weeds, returns organic matter to fix nitrogen. The safflower can punch root holes through a hard pan and is killed by any winter frost before any flower heads are set.*

Photo: Emma Leonard, AgriKnowHow

6 Manuring of Pulses (2013) GRDC Fact Sheet. https://grdc.com.au/Resources/Factsheets/2013/09/Manuring-of-Pulse-Crops
Returning nutrients to the soil (2000) *GroundCover*™. https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-31-SA/Returning-nutrients-to-the-soil-canola-vetch-stubble-extra-tasty-to-microbes

MORE INFORMATION

Fodder crops and soil improvement in low rainfall areas: http://www.malleecma.vic.gov.au/resources/technical-bulletin/foddercrops2011_final_lowres.pdf

GRDC Manuring of pulse crops Fact Sheet: https://grdc.com.au/Resources/Factsheets/2013/09/Manuring-of-Pulse-Crops

1.2.4 Benefits of vetch in the rotation

In a cropping sequence vetch can offer agronomic benefits primarily through the fixation of nitrogen for the following crop (see Section 3 Paddock preparation).

Vetch is well adapted to no-till, standing stubble systems and can be grown and harvested using the same equipment as for cereals and other pulse crops.

Vetch makes a good disease break for cereals and oilseeds. Grass-free vetch crops are a good break in the life cycles of the cereal diseases crown rot and take-all. However, vetch can cause carryover of some diseases such as Botrytis grey mould and Sclerotinia to faba bean and lentil.

1.2.5 Weed control and herbicide resistance management

Grass-selective herbicides or manuring vetch can be used to control grass weeds such as ryegrass, barley grass and brome grass. Herbicide options for broadleaf weed control in vetch are limited to pre-emergent herbicides.

Vetch is a poor competitor for weeds in early growth stages. Knockdown herbicides should be used to provide a clean seedbed and pre-emergent herbicides for some residual control of broadleaf weeds. Vetch is a very good competitor from seven nodes (10–15 cm high) onwards.

Grazing, silage and early hay cuts, brown manuring and crop-topping or spray-topping of vetch provide non-selective weed control options that can be part of an integrated weed management strategy.

1.2.6 Nitrogen fixation

Results from the Australian National Vetch Breeding Program (ANVBP) across five sites over three years have shown increases in soil nitrogen after vetch was grown for grain (56 kg/ha), hay (94 kg/ha) and green manure (154 kg/ha) (see Table 3).

1.2.7 Soil cover

The leafy structure and rambling growth pattern of vetch can provide good soil protection during the growing season but stubbles lack bulk and can leave lighter soils vulnerable during summer.

1.2.8 Biology booster

Research in the Mallee found total microbial activity in soil after vetch was 16% greater than after wheat.[7]

7. Inoculating Legumes: a practical guide (2012), GRDC https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

1.3 Suitable environments

Vetch is adapted to a wide range of soil types, from light sands to heavier clay soils, and prefers slightly acidic to alkaline conditions (pH 5.2 to 8.2). However, vetch is more tolerant of acidic soils than most grain legumes, except for lupin which will tolerate pH levels as low as 4.0.

Vetch performs best on moderate-to-high-fertility soils. In hard-setting soils and soils with subsoil compaction, root growth and consequently drought tolerance may be poor, resulting in reduced production. Stony and uneven soils can create difficulties for hay-making and harvesting grain.

Vetch is negatively affected by high salinity and boron levels encountered in subsoils in many areas in the southern cropping zone in Australia. It is more tolerant of salinity than lentil and chickpea, but considered similar to faba bean, field pea and lupin.

Vetch is very sensitive to aluminium and manganese toxicity, which often occur on acidic soils, generally making these unsuitable for vetch.

The species and varieties differ in their tolerance to low rainfall but vetch can be grown in districts with as little as 250 mm annual rainfall. Rainfall also influences selection of varieties and whether they are grown for grain or forage (Section 2, Table 1).

While including vetch is a good option for dryland situations, it is not ideal when a crop is likely to be flood irrigated at any stage, due to potential foliar disease problems. Irrigation with saline water should also be avoided.

Common vetch varieties do not tolerate prolonged waterlogging but Woolly pod and Purple vetch have been found to survive waterlogging where other crops, such as oats, die out.

Vetch can be affected by frost at flowering and early podding as well as by temperature spikes of more than 35°C, which can cause flowers to abort.

1.3.1 Productivity

Overall productivity is determined by rainfall region, species and variety (See Section 2, Table 1).

Common (grain) vetches produce good yields of forage and grain while Woolly pod vetch and Purple vetch are generally grown for dry matter.

1.3.2 Nitrogen returns

Vetch can fix substantial amounts of nitrogen but this depends on biomass production and rainfall (see Table 3). No difference in nitrogen fixation has been recorded between vetch varieties at the same weight of biomass production. Nitrogen fixation is directly correlated to biomass production.

This increase in soil nitrogen can have a positive impact on the yield and quality of the following crop.

Table 3: Increases in soil nitrogen after vetch grown for grain, hay and green manure in kg N/ha.

Sites in South Australia	Rainfall	Soil texture	pH	Planted for	2001		2002		2003		Average (kg N/ha)		Increased (kg N/ha)
					B	A	B	A	B	A	B	A	
Blyth	350 mm	Sandy loam	8.4	Grain		36		34		31		33.7	60.5
				Hay	19		21	40	18	43	19.3	41.5	93.2
				Green manure				61		58		60	169
Lameroo	383 mm	Non wetting sand	8.3	Grain	16	27	18	31	17	29	17	29	50
				Hay				36		33		35	74
				Green manure				48		42		45	118
Kingsford	467 mm	Heavy loamy clay	7.4	Grain		38	27	42		39		40	63
				Hay	25			49	22	51	25	50	106
				Green manure				68		71		70	188
Peake	384 mm	Loamy Clay	8.2	Grain		25	21	27		36		29	49
				Hay	17			34	15	48	18	41	98
				Green manure				42		56		49	132
Charlick	350 mm	Loamy clay	7.8	Grain		32	20	29		38		33	59
				Hay	20			40	17	46	19	43	101
				Green manure				62		56		59	168

Before (B) = soil is taken before seeding vetch. After (A) = soil is taken a year after seeding vetch, just before seeding following crop.
Source: R Matic, SARDI, 2016.

Nitrogen was calculated using a formula from SARDI Soil and Plant Analysis to achieve a total of nitrogen for 60 cm/ha: [(nitrate nitrogen + ammonium nitrogen) x 1.4] x 3.

For example, at Blyth three years before, a vetch crop had soil nitrogen of 19 kg/ha (nitrate + ammonium nitrogen).

1. *(19 x 1.4) x 3 = 81 kg/ha (see comments above about decimal places) total nitrogen (this is not all available for plant).*
2. *On the same paddocks after vetch (example for grain production) average was 34 kg N/ha. (34 x 1.4) x 3 = 142 kg N/ha.*
3. *Difference in total nitrogen before and after vetch crop is: 142–81 = 61 kg N/ha.*

1.4 Markets

Vetch grain is mainly used as seed to sow, for feed as grain, forage or hay or as a manure crop. Only grain from Common vetch is also used as livestock feed.

Purple vetch must not be fed to pigs and only used as birdfeed in a mix with other recommended grains.

Woolly pod vetches cannot be fed to any livestock and are only grown for manure crops or forage production.

None of these species of vetch are used for human consumption.

MORE INFORMATION

For information on PBRs, please see *South Australian Sowing Guide 2016*: https://grdc.com.au/Resources/Bookshop/2016/02/SA-Sowing-Guide-2016

1.4.1 Stockfeed (ruminants)

Grain from Common vetch varieties including Rasina⍦, Morava⍦, Volga⍦, Timok⍦, Blanchefleur, Languedoc and Cummins are used to feed ruminants and can safely comprise up to 100% of the diet of sheep and beef cattle.

1.4.2 Stockfeed (monogastrics)

While there is a limited domestic and export market for grain vetch for the birdseed market, use of vetch in poultry rations is not recommended. This is because vetch contains the toxin gamma-glutamyl beta-cyanoalanine (GBC). This toxin reduces growth rates and feed intake of poultry, adversely affecting the metabolism of laying hens and may reduce growth rates and feed intake of pigs if included as more than 20–25% of the diet in pigs, depending on variety. GBC can give rise to favism, a sometimes-fatal haemolytic disease in humans (Section 2, Table 1).

Grain vetch is also exported to limited birdseed markets.

1.4.3 Seed

Seed is in demand as seed for manure crops. Many varieties are subject to Plant Breeder's Rights and seed purchase arrangements (Section 2.1.1 Common or grain vetch – Vicia sativa ssp. sativa). Vetch grain for sowing often receives a higher price than other pulse grains.

1.4.4 Hay

Vetch hay is very popular with dairy farmers as a high-protein forage for milk production, but it is also good for beef and sheep production. Vetch hay and silage price are similar to clover or field pea hay.

Planning

Key points

- **Select varieties based on vetch species, paddock situation and end use**
- **Vetch should not be grown more than once within a five-year period in the same paddock; however, farmers sowing soft-seeded varieties grow vetch successfully every four years**
- **Vetch is a break crop for foliar and root disease in cereals and oilseeds but could carry over some soil-borne diseases, such as Sclerotinia**
- **Diseases of vetch can be transferred via soil, stubble or volunteers of other pulse crops**
- **Residues of some herbicides (such as sulfonylureas) can reduce vetch growth and yield severely**

MORE INFORMATION

A paper on 'Pulse performance and agronomy update' was delivered by SARDI's Larn McMurray at the Southern Region updates held in February 2017

Please see https://grdc.com.au/resources-and-publications/grdc-update-papers

A paper on 'Image analysis to quantify pulse quality traits' was delivered by PhD student Linda McDonald at the southern region GRDC Updates held in February 2017

Please see https://grdc.com.au/resources-and-publications/grdc-update-papers

IN FOCUS

Australian National Vetch Breeding Program

The Australian National Vetch Breeding Program (ANVBP) collaborates with growers, scientists and agronomists in South Australia, Victoria, New South Wales, Western Australia and Tasmania, running trials aimed at identifying the best-performing varieties and end uses for vetch in particular areas.

There are also companies which have released vetch varieties in Australia.

ANVBP focuses on breeding varieties with:

- high yields of grain and dry matter
- resistance to rust, Ascochyta blight and Botrytis grey mould
- soft seed to avoid volunteer vetch weed problems in following crops
- lower toxins in the grain so it is suitable as a stockfeed
- varieties adapted to lower-rainfall areas where other pasture legume or pulse crops are performing poorly
- non-shattering pods.

Species and variety choice is determined by the paddock situation and end use. Vetch's place in rotation is determined by end use, weed burden, herbicide residues and disease carryover.

2.1 Variety choice

Vetch varieties can be selected from three species that have different end uses. The first step in selecting a vetch variety is to consider the likely rainfall; the second is to determine end use as different species have different end uses.[1]

- Common or grain vetch – *Vicia sativa* subspecies *sativa* – forage, manure crop, grain for stockfeed, seed.
- Purple vetch – *Vicia benghalensis* subspecies *benghalensis* – forage and manure crop, seed.
- Woolly pod vetch – *Vicia villosa* subspecies *dasycarpa* and *eriocarpa* – forage and manure, seed.

Some Common vetch varieties, such as Morava⍭, Rasina⍭, Timok⍭ and Volga⍭, produce high yields of forage and grain.

Vetch species and varieties differ in their adaptation to rainfall regions, in their end-use suitability, productivity and percentage of hard seed. When selecting a vetch variety the following factors all need to be considered (see Table 1 and Table 2):

- rainfall
- suitability for early grazing
- forage and/or grain production
- suitability for stockfeed
- percentage of hard seed
- maturity – flowering in relation to frost and heat stress
- pod shatter – if for grain
- level of anti-nutritional factors for stockfeed
- disease resistance – in-crop control of foliar diseases can be expensive
- herbicide tolerance – impact depends on the herbicide, soil type and rainfall and time since application (see Section 8 In-crop management – weeds).

If vetch is sown in a mixture with cereals for cutting for silage or hay, a cereal variety with similar maturity should be selected in order to maximise quality at cutting. Vetch silage and hay should be cut in the late flowering to small pod stage (see Figure 1).

Species and varieties have similar susceptibility to insect pests (See Section 2.5.5). From early growth through to pod maturity they are susceptible to bluegreen and cowpea aphids, as well as to native budworm during pod formation and filling.

The lists and tables present varieties in alphabetical order. Section 2.1.1 to Section 2.1.3 indicate whether an improved/replacement variety is available.

MORE INFORMATION

South Australian Sowing Guide 2016
www.grdc.com.au/SASowingGuide2016

Seed companies supplying vetch
Auswest Seeds, https://www.auswestseeds.com.au

Heritage Seeds, http://www.heritageseeds.com.au/forage-pasture-3/clover-pasture-legumes/vetch

Pasture Genetics, http://pasturegenetics.com/

For farm trial information, please see: Emerging forage legume varieties 2013
http://www.farmtrials.com.au/trial/14135

1 PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

Photo 1: *Not all vetch species are the same, nor can they all be grown for the same outputs. Variety choice must match vetch to the growing environment and end use.*

Photo: Emma Leonard, AgriKnowHow

IN FOCUS

Root mass and penetration

Root growth of vetch is often most rapid until pod development, when seeds begin to fill. After, roots continue to grow at a much slower rate until close to crop maturity. The total root length beneath pulse crops is about 10 times smaller than in cereal crops. Root length density of pulse crops rarely exceeds 1 cm of root/cm^3 of soil, even in the surface layers. This restricted rooting density has likely consequences for the uptake of water by the vetch plant.[2]

Vetch roots do not produce as much biomass as chickpea or wheat plant roots.

2 P Gregory (1988) Root growth of chickpea, faba bean, lentil, and pea and effects of water and salt stresses. In 'World crops: Cool season food legumes. Current Plant Science and Biotechnology in Agriculture Volume 5, 1988, pp 857-867, http://link.springer.com/chapter/10.1007/978-94-009-2764-3_68

Table 1: Adaptation, usage and production of varieties of vetch in the main subspecies grown in Australia based on seven trials in South Australia, 2013 to 2015.

Variety	Rainfall (mm)	Suitability for early grazing	Forage production	tonnes DM/ha	Grain production	Grain t/ha	Grain in stockfeed	% hard seed
Common or grain vetch – *Vicia sativa* ssp. *sativa*								
Blanchefleur	350-450 g <350-400 f	Good	Moderate	4.03	Good	2.15	Yes (max for pigs 20%)	5-10
Cummins	<350-450 g <350-400 f	Moderate	Moderate	-	Good	-	Yes (max for pigs 20%)	5-15
Languedoc	<350-400 g <350 f	Good	Moderate	-	Good	-	Yes (max for pigs 20%)	5-15
Morava⁽ᵖ⁾	400->600 g <350->600 f	Poor	Good	5.06	Good	2.16	Yes (max for pigs 25%)	0
Rasina⁽ᵖ⁾	350-600 g <350-450 f	Good	Moderate	4.7	Good	2.37	Yes (max for pigs 25%)	0
Timok⁽ᵖ⁾	<350->600 g <350->600 f	Good	Very good	5.26	Good	2.48	Yes	0-2
Volga⁽ᵖ⁾	<350-450 g <350-450 f	Moderate	Good	5.51	V. good	2.75	Yes (max for pigs 25%)	2-5
Purple vetch – *Vicia villosa* ssp. *benghalensis*								
Benatas[1]	350-800 f	Moderate	Good	9.71	Poor		No	low
Popany	400->600 f	Poor	Good	5.28	Poor		No	5-10
Woolly pod vetch – *Vicia villosa* ssp. *dasycarpa and eriocarpa*								
Capello⁽ᵖ⁾	400->600 f	Poor[2]	Very good	6.23	Poor		No	15-20
Haymaker⁽ᵖ⁾	400->600 f	Poor[2]	Very good	6.26	Poor		No	20-30
Namoi	400->600 f	Very poor[2]	Very good	-	Poor		No	>80
RM4⁽ᵖ⁾	<350->600 f	Moderate[2]	Very good	6.71	Moderate		No	2-5

Notes: 1. Source Tasglobal Seeds; 2. Graze post 10-node stage to end of flower. g = for grain; f = for fodder, DM assessments at flowering; 3. Grazed post 15 nodes to the end of flowering.
Source: SARDI Sowing Guide 2013 and 2016

Table 2: Additional characteristics that influence variety choice.

Characteristic	Maturity	Shattering	GBC[1]	Disease rating		
				Ascochyta blight	Botrytis	Rust
Common vetch – *Vicia sativa* ssp. *sativa*						
Blanchefleur	Early	MS	0.9-1.2%	MS	S	VS
Cummins	Early-mid	MS	1.2%	MS	S	VS
Languedoc	Very early	MS	1.0-1.6%	MR	S	VS
Morava(d)	Late	R	0.65%	S	VS	R
Rasina(d)	Early	MR	0.66 -0.85%	MS	S	R
Timok(d)	Mid	MR	0.57%	MS	S	R
Volga(d)	Early	MR	0.54%	MS	S	R
Purple vetch – *Vicia villosa* ssp. *benghalensis*						
Benatas	Late	-	-	-	-	-
Popany	Very late	MR		MS	VS	R
Woolly pod vetch – *Vicia villosa* ssp. *dasycarpa* and *eriocarpa*						
Capello(d)	Late	R		MR	VS	R
Haymaker(d)	Late	R		MR	VS	R
Namoi	Very late	R		MR	VS	R
RM4(d)	Mid	MR		MR	VS	R

Note 1. GBC – gamma-glutamyl beta-cyanoalanine – an anti-nutritional factor
Key R – resistant, MR – moderately resistant, MS – moderately susceptible, S – susceptible, VS – very susceptible
Source: Rade Matic, ANVBP

Photo 2: *Morava(d) and Rasina(d) are among new Common vetch varieties, which have improved rust resistance, productivity and soft seed percentage.*

Photo: Wayne Hawthorne, formerly Pulse Australia

2.1.1 Common or grain vetch – *Vicia sativa* ssp. *sativa*

The newer varieties of Common vetch – Morava⁽ᵈ⁾, Rasina⁽ᵈ⁾, Timok⁽ᵈ⁾ and Volga⁽ᵈ⁾ – have improved rust resistance, productivity and soft seed percentage.

Blanchefleur

Description – hairy, oblong, squarish adult leaves with medium green foliage. White flowers on short stalks. Long, narrow pods containing pillow-shaped, reddish-brown mottled seed which is orange when split. Seed size is 6.6 g/100 seeds.

This market for varieties with orange cotyledon, such as Blanchefleur, is limited to domestic markets for birdseed and sowing seed for grazing and manure crops. This restriction is to prevent the substitution of vetch grain for lentil. Both vetch and lentil are on the Australian Government's prescribed grain list of Australian Quarantine Services.[3]

Prior to the release of Morava⁽ᵈ⁾, Blanchefleur was the preferred grain variety in areas above 350 mm rainfall. Blanchefleur has mid-maturity and is well-suited to medium to high-rainfall areas where rust is not a regular problem as it is very susceptible to rust.

Replaced by Rasina⁽ᵈ⁾ in low-rainfall areas and Morava⁽ᵈ⁾ in higher-rainfall areas.

Cummins

This is a mid to early maturing, white-flowering variety selected from Languedoc. Seed size is 6.1 g/100 seeds.

It is well-adapted to low to medium-rainfall areas, where it generally yields higher than Blanchefleur. Cummins is susceptible to rust and moderately susceptible to Ascochyta blight.

Replaced by Rasina⁽ᵈ⁾ in low-rainfall areas and Morava⁽ᵈ⁾ in higher rainfall areas.

Languedoc

Description – hairy, oblong to squarish adult leaves with medium green foliage. Light purple flowers on short stalks. Long, narrow pods containing pillow-shaped, brown-grey seed, which is beige when split. Seed size is 6.7 g/100 seeds.

This is an early-flowering and maturing variety recommended for low-rainfall areas, although it can lodge severely if there is heavy rainfall when it is ripe, making harvest difficult. Languedoc is generally higher-yielding than Blanchefleur in areas with less than 350 mm rainfall. Its hard seed content is generally around 5–10% and it is highly susceptible to rust.

Replaced by Rasina⁽ᵈ⁾.

Morava⁽ᵈ⁾

Description – hairy, oblong large adult leaves with dark green foliage. Dark purple flowers on short stalks. Very long, narrow pods containing pillow-shaped, large, dark brown seed, which is beige when split. Seed size is 8.3 g/100 seeds.

Developed in 1998 by the Australian National Vetch Breeding Program (ANVBP), Morava⁽ᵈ⁾ is a late-flowering vetch variety with 100% soft seeds. It has large seed and is more resistant to shattering than other vetch varieties.

Morava⁽ᵈ⁾ has superior grain yield to other vetches in high-rainfall areas and, in all other areas, has a higher yield than Blanchefleur, Languedoc and Cummins where rust in present.

It has a lower level of the anti-nutritional factor gamma-glutamyl beta-cyanoalanine (0.65%) than Blanchefleur and Languedoc. Morava⁽ᵈ⁾ produces high herbage yields. Morava⁽ᵈ⁾ is later flowering and maturing than Blanchefleur and grain yield will be reduced in seasons with dry finishes.

3 Australian Government Department of Agriculture and Water Resources (2016), http://www.agriculture.gov.au/export/controlled-goods/plants-plant-products/ian/03/08 Industry Advice Notice no.2003/08: Export of Split Vetch Prohibited

Morava⊕ is rust-resistant, susceptible to Ascochyta blight and very susceptible to Botrytis grey mould, because it produces very high biomass in wetter areas.

Morava⊕ is a PBR variety and seed can be sourced from Heritage Seeds.

Rasina⊕

Description – hairy, oblong to squarish adult leaves with medium green foliage. Light purple flowers on short stalks. Long, narrow pods containing pillow-shaped, dark brown speckled seed which is dark beige to greenish when split. Seed size is 6.9 g/100 seeds.

Developed in 2006 by ANVBP, Rasina⊕ is an earlier-flowering, soft-seeded variety that replaces Languedoc, Blanchefleur and Cummins in low to medium-rainfall areas for grain production. It has a low level of the anti-nutritional factor GBC (0.6–08%).

A significant advantage over Languedoc, Blanchefleur and Cummins is its resistance to rust. Rasina⊕ is not expected to replace Morava⊕ in higher-rainfall districts or for hay production.

Rasina⊕ is a PBR variety and seed can be sourced from Heritage Seeds.

Timok⊕

Description – dark green leaf which is convex to straight in early stage; flowers are light-violet; pods medium to long, pod width medium to wide. Seed coat brown with black speckling, with grey-brown cotyledons. Seed size is 6.9 g/100 seeds.

Released in 2013 by ANVBP, Timok⊕ was bred to complement Morava⊕ in medium to high-rainfall areas for grain and especially for silage and hay production. It is a soft-seeded variety and has a low level of anti-nutritional factor GBC (0.57%).

Timok⊕ has better early growth than Morava⊕ and will improve the reliability of vetch and economic production in cropping systems especially in medium-rainfall areas (350–450 mm per year). Morava⊕ is still the preferable variety for hay and silage in rainfall areas with more than 450 mm per year.

It is a high-yielding and highly rust-resistant Common vetch variety which is moderately susceptible to Ascochyta blight and susceptible to Botrytis grey mould.

Timok⊕ is a PBR variety and seed can be sourced from Pasture Genetics.

Volga⊕

Description – leaf is concave medium green to dark green; flowers are medium-violet; pods medium to long. Seed coat is brown with blue-black speckling, cotyledons are grey-brown. Seed size is 7.8 g/100 seeds.

Released in 2013 by ANVBP, Volga⊕ is a high-yielding grain and herbage variety for low to medium-rainfall areas. Its early flowering makes it particularly suited to shorter-season areas where the growing season finishes sharply.

It has a small proportion of hard seed and a low level of the anti-nutritional factor GBC (0.54%).

Volga⊕ has good initial establishment and early maturity. It is rust-resistant and moderately susceptible to Ascochyta blight. It is earlier-flowering and maturing than Blanchefleur and Rasina⊕.

Volga⊕ is a PBR variety and seed can be sourced from Heritage Seeds.

2.1.2 Purple Vetch – *Vicia benghalensis* ssp. *benghalensis*

Benatas

Description – similar to Popany but no detailed description is available.

Developed by Tasglobal Seeds, Benetas produces high forage yields with good early spring vigour. It is later-flowering than Popany and has improved cold tolerance during vegetative growth, where it has survived to –7°C. It is also tolerant of moderate waterlogging. These characteristics make it especially suited to cooler, higher-rainfall regions.

No disease resistance data is currently available.

Benetas seed can be sourced from AusWest Seeds and Ardent Seeds in Tasmania.

Popany

Description – oblong, narrow leaves with medium to dark green foliage. Purple flowers with dark lips on stalks the length of the leaf. Medium-length brown pods containing velvety black, globular seed with a white hilum which is yellow when split. Seed size is 4.5 g/100 seeds. A small proportion of seed is hard.

Popany is a late-maturing variety good for hay and silage production in medium to high-rainfall areas.

Grain yield is significantly lower than yields of Common vetch varieties and seed size is smaller. This variety is resistant to rust but susceptible to Ascochyta blight and chocolate spot.

Popany seed can be sourced from farmer sale as well as several seed houses.

2.1.3 Woolly pod vetch

All currently available Woolly pod varieties can be grazed from 10 nodes to pod set because of anti-nutritional issues outside these growth stages.

Unlike the other vetch species, they are all moderately resistant to Ascochyta blight. If disease conditions occur they are susceptible to Botrytis grey mould.

Grain can only be sold as seed.

Capello⁽ᵈ⁾ and Haymaker⁽ᵈ⁾ – *Vicia villosa* ssp. *dasycarpa*

Description – oblong, narrow leaves with medium green foliage. Purple flowers with pink inner on stalks longer than the leaf. Short, beaked pods containing dark brown, globular seed, which are bright yellow when split. Seed size is 4.5 g/100 seeds. Moderately hard seeded.

Haymaker⁽ᵈ⁾ and Capello⁽ᵈ⁾ are selected soft seed varieties from Namoi. They are lower in grain yield but are much higher in dry matter production than Common vetch varieties in rainfall areas of more than 450 mm per year. These two varieties are very good for hay and silage production in areas where there is more than 400 mm of annual rainfall.

Both varieties are owned by Heritage Seeds.

Namoi

Description – oblong, narrow leaves with medium green foliage. Purple flowers with pink inner on stalks longer than the leaf. Short, beaked pods containing dark brown, globular seed, which is bright yellow when split. Seed size is 4.5 g/100 seeds. Very hard seeded.

Namoi can be sourced from farmer sale as well as several seed houses.

RM4ᶲ – *Vicia villosa* ssp. *eriocarpa*

Description – oblong, narrow leaves with medium green foliage. Purple flowers with pink inner on stalks longer than the leaf. Short, beaked pods containing dark brown, globular seed, which is bright yellow when split. Seed size is 4.5 g/100 seeds. Soft seeded.

Bred by ANVBP and released in 2014, RM4ᶲ is a multipurpose variety that can be used for silage or hay, grazing, as a manure crop or for seed.

RM4ᶲ has moderate early growth, better than other woolly pod varieties. It produces more dry matter than Capelloᶲ and Haymakerᶲ in low and medium-rainfall areas and is also suitable for higher-rainfall areas (greater than 400 mm to 650 mm per year). Its early maturity helps RM4ᶲ produce more dry matter than other woolly pod varieties when the growing season finishes sharply. It is excellent for improving soil nitrogen and soil structure.

RM4ᶲ is a PBR variety and seed can be sourced from Heritage Seeds.

2.2 Australian National Vetch Breeding Program

The ANVBP collaborates with growers, scientists and agronomists in South Australia, Victoria, New South Wales, Western Australia and Tasmania, running trials aimed at identifying the best-performing varieties and end uses for vetch in particular areas.

The ANVBP allows producers and end users in different regions to observe how present varieties are performing and to evaluate potential new varieties that could be suited to those areas. The ANVBP focuses on breeding varieties with:

- high yields of grain and dry matter
- resistance to rust, Ascochyta blight and Botrytis grey mould
- soft seed to avoid volunteer vetch weed problems in following crops
- lower toxins in the grain so it is suitable as a stockfeed
- varieties adapted to lower-rainfall areas where other pasture legume or pulse crops are performing poorly
- non-shattering pods.

There are few private breeding companies producing vetch for the Australian market.

2.3 Place in rotation – considerations for future crops

To reduce the risk of disease and crop contamination, ideally vetch should not be grown more than once within five years in the same paddock and should not be sown adjacent to vetch, bean or lentil stubbles. In reality a one-in-four-year rotation has been found to be successful, especially when sowing soft-seeded varieties.

2.3.1 Disease

Vetch provides a good break crop for root and some foliar diseases of cereals and canola. It can host root-lesion and stem nematodes as well as several root diseases which can affect cereals and other pulse crops (Table 3). Carryover of some soil and stubble-borne diseases can be tested using the PreDicta® B testing service; the tests relevant to vetches measure soil inoculum levels of Rhizoctonia bare patch (see Figure 2) and stem nematode.

Because it is a close relative of other common pulses grown in the southern region, there can be some disease crossover between vetch and these pulses as well as with lupin (see Table 3). Disease crossover can come from adjacent crops, from stubble or from the soil, depending on the disease (see Section 3 Paddock preparation).

Table 3: Vetch diseases and potential for cross-infection from other pulses.

Disease	Vetch	Lentil	Field pea	Faba bean	Chickpea	Lupin
Ascochyta blight# (*Ascochyta fabae*)	*	^	^	**	^	^
Botrytis grey mould (*Botrytis cinerea*)	**	**	*	**	**	*
Chocolate spot (*Botrytis fabae*)	**	**	^	**	^	^
Rust (*Uromyces viciae-fabae*)	**	^	*	**	^	^
Sclerotinia stem rot# (*Sclerotinia* sp.)	**	**	*	**	**	**
Stem nematode (*Ditylenchus dipsaci*)	*	*	**	*	*	^
Viruses: non-persistent AMV, BBWV, BYMV, CYVV and PSbMV	**	**	**	**	**	**
Viruses: persistent BLRV, BWYV, SbDV and SCSV	**	**	**	*	**	**
Root rots *Fusarium* sp.	*	*	*	*	*	*
Phoma sp.	*	*	**	*	**	*
Pythium sp.	*	*	*	*	*	*
Rhizoctonia sp.	**	**	**	**	**	**

Key *This disease occurs on this crop but has not caused major damage **This disease has caused major damage on this crop
^Non host #Species differ between crops
Source: PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

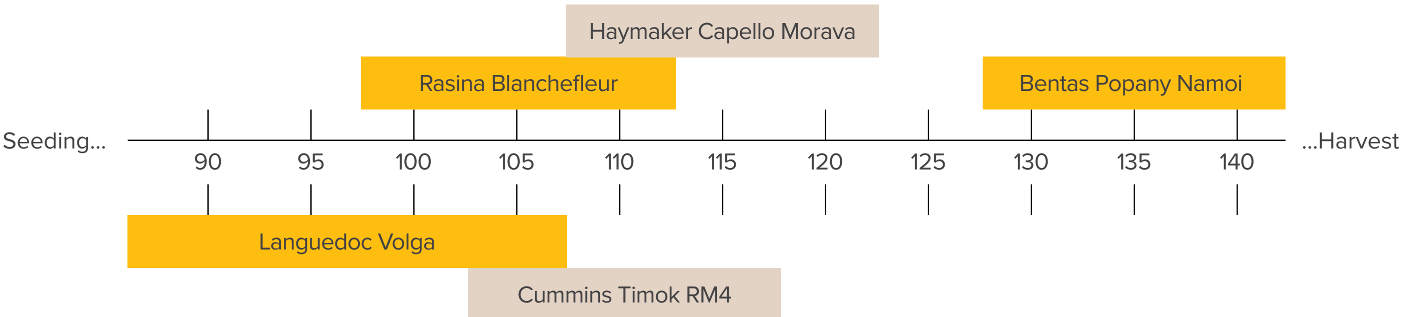


Figure 1: *Days to flowering from sowing by variety if sown on the same day*

Source Rade Mattic ANVBP

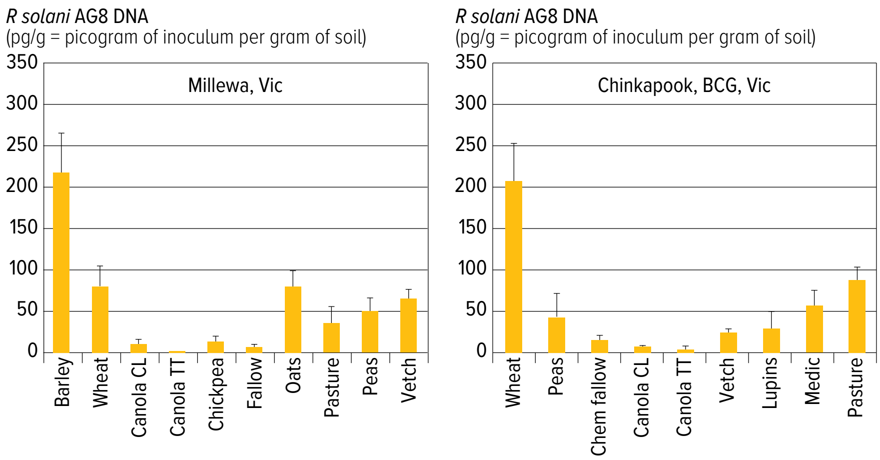


Figure 2: *The effect of crop rotation, including vetch, pea and lupin, on Rhizoctonia solani AG8 inoculum level in low-rainfall sites in Victoria in 2011. As few as five ryegrass plants/m² can maintain or increase Rhizoctonia levels in a break crop.*

Source: *GroundCover™ Supplement* 98, (2012) GRDC https://grdc.com.au/resources-and-publications/groundcover/ground-cover-issue-98-may-june-2012

2.3.2 Weeds

Self-sown vetches from hard-seeded varieties can cause admixture quality problems in some crops at harvest. Separating vetch from field pea and lentil in the harvesting process can be difficult. Rotations should be designed to avoid unwanted contamination of vetch in these crops.

The control of vetch in other pulse crops still largely relies on pre-season seedbank management.

WeedSmart (https://weedsmart.org.au/) offers a suite of tools to help plan weed management for future crops on a paddock-by-paddock basis.

In trials in the Mallee (2011–2013) to identify profitable rotations for brome grass control, the best brome grass control and gross margins were achieved with a sequence of vetch and Clearfield® canola or Clearfield® wheat followed by wheat (Figure 3).[4]

1. Mallee rotations that beat brome grass and make money (2013) GRDC. http://www.farmtrials.com.au/trial/16654

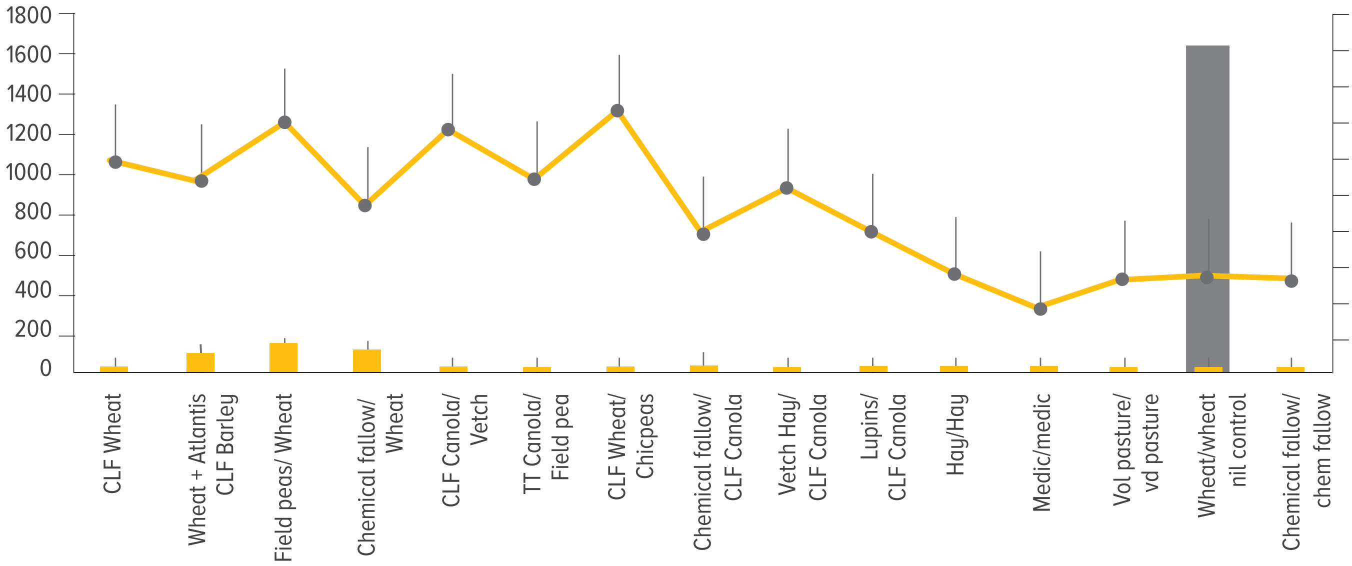


Figure 3: *Rotation impacts on gross margin and weeds in the Mallee – cumulative gross margin ($/ha) and final brome grass populations on 29 August 2013 (plants/m²) in 2011–13.*

2011–2013 GM ($/ha): P<0.001, LSD=$238, CV20%; final brome (plants/m²): P<0.001, LSD=13 plants/m², CV=18%.

Where vetch exists as a volunteer in cereals there are several herbicide options including mixes of phenoxy-based herbicides, for example MCPA, that can be used, depending on which cereal crop the volunteers are growing in. Check herbicide labels for registration for use in vetch on APVMA website.

Photo 3: *(Left) tares on the headland of a vetch crop. The control of vetch or tares in pulse crops largely relies on pre-season weed seedbank management. (Right) tares (pictured left) is a smaller, more spindly plant than modern grain vetch plants (pictured right).*

Photo: Emma Leonard, AgriKnowHow

2.3.3 Nitrogen fixation

Results from the ANVBP across five sites over three years have shown increases in soil nitrogen after vetch was grown for grain (56 kg/ha), hay (94 kg/ha) and green manure (154 kg/ha) (see Section 1, Table 2).

2.3.4 Stubble cover

Vetch stubble residues lack bulk and provide only partial protection to the soil after harvest. Vetch stubble should either not be grazed or grazed with caution to ensure adequate stubble cover is maintained to minimise risk of wind and water erosion on sandy soils and sloping paddocks. Vetch holds the soil better than field pea as it produces more cover and surface roots.

At seeding, the stubble of unharvested crops can be a problem because the long vines build up under the seeder. This stubble may have to be harrowed or disced ahead of seeding to reduce this problem.

2.3.5 Soil moisture reserves

In crop sequencing trials, vetch consistently fixed more nitrogen and used more water than pea, probably because of its longer growing season and greater dry matter accumulation. However, an early manure crop or cutting as silage results in more water remaining in the profile for the following crop than if vetch was grown to maturity and harvested as grain.[5]

2.4 Vetch benefits to cereal rotations

- Increased yields of following cereal crops.
- Allows an extended phase of cropping.
- Decreases many cereal diseases – grass-free vetch crops break the life cycle of root diseases, crown rot, take-all and Rhizoctonia.
- Controls grass weeds – cutting for forage, using grass-selective herbicides or manuring can be used with vetches to control weeds, such as brome grass and barley grass, which are difficult to control in some other crops.
- Allows for crop-topping to prevent herbicide-resistant weeds from setting seed.
- Available soil nitrogen is improved.
- Well-adapted to no-till, standing-stubble systems aimed at improving soil structure and fertility.

2.5 Paddock selection – considerations for a vetch crop

2.5.1 Soil type

Vetch will grow on a wide range of soil types from light sandy soils to heavier clay soils.

On light sandy soils the Common and Woolly pod varieties perform well. All perform well on loam clay soils but the best production comes from soils with good fertility.

Vetch prefers alkaline soils (pH 5.2–8.2) but the variety Benatas, for example, can perform on slightly more acidic soils.[6]

Common vetch will not survive prolonged waterlogging. The vetch subspecies Purple vetch and Woolly pod will tolerate waterlogging and survive better than other crops, such as oats.

Vetch is moderately sensitive to salinity and can have difficulty accessing water and nutrients from saline layers in the soil. Soil chloride levels >600 mg/kg have been found to reduce root growth in crops such as chickpea, lentil and linseed.

Vetch is classified among the medium group for sensitivity of all field crops to sodic soil conditions.

5 M Peoples (2012) Ground Cover Supplement 98, (2012) GRDC https://grdc.com.au/resources-and-publications/groundcover/ground-cover-issue-98-may-june-2012

6 C Gazey, Jennifer Carson (2016) Managing Soil Acidity – WA Fact Sheets, Department of Agriculture and Food, Western Australia. http://www.soilquality.org.au/factsheets/managing-soil-acidity-western-australia

2.5.2 Herbicide residue

Rotations must also take into account herbicide residues and plant-back requirements in relation to soil pH, texture and organic matter content especially after drought conditions. Herbicide residue impacts are more pressing where rainfall has been minimal and in many cases where the soil type is heavier.

It is very important to know the chemical history of the paddock for at least two seasons. This includes knowledge of:

- the chemical used
- the group to which the chemical belongs
- the plant-back periods
- the soil pH (which affects the half-life and longevity of herbicides)
- rainfall
- other requirements for specific herbicide breakdown (check labels).

Residues of sulfonylureas (clorpyralid) and imidazolinones (Group B) can be particularly harmful in alkaline soils. Always check withholding periods. For example, there is a 10-month withholding period for sowing vetch after the use of the Group B herbicide active ingredient imazethapyr.

2.5.3 Sowing into cereal stubble

Vetches grow well when sown after cereal or oilseed crops. Paddocks with adequate standing stubble cover provide a trellis lifting the crop off the soil surface, which is good for grain crops.

If sowing for hay crops, stubble cover is also good to provide early protection. But stubble should be rolled to the surface to minimise incorporation with the cut hay.

2.5.4 Disease

Controlling foliar diseases in vetch can be expensive. Effective disease management relies on variety and paddock selection, plus the use of clean seed, best agronomic practice and the strategic use of fungicides (Section 7 In-crop management – disease).

Time of sowing and seasonal conditions influence the incidence of foliar disease, particularly Botrytis grey mould (BGM). A dense canopy is conducive to BGM in a wet season.

See Table 3 for the potential disease carryover from other crops in the rotation. A four-to-five-year break from vetch and disease carryover crops is required to minimise disease transfer and vetch should not be sown adjacent to vetch, bean or lentil stubbles.

2.5.5 Insect pests

Vetch varieties show little difference in their pest susceptibility. Generally damage from pests of emerging crops, such as snails, slugs, millipedes and earwigs, is not a major problem. This is partly because vetch cotyledons do not grow above the soil surface, so plants can reshoot underground if the tops have been eaten off.

All current vetch varieties are susceptible in early growth stages to redlegged earth mite and lucerne flea. Most are susceptible to bluegreen and cowpea aphids from early growth through to pod maturity, as well as to native budworm during pod formation and filling (see Section 6 In-crop management – pests).

2.5.6 Cross-pollination

If Woolly pod vetch crops are to be used as seed, they should be planted more than 400 m from other varieties to reduce the risk of cross-pollination. Common vetch varieties are self-pollinated and do not need to be planted more than 50 m from other vetches.

Paddock preparation

Key points

- **Sowing into paddocks with low broadleaf weed infestations is important, as vetch is a poor early competitor against weeds**
- **Use integrated pest, disease and weed management practices**
- **Control the weed and volunteer 'green bridge' before seeding to minimise disease and pest carryover**
- **Remediate soil constraints during the summer fallow period**

MORE INFORMATION

A Northern and Yorke Natural Resource Management Board fact sheet on calculating lime requirement including varying lime rates is at http://www.naturalresources.sa.gov.au/files/83bf5aa4-a456-428b-8dfa-a31c00a45237/sustainable-agriculture-liming-acid-soils-fact.pdf

For details on soil acidity and liming, see the following article by Brett Upjohn, Greg Fenton & Mark Conyers –'Management of dispersive (sodic) soils expereincing waterlogging', Agfact AC. 19, 3rd edition 2005, https://www.agric.wa.gov.au/waterlogging/managing-waterlogged-dispersive-sodic-soils

Management of dispersive (sodic) soils experiencing waterlogging, https://www.agric.wa.gov.au/water-erosion/management-dispersive-sodic-soils-experiencing-waterlogging

A video on variable rate gypsum is at https://grdc.com.au/Media-Centre/Over-the-Fence/2014/07/Big-gains-at-a-low-cost

A *GroundCover*™ grower story on seeding non wetting soils is at https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-107-NovDec-2013/Smart-new-way-to-place-seed-over-moistureRocks

IN FOCUS

The approach to paddock preparation and sowing vetch is essentially the same as for other legume crops. However, since vetch is a poor competitor at emergence it is especially important to pay attention to detail at this stage to help ensure maximum production potential.

Ensuring good paddock preparation maximises crop establishment.

3.1 Soil preparation

Testing for soil limitations and remediation should occur in the summer or autumn prior to sowing vetch.

3.1.1 Soil pH

While vetch is more tolerant of acidic soils than most grain legumes, it still prefers soil pH to be 5 or greater. Good yields have been grown in paddocks with pH as low as 4.5 where aluminium and manganese levels were low.

On soils pH <5.2 nodulation and consequently nitrogen fixation will be poor. Root growth may also be reduced in acidic soils and soils with subsoil compaction.

Low pH can be remediated with an application of lime during the summer or autumn period prior to seeding.

3.1.2 Hard setting and compaction

Both of these soil conditions can reduce root growth and free drainage, limiting vetch production.

Hard setting and surface crusting are often linked to sodicity. Exchangeable sodium percentage (ESP) is the measure for sodicity and soils with an ESP of greater than 6 are considered sodic. Sodicity can generally be improved by the addition of gypsum.

Deep tillage and ripping are used to amend soil compaction and may also be used to achieve deeper incorporation of lime, gypsum and organic matter.

Implementing a controlled-traffic system after ripping can help minimise recompaction across a paddock.[1]

3.1.3 Non-wetting

In non-wetting soil, crop establishment can be improved by sowing adjacent to last year's stubble row, soil disturbance and the use of soil wetting agents and press wheels. If non-wetting soil is severe, addition of clay is worthwhile if a suitable clay source is available.

In non-wetting soil, delaying sowing until the soil has become wet may be the best option. Dry sowing with seed furrows left to trap water may not work as furrows may become filled with soil before germinating rains occur.

1 S Davies, T Overheu (2015), Management of dispersive (sodic) soils experiencing waterlogging. Department of Agriculture and Food, Western Australia.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

MORE INFORMATION

Watch GroundCover™ TV for details stubble height and crop emergence
https://grdc.com.au/archive/video/2015/01/gctv15/xdtsbgczxpm

Web resource APVMA website
https://apvma.gov.au

GRDC Green bridge Fact Sheet
https://grdc.com.au/resources-and-publications/all-publications/factsheets/2010/01/grdc-fs-greenbridge

The GRDC Integrated Weed Management Hub
https://grdc.com.au/resources-and-publications/iwmhub

3.2 Stubble

The surface retention of cereal stubble does not affect vetch germination or growth and may improve establishment on hard-setting, surface crusting soils. It is important to keep adequate plant residues on the surface to protect the soil from moisture loss and erosion during establishment, growth and after harvest.

Standing stubble of the previous crop can also help create a trellis for vetch. However, in hay crops, this standing stubble can be included in the baled material and can reduce hay quality.

Infected stubble of host crops can be an important source of the diseases Ascochyta blight, Botrytis grey mould, chocolate spot and rust (See Section 2.5.3 and Section 2.5.4).

3.3 Weed control

Controlling weeds and volunteers as early as possible will help conserve soil moisture, reduce potential disease carryover and minimise blockages at seeding. Removal of weeds is important as vetch is a poor competitor at emergence and in-crop herbicide options are extremely limited.

3.3.1 Summer weed control

As a result of an increase in the use of no-till cropping and the incidence of summer weeds, many growers have adopted a spray fallow system which has predominantly used glyphosate over summer to remove weeds and conserve moisture for the next crop.

To reduce the risk of glyphosate resistance developing in fallow weeds, some growers are using weed-detecting technology (WeedSeeker®, WEEDit) to detect individual weeds that have survived the glyphosate application and spraying these with an alternative knockdown herbicide.

Weed-detecting technology uses optical sensors to turn on spray nozzles only when green weeds are detected, greatly reducing total herbicide use per hectare. The units have their own light source so can be used day or night. Moving from a blanket to a targeted application enables a higher herbicide rate per plant to be applied but generally much less herbicide per hectare.

The new technology also has the potential to map troublesome weed patches so that these areas can be targeted with a pre-emergent herbicide before sowing.

The use of selective grass herbicides and higher rates of paraquat and diquat (bipyridyl herbicides, Group L) are covered by a permit (PER11163), which is in force until 28 February 2019 and is for all Australian states.

This permit allows the use of about 30 different herbicides from groups with seven modes of action. Additional modes of action are likely to be added to the permit over time.

Some herbicide rates have been increased to enable control of larger or stressed weeds. For example, glyphosate (450 grams of glyphosate per litre) rates range from three to four litres per hectare (using a set water rate of 100 L/ha), which far exceeds the label blanket rates of 0.4 to 2.4L/ha. Similar increases in rate have also been permitted for paraquat (for example, Gramoxone®).

3.3.2 Removing the 'green bridge'

Vetch should be sown into a clean seedbed, with weeds and volunteers controlled with cultivation and/or herbicides prior to planting. If not achieved earlier, paddocks should be free of weeds for two to three weeks prior to seeding to prevent pest and disease carryover.

Left uncontrolled, volunteers (see Section 2, Table 2) and weeds can result in the carryover of pests and diseases to the vetch crop.

A wide range of products are registered for controlling weeds in fallows. These include mixtures of paraquat (Group L) and diquat (Group L) and 2,4-D (Group I) and glyphosate (Group M).

Check plant-back periods before sowing vetch. For example, there is a 7–10 day plant-back period constraint before planting vetch following an application of 2,4-D (Group I).

There are no pre-planting residual herbicides registered for use with vetch crops in NSW or Queensland. Some formulations of trifluralin (Group D) are registered for pre-planting use in vetch crops in South Australia and Western Australia, but not in NSW or Queensland.

Self-sown vetch can itself become a green bridge for pests and diseases in the following season. Volunteer vetch seedlings need to be controlled early to minimise the effects of aphids, viruses and diseases in other pulse crops.

Photo 1: *Vetch is a poor competitor at emergence and in-crop herbicide options are limited, especially for broadleaf weeds. Controlling summer weeds and the 'green bridge' to minimise pest and disease carryover are essential tools in the successful production of vetch.*

Photo: Emma Leonard, AgriKnowHow

3.4 Carryover pests

Carryover pests to consider are mites, including balaustium and redlegged earth mites, aphids and lucerne flea. Removal of the green bridge will reduce infestations of establishment pests in vetch and is an important part of integrated pest management.

Table 1: Best-bet IPM strategy, establishment to maturity.

	Post-harvest	Pre-sowing
Earth mites and lucerne flea	**Assess risk.** **High risk when:** • history of high mite pressure • pasture rotating into crop • susceptible crop being planted (for example, canola, pasture, lucerne, vetch) • seasonal forecast is for dry or cool, wet conditions that slow crop growth **If risk is high:** • ensure accurate identification • use Timerite® (redlegged earth mites only) • heavily graze pastures in early-mid spring	**If high risk:** • use an insecticide seed dressing which is compatible with rhizobia inoculum on susceptible crops (see Section 4.4 Seed inoculation and seed dressing) • monitor more frequently until crop establishment • use higher sowing rate to compensate for seedling loss • consider scheduling a post-emergent insecticide treatment • earlier sowing into warm soil to give quick emergence and more vigorous seedlings **If low risk:** • avoid insecticide seed dressings • monitor until crop establishment
Slugs and snails	**Assess risk.** **High risk when:** • high stubble load • annual average rainfall >450 mm • history of slug infestations • canola being planted • summer rainfall • heavy clay soils	**If high risk:** • burn stubbles • cultivate worst areas • remove weeds in paddocks/along fencelines, at least eight weeks prior to sowing • deploy shelter traps prior to sowing • sow early to get crop established prior to cold conditions • use soil compaction at sowing (such as press wheels) • bait at/after sowing prior to emergence
Aphids – virus transmission	Control green bridge (in fallows) Sow virus-free seed Sowing into standing stubble may reduce aphid landing	**Assess risk of aphid outbreak.** **High risk when:** • warm, mild conditions • abundant weed hosts • nearby food sources, such as clover/medic Aim to close canopy and minimise gaps to outcompete infected plants
Aphids – direct damage	Remove green bridge (aphid hosts) to minimise build-up during autumn and spring Sowing into standing stubble may reduce aphid landing and delay aphid build-up in crops	• Control in-crop weeds to minimise sources of aphids • Beneficial insects suppress low populations and reduce the chance of outbreaks • High nitrogen may make the crop more attractive to aphids

Source: IPM Guidelines for Grains (2013), Queensland Government and GRDC. http://ipmguidelinesforgrains.com.au/workshops/resources/

3.5 Carryover diseases

Carryover diseases on vetch volunteers include rust and viruses. Other diseases are carried over on stubble and in the soil and these will not be controlled by green bridge management. More detail on disease control is in Section 7 In-crop management – disease.

Table 2: Infection sources for major vetch diseases.

Disease	Stubble	Seed	Soil	Aphids	Volunteer seedlings
Ascochyta blight	***	**	-	_	**
Botrytis grey mould	**	_	_	_	**
Chocolate spot	***	*	***	_	**
Rust	**	_	*	_	***
Seed-borne viruses	_	**	_	***	***
Non-seed-borne viruses	_	_	_	***	***

Source: PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

Seeding

Key points

- **Time of sowing is influenced by region, variety maturity and end use**
- **Early sowing can produce a very bulky canopy that leads to foliar diseases such as Botrytis grey mould (BGM) in wet seasons**
- **Seeding equipment and row spacing can be the same as for other grain crops**
- **Using quality seed is important for good establishment and early vigour**
- **Inoculation with rhizobia is generally recommended for low organic matter and acidic soils**
- **Sowing depth must take into account herbicide use**
- **Minimal fertiliser is required at sowing**

IN FOCUS

Vigorous vetch crops can increase soil nitrogen by about 50 kg/ha after a grain crop and up to about 150 kg/ha after a green manure crop. Consequently, vetch requires minimal additional nitrogen at seeding or in-crop. However, to achieve good nitrogen fixation attention must be paid to inoculation with the correct rhizobia group and the use of management that optimises the symbiotic relationship between the rhizobia and vetch plant. More details are in sections Section 4.4 Seed inoculation and seed dressing and Section 4.7 Seeding fertiliser.

Vetch is suited to no-till, reduced-tillage, stubble-retention systems. It can be sown using conventional cereal sowing equipment. Its larger seed size means it does not need to be sown very shallow like canola or other pasture species.

4.1 Time of sowing

Sowing time is influenced by rainfall, variety maturity, end use and foliar disease risk (see Table 1).

Early sowing is important for early plant vigour and to maximise forage production. Vetch can be sown dry to promote early seedling establishment and growth (Figure 1). Dry sowing on non-wetting soil is not very successful. Seedling pests such as redlegged earth mites and lucerne fleas can often be avoided when the crop is early sown to avoid emergence under cold, wet conditions.

Sowing early can increase the risk of yield loss through frost damage or leaf disease due to excessive foliage growth. Frost risk can be reduced by sowing early-maturing varieties into good stubble cover to minimise soil moisture loss. Good pre-seeding weed control to conserve moisture also helps mitigate frost damage. Frost-affected grain crops may be more profitable if conserved as forage.

Vetch grown for forage and manure crops is generally sown earlier and at higher seeding rates to produce bulkier crops and optimise forage quality and yield. In trials run by BCG in the Wimmera–Mallee to compare choice of forage crops for winter feed, Rasina⟮D and Morava⟮D vetch had similar production levels to the forage cereals, but the peak in production occurred one month later compared to forage cereals, shifting the feed curve for vetch to later in the season.[1]

Sow vetch for grain production at a similar time to sowing wheat in the same region. Vetch hay crops can also be sown at this time.

Later sowing or grazing of early-sown vetch grain crops runs the risk of lower grain yield if high temperatures and dry conditions are experienced during flowering and pod fill. It also reduces the risk of foliar diseases, such as Botrytis grey mould (BGM), which can severely damage vetch crops prior to cutting or harvesting.

1 A Friske (2011) Choice of forage crops for winter feed, BCG. http://www.farmtrials.com.au/trial/14067

Table 1: Vetch time of sowing by rainfall region, end use and variety maturity.

Rainfall zone (mm)	Optimum sowing date			
	For grain		For forage	
	Early varieties	Late varieties	Early varieties	Late varieties
<250	Mid–late April	Mid–late April	Mid–late April	Mid–late April
251–300	1st–2nd week May	1st week May	1st–2nd week May	Mid April–1st week May
301–375	3rd week May	2nd week May	2nd week May	1st week May
376–450	1st week May–1st week June	3rd–4th week May	2nd–3rd week May	1st–2nd week May
>450	1st–4th week June	4th week May	2nd–4th week May	1st–3rd week May

Source: PIRSA (2010) Vetch the Ute Guide, GRDC – https://grdc.com.au/vetch-the-ute-guide

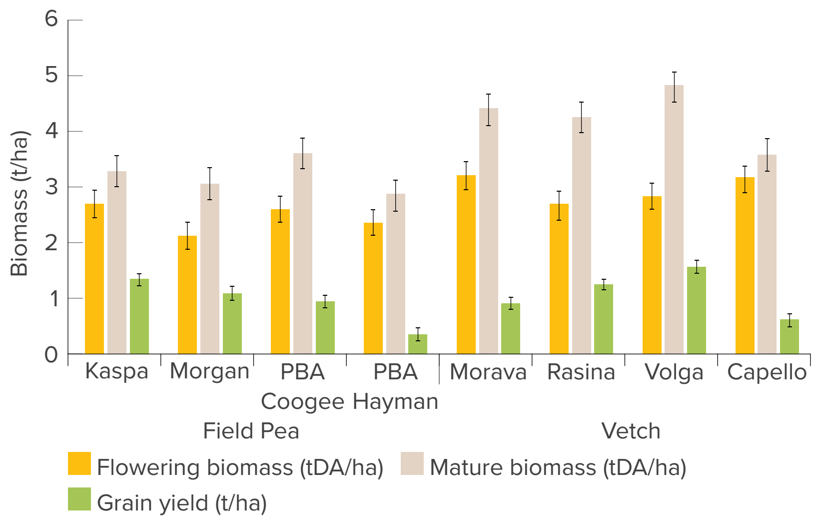


Figure 1: *Biomass yield at flowering and at maturity (tDM/ha), and grain yield (t/ha) of field pea and vetch varieties, Minnipa 2013*

4.2 Pre-seeding weed control

There are only limited herbicides registered for use in vetch for grass control. For broadleaf weeds, post-sowing pre-emergent (PSPE) herbicide is the only option. Achieving good weed control pre-sowing is crucial (see Section 3.3).

The importance of cleaning and decontaminating spray equipment before the application of herbicides cannot be overstated. Traces of sulfonylurea herbicides (such as chlorsulfuron, metsulfuron or triasulfuron) in spray equipment can cause severe damage to vetch and other legumes.[2]

Pulse crops can be severely damaged by some hormone herbicide sprays, such as 2,4-D ester, drifting into the crop. This can happen when these sprays are applied nearby in very windy or still conditions, especially where there is an inversion layer of air on a cool morning.[3]

Vetch is not tolerant to the phenoxy-based herbicides (e.g. MCPA).

Taking some general precautions can help to reduce the likelihood of crop damage with residual herbicides that are registered for used in vetch at planting:

MORE INFORMATION

Information on disease-testing services around Australia is at: http://extensionaus.com.au

Pulse inoculation techniques www.pulseaus.com.au/growing-pulses/publications/pulse-inoculation

Germination testing and seed rate calculator Fact Sheet http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/157442/pulse-point-20.pdf

2 Best Management Guide Faba Bean Production Southern and Western region (2016), Pulse Australia. http://www.pulseaus.com.au/growing-pulses/bmp/faba-and-broad-bean/southern-guide

3 PIRSA (2010) Vetch the Ute Guide, GRDC – https://grdc.com.au/vetch-the-ute-guide

- Do not apply residual herbicides if heavy rain is imminent.
- Maintain at least 7.5–10 cm soil coverage over the seed.
- Avoid leaving a furrow or depression above the seed that could allow water (and chemical) to concentrate around the seed or seedling.
- Avoid leaving an exposed, open slot over the seed with disc openers and avoid a cloddy, rough tilth with tyned openers.

4.3 Seed quality

Quality seed is vital for crop establishment and ultimate production. Good seedling vigour is also important as it helps improve establishment.

Weathering of crops after ripening and poor storage can substantially reduce viability of seed (see Section 10 In-crop management – environmental impacts).

Germination and vigour may deteriorate in storage if seed is more than one year old, frosted or weather-damaged (see Section 11.2.1).

Check germination percentage and purity before purchasing seed and ask for the test certificate. Ideally the germination percentage should be more than 90%. Experience from the Australian National Vetch Breeding Program (ANVBP) found that a germination percentage of more than 95% is required for Common vetch and more than 92% for Woolly pod.

If it is low (below 80%), increase the seeding rate or obtain new seed with a higher germination percentage.

Home-saved seed should be cleaned and graded to ensure seed is free from weed and crop seed contamination.

Retain seed from the healthiest crop where Ascochyta, Botrytis grey mould and chocolate spot levels are the lowest. Seed disease testing services are available and ideally sow seed with nil infection.

Seed-borne inoculum is usually less important for vetch diseases than stubble-borne inoculum.

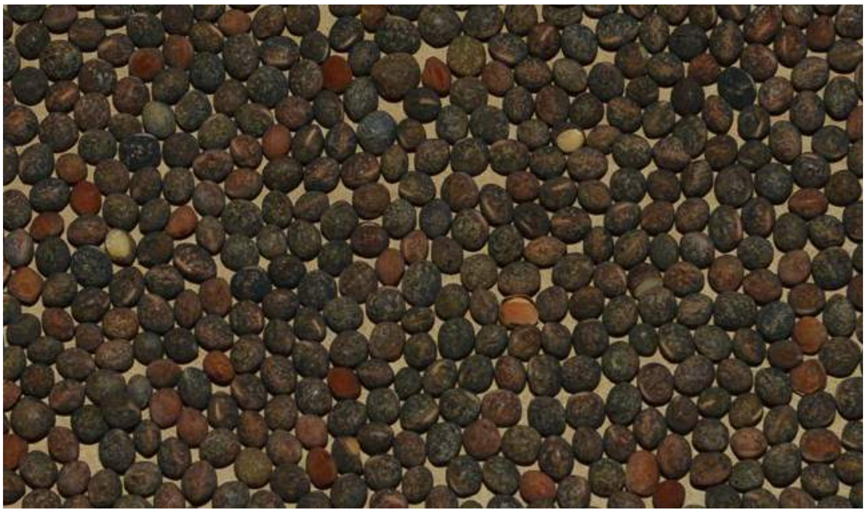


Photo 1: *Quality seed is vital for crop establishment and ultimate production. Avoid sowing seed that is shrivelled or contains too many cracked seeds or seeds without seed coat. Seeding rates should be modified for germination percentage.*

Photo: Emma Leonard, AgriKnowHow

MORE INFORMATION

AInoculating legumes: a practical guide https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

GRDC Nitrogen fixation Fact Sheet https://grdc.com.au/GRDC-FS-NFixation-Legumes

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

4.4 Seed inoculation and seed dressing

To achieve nitrogen fixation, the correct strain of rhizobia must be present to form a symbiotic relationship with the vetch. The same species of rhizobia can nodulate legumes in inoculant Group E and Group F. Group E is recommended for vetch, especially in acidic soils. Rhizobia suited to vetch have been widely distributed in most cropping areas in the southern region. However, these rhizobia have moderate sensitivity to soil acidity, which means rhizobia levels can fall below that needed for optimal nodulation.

Inoculants can be applied either on the seed, in-furrow by water injection or in a granular form.

Vetch requires the same strain of rhizobia as pea, lentil and faba bean. If these crops have been grown during the past five years, the correct rhizobia may be present. This is especially true for alkaline, self-mulching grey clays where high numbers of rhizobia may be found.

On acidic soils (pH <5.2), vetch often nodulates poorly. Lupin rhizobia, which is Group G, is acid-tolerant but not suited to vetch. Use of granular inoculums and application of lime may make some acidic soils suitable for growing vetches.[4]

Inoculation is generally recommended. It is especially important on acidic soils prone to waterlogging and poorly structured soils with low organic matter where survival of rhizobia is poor.

Use of fungal seed dressing is seldom beneficial. Thiram plus thiabendazole is registered for use on vetch to provide protection against seedling root rots (*Fusarium* spp. and *Pythium* spp.). Use of fungal seed dressing can minimise the risk of introduction of disease into new vetch-growing areas.

Insecticide seed dressings (dimethoate) or an in-crop spray of omethoate can be used as part of an integrated approach to the control of redlegged earth mite.

If the seed dressing is compatible with inoculum, apply the seed dressing first and then inoculate immediately before seeding. Do not mix inoculants and seed dressing together unless the inoculant label specifies compatibility. Do not use fungicide seed dressings with a seed-applied inoculant in acid soils as this can reduce rhizobia number.

A granular inoculant may assist in rhizobia survival, particularly in acidic soils, when sown dry or fungicide seed treatments are used.

MORE INFORMATION

A fact sheet on controlled traffic and farming set up is at: www.spaa.com.au/pdf/253_SPAA_fact_sheet_(controlled_traffic).pdf

http://www.naturalresources.sa.gov.au/files/15e99f33-a569-4fcd-b8c5-a38700a74fe3/inter-row-in-fodder-shrubs-gen.pdf

4.5 Seeding system – depth and row spacing

Vetch as a pure stand or vetch mixes for forage or manure crops can be sown together using an air-seeder. Mixes can be sown with the other seed or in alternate rows using a combine seeder.

4.5.1 Sowing depth

Seed should be sown at a depth of 2–4 cm as for wheat in a similar rainfall district.

Sowing can be deeper on lighter soils. Vetch can be broadcast onto dry soil and buried by trampling by sheep or harrowing, so sowing depth can vary from very shallow to deep. Shallow-sown vetch is more prone to damage by soil-active herbicide.

When dry sowing, sow at 4–8 cm deep to ensure good moisture conditions before germination and to protect applied inoculum from high temperatures near the soil surface. If the opening rains are delayed some weeks, deep-sown crops can be slower to establish and grow when soil temperatures fall.

4 Pulse Australia (2014). Southern/western lentil best management practices training course. Pulse Australia Limited.

Deeper sowing is also required to minimise damage from residual herbicides used for vetch.

Vetch cotyledons remain below the soil surface and only the shoot pushes through, so reshooting is possible if the initial shoots are damaged by insects or vermin.

4.5.2 Row spacing

Vetch is generally sown on the same row spacing as used for cereal production. It can also be broadcast and incorporated by sheep or harrows, so there is no specific row spacing.

Some growers use a medium to wide row spacing (25–36 cm) to suit trash clearance, inter-row weed control or to have a more open canopy to reduce the development of diseases such as Botrytis grey mould.

Wider-spaced crops risk lower forage production and are less competitive with weeds. Weed control can be more difficult with wider row spacing unless sown with adequate stubble cover, or a shielded sprayer is used for inter-row weed control.

4.5.3 Wheel tracking

Consider tramlining and controlled-traffic farming set-ups to avoid physical damage to the crop from machinery. This damage can provide 'hotspots' for disease.

Photo 2: *Vetch can be sown with the same equipment as cereals and pulse crops. Row spacing is generally the same as for other crops in the rotation but seeding depth needs to vary in relation to access to soil moisture and the use of residual herbicide.*

Photo: Emma Leonard, AgriKnowHow

4.6 Sowing rates

Seeding rates are determined by the end use and vetch subspecies. Rates also depend on the expected rainfall and time of sowing and should be adjusted for germination percentage.

Aim for a lower plant density in regions averaging less than 350 mm of annual rainfall and higher densities in areas with more than 500 mm annual rainfall.

Seeding rates can be increased by 10–15% for manure crops and if sowing is delayed beyond the optimum time (Table 1).

For mixtures of vetch and cereal hay use a 1:1 or 1:2 cereal:vetch mix at a total seeding rate of:

- 40 kg/ha in areas with less than 400 mm annual rainfall;
- 60 kg/ha in areas with 400–550 mm annual rainfall; and
- 60-100 kg/ha in areas with more than 550 mm annual rainfall.[5]

A lower plant population results in a less bulky crop, reducing the potential grain or forage yield but lowering the risk of foliar disease.

Sowing overlaps (for example, headlands) can exacerbate disease development due to more bulky crop growth. The use of precision agricultural tools including guidance, autosteer and section control and controlled-traffic farming systems can help minimise sowing overlaps.

4.6.1 Calculating seed rate

The number of seeds that emerge is often less than the seeds sown due to non-viable seed, seedlings with poor vigour, disease, herbicide damage or poor soil structure.

Seeding rate (kg/ha) = plant density (plants/square m) x 1000 seed weight (g) ÷ emergence percentage (from germination test).

Table 2: Target plant density and common seeding rates for vetch by end use and subspecies.

	End use	Common vetch varieties	Purple vetch varieties		Woolly pod	
	Plant density (plants/m²)	Sowing rate (kg/ha)	Plant density (plants/m²)	Sowing rate (kg/ha)	Plant density (plants/m²)	Sowing rate (kg/ha)
Grain/seed	40–60	40–50*	60	20–40	50	20–40
Green manure	60–70	50–60	65	25–40	50	25–40
Hay	50–70	50–60	60	25–35	50	25–35
Grazing	50–70	50–60	65	25–40	50	25–40
Regenerating pasture	40–60	40–60	-	20–40	40	20–40

* In WA, target a plant population up to 50 kg/ha unless high grain yields expected.
Source: PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

4.7 Seeding fertiliser

The nutrient requirements of vetches are similar to other legumes. Generally Common vetches are grown in rotation with cereals; this provides enough residual nutrients to maintain soil fertility for vetch growth.

On-farm practice is often 50–75 kg/ha triple superphosphate (0N:20.6P:0N:1S) or 100 kg of single superphosphate (0N:9P:0K:11S) at sowing to provide a good start and growth. However, many growers choose to sow without any fertiliser with good results.[6]

4.7.1 Phosphorus (P)

If soil levels are low then 10–30 kg P/ha may be required to gain good forage and seed yields. Where levels are high, maintenance levels to meet removal (Table 3) are all that is required (5–15 kg P/ha).

5 B. Bull; A Mayfield (1992) Growing Vetch – out of print

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

4.7.2 Nitrogen (N)

Vetch should be self-sufficient for nitrogen (N) if well-nodulated. Rates of 5–15 kg N/ha at seeding to aid establishment may be useful on lighter and slightly acid soils.[7] Hay crops of cereal and vetch can benefit from up to 30 kg N/ha at seeding, particularly if early grazing is also required.

4.7.3 Potassium (K)

In higher-rainfall areas where hay is often cut, rates of 15–30 kg K/ha at seeding may be required if soils are low in potassium.

4.7.4 Sulfur (S)

If soils in the region generally respond to sulfur then apply 5-2 kg S/ha at sowing. Soils that leach or have grown canola are more likely to require sulfur.

4.7.5 Zinc (Zn)

Zinc is required for vetch on alkaline soils but use of zinc in other parts of the rotation may be sufficient and so it generally does not need to be applied to the vetch.[8]

4.7.6 Copper (Cu)

In south-eastern Australia responses to copper on legumes is rare.

4.7.7 Manganese (Mn)

A response to manganese may be seen in high pH soils (pH >8). This is usually applied in-crop as a foliar application.

4.7.8 Molybdenum (Mo)

This may be required on acidic soils where molybdenum becomes unavailable. Rates of 50–60 g Mo/ha should be applied if no applications have been made in the past five years.[9]

Table 3: Guide to nutrient removal by one tonne of vetch grain.

Major nutrients	Kg removed in grain	Minor nutrients	Kg removed in grain
Nitrogen	44	Copper	8*
Phosphorus	3.8	Zinc	26*
Potassium	10*	Manganese	12*
Sulfur	1.5*		
Calcium	0.8		
Magnesium	1.2		

* Value for field pea, estimated to be same for vetch
Source: PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

7 PIRSA (2010) Vetch the Ute Guide, GRDC – https://grdc.com.au/vetch-the-ute-guide

8 Better Soils (1998) Advisory Board of Agriculture, http://soilwater.com.au/bettersoils/module2/2_7.htm

9 B. Bull; A Mayfield (1992) Growing Vetch – out of print)

4.8 Rolling

Surface rolling or prickle chaining flattens clods and ridges caused by sowing or press-wheels, and presses rocks and sticks into the soil, leaving a flat surface to allow the harvester comb or forage harvester to cut close to ground level. Rolling helps to reduce harvest losses, machinery wear and contamination in the seed or forage sample.

Rolling should be carried out post-sowing, pre-emergence and is best done with a rubber-tyred roller, when the soil is moist.

It may have to be delayed until the crop has emerged if the soil is prone to hard-setting, crusting or eroding on sandy or sloping country. Emerging shoots can be broken off if rolling when plants are just at emergence.

If rolling is carried out post-emergence, it should be done later in the day in warm weather so plants are limp and not brittle from cold or frosty conditions.

Avoid rolling two weeks before or after applying a post-emergent herbicide.

Rolling vetch post-emergence could increase the possibility of early leaf diseases, aiding the early spread of disease later within the crop.

Both rubber-tyred and steel rollers can be used successfully although a lighter roller is preferred when rolling post-emergence. 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. This is especially true on heavier soil types and when pushing rocks and sticks below the soil surface. Lighter rollers work well on sandier soils.

Growth stages

Key points

- Vetch is an annual legume that produces a scrambling vine with moderate stem strength and multiple lateral branches that develop from near the base.
- The plant is thin stemmed, so it is initially semi-erect until its lengthy stems cause lodging before flowering.
- Germination is hypogeal, meaning the cotyledons of the germinating seed remain below the ground and inside the seed coat.
- Vetch roots are sensitive to saline, high boron and sodic soils.
- Flowering begins on the lowest branches, gradually moving up the plant and continuing until near maturity.
- Vetch has an indeterminate growth habit, meaning it is possible to find flowers, immature pods and mature pods on a plant all at the same time.

5.1 Introduction

Common vetch is a succulent, annual legume with long, smooth stems of moderate stem strength and tendrils that help it climb and increase the stem support. It grows as small bushes, some 40–80 cm high, with multiple lateral branches that develop from near the base. It is a large, climbing, semi-prostrate plant with 9–16 internodes and multiple green to dark green leaves.

The vetch plant experiences hypogeal emergence, like field pea (Figure 1), which means the cotyledons of the germinating seed remain below the ground and inside the seed coat.

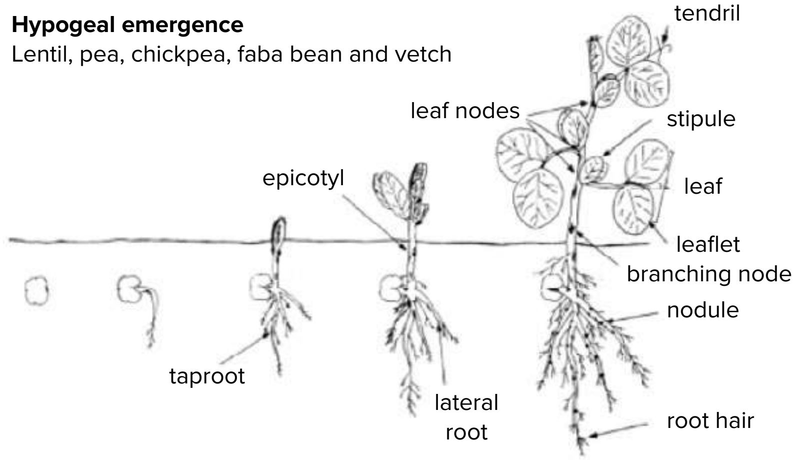


Figure 1: *Seedling development of lentil.*

Source: Best Management Guide –Lentil Production: Southern Region, (2015), Pulse Australia, http://www.pulseaus.com.au/growing-pulses/bmp/lentil/southern-guide

Seedlings with hypogeal emergence are less likely to be killed by frost, wind erosion or insect attack. This is because new stems can develop from buds at nodes at, or below, ground level. However, their growth may be slowed considerably if the initial shoot is damaged.

The **vetch plant** is a slender, initially erect plant that has thin stems and a trailing habit when in advanced growth stages. It is a bushy annual with compound leaves (4–8 pairs of leaflets), similar to lentil leaves, with a tendril at each tip. Plants can have single stems or many branches, depending upon the population in the paddock.

The many and lengthy stems of a vetch plant originate from near the ground. Plant stems normally range from 50–200 cm in length. Plants generally grow taller when there is adequate soil nutrition and moisture along with cool growing season temperatures.

Because of their relatively long stem lengths, vetch crops lodge mid-season due to their weak stems, particularly if well grown with high crop biomass and grain yields.

Flowering begins on the lowest branches, gradually moving up the plant and continuing until harvest. Flowers can be purple or white, and are self-pollinated.

Vetch plants flower profusely over an extended period and can set many pods, with each pod containing multiple seeds depending on the growing season conditions.

Pods and seeds. Due to its indeterminate growth habit it is possible to find flowers, immature pods and mature pods on a plant at the same time. This means that crop desiccation may be required as an aid to grain harvest in order to create more even maturity.

Seeds are small in comparison with pulses and are a characteristic round shape.

Growth stage

GS00–GS04

Development phase – Germination to emergence

In moist soil with temperatures above 5°C seeds germinate within a few days.

Root emerges then shoot with leaves initially pointing downwards. Cotyledons (embryonic leaves) remain below ground.

If not inhibited by subsoil constraints the tap root can reach to 1m.

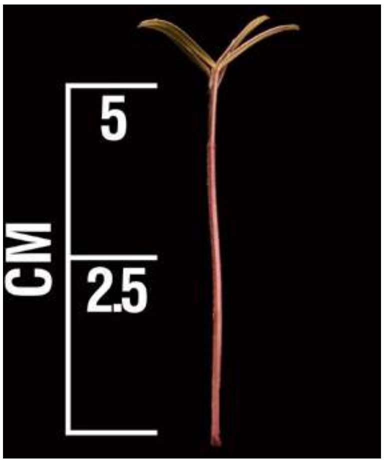
Emergence occurs after 10 days in warm conditions (12°C) but can be delayed as long as 21 days if cold (5°C).

Key management

Sow into a weed-free seedbed. Roll prior to emergence. Apply PSPE herbicides before emergence.

Growth stage

GS101 first node first leaf fully unfolded with one pair leaflets.



Development phase – vegetative

A node is counted as developed when leaves are unfolded and flattened out.

The vegetative stage is determined by counting the number of developed nodes on the main stem, above ground level. Vegetative nodes are counted from the point at which the first true leaves are attached to the stem. The last node counted must have its leaves unfolded.

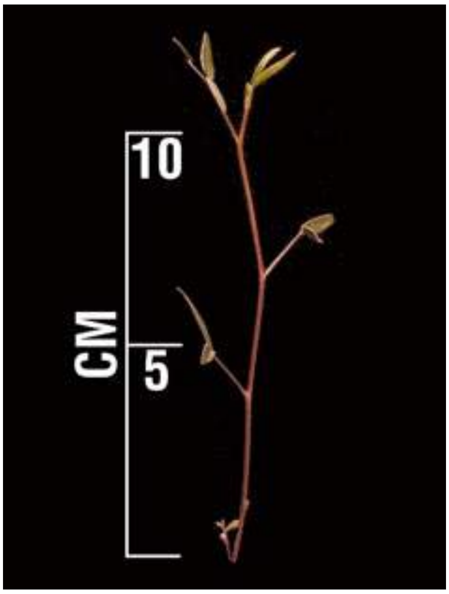
Key management

Monitor for establishment pests including RLEM and lucerne flea.

Growth stage

GS104 fourth leaf fully unfolded with more than one pair of leaflets, complex tendril.

GS1(N) N last recorded node.



Development phase – vegetative

Multiple lateral branches develop from near the base. No secondary branching. Stems range from 50-200 cm.

Vetch leaves are concave, green and hairy on both sides. Leaflets of Common vetch are broader and appear more succulent than those of woolly pod vetch.

Roots continue to extend and secondary roots branch.

Root nodules can start appearing as early as 15 days after emergence. These are generally on the tap and secondary roots near the surface.

Peak nodule growth coincides with peak vegetative growth.

Key management

Monitor for pests every 7–10 days if <15°C or every 3 days if 15–20°C

Control pests

Do not graze woolly pod vetch (RM4) before 10 nodes or 15 nodes

Do not graze lower than three nodes

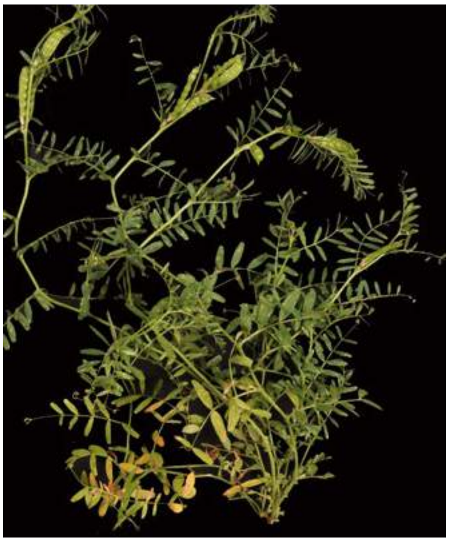
Monitor for disease and control

Check nodulation and for nutrient deficiency

Waterlogging will limit nitrogen fixation by nodules.

Growth stage

GS201-203 Flowering



Development phase – reproductive

Reproductive phase commences as the plant begins to flower but biomass production can continue if soil moisture is available and temperature is below 30°C. Flowering can recommence if rain follows high temperatures.

Flowering in vetch is indeterminate, occurring from axillary buds on the main stem and branches. It proceeds from lower to higher nodes. Each flower produces a pod containing multiple seeds.

Flowers self-pollinate.

Nodulation starts to decline at flowering. Most nodules will be in the top 15 cm of soil.

Generally flowers between September and November.

Key management

Monitor for disease–Ascochyta, Botrytis and rust.

Apply fungicides before canopy closure.

Check pesticide withholding periods for hay cutting.

Cut for silage and hay before pod set.

Peak biomass.

Growth stage

GS204-207 Pod set to pod fill

Development phase – reproductive

As stems elongate plants start to lodge. Pods start to fill and the plants start to dry-off.

Most pods form on the middle and lower nodes.

Narrow pods about 20–50 mm long contain 3–8 seeds (variety specific).

Root growth can continue until maturity.

Key management

Terminate manure crops – timing depends on motivation – weed control or biomass.

Growth stage

GS208-210 Green wrinkled pod to dry seed

Development phase – reproductive

Seeds ripen from late October.

Grain maturity is reached 180–250 days after sowing depending on variety.

Key management

Desiccate weeds and to advance harvest by 10 days.

Growth stage

GS301-303 lower pods dry, down to all pods dry.

Development phase – senescence

Vetch seeds are medium to large in size (6.5–8.9 g/100 seeds). The testa (seed coat) is of a brownish, dull grey or black in colour. Cotyledon colour varies with the variety.

Key management

Vetch is ready to harvest when more than 90% of pods lose green colour. Stems may still show some green. Seed in left pod is still too green, right pod is mature and ready for harvest.

In-crop management – pests

Key points

- Start to monitor at early growth stages and continue to monitor for pests through the growing season
- Use integrated approaches to pest, disease and weed management
- Where possible use only selective insecticides to preserve beneficial insect populations

MORE INFORMATION

A PowerPoint presentation on the IPM toolbox is at http://ipmguidelinesforgrains.com.au/wp-content/uploads/July2013ppt_IPM.pdf

Watch *GroundCover*™ TV for details on integrated pest management https://www.youtube.com/watch?v=OiKuPLCLs9g&list=PL5BC991F931DFFD9C

To help identify insects, visit the Insect identification Insectopedia – http://ipmguidelinesforgrains.com.au/insectopedia/index.htm

A pest and beneficial insect gallery is at http://www.cesaraustralia.com/sustainable-agriculture/identify-an-insect/insect-gallery/

Pestnotes by **cesar** is at http://www.cesaraustralia.com/sustainable-agriculture/pestnotes

Compared to most other pulse crops, vetch can be a relatively low-maintenance, low-input crop. This is especially true if sown as a manure crop for the control of in-crop weeds in that phase of the rotation. Control measures for pests, diseases and weeds are determined by incidence, seasonal and regional conditions, variety and end use.

6.1.1 Pest management

As with other legumes, insects and mites can cause severe damage if left unchecked. The most damage from these pests is likely to occur during seedling establishment, especially if conditions are cold and wet in autumn. Early sowing into warm soils reduces the risk of mite damage.

Photo 1: *Severe damage primarily caused by lucerne flea and redlegged earth mite in a crop of vetch that did not receive insecticide treatment.*

Photo: Emma Leonard, AgriKnowHow

As vetch is usually sown after a cereal, mite numbers will be reduced, but if sown after a pasture phase the risk of mite damage is high. The Timerite® decision-support tool can be used to target mites the previous spring if they are a problem.

As crops grow they are less affected by mites, lucerne flea, slugs and snails unless growth is slowed by dry or cool, wet conditions (Table 1). Controlling pests that cause damage at podding and grain filling is only relevant for crops that will be harvested for grain. Later control may also be required if infestation is severe and could impact on neighbouring crops.

Aphids can be devastating to vetch at any time during the life cycle.

Chemical pest control treatments should be part of a program of integrated pest management (IPM) based on:

- accurate pest identification
- density of pests and likely damage
- value of the end product.

Table 1: Insect pests and their potential for damage at different growth stages.

Group	Species	Growth stage			
		Emergence/ seedling	Early growth	Flowering	Podding/ grain fill
Aphids	Bluegreen aphid (*Acyrthosiphon kondoi*)	✓	✓✓	✓✓	X
	Cowpea aphid (*Aphis craccivora*)	✓	✓	✓✓	X
Mites and springtails	Balaustium mite (*Balaustium medicagoense*)	✓✓	✓✓	✓	X
	Blue oat mite (*Penthaleus* spp.)	✓✓	✓✓	✓	X
	Clover/Bryobia mite (*Bryobia* spp.)	✓✓	✓✓	✓	X
	Redlegged earth mite (RLEM) (*Halotydeus destructor*)	✓✓	✓✓	✓	X
	Lucerne flea (*Sminthurus viridis*)	✓✓	✓✓	✓	X
	Onion, plague and western flower thrips (*Thrips tabaci, T. imaginis* and *Frankliniella occidentalis*)	✓	✓	✓	X
Moths and caterpillars	Native budworm and corn earworm/cotton bollworm (*Helicoverpa punctigera* and *H. armigera*)	✓	✓	✓	✓✓
	Cutworms (*Agrotis* sp.)	✓	✓	✓	X
	Brown pasture looper (*Ciampa arietaria*)	✓	✓	✓	X
	Looper caterpillar (*Chrysodeixis* sp.)	✓	✓	✓	X
Snails and slugs	Snails (*Theba pisana, Cernuella virgata, Cochlicella acuta, Cochlicella barbara*)	✓	✓	✓	✓ contaminant
	Slugs (*Deroceras reticulatum, Milax gagates)*	X	✓	✓	X

Note: X not damaging at this growth stage ✓ potential for some damage ✓✓ potential for considerable damage.

Source: modified from PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

6.1.2 Beneficial and natural enemies

All pests have natural enemies, so a key component of any IPM program is to maximise the number of beneficial invertebrates (see below). Where possible use only selective insecticides. If broad-spectrum insecticides are to be used, use judiciously, for example as border, spot or barrier sprays. Preserve native vegetation which provides refuges for beneficial pests.

Table 2: Best-bet IPM strategy establishment to maturity for key insect pests of vetch.

	Growth stage		Beneficial invertebrates/ biocontrols
	Establishment–vegetative	**Flowering–maturity**	
Aphids	Assess risk of aphid outbreak. High risk: • warm, mild conditions • abundant weed hosts • nearby food sources, e.g. clover/medic.	Conserve and monitor beneficial insects that suppress aphids. If control is required, use selective 'soft' pesticides if registered. Use of broad-spectrum pesticides may cause an increase in aphid numbers through control of beneficial insects. Check post-application for signs of flaring.	Aphid wasp parasites, ladybird beetles, hoverflies and lacewings. Aphid diseases.
Mites and springtails	Monitor susceptible crops through to establishment using direct visual searches. Be aware of edge effects; mites move in from weeds around paddock edges. If spraying: • ensure accurate identification of species before deciding on chemical. Lucerne fleas leave distinct windows in leaves. RLEM leave silver patches and seedlings become stunted or dead. • consider border sprays (mites) and 'spot' sprays (lucerne fleas) • spray prior to winter egg production to suppress populations and reduce risk in the following season Use Timerite® to determine the best spray timing.	As the crop grows, it becomes less susceptible unless growth is slowed by dry or cool, wet conditions.	At least 19 predators and one pathogen are known to attack RLEM in eastern Australia. Some also impact upon other species. The French anystis mite is the most effective predator but is limited in its distribution. Snout mites will also prey upon RLEM and lucerne fleas and help keep populations in check.

Moths, caterpillars and cutworms	Monitor for cutworm larvae which live and pupate in the soil but emerge to feed at night. Look for seedlings with stem cut through. Most damaging late winter to early spring.	Monitor for moths: H. *punctigera*: from mid-to-late winter, using pheromone traps or at night. High risk: • wet winter in inland breeding areas • large moth flights detected • wet conditions in spring extend the period of crop susceptibility H. *armigera*: from spring (October to November), using pheromone traps. If high risk: • Timely monitoring of susceptible crops is critical. Continue until crop is dry and unattractive, or harvested. Ensure post-treatment checks are made. • Use thresholds to guide spray decisions (none for vetch but use other pulses, e.g. chickpea, as a guide). • Use soft options first, particularly if aphids are present. Consider biological insecticides (*Bt* or NPV) to control small larvae less than 7 mm.	On larvae – glossy shield bug, spined predatory shield bug, damsel bug, assassin bug, tachinid flies, orange caterpillar parasite, two-toned caterpillar parasite, orchid dupe, *Bt*, NPV, caterpillar fungal diseases, lacewings and spiders. On eggs – damsel bug, caterpillar egg parasites, ladybird beetles, lacewings and spiders.

Source: IPM Guidelines for Grains (2013), Queensland Government and GRDC, http://ipmguidelinesforgrains.com.au/workshops/resources/ and (Biocontrol) Vetch: the Ute Guide (2010) PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

In-crop management – disease

Key points

- **Start to monitor at early growth stages and continue to monitor for disease through the growing season**
- **Control foliar diseases when at early stages, preferably before canopy closure**
- **Use integrated approaches to pest, disease and weed management**

MORE INFORMATION

Fungicide resistance management strategies – http://www.croplife.org.au/resistance-strategy/2015-fungicide-resistance-management-strategies1/

Chemical information Herbiguide http://www.herbiguide.com.au

Details on farm biosecurity are at http://www.farmbiosecurity.com.au

A full list of registered products is at www.apvma.gov.au

7.1 Disease management

The diseases that cause major damage in vetch are chocolate spot (*Botrytis fabae*), Botrytis grey mould (*Botrytis cinerea*), rust (*Uromyces viciae-fabae*), Sclerotinia stem rot (*Sclerotinia sclerotiorum* and *S. trifoliorum*), stem nematode (*Ditylenchus dipsaci*), *Rhizoctonia* spp., and the mosaic and yellowing viruses. The other diseases listed in this section can cause problems in some seasons or regions (see Section 7.1.1 to Section 7.1.7).

Effective disease management relies on an integrated approach including: selection of a variety with the most suitable profile of disease resistance, most suitable paddock, clean seed, best agronomic practices and canopy management, as well as the use of fungicides (see Section 7, Table 1).

The use of integrated disease management (IDM) in vetch is especially important because controlling established foliar diseases with fungicides in vetch may not always be possible as there are few registered fungicides and some have long withholding periods (see Table 2). For rust there are several options, while control options for Ascochyta are limited and viruses non-existent.

If not sowing a resistant variety, a fungicide application may be needed in seed production crops, especially in high-rainfall regions, wet years or high disease risk situations (see Section 2.5.4).

Fungicides can be necessary to control rust in susceptible varieties if used for feed as infected plants can induce abortions in pregnant livestock.

Care needs to be taken using some fungicides that have long withholding periods (WHP) (for example, carbendazim, 28 days WHP) (see Table 2). Fungicides with long WHPs should be avoided if the vetch crop is to be conserved as silage or hay destined for the dairy industry. The withholding period must be completed before cutting because time elapsed after cutting does not count as being within the withholding period (http://agriculture.vic.gov.au/agriculture/farm-management/chemical-use/agricultural-chemical-use/chemical-labels/withholding-period-statements-on-labels).

Ascochyta blight occurs in the earlier stage of crop development, potentially reducing grain and dry matter production. However, Botrytis can cause greater yield losses if the crop is dense and the growing season is cool and wet (see Table 3). Note that some Ascochyta species are crop specific.[1]

Understanding the potential sources of disease inoculum is important when planning planting and control programs (see Section 2.1, Section 3.5 and Table 2).

1 L Sigel, J Brand, Josh Fanning, Pulse Disease Guide (2017), Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/plant-diseases/grains-pulses-and-cereals/pulse-disease-guide

Table 1: Integrated disease management strategies for vetch.

Factor	Best practice
Paddock history	A minimum of three, preferably four, years of break between vetch crops.
Paddock hygiene	Select paddocks at least 500 m from last year's vetch stubble. Avoid sowing adjacent to faba bean and, if possible, field pea and lentil stubbles (see Section 2, Table 2; and Section 7, Table 2).
Variety	Select a variety with suitable disease resistance for your district. (see Section 2, Table 1).
Seed health	Use seed from crops that had a low disease severity, especially at podding. Laboratory seed tests can confirm disease levels. Use seed with less than 10% chocolate spot or 5% Ascochyta. Rust is not seed-borne (see Section 4.3 Seed quality).
Sowing time	Do not sow too early. Early emergence leads to excessive vegetative growth, early exposure to disease and early canopy closure, increasing foliar disease (see Section 4.1 Time of sowing).
Sowing rate	Higher than ideal seeding rates and plant populations can lead to a dense crop canopy and increased disease risk (see Section 4, Table 2).
Row spacing	Wider rows can delay canopy closure, reducing the risk of chocolate spot. Any increased lodging may increase the chance of foliar diseases (see Section 4.5.2 Row spacing).
Canopy	Delay sowing, reduce seeding rates or else graze or cut early-sown crops.
Fungicide application	Success depends on monitoring, correct disease identification, adequate coverage and timeliness of sprays with the correct fungicide. Seed: To reduce transmission of disease (helps control Ascochyta, Botrytis grey mould and seedling root rots). Foliar: Most effective when applied before or at first signs of disease and before rain. Protection lasts 10–12 days. Subsequent new growth is unprotected.
Aphid control	Early detection and control can reduce virus spread. Summer weed control, thicker crop density, stubble and minimal bare soil reduce the presence of aphids (see Section 6.1.2).
Harvest management	Early harvest reduces disease infection on the seed. Windrow or desiccate to enable earlier harvesting.

Source: PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

Table 2: Fungicide active ingredients registered for use on vetch.

Chemical	Withholding period		Ascochyta blight	Chocolate spot and Botrytis grey mould	Rust
	Grazing	Harvest			
Mancozeb	14 days	28 days	✓	✓	✓
Carbendazim	28 days	28 days	Not registered	✓	Not registered
Metiram	21 days	42 days	✓	✓	✓

Visit PUBCRIS APVMA for a full list of registered products, www.apvma.gov.au. For crops cut for grazing or conservation as forage or silage the grazing withholding period applies (https://apvma.gov.au/node/1020)
Source: PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

Table 3: Fungicide spraying program.

Critical period	Disease		Fungicide	Comments
	Target	Secondary		
1st critical period Early vegetative (6–8 weeks after emergence).	Ascochyta blight	-	Mancozeb or metiram	Early fungicide application can restrict early development and spread of disease. Use at first sign of infection. Use the higher rate for dense crops or if disease pressure is severe.
	Rust	-	Mancozeb or metiram	
	Rust plus	Ascochyta blight	Mancozeb or metiram	
2nd critical period Before canopy closure (13–16 weeks after emergence).	Ascochyta blight and/or rust plus	Chocolate spot	Mancozeb or metiram	On-farm experience – application is more effective before canopy closure.
	Chocolate spot	-	Carbendazim	If Ascochyta is detected, and/or chocolate spot appears in the crop canopy, and rain or high humidity are likely, apply fungicide if crop has sufficient yield potential.
	Chocolate spot plus	Ascochyta blight	Carbendazim + Mancozeb or metiram	Apply a maximum of two consecutive applications at 14-day intervals. Apply a minimum of 100L/ha water.
3rd critical period End of flowering when pods are filling (15–20 weeks after emergence).	Ascochyta blight and/or rust plus	Chocolate spot	Mancozeb or metiram	If Ascochyta or rust is present, rain is likely or new spots of chocolate spot or rust appear on unprotected leaves on the upper third of the plant, apply fungicide if the crop has sufficient yield potential.
	Chocolate spot plus	Ascochyta blight and/or rust	Carbendazim + Mancozeb or metiram	Observe all withholding periods.
	Chocolate spot	-	Carbendazim	

Source: PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

MORE INFORMATION

An app on crop disease symptoms of pulses is at https://itunes.apple.com/au/app/crop-disease-au/id946310779?mt=8

7.1.1 Ascochyta blight (*Ascochyta fabae*)

Description – Dark leaf spots which show through both sides, becoming grey with age.

Leaf spots are circular, becoming elongated; pale centres may fall out, leaving holes in leaf; tiny black-fruiting bodies develop within lesions.

Herbicide damage (particularly simazine) can be mistaken for Ascochyta blight but is usually confined to leaf margins and spots do not have grey centres with black specks.

Stems develop elongated, dark, sunken lesions; stems may split and break causing plants to lodge.

Pods develop black, sunken lesions, which can penetrate the pod and infect the developing seed. Badly infected seeds have brown or black stains.

First appears on leaves of seedlings when wet, cold conditions occur, usually well before flowering. Progresses to infect upper leaves, flowers, stems and pods.

Infection on mature pods leads to seed staining, especially when late rains occur pre-harvest. Disease can develop on pods of windrowed crops.

This disease is widespread in southern Australia.

Economic importance – Mostly in high-rainfall areas, more than 450 mm per year, but severity varies greatly crop to crop and season to season. Yield losses are not as severe as Ascochyta blight in faba bean.[2]

Management – Grow varieties with resistance; sow disease-free seed; use crop rotation; sow away from vetch and bean residues (including self-sown plants).

Apply fungicide during seedling stages 6–8 weeks after sowing. Spray before an average infection of one lesion per plant develops and rainfall is likely during the next week. A late fungicide application after flowering and no new growth is occurring assists in preventing seed staining.

Sowing into standing stubble helps raise the crop off the ground and improve airflow, making the crop environment less conducive to Ascochyta.

7.1.2 Chocolate spot and Botrytis grey mould (*Botrytis fabae* and *B. cinerea*)

Description – These are major diseases in all vetch growing areas. They infect plants at any stage but are worse after flowering; they defoliate plants, ruining forage quality and reducing pod set.

Botrytis is favoured by temperatures of 15°C to 25°C and high humidity (>70%) for 4–5 days. Very rapid build-up (aggressive stage) during warm, humid conditions late in the season. Worse in early-sown and dense crops, and heavy wet soils. Fluffy, grey fungal growth produces masses of spores on fallen leaves and petals under wet conditions.

Non-aggressive spots, initially pinhead-sized and circular, reddish-brown on leaves and flowers; spots on one side of leaf only, most obvious as 'chocolate spots' early in the season. Spores are wind-blown so disease tends to be in the upper canopy. Spots expand rapidly and combine under suitable conditions, blackening and killing large areas of leaf; infection can spread into stems.

Flowers turn brown and are killed, reducing pod set. Pods develop reddish-brown, pinhead-sized spots. Pods may split, allowing infection of seed, which may be covered in small reddish-brown spots.

Severe infection can result in complete crop failure.

2 Grain Legume Handbook (2008), GRDC, https://grdc.com.au/grainlegumehandbook

Economic importance – Occurs in all areas where vetch can grow. Losses range from minor to complete crop failure depending on the level of infection, time of infection occurrence and amount of spring rainfall. In unprotected crops, in a mild, wet spring disease commonly reduces yield by 30–50% through loss of leaves and collapse of stands.

Management – No varieties have good resistance. Fungus survives on stubble, volunteers and infected seed, so ensure good rotations and pre-seeding hygiene.

Manage the canopy by delaying sowing; using crop rotation and sowing away from bean and vetch residues. Control volunteer vetch plants. Check the crop every seven days when temperatures are below 15°C.

Check every three days when 15–20°C and humidity is over 70%.

Fungicide application may be futile if disease has developed unchecked and the crop is bulky and lodged, preventing fungicide penetration into the canopy.

Less than 350 mm/year

- graze crop to reduce canopy size if required, or
- apply a protective fungicide only if disease risk is high in a seed production crop and humidity in the crop is likely to be high for at least a week, especially if signs of infection are present.

More than 450 mm/year

- graze crop to reduce canopy size if required, or
- apply a protective fungicide if disease is present or risk is high in a grain production crop and humidity in the crop is likely to be high for at least a week.
- Repeat (10–21 days in severe cases) before rain, as determined by unprotected growth, rain since last application and expected rain. Last spray when flowering has ceased and no new growth is expected.

Photo 1: *Dense, wet canopies, particularly in warm conditions, are conducive to the development of Botrytis, especially in the understorey where fungicides cannot penetrate.*

Photo: Wayne Hawthorne, formerly Pulse Australia

7.1.3 Rust (*Uromyces viciae-fabae*)

Description – Rust is the most important disease of vetch in Australia. It is most prevalent in long-season districts and in warmer areas, such as northern NSW. It occasionally causes significant crop losses in southern areas in warm to hot (20–30°C), humid conditions.

Severe infection causes premature defoliation, resulting in reduced seed size.

Initial infection appears as creamy-coloured spore masses on leaves; replaced by orange-brown pustules surrounded by a light yellow halo; severely infected leaves wither and drop off.

Rust pustules on stems are similar but often larger than on leaves, and become darker as plants mature. Isolated rust pustules may develop on the pods.

Rust can occur earlier in the season than in other pulses but generally occurs during warm, humid conditions through grain filling. Can develop very quickly under favourable conditions. Above 20°C, rust generations are every 10 days.

Economic importance – This disease has caused losses of up to 30% on its own and in combination with chocolate spot can reduce yields by up to 50%.

Management – Sow a resistant variety. Sow away from vetch and bean residues and self-sown plants remaining after sowing.

Where broad-spectrum fungicides are used as treatments for other diseases, separate rust control is unlikely to be needed unless the product used does not control rust (such as carbendazim).

Graze the canopy to reduce crop bulk and its susceptibility to rust. Grazing rust-infected plants has caused abortion in pregnant stock.

Photo 2: *Rust is the most serious disease of vetch in Australia and growing varieties with resistance is an important management strategy. Symptoms can occur early in the season as creamy-coloured spore masses on leaves which are replaced by orange-brown pustules surrounded by a light yellow halo as the disease progresses; severely infected leaves wither and drop off.*

Photo: R Matic

7.1.4 Root rots (*Fusarium, Phoma, Rhizoctonia and Pythium* spp.)

Description – Plants are stunted and often die in patches. Leaves yellow and wilt before dying. Crown and stem bases are brown to black.

Roots are blackened and the root system is severely reduced. Lateral roots are short with tips rotted and, if infected with *Rhizoctonia*, these are often pointed.

Management – Control any green plant growth for at least several weeks prior to sowing; Rhizoctonia builds up on green plants. It is also more common in sandy infertile soils and in crops sown using minimal disturbance (such as disc seeders).

Shattering the soil below seed level at seeding will reduce Rhizoctonia.

Ensure adequate nitrogen and zinc nutrition.

Avoid situations where there is wet, cold weather with poor soil structure and free surface water. Also close rotations of vetch, faba bean or other pulses, especially field pea and chickpea, can increase the severity of Rhizoctonia.

7.1.5 Sclerotinia stem rot (*Sclerotinia sclerotiorum* and *S. trifoliorum*)

Sclerotinia has a very wide host range for species, including most broadleaf crops and weeds. Sclerotinia can build up in paddocks and the sclerotes can survive up to 10 years in soil, so will be a problem for other crops like canola, grown in the rotation.

Description – Affects isolated plants at any stage of growth. Plants wilt and collapse.

Infects stems, leaves or pods; young plants develop a slimy-wet rot at ground level.

Plants have a blackened base covered with fluffy, white fungal growth and are easily pulled from the soil.

Sclerotes (2–5 mm in diameter) form on the surface and in the centre of stems. Sclerotes are white at first, then turn black and hard.

Occurs where there is a high frequency of pulses and oilseeds in the crop sequence, high seeding rates or cool, wet conditions.

Management – Once established in a crop it is difficult to control. Lower seeding rates, wider row spacing and good weed control produce a more open crop that is less prone to disease.

Rotation with cereals will decrease soil inoculum levels.

Photo 3: *Sclerotinia occurs where there is a high frequency of pulses and oilseeds in the crop sequence, high seeding rates, or cool, wet conditions. Rotations including cereals decrease inoculum levels and are an important part of an integrated disease management strategy, as in-crop control is difficult.*

Photo: T Bretag

7.1.6 Stem nematode (*Ditylenchus dipsaci*)

Stem nematode is not a recognised problem in vetch. Vetch is a host but is relatively tolerant compared to pea, oats and canola.

Description – Patches of malformed and stunted plants. Leaves curled with water-soaked spots. Stems sometimes die back, turning reddish-brown from the base and stopping at a leaf.

Herbicide damage can produce similar symptoms.

Only occurs in parts of South Australia and Victoria and is worse in wet conditions. It has not been recorded in Western Australia.[3]

Management – Sow nematode-free seed. Use Predicta® B DNA-based testing service to assess soil status before sowing. Do not introduce through infected straw. Avoid rotations of susceptible crops, such as oats, wild oats, pea, vetch, and some broadleaf weeds (such as bedstraw) that can increase nematode populations.

MORE INFORMATION

Predicta® B
http://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b

7.1.7 Viruses

Virus diseases are not regarded as significant in vetch. Some viruses are seed-borne, but most rely on living plant tissue to survive between seasons (green bridge). It is possible for vetch to be a host for viruses and to infect other crops, yet show no symptoms.

Bean yellow mosaic virus (BYMV), Clover yellow vein virus (CYVV), Pea seed-borne mosaic virus (PSbMV), Broad bean wilt virus (BBWV) are non-persistent, which means aphids lose their infectivity soon after feeding on healthy plants. So, aphids usually only spread them over short distances.

Bean leafroll virus (BLRV), Subterranean clover red leaf virus (SCRLV), Beet western yellows virus (BWYV), Subterranean clover stunt virus (SCSV) (yellowing or luteoviruses) are persistent, with the aphids remaining infected for life. These viruses can be spread by aphids over long distances. The relatively long feeding

3 Stem Nematode (2013) Fact sheet, Plant health Australia, http://www.planthealthaustralia.com.au/wp-content/uploads/2013/01/Stem-nematode-FS.pdf

time needed for the aphid to transmit the virus makes them responsive to control by insecticides.

Virus symptoms can include yellowing, leaf mottling or mosaics, stunting and tip distortion. Symptoms can easily be mistaken for herbicide damage, nutrient deficiencies, salinity effects or other abiotic factors. It is difficult to diagnose a virus just on field symptoms.

Growers are advised to seek expert advice. Crop patches or rings which increase over time often indicate the presence of a virus.

IN FOCUS

Presence of aphids may indicate symptoms are caused by a virus.

1. Seed-borne viruses can be controlled by sowing virus-free seed (less than 0.1% seed infection in high-risk areas, less than 0.5% seed infection in low risk areas). Infection can come from infected neighbouring crops.
2. Minimise aphid landing sites. Avoid bare soil as aphids land in crops where there is a clearly defined contrast in colour between bare soil and green foliage. Ensure good crop establishment, retain standing cereal stubble and produce a dense crop canopy.
3. Minimise herbicide stress, as stressed plants are more attractive to aphids.
4. Control in-crop weeds (potential sources of virus) and/or vectors early.

In-crop management – weeds

Key points

- **Use integrated approaches to pest, disease and weed management**
- **Controlling broadleaf weeds prior to emergence is vital as there are no in-crop options available**
- **Most grasses can be controlled with selective grass herbicides, unless resistance has developed**

8.1.1 Weed management in-crop

Vetches provide a valuable opportunity to use alternative weed control practices to those used in cereal and oilseed phases. The opportunity to use grass herbicides, alternative herbicides and herbicide groups, as well as making hay, a green or brown manure crop and crop-topping, assists in reducing the soil seedbank and controlling some weeds.

However, there are only limited herbicides registered for use in vetch for grass control and for broadleaf weeds post-sowing pre-emergent (PSPE) herbicide is the only option.

Herbicides that require incorporation by sowing (IBS) are only registered for use with knifepoint, press-wheel seeding systems. Residues from unregistered chemicals can be detected in forage, seed and, if these are fed to livestock, these can also be detected in products (milk, meat or offal).

Even registered herbicides can cause some crop damage (Section 8.4 Herbicide damage effects in vetch) and registrations vary between states. Vetch species can differ in their tolerance to the same herbicide application in different seasons or conditions

Most grass weeds can be controlled either pre or post-emergence. For example, diuron can be used IBS or PSPE and metribuzin PSPE. Take care to apply the herbicide at the right growth stage of both vetch and weed. Always consult the label.

Weeds such as bedstraw and biofora once limited the planting of vetch but can be controlled with products containing mixes of paraquat and diquat (e.g. Revolver®).

Flumetulam (Broadstrike®) is only registered for use on in Popany vetch, for control of weeds such as bedstraw.

Poor early crop competition can also result in ryegrass infested crops, but crop topping, harvesting as forage or green/brown manuring helps make vetch a more robust part of a rotation.

Crop-topping or desiccation may reduce vetch yield, depending on the crop stage at application, but reduces the seed set of weeds, allowing minimal or no movement of the weed population towards herbicide resistance (Section 11.3.2).

Always check and abide by herbicide product labels consult the Australian Pesticides and Veterinary Medicines Authority website (https://portal.apvma.gov.au/pubcris).

Photo 1: *Unregistered herbicides are being used by farmers to successfully control grass weeds in vetch crops but these can have a negative impact on vetch production depending on the season, environment and wetter used. Further research is required on these products, so registered herbicide options remain limited and registrations vary between states.*

Photo: Emma Leonard, AgriKnowHow

MORE INFORMATION

CropLife Austrlaia, Herbicide Resistance Management Strategies – https://www.croplife.org.au/resistance-strategy/2017-herbicide-resistance-management-strategies/

GRDC Cropping with herbicide resistance Fact Sheet – https://grdc.com.au/resources-and-publications/all-publications/factsheets/2012/05/herbicide-resistance

GRDC Integrated Weed Management Hub – https://grdc.com.au/resources-and-publications/iwmhub

GRDC Integrated Weed Management Hub – Common weeds of cropping – https://grdc.com.au/resources-and-publications/iwmhub/common-weeds-of-cropping

IN FOCUS

8.1.2 Effective weed control

- Prevent weed seedset to ensure a low weed seedbank.
- Control weeds as early as possible.
- Control when weeds and crops are at the correct growth stage.
- Apply post-emergent grass herbicides while canopies still allow adequate spray coverage of weeds.
- Do not spray when weeds or the crop are under stress.
- Check the 'rainfast' period prior to rain.
- Do not spray in windy conditions over 15 km/h.
- Use the right nozzle output and droplet size to ensure adequate coverage.
- Ensure the spray rig is properly cleansed of damaging residual chemicals.
- Check the withholding period for grazing and harvest.

8.1 Tolerance of vetch species to a range of herbicides

Although there is a range of grass herbicides that are able to be applied to vetch, only flumetsulam is registered for post emergent application for broadleaf weeds and only in Popany.

The vetch groups vary in their tolerance to various herbicides, with the purple vetch variety, Popany often being most tolerant and of late enough maturity to be able to recover from any herbicide effects (Table 1).

Table 1: Tolerance of vetch species to herbicides used at different growth stages.

	Herbicides						
Vetch species	**Timing**	**Before sowing**	**Incorporated by sowing (IBS) or post-sowing pre-emergence (PSPE)**	**Post-sowing pre-emergence (PSPE)**		**Post-emergence**	
	Herbicide	Trifluralin	Diuron	Metribuzin	Cyanazine SA only	Grass herbicide e.g. fluazifop	Flumetsulam
	Herbicide Group	Group D	Group C			Group A	Group B
Common	High	High	High	High	High	High	Not registered
Woolly pod	High	High	Not registered	High	High	High	Not registered
Purple	High	High	Not registered	High	High	High	High

Source: PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

8.2 Herbicide mode of action

The main reason for the development of herbicide resistance is because of the repeated and often uninterrupted use of herbicides with the same mode of action.

Selection of resistant weed strains can occur in as little as 3–4 years if no attention is paid to resistance management.

All herbicides sold in Australia are grouped by mode of action. The mode of action is indicated by a letter code on the product label. The mode of action labelling is based on the resistance risk of each group of herbicides.

Groupings of herbicides have changed over the years to improve the accuracy and completeness of the modes of action. Ultimately, this enables informed decisions to be made about herbicide rotation and resistance management.

All herbicide labels now carry the mode of action group clearly displayed. This enables users to better understand the mode of action grouping and resistance risk by reference to the mode of action chart.

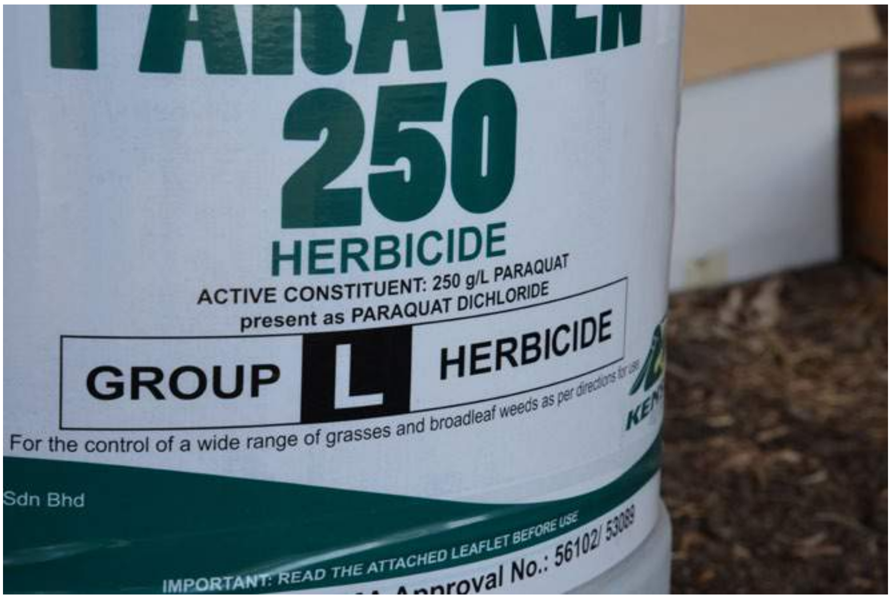


Photo 2: *All herbicides sold in Australia are grouped by mode of action. The mode of action is indicated by a letter code on the product label. The mode of action labelling is based on the resistance risk of each group of herbicides.*

Photo: Emma Leonard, AgriKnowHow

MORE INFORMATION

Herbicide modes of action, Croplife: http://www.croplife.org.au/industry-stewardship/resistance-management

8.3 Avoiding herbicide damage

Most IBS and PSPE herbicides can cause damage in vetch. In most cases this is due to:

- product solubility and sowing too shallow
- accumulation of herbicide into furrows from press-wheels
- run-off from non-wetting inter-rows
- an uneven soil surface.

Damage can be worst in lighter-textured soils (especially sands) and soils with low organic matter. Herbicide applied to dry soil followed by heavy rainfall can wash into the root zone, causing serious damage to the emerging crop.

Herbicide crop injury symptoms can be confused with symptoms produced by other causes, such as from frost, disease, nutrient deficiencies or toxicities (See Section 10, Table 1). Checking affected crops for missed strips and for differences in damage due to changes in soil type can help identify the cause of the damage. Symptoms of crop damage from herbicides do not always mean there will be a lower yield.

To reduce the risks of herbicide damage when using soil-active products PSPE:

- Sow at 5 cm or deeper – vetch can readily emerge from at least this depth, especially in lighter soils.
- Apply the herbicide to a level soil surface (such as after prickle chaining, rolling).
- Ensure rolling after press wheels levels the ridges (see Section 4.8).
- Avoid applying herbicide post-sowing to dry soils before heavy rainfall.
- Choose the right rate for your soil type (lower rates for lighter soils).
- Split the application between IBS and PSPE.

A collaborative project in the GRDC Crop Sequencing Initiative used three herbicides: clethodim (not registered for use in vetch), haloxyfop and glyphosate for grass removal or spray-topping in Morava⁽ᵇ⁾ vetch. Trials assessed the herbicides' impact on biomass production and nitrogen fixation.

In a trial at Boree Creek, NSW, glyphosate was the only chemical to suppress both dry matter and nitrogen fixation, slashing peak biomass production from 6.1 t/ha for the untreated control to 3 t/ha when glyphosate was used to crop-top in August.[1]

8.4 Herbicide damage effects in vetch

The following damage symptoms may arise from herbicide application, misapplication/drift or residual herbicide in the soil. Chemicals should only be applied in accordance to the label.[2]

8.4.1 Group A

Description

Grey or brown spots on leaves which do not necessarily show through both sides. Herbicide (e.g. Group A) applied at high temperature with oils or surfactants added. Leaf burning from trace element foliar applications. Damage is increased by frost or high temperatures soon after spraying.

Management

Be alert to label restrictions for temperature, frost, water rates, droplet size, additives and adjuvants.

1 GRDC (2012), GroundCover Supplement 98, GRDC, https://grdc.com.au/resources-and-publications/groundcover/ground-cover-issue-98-may-june-2012

2 PIRSA (2010) Vetch the Ute Guide, GRDC – https://grdc.com.au/vetch-the-ute-guide

8.4.2 Group B

Description

Visual symptoms appear 5–8 days after spray application or where there are residues in the soil. Seedlings may emerge and grow for several weeks before plants become stunted with shortened internodes. New foliage is yellow to red to purplish, progressing throughout the plant. Leaf curl may be apparent. Growth of lateral roots may be reduced.

Management

Follow plant-back periods as indicated on label. Group B herbicide can result in more crop damage when applied where Group B residues exist.

Cold, wet conditions, conditions that stress and prevent plants from recovering, zinc deficiency and compacted soil (such as wheel tracks) can be contributing factors. Grass herbicides can strip Group B residues from the spray boom and tank – ensure correct decontamination procedure.

8.4.3 Group C

Description

Visual symptoms appear as weeds emerge (where soil-applied) or 4–6 days after spray application to emerged weeds. Rapid yellowing and necrosis beginning at the edge of leaves leads to their desiccation and burnt appearance. Interveinal chlorosis or veinal chlorosis can occur. Tolerant plants (crops) usually recover.

Management

Follow plant-back periods as indicated on the label where soils are alkaline and calcareous, leachable with low organic matter, or of lighter texture. Duplex soils with shallow sand over heavy clay also present a risk of damage. Damage is most likely from herbicide leaching into seed furrows after heavy rainfall in ridged soils, where there is water harvesting off non-wetting inter-rows and in shallow-sown crops.

8.4.4 Group D

Description

Visual symptoms appear as the crop emerges with intermittent emergence along drill rows as a result of shortening and thickening of the hypocotyl.

Seeds germinate, but shoots are unable to emerge.

Emerging leaves in affected plants may be twisted and distorted.

Roots can be shortened and thickened.

Management

Avoid sowing seed into the layer of herbicide-treated soil. This results from the seeder set-up causing variable depth of sowing, or sowing too fast, throwing herbicide-treated soil on to adjacent furrows.

Symptoms are often worse where wet, cold conditions slow germination and emergence.

8.4.5 Group F

Description

White/yellow spots/bands may develop within 3–4 days after application (2 days in bright, sunny weather). Plants turn light green and whole leaves turn yellow to cream colour for 4–6 weeks.

Effects may disappear as new growth develops with no long-term effects.

Management

Effects are worse in lighter soils and when applied to crops suffering stress such as frost, cold, wet conditions or high temperatures soon after spraying.

8.4.6 Group G

Description

Numerous white spots on the leaves from the droplets of herbicide contact within 1–2 days of application.

May lead to desiccation and death in vetch although grasses and cereals generally recover.

Management

Ensure that herbicide drift does not occur on vetch crops, especially where fine droplets are targeted for the use of products as indicated by the label.

8.4.7 Group J

Description

Visual symptoms appear underground or as the crop emerges, with reduced or poor seedling emergence.

Shoots, if emerged, are often swollen and bright green.

Roots are often pruned, leaving stubby root knobs.

Management

Ensure seed is not sown into the band of herbicide in the soil. Effects are worse when wet, cold conditions slow germination and emergence.

8.4.8 Group K

Description

Visual symptoms appear as the crop emerges, with reduced or poor seedling emergence.

Seedlings are malformed and twisted, with transitory crop yellowing. In most cases weeds do not appear.

Management

Ensure seed is not sown into the band of herbicide in the soil.

Effects are more severe in light-textured soils with low organic matter, in waterlogged conditions, where crops are stressed from lack of moisture or lack of nutrients, and when frost occurs within 10 days of application.

8.4.9 Group L

Description

Visual symptoms appear within hours of application, with spots of dead tissue on otherwise healthy leaves. There may also be wilting and interveinal yellowing followed by browning and blackening of the leaf edges.

Plants shrivel up within 4 days of application if damage is severe.

Signs are often worse on one side of the plant or stem.

Effects disappear as new growth develops.

Management

Ensure that herbicide drift does not occur on to vetch crops.

8.4.10 Group M

Description

Symptoms are most obvious at growing points within 5–7 days of application.

Plants are stunted (growth stopped until recovery or death) with leaves turning yellow to red, followed by browning.

There may be some twisting of plants.

Plants look flaccid and tend to lie on the soil surface.

Management

Ensure that herbicide drift does not occur onto vetch crops.

In-crop management – nutrition

Key points

- In-crop nutrient requirements are generally minimal unless nodulation fails
- Rhizobia nodules need to be pink to be effective
- Use leaf tissue testing, especially for micronutrients if deficiency is suspected

MORE INFORMATION

A paper on 'Maximising the fixed nitrogen benefits of pulses' was delivered by SARDI's Ross Ballard and the University of Adelaide's Maarten Ryder at the southern region GRDC Updates held in February 2017, https://grdc.com.au/resources-and-publications/grdc-update-papers

An app with crop nutrient deficiency photos is at http://www.ipni.net/ndapp

GRDC Micronutrients Fact Sheet http://www.grdc.com.au/GRDC-FS-CropNutrition-Micronutrients

A GroundCover™ TV episode on legume nodulation sampling is at https://grdc.com.au/Media-Centre/GroundCover-TV/2015/09/Episode-17-September-2015/bfnBsEM64t0

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

GRDC Nitrogen fixation Fact Sheet https://grdc.com.au/GRDC-FS-NFixation-Legumes

9.1 Nutrition

In-crop applications of macro nutrients are rarely required in vetch. The main reason for nitrogen application would be if nodulation failure occurred.

In relation to micronutrients, manganese may be required for vetch on highly alkaline soils or under fluffy soil conditions. Foliar applications of iron may be needed for vetch grown on highly alkaline and wet soils. Vetch may respond to molybdenum in acidic soils that are deficient.

Use leaf tissue testing to assess nutrient requirements, especially for micronutrients, preferably before deficiency symptoms appear (see Table 1 and Figure 1).

9.1.1 Nodulation failure

If plants have failed to form sufficient active nodules, insufficient nitrogen will be fixed by the crop. If soil-available nitrogen is low the crop may be nitrogen-deficient.

Description

Plants become yellow or pale green with restricted growth, especially during cold, wet periods through the seedling stages. Oldest leaves are the worst affected. There are few or no nodules on the roots or nodules lack red pigmentation inside.

Plants can appear normal until flowering on soils with moderate to high nitrogen levels when they become pale green. Older leaves are affected most and first.

Management

As a salvage operation, apply nitrogen (N) to the affected crop with N fertiliser, if economic.

Ensure future crops are adequately inoculated with viable Group E or F inoculum.

When assessing the effectiveness of nodulation, the more nodules and the earlier the infection (i.e. on the tap and crown roots) the better. Nodules need to be pink to be effective.

Photo 1: *Vetch roots showing an adequate level of nodulation for good nitrogen fixation. Vetch can fix between 50 and 150 kg N/ha depending on end use. No differences in nitrogen fixation have been recorded between vetch varieties. Nitrogen fixation is directly correlated to biomass production.*

Photo: Emma Leonard, AgriKnowHow

Table 1: A guide to nutrient deficiency symptoms.

Symptom	Old to middle leaves						Middle to new leaves					New leaves to terminal shoots					
Deficiency	N	P	S	K	Mg	Zn	N	Mg	Mn	Zn	B	Mn	Fe	Zn	Cu	Ca	B
Chlorosis																	
Complete	x		x									x#	x				x#
Mottled	x	x	x		x					x	x						
Interveinal					x						x						
On margins			x		x												
Necrosis																	
Complete		x				x											
Distinct areas (including spotting)				x		x		x	x		x	x		x			
Margins													x			x	
Tips				x		x			x			x		x	x		
Pigmentation within necrotic or chlorotic areas																	
Purple	x	x	x	x		x		x	x	x		x				x	
Dark green		x									x						
Brown		x	x						x		x	x	x	x			
Red					x						x			x			
Malformation of leaflets																	
Rolling in of margin				x				x					x			x	x
Wilting		x													x		
Twisting									x			x			x		x
Malformation of leaves																	
Cupping	x						x								x		
Umbrella formation								x			x						
Malformation of stems and roots																	
Internode shortening											x			x			x
Petiole collapse																x	
Root distortion											x		x			x	x

Source: PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide
Original source – Symptoms of Nutrient Disorders – Faba Bean & Field Pea, Snowball and Robson (1991), University of Western Australia. # = mild

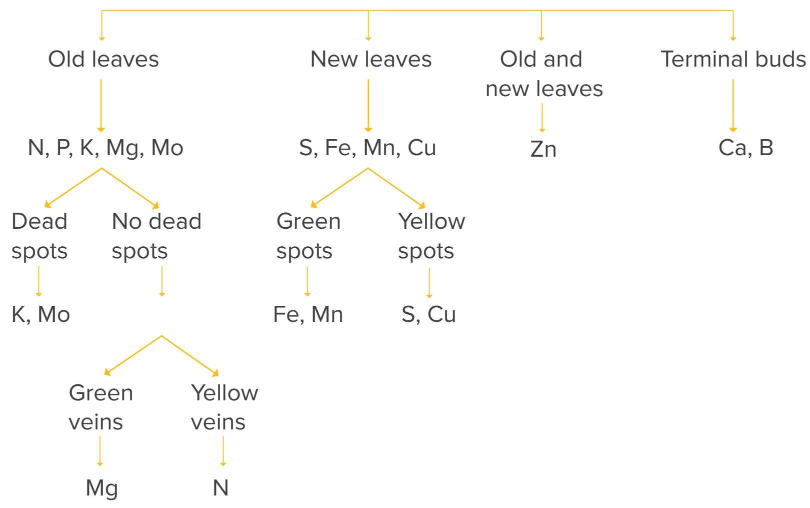


Figure 1: *Considerations when diagnosing nutrient disorders.*

Source: Reddy and Reddi (1997) 'Mineral nutrition, manures and fertilizers'. In "Principles and Agronomy". pp.204-256. Kalyani Publishers, Ludhiana, India.

In-crop management – environmental impacts

Key points

- **Heat waves and moisture stress can adversely affect vetch.**
- **Vetch seedlings are tolerant of frost but plants are most vulnerable to frost during reproductive phases of flowering, pod-set and grain-fill.**
- **Vetch is most sensitive to waterlogging at flowering. Avoid growing vetch on poorly drained soils and areas prone to waterlogging.**
- **Other factors that can impact the growing crop are lack of sunlight and soil erosion.**

10.1 Moisture stress

Vetch is considered a moderately drought-tolerant crop. Vetch is sensitive to waterlogging.

10.1.1 Drought

Moisture stress in vetch influences biomass production and plant height. Hence, it can affect forage and grain yield as well as harvestability when the crop height is too short (to harvest or bale).

Vetch varieties can respond differently to moisture stress depending on their general tolerance (to moisture stress), specifically at flowering.

Timing of moisture stress relative to growth stage is important:

- Seeding/germination: lack of rain can lead to poor establishment and growth.
- Vegetative growth can also be affected by intermittent moisture stress and result in short crops.
- Flower-set can be reduced by drought and warm conditions in spring.
- Pod-set can be aborted, this is usually noted on the last-formed pods in the upper parts of the plant.
- Grain-fill can be reduced, with fewer and smaller grains.

Management to minimise moisture stress

- Control summer weeds.
- Remediate soil compaction and avoid sowing where subsoil constraints (e.g. salt, boron) will impede root growth.
- In low and medium-rainfall areas consider wider row spacing and sow into retained stubble to minimise moisture loss from soil before canopy closure.
- Sow early in early-maturing areas.
- Sow early-maturing varieties.
- Consider cutting grain crops for silage or hay.

10.1.2 Waterlogging

Vetch plants can appear to survive waterlogging and then die as the soil dries. Vetches are susceptible to waterlogging, especially at germination. Common vetch is more susceptible than the other vetch species.

Waterlogging 6 days after germination of vetch can delay the emergence by up to 5 days and reduce the final plant density by 80%. Waterlogging depresses vegetative growth of plants but affects root growth more than shoot growth.

Plants can show symptoms of iron or nitrogen deficiency. They may also show signs of salinity, with the oldest leaf tips dying back from the tip.

Roots are shallow and blackened with root rots. Nodulation can be reduced by extended waterlogging

Vetch, like pulse crops, is most sensitive to waterlogging at flowering. The response of vetch to waterlogging is similar to its response to low light and low temperatures; all result in flower and pod abortion and leaf senescence (drying off).[1]

Management of waterlogging

- Avoid poorly drained soils and areas prone to waterlogging.
- Sow early to improve emergence and adequate growth before water lays, except in high-rainfall areas where sowing shod be delayed.
- Consider using raised beds for vetch grown for grain.

1 Pulse Australia (2016) Southern Lentil: Best Management Practices Training Course. Pulse Australia

- Monitor regularly for pests and disease as plants are more susceptible to root and foliar disease, and may be more affected by aphids when subjected to waterlogging.

10.2 Temperature

Vetch is like cool-season pulses in its susceptibility to extremes of hot or cold conditions, especially at flowering. Heat waves (temperatures >35°C) and water deficiency (moisture stress) can severely affect vetch.

Plants are most vulnerable to frost during reproductive phases of flowering, pod-set and grain-fill.

10.2.1 Heat

Canopy development in vetch is quite rapid, especially during early sown and warmer winter conditions. At any location, seasonal variations in temperature can bring about a significant shift in flowering times for the same time of sowing (i.e. up to 10 days is possible).

On hot days, the leaves of the vetch plant fold and the stomata close in order to reduce evapotranspiration. Plants can look wilted and appear more blue-grey in colour. A common mechanism to cope with high temperatures is to increase pod and leaf drop.

When heat stress occurs during flowering and pod-filling, significant reductions can occur in grain and forage yield, seed quality and subsequent profitability to the grower.

Management to minimise heat stress

- Apply management to minimise moisture stress and root growth.
- Sow early in early-maturing areas.
- Sow early-maturing varieties.
- Consider cutting grain crops for silage or hay.

10.3 Frost

Grain yield losses from frost damage can be severe for a sensitive crop like vetch.

Frost damage during flowering and pod-fill occurs when the plant is at a vulnerable stage of growth at the time of the frost. Timing is critical,[2] and the level of damage depends on severity and duration of the frost, crop sensitivity, variety maturity and sowing time. Any subsequent frosts can lead to further damage.

Compared to pulses like faba bean, vetch plants flower later and can escape some early frosts.

Frost in pre-flowering stages does not leave vetch more vulnerable to the foliar disease bacterial blight.

During flowering or podding frost can cause significant yield and grain loss due to flower drop and aborted pods. It will normally affect the flowers and smallest pods first; despite the fact they are the higher pods on the plant. Pods at a later stage of development are generally more resistant to frost than flowers and small pods. However, pods may suffer some mottled darkening of the seed coat.

Milder frosts can blacken developing seeds but not all seeds in a pod may be affected. Frosted pods are puffy and the outer layer of skin lifts producing a mottled appearance.

2 F Stoddard, C Balko, W Erskine, H Khan, W Link, A Sarker (2006) Screening techniques and sources of resistance to abiotic stresses in cool-season food legumes. Euphytica 147:167–186, http://www.google.com.au/

Severe frosts can also deform stems and cause lodging but vetch has some inherent ability to recover from frost damage by being able to regenerate new branches in severe cases. New regrowth occurs from the base of the frost-affected plants if moisture conditions are favorable.

In severe frosts, leaves are killed and the stem is wilted. If the plant is in the vegetative growth sage between node 1 to 5, there can be quick recovery from underground axillary buds. If the plants are at the 7th node stage or beyond, plants will most likely die because axillary bud initiation will most likely not occur as the plant is moving into reproductive stages.

Importantly, unlike chickpea, low temperatures (<2°C) are not known to cause pollen sterility in vetch.

Frost tolerance for vetch at flowering is the same as for lentil, i.e. –2°C to –3°C.

10.3.1 Managing frost

Frost frequency and intensity is unpredictable. Management of frost risk can only be based on the likelihood of a frost occurring, without knowing exactly when, or if, it will happen.

Vetch is a bulky and usually a lodged crop during flowering and pod-fill. This lodged, dense canopy can provide some limited protection to frost, compared with a more upright crop, when frosts do occur.

Sowing too late (to avoid frost during flowering) can lead to shorter crops, poor grain yield, harvest difficulties and poor quality if the season finishes quickly. There is a trade-off between sowing early to maximise forage and grain yield potential, and exposing the crop to a greater risk of frost at flowering.

Although it is difficult to totally minimise frost risk it is important to:

- know the period of highest probability of frost incidence;
- map the topography to show areas of greatest risk and specifically manage these areas to minimise frost damage;
- aim to reduce exposure to frost or impact at vulnerable growth stages;
- choose the appropriate variety and time of sowing;
- choose sowing dates and variety maturity to reduce frost risk;
- wider rows may increase frost risk;
- if frost occurs at flowering consider cutting grain crops for silage or hay.
- manage the pulse canopy: row spacing, retained cereal stubble and small changes in temperature around the critical trigger point can assist in avoiding frost damage;
- consider planting in rows up and down a slope to increase air-flow and cool air drainage;
- understand the impact of soil type, condition and moisture status; and
- manage crop nutrition and minimise crop stress level to lessen frost damage.[3]

10.4 Hail and physical damage

Vetch is sensitive to hail damage. Stems, leaves and pods are damaged in hail. Recovery is dependent on further growth and freedom from foliar disease.

During the vegetative stage hail can shred leaves, bruise stems and slow crop development. Stem breakage and bruising is often on one side. Later hail can remove flowers and pods or flatten crops. Hail can cause a swathe of damage through the crop.

3 W Hawthorne (2007) Managing Pulses to Minimise Frost Damage. Australian Pulse Bulletin PA 2007 #01, http://www.pulseaus.com.au/storage/app/media/crops/2007_APB-Pulses-frost.pdf

MORE INFORMATION

A video on extreme temperature analysis to better understand frost events. https://www.youtube.com/watch?v=Zw637FiX5PU

GroundCover™ TV: Frost R&D. https://www.youtube.com/watch?v=og9wPzjchjA P511

Frost's emotional impact: is it greater than its economic impact? https://www.youtube.com/watch?v=GC2P2Tha5Es P511

Physical damage from excessive traffic, wind erosion, frost, hail, post-emergent rolling or herbicide damage can increase the spread of foliar disease in vetch, just as it does in pulses.

Offset risk in prone areas by sowing a range of varieties with different maturities. Consider cutting grain crops for silage or hay if severely damaged by hail.

10.5 Chemical leaf spotting

Some spray oils used with post-emergent selective grass herbicides can cause minor leaf spotting and/or burning, which should not be confused with disease symptoms.

Advice from an experienced agronomist should always be sought for specific details on soil and foliar-active chemcals and the risk of crop damage in any particular situation.

10.6 Lack of sunlight

Lack of sunlight can be a major factor in determining the level of pod-set in some pulses in southern Australia. A Mediterranean climate with winter rainfall dominance and a dense canopy can lead to poor pod-set through lack of sunlight. Total radiation, rainfall, evaporation, temperature, humidity and wind strength are all contributing factors to the level of pod-set.

In vetch, as faba bean, the amount of radiation hitting the flower from when it opens and for the following 3 days is the overwhelming contributing factor to level of pod-set.[4]

4 F Stoddard (1993) Limits to retention of fertilized flowers in faba beans (Vicia faba L.). Journal of Agronomy and Crop Science 171 (4): 251-259, http://onlinelibrary.wiley.com/doi/10.1111/j.1439-037X.1993.tb00137.x/abstract

Late season management

Key points

- Late season management is determined by end use
- Conservation as high-quality forage requires attention to detail – especially cutting and curing
- Timing of termination for manure crops relates to whether the objective is weed control or maximising biomass
- Correct timing of grain harvest is important to minimise grain damage through extra handling or grain loss due to pod shatter

IN FOCUS

Linking vetch management to end use is especially crucial in late season management. Usually vetch for forage will be cut first, followed by manure crops and finally vetch that is to be kept for seed. Timing of harvest will influence the forage quality and the amount of nitrogen fixed and the type of weeds that set seed.

Late season management varies depending on end use, with timing of harvest or vetch termination being the crucial factor to maximise each outcome.

11.1 Forage

Vetch can be conserved as silage or hay, with silage cut and baled earlier as it can be conserved at higher moisture content than hay. Forage production is always a balancing act between maximising quality and dry matter, as well as minimising weather damage.

11.1.1 Timing of cutting

To maximise forage quality (crude protein, metabolisable energy and digestibility) vetch silage and hay should be cut in the late flowering to small pod stage. Dry matter yield increases with later cutting but quality decreases as the vetch grain fills (see Table 1).

If cutting hay as a means of controlling weeds, it is important to cut before weed seedset. Cutting earlier, for silage, is generally more effective for controlling weed seedset, provided there is follow-up herbicide to prevent seedset from post-cutting weed regrowth.

Unlike cereals, foliage and feed value of vetch is relatively unaffected by frost, so frosted vetch does not have to be cut for forage immediately to preserve forage quality. Frost can affect seed in the pods, which is a concern if growing for grain.[1]

Table 1: Change in forage quality, digestibility and dry matter (DM) production at three cutting dates from trials of oat–legume hay at Wagga Wagga, NSW. Values are adjusted for an average legume content of 30% in all oat–legume mixtures and 90% legume in legume monocultures.

Forage	Cut 2 Oct.		Cut 23 Oct.		Cut 6 Nov.	
	Dry matter t/ha	Digestibility %	Dry matter t/ha	Digestibility %	Dry matter t/ha	Digestibility %
Oats/Purple vetch	8.45	71	15.17	64	11.00	54
Oats/Common vetch	6.96	72	13.27	61	13.37	56
Oats/field pea	9.48	74	14.68	66	12.71	59

Source: Yield and digestibility of legume and oat forages (2005), Prime Facts 52, NSW DPI, http://pandora.nla.gov.au/pan/53289/20051213-0000/primefact_52-final.pdf

1 P McIntosh, P Bowden (2015) Using Pulses for forage, Pulse Australia http://www.pulseaus.com.au/growing-pulses/publications/using-pulses-forage

Photo 1: *Cutting time is a balance between maximising quality and dry matter production. If cutting hay to control weeds it is important to cut before weed seedset.*

Photo: Emma Leonard, AgriKnowHow

MORE INFORMATION

For details on Australian feed test laboratories see https://www.dairyaustralia.com.au/farm/feedbase-and-animal-nutrition/feed-management/feed-lab-testing

11.1.2 Vetch forage quality

Vetch hay and silage are an excellent, reliable and cost-effective protein source, especially for milk production. Vetch hay contains 12–20 g/kg crude protein and 8–11 MJ dry matter digestible energy.[2]

Vetch forage quality should be measured using an accredited feed testing service. Generally, vetch hay and silage quality and price are similar to clover or lucerne hay.

Conditioning helps dry pods and stems faster to minimise weather damage and loss of leaf during baling or ensiling. All these factors help maintain forage quality.

11.1.3 Forage-making equipment

Silage and hay-making require specialised equipment – a mower, usually with in-built conditioners, rake, baler and handling equipment.

A rule of thumb for cereal hay is that if less than 200 ha (4–5 t/ha crop) of hay is to be made, then using contractors is the most cost-effective, but owning equipment can give peace of mind.

One mower and one baler are required for about every 350–400 ha of hay, while a rake can generally service 1000 ha. If a spread of variety maturities is grown, less machinery might be possible.[3]

Vetch can be cut with a rotary or flail slasher and with knife or disc cutters, however in heavy stands of pure vetch these can become clogged with vine and generally their performance is inferior to a rotary or flail slasher.

The stems of vetch dry a little slower than leaves. Quality reduces if leaf is lost during baling, which can occur if the stems take too long to dry. Conditioning squashes and cracks the stems, allowing water to be released which helps accelerate drying.

If drying down is difficult it may be preferable to ensile (haylage) but there is a risk of self-combustion if material is baled at too high moisture.

2 PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

3 Producing Quality Oat Hay (2016), Aexco, http://aexco.com.au/producing-quality-oat-hay/

11.1.4 When to bale

Hay should be baled at 15–16% moisture. Suitable storage temperature depends on bale size and conformation (See Table 1).

Moisture content cannot be judged from a single sample of drying hay. The following is a guide to the moisture content of the hay crop as it is drying:[4]

- 30–40%: leaves begin to rustle. They do not give up moisture unless rubbed hard. Moisture easily shows in stems scratched with a fingernail or, not so easily, when twisted in the hands.
- 25–30%: the hay rustles. A bundle twisted in the hands will snap with difficulty; it will show no surplus moisture. Thick stems may show moisture if scraped or split open with a fingernail.
- 20–25%: the hay rustles readily. A bundle will snap easily if twisted; leaves may shatter and there are few moist stems.
- 15–20%: the hay factures easily. Bundles snap easily when twisted. It is difficult to see any moisture and the leaves shatter readily.

The ultimate test is to make a few bales and test with a moisture meter.

It is too wet to bale if: the crop wraps on moving parts of the baler; the baler engine labours unduly; the bales are too heavy; the hay bale lacks spring; there is a smear of moisture on the side of the bale.

High-moisture bales can result in the growth of mould, reducing quality, palatability and possibly introducing toxins. They can also self-combust.

Hay baled at too low a moisture content shatters; the hay is dusty; there are too many leaf fragments; and the bales are too loose and light, even after tightening the bale chamber.

Finally, if the crop is too dry, for example 12–14% moisture content, it may be necessary to wait for the evening dew to bring the crop back up to 18–20% moisture content.[5]

Photo 2: *Vetch and vetch oat mixes can retain a green colour but be sufficiently dry to bale. Use the scrunch test to estimate moisture content and use a moisture meter to test bale moisture content. Baling material too wet will result in degradation and can lead to self-combustion.*

Photo: Emma Leonard, AgriKnowHow

4 P McIntosh, P Bowden (2015), Using Pulses for forage, Pulse Australia, http://www.pulseaus.com.au/growing-pulses/publications/using-pulses-forage

5 P McIntosh, P Bowden (2015), Using Pulses for forage, Pulse Australia, http://www.pulseaus.com.au/growing-pulses/publications/using-pulses-forage

Table 2: Recommended moisture content for safe storage of various types of hay bales.

Bale type	Moisture content range (%)
Small rectangular bales	16–18
Round bales – soft centre	14–16
Round bales – hard centre	13–15
Large square bales	12–14
Export bales	Less than 12

Source: Producing Quality Oat Hay (2016), Aexco (http://aexco.com.au/producing-quality-oat-hay)

11.1.5 Weather damaged forage

Rain on cut forage can reduce quality prior to baling through:

- loss of colour – discolouration can indicate factors that affect the value of the hay or silage to end-users;
- stock feed value – palatability, digestibility and energy value can all be reduced by weather damage; and
- mould – the growth of mould in warm, moist conditions can adversely affect appearance and colour, palatability and feed value, and the feed may become toxic to stock.

Silage quality can be severely affected if ensiled at high moisture, especially if air is not properly exhaled from the stack or bale.

Time of cutting, windrowing, tedding, conditioning, chopping and promptness of baling or ensiling at the correct moisture can help avoid adverse weather damage.

11.2 Manure

A green crop of vetch can be worked into the soil with cultivation equipment to boost organic matter content. More commonly, the vetch crop is brown manured by desiccating, using a knockdown herbicide to kill both the vetch and weeds, and allowed to decompose over the fallow period before being incorporated into the soil at sowing.

11.2.1 Time of termination

Timing of termination of a manure crop is determined by the objective of the manure crop.

- Weed control – timing is determined by the growth stage of the weed, not the vetch, and must be before weed seed-set. This contrasts with crop-topping, where the timing is determined by the vetch to ensure grain has set (see Section 11.3.1).
- Organic matter and nitrogen fixation – herbicide application will be later when the plants have reached peak biomass, at late flowering to early podding. The amount of nitrogen fixed is directly linked to dry matter (DM) production – approximately 25 kg of nitrogen per tonne of DM.[6]
- Conserve soil moisture for the following crop – usually a later termination than for weed control but still earlier than harvest and timing will also be determined by in-crop rainfall.

Trials in the Mallee identified that in seasons with low spring and summer rainfall, early termination of vetch (3 months after sowing) can result in more nitrogen fixation. With more spring rain, greater biomass and nitrogen fixation will occur so later

MORE INFORMATION

A *GroundCover*™ article on brown manure is at https://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-116-May-June-2015/Brown-manure-legumes-lower-total-crop-risk

VIDEO

Video YouTube – Brown Manure Vetch Termination – https://www.youtube.com/watch?v=TboLg-H3_I8

6 Inoculating Legumes: a practical guide (2012), GRDC, https://grdc.com.au/GRDC-Booklet-InoculatingLegumes

termination would be better. Earlier termination may also be relevant in paddocks with subsoil constraints which reduce vetch's ability to access deep soil moisture.[7]

There is a relationship between time of sowing and peak biomass production and this varies with species and variety. Sowing past the end of May reduced biomass production (Figure 1 and Figure 2).

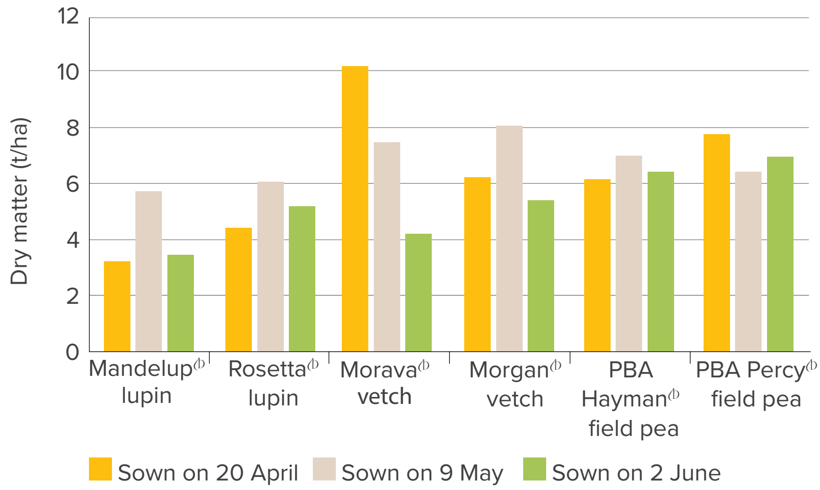


Figure 1: *Biomass production at the 'flat pod' stage of lupin, vetch and field pea over three sowing dates at Wagga Wagga in 2012.*

Source: Manuring of pulse crops (2013) Fact Sheet, GRDC, https://grdc.com.au/resources-and-publications/all-publications/factsheets/2013/09/manuring-of-pulse-crops

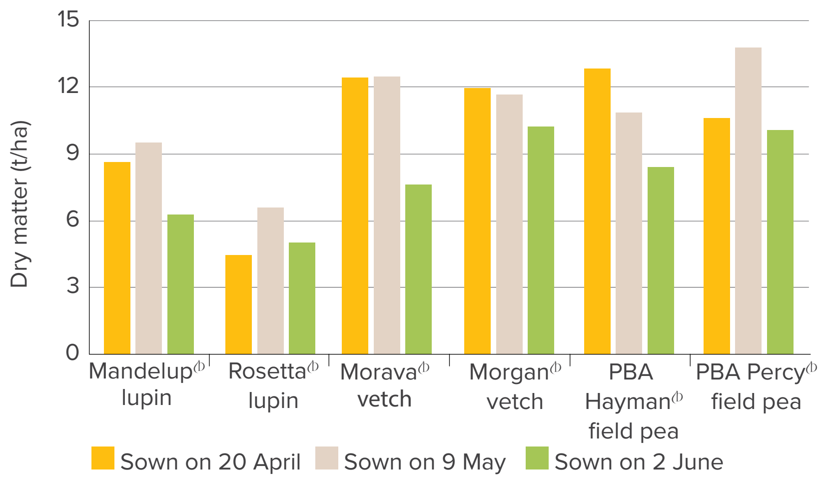


Figure 2: *Biomass production at maturity of lupin, vetch and field pea over three sowing dates at Wagga Wagga in 2012.*

Source: Manuring of pulse crops (2013) Fact Sheet, GRDC, https://grdc.com.au/resources-and-publications/all-publications/factsheets/2013/09/manuring-of-pulse-crops

7 D Ferrier, H van Rees, L Watson, M Peoples (2013), Vetch termination influence on the following crop, BGC Season Research Results, www.farmtrials.com.au/view_attachment.php?trial_attachment_id=6267

Table 3: Vetch end-use termination treatment effect on pre- and post-harvest soil nitrogen and water (0–120 cm).

2012 vetch termination treatment	2013 pre-sowing nitrogen (kg N/ha)	2013 pre-sowing soil water (mm)
Cultivated	66_{b}	57
Brown manure	85_{a}	70
Grazed x 2	78_{ab}	67
Grain harvest	71_{ab}	54
Hay	44_{c}	51
Sig. diff	**0.004**	**NS**
LSD (P=0.05)	**17**	
CV%	**15**	**32**

If the subscript letters between treatments are the same, treatments are not statistically different to one another. Where there are no significant differences between treatments, NS (not significant) is displayed. Different subscript letters between treatments denote significant differences. For example, 'Cultivated' is different to 'Brown manure' but not 'Grazed x2'.
Source: D Ferrier, H van Rees, L Watson, M Peoples (2013), Vetch termination influence on the following crop, BGC Season Research Results, www.farmtrials.com.au/view_attachment.php?trial_attachment_id=6267

Photo 3: *Two vetch crops conserved as manure. Brown manure terminated with chemical (left) and green manure terminated with cultivation (right). Brown manure leaves more nitrogen and ground cover to protect fragile soils.*

Photo: (left) T Bray, (right) Wayne Hawthorne, both formerly Pulse Australia

11.2.2 Chemicals for brown manuring

A double-knock is used to achieve maximum efficacy of weed and crop kill in a brown manure. (Please see http://www.farmtrials.com.au/trial/16612)

This includes early glyphosate application at full label rate and possibly additional herbicides, to improve efficacy. Note herbicides reported in the trial are not all registered or applied at label rate. This is followed about two weeks later with paraquat application at full label rate to control any surviving weeds. Efficacy achieved is determined by the timing of the initial 'knock'. Always follow label rates and instructions when applying chemicals.[8 9]

11.3 Grain and seed

Although vetch is not produced for human food markets, its feed and seed markets still demand a quality sample without cracking, staining, de-hulled seeds or insect damage. Early harvest is critical to achieve a quality product.

8 PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

9 Manuring of pulse crops (2013) Fact Sheet GRDC https://grdc.com.au/~/media/Documents/Resources/Publications/Fact-sheets/FINAL-low-res-GRDC-Fact-Sheet-Manuring-Pulse-Crops-pdf.pdf

11.3.1 Harvest timing

Vetch grain should be harvested as soon as the crop is mature. This is when upper pods turn brown and the stems are brittle enough to feed through the harvester. Moisture content of the grain should be less than 13% at harvest to meet receival standards for storage (see Section 11.7, Table 5 and Table 4 (below)). If too dry, cracking may occur – with downgraded quality as a consequence.

Cool, damp harvesting conditions should be avoided but harvesting early or later in the day when there is some humidity helps reduce pod shatter and seed loss. Vetch grain that is just ripe for harvest can be harvested under warmer conditions than vetch that has been left mature for some time.[10] In southern Australia, vetch crops can reach maturity 180 to 250 days after sowing, depending on the sowing date, variety, and a range of environmental factors including rainfall and temperature.

Vetch is ready to harvest for grain when more than 90% of the pods lose their green colour. Stems may still show some 'green-ness'. Windrowing, or desiccation, of vetch crops for grain harvest can commence when the majority of seeds are physiologically mature. This is assessed as being when at least 50% of the seeds in the pods present in the top third of the canopy are displaying some colour change (yellow-buff) and the remaining seeds are firm to touch and a deep green colour. As an indicator this will coincide with 60% of the pods in the top third of the canopy appearing yellow-buff. At this stage, at least 85% of the pods should be yellow to ripe, and the top pods should have turned from a dark green colour to a lighter green to yellow colour.

Cotyledons of the top-most pods change from a green colour to yellow or red, depending on the vetch type. There is still yellow to green leaf present. Lowest pods start to turn light brown and have seeds with completely normal cotyledon colour for the variety. For early harvest or if summer weeds would otherwise prevent timely harvest, vetch crops can be desiccated or windrowed. Early harvest or windrowing can help reduce seed staining from late rains and reduce pod shatter and seed loss (see Windrowing).

10 Vetch the Ute Guide (2010) PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

Table 4: Vetch grain minimum receival standards for farm-dressed seed.

Parameter	Requirements	Comments/Variations
Physical characteristics	Vetch should be whole, sound, dry, fresh and colour typical of the variety of the season.	
Purity	97% min by weight	Includes whole vetch, defective vetch, skins and de-coated vetch.
Moisture	14% max	-
Defective	5% max by weight	Vetch not of the specified variety. Vetch kernels that are broken, chipped, diseased, frost-damaged, insect-damaged, sappy, shrivelled, split, sprouted, weather-damaged, wrinkled. Includes pods that contain vetch, whether broken or unbroken and loose seed coat. Vetch where whole or part of the seed coat only is damaged is included as sound vetch.
Mould	1 grain max per 200 g	Mould (field and/or storage), caked, bin burnt and heat damaged.
Poor colour	1% max by weight	Vetch whose seed coat or kernels are distinctly off-colour from the characteristic colour of the predominating class.
Foreign material	3% max by weight, of which max 2% by weight cereal grain and 0.5% max by weight unmillable material	Includes unmillable material and all vegetable matter other than vetch seed material. Includes cereal grain.
Unmillable material	0.5% max by weight (of which 0.3% max by weight of soil)	Soil, stones and non-vegetable matter.
Snails	One (1) max	Dead or alive, whole or substantially whole (more than half) including bodies per 200 g sample.
Field insects	Fifteen (15) max	Dead or alive per 200 g sample.
Grasshoppers and locusts	Two (2) max	Dead or alive per 200 g sample.
Foreign seeds	–	–
Objectionable material	Nil tolerance	Includes objectionable odour.
Ryegrass ergot	Two (2) cm max	Pieces laid end to end per 200g sample.

Source: Australian Pulse Standards (2016), Pulse Australia, http://www.pulseaus.com.au/storage/app/media/markets/20160801_Pulse-Standards.pdf

MORE INFORMATION

GRDC Pre-harvest herbicide Fact Sheet http://www.grdc.com.au/GRDC-FS-PreHarvestHerbicide

Reducing Harvester Fire Risk: The Back Pocket Guide http://www.grdc.com.au/GRDC-BPG-ReducingHarvesterFireRisk

For details on the Grain Harvesting Code of Practice see http://www.cfs.sa.gov.au/site/prepare_for_a_fire/cfs_codes_of_practice_jsp

11.3.2 Desiccation, windrowing and crop-topping

While these three practices produce a similar end point – a dry crop to harvest – they have different additional outcomes.

- **Desiccation** – used to achieve early harvest, even crop ripening and to 'brown off' late weed growth to make harvest easier. Desiccation advances maturity up to 10 days.
- **Windrowing** – for uniform ripening and earlier grain harvest or directly in front of the harvester to reduce snail contamination.
- **Crop-topping** – to control seed-set in escaped weeds, often grass weeds, and to ripen vetch earlier. Timing is based on the weed growth stage, and so can impact on vetch grain yield and quality.

Desiccation

Spray with registered herbicides, such as paraquat (check product labels as not all are registered for this use in vetch), once grains have reached physiological maturity; grain moisture is about 30%, usually 20–30 days after the end of flowering. The lower 75% of pods are turning black and seeds are firm with thin and leathery shells.

Harvest 7–10 days after desiccation. Observe withholding period to avoid chemical residues in grain.

Windrowing

Windrowing pure vetch (versus mixures of vetch and cereal) is not commonly done and windrows need to be of sufficient bulk to prevent blowing around in strong winds. Cutting wide swathes, combining them in to a bulky windrow and rolling immediately using a 'cotton reel roller' to compact the windrow will reduce the risk of being blown around.

The advantages of windrowing for grain harvest are:

- Uniform maturity of the crop for harvest.
- Earlier harvest at higher grain moisture content.
- Early harvest to avoid seed staining from late rains.
- Easier harvest with fewer losses when lodged.
- Less pod splitting and shattering if rain.
- Lower cutter bar height, especially in short crops, enabling lowest pods to be harvested.
- Late-maturing weeds dried to enable earlier harvest.
- Less loss from pod shatter than weather-delayed harvest of standing crop if harvest delayed.
- Reduced snail contamination in the sample if windrowed late directly in front of the harvester.
- Destruction of weed seeds when windrows are (hot) burnt.

A disadvantage of windrowing is the transfer and concentration of nutrients, especially potassium, into windrows.

Crop-topping

Earlier-maturing varieties allow optimal timing of crop-topping to achieve good control of weed seed-set with minimal effect on grain yield.

Crop-top as late as possible (i.e. dough stage of the ryegrass), when 50% or more vetch seeds within the pods have changed from green to yellow.

Crop-topping too early, particularly in later maturing varieties, risks loss of vetch grain yield and increased numbers of seeds with poor quality (darkened seed coats or small, green, immature seeds (see Table 4).

Avoid using coloured foam markers when crop topping as these may stain vetch seed through the pods.

Weed wiping can be used with some success in vetch to prevent seed-set of ryegrass and other tall weeds that stand above the lodged crop. In some cases though, vetch crops might be too tall or bulky for the ryegrass for this to be a reliable option.

11.3.3 Harvester equipment and set-up

Vetch can be harvested with a conventional or rotary combine harvester. Harvesting problems are often associated with severe lodging, short crops with little growth and their pods close to the ground, or excessive harvesting speed. The use of either crop lifters or a flexible or Draper-type pick-up front is needed to harvest the grain crop from windrows.

Vetches thresh readily, so to minimise seed damage and losses during harvest it should not be heavily threshed. This can be achieved by using low drum speed and with adequate concave clearance (see Table 5). Use maximum wind and sieve settings for the grain size and try to use draft to remove trash. The rake at the back of the sieve may need to be turned off to stop weeds entering the returns.

Where summer weeds are present, desiccation would be useful, otherwise increase drum speed to prevent harvester blockages.

Excessive harvesting speeds should be avoided to minimise feed-in problems.

Axial or rotary harvest drums cause less seed damage and harvesting earlier in the day when conditions are less dry can help minimise damage.

11.3.4 Harvesting fire safety

Pulse dust is flammable and likely to cause fires. Be wary of slipping belts and collapsed bearings that could ignite the dust. To reduce fire risk, remove the build-up of dust and clean the engine daily. Drag an earthing chain to reduce static electricity on the header. Keep a fire-fighting unit nearby during harvest and carry an extinguisher on the harvester, just in case a fire does start.

There are several important things that reduce the risk of fires:

- Operate only when the conditions are favourable under the Grain Harvesting Code of Practice.
- Diligent, regular clean-down of residues, especially with legumes.
- Check under guards and covers for build-up of dust and chaff.
- Check bearings and moving parts for hot spots (use a hand-held digital thermometer).
- Check electrical system for worn cables (especially from rodent damage).
- Check fuel and hydraulic lines for leaks.
- Use a drag chain to avoid build-up of static electricity.
- Use the battery isolation switch when the header is not in use.
- Locate firefighting gear close by.
- Train all staff in using firefighting equipment.

Table 5: A guide to harvester set-up for various pulse crops including vetch.

	Lentil (red)	Lupin	Pea	Vetch
Reel speed	Slow	Slow	Medium	Slow
Spiral clearance	Low	High	Standard	Low
Thresher speed	400–600	400–600	400–600	400–600
Concave clearance	20–30 mm	10–30 mm	10–30 mm	10–30 mm
Fan speed	Medium	High	High	Medium
Top sieve	32 mm	32 mm	32 mm	32 mm
Bottom sieve	10 mm	16 mm	16 mm	10–16 mm
Rotor speed*	Slow	700–900	700–900	Slow

* Rotary machines only
Source: Grain Legume Handbook (2008), GRDC, https://grdc.com.au/grainlegumehandbook

11.3.5 Harvesting for seed

When harvesting for seed, either for market or to be home-saved, select an area of a paddock where there has been good nutrition and minimal disease, pest and weed infestation. This will help to ensure maximum germination and minimal weed and disease carryover. Ensure headers, bins, augers and other equipment are free of grain and weed contaminants. The middle of the crop is likely to be the best area for seed production as weed and insect problems are usually worst at the edges (see Section 12 Post-harvest management).

11.3.6 Weather-damaged grain

Photo 4: *Weather events prior to harvest can result in visual seed damage to the seed coat or kernel, including poor colour, loose seed coat, sprouting and wrinkling.*

Photo: Emma Leonard, AgriKnowHow

Weather-damaged seed generally shows visual damage symptoms to the seed coat or kernel due to some form of weather event prior to harvest. Weather damage may lead to poor colour, loose seed coat, sprouting, wrinkling or other defects.

Wrinkled seed – arises from stress during the maturation phase that causes damage to the seed coat. The seed coat will be significantly indented into the kernel as coarse rather than soft waves.

Loose seed coat – is caused by weather conditions such as rain near harvest or poor handling or harvesting techniques. It results in breakage or cracking of the seed coat that might be separated from the kernel or about to separate.

Shrivelled seed – arises from some form of stress during the maturation phase. Seed coats may be wrinkled, significantly indented into the kernel and tightly adhere to the kernel. Grains are often smaller than the majority of the sample.

Weather damage can be managed by:

- Desiccation or windrowing vetch and harvesting as early as possible for grain.
- Growing vetch as a forage crop and cutting as hay or silage to avoid weather damage at grain harvest.

11.3.7 Grain delivery

Unlike most pulse grains, there are few, if any, bulk-handling storage locations that handle Common vetch grain. Viterra (http://ezigrain.abb.com.au/receivalstandards/receivalstandards.asp) no longer even publish a segregation or receival standard for vetch and Graincorp (http://www.graincorp.com.au/Docs/GrainCorp%20Harvest%20Guide%202016-17_Online.pdf) only mention vetch as a weed contaminant of other grains.

This means that vetch grain must be stored on-farm, and cash buying or warehousing options are not available to growers wishing to sell vetch as grain. Sales of vetch grain must therefore be made privately to agents or direct to the end user.

Vetch grain sold as seed to other growers or agents can only occur if it is a variety not covered by Plant Breeder's Rights (PBR). If the vetch variety is covered by PBR, as most new varieties are now, then arrangements must be made direct with the commercial partner for that particular variety.

11.3.8 Hay delivery

With oaten hay there are quite a few agencies that purchase the hay for either export or domestic sales. These agencies are not as prevalent when wanting to sell pure vetch hay or oaten/vetch mixtures in hay. Hence sales must be made privately, usually direct to end users (e.g. dairy farmers). Quality, as established by a feed test, is critical in hay prices and sales (e.g. http://www.feedtest.com.au).

Key attributes of any hay usually include:

- Digestible Dry Matter (DDM) – the percentage of hay that an animal can digest. Higher DDM percentages are generally more desirable.
- Neutral Detergent Fibre (NDF) – the fibre measured by NDF is that which provides 'bulk' in the diet and as a result reduces an animal's intake. Low NDF is often more desirable (<57%).
- Acid Detergent Fibre (ADF) – the least digestible parts of hay. ADF is used to calculate energy values. Low ADF is generally more desirable (<32%).
- Protein – crude protein is an indicator of the protein that may be metabolised by animals. Oaten hay typically falls in the range of 6–7% protein. Vetch and legume hays have a considerably higher protein percentage (e.g. 12–20%).

Post-harvest management

Key points

- **Maintaining quality of vetch hay and grain starts with good harvest management**
- **Moist and/or contaminated hay or grain will deteriorate**
- **Minimising handling of grain helps reduce damage**

VIDEO

Storing pulses – https://youtu.be/CeWA-OdhhSk

12.1 Hay storage

Hay needs to be stored in dry, vermin-free conditions as moisture and vermin cause hay quality to deteriorate. There are multiple storage options and selecting the most suitable option will depend on a variety of factors (see Table 1), including costs (see Figure 1).[1]

Factors influencing the choice of hay storage include:

- timeframe of storage;
- available capital;
- frequency of loading in and out;
- distance to existing storage; and
- customer requirements.

Table 1: Hay storage option pros and cons – three stars is the best option, one star the worst.

Storage factor	Top hay tarp	Full hay tarp	Steel shed 3 sides	Steel shed open sides	Hay caps
Capital cost per tonne	***	**	*	*	**
Durability	*	*	***	***	**
Annualised cost per year	**	**	**	***	***
Top layer waterproof	*	**	***	***	**
Seepage from beneath	*	***	***	***	*
Side bleaching	*	***	***	**	*
Labour required at stacking	**	*	***	***	**
OH&S during stacking	*	*	***	***	***
Freight savings from paddock	***	***	*	*	***

Note: Hay caps are only currently available for large square bales
Source: Producing Quality Oat Hay (2016), Aexco, http://aexco.com.au/producing-quality-oat-hay

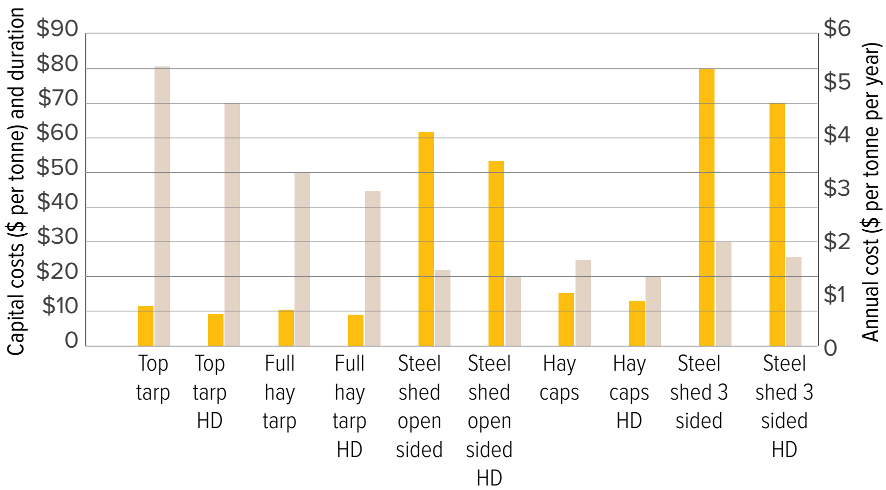
MORE INFORMATION

For details on stored grain, visit Stored Grain Information Hub – http://storedgrain.com.au/

VIDEO

Storing planting seed – https://grdc.com.au/Media-Centre/GroundCover-TV/2016/01/GCTV18/IaC96M27xoM

1 Producing Quality Oat Hay (2016), Aexco, http://aexco.com.au/producing-quality-oat-hay/



Capital costs per tonne	$10.77	$9.33	$9.96	$8.63	$61.54	$53.33	$15.38	$13.33	$80.00	$69.33
Duration years	2	2	3	3	40	40	10	10	10	10
Annual costs t/year	5.38	4.67	3.32	2.88	1.54	1.33	1.54	1.33	2.00	1.73

Figure 1: *Estimated hay storage costs for different storage options for large square bales compared to high-density square bales, which are the same size but approximately 10% heavier. Excludes labour and logistical inputs.*

Source: Producing Quality Oat Hay (2016), Aexco, http://aexco.com.au/producing-quality-oat-hay

12.2 Grain storage

Meticulous hygiene and aeration cooling are the first lines of defence against pest incursion. Extra costs and/or downgrading are imposed at delivery points if live insects are found in a load (see Section 11, Table 4).

Vetch grain should be stored at no more than 13% moisture, which is ideally achieved at harvest. At moisture level above 13%, aeration of stored grain will be required to prevent pockets of moist grain developing (see Figure 2). Green pods and grains increase the risk of mould developing during storage even at lower moisture content. Moisture pockets can result in moulds and grain damage as well hotspots for grain storage pests to bread (see Table 2).[2]

MORE INFORMATION

The Grain Storage GrowNotes™ is now available. Please see: https://grdc.com.au/grain-storage-grownotes

2 PIRSA/GRDC (2010) Vetch: the Ute Guide. PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

Photo 1: *Vetch for grain or seed should be stored at 13% moisture or less and treated like other stored pulse crops.*

Photo: Emma Leonard, AgriKnowHow

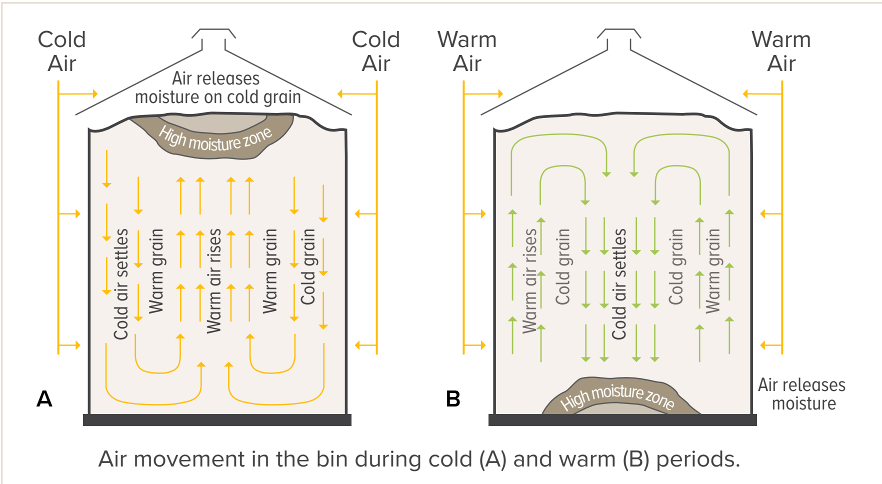


Figure 2: *Influence of ambient temperature and the location of high-moisture hotspots in grain storage silos.*

Source: Vetch: The Ute Guide (2010) PIRSA/GRDC – https://grdc.com.au/vetch-the-ute-guide

Table 2: The influence of temperature and moisture on stored grain insect and mould development.

Grain temperature (°C)	Insect and mould development	Grain moisture content (%)
40–55	Seed damage occurs, reducing viability	
30–40	Mould and insects are prolific	More than 18
25–30	Mould and insects are active	13–18
20–25	Mould development is limited	10–13
18–20	Young insects stop developing	9
Less than 15	Most insects stop reproducing, mould stops developing	Less than 8

Source: Grain Storage pest control guide (2013) GRDC, Kondinin Group

While the number of times grain is moved should be minimised to prevent damage, transferring grain between two silos in warm, windy weather can reduce moisture content by 1–2%.

Weatherproof sheds and silos are suitable storages. Bunkers need to be waterproof. Silo bags should only be considered as short-term, temporary storage as discolouration of grain can occur, moisture can be difficult to handle, odours arise and bags can be punctured by vermin, birds or pests.

Grain stores should be cleaned and any residual grain storage pests exterminated prior to filling with fresh grain.

For post-harvest storage, vetch should be treated like pulse crops. Chemical structural treatments before storing pulses is not recommended. This is because pulses are not specified on the labels of chemicals used for structural treatments and maximum residue level in pulses for those products are either extremely low or nil.

The use of diatomaceous earth (DE) as a structural treatment is possible but wash and dry the storage and equipment before using for pulses. This will ensure the DE does not discolour the grain surface (see the GRDC's Storing pulses, http://storedgrain.com.au/storing-pulses)

Fumigation is the only option available to control pests in stored pulses, and this should only be done in a gas-tight, sealable storage.

The ideal grain storage plan is to:

- dry and cool vetch grain;
- store grain in the dark; and
- sell vetch as quickly as possible.

The GRDC Stored Grain Hub (http://storedgrain.com.au) provides a valuable reference library of the latest information on grain storage.

12.2.1 Grain handling and cleaning

Belt shifters are recommended as vetch can be damaged by augers. Minimise handling grain to limit physical damage. Run augers full and at a slower speed than for cereals. Avoid dropping the vetch from great height on to hard surfaces.

Poor handling can lead to cracked, skinned, broken and discoloured grain which affects classification and market appeal. While visual appeal is an issue for human consumption markets, into which vetch is not sold, such defects can also reduce germination and consequently viable seed percentage.

Poor grain colour (seed or kernel) can be caused by premature ripening due to heat, drought or disease stress, harvesting immature seed ('green kernel'), delayed harvest, rain at harvest, disease, frosting or a dry, hot finish. Prolonged wet weather pre-harvest may lead to poor colour, loose seed coat or wrinkled grain, which is more prone to damage during harvest and handling.

Such defects can be minimised by:

- Controlling disease, especially Ascochyta blight, chocolate spot and rust.
- Managing the crop to lessen effects of frost or a dry finish.
- Crop-topping or desiccating at the right time.
- Harvesting as soon as the crop is ready, before rain and before grain moisture is too low.
- Carefully harvesting and handling grain to minimise grain damage.
- Storing in dry, sealed storage conditions.

Marketing

The final step in generating farm income is converting the tonnes produced into dollars at the farmgate. This section provides best-in-class marketing guidelines for managing price variability to protect income and cashflow.

Only Common (grain vetch) – *Vicia sativa* ssp. *sativa* – can be sold as stockfeed. Its inclusion in pig diets is limited to 25%.

13.1 Price determinants for feed grains in southern markets

Stockfeed markets are the biggest consumers of grain domestically in Australia. While South Australian markets are mainly export-oriented, strong livestock industries in Victoria draw grain into the domestic market. Domestic stockfeed grain consumption in southern Australia is equivalent to approximately 40% of the total winter crop produced in SA and Victoria.

The domestic market in Victoria traditionally draws grain in from NSW to support domestic stockfeed markets as well as bulk and container export programs. Southern Australia accounts for approximately 35% of national stockfeed use.

The biggest stockfeed market in southern Australia is the dairy industry, representing 40% of all stockfeed demand in these markets, with about 90% of this demand taking place in Victoria.

While the largest consumer of feed grains in Victoria is the dairy industry, in SA the number one position is held by the poultry industry, at 50% of South Australia's feed grain demand (compared to 25% in Victoria). Poultry accounts for about 30% of feed demand across southern Australia.

The poultry industry (for eggs and chicken meat) has seen continued growth, with strong growth expected to continue, especially in SA, driven by the availability of land, of feed grains and a more favourable regulatory environment. Similar factors are also driving growth in the production of pig meat in SA. The pig industry is the third-largest consumer of feed grains across southern Australia, representing 13% of demand, however it is the second-largest consumer in SA at nearly 25%.

The other major source of demand for stockfeed in southern markets is Tasmania, with grain being exported from Victoria to Tasmania to supply the dairy and aquaculture industries.

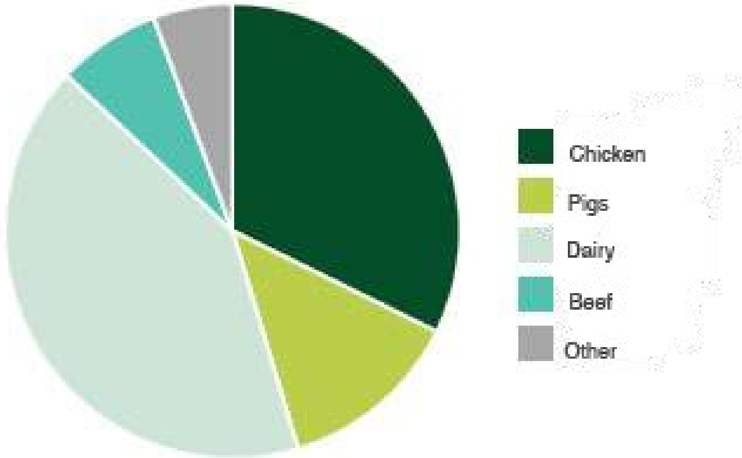


Figure 1: *Sources of demand for stockfeed in southern Australia.*

The key drivers of prices for feed grains in southern markets include:

- Rate of exports and remaining supply of feed grains for domestic markets.
- Commodity prices in the consuming industry (i.e. meat prices).
- Trends in the dairy industry (i.e. milk price).
- Consumption trends in domestic livestock markets.
- Livestock health.
- Seasonality/supply of pasture and fodder versus grains.
- Imports of alternate feed sources (i.e. soybean meal).
- Prices of competing feed grains.

Demand for grain from stockfeed markets tends to be steady throughout the year. However, knowing there is strong competition from the export market, some buyers will seek to secure requirements shortly after harvest, when the supply of grain is more certain.

13.1.1 Executing tonnes into cash

When it comes to accessing domestic stockfeed markets, there are several ways this can be approached.

1. Sale to a feed miller or manufacturer.
2. Sale direct to farm or end user.
3. Sale to a trader or merchant who on-sells the grain to the stockfeed market.

Each organisation will differ in terms of how they manage grain purchases, the professionalism of the enterprise, and management around grain requirements and grain purchases, documentation and record-keeping.

Hence it is particularly prudent when making sales into these markets to be vigilant in maintaining records of contracts, even when they are executed by phone. It is strongly advised that the seller keeps a written record of the particulars of the contract including price, quantity, quality, delivery and payment terms to protect themselves in the event of a dispute with the other party as to the details of the sale agreement.

It is even better practice to send a contract confirmation to the buyer in the event they don't provide one to you, or even if they do. Grain Trade Australia provides standard form contract documents that can be completed by either party and returned to the buyer by email as confirmation of the verbal contract. This way, any misunderstandings that might have taken place on the phone can be quickly identified and rectified immediately, while the conversation is still fresh in both your minds rather than waiting until delivery to identify a problem.

13.1.2 How to sell for cash

Like any market transaction, a cash grain transaction occurs when a bid by the buyer is matched by an offer from the seller. Cash contracts are made up of the following components, with each component requiring a level of risk management:

Price

- Future price is largely unpredictable, hence devising a selling plan to put current prices into the context of the farm business is critical to manage price risk.

Quantity and Quality

- When entering a cash contract, you are committing to delivery of the nominated amount of grain at the quality specified. Hence production and quality risk must be managed.

Delivery terms

- Timing of title transfer from the grower to the buyer is agreed at time of contracting. If this requires delivery direct to end users, it relies on prudent execution management to ensure delivery within the contracted period.

Payment terms

- In Australia, the traditional method of contracting requires title of grain to be transferred ahead of payment; hence counterparty risk must be managed.

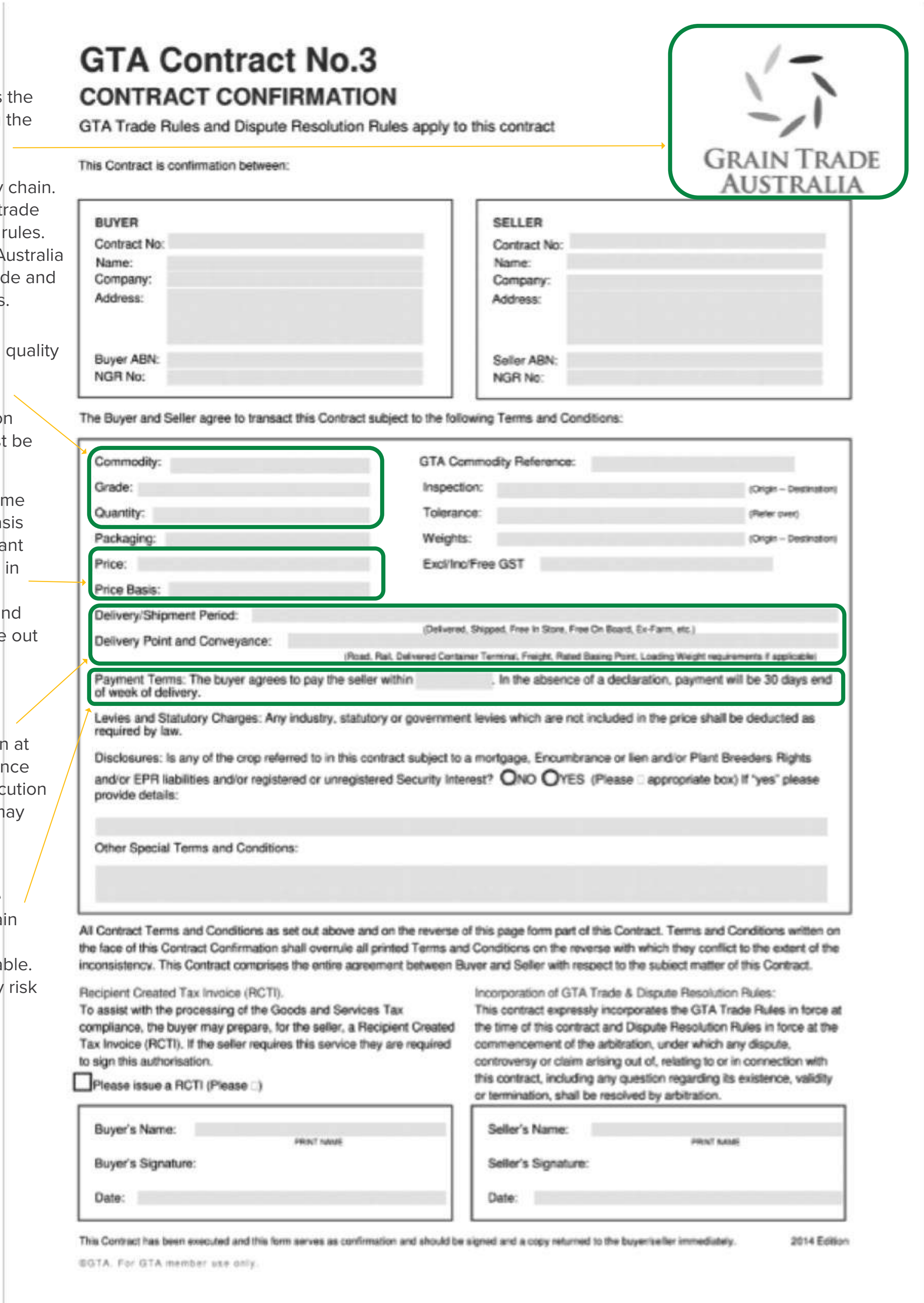
Grain Trade Australia is the industry body ensuring the efficient facilitation of commercial activities across the grain supply chain. This includes contract trade and dispute resolution rules. All wheat contracts in Australia should refer to GTA trade and dispute resolution rules.

Quantity (tonnage) and quality (bin grade) determine the actuals of your commitment. Production and execution risk must be managed.

Price is negotiable at time of contracting. Price basis or price point is important as it determines where in the supply chain the transaction will occur and so what costs will come out of the price before the growers net return.

Timing of delivery (title transfer) is agreed upon at time of contracting. Hence growers negotiate execution and storage risk they may have to manage.

Whilst the majority of transactions are on the premise that title of grain is transferred ahead of payment this is negotiable. Managing counterparty risk is critical.



GTA Contract No.3
CONTRACT CONFIRMATION
GTA Trade Rules and Dispute Resolution Rules apply to this contract

GRAIN TRADE AUSTRALIA

This Contract is confirmation between:

BUYER
Contract No:
Name:
Company:
Address:
Buyer ABN:
NGR No:

SELLER
Contract No:
Name:
Company:
Address:
Seller ABN:
NGR No:

The Buyer and Seller agree to transact this Contract subject to the following Terms and Conditions:

Commodity: GTA Commodity Reference:
Grade: Inspection: (Origin – Destination)
Quantity: Tolerance: (Refer over)
Packaging: Weights: (Origin – Destination)
Price: Excl/Inc/Free GST
Price Basis:
Delivery/Shipment Period:
(Delivered, Shipped, Free In Store, Free On Board, Ex-Farm, etc.)
Delivery Point and Conveyance:
(Road, Rail, Delivered Container Terminal, Freight, Rated Basing Point, Loading Weight requirements if applicable)
Payment Terms: The buyer agrees to pay the seller within . In the absence of a declaration, payment will be 30 days end of week of delivery.
Levies and Statutory Charges: Any industry, statutory or government levies which are not included in the price shall be deducted as required by law.
Disclosures: Is any of the crop referred to in this contract subject to a mortgage, Encumbrance or lien and/or Plant Breeders Rights and/or EPR liabilities and/or registered or unregistered Security Interest? NO YES (Please appropriate box) If "yes" please provide details:
Other Special Terms and Conditions:

All Contract Terms and Conditions as set out above and on the reverse of this page form part of this Contract. Terms and Conditions written on the face of this Contract Confirmation shall overrule all printed Terms and Conditions on the reverse with which they conflict to the extent of the inconsistency. This Contract comprises the entire agreement between Buyer and Seller with respect to the subject matter of this Contract.

Recipient Created Tax Invoice (RCTI).
To assist with the processing of the Goods and Services Tax compliance, the buyer may prepare, for the seller, a Recipient Created Tax Invoice (RCTI). If the seller requires this service they are required to sign this authorisation.
Please issue a RCTI (Please)

Incorporation of GTA Trade & Dispute Resolution Rules:
This contract expressly incorporates the GTA Trade Rules in force at the time of this contract and Dispute Resolution Rules in force at the commencement of the arbitration, under which any dispute, controversy or claim arising out of, relating to or in connection with this contract, including any question regarding its existence, validity or termination, shall be resolved by arbitration.

Buyer's Name: PRINT NAME
Buyer's Signature:
Date:

Seller's Name: PRINT NAME
Seller's Signature:
Date:

This Contract has been executed and this form serves as confirmation and should be signed and a copy returned to the buyer/seller immediately. 2014 Edition
©GTA. For GTA member use only.

Figure 2: *Typical cash contracting as per Grain Trade Australia standards.*

13.1.3 Counterparty risk

Most sales involve transferring title of grain prior to being paid. The risk of a counterparty defaulting when selling grain is very real and must be managed. Conducting business in a commercial and professional manner minimises this risk.

There is not much point selling for an extra $5/t if you don't get paid.

Counterparty risk management includes:

1. Dealing only with known and trusted counterparties.
2. Conduct a credit check (banks will do this) before dealing with a buyer they are unsure of.
3. Only sell a small amount of grain to unknown counterparties.
4. Consider credit insurance or a letter of credit from the buyer.
5. Never deliver a second load of grain if payment has not been received for the first.
6. If possible, do not part with title of grain before payment or request a cash deposit of part of the value ahead of delivery. Payment terms are negotiable at time of contracting.

Above all, act commercially to ensure the time invested in a selling strategy is not wasted by poor counterparty risk management. Achieving $5/t more and not getting paid is a disastrous outcome.

13.1.4 Read market signals

The appetite of buyers to buy a particular commodity will differ over time depending on market circumstances. Ideally growers should aim to sell their commodity when buyer appetite is strong and stand aside from the market when buyers are not very interested in buying the commodity.

Principle: 'Sell when there is buyer appetite' – when buyers are chasing grain, growers have more market power to demand a price when selling.

Buyer appetite can be monitored by:

i. The number of buyers at or near the best bid in a public bid line-up. If there are many buyers, it could indicate buyer appetite is strong. However, if there is one buyer $5/t above the next-best bid, it may mean cash prices are susceptible to falling $5/t if that buyer satisfies their buying appetite.
ii. Monitoring actual trades against public indicative bids. When trades are occurring above indicative public bids it may indicate strong appetite from merchants and the ability for growers to offer their grain at price premiums to public bids.

13.1.5 Know the specifications of your grain

Feed 'grades' of grain as defined by bulk handler receival standards can have very broad quality specifications. For the lowest grades there is often no minimum tolerances on screenings or protein, hence no two parcels are the same.

However, the important factor for the stockfeed market is not what 'grade' the grain is but its energy and protein components, which ultimately determine conversion into meat or other animal products. Hence, having your grain tested and knowing your specifications helps the buyer to know exactly what the value of the grain will be in their production system.

Without this information the buyer may base their pricing on the 'minimum' specification or likely worst-case scenario to protect themselves in the event they receive grain of the lowest quality allowable in the grade specifications. However, knowing why your grain was downgraded and the specifications of the load, the buyer may be able to pay premiums for the exact quality you are offering, above the minimum specification.

13.2 Ensuring access to markets for southern Australian feed grains

Planning where to store the commodity is important in ensuring access to the market that is likely to yield the highest return.

In South Australia the predominant animal industries of pigs and poultry are highly intensive and tend to be geographically concentrated. Hence proximity to these markets can be an important determinant of market access. Some growers may not have access to these markets at all, due to large distances between production and demand making the cost of transport prohibitive.

In Victoria the dominant dairy market is concentrated in Gippsland, the Western District and the Goulburn Valley. Again, proximity to these markets must be considered as part of any marketing plan to access demand from the stockfeed industry.

The market for feed grains into Tasmania is often serviced by feed manufacturers and traders who export the grain by truck and ferry from the Port of Melbourne.

13.2.1 Storage and logistics

Return on investment from grain-handling and storage expenses is optimised when storage is considered in light of market access to maximise returns as well as harvest logistics.

Storage alternatives include variations around the bulk handling system, private off-farm storage and on-farm storage. **Delivery and quality management** are key considerations in deciding where to store your commodity.

Commodities destined for the domestic end-user market (such as feedlot, processor, or container packer) may be more suited to on-farm or private storage to increase delivery flexibility.

Storing commodities on-farm requires **prudent quality management** to ensure delivery at agreed specifications. The business can be exposed to high risk if this aspect is not well-planned. Penalties for out-of-specification grain on arrival at a buyer's weighbridge can be expensive. The buyer has no obligation to accept delivery of an out-of-specification load. This means the grower may have to incur the cost of taking the load elsewhere while also potentially finding a new buyer. Hence there is potential for a distressed sale which can be costly.

On-farm storage also requires **prudent delivery management** to ensure commodities are received by the buyer on time with appropriate weighbridge and sampling tickets.

Principle: 'Storage is all about market access' – storage decisions depend on quality management and expected markets.

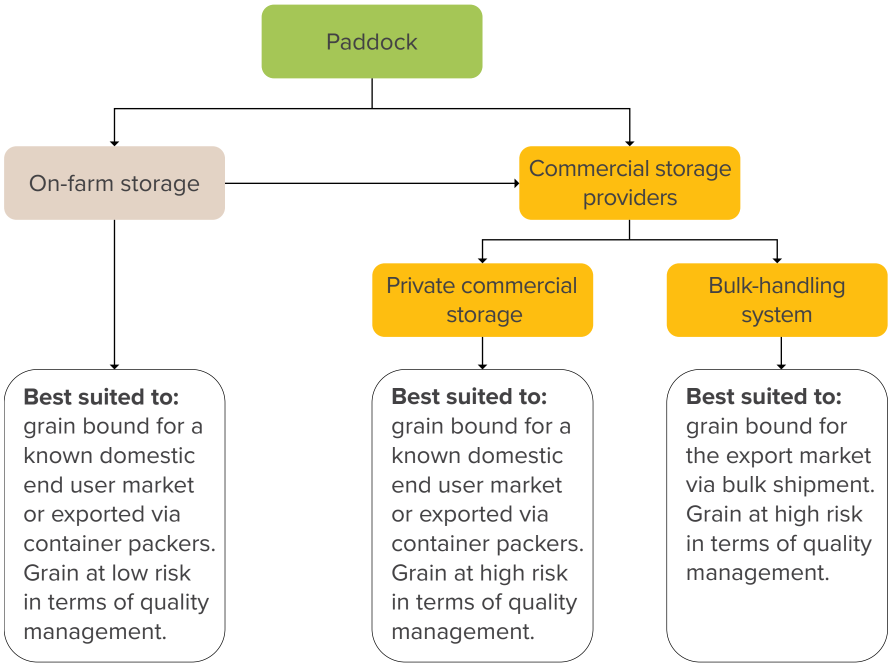


Figure 3: *Grain storage decision-making.*

Note: Decisions around storage alternatives of harvested commodities depend on market access and quality management requirements.

13.2.2 Separate the delivery decision from the pricing decision

Organised stockfeed buyers with a clear outlook as to what their grain requirements will be across the season may seek to purchase their grain in advance of delivery. That is, they may purchase grain in March for delivery between May and July. This provides the seller the opportunity to obtain price certainty immediately while delivery may not take place until some point in the future.

The benefit of this is that a seller can capture strong value when it presents, even though it may not be a convenient time to arrange delivery. Or you can create cashflow certainty for a known future commitment at today's price.

13.2.3 Cost of carrying grain

Storing grain to access sales opportunities post-harvest invokes a cost to 'carry' grain. Price targets for carried grain need to account for the cost of carry.

Carry costs for canola are typically $4–5/t per month consisting of:

i. monthly storage fee charged by a commercial provider (typically about $1.50–$2/t per month)

ii. the interest associated with having wealth tied up in grain rather than cash or against debt (about $2.50–$3/t per month depending on the price of the commodity and interest rates.

The price of carried grain therefore needs to be $4–5/t per month higher than was offered at harvest.

The cost of carry applies to storing grain on-farm as there is a cost of capital invested in farm storage plus the interest component; $4–5/t per month is a reasonable assumption for on-farm storage.

Principle: 'Carrying grain is not free' – the cost of carrying grain needs to be accounted for if holding grain and selling it after harvest is part of the selling strategy.

Principles summarised

1. 'Always keep written records' – thorough record-keeping is everyone's responsibility, not just the buyer's.
2. 'Seller beware' – know your counterparty.
3. 'Know your specs' – grades don't always convey quality.
4. 'Separate the delivery decision from the pricing decision'.
5. 'Sell when there is buyer appetite' – when buyers are chasing grain, growers have more market power to demand a price when selling.
6. 'Storage is all about market access' – storage decisions depend on quality management and expected markets.
7. 'Carrying grain is not free' – the cost of carrying grain needs to be accounted for if holding grain and selling it after harvest is part of the selling strategy.

13.3 Hay

Understanding the dynamics of hay markets can improve grain growers' returns when cutting crops for hay.

Hay can be very profitable. However, it requires a working knowledge of livestock industries and their quality requirements. Quality is a critical issue and vetch quality is heavily influenced by the growth stage at which it is cut. Yet cutting at optimum quality means that maximum yield is not achievable.

Hay is usually used as a grazing supplement. In a widespread drought, the growing conditions that pose a threat to grain production also limit pasture and silage production, which can result in a peak in hay demand and prices in local and other domestic markets.

In general terms, dairy farmers buy the most hay, followed by sheep farmers and beef producers. Most hay is sold at baling, in late spring, but depending on the timing and scale of the autumn break, April and May can be another peak trading period.

Producing vetch hay for export markets is generally not the norm. A longer-term approach is required when producing export hay and contract arrangements with a hay processing plant are required.[1]

The market for hay does not have the sophistication of grain. Growers need to be aware that compared to grain, hay:

- is mainly produced and consumed on-farm, hence the traded portion is smaller;
- is not readily accumulated, stored or traded;
- has a greater variation in quality;
- buyers with many feeding objectives tend to give contrary pricing signals;
- price is not always directly linked to quality;
- price is influenced greatly by marketing relationships;
- trade occurs commonly between regular farmer trading partners and not via merchants; and
- trade is conducted via a traditional word-of-mouth basis.

13.4 Hay demand

Hay demand varies greatly from season to season. As much as 62% of hay produced is used by the dairy sector. With about two-thirds of the country's dairy cows in Victoria, this demand is focused here. Beef feedlots are a large factor in the markets of northern NSW and Queensland but are often limited due to reduced operating

1 GRDC (2016) Marketing important for hay producers. GRDC Grains Research Updates Newsletter 43, https://grdc.com.au/archive/grdc-enewsletters/grdc-grains-research-update-newsletter-southern-region/grdc-grains-research-update-newsletter-issue-43/marketing-important-for-hay-producers

margins. In Western Australia dairy and beef herds are both potential markets for vetch hay as it offers a high-protein fodder source.

13.5 Hay supply

Pasture hay has traditionally dominated Australian hay production. Silage is an expanding source of fodder, as is alkalage. Oaten hay targeted at export is also an increasing trend.

Total hay production can be boosted by the contribution of a late flush of pasture hay in regions and failure of cereal crops from frost or drought being cut for hay. With shortages of irrigation water there is also an expanding role for dryland producers of hay, particularly for cereal and vetch hay. There is often a strong demand for high-protein hay created by the low production of clover and lucerne hay.

13.6 How the export market operates

In a 'normal', non-drought year exporters will be aiming to fill the majority of their plant's pressing capacity in spring. These export prices for cereal hay in early spring set a benchmark for domestic cereal hay values, as well as those for pasture hay. Export quality requirements of low moisture, high sugars and the cosmetics of greenness, mean that domestic consumers are often prepared to buy hay of a lower quality at a reduced price.

It would be tidy if the market was to pay purely on payment for energy. However, ruminant rations have upper limits on the proportion of grain. For proper rumen function, cattle and sheep must have a portion of the ration containing a functional fibre such as hay.

Unlike grain, forward contracting of hay has not been widely accepted. With new written agreements available from Grain Trade Australia (see example Figure 1) and a sustained demand for a reliable source of hay, we should see the frequency of forward contracting of hay increase.[2]

13.6.1 How the domestic market operates

Pastures provide the bulk of feed for ruminants and fodder is only a smaller supplementary feed. When droughts hit a broad range of grazing regions, the demand for hay can spike dramatically. The volatility of hay prices is also enhanced by how tightly growers retain their hay for on-farm use. Only around 40% of hay produced is typically sold each year.

Irrigation regions rely on affordable irrigation water to produce fodder through either extending the growing season and/or to irrigate highly productive summer crops.

2 Handley D (2008) Hay:what's driving the market? GRDC Update Papers, https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2008/06/hay-whats-driving-the-market

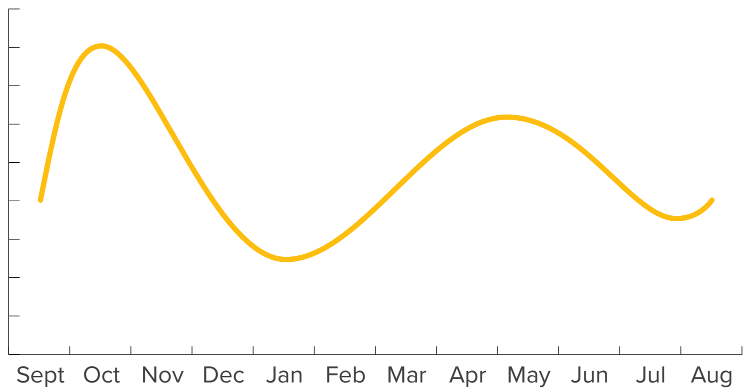


Figure 4: *Typical hay trade volumes.*

Source: JumbukAg Consulting https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2016/08/markets-for-hay-whats-under-the-bonnet

Hay prices are volatile but no more so than wheat prices. Droughts have changed the buying behaviour of many hay buyers. Hay has been the greatest limiting factor for many dairy farmers during these dry times. Dairy farmers tend to be the most astute group of buyers as their margins are tight and the optimum nutritional performance of their cows is paramount. Dairy farmers of the irrigated areas (e.g. northern Victoria) in particular have tended to become both savvy buyers and more self-reliant for their hay needs by purchasing more land to grow their own hay.Insecurity of supply and necessity to enter the market and haggle each year with sellers is shifting some buyers away from hay purchases and into more home-grown fodder supplies. Dairy farmers tend to have the capacity to blend co-product feeds to create a ration and buy on the nutritional merits of hay. Beef and sheep farmers tend to have less feed-mixing equipment and are less driven by the quality attributes of hay on offer.

13.7 Market intelligence

The Australian Fodder Industry Association (AFIA) regularly produces a newsletter, ‘Focus on Fodder’ (http://www.afia.org.au/index.php/news-events/focus-on-fodder) and a ‘Hay report’ (http://www.afia.org.au/index.php/resources/hay-report) to assist growers in understanding hay markets and prices.

There is also a National Hay report produced by Dairy Australia (purchases of hay and grain) (http://www.dairyaustralia.com.au/Pastures-and-Feeding/Supplements/Hay-and-grain-report/National-hay-report.aspx). This includes historic cereal hay prices versus grain, but does not cover vetch hay.

13.8 Determining market outlook

Broadacre croppers who are growing hay primarily as a cash crop, see their dairy clients as a critical sector that underpins their annual sales. Pressure comes when new season opening milk prices are considered low or below costs of production. How dairy farmers react to lower prices and how their budgetary changes impact on their buying behaviour is unclear. Rather than building hay stocks some industry analysts suggest that dairy farmers are likely to make just enough hay for the feed gaps of a typical season.

A discouraging hay demand outlook from the dairy sector may also encourage some vetch growers to plough their crops in rather than cut for hay. This would be more likely if these growers have hay shed space that they would like to free up for their expanded export oaten hay commitments. Irrigated lucerne hay growers are also reducing their production due to the dairy ‘crisis’ and high cost of irrigated water.

This could provide some opportunities for vetch and oaten hay sellers as tight hay stocks could remove any supply buffer. The 2017 season had some of the lowest stocks of carryover hay since 2010. If this combines with some lean hay production from the dairy sector and a late break in 2017, the hay market may be vulnerable to some spikes in demand.

But prices are likely to fall. Hay sellers may find they could face stronger demand if the opening prices for hay are much cheaper than current rates. If pasture and cereal hay prices are well under $200 a tonne, delivered to farm, it may be financially prudent for dairy farmers to buy hay and maximise the grazing from the home-grown pastures.

13.9 Conclusion

Hay will continue to be an option for grain growers for a range of reasons. Success can be improved with some awareness of the scale of Victorian pasture production and the quality needs of hay buyers.[3]

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Current research

Project Summaries https://grdc.com.au/research/projects

As part of a continuous investment cycle each year the Grains Research and Development Corporation (GRDC) invests in several hundred research, development and extension, and capacity building projects. To raise awareness of these investments the GRDC has made available summaries of these projects.

These project summaries have been compiled by the GRDC's research partners with the aim of raising awareness of the research activities each project investment.

The GRDC's project summaries portfolio is dynamic: presenting information on current projects, projects that have concluded and new projects which have commenced. It is updated on a regular basis.

The search function allows project summaries to be searched by keywords, project title, project number, theme or by GRDC region (i.e. northern, southern or western region).

Where a project has been completed and a final report has been submitted and approved a link to a summary of the project's final report appears at the top of the page.

The link to Project Summaries is https://grdc.com.au/research/projects

Final Report Summaries https://grdc.com.au/research/reports

In the interests of raising awareness of the GRDC's investments among growers, advisers and other stakeholders, the GRDC has available final reports summaries of projects.

These reports are written by GRDC research partners and are intended to communicate a useful summary as well as present findings of the research activities from each project investment.

The GRDC's project portfolio is dynamic with projects concluding on a regular basis.

In the final report summaries there is a search function that allows the summaries to be searched by keywords, project title, project number, theme or GRDC regions. The advanced options also enables a report to be searched by recently added, most popular, map or just browse by agro-ecological zones

The link to the Final Report Summaries is https://grdc.com.au/research/reports

Online Farm Trials www.farmtrials.com.au

The Online Farm Trials project brings national grains research data and information directly to the grower, agronomist, researcher and grain industry community through innovative online technology. Online Farm Trials is designed to provide growers with the information they need to improve the productivity and sustainability of their farming enterprises.

Using specifically developed research applications, users are able to search the Online Farm Trials database to find a wide range of individual trial reports, project summary reports and other relevant trial research documents produced and supplied by Online Farm Trials contributors.

The Online Farm Trials website collaborates closely with grower groups, regional farming networks, research organisations and industry to bring a wide range of crop research datasets and literature into a fully accessible and open online digital repository.

Individual trial reports can also be accessed in the trial project information via the Trial Explorer.

The link to the Online Farm Trials is ‘Online trials’: http://www.farmtrials.com.au

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