Faba beans -
A growers’ guide

- Paddock selection
- Cultivars and plant structure
- Herbicides
- Sowing date and plant population
- Protein manipulation
- Pests and diseases
- Fungicides
- Cropping sequences
Background

Faba beans (*Vicia faba*) have the potential to be a valuable component of the arable cropping rotation. Faba beans are an excellent break crop for arable growers and are one of few crops that fit well into a sustainable cropping programme. Faba beans have the potential to improve soil fertility and structure through the deep tap roots and nitrogen fixing ability of the crop. As a break crop in the rotation, faba beans allow for alternative approaches to disease, pest and weed management.

This booklet

The information enclosed in this FAR Focus summarises three years of research including topics such as; the effect of time of sowing and plant population on canopy structure and yield, how spring and winter bean cultivars compare when sown at different timings, fungicide strategies to best protect the crop throughout the growing season and the manipulation of the protein content.

Results throughout this booklet are supported by the results from two years of paddock survey information conducted throughout Canterbury and North Otago. The paddock survey was jointly funded by FAR and the MPI Sustainable Farming Fund (MPI SFF) with the support of PGG Wrightson and the New Zealand Feed Manufacturers Association (NZFMA). The survey included 55 paddocks grown over two consecutive seasons, and examined crop establishment, canopy composition, disease presence and severity and efficiencies at harvest.

This booklet outlines guidelines for growers around the management of faba bean crops. It covers paddock selection, cultivar choice, physiology, herbicides, sowing date and plant populations, disease identification, fungicide application, protein manipulation, and a comparison to other break crop options. Topics outside the scope of the research conducted e.g. pollination and row spacing, are not covered, however where previously published data is available this has been included. This booklet gives an overview to growing faba bean crops; however individual management should be tailored to individual soil types and climate.

This booklet comprises eight sections where knowledge on the management of faba bean crops has been summarised from published, FAR generated and collaborative results. Section 6, Pests and diseases, was prepared by Ian Harvey of PLANTwise Services Ltd.

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FAR Focus 8
Faba beans - A growers’ guide

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1. Site related issues

- Paddock selection
Paddock selection

Faba bean crop performance can be extremely variable between seasons and paddocks. Aside from differences generated post establishment, e.g. Irrigated or dryland and damaging environmental conditions, a number of other issues can be detrimental to yield before the crop is established.

To avoid failure with this crop, the following aspects should be considered and addressed before establishment:

1. **pH**

Faba bean performance is increased when established in higher pH soils. Low levels of pH will initiate stunting of crop growth and yellowing of the leaves throughout the canopy. Applying lime prior to establishment is recommended if pH levels are marginal; where this can be done in the season prior to establishment of the faba bean crop the benefit of the lime will be greater.

In New Zealand, where a pH of at least 6 has been targeted, healthier crops have established. However recommended pH levels in the literature vary. For example Matthews and Marcellos, 2003, recommend a pH range of 5.2 - 8 whereas Jensen et al, 2010 noted that for best production, faba bean crops should be grown on well-structured loam or clay soils with a pH of 6.5 - 9 (Figure 1).

2. **Previous herbicides**

Previous herbicide applications should be checked and product labels consulted for withholding (plant back) periods, as faba beans can be effected by residual herbicide damage. Be careful with residual products containing Clopyralid (Versatill™, etc) and Aminopyralid (Tordon Max™), products containing picloram (e.g. Radiate™ etc) and sulfonyl-ureas like Glean®. Glean was a successful product in herbicide screening work. Consult the herbicide manufacturer if in doubt.

3. **Irrigation/rainfall**

Faba beans are a longer season crop than peas and do not tolerate drought well. Irrigated soils or heavier soil types should be targeted for this crop, preferably in higher rainfall areas. Jensen et al (2010) reported the crop to be reasonably tolerant to waterlogging, however crops become more prone to infection from foliar disease, such as chocolate spot under waterlogged conditions.

![Figure 1](Figure1) The old paddock boundary is clearly evident in this crop of faba beans, Canterbury, 2010. Top ridge of light green had a pH of 5.0; the dark green in the foreground had a pH of 6.1.
4. Cultivation and drilling

The crop does not tolerate compaction even in the absence of root rot diseases. Where soils are compacted the crop is shorter, less vigorous and often of a paler green colour. Good soil structure where roots, particularly the tap root, can freely penetrate the soil is important, so paddocks with a known hard pan should be avoided.

Direct-drilling should only be used where soils are not compacted, and the targeted establishment is either autumn or late in the spring when soils are less likely to be wet. Ensure your drill will be able to cope with the large bean seed.

5. Nutrients

Faba beans are a sensitive crop. A crop of faba beans will highlight areas in a paddock of different fertility, old fence lines or gaps in previous fertiliser applications.

Phosphorus and Potassium fertiliser

There is a lack of data to demonstrate yield responses to phosphorus (P) and potassium (K) fertilisers. However where soil levels are in the low range (<20mg/L for Olsen P and <0.3 me/100g for K), P and/or K fertilisers should be applied, despite faba beans’ requirement for these nutrients being relatively low. Work published by Jensen et al (2010) found that phosphorus uptake rate follows (or regulates) dry matter production of the crop. He also found that faba bean plants are more responsive to phosphorus at maturity than at the seedling stage. This is thought to be due to the high levels of phosphorus reserves in the faba bean seed.

Sulphur

Sulphur in the sulphate form should be applied to crops, especially in known sulphate deficient/ responsive areas.

Nitrogen

Where the crop has produced nodules and nodulation is occurring faba beans do not require nitrogen.

Micronutrients

Adequate supply of micronutrients to the crop should be ensured, particularly Boron and Molybdenum. Soils can be tested for micronutrients, and base fertiliser or foliar applications made to increase availability to the crop. There is a gap in research as to the quantification of low levels.

6. Previous crop history

Where the paddock history demonstrates include a crop that is susceptible to Sclerotinia (Sclerotinia sclerotiorum) e.g. brassicas, potatoes, carrots, beets, and most legumes, cultural control options should be utilised prior to establishment, and chemicals as required throughout the growing season to prevent further inoculum build up in the soil (see Section 7, Sclerotinia).

Aphanomyces (a root rot disease common in peas) can also infect faba beans. While this disease is unlikely to cause significant problems in faba beans the crop may act as a host for the disease meaning inoculum levels in the soil are maintained or increased. Thus it will be important to have non susceptible crops in the rotation to reduce inoculum and to test for aphanomyces prior to planting subsequent pea crops.

Australian literature recommends a four year break between faba bean crops to reduce stubble borne disease pressure. Likewise it is recommended that faba bean crops are established downwind and have at least a 500 m buffer from neighbouring faba bean stubble to avoid increased disease pressure (Hawthorne, et al 2004).

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**Paddock survey**

- Crop performance throughout Canterbury and North Otago has been severely inhibited at times by root rot diseases coupled with water logging and restricted soil structures.

- Root rot pathogens (both major and minor) were found in the two years the paddock survey disease data was collected. Disease incidence was at 93% in year one and 87% in year two, but severity varied notably and usually disease was not severe.

**Further reading:**


2. Cultivars and plant structure

- Cultivar selection
- Plant structure
Key points:

- Faba beans are a legume crop producing a tall and large canopy, 20 t/ha fresh weight at late pod fill.
- The environment faba beans are to be sown in should determine the cultivar selected.
- Crops grown in New Zealand have yielded between 1 and 9 t/ha.

Faba beans are a late maturing legume crop and benefit from a longer growing season. The crop can tolerate winter frosts; however, the optimum growing temperature is 18 - 27°C. Irrigation should be applied when soil moisture is limited; from pod fill, root growth stops, with all the growth going into above ground biomass (Jensen et al., 2010).

Cultivar selection

The environment in which the crop is to be established and the targeted establishment date, influence cultivar selection.

Differences in cultivar characteristics of winter and spring faba beans (Figure 2):

Observed characteristics of a winter bean:
- Better resistance to root rots
- Hardiness to waterlogging
- Large seed size
- Retains green stem for longer
- Increased tillering ability
- Increased straw strength
- Greater degree of shedding pre harvest
- More winter hardy
- Deeper rooting system, and therefore more drought tolerant.

Observed characteristics of spring beans:
- More susceptible to root disease in water logged conditions
- Smaller beans
- Increased podding ability
- Shallower rooting system, more prone to drought

Figure 2. Contrast in maturity of autumn sown winter and spring beans, the winter beans remaining green much longer.
Plant structure

When grown in optimal environmental conditions faba beans are an erect, tall growing crop (1 - 2.5 m) and have the ability to tiller. Tillering is influenced, by variety and 1 - 3 tillers are commonly produced. The crop produces a deep taproot that has an abundance of feeder roots (Figure 3) and nodules (Figure 4) which fix nitrogen to the soil. Nitrogen fixation typically commences at nodule emergence, until then the plant relies on large quantities of seed N source and mineral N. Large-seed varieties of faba beans sown at 40 plants/m² may contain up to 10 kg N/ha (Jensen et al., 2010).

The crop will flower from approximately 20 cm in height at the 5 - 7th leaf bearing stem node. Flowers grow in clusters of 3 - 8, with each flowering node producing 1 - 5 pods. The pods ripen from the lowest pods working up the stem; as the crop ripens the canopy defoliates and goes black, with the pods becoming leathery (Matthews & Marcellos, 2003).

Paddock survey

- The average height of the crop canopies produced over the 2010 - 2011 seasons was 130 cm; an average of 1.4 tillers were produced per plant with a mean number of 15.5 pods produced on the main tiller. Each pod held an average of 3.5 beans.
- The mean yield of paddocks surveyed was 5.6 t/ha with a range from 1 to 8.5 t/ha.

Further reading:


Figure 3. Early season nodulation on winter sown crops.

Figure 4. Nodule on the fibrous roots of a faba bean crop.
3. Herbicides

- Chemical weed control
- Managing volunteers
Key points:

- Some herbicide residues are injurious to legumes eg Tordon Max™. Previous applications need to be considered before establishment.
- To avoid pre-emergent herbicide damage, the targeted sowing depth should be 7.5 - 10 cm.
- Although there are very few herbicides registered for pre or post-emergent applications, FAR herbicide screening experimental work has identified chemicals that are safe for use on faba beans.

When selecting paddocks, previous herbicide applications need to be considered. Products such as Glean® or Tordon Max need additional consideration in regards to residue periods, previous applications, timing and rates applied. Tordon Max is injurious to legumes, the breakdown of the product is determined by moisture and temperature, so plant back periods should be adhered to carefully (Young, 2012).

Damage from pre-emergent herbicide applications in faba beans can be prevented/ reduced by ensuring the sowing depth of the crop is targeted at 7.5 - 10 cm. Herbicide damage can be seen in Figures 5 and 6 as bleaching of the tips and outside edge of the newest emerging leaves. The crop will eventually grow out of this minor crop damage.

Figure 5. Herbicide damage to the winter sown crop by the application of the spring sown herbicides.

Figure 6. Herbicide damage on the leaf tips of the first establishing plants.

Chemical weed control

Registered herbicide options for faba beans are minimal. The Novachem Manual 2012 outlines three registered herbicides for use in broad bean crops;

- Leopard® (quizalofop) for grass weeds post emergence.
- Simazine (Simazine) pre-emergence for annual broadleaves and grasses.
- Linuron (Linuron) pre emergence for annual broad leaves alone.

Herbicide screening trials conducted at the FAR Arable Site, Chertsey, over the last three years have included faba beans. Please note products trialled are not registered for use on faba beans, nor does their naming in this report constitute a recommendation.

Pre-emergent options that have proven safe for use on faba beans constantly over the last three years include Gardoprim® (terbuthylazine) and Gardoprim + Glean (chlorsulfuron) at each of the full, half and quarter rates. Products such as Butisan® S (metazachlor –
Note: not in Novachem manual), Firebird® (flufenacet + diflufenican), Firebird + Stomp® (pendimethalin), Gardoprim + Firebird and DFF (Quantum®) (diflufenican), have been trialled for one or two years and have proven safe for use on faba beans at the full, half or quarter rate of application.

Post emergent herbicide options that have been trialled and found to be safe on faba beans include Puma® (fenoxaprop-P-ethyl), Twinax® (pinoxaden), Topik® (clodinafop-propargyl), Fusilade Forte™ (aryloxphenoxypropionate) and Kerb* Flo (propyzamide). There is only one year of data on each of these products.

Managing volunteers

Faba bean volunteers can harbour disease, creating a green bridge for disease to be carried over into the following season. From the herbicide screening data Hussar® (iodosulfuron-methyl-sodium + mefenpyr-diethyl) and Othello® (diflufenican + mesosulfuron methyl + iodosulfuron-methyl-sodium + mefenpyr-diethyl) post-emergence have proven to be exceptional at killing off faba beans.

Pre and post-emergent combinations of Firebird followed by Othello, Gardoprim followed by Sencor® (metribuzin) and Gardoprim followed by Othello are also very effective at eliminating faba beans.

Further reading:


4. Effect of time of sowing and plant population

- Establishment date
- Plant population
- Canopy composition
- Protein content
Key points:

- Sowing date has a greater impact on yield than sowing rate.
- Delaying establishment from late autumn until early spring, reduced yield by 29% for the spring cultivar and 35% for the winter cultivar.
- As plant population increased so did crop yield. However this saturates at approximately 40 plants/m² in the spring cultivar and 30 plants/m² in the winter cultivar.
- As canopy height increases so too does the brackling height and height to first pod.
- As canopy height increases, the number of pods/plant decreases.
- The mean protein content of the spring cultivar over three years (2009 - 2011) was 27.7%; the winter cultivar had the higher average protein content at 31.1% from 2 years of data.

Establishment date

Experimental work (2009 - 2011) at Wakanui, Mid Canterbury (Figure 7), has shown that delaying the sowing date of both spring and winter cultivars of faba beans significantly decreases yield (Figure 8). Experimental work in the 2009 and 2010 seasons was on shallow Wakanui Silt Loam soil, there were no problems in either winter with water logging or compacted soils. The third year of work was on heavier Wakanui Silt Loam soil, and a favourable winter meant excess soil moisture did not effect plant growth or root disease development.

Yield differences as a result of sowing date were greatest between the winter sowing (mid June) and the spring sowing (end of August). There was an average yield decrease of 1.7 t/ha when sowing was delayed from the winter until spring; 2.01 t/ha in the spring cultivar and 1.3 t/ha decline in the winter cultivar.

The mean difference of delaying establishment from autumn to winter (end of April to mid June) was 0.6 t/ha. The yield penalty associated with this 6 week gap in sowing date was more evident for the winter cultivar with a decrease in yield of 1.1 t/ha versus a 0.14 t/ha decrease in the spring cultivar. The total loss of yield potential as a result of delaying establishment from autumn to spring was 29% for the spring cultivar and 35% for the winter cultivar.

Experimental work conducted in the UK (2010/11) looking at the effect of time of sowing and sowing rates with winter cultivars of faba beans, has shown a similar result to that found in Canterbury. Where the crop was established early on 25 September (early autumn) the
yield of winter beans was greater than the later sown 21 January (mid winter) crops. The mean yield loss associated with delayed sowing was 58% (Freer, et al, 2012).

Guidelines written for New South Wales Agriculture by Matthews & Marcellos, 2003, also support the findings of experimental work in Canterbury. They found that the greatest growth potential occurs with early planting, which in turn favours high yield and large amounts of nitrogen fixation. Late sowing reduces yield by lowering crop biomass, shortening the pod-filling period and increasing risk from moisture stress and high temperatures. Although in New Zealand the risk of moisture stress and high temperatures is not as much of a concern, the principle of a shorter growing season with delayed planting is relevant.

**Plant population**

The effect of plant population across both the winter and spring bean varieties was less consistent as a determinant of yield. Three years of data suggests that initially, as plant population increased so too does the yield of the crop, this saturates at approximately 40 plants/m² for the spring cultivar and at a lower rate in the winter cultivar at 30 plants/m² (Figure 9). The relationship generated in the spring cultivar was significant (P = <0.01), however this relationship was not significant within the winter cultivar. Differences obtained in UK research with lower plant populations (comparing 18 plants/m² with 27 plants/m²) produced a yield advantage to the higher plant population (Freer, et al, 2012).

![Figure 8. Influence of time of sowing on yield (t/ha) of winter and spring beans (mean of sowing rates, data 2009 - 2011), Wakanui, Mid Canterbury.](image)

![Figure 9. Influence of plant population on yield (t/ha) of winter and spring beans (mean of sowing dates, data 2009 - 2011), Wakanui, Mid Canterbury.](image)
Paddock survey

- The yield reduction resulting from delayed sowing date seen in experimental data tended to be similar in the paddock survey, however not significantly. This is most likely a result of other variables (Figure 10).

**Figure 10.** Influence of time of sowing on yield (t/ha) of spring beans, Faba bean paddock survey 2010 - 2011, Mid Canterbury - North Otago.

- Survey data for plant population was similar to experimental data collated with little or no change in yield at the commercially used plant populations (30 - 60 plants/m²) (Figure 11).

**Figure 11.** Influence of plant population on yield (t/ha) of spring beans, Faba bean paddock survey 2010 - 2011, Mid Canterbury - North Otago.
Canopy composition

Three years of experimental work has consistently shown significant trends in canopy structure as a result of varying the time of sowing, particularly when working with the spring cultivar. Differences as a result of plant population were less evident.

As the spring cultivar establishment date was moved from autumn through to winter and spring, the height of the crop canopy increased, resulting in an increase in the height of brakling (where the top of the canopy lodges) and also an increase in the height to first pod. Data has also consistently shown that as sowing date moved later the number of pods produced per plant decreased (Figure 12).

Winter beans showed the same trends in canopy structure, however the differences generated as a result of time of establishment were not significant (Figure 13).

![Figure 12. Influence of the time of sowing on the canopy structure of spring beans, (mean of sowing rates 2009 - 2011 data), Wakanui, Mid Canterbury.](image)

![Figure 13. Influence of the time of sowing on the canopy structure of winter beans, (mean of sowing rates 2010 - 2011 data), Wakanui, Mid Canterbury.](image)
**Paddock survey**

- Although only the height to first pod trend was significant, survey data supported the trends found in experimental results (Figure 14).
- As sowing date is delayed, the height of the canopy, height to brackle and height to first pod increases.
- Delaying sowing date resulted in fewer pods per main tiller.

![Graph showing trends in height and pod numbers](image)

**Figure 14.** Influence of the time of sowing on the canopy structure of spring beans, faba bean paddock survey 2010 - 2011, Mid Canterbury – North Otago.

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**Protein content**

Average yield and protein content increased with each year of experimental data collected. The mean protein content of the spring and winter faba bean cultivars varied by 3.4%. The mean protein content of the spring cultivar over three years (2009-2011) was 27.7%. The winter cultivar had the higher average protein content at 31.1% from 2 years of data.

Each year the experiment site was established on better soils. In the first year of work (2009), the plots were established on light river flat soils, the soils were lighter in year one than year two. In the second year of experiments, the site on the river flats was selected from the electromagnetic scan (EM) and water holding capacity maps to be located on the heaviest part of the paddock. The third consecutive year of research was moved up from the river flats to a much heavier Wakanui silt loam. This may account for the seasonal trends seen throughout the research programme (Figure 15). The trend for increasing yield and protein content as growing conditions improved was significant in the spring cultivar. Interestingly, Jensen *et al* (2010) commented that faba beans are best grown on heavier textured soils, but tolerate nearly any soil type.

The protein content of both the winter and the spring bean correlated positively with yield. The increase in protein content for yield was significant in the spring beans: for each tonne/ha of yield, protein content increased by 0.61%. The non-significant increase in protein content for yield with the winter bean was 0.44% per 1t/ha (Figure 16). The crops established in autumn were the highest yielding, followed by the winter establishment date, the spring sown crops producing the lowest yield. The same was apparent for protein content. The earlier sown crops, which were the highest yielding, had the highest protein content in both the winter and spring cultivars, although this was only significant in the spring cultivar (Figure 17).
Figure 15. Influence of growing season on the protein content (%) of spring and winter bean cultivars.

Figure 16. Influence of yield (t/ha) on the protein content (%) of spring and winter bean cultivars (2009 - 2011).
Plant population had less of an impact on yield than time of establishment and there was no significant effect of sowing rate on protein content (Figure 18).

Further reading:
Paddock survey

- Survey data followed the trend of experimental data, although not significantly. As yield increased, protein content also increased (Figure 19).
- Sowing date had no significant effect on protein content within the survey (Figure 20).

**Figure 19.** Influence of yield (t/ha) on protein content (%) on spring beans, faba bean paddock survey 2010 - 2011, Mid Canterbury - North Otago.

**Figure 20.** Influence of sowing date on protein content (%) on spring and winter beans, faba bean paddock survey 2010 - 2011, Mid Canterbury - North Otago.
5. Protein manipulation

- Inoculation
- Protein data summary
Key points:

- No significant difference in yield was generated as a result of fertiliser applications at either early or late flower.

- Inoculation of faba beans in New Zealand is not common practice. A 2011 experiment produced no significant yield advantage from the use of inoculated seed.

- Three years of data shows a highly significant relationship between yield and protein content when analysed as a linear or polynomial correlation.

- Across a sample size greater than 100, the linear relationship shows that for every 1 t/ha increase in grain yield, protein content increased by 0.52%.

Protein manipulation experimentation was carried out in the 2011/12 season. An experiment was established within a commercial paddock of the spring cultivar Ben to determine if the crop was more responsive to early or late flower applications of fertiliser and nutrients.

There was no significant difference in yield generated as a result of fertiliser applications made to the crop at either early or late flower. The highest yielding treatment, although not significantly different, was a result of 80 kg N/ha applied at late flower (Figure 21).

The protein content of the harvest samples showed no significant difference in the protein content of the crops as a result of fertiliser applications. The range in protein content was from 26.9 to 27.4%. Surprisingly the untreated crop had the highest mean protein content.

The site where this experiment was established was located at Wakanui. The site had good initial fertility; a more responsive site may have generated different results.

When the yield and resulting protein contents are correlated from this trial, a highly significant polynomial trend, shows that the protein capacity of the trial was reached when the crop was yielding 8.7t/ha (Figure 22).

Figure 21. Influence of early and late fertiliser and nutrient applications on yield (t/ha).
Inoculation

Inoculation of faba beans is not common practice in New Zealand as most cultivated soils already contain large populations of indigenous rhizobia and mycorrhizae, (Jensen et al, 2010).

Work in the 2011/12 season showed no significant yield advantage through the addition of inoculant to the seed at sowing. Replicated plots were established under both dryland and irrigated scenarios at Chertsey, and under irrigation at Wakanui, Mid Canterbury to test the effect of inoculation (Table 1).

The inoculated Wakanui plots produced 0.6% more protein. However, this is more likely to be a result of the link between higher yields and higher protein.

Table 1. Effect of inoculation on faba bean yield (t/ha).

<table>
<thead>
<tr>
<th></th>
<th>Plus inoculant</th>
<th>Minus inoculant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chertsey – irrigated</td>
<td>5.98</td>
<td>6.04</td>
</tr>
<tr>
<td>Chertsey – dryland</td>
<td>3.23</td>
<td>3.55</td>
</tr>
<tr>
<td>Wakanui – irrigated</td>
<td>7.43</td>
<td>6.72</td>
</tr>
<tr>
<td>Mean</td>
<td>5.55</td>
<td>5.44</td>
</tr>
</tbody>
</table>
Protein data summary

Figure 23 shows a summary of the correlation between yield and protein content from three years of trial work and two seasons of paddock surveying. The data shows a highly significant (P<0.001) relationship between yield and protein content when analysed as a linear or polynomial correlation.

The linear relationship shows that for every one tonne increase in grain yield/ha, the protein content of the crop increased by 0.52%. The polynomial relationship shows that the rate of increase in protein content for yield reduced when crop yields hit 7 t/ha. This is probably a result of a slight reduction of nitrogen content in the grain, hence the protein content falling.

![Figure 23. Correlation between yield (t/ha) and protein content (%) of all samples collected, Mid Canterbury – North Otago, 2009 - 2011.](image)

**Note:** The points on the graph where the protein content is highest are the winter cultivar.
6. Pests and diseases

- 6.1 *Botrytis* / chocolate spot
- 6.2 Ascochyta
- 6.3 Rust
- 6.4 *Sclerotinia*
- 6.5 Root rots
- 6.6 *Stemphylium* blight
- 6.7 Viruses
- 6.8 Aphids
6.1 *Botrytis* / Chocolate spot complex

**Causal fungi:** *Botrytis cinerea, B. fabae.*

**Occurrence and importance**
This is the most common disease of faba bean / broad beans in New Zealand. Both species of *Botrytis* can cause similar damage either separately or together in a crop or on a single plant. Left unchecked in crops grown under conditions conducive to disease development, grain yield losses can be high, with estimates up to 30%.

**Symptoms**
Two types of spots occur on leaves:

1. Small circular brown - red spots occur which remain restricted in size. This is termed the “non-aggressive” phase of the infection (Figure 24).

![Figure 24](image)

**Figure 24.** Non-aggressive stage of leaf infection by a *Botrytis sp.*

2. Larger “blight” type lesions occur which can cover a major proportion of the leaf surface and eventually cause leaflets to fall off. This is termed the “aggressive” phase and can develop from the above non-aggressive spotting or directly from infection (Figure 25).

![Figure 25](image)

**Figure 25.** Development of the aggressive stage of leaf infection by *Botrytis sp.* from the non-aggressive stage (a) and directly (b).

Early development of the “blight” type lesion is often indistinguishable in the field from early leaf infection by *Ascochyta fabae,* (see over page).

These *Botrytis* species can also cause pod lesioning (Figure 26). Both fungi develop copious smoky-grey sporulation on the infected tissue under warm, moist conditions. Under conditions conducive to the pathogen, infection will cause a complete defoliation of infected leaves.

![Figure 26](image)

**Figure 26.** Infection by a *Botrytis sp.* on faba bean pod; note smoky-grey sporulation on the infected tissue.

**Pathogens and life cycles**
*B. cinerea* is a pathogen with an extremely wide host range. *B. fabae,* on the other hand, is restricted to varieties of *Vicia faba.* Both produce airborne conidia (asexual spores) that spread infection over wide areas. The only way of distinguishing between the two pathogens is to measure and observe the conidia (spores) under the microscope, with those of *B. fabae* being larger and more rounded than those of *B. cinerea.*
Both species produce resting bodies (sclerotia) on old diseased tissue. This allows these fungi to overwinter in the soil and in crop debris. Although not a major means of spread, infected trash and sclerotia in seed lines can also harbour the pathogens. B. fabae is reported to also be transmitted internally in seed.

**Management and control**

1. Sow seed of known high-health

2. Monitor crops for infection and spray with an appropriate fungicide at first signs of infection.

3. Work-in old trash (especially that which has been chemically desiccated before harvest) to discourage the formation and/or sporulation of sclerotia in the spring.

**Note:** Although there are no registered or recommended fungicides for the control of these pathogens in faba bean crops, a number of effective products are available. Consult with your advisor or chemical firm representative for suggested best options and see Section 7, Fungicides, in this FAR Focus.

### 6.2 Ascochyta blight

**Causal fungus:** *Ascochyta fabae* (sexual phase: *Didymella fabae*).

**Importance**

This disease can be very damaging to faba bean crops. Infection can begin early in the season (especially in autumn sown crops) and progress throughout the season to cause severe crop losses.

**Symptoms**

The disease is first noticed as a dark brown spot with red margins on the leaves which expands rapidly and may coalesce with neighbouring lesions (Figure 27). As the lesions mature, fruiting bodies (pycnidia) form on the tissue at the centre. These are visible to the naked eye (Figure 28). Lesions on stems are elliptical along the axis of the stem, sunken with brown and red margins (Figure 29). These lesions also contain pycnidia. Early infection can cause stems to become kinked.

As infection progresses, leaves fall and stems may break and lodge. Pod infection can spread into the developing seeds, causing brown staining. However, infected seed can also be symptom free.

**Disease life cycle**

The two main methods of infection into a crop or region are from infected plant debris and infected seed lines. The fungus spreads and develops rapidly in a crop under cool, moist conditions, with rain events being particularly conducive to disease development as the spores are rain splashed to new infection sites.

Infected seed causes lesions to develop on cotyledons and lower leaves. Infection can then spread up the plant and onto neighbouring plants.

Infected trash can produce conidia in the spring that are spread by rain splash onto lower leaves of plants.

Overseas, a sexual (or telemorph) stage of the pathogen has been reported but there are no reports of this stage occurring in New Zealand. When present, it is reported to produce rows of fruiting bodies (perithecia) on diseased stems which, when mature in the spring, release air borne spores (ascospores) that spread the disease into the next faba bean crop planted in the area.

**Management and control**

1. Plant disease-free seed. Infection in seed lines is readily detected in a laboratory test.

2. Monitor crops regularly, especially autumn sown ones, and apply a fungicide treatment at first sign of infection. Use a hand lens (x10+) to confirm the presence of pycnidia at the centre of lesions.

3. Although there are no registered or recommended fungicides for the control of this pathogen in faba bean crops, there are a number of effective products available. Consult an advisor or chemical company representative for suggestions or see Section 7, Fungicides, in this FAR Focus.
6.3 Rust

Causal fungus: *Uromyces viciae-fabae*.

Occurrence and importance

This disease occurs sporadically in faba bean crops in New Zealand. Early sown grain crops can have high losses through defoliation and stem infections.

Symptoms and disease life cycle

This rust fungus produces five spore stages (macrocyclic rust) which all occur only on the faba bean host (autoecious rust). The life cycle is therefore complex and is roughly described and where possible illustrated, below. The spore stages are traditionally given Roman numerals (although there is no 0 in the Roman system).

0 Spermatia - are the first spore type to be produced in fruiting bodies called pycnia. These are seen as light yellow/green blisters on the underside of the leaf - mostly in circles (Figure 30). These spores are non-infectious but mate to produce the next spore stage.

I Aeciospores - are produced in pustules called aecia, that develop in the centre of the ring on pycnia (Figure 31). The spores are yellow and single celled and are carried in the wind to new infection sites.

II Urediniospores (Figure 32) - develop in pustules called uredinia which develop from either aeciospore infection or secondary urediniospore infection. These uredinia first appear as light green spots on the leaf surfaces which then expand and produce a red-brown pustule (Figure 33). As the infection develops, defoliation eventually occurs. Infection can also occur on stems, appearing as elongated lesions. This is the infectious stage, where the disease cycles within the season, and the stage most commonly seen by growers.

III Teliospores - are the “winter spore” stage that are almost black *en mass* and develop in the uredinia pustules which then become telia pustules (Figure 34). These single celled thick walled spores perennate the pathogen, over-wintering mostly in stubble then germinating in spring to produce the next spore stage.
IV Basidiospores - are produced in spring when teliospores germinate. They are produced on a germ-tube like structure called a basidium. There are always four spores per basidium; two are + mating types while two are - mating types. These are ejected from the basidium and windblown to new infection sites on faba beans where they develop pycnia, thus completing the life cycle.

This complex life cycle may be circumvented by the carry-over of urediniospores produced on volunteer faba beans growing through winter.

**Note:** Overseas there are reports of up to eleven races of the pathogen but no study of the make-up of the New Zealand population has ever been undertaken.

**Control**

Little is known at this time of the susceptibility of the cultivars of faba beans grown in New Zealand to the possible races that occur here.

Chlorothalonil is the only fungicide registered for the control of this disease in New Zealand. However, a number of other products and mixtures are effective. An advisor or chemical company representative should be consulted on options available.

6.4 *Sclerotinia* rot

**Causal fungi:** *Sclerotinia sclerotiorum, S. minor.*

**Occurrence and importance:**

Diseases caused by *Sclerotinia* spp. occur worldwide in all cropping regions. The host range of these pathogens spans 64 plant families, 225 genera and 361 species. *S. sclerotiorum* commonly attacks faba beans in New Zealand, but actual losses have not been determined. However, in other susceptible crops, losses can range from minimal to 100%. *S. minor* is less common in faba beans.

**Symptoms and life cycle**

*S. sclerotiorum*

Plants can become infected from two sources (see life cycle diagram - Figure 41 on page 30).

1. Airborne ascospores (sexual spores) colonise damaged host tissue or fallen, degrading floral parts that adhere to stems, leaves or lodge in leaf axils. The fungus then advances into the stem causing a light tan lesion that expands up and down the stem (Figure 35), eventually causing the stem to break (Figure 36) and the plants to die. This is known as carpogenic infection. This arises from fruiting bodies (apothecia - Figure 37) that form from sclerotia that over-winter in the soil. These apothecia puff out ascospores for several days under moist conditions in the spring.

2. Sclerotia (resting bodies) in the soil can germinate and directly infect stems at or just below the soil level (Figure 38). This is known as myceliogenic infection. This type of infection is not as common as carpogenic.

Figure 33. Uredia on the upper leaf surface.

Figure 34. Telia on a stem.

Figure 35. Stem lesion on faba bean caused by *Sclerotinia sclerotiorum*.
Under moist conditions a white cottony growth can sometimes occur on the infected stems. As the stem lesions mature, black bodies (sclerotia) of varying sizes form in the lumen (inner cavity) of the infected stem directly under the lesions (Figure 39). Patches of plants can become infected in a crop and lodge.

**S. minor**

This pathogen is less common in faba bean crops than *S. sclerotiorum*. Infection only occurs myceliogenically (see Figure 38). Infected stem bases develop a light tan lesion that advances up the plant. Numerous small black sclerotia develop both on the lesion surfaces and in the lumen (inner cavity) of the stems (Figure 40).

In both species of *Sclerotinia*, sclerotia enable the pathogens to over-winter in debris and in the soil. Sclerotia can be distributed with seed, as many sclerotia are the same size and shape as many host seeds and are not dressed out in seed cleaners (although generally this is not the case with faba beans). Sclerotia can be distributed by farm implements, animals and within irrigation water. Sclerotia of *S. sclerotiorum* and *S. minor* can also survive passage through animal digestive tracts. Ascospores of *S. sclerotiorum* are reported to be transmitted by honeybees.

The life of sclerotia in the soil ranges from several months to 4 years and depends on soil type, and environmental conditions such as temperature, moisture and depth of burial. The presence in the soil of natural enemies such as bacteria, fungi or insects that degrade the bodies can also affect this longevity.
The sexual or carpogenic germination of sclerotia is affected by soil moisture content, temperature, strains of the fungus, burial depth and age of sclerotia. A cold conditioning of several weeks at 4 - 10°C is required to trigger germination but response to cold conditioning varies with strains of the fungus from different geographic locations. Light is not essential for germination, but it is required for normal development and maturation of the apothecia.

**Control**

**Cultural**
- Crop rotation away from susceptible hosts is the major means of control. Note that brassicas, potatoes, carrots and beets, most legumes like peas and lentils, and composites such as sunflower are all hosts of the pathogen.
- Deep ploughing of soils heavily infested with sclerotia can be a short-term control measure, but if they are unearthed in a later season, there can be continuing problems. Several weeds, especially thistles, are hosts of *Sclerotinia spp.*, so the destruction of infected stands is essential.
- Dense crops are more susceptible to infection and disease spread than those in wide, aerated rows.
- Flooding of fields has been shown to markedly reduce sclerotium viability.

**Chemical**

A wide range of fungicides are registered in New Zealand for the control of *Sclerotinia* diseases. However, none have specific registration for the control of these diseases in faba bean crops. Those fungicides that have registrations in other crops, and which are effective against *Sclerotinia spp.* are:

- Carbendazim (and products containing this chemical), Shirlan® (fluazinam) and thiophanate-methyl (Topsin™ M-4A - and products containing this chemical). All of these fungicides / products have systemic activity.
- Two dicarboximide protectant fungicides that have specific activity against *Sclerotinia* diseases are Rovral® (iprodione) and Sumisclex® (procymidine).

Fungicides for *Sclerotinia* control should be applied either at the first sign of infection or as a protectant. Note that there are new fungicides being marketed for the control of *Sclerotinia* and these may be suggested by advisors and company representatives.

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**Figure 41.** Stylized life cycle diagram of *Sclerotinia sclerotiorum* (from Harvey - 2005).
6.5 Root rots

Causal fungi: *Fusarium* spp., *Phoma medicaginis*, *Theilaviopsis basicola*.

Occurrence, importance and symptoms
All crops have some degree of root rotting but this can range from minor feeder root necrosis to taproot rotting (Figure 42) and whole plant death (Figure 43). Few plants actually die from root rots in a crop but varying severity of infection depends on several factors, including soil moisture and previous cropping history.

![Figure 42. Feeder root necrosis (arrow) and general tap-root necrosis (oval) of faba bean.](image)

Causal fungi
Several species of *Fusarium* have been found associated with root rots in faba beans, but *F. solani* is the most commonly isolated species. These fungi have a wide host range, but those species and strains that are pathogenic to legumes are likely to be the most destructive on faba beans. Thus crops of faba beans that are planted in paddocks that have recently had peas, beans or lucerne are more likely to be at risk from root rots. Clovers may also harbour infection.

*Phoma medicaginis* is a pathogen of peas and lucerne, and the strains that infect faba beans may have originated from these crops. This pathogen is a common cause of root rot in peas but less common as a cause of root rot in faba beans.

*Theilaviopsis basicola* has a wide host range including many legumes. Inoculum builds up in the soil over time and eventually causes a disease commonly known as black root rot. However this disease is rarely found in faba beans in New Zealand.

All of the above pathogens produce resistant spore stages that allow inoculum to be carried over in the soil for many years.

Note that several other fungi have been reported here in New Zealand and overseas that produce root rotting of faba beans, but have not been detected as causing significant damage in field crops of faba beans to date. One is the common pea root rot pathogen *Aphanomyces euteiches*. *Rhizoctonia solani* and several *Pythium* spp. have been recorded on faba beans overseas but not in New Zealand to date.

Control
The only two practical methods of control are:
1. Maintenance of optimal soil moisture
2. Long crop rotations that do not include a legume crop.

6.6 Stemphylium blight

Causal fungus: *Stemphylium botryosum* (sexual phase - *Pleospora herbarum*).

Occurrence and importance
This blight has recently been detected in some South Island faba bean crops. Leaf damage and defoliation appeared severe in parts of paddocks but no estimation of loss from the disease has been determined.

Symptoms
Leaves up the plant become brown to greyish black from either discrete large lesions or from edge necrosis (Figure 44). Lesions have no halo. Whole areas in the paddock can develop a blighted appearance (Figure 45).
6.7 Virus

Causal viruses: Various.

Occurrence and importance
Viral infections are found in most faba bean crops to varying degrees of incidence and severity. Their effect on grain yield is not yet fully understood.

Symptoms and life cycle
Two distinct symptoms can be detected in faba beans.

1. Tops yellows (Figure 46)
This is becoming the most prominent symptom in crops and is caused by the leuteoviruses Soybean dwarf virus (SDV) and Beet western yellows virus (BWYV). Infected plants exhibit inter-veinal yellowing, curling margin and become leathery. Plants may be stunted, not affected at all or slightly taller than uninfected plants, depending on the growth stage that the infection is introduced (by aphids). Early infected plants can develop a proliferation of apical buds.

Control
No attempts have been made to control this blight in faba bean crops, as it has generally developed quite suddenly before any suitable protectant could be applied. However, if this disease is detected early enough, there are several fungicides that could be used in an attempt to minimise the damage. An advisor or chemical company representative should be consulted on available options.
as many species of weed. Aphids (especially the black bean aphid *Aphis craccivora*) vector the infection into the crops from outside sources, especially lucerne crops.

**Control**

1. Avoid planting faba beans adjacent to lucerne or clover crops.
2. Maintain good aphid control throughout the growth of the crop.

(Note: Past and recent surveys of viruses in faba bean crops have identified a number of additional viruses that can infect this crop. These include *Bean yellow mosaic virus* (BYMV) and *Pea seed borne mosaic virus* (PSBMV), but the effects of these and the symptoms they induce are not yet clear. Additionally, a new virus to New Zealand - *Red clover vein mosaic virus* (RCVMV) has recently been identified, but its importance in faba beans is yet to be determined.

(Note: this section is based on information collected as part of the MPI SFF project “Getting the best from beans” and the work of John Fletcher, Plant & Food Research, Lincoln, 2012).

### 6.8 Aphids

*Aphis craccivora.*

**Occurrence and importance**

Most crops have some degree of infestation from the black bean aphid - *Aphis craccivora* (also known as the cow pea aphid). They produce a range of reactions in the plant from negligible to severe feeding damage, and losses from the vectoring of virus infection.
7. Fungicides

- Disease control
- Protein content
Key points:

- Fungicide timing proved to be more important than product choice. When comparing a Folicur+Protek programme starting at mid-late flower to the same programme with a start date of late flower -early pod fill, the earlier commencing programme gave a significantly higher yield (0.63 t/ha).

- The mean yield of the fungicide programmes that commenced at early flower was the highest at 8.9t/ha, mid-late flower 8.8 t/ha; fungicide programmes that commenced at late flower early pod fill had a mean yield of 8.5 t/ha.

- Of the fungicide programmes that commenced at late flower-early pod fill and partnered ProtekTM with either of Folicur®, Proline® or Comet®, the greatest control of Botrytis was achieved with the Folicur+Protek and Comet+Protek combinations, both having 48.5% severity of infection.

- Comet+Protek provided marginally better rust control compared to that of the Proline+Protek; 17 and 18% disease severity respectively.

Faba beans’ growth habit makes them highly susceptible to a variety of diseases. Fungicide application throughout the course of the growing season is essential to maintain the green area of the canopy. During periods of warm weather and rapid growth the length of time a fungicide application will protect from new infections is reduced. In Australia fungicide protection can be for 2 - 3 weeks, however this time may be reduced to 7 - 14 days during periods of rapid growth and intense rainfall, or if conditions are conducive to disease development (Hawthorne, et al., 2004).

Fungicide research work (2009 - 2011) has been overlaid in commercial crops of the spring cultivar located at Wakanui, Mid Canterbury.

Few products are registered for use on faba beans. Products and rates outlined in this section do not constitute a recommendation.

Disease control

The 2012 trials were infected by Botrytis cinerea (chocolate spot) and Sclerotinia sclerotiorum. At late pod fill (20 December) the untreated crop had lost 90% of the leaf area in the pod fill region (approx. 30 cm – 100 cm crop height region) to Botrytis (chocolate spot). Fungicide applications were made at mid flower (26 October) and mid pod fill (2 December) as per the treatment list (Table 2) and a blanket spray of Bravo® 2 l/ha (chlorothalonil) + Folicur 0.44 l/ha (tebuconazole) was applied on the 23 December. (Note: Due to residue concerns Bravo® cannot be applied to faba beans).

Fungicide application significantly reduced the severity of the chocolate spot infection compared to the untreated crop. The combination of Bravo and Folicur had significantly more chocolate spot present in the canopy than the other fungicide programmes.

Table 2. Influence of fungicide application on the leaf area affected in the pod fill region of the plant with Botrytis (chocolate spot) (% severity) and the incidence of stems infected with Sclerotinia, Wakanui, Mid Canterbury, 2010.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Botrytis % severity</th>
<th>Sclerotinia rot % incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Untreated control</td>
<td>90.5</td>
<td>6.0</td>
</tr>
<tr>
<td>2 Protek 1.0 (a.i carbendazim)</td>
<td>44.9</td>
<td>3.0</td>
</tr>
<tr>
<td>3 Proline 0.8 (a.i prothioconazole)</td>
<td>43.4</td>
<td>4.0</td>
</tr>
<tr>
<td>4 Protek 1.0 + Proline 0.8</td>
<td>30.5</td>
<td>1.0</td>
</tr>
<tr>
<td>5 Protek 1.0 + Comet 0.8 (a.i. proclostrobin)</td>
<td>30.3</td>
<td>4.0</td>
</tr>
<tr>
<td>6 Proline 0.8 + Comet 0.8</td>
<td>37.5</td>
<td>2.0</td>
</tr>
<tr>
<td>7 Bravo 2.0 + Folicur 0.44</td>
<td>64.3</td>
<td>10.0</td>
</tr>
<tr>
<td>8 Sumisclex (a.i. procymidone) 1.1 + Proline 0.8</td>
<td>38.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Mean</td>
<td>47.5</td>
<td>4.0</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>17.2</td>
<td>8.4</td>
</tr>
<tr>
<td>Significance</td>
<td>***</td>
<td>ns</td>
</tr>
<tr>
<td>P value(5%)</td>
<td>&lt;0.001</td>
<td>0.504</td>
</tr>
</tbody>
</table>
The greatest control of *Botrytis* was achieved when Protek was partnered with either the triazole Proline or the strobilurin Comet. The addition of the Proline and Comet to the Protek decreased the severity of infection by 14% when compared to the Protek alone.

The incidence of *Sclerotinia* was not significantly affected by fungicide application.

Disease levels present in the 2010 fungicide work were far greater than that of the 2009 untreated crop, which had 25% of the leaf area in the pod fill region affected with *Botrytis* on the 6 January. The equivalent assessment made in the 2011 fungicide experiment on the 2 January found no *Botrytis* in the crop, however 6% of the leaf area in the mid-pod region of the plant was infected with rust (*Uromyces viciae-fabae*).

Fungicide strategies applied in the 2011 season consisted of five fungicide timings and four products being assessed (Table 3).

Disease was first found in the plots on 10 December (flowering), with very low levels of *Botrytis*. Rust was the first disease present at assessable levels; however it was not the most damaging disease. The severity of rust damage to the crop (leaf area affected (LAA)) reached 40% severity on the leaves in the mid-pod region of the canopy by 17 February, at the same assessment timing the severity of infection of *Botrytis* was assessed at 60% of LAA, in the same region of the canopy.

Disease progression throughout the season showed where a fungicide programme commenced at T1 or T2 (early or mid-late flower), the control of the two key diseases *Botrytis* (chocolate spot) (Figure 50) and rust (Figure 51) was greater at all assessment timings (2 Jan - 17 Feb).

### Table 3. Timing of fungicide applications and product rates applied 2010/11.

<table>
<thead>
<tr>
<th>Growth stage</th>
<th>Date</th>
<th>Product</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 Early flower</td>
<td>8 Dec</td>
<td>Folicur</td>
<td>0.3 l/ha</td>
</tr>
<tr>
<td>T2 Mid-late flower</td>
<td>21 Dec</td>
<td>Protek</td>
<td>1.0 l/ha</td>
</tr>
<tr>
<td>T3 Late flower- early pod fill</td>
<td>28 Dec</td>
<td>Proline</td>
<td>0.4 l/ha</td>
</tr>
<tr>
<td>T4 Late flower + 3 weeks</td>
<td>17 Jan</td>
<td>Comet</td>
<td>0.4 l/ha</td>
</tr>
<tr>
<td>T5 Late flower + 6 weeks</td>
<td>7 Feb</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 50.** Influence of fungicide product and timing on the severity of *Botrytis* (% leaf area affected with disease), Wakanui, Mid Canterbury 2011.
Figure 51. Influence of fungicide product and timing on the severity of rust (% leaf area affected with disease), Wakanui, Mid Canterbury 2011.

Of the fungicide programmes that commenced at late flower-early pod fill and partnered Protek with either of Folicur, Proline or Comet, the greatest control of Botrytis was achieved with the Folicur+Protek and Comet+Protek combinations, both having 48.5% severity of infection. Comet+Protek provided marginally better rust control compared to that of the Proline+Protek; 17 and 18% disease severity respectively.

Direct comparison between two applications of Folicur+Protek starting at mid-late flower (T2) and late flower-early pod fill (T3) clearly show the greater level of disease control achieved with beginning the fungicide programme earlier. When assessed on 17 February the percent leaf area affected with Botrytis was 16% where the fungicide programme commenced at mid-late flower, versus the 48.5% LAA when the first fungicide was applied at late flower-early pod fill (T3). The severity of the rust infection in the crop was 6% with the mid-late flower start date. Where the canopy was unprotected until late flower-early pod fill (T3), there was 30% LAA affected with rust.

Differences in the severity of disease present resulting from the fungicide applications carried through to yield. The mean yield was 8.6 t/ha, with the untreated crop yielding 82% of the mean.

All fungicide programmes significantly increased yield when compared to the untreated control. However there was no additional benefit from a four spray fungicide programme.

When comparing two spray fungicide programmes that started at late flower-early pod fill (T3), followed by a T3 + 3 weeks (T4) application, Proline was the most effective triazole partner for Protek in terms of yield (Figure 52). Comet+Protek alone was 0.1 t/ha higher yielding than that of the Folicur+Protek treatment; both treatments were applied at T3 and T4 and yielded below the mean at 95 and 94% respectively. When Comet was added to Folicur+Protek applied at late flower-early pod fill (T3) and T3 + 3 weeks (T4) an additional 0.5 t/ha was gained.

Fungicide timing proved to be more important than product choice. When comparing a Folicur+Protek programme starting at mid-late flower (T2) to the same programme with a start date of late flower-early pod fill (T3), the earlier commencing programme gave a significantly higher yield (0.63 t/ha).

The mean yield of the fungicide programmes that commenced at early flower was the highest at 8.9 t/ha, mid-late flower 8.8 t/ha; fungicide programmes that commence at late flower early pod fill had a mean yield of 8.5 t/ha.
Figure 52. Influence of fungicide product and timing on yield (t/ha).

**Protein content**

Across the 13 fungicide programmes a difference in protein content of 2.2% (from 26.7 to 28.9%) was generated (Figure 53).

Figure 53. Influence of fungicide treatment on the correlation between yield (t/ha) and protein content (%) in spring beans, Wakanui, Mid Canterbury 2011.
Paddock survey

- There was greater disease pressure on crops in 2011 from chocolate spot; the key disease that reduces green leaf area on the canopy.

- Rust in 2011 was only found in the paddock containing the FAR experimental work.

- Incidence and severity of root rot was higher in 2010, this can be attributed to the spring cultivar being sown early and sitting through a wet winter, particularly in South Canterbury.

- In 2011 with higher disease pressure there was an average of 2.9 fungicide applications made to faba bean crops. In 2010 this was marginally lower at 2.6.

Table 4. Summary of disease severity and incidence, Mid Canterbury - North Otago.

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence of chocolate spot</td>
<td>80%</td>
<td>100%</td>
</tr>
<tr>
<td>Average severity of infection</td>
<td>8%</td>
<td>34%</td>
</tr>
<tr>
<td>Incidence of rust</td>
<td>6%</td>
<td>4%</td>
</tr>
<tr>
<td>Average severity of infection</td>
<td>4%</td>
<td>-</td>
</tr>
<tr>
<td>Incidence of root rot</td>
<td>93%</td>
<td>87%</td>
</tr>
<tr>
<td>Average severity of infection</td>
<td>15%</td>
<td>9%</td>
</tr>
<tr>
<td>Incidence of Sclerotinia</td>
<td>33%</td>
<td>91%</td>
</tr>
<tr>
<td>Incidence of virus</td>
<td>27%</td>
<td>91%</td>
</tr>
</tbody>
</table>

Further reading:

8. Cropping sequences

- Dry matter production and quality as a potential whole crop silage
- Grain yield and quality
- Gross margin
- Soil quality
A long term cropping sequences experiment was established at Wakanui to look at three high protein legume crops, how they perform, and the effect on the subsequent crops. This was established as a component of the MPI SSF “Getting the Best from Beans” project.

The three crops were sown on the 20 September 2011 as farm scale plots (32 x 24 m) following ryegrass, and were managed as individual crops.

- Faba Beans – Spring cultivar cv Ben @ 303 kg/ha
- Peas – Marrowfat cv Midichi @ 365 kg/ha
- Lupins – Albus type cv Promore @ 150 kg/ha

**Dry matter production and quality as a potential whole crop silage**

The plots were sampled for dry matter twice during the growing season to enable the quantification of the biomass produced by each crop, and a compositional analysis to be done to determine the feeding value of the crop if it were to be made into silage.

Of the three crops, the largest canopy was produced by the lupins, which reached a fresh weight on the 28 February of 122 t/ha. The fresh weight of the faba bean crop reached 68 t/ha at the first assessment (20 January) and the peas 25 t/ha.

The three legume crops have different growth patterns and canopy structure, so ripened at different intervals. Hence when samples were taken for dry matter and composition analysis, the peas at the first sampling date were close to harvest and were at a much higher percentage dry matter (28%) than the lupins (15%) and faba beans (17%). At the second assessment on 28 February the beans had come up to 41% dry matter while the lupins were still extremely vegetative with a mere 17% dry matter.

Full quality composition analysis was conducted using near-infrared spectroscopy (NIRS) analysis of the whole crop dry matter samples (latest assessment for each of the crops). Of the three crops, the highest protein content was in the faba beans (14.3%). Faba beans and the peas had significantly higher protein contents than the lupins (Table 5). The highest level of soluble sugars and metabolisable energy was also found in the faba beans, again followed by peas with lupins being well behind. The key limitation to this information is the level of crop development at sampling; the peas were sampled just prior to desiccation at a mean dry matter content of 28%, the beans at 41% and lupins at just 17%.

Lupins produced the most dry matter overall, (20 t dm/ha), followed closely by the faba bean canopy (19 t dm/ha). The peas being a much more compact crop, had produced a canopy of 7 t dm/ha just prior to desiccation (Figure 54).
Table 5. Crop quality composition (crude protein, crude fat, ASH, acid detergent fibre digestion, neutral detergent fibre, soluble sugars and starches and metabolisable energy) of peas (samples 20 January), faba beans and lupins (samples 28 February).

<table>
<thead>
<tr>
<th></th>
<th>CP</th>
<th>Lipid</th>
<th>Ash</th>
<th>ADF</th>
<th>NDF</th>
<th>SSS</th>
<th>ME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faba beans</td>
<td>14.3</td>
<td>3.0</td>
<td>8.9</td>
<td>24.9</td>
<td>37.1</td>
<td>33.6</td>
<td>11.8</td>
</tr>
<tr>
<td>Peas</td>
<td>13.6</td>
<td>0</td>
<td>7.8</td>
<td>27.4</td>
<td>43.5</td>
<td>25.4</td>
<td>11.4</td>
</tr>
<tr>
<td>Lupins</td>
<td>10.8</td>
<td>1.8</td>
<td>5.4</td>
<td>35.5</td>
<td>55.9</td>
<td>10.5</td>
<td>9.1</td>
</tr>
<tr>
<td>Mean</td>
<td>12.9</td>
<td>1.6</td>
<td>7.3</td>
<td>29.3</td>
<td>45.5</td>
<td>23.2</td>
<td>10.8</td>
</tr>
<tr>
<td>LSD</td>
<td>2.2</td>
<td>0.7</td>
<td>0.6</td>
<td>1.7</td>
<td>4.1</td>
<td>3.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Sig</td>
<td>*</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
</tbody>
</table>

Figure 54. Dry matter production (t/ha) assessed on the 20 January and 28 February.

Grain yield and quality

The three crops were harvested over a period of 12 weeks. The highest yielding crop was the faba beans at 6.38 t/ha, followed by the marrowfat pea crop at 5.41 t/ha. The lupins, despite producing the biggest canopy had the lowest harvest index at 8% with a yield of 1.53 t/ha. The harvest index of the beans and peas was 34 and 75% respectively.

In terms of the quantity of protein produced per hectare, the faba bean crop produced the most at 1.71 t/ha. The peas produced 1.32 t/ha and the lupins 0.51 t/ha (Table 6).

Protein content of the grain of the three crops was significantly different (p = <0.001). The lupin crop had the greatest protein content (33.1%), followed by the faba beans (26.9%) and the peas (24.4%).
**Table 6.** Protein production per hectare of faba beans, peas and lupins grown at Wakanui, 2011.

<table>
<thead>
<tr>
<th></th>
<th>Faba Bean</th>
<th>Pea</th>
<th>Lupin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole crop silage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry matter (t/ha)</td>
<td>19.0</td>
<td>7.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Dry matter protein (%)</td>
<td>14.3</td>
<td>13.6</td>
<td>10.8</td>
</tr>
<tr>
<td>Dry matter protein (t/ha)</td>
<td>2.7</td>
<td>1.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Grain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain yield (t/ha)</td>
<td>6.4</td>
<td>5.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Grain protein (%)</td>
<td>26.9</td>
<td>24.4</td>
<td>33.1</td>
</tr>
<tr>
<td>Grain protein (t/ha)</td>
<td>1.7</td>
<td>1.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Harvest index</td>
<td>34.0</td>
<td>75.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>

**Gross margin**

Silage is sold per kilogram of dry matter with a price set for individual crops. Adjustment could be made to this based on quality testing, however this is not necessarily common practice. For the purpose of calculating the gross margins of the crops, the returns for all crops have been calculated at 22 cents per kilogram of dry matter. Making the income/ha directly proportional to the quantity of dry matter produced.

The greatest return/ha for a standing crop was achieved by the lupins ($3,316) (Table 7). As the second highest producer of biomass, the faba bean crop had a standing return rate of $2,776/ha, while the return for peas was $524/ha. In terms of the cost to produce a kilogram of standing dry matter for each of the cropping options the difference between the faba beans and lupins was slight at seven and six cents respectively, the peas were higher at 15 cents/kg of standing dry matter.

**Table 7.** Gross margin for standing whole crop silage crops of faba beans, peas and lupins grown at Wakanui, 2011.

<table>
<thead>
<tr>
<th></th>
<th>Faba Bean</th>
<th>Pea</th>
<th>Lupin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest date</td>
<td>28 Feb</td>
<td>20 Jan</td>
<td>28 Feb</td>
</tr>
<tr>
<td>Income/ha ($)</td>
<td>4125</td>
<td>1595</td>
<td>4455</td>
</tr>
<tr>
<td>Seed ($)</td>
<td>348</td>
<td>310</td>
<td>248</td>
</tr>
<tr>
<td>Establishment ($)</td>
<td>155</td>
<td>155</td>
<td>155</td>
</tr>
<tr>
<td>Herbicide ($)</td>
<td>47</td>
<td>74</td>
<td>47</td>
</tr>
<tr>
<td>Insecticide ($)</td>
<td>27</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fertiliser ($)</td>
<td>214</td>
<td>214</td>
<td>214</td>
</tr>
<tr>
<td>Fungicide ($)</td>
<td>209</td>
<td>157</td>
<td>157</td>
</tr>
<tr>
<td>Irrigation ($)</td>
<td>258</td>
<td>86</td>
<td>258</td>
</tr>
<tr>
<td>Spray application ($)</td>
<td>90</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>Total Expenditure/ha ($)</td>
<td>1,349</td>
<td>1,071</td>
<td>1,139</td>
</tr>
<tr>
<td>Gross Margin/ha ($)</td>
<td>2,776</td>
<td>524</td>
<td>3,316</td>
</tr>
</tbody>
</table>

**Note:** Excludes harvesting costs. Figures used in the gross margin are actual costs and are subject to change. Based on 22 cents/kg dm.
When returns are compared in terms of grain yield, the standing crop of peas had a gross margin of $2,910 per hectare (Table 8). The faba bean crop required additional applications of fungicide, insecticide and irrigation to that of the peas, finishing on a gross margin per hectare standing of $1620. The lupin crop, despite the lowest set of expenses, had a gross margin of $258 per hectare due to a grain yield of 1.53 t/ha.

The cost of production per standing tonne of crop was very similar between the faba beans and peas at $216 and $212 respectively. The lupin crop however cost nearly four times more to produce each tonne of crop ($801).

In terms of protein content, the most cost effective tonne of protein was produced by the faba beans. It cost $807 to produce one tonne of protein from a faba bean crop; this is $67 less per tonne than peas and $1,617 less than lupins. The cost to produce one tonne of protein from the lupins was $2,420.

Table 8. Gross margin for standing grain crops of faba beans, peas and lupins grown at Wakanui, 2011.

<table>
<thead>
<tr>
<th>Harvest date</th>
<th>Faba bean</th>
<th>Pea</th>
<th>Lupin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income/ha ($)</td>
<td>2999</td>
<td>4058</td>
<td>967</td>
</tr>
<tr>
<td>Seed ($)</td>
<td>348</td>
<td>310</td>
<td>248</td>
</tr>
<tr>
<td>Establishment ($)</td>
<td>155</td>
<td>155</td>
<td>155</td>
</tr>
<tr>
<td>Herbicide ($)</td>
<td>62</td>
<td>136</td>
<td>104</td>
</tr>
<tr>
<td>Insecticide ($)</td>
<td>27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertiliser ($)</td>
<td>214</td>
<td>214</td>
<td>214</td>
</tr>
<tr>
<td>Fungicide ($)</td>
<td>209</td>
<td>157</td>
<td>157</td>
</tr>
<tr>
<td>Irrigation ($)</td>
<td>258</td>
<td>86</td>
<td>258</td>
</tr>
<tr>
<td>Spray application ($)</td>
<td>105</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Total expenditure/ha</td>
<td>1,379</td>
<td>1,148</td>
<td>1,225</td>
</tr>
<tr>
<td>Gross margin /ha</td>
<td>1,620</td>
<td>2,910</td>
<td>-258</td>
</tr>
</tbody>
</table>

Note: Excludes harvesting costs. Figures used in the gross margin are actual costs and are subject to change.

Table 9 and 10 account for fluctuation in market price and yield.

Table 9. Situational analysis for yield (t/ha) and market prices ($/ha) for faba beans.

<table>
<thead>
<tr>
<th></th>
<th>5 t/ha</th>
<th>6 t/ha</th>
<th>7 t/ha</th>
<th>8 t/ha</th>
<th>9 t/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>$300/t</td>
<td>1500</td>
<td>1800</td>
<td>2100</td>
<td>2400</td>
<td>2700</td>
</tr>
<tr>
<td>$400/t</td>
<td>2000</td>
<td>2400</td>
<td>2800</td>
<td>3200</td>
<td>3600</td>
</tr>
<tr>
<td>$500/t</td>
<td>2500</td>
<td>3000</td>
<td>3500</td>
<td>4000</td>
<td>4500</td>
</tr>
<tr>
<td>$600/t</td>
<td>3000</td>
<td>3600</td>
<td>4200</td>
<td>4800</td>
<td>5400</td>
</tr>
</tbody>
</table>

Table 10. Situational analysis for yield (t/ha) and market prices ($/ha) for peas.

<table>
<thead>
<tr>
<th></th>
<th>3 t/ha</th>
<th>3.5 t/ha</th>
<th>4 t/ha</th>
<th>4.5 t/ha</th>
<th>5 t/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>$500/t</td>
<td>1500</td>
<td>1750</td>
<td>2000</td>
<td>2250</td>
<td>2500</td>
</tr>
<tr>
<td>$600/t</td>
<td>1800</td>
<td>2100</td>
<td>2400</td>
<td>2700</td>
<td>3000</td>
</tr>
<tr>
<td>$700/t</td>
<td>2100</td>
<td>2450</td>
<td>2800</td>
<td>3150</td>
<td>3500</td>
</tr>
<tr>
<td>$800/t</td>
<td>2400</td>
<td>2800</td>
<td>3200</td>
<td>3600</td>
<td>4000</td>
</tr>
</tbody>
</table>
Soil quality

At establishment (20 September) there was 95.1 kg of soil mineral nitrogen in the soil profile (0 - 60 cm). Post-harvest soil sampling showed the quantity of soil mineral nitrogen to have increased as a result of each of the three crops. The greatest increase of 85 kg mineral nitrogen per hectare was a result of the pea crop. Following the harvest of the peas (12 weeks earlier than lupins and 8 weeks earlier than the faba beans) the ground was left fallow. The lupin crop added 30 kg of mineral nitrogen to the soil profile while the faba beans added the least at 8 kg of mineral nitrogen.

The levels of soil mineral nitrogen at establishment were high in this trial. The New South Wales Agriculture Faba Bean Guide states that faba bean crops fix the most N when levels of soil nitrate-N in the top 90 cm are less than about 50 kg N/ha at sowing and the N demand by the faba bean plant for growth is high, meaning the plant has to work harder. Faba bean is an efficient rotation crop in wheat systems as it increases yield (up to 1.5 t/ha), and grain protein (up 0.7 - 1%) in the next wheat crop (Mathews and Marcellos, 2003).

Differences generated in soil mineral nitrogen levels following the crop are expected to change over time. Peoples et al (2009) reported that only a fraction of the nitrogen in legume residues becomes available as mineral nitrogen in the first year. The release of mineral N is influenced by soil water content, temperature, pH, the amount of residues returned to the soil after a legume phase, the ‘quality’ (particularly C:N ratio) of those residues, and the length of the fallow period between the end of the legume phase and the sowing of the next crop. Peoples et al (2009) also commented that the direct effect of legumes on soil N fertility are not necessarily the main source of rotational benefits for following crops. For example faba beans provides a break in disease cycles (both cereal leaf and root disease cycles) in wheat, thus contributing to increased yield of that crop.

Paddock survey

- The 2011/12 survey results showed the average cost per hectare of fungicides applied to be $128.
- Pesticide applications averaged $24/ha.
- Irrigation applications for the season averaged $92/ha.
- Herbicide application averaged $76/ha.
- The greatest expenditure to production was in the cost of the seed.

Further reading:


9. Harvest guide

- Aspects to consider
**Key points:**

- Desiccant is an option for faba beans to eliminate variation in crop finish.
- Faba beans can be harvested when other crops may still be too damp, e.g. mornings, or after a light shower.
- Header set up is crucial in minimising unnecessary yield losses.

As the faba bean crop matures the pods turn black and the stem dies off. The beans inside the pods dry out and the crop becomes leathery/brittle. Crop moisture must be no more than 15% for receival and storage.

**Aspects to consider**

**Desiccant**

Desiccant is an option for faba beans to eliminate variation in the crop’s finish. This can be particularly useful where a paddock has grown unevenly, been exposed to different levels of moisture availability or is particularly weedy.

At the point of desiccation, the majority of the crop canopy green leaf area should have died down, enabling full penetration into the bottom of the canopy. As a contact-only herbicide, Reglone® acts rapidly on the remaining green area of the crop and weeds.

Reglone is recommended at a rate of 3.0 litres per hectare, to be applied with a water rate of 200 - 500 litres per hectare and a non-ionic surfactant adjuvant.

**Moisture**

Faba beans can be harvested when other crops may still be to damp, e.g. mornings, or after a light shower.

Harvesting slightly damp crops with slightly leathery pods may aid reducing harvest losses and shedding on contact with the reel.

**Header set up**

(Matthews & Marcellos, 2003)

- Open front headers are best for harvesting faba beans as most of the crop has to go through the machine.
- Rotary combines are gentler on the seed than concave, drum and straw-walker machines.
- Be as gentle with the seed as possible during harvest. This means wide concave clearances (15 - 35mm) and slow drum speeds (400 - 600 rpm).
- Use maximum airflow to get a clean sample.
- The reel should only touch the top part of the crop. Adjust speed to match the ground speed of the machine to reduce shattering of pods.
- Minimise the amount of repeat threshing by adjusting sieves.

**Additionally**

Spring cultivar pods may split, but should hold the seed. Monitor losses on the ground.

In more extreme weather (very hot or continual wetting and drying conditions) splitting of the pods is more evident with seed shedding, particularly in the heat. In wind damaged crops the degree of shedding varies with the degree of crop damage and disease present.

To achieve a clean sample apply full air whilst harvesting.

Use the reel to pick up the crop slowly. The reel may need to be set as high as possible.

Try and set the cutter bar below the lowest pods as harvest losses due to missing the lower pods can be significant.

---

**Figure 55.** Naturally senesced spring faba beans.
Paddock survey

- From the survey data collated, the average yield loss per ha for a grower in the 2010 season was 850 kg/ha. In the 2011 season the losses in the spring cultivar across the survey paddocks averaged at 960 kg/ha. Losses in the winter cultivar were 1300 kg/ha.

Further reading: