FINAL REPORT 2015

PROJECT CODE	:	**S0213**

PROJECT TITLE	Forage peas – a potential new break crop option for SA

PROJECT DURATION

Project Start date	1 July 2013
Project End date	30 June 2015

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Project Code	
Project Type	

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PROJECT REPORT

Executive Summary

The recently released Pulse Breeding Australia forage/dual purpose field pea varieties PBA Coogee and PBA Hayman provide growers with an alternative to vetch and other break crops, however limited evaluation and agronomic understanding has occurred to date. Field trials were conducted in SA to compare these varieties with other pea and vetch varieties for agronomic suitability. Results showed:

- Biomass comparisons between field peas and vetch were complex, varying with site, year, variety and sowing date. Generally vetch varieties produced equal or greater biomass levels than peas in the presence of the disease 'blackspot' or under favourable growing environments. Conversely field peas varieties generally showed greater grain yields than the vetch;
- PBA Hayman has greater biomass potential than all field pea varieties as well as vetch in some situations, but was found to be more sensitive to 'blackspot' and has significantly lower grain yield potential (20-80% lower) than other field pea varieties;
- Current recommendations for maximizing grain yield in field pea will also maximize biomass production, ie earliest sowing around 'Blackspot Manager' recommendations and sowing densities of 50 plants/sq. m;
- On balance, forage peas fixed similar total amounts of N to the grain pea Kaspa, with some varietal differences evident in some trials.

Project Objectives

- To assess the potential of newly released forage field pea varieties as a more profitable and reliable option over vetch and grain field peas.
- To provide agronomic management guidelines for their successful production.
- To assess nitrogen fixation and hay quality performance of forage field peas compared with grain field peas and vetch.

Overall Performance

Achievement of project objectives

Field trials were conducted to compare field pea and vetch cultivars for biomass and grain yield potential. These trials provided information to maximize the performance of new forage and dual purpose field pea cultivars which have been communicated through farming system and GRDC updates as well as SARDI sowing guides and crop harvest reports. Nitrogen fixation and feed quality parameters were also measured to provide a holistic comparison of field pea and vetch varieties allowing growers to make sound crop choice decisions.

Personnel:

Scientific, industry and technical support for this project was provided by:

- Michael Lines, Research Officer, SARDI, Clare (Resigned January 2015)
- Dr Liz Farquharson (nee Drew), Senior Research Officer, SARDI, Waite
- Ross Ballard, Senior Scientist, SARDI, Waite
- Mr Stuart Nagel, Vetch breeding, SARDI, Waite
- Mr Leigh Davis, Senior Agricultural Officer, Minnipa Agricultural Centre
- Dr Joe Panozzo, Senior Research Scientist, DEPI, Horsham
- Site cooperators: Hart Field Day Site, Minnipa Agricultural Centre, Mr Pat Connell (Tarlee) and Mr Gary Fhlor (Lameroo)

Project management, field work, data collection, analysis and report preparation was performed by Michael Lines, Research Officer, SARDI, Clare.

Difficulties encountered:

Biomass sampling difficulties were encountered in the first year of the project. Due to the tangled growth habit of both field pea and vetch it was difficult to separate out plants within a defined sampling area of the whole plot. This was overcome in the second year of the project by creating small sampling zones within the plot for each sampling time.

Nitrogen fixation and quality analysis were performed in the USA and Victoria respectively and processing and result analysis took longer than originally anticipated, delaying the respective KPI's as amended in 2014 and 2015 progress reports.

Key Performance Indicators (KPI)

KPI	***Achieved (Y/N)***	***If not achieved, please state reason.***
Field trials comparing biomass production of field pea and vetch (Experiments 1, 2 & 3) are conducted at 3-4 growing regions in 2013. Field trials were successfully completed as planned at four locations (Minnipa, Lameroo, Hart and Tarlee) in 2013.	Y	
Nodulation and nitrogen fixation of field pea and vetch (Experiment 1) is assessed and analysed. Assessments were collected at two sites (Hart and Tarlee) and data analysed as planned.	Y	
Hay quality and digestibility of field pea and vetch samples (Experiment 3) is tested and analysed.	Y	

Samples were collected from the Tarlee site and tested by Feed Test laboratories and analysed as planned.		
Results to be collated, analysed and communicated in local farming systems reports and other relevant extension channels. Results of 2013 field trials were analysed and communicated to industry through a number of reports and field days (see Communication section below).	Y	
Field trials comparing biomass production of field pea and vetch (Experiments 1, 2 & 3) are conducted at 3-4 growing regions in 2014 Field trials were successfully completed as planned at four locations (Minnipa, Lameroo, Hart and Tarlee) in 2014.	Y	
Nodulation and nitrogen fixation of field pea and vetch (Experiments 1 & 2) is assessed and analysed. Assessments were collected at two sites (Hart and Tarlee) and data analysed as planned.	Y	
Hay quality and digestibility of field pea and vetch samples (Experiments 3) is tested and analysed. Samples were collected from the Tarlee site and tested by Feed Test laboratories and analysed as planned.	Y	
Results to be collated, analysed and communicated in local farming systems reports and other relevant extension channels. 2014 results were presented during 2015 at the GRDC Advisor update and in a number of farming system summaries and the 2014 SARDI Harvest report distributed to over 8,000 growers and industry personnel.	Y	

Technical Information

Forage and dual purpose field peas were compared with grain field peas and vetch at four replicated trial sites in South Australia (SA) in both 2013 and 2014, providing an understanding of their performance and potential as a break crop option for SA farming systems. The forage field pea variety PBA Hayman agronomically performed very differently to the grain variety Kaspa and dual purpose varieties Morgan and PBA Coogee and will require a different management strategy to optimize its production in SA.

Comparison of field pea and vetch

Biomass of field pea and vetch varieties were assessed at three timings across three sites in 2013 and 2014. Field pea varieties generally showed equal or greater early season biomass production (measured at 10 weeks post sowing) than vetch varieties, and common vetch varieties (Morava and Rasina) generally showed equal or greater biomass than wooly pod vetch varieties (Capello or RM4).

The interaction between variety and time of sowing was significant and complex across sites and years for biomass production at the critical early pod development stage (EPDS), see Figure 1. Over all experiments, vetch produced higher EPDS biomass levels than field pea with the 'wooly pod' type Capello having slightly higher yields than the 'common' variety Rasina. Several of the new vetch varieties were only evaluated for one year and not included in this analysis and were often higher yielding. Generally vetch varieties produced equal or greater biomass levels than field peas in the presence of blackspot or under favourable growing environments. The best relative performances by field peas were at later sowing dates in lower rainfall environments such as Minnipa, except for PBA Hayman which was poor performing under these conditions.

The early sowing timing maximized biomass production of both crop species by approximately 30%, however this was variable across experiments. Where the major field pea disease 'blackspot' occurred the growth of field pea was reduced. Generally vetch was more responsive to the early sowing date but this response was reduced at the high rainfall site of Tarlee (Figure 1).

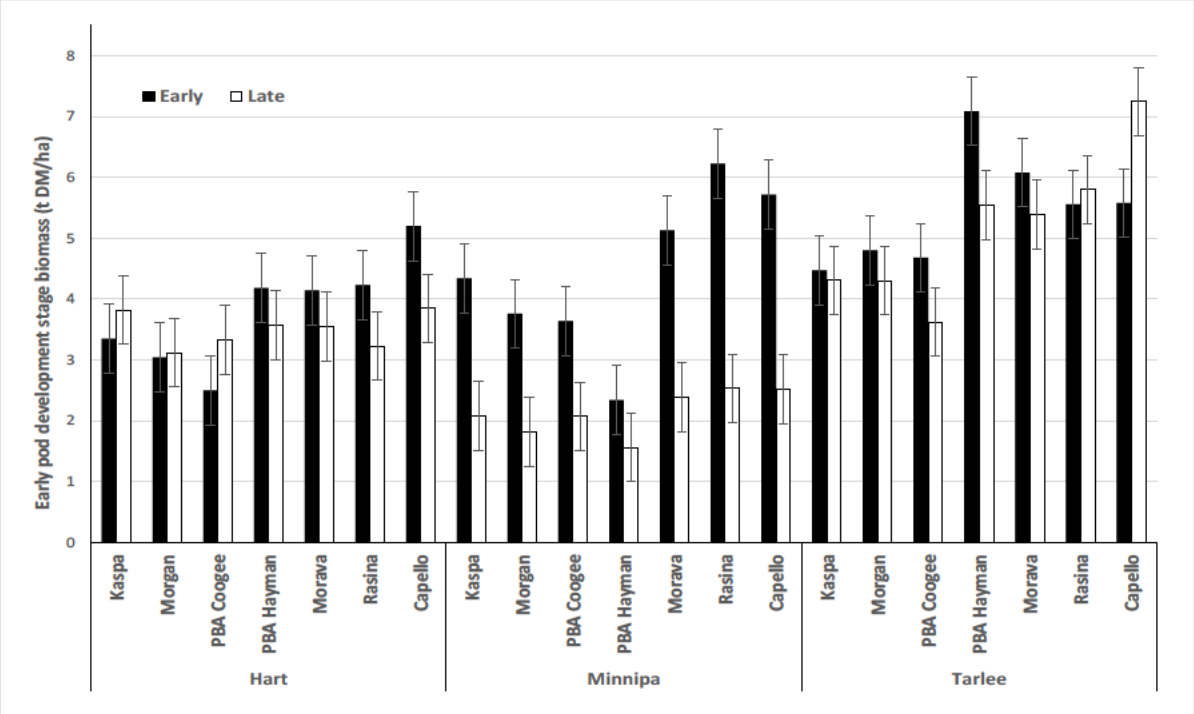

Figure 1: The effect of sowing date and crop variety on the early pod development stage biomass yield (t/ha) at three sites in South Australia across two trial years (2013, 2014).

PBA Hayman was found to have a higher EPDS biomass production potential than all other field pea varieties evaluated, producing yields up to 70% greater than Kaspa (grain) and Morgan (dual purpose). This was particularly evident when sown early or grown under long and favourable seasonal conditions such as Tarlee (Figure 1). PBA Hayman was also better suited to earlier sowing dates in favourable environments such as Tarlee and Hart 2013 than the other pea varieties. This is likely to be due to its later flowering and pod development timing allowing a greater biomass accumulation period prior to hay cutting (EPDS). In some situations PBA Hayman produced greater biomass than both common and woolly pod vetch varieties. For

example, at Tarlee in 2013 PBA Hayman sown early produced 7.7 t/ha compared to 5.6 t/ha in the best vetch variety, RM1 and just 4.7 t/ha in Morgan (also sown early). However under high blackspot disease pressure and dry spring conditions at Minnipa in 2014 PBA Hayman only produced EPDS biomass between 23% and 59% of all other varieties indicating is poor suitability to these situations.

Agronomic evaluation of Forage and Dual purpose field peas

Severe epidemics of 'blackspot' occurred at Minnipa and Hart in 2014 and infection levels were higher in the early sown treatments. These outbreaks highlighted a major weakness of using field pea as a forage option compared with vetch, as yields of field pea were greatly reduced and the production advantage from early sowing lost, whereas early sowing in vetch generally maximized dry matter production. Further to this, PBA Hayman was found to be more sensitive to 'blackspot' than other field pea varieties, and under high disease pressure biomass production was reduced compared to all other varieties. The new dual purpose (forage/grain) pea, PBA Coogee also incurred higher infection levels than the afore mentioned varieties but was not as susceptible as PBA Hayman. Delayed sowing of PBA Hayman also reduced its biomass production advantage over other field peas, particularly under unfavorable late season conditions eg Minnipa. This was primarily due to its later flowering and slower early vigour characteristics than the other field peas and is somewhat problematic, as delayed sowing is a key management strategy for reducing 'blackspot' infection levels in field peas. Biomass production of PBA Coogee was similar to Kaspa and Morgan (Figure 1).

Field pea varieties generally showed similar or greater grain yields than vetch varieties averaging 10% higher overall. Kaspa was the highest yielding variety followed by Morgan. PBA Coogee was always lower yielding than Kaspa (14-54%) and equal or lower than Morgan. Rasina was the highest yielding vetch line, 13% lower than Kaspa. PBA Hayman was found to have significantly lower grain yield potential (20-80% lower) than all other field pea varieties and grain retrieval may be difficult in some seasons or environments due to its late maturity. Due to the relative smaller seed size of PBA Hayman (averages 14 g/100 seeds compared with 20-25 g/100 seeds in Kaspa) a lower seeding rate is required to achieve the same targeted plant density, helping to overcome this issue to some extent.

Plant density trials at Lameroo, Minnipa, Tarlee and Hart confirmed that current recommendations for maximizing grain yield in field pea will generally maximize biomass production, ie earliest sowing around 'Blackspot Manager' recommendations and sowing densities of 50 plants/sq. m. All varieties generally incurred reductions in biomass from reducing plant densities to 25 plants/sq. m. Where the sowing date is delayed past optimum to manage blackspot, biomass and grain yield can be maximized by increasing sowing density of all varieties to 75 plants/sq. m, with little negative effect on grain yield.

Nodulation and nitrogen fixation assessment (Tarlee and Hart)

The total number of nodules per plant was measured approximately 10 weeks after sowing and biomass cuts taken at flowering were analysed for nitrogen content (%N) and the amount of nitrogen derived from atmosphere (%Ndfa) using the 15N natural abundance technique. These measures were then used to calculate the amount of fixed nitrogen in the shoots of each treatment at flowering and the amount of nitrogen fixed/t of dry matter at flowering. (A detailed report is provided as Appendix 1).

Forage pea and vetch varieties were found to form adequate number of nodules per plant with background soil rhizobia. There was 60 kg N/ha more fixed nitrogen in legume shoots at Tarlee (130kgN/ha) than Hart (74 kgN/ha) across the two trial years. This was also reflected in the amount of N fixed/t DM produced, which was 17.4 kg N/t DM for Hart, compared to 25 kg N/t DM for Tarlee. Time of sowing was critical to the total amount of fixed nitrogen, with crops sown

earlier fixing on average 15 kg/ha more than crops sown late. This was due to both a higher %Ndfa (the proportion of N derived from the atmosphere) and higher biomass for crops sown earlier. Both crop species and variety significantly affected the total amount of N fixed, however this varied with site. At Tarlee vetch fixed 42 kg/ha more N than field pea, however at Hart there were no significant differences between species when data was combined across years. When combining all data there were only minimal variety differences in amounts of N fixed per tonne of dry matter produced. On average all vetch and pea varieties fixed 21 kg N/t DM with the exception of PBA Hayman which produced only 19 kg N/t DM. Vetch fixed N at an average of 22 kg N/t DM compared to 20 kg N/t DM for field pea.

Biomass and feed quality of field pea and vetch grown in mixes with oats

A trial at Tarlee in both project years compared the forage and dual purpose field peas with Kaspa and vetch varieties with varying mixes of oats. In 2013 legume/oat ratios in the mixes were 100/0, 75/25, 50/50 and 25/75 by weight. All legumes competed poorly with Wintaroo oats and there was no effect of varying oat percentage on EPDS biomass yields across the legume varieties. Across all oat mixes the PBA Hayman/oat mix produced the highest yields (7.43 t/ha) and Capello vetch the lowest (5.83 t/ha) but all mixes were statistically the same as the 100% oat treatment (6.58 t/ha). In 2014 the ratios were modified to 100/0, 80/20, 60/40 and 40/60 to reduce the competitiveness of Wintaroo oats. Capello (6.72 t/ha) and PBA Hayman (6.45 t/ha) produced the highest EPDS biomass yields and PBA Coogee the lowest (4.65 t/ha) without competition from oats, compared with 9.02 t/ha in the 100% oat treatment. As oats were added to the mixes yields increased rapidly and at 20% oat mix biomass yields were the same as the 100% oat treatment in all varieties except for Rasina vetch (6.87 t/ha).

Feed tests conducted on samples collected at the EPDS showed variable results across seasons reflecting the seasonal variation in observed varietal biomass production. In the absence of oats, vetch had 4% higher crude protein (CP) levels than field peas in 2013. In 2014 results were more variable with Capello (21.8%) having higher CP levels than all other varieties, and Rasina, Morava and PBA Hayman (16.9, 16.3 and 16.5% respectively) all having higher levels than Kaspa (13.1%). Metabolizable energy (ME) levels were generally similar between varieties in both years except for PBA Hayman which was lower than all other varieties in 2013 and averaged 12% lower than Morgan over both years. In 2013 PBA Hayman returned the lowest Digestability of Dry Matter (DMD) value and the highest Neutral Detergent Fibre (NDF) level both indicating a lower level of feed quality, which was also observed in the PBA Hayman/oat mixes. These results were not repeated in 2014, where no varietal differences were observed. Further work is required to assess if this is an inherent feature associated with PBA Hayman or due to other effects such as hay cutting timing. Oat/legume mixes of 20/80% in 2014 generally showed 3-7% higher CP levels than the 100% oat treatments with the exception of Kaspa and Capello which were the same as the oats. Once oat/legume ratios reached 40/60% there were little differences in the CP levels between these and the 100% oat treatments. ME levels were reduced to that of the 100% oat treatment upon the addition of oats at just 20% in all legumes, however the feed quality indicators (DMD and NDF) showed higher quality levels in all legume/oat mixes even at 60% oats in 2014. A complete summary of the feed quality data is provided as Appendix 2.

Conclusions Reached &/or Discoveries Made

- The forage field pea variety PBA Hayman agronomically performed very differently to the grain variety Kaspa and dual purpose varieties Morgan and PBA Coogee. It will require a different agronomic management package to optimize its production in SA;
- PBA Hayman was found to have a higher biomass production potential than other field pea varieties evaluated (up to 70% greater than Kaspa and Morgan in some conditions).

This was particularly evident when sown early or grown in more favourable environments. In some situations it produced biomass levels greater than both the common and woolly pod vetch varieties;

- PBA Hayman was found to be more sensitive to the pea disease 'blackspot' than all the other varieties, and under high disease pressure biomass production was dramatically reduced compared with Kaspa and Morgan. Delayed sowing also reduced its biomass production advantage in some situations;
- PBA Hayman has significantly lower grain yield potential (20-80% lower) than other field pea varieties and grain retrieval may be difficult in some seasons or environments due to its late maturity;
- The value of PBA Hayman as an alternative to vetch in SA will depend largely on being able to sow it early and control blackspot disease infection. This will often be difficult to achieve in field pea producing areas of this state and sowing dates will need to be as early as possible around safe "black spot manager predictions";
- Biomass production of the potential dual forage/grain field pea variety PBA Coogee was generally only similar to Kaspa and Morgan and grain yield was always lower than Kaspa (14-54%) and equal or lower than Morgan. This suggests Kaspa or Morgan remain the variety of choice for grain yield or "dual purpose" situations apart from in disease prone areas where the improved resistance rating of PBA Coogee to bacterial blight and powdery mildew will be an advantage;
- Biomass comparisons between field peas (Kaspa, Morgan and PBA Coogee) and vetch were complex, varying with site, year, variety and sowing date. Generally vetch varieties produced equal or greater biomass levels when blackspot was present or in favourable growing environments. The best relative performances by the field pea varieties were at later sowing dates in lower rainfall environments. Conversely field peas varieties generally showed similar or greater grain yields than the vetch varieties and have larger and more established markets available;
- Current recommendations for maximizing grain yield in field pea will also maximize biomass production, ie earliest sowing around 'Blackspot Manager' recommendations and sowing densities of 50 plants/sq. m. Where the sowing date is delayed past optimum to manage blackspot, biomass yield can be maximized by increasing sowing density of all varieties to 75 plants/sq. m, with little negative effect on grain yield;
- Forage pea and vetch varieties formed an adequate number of nodules per plant with background soil rhizobia, and pea and vetch varieties sown at the early timing (early-mid May) fixed on average 15kgN/ha more than those sown later (late May-early June);
- On balance the forage peas fixed similar total amounts of N to the grain pea Kaspa, with some varietal differences evident in some trials;
- Feed quality results were variable across seasons and varieties but on a whole vetch had higher crude protein levels than peas. Further work is required to understand the relatively lower results of metabolizable energy and feed quality parameters in PBA Hayman compared with other peas;
- Oat/legume mixtures of greater than 20% oats generally reduced ME and CP levels similar to those found in 100% oats however some varietal differences were observed.

Intellectual Property

All results and findings from this project have been made freely available to the Australian grains industry.

Application / Communication of Results

Main Findings

Field trials were conducted to compare field pea and vetch cultivars for biomass and grain yield potential.

- Biomass comparisons between field peas and vetch were complex, varying with site, year, variety and sowing date. Generally vetch produced equal or greater biomass levels than pea in the presence of the disease 'blackspot' or in favourable growing environments. Conversely field pea varieties generally showed greater grain yields than the vetch;
- The forage field pea variety PBA Hayman agronomically performed very differently to the grain variety Kaspa and dual purpose varieties Morgan and PBA Coogee. It will require a different agronomic management package to optimize its production in SA;
- PBA Hayman has greater biomass potential than all field pea varieties and in some situations than vetch but was found to be more sensitive to 'blackspot' and has significantly lower grain yield potential (20-80% lower) than other field pea varieties;
- Current recommendations for maximizing grain yield in field pea will also maximize biomass production, ie earliest sowing around 'Blackspot Manager' recommendations and sowing densities of 50 plants/sq. m;
- On balance forage peas fixed similar total amounts of N to the grain pea Kaspa, with some varietal differences evident in some trials.

Potential Industry Impact

Field pea and vetch occupy annually around 120,000 Ha of South Australia's cropping area. PBA Hayman and PBA Coogee are now both widely available to growers and interest in forage/dual purpose peas as an alternative to field pea, vetch and other break crop options continues to expand, particularly in areas such as the SA mallee. This is primarily due to increased weed control options, larger and more stable grain markets and equal or increased biomass production in some areas over vetch as well as the lack of adaptation in other pulse species such as lentil and faba bean. The agronomic and feed quality findings in this project were not previously known, particularly those on black spot susceptibility, area suitability and nitrogen fixation capacity, and this will now aid in the successful production of these varieties. Perhaps of equal importance is that these varieties have now been widely 'road tested' across a diverse range of SA's cropping zones providing a solid insight into their weakness and limitations. This will in turn aid in the prevention of future crop failure or production loss through poor varietal selection or agronomic practice. Further to this, the production of field peas for a forage use is poorly understood and their relative standing compared to vetch also limited. These trials have now provided holistic comparisons of grain field peas and vetch both on their own and as mixtures with oats furthering the understanding of the role and value of them in SA's cropping systems.

Publications and Extension (Refer to Appendices 3 and 4)

- Hart Field Day and Twilight Walks 2013 & 2014;
- GRDC Grower Updates, Crystal Brook 2014;
- GRDC Advisor Updates, Adelaide 2014 & 2015;
- Minnipa Agricultural Centre Field Day 2013 & 2014;
- Landmark agronomists trial visit of Hart Field Day site 2014;
- Owen, Freeling, Paskeville, Balaklava-Whitwater and Yorke Peninsula Alkaline Soils Group bureau and farming Systems field day pulse talks;
- Crop Science Society September 2014 meeting;
- Australian Rhizobium Conference Field Tour Visit of the Hart Field Day Site 2014;
- Pulse Breeding Australia Inaugural Pulse Conference Field Day, Tarlee, October 2013
- PBA Field Pea annual operations meeting, Adelaide 2013,2014, 2015.

McMurray LS, Lines MD. 2015. Forage peas – a potential new break crop option. In 'Hart – Trials results 2014'. (Eds: S Noack) pp 26-30. (Hart Field-Site Inc, Clare). **Appendix 3.**

McMurray LS. Davis L, Lines MD. 2015. Forage peas – a potential new break crop option for SA? In 'Eyre Peninsula Farming Systems Summary 2014'. (Ed: N Scholz) pp 72-75. (Eyre Peninsula Farming Systems Project, Minnipa). **Appendix 4.**

Fischer KE, McMurray LS. 2015. PBA Wharton outperforms in 2014 pea variety trials. In 'SARDI Crop Harvest Report 2015'. (Eds: SARDI) pp 1-3. http://pir.sa.gov.au/research/services/reports_and_newsletters/crop_performance#toc2. (March 2015). (PART OF ARTICLE ON FORGAE PROJECT)

Lines MD, McMurray LS. Davis L, 2014. Field Pea and Vetch forage options for Low Rainfall Regions. In 'Eyre Peninsula Farming Systems Summary 2013'. (Ed: N Scholz) pp 56-59. (Eyre Peninsula farming Systems Project, Minnipa).

Lines MD, McMurray LS. 2014. Forage peas – a potential new break crop option. In 'Hart – Trials results 2013'. (Eds: Hart Field-Site Group Inc) pp 25-30. (Hart Field-Site Inc, Clare).

Lines MD, McMurray LS, Brand JD, Ware A, Davidson JA, Kimber R, Jeff Paull, Hobson K. 2013. Pulse Check - Varieties and Agronomy Update. In '2014 GRDC Update, South Australia, Share knowledge – accelerate adoption, Grains Research Update'. (Ed: J. Crane) pp 65-73. (GRDC Advisors Update, Adelaide, South Australia).

Suggested Pathway to Market

The path to market for the outcomes of this project have been and are through:

- Field days and results booklets, eg Hart Field Day Group, Eyre Peninsula Farming Systems, Mid North High Rainfall Zone which has widely occurred to date.
- GRDC advisor updates (Pulse session)
- Ongoing variety discussion forums, eg Bureau group visits to NVT sites, field days, variety releases.
- SARDI Field Pea Sowing Guide and Harvest Report
- Pulse Australia relevant tech notes and annual update (including updating Pulse Australia's web based-forage pea production tech note)
- PBA variety release brochures for PBA Hayman and PBA Coogee and any future forage/dual purpose PBA release

The researchers on this SAGIT project also lead the SA node of Pulse Breeding Australia's field pea breeding effort and have provided these research findings and understanding directly to the PBA field pea breeder to help guide and improve future field pea and dual purpose/forage field pea varietal development and release. Prior to this research PBA had no information on the appropriate flowering, maturity and pod filling timing and duration required in forage peas and how that can be best targeted in a dual purpose field pea type. The information on released and potential vetch breeding genotypes is also readily available to the SARDI vetch breeding group for their use where applicable.

POSSIBLE FUTURE WORK

Outcomes of this work showed that the value of forage peas as an alternative to vetch depends largely on early sowing and the ability to control blackspot disease epidemics.

Blackspot and its relationship with delaying sowing date continue to be a major constraint to field pea production in SA. The availability of regionally validated disease forecasting models and greater understanding of the disease and its agronomic management has greatly improved risks around sowing time of field peas, however further genetic improvements in resistance to black spot are required, particularly if sowing date is to occur on the season break. Pulse Breeding Australia (PBA) field pea, both through the breeding program and germplasm enhancement nodes, are continuing to address this issue, however progress has been slow due to the complex nature of this disease.

Foliar fungicides with greater efficacy than mancozeb are still required to avoid yield loss from disease infection particularly at earlier sowing dates. Foliar fungicides with different active ingredients are being used in other crops and also in high value field pea production internationally. Preliminary trial work has been initiated by SARDI through the GRDC funded Southern Region Pulse Agronomy project to assess the efficacy of a number of these products and various use patterns on blackspot.

Further agronomic work on cutting timing and its interaction with feed quality parameters of forage pea and vetch varieties would aid with understanding the requirements to maximize feed quality characteristics of legume hay.

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