National Faba Bean Improvement Program - Southern Region, Victorian Component

Summary

Faba beans are widely adapted and adopted across Victoria (VIC) from low rainfall, short season environments in the southern Mallee, to high rainfall, long season, acid soil environments in the south west regions of VIC. They also perform well under irrigation in central VIC. Over the past five years, the area sown to faba beans has averaged 38,000ha in VIC, compared to 24,000ha in New South Wales (NSW), 2,000ha in Queensland (QLD), 21,000ha in Western Australia (WA) and 48,000ha in South Australia (SA).

The faba bean evaluation program in VIC has focused on:

1. Developing high yielding faba bean varieties suitable for human consumption that can be grown in low, medium, high rainfall and irrigation areas of VIC. Traits to be incorporated into these varieties include new, high quality resistance to ascochyta blight (Ascochyta fabae), chocolate spot (Botrytis fabae) and rust (Uromyces viciae-fabaе).
2. Increasing the awareness of growers and other industry representatives about issues relating to faba bean production and marketing.

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Conclusions
Two new faba bean varieties, Fiesta VF and Manafest, with potential to increase yields from 5-20% across VIC have been released.

The release of new varieties with strong resistance to disease has reduced dependency on fungicides to control disease.

Manafest has good tolerance to iron and manganese chlorosis, which occurs on waterlogged and high pH soils.

Potential new faba bean varieties are ACC483/3, Ic*As/56/1, Ic*As/7/3, and Ic*As/7/6.

Kerang is the only irrigated faba bean evaluation site in VIC. This site provides valuable information for the National Faba Bean Improvement Program (NFBIP) about irrigation, yield, disease, rhizobium strains, fungicide management and weed control.

The variety Ascot VF yields between 10-20% less than other current commercial varieties of faba beans. However, Ascot VF has an unblemished, disease free seed coat quality better than any other variety, making it very attractive for grain merchants.

Homer, a potential release from the northern NSW breeding program, yielded less than recently released varieties Fiesta VF and Manafest in southern Australia and so has not been adopted by growers in these areas.

NFBIP has been evaluating broad beans at Hamilton. The lines being evaluated are reselections that have been crossed with varying material. They have been yielding up to 25% more than the current commercial broad bean variety. However, the disease resistance levels of the evaluated lines are the same as those of Aquadulce.

Potential new faba bean varieties have better grain yields and greater resistance to ascochyta blight and chocolate spot.

There is evidence that chocolate spot, ascochyta blight resistance and agronomically desirable characteristics can be recombined and improved through a system of crossing and recurrent selection, e.g. ACC483/3 is a reselection from Fiesta VF. The line has been through extensive testing for resistance against ascochyta blight and has been selected for release as a variety in 2004.

Hamilton and Rutherlgen are the high rainfall, acid soil sites used for evaluation in VIC. The Hamilton site is an extremely valuable chocolate spot, disease monitoring and evaluation site for the NFBIP. It is the best site in southern Australia for chocolate spot disease screening and for the past three years has been used as the major selection site for resistance to this
Agronomic traits such as disease resistance, seed purity, colour and uniformity, time of flowering and lodging resistance remain major selection criteria in the program.

Adaptation of faba bean varieties differs between northern and southern Australia. Varieties such as Manafest that are widely adapted and high yielding in southern Australia do not perform as well in northern NSW. Similarly, Fiesta VF grows very well in all southern states of Australia but not in the north.

In conjunction with the National Rhizobium Evaluation Program DAV365, faba beans have been evaluated with different rhizobium strains across a wide range of soil types in VIC.

**Recommendations**

Quality and yield should be given equal consideration when selecting parents for the breeding program.

Utilise the northern faba bean breeding program as a source of early maturing breeding material for the Victoria short season, low rainfall environment.

A disease screening nursery containing all entries in stages 1, 2, 3 and 4 trials should be established at Horsham and Hamilton to ensure that all varieties released from the National Faba Bean Improvement Program (NFBIP) are resistant to chocolate spot and ascochyta blight. These trials should also be used to monitor other diseases (cercospora and alternaria) and insect activity.

Breeders need close liaison with grain marketers to plan crosses that will meet future market expectations. Feedback from foreign traders is that the seed coat of Fiesta VF is a darker buff colour than Manafest and that the seed of Fiesta VF will turn darker more quickly than Manafest. A new faba bean should have the seed uniformity and size of Fiesta VF with the seed coat colour of Manafest.

Faba beans need to be inoculated with the correct rhizobium strain for healthy root and plant development, especially in soils that are considered difficult, i.e. soils that are subject to waterlogging or have low pH. The most effective rhizobium strain for faba beans is the old field pea strain, SU303; not the current faba bean rhizobium strain WSM1274. Treating seed with a pulse seed treatment such as P-Pickel T or Apron XL will kill the rhizobia. Further research should focus on nationally evaluating the best rhizobium strain for faba bean.

Windrowing of faba beans has become increasing popular. Further research work is required to develop a package to optimise this practice. During harvest 2001/02 there were many faba and broad bean crops windrowed before seed had reached full physiological maturity, reducing seed weight. Many windrows were left for a prolonged period of time during which the seed weathered, resulting in seed coat discolouration that decreased the market value of the grain. Windrow research should focus on the maturity stage at which beans can be windrowed and how long windrows should be left before being harvested.

Before the release of a new faba bean variety, research should be undertaken to determine the best seeding rates for that variety. For instance, when Fiesta VF was first made available to farmers in 1998 there was a very late (July) notification of seed shortage, resulting in a 20% reduction in original seed allocations. The late seed notification forced growers to decrease seeding rates to enable them to sow the planned areas of faba bean. There were more than 150 enquiries about whether low seeding rates were likely to significantly reduce grain yields.

**Outcomes**

**Economic Outcomes**

New dual disease resistant varieties will save growers money by reducing fungicide applications and producing clean, disease free seed for export markets. This will be able to be achieved by 2004 with the release of ACC483/3, which is resistant to ascochyta blight. This resistance should reduce the number of fungicide applications needed by at least one and possibly two sprays. If 50% of growers take up this new variety within two years of its release, there will be an estimated 19,000ha of ACC483/3 beans sown in 2006. This will save up to $1.6 million/year on fungicides alone, without taking account of savings from reduced seed cleaning costs.
Environmental Outcomes
The release of two varieties with MR to ascochyta blight and chocolate spot will reduce the agricultural chemical input by a minimum of 2.5kg/ha each time a bean crop is grown. Access to disease-resistant varieties has increased grower confidence in growing beans. The area of non traditional cropping ground has increased due to new varieties' tolerance of subsoil limitations. Cropping with faba beans instead of fallowing will reduce ground water recharge and consequent potential salinity problems. Growing legumes increases soil nutrients. A pulse crop increases the amount of available nitrogen (N) for following crops by 40kg/ha; thus reducing the amount of N fertiliser applied and so reducing overall input costs.

Social Outcomes
New faba bean varieties with resistance to chocolate spot, ascochyta blight and rust will give growers confidence to grow a successful and more profitable crop across a wider growing region with greater economic benefit within the faba bean industry due to faba beans becoming a low input crop with regards to fungicide and maintenance. The high rainfall areas of VIC have had three consecutive years of failed faba crops due to severe infection of chocolate spot in the growing season around August, resulting in growers recording up to 95% crop failure. Producing a chocolate spot resistant variety will renew faba bean grower confidence in this cropping area.

Achievements/Benefits
New faba bean germplasm has been introduced into Australia by the NFBIP, which is based at Waite Institute, Adelaide. Faba beans are introduced from regions that have produced high yielding material in the past (Brazil, Argentina, Ecuador, Paraguay, Spain, China, Tunisia, Sudan, Lebanon, Cyprus, Greece, Turkey, Italy and Portugal) and from low rainfall areas (Egypt, Ethiopia, Morocco, Libya, Algeria and Iraq). Emphasis was placed on disease resistance. New introductions are initially grown at the Waite Institute to assess disease resistance and agronomic suitability prior to evaluation in VIC.

Disease resistance:
The diseases ascochyta blight and chocolate spot are two of the major factors limiting the expansion of faba beans in VIC. Disease resistant faba bean lines are developed through introduction, hybridisation and by selecting disease resistant plants from existing heterogenous populations.

High yielding lines with moderate resistance to ascochyta blight and chocolate spot have been selected from the progeny of a cross between the two commercial faba bean lines Icarus\(^{D}\) and Ascot VF\(^{D}\) (Ic\*As) that were made in Adelaide. These progeny were subsequently evaluated across VIC. In particular there was close monitoring of chocolate spot resistance in new lines at Hamilton, VIC.

Advanced testing
Advanced faba bean yield trials are sown in SA, VIC, WA and NSW. These trials aim to assess the disease resistance and adaptation of potential new faba bean varieties across southern Australia prior to release. Victoria's advanced trials are located in the Wimmera, southern Mallee, North East, South West and Northern Irrigation Regions. The seed quality of all potential new varieties is tested in SA as part of a nationally coordinated quality assessment project. DAS290, funded by GRDC. A quality screening support for pulse breeding programs - Southern Region project ran from July 1999 to June 2002. Any quality testing before this would have been undertaken as part of project DAW440 - A national coordinated program for the quality evaluation of Australian pulses.

Evaluation
Victorian faba bean evaluation areas include the low rainfall (<330mm) short season environments in the Mallee and the north central irrigation area. Wimmera trials are grown at a site with a medium rainfall (400mm), medium growing season and alkaline soils. The south west region is principally black acid soil with an average rainfall of 610mm and a long growing season. The north east region of VIC is considered to have red acid soils, an average rainfall of 600mm and with a medium to long growing season environment.

Major Achievements
A major aim of the National Faba Bean Improvement Program (NFBIP) is to release faba bean varieties for south east Australia that are resistant to the three major diseases of faba beans, ascochyta blight, chocolate spot and rust. The varieties released from NFBIP to date are Fiesta VF and Manafest in 1998 and 2001, respectively. The Victorian component of DAV367 has made significant contributions to these releases.
ACC483/3 is a variety currently being commercialised for Plant Tech with seed being available to growers in 2004. Ic*As/56/1, Ic*As/7/3 and Ic*As/7/6 are being re-selected as there is enough data collected for these lines to be commercialised.

Four lines (ACC483, Ic*As/56/1, Ic*As/7/3, Ic*As/7/6) have good lodging resistance, excellent early season growth, buff seed coat and a uniform seed size crucial for the export market. These lines have yielded equal to or better than Fiesta VF in the major faba bean growing areas of the Wimmera and South West of VIC. ACC483/3 is a selection from Fiesta VF with equivalent if not better yields than Fiesta VF and better resistance to ascochyta blight. ACC483/3 is being multiplied and may be released in 2004. Ic*As/7/3 and Ic*As/7/6 have been re-selected for a buff seed coat by the national faba bean breeder. A buff seed coat colour is preferred for the export market. The release of ascochyta blight and chocolate spot resistant lines will reduce costs associated with fungicide sprays and improve quality and reliability of yield.

The evaluation and selection of faba bean accessions and germplasm with improved field resistance to ascochyta blight and chocolate spot is on track within the Victorian component of the national breeding program. A large proportion of the germplasm is expected to be either MR or resistant to both diseases within the next three to four years. Field disease nurseries evaluating diseases resistance of ascochyta blight and chocolate spot have been established and continuous improvement in resistance is being achieved.

Improved grain quality has been an important aim of the breeding and evaluation program. Selection of genotypes with good quality buff coloured seed has been simultaneous with selection for other important traits such as yield, disease resistance and superior agronomic traits. Yield data are very encouraging, indicating that the new types can be grown economically in south west VIC, Wimmera and possibly the Mallee, producing good grain quality under average rainfall.

Potential new releases

ACC483/3
ACC483/3 is a selection from Fiesta VF that has been commercialised and will be available for growers in 2004. Its seed size (60-80g/100 seeds) and buff seed coat colour are similar to those of Fiesta VF. Two tonnes of ACC483/3 seed were sown in 2002. One lot of seed was sown on irrigation in Hay, NSW. The second lot of seed was sown in south eastern Australia. Plant Tech has the rights to this variety. ACC483/3 has shown widespread adaptation across all growing season environments of VIC, especially those with short to medium growing seasons. ACC483/3 has conventional faba bean morphology. The variety is tall standing, similar to Fiesta VF and not as tall as Manafest. It has excellent early plant vigour and erect early branching and is competitive with weeds. ACC483/3 flowers at the same time as Fiesta VF; three weeks earlier than Icarus and four days after Fiord and Barkool. Its resistance to ascochyta blight will ensure a much cleaner seed coat colour similar to Ascot at harvesting time. Its moderate susceptibility to chocolate spot will merit a fungicide application during first stages of flowering to prevent the disease from causing flower abortion and yield loss.

Ic*As/56/1
Ic*As/56/1 is a tall line with good lodging resistance and excellent early vigour. Ic*As/56/1 flowers about 4-7 days after Fiord, similar to Fiesta VF. It is MR to chocolate spot, resistant to ascochyta blight and MR to rust. Ic*Ac/56/1 has a medium sized seed with a buff seed coat. Ic*As/56/1 is being multiplied at Charlick, SA, by the national faba bean breeder with 200kg of seed expected to be available at the end of the 2002/03 season. Ic*As/56/1 is likely to be the first dual resistant faba bean variety released in Australia.

Ic*As/7/3
Ic*As/7/3 is a medium to tall line with good lodging resistance and excellent early vigour. Ic*As/7/3 is MR to chocolate spot, resistant to ascochyta blight and MR to rust. Ic*As/7/3 flowers at a similar time to Fiesta VF. Ic*As/7/3 is similar in seed size (55-75g/100 seeds) and colour to FiestaVF and has uniform seed size. Seed is being multiplied at Charlick, SA, with the dry season expected to limit seed production to 100kg.

Ic*As/7/6
Ic*As/7/6 shows wide adaptation across all VIC faba bean evaluation sites, yielding 30% and 27% more than Fiesta VF in the south west and on irrigation, respectively. It is also the highest yielding dual disease resistant variety for the Mallee and Wimmera regions. Ic*As/7/6 is a medium to tall line with good lodging resistance and excellent early vigour. Its yield is equal to or greater than Fiesta VF, particularly in VIC’s major faba producing areas. Ic*As/7/6 is MR to chocolate spot, resistant to ascochyta blight and MR to rust and flowers at a similar time to Fiesta VF. Ic*As/7/6 has a medium sized seed with a uniform seed size. It is being screened in shade houses and tested for uniformity of seed coat colour.

Rhizobium evaluation
For maximum production, faba beans require effective nodulation by rhizobia. The survival and growth of *Rhizobium* sp. in soil environments can be affected by a combination of factors including alkalinity (often in conjunction with high concentrations of calcium and boron), acidity (and aluminium toxicity), salinity, soil temperature, moisture, fertility (including nutrient deficiencies) and soil structure. The correct soil pH is crucial for the survival of *Rhizobium* sp., and strains of rhizobia differ in their ability to infect the host plant in adverse soil pH environments; hence the investigation of rhizobia faba bean interactions across a diverse soil pH range (4.2 to 8.9 CaCl\(_2\)). Rhizobial strains also function differently across individual varieties of the same species.

*Rhizobium* field experiments on faba beans were conducted at nine sites in SE Australia 1999/00 and 2001/02. These experiments were conducted at Rutherford, NE VIC; Penshurst and Hamilton, SW VIC; Horsham, Wimmera, VIC; Walpeup, Mallee, VIC; Brocklesby, southern NSW, and in northern Tasmania (TAS).

Seed coat discolouration
In 1999, chocolate spot and ascochyta blight were present at low levels in most crops and were not expected to cause major losses. However, grain harvested from many crops had a high proportion of discoloured seed. From visual inspection of the grain, it was unclear whether the discolouration was caused by weather damage resulting from rainfall just prior to harvest, or by disease. The faba bean program investigated the cause of this seed coat discolouration in faba beans and determined the health of the discoloured seed.

Findings from this project were communicated to growers and industry representatives through a wide range of media including GRDC Updates, the Faba Bean Symposium Conference, Australia Grain Magazine, Ground Cover, NFBIP annual report, Victorian Faba Bean Evaluation annual report, Farming Systems annual report (Birchip, Wimmera Farming and Southern Farming), radio, TOPCROP meetings, rural newspapers and local and state newspapers.

**Other research**

Future research should incorporate rhizobium evaluation; since individual rhizobium strains react differently across regions.

Produce varieties that have less seed discolouration in storage.

Broad leaf weed control is vital in beans. Once the crop has emerged, there are limited registered chemicals that can control broadleaf weeds in beans. Identifying new chemicals to control broadleaf weeds will assist and encourage growers to sow a greater area of their farms to beans.

Develop a fungicide management protocol for new varieties. In high disease pressure years (1992, 1996 and 2000 for ascochyta blight and 1998, 1999, 2000 for chocolate spot), faba bean crops were devastated by disease. Developing a fungicide package for potential new releases will provide security for growers as they will be able to economically produce faba beans in high disease pressure years without losing their crop income.

Investigate different sowing rates for new lines. As the industry experienced in 1998 when Fiesta VF was made available to growers for the first time, the main question to researchers, was 'What is the lowest rate beans can be sown without encompassing a yield penalty?' Fortunately, the VIC component of the NFBIP carried out sowing rate trials the previous year and could answer the question. In 2003 a sowing rate trial for potential releases should be performed so researchers and agronomists can respond to industry's need for sowing rate information.

Ninety percent of the faba beans produced in Australia are exported overseas for human consumption. Research quality testing, including cooking, of faba beans is critical for our markets. Quality testing on faba beans with the national coordinated program for the quality evaluation of Australian pulses should be continued.

Faba bean plants continue to drop flowers and abort pods every year. This problem is believed to reduce yield, restricting production. Increased faba bean production is an outcome the NFBIP is striving to achieve. Determining the cause and consequences of flower loss and pod drop is crucial for the breeding program. The outcome of research to address these issues will help growers achieve high yielding bean crops and result in increased production of beans.

**Intellectual property summary**

The management of intellectual property (IP) will be the responsibility of The University of Adelaide (UA).
Varieties released directly from germplasm introduced from overseas (e.g. ICARDA) will not be covered by Plant Breeder’s Rights (PBR). All other varieties will be protected by PBR to protect the investment of stakeholders. Each variety will be commercialised, through a public tender process, by a company with proven skills in seed multiplication, promotion and distribution. A committee of representatives from the state government, GRDC and industry groups will select the successful commercial partner based on a set of criteria developed by the state government and GRDC stakeholders. Equity will be based on the financial input of stakeholders into the development of the new varieties.