New vetch varieties for grain and hay production for Australian farmers

PROJECT DETAILS

PROJECT CODE: DAS00086
PROJECT TITLE: NEW VETCH VARIETIES FOR GRAIN AND HAY PRODUCTION FOR AUSTRALIAN FARMERS
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Summary

This project focused on the development of vetch varieties for national grain and hay and silage production with respect to improved on-farm productivity.

Project objectives were to:

1. breed and develop new common vetch varieties that are well adapted to diverse Australian rainfall areas, resistant to the main diseases (rust, ascochyta and botrytis), low in grain toxin (< 0.65%), non-shattering, and with beige or yellow cotyledons.
2. develop new woolly pod vetch varieties that combine the required traits for grazing and hay and silage production, soft seeds, palatable for grazing, and tolerant to ascochyta and botrytis.

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Conclusions

The National Vetch Breeding Program (NVBP) is focused on breeding improved common vetch (Vicia sativa) and woolly pod vetch (Vicia villosa) varieties.

The emphasis of the project was to breed common vetch varieties tolerant to drought and heat stress, resistant to rust and ascochyta and with grain toxin levels < 0.5%. Over the past two years, the project evaluated advanced breeding lines for herbicide tolerance. The project successfully addressed the potential of vetch to provide a grain legume option for regions where there are currently no reliable legume species. Common vetch varieties have multipurpose end use options, as grain, hay and silage, pasture and green manure.

Breeding new vetch varieties is based on traits required and requested by growers and end users in Australia. Recombination of germplasm from different origins produced improved vetch varieties. The acknowledged benefits from vetch in subsequent crops have significantly increased the area of vetch sown on farm in Australia over the past 10 years.

Two new vetch varieties released in 2012/13 will increase the area sown to vetch where growers plant vetch for early grazing in July and for grain production in lower rainfall areas (< 350 mm/yr). Observations showed these lines have better early establishment and growth and yield more than current varieties in grain and dry matter production in South Australia (SA), Victoria (VIC), New South Wales (NSW) and Western Australia (WA) for the past three to five years.

The project concentrated on woolly pod vetch providing growers with varieties that have high dry matter production, soft seed, ascochyta resistance, non-shattering characteristics, and good palatability as green plants. This project began breeding improved varieties over the past three years but at this stage no new breeding lines for release as new varieties have been produced. Selections were made from introductions, mostly imported from Serbia by this project, that possess some of the required traits i.e. higher in dry matter production, and more tolerant to ascochyta, botrytis, and frost when compared to current varieties.

Since 1992, NVBP tested many introductions and combined parental germplasm that possessed one or more essential characteristics for recombination to provide better vetch varieties for Australian growers.

Recommendations

The foliar diseases, rust and ascochyta, are still major issues in vetch production. In 2010, both diseases occurred in most areas for the first time in many years prompting concern from agronomists and growers. Morava\(^1\) and Rasina\(^1\) are both resistant to rust and tolerant of ascochyta. However, severe symptoms were observed on other varieties. It is still not economic to apply recommended fungicides to vetch. One application of fungicide can increase the cost of production by $19/ha for chemicals (mancozeb\# $8.75/kg x 2.2 kg/ha), and $4 to $7/ha for machine or sprayer use, equating to $23 to $26/ha/application with a

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recommended three to four applications per year. A crop infected by rust must not be used for stockfeed as it may induce abortion in pregnant animals. All new varieties released from the NVBP will be rust resistant.

Grain from Morava and Rasina can be fed freely to all ruminants. Trials conducted in this project demonstrated that grain from these varieties provides an excellent protein source for the fattening or maintenance of livestock, either pure or in a mixture with cereals and hay. It is an excellent cost effective protein source for intensive livestock systems particularly if produced on-farm. All new varieties of common vetch released by the NVBP will have similar or lower grain toxin levels to these varieties.

Two common vetch lines are currently in the process of Plant Breeders’ Rights (PBR) registration for release as new varieties in 2012/13. SA-34823 is earlier than Rasina and higher in grain and hay production than present varieties for the past four years in low and mid rainfall areas, 330 to 380 mm/yr. SA-34748 matures between Rasina and Morava and is higher in grain and hay production than all current varieties in mid and high rainfall areas (> 350 mm/yr).

It was recognised that V. villosa (woolly pod vetch) has the potential to perform better than common vetch in hay production areas with > 400 mm/yr rainfall, by 0.7 to 1.3 tonnes/ha. This can equate to an extra $120 to $220/ha with the current price of $140 to $210/t for vetch hay. The major disadvantages of this species are the hard seed percentage of current varieties and the toxicity of the grain. However, with proper management, it is an excellent fodder crop, both green and as dry matter, and also a productive green manure option in rotation. The program has selected and bred germplasm from woolly pod vetch to provide growers with higher yield varieties for hay and silage production with lower hard seed levels. New varieties are planned for release in 2014/15.

Outcomes

Economic: In this project, a number of lines were assessed or selected with higher grain and hay yields than present varieties in areas of 330 to 500 mm/yr of rainfall. Over three years at five sites in SA, two in VIC, three in NSW and one site in WA, these yielded more than all current varieties in grain production by 11 to 14%, equating to 550 to 700 kg/ha or $250 to $320/ha using current grain prices of $460/t.

The foliar diseases, rust and ascochyta, can significantly reduce grain and dry matter production and quality of hay, silage and grain. Several lines were selected during the project that showed good rust resistance. Control of rust is very important, as plants infected by rust can cause abortions in pregnant animals (data from growers in SA’s Mid North and Russia). Avoiding one fungicide spray can reduce production costs by $19/ha for chemicals (mancozeb# $8.75/kg x 2.2 kg/ha) and $4-$7/ha for sprayer use.

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

It was recognised that woolly pod vetch can perform better than common vetch for hay production in areas with > 400 mm/yr rainfall, by 0.7-1.3t. This yield advantage with a current price of $140-$210/t will return an extra $120-$220/ha. The program has selected and bred germplasm from woolly pod vetch to provide growers with better varieties for hay and silage. New varieties are planned to be released in 2014/15.

Environmental: Disease resistant vetch varieties can be successfully grown without chemical use. As a legume component in a farming system, vetch can help in managing diseases and weed resistance in following crops and returns significant amounts of nitrogen to the soil. Reducing on-farm reliance on chemicals and mineral fertilisers has positive environmental and economic benefits on-farm.

Social: The social benefits are delivered by increased profit on-farm and to the community through greater profitability and prosperity from vetch production in a cropping rotation. Economic, environmental and social benefits from high yielding, disease resistant, versatile vetch varieties for Australian growers have been and continue to be considerable.

Two new common vetch varieties will be released in 2012/13 that are higher in grain and hay yield and show better initial growth than present varieties. These will be rust resistant, soft seeded (> 95% germination), with grain toxin levels < 0.65%.
For woolly pod vetch, the project selected five lines, from introductions, that showed 5-10% higher hay yields than current varieties Haymaker and Capello at four sites over three years. These lines also showed better early establishment and softer seeds.

**Achievements/Benefits**

Vetch (*Vicia* spp.) is a legume of Mediterranean origin that has shown agronomic potential in a range of Australian cropping environments. Vetch can play a valuable role in rotations because of its multiple end uses including grain, grazing, fodder hay, silage and green manure, and because of resistance to the cereal diseases, cereal cyst nematode (CCN) and take all. Vetch can be included in crop rotations as a legume option for multipurpose end use where there are currently no alternative reliable options. There are four regions (occupying about 6.5 million ha) within the low rainfall cereal growing zones of Australia that do not have a viable grain legume option for growers: the Esperance region of WA, northern Eyre Peninsula and Murray Mallee in SA and the Victorian Mallee. Productivity of cereal cropping enterprises in these environments is constrained by the lack of suitably adapted crop legumes that can act as a disease break in rotations, increase soil nitrogen reserves for subsequent cereal crops and improve soil conditions. Many growers in these areas, especially in the lower rainfall parts of the target region, adopted vetch as the best option for inclusion in rotations.

There have been several publications over the past few years regarding nitrogen fixation by vetch crops. Project results showed 54 kg, 98 kg and 145 kg/ha were fixed after vetch for grain, hay and green manure, respectively. Dr Ian Rochester and his team at CSIRO Plant Industry (PI) in Narrabri, NSW, conducted extensive field trials to identify the benefits of vetch to cotton growers. Dr Rochester's research assessed a variety of legumes commonly grown in rotation with cotton including faba beans, field peas, clovers and medics. Vetch's ability to fix nitrogen far exceeded that of the other legumes, commonly fixing up to 200 kg of nitrogen per hectare. This program collaborated with the CSIRO on this project for the past two years and provided seed of Morava for its experiments.

Australian vetch producers will benefit from greatly improved gross margins of cropping rotations. In addition to viable grain and forage production from vetch, cereal crop yields following a vetch crop are usually at least 30% to 50% higher than those derived from continuous cropping with cereals (high wheat protein producers, Lameroo, SA; Murray Unkovich, ‘Cereal yield after legumes').

**Major achievements of the project**

Two lines, SA-34823 and SA-34748, were selected because they possessed the main targeted characteristics important to become new improved common vetch varieties. These lines are well adapted to low and medium rainfall areas (330-400 mm) with acidic (pH 5.5) to alkaline (pH > 9) soils. Over four years, the advanced breeding lines yielded 11% to 14% more grain than current vetch varieties, resulting in a yield increase of between 550 to 700 kg/ha or $250 to $320/ha in value with the current grain price of $460/t. Small amounts of pure seed for further multiplication will be available in 2011.

The new vetch lines are earlier in maturity than the most popular vetch variety, Morava. Many areas in SA suffered extremely sharp finishes in early October 2006, 2007 and 2008. Despite the conditions, the lines performed significantly better in grain production than current vetch varieties. Both lines are rust resistant as reported by Joop Van Leur, NSW Industry and Investment (NSW I&I), and showed better tolerance to ascochyta as assessed by South Australian Research and Development Institute (SARDI) pulse plant pathologist Jenny Davidson.

SA-34823 and SA-34748 have 0.56-0.65% toxin levels in the grain predicted by a near infrared (NIR) instrument. The seed mass was 0.40-0.70 mg by the Diffuse Reflectance Infrared Fourier Transform (DRIFT) method.

During the project, two to three field days a year were organised for vetch producers and users to communicate progress and results from the project and collect information from growers regarding what they would like to see in potential new varieties.

Frost and botrytis tolerant germplasm was imported from Serbia and included in the breeding program in 2010. Over 80% of these lines survived 11 days of -10C in the winter of 2008/09.

Woolly pod vetch is currently unknown to many Australian growers. In this project, several parental lines were selected with the major requirements for improved woolly pod varieties i.e. high dry matter yields, more tolerance to ascochyta and botrytis and with softer seeds than the current varieties, Capello and Haymaker. One or two of five selections are also under consideration to become new woolly pod vetch varieties for Australian growers. Over three years, these yielded more than...
Capello and Haymaker in hay production by 4 to 14% (400 kg -1.1 t), respectively.

Lamb feeding experiments indicated that common vetch grain of Morava and Rasina\(^\text{c}\) can be considered as an alternative to other crops in ruminant diets.

**Other research**

Further research is required to determine the tolerance of both common and woolly pod vetch species to commonly used herbicides, both post planting pre-emergent and post emergent to provide growers and agronomists with relevant recommendations on which herbicides are safest.

The heavy disease pressure in 2010 clearly demonstrated that further work is required on the tolerance of both species to ascochyta, particularly in common vetch. The advanced breeding lines of woolly pod vetch in the program for release as new varieties all have improved tolerance to ascochyta. However, several common vetch lines had to be removed from advanced trials due to susceptibility to this disease. Ascochyta-resistant common vetch material was imported from international germplasm collections and is being integrated into the breeding program. This requires further evaluation to confirm results as superior germplasm.

Botrytis tolerance also requires further investigation, particularly in the higher rainfall areas where the larger and denser crops can be prone to creating conditions that are favourable to the promotion of botrytis. The woolly pod introductions currently being assessed show acceptable tolerance to botrytis. This tolerance needs to be incorporated into the breeding material. Similarly, botrytis tolerant germplasm of common vetch was imported from international collaborators and is being included in the crossing program. Again this requires further evaluation to confirm the inclusion of the targeted genes in superior germplasm.

Due to the recent lack of heavy disease pressure for rust, it has been difficult for the NVBP to screen early generation breeding material for resistance. This resulted in the need to improve rust screening techniques and capabilities to be developed in conjunction with pulse pathologist, Joop van Leur of NSW I&I. In this project, advanced germplasm had to be sent to international institutes (D. Rubiales, Uni of Cordoba, Spain) for rust screening prior to promotion into PBR trials. This caused delays in the promotion of material and the release of future varieties.

It became evident through consultation with growers and agronomists that frost tolerance is also an issue requiring further research in both species. As vetch expands further into the more marginal cropping areas, frost becomes more of an issue as these areas are often prone to severe and late frost events. Frost tolerant germplasm was sourced from international collaborators. This material was released from quarantine in 2011 and will be assessed for other desired traits and included in future crossing.

This project showed the potential of woolly pod vetch in medium to high rainfall areas but it also determined that this crop has little or no presence in the domestic market because growers are not aware of its benefits.

This species needs to be trialled in its target environments and its potential demonstrated to growers who grow and use high quality hay and silage.

Other research includes integrated management for standing ability, reduction of diseases and quicker drying of hay that can be overcome by intercropping vetch with erect cereal or canola crops.

**Intellectual property summary**

The GRDC/Rural Industries Research and Development Corporation (RIRDC) and SARDI have existing intellectual property (IP) in the germplasm developed by the Australian National Vetch Breeding Program. Varieties developed within this program will be protected by PBR to protect investment of all stakeholders.

Equity has to be split on the basis of inputs from each party.