

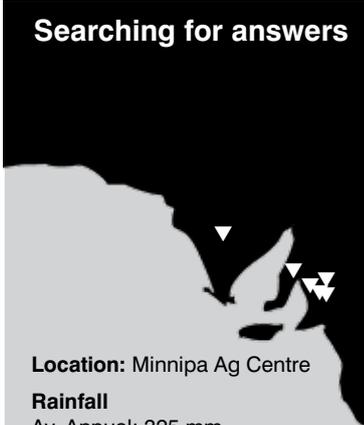
Improving yield and reliability of field peas under water deficit

RESEARCH

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Searching for answers



Location: Minnipa Ag Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm

Yield
Potential: 2.43 t/ha (Pulses)
Actual: 1.50 t/ha (site av)

Paddock History
2010: Barley
2009: Wheat
2008: Wheat

Soil Type
Brown loam

Plot Size
10 m x 1.5 m x 3 reps

Yield Limiting Factors
Anthesis heat and moisture stress

growers in low rainfall regions.

- Preliminary results from the second season and summary of first season experiments are presented with more detailed trait data currently being analysed, with one more year to follow.
- Correlations between yield and canopy traits such as greenness and growth rate have been identified.
- We have also used APSIM to model the seasonal soil moisture stress for all environments.

Why do the trials?

Grain legumes are generally more sensitive to periods of drought than cereals and consequently their yield is more variable (Figure 1) with production concentrated in the medium and high rainfall areas. By increasing the yield and reliability of field peas under water deficit we can increase their reliability and improve their value in dryland farming systems.

Background

Pulse crops provide a cereal disease break, weed management options, nitrogen benefit and alternative marketing opportunities. Field pea is the major pulse crop grown across southern Australia and is currently grown over 300,000 ha in Australia. Field pea production in recent seasons has been displaced in the higher rainfall areas by higher value crops such as lentil and chickpea and increased sowing area is occurring in the lower rainfall areas where it is considered the most reliable break crop option. Pulse Breeding Australia (PBA) Field Peas aims to improve the reliability and adaptation of field peas in medium and low rainfall areas of Australia.

These regions are dominated by large areas prone to periods of moisture stress and water deficit; hence a major breeding priority of the program is drought tolerance.

Currently PBA has no effective way of breeding for drought tolerance and relies on selecting varieties that perform well in breeding trials such as the one conducted annually at Minnipa. This method has made some improvements through varieties such as PBA Gonyah and PBA Twilight, however progress has been slow and the traits responsible for improved yield in these varieties are not well understood. Improvement of yield under stress can be achieved by direct selection for yield, or targeting adaptive traits, or a combination of both. In this project, we will focus on secondary adaptive traits – their value, how to measure them and how to implement them into the breeding program.

How was it done?

Thirty field pea accessions were sown – representing a range of flowering times, duration of flowering times, pod number, pod size, leaf type and other plant characteristics. Accessions were sown in 2010 across four different sites and in 2011 across five different sites that differed in average rainfall.

Key messages

- This three year research project aims to increase the yield and reliability of field pea under water deficit and is a major pre-breeding target of Pulse Breeding Australia.
- Key traits being monitored include phenology, canopy and yield traits and the adaptive value of these traits will be explored.
- The trade-offs between adaptation to stress and yield in good environments will be investigated.
- Improving the reliability of yield of field pea in water limiting environments will help to provide a robust break crop option for

Table 1 Mean, minimum and maximum yield (t/ha) of field peas in 2010 and 2011

Environment	Mean	Standard Error	Minimum	Maximum
Minnipa 2011	1.5	0.37	0.45	2.2
Minnipa 2010	2.5	0.43	1.80	3.2
Roseworthy 2011	2.3	0.46	0.76	3.1
Roseworthy 2010	2.9	0.52	1.80	4.0
Mallala early sowing 2010	3.1	0.46	2.10	3.9
Pinery early sowing 2011	2.5	0.46	0.95	3.4
Mallala late sowing 2010	3.0	0.44	1.80	3.8
Pinery late sowing 2011	1.9	0.39	0.86	2.6
Turretfield 2010	3.1	0.55	2.10	4.1
Turretfield 2011	2.5	0.52	0.93	3.2
Willamulka 2011	2.7	0.42	1.60	3.6
Total across all environments	2.5	0.21	0.45	4.1

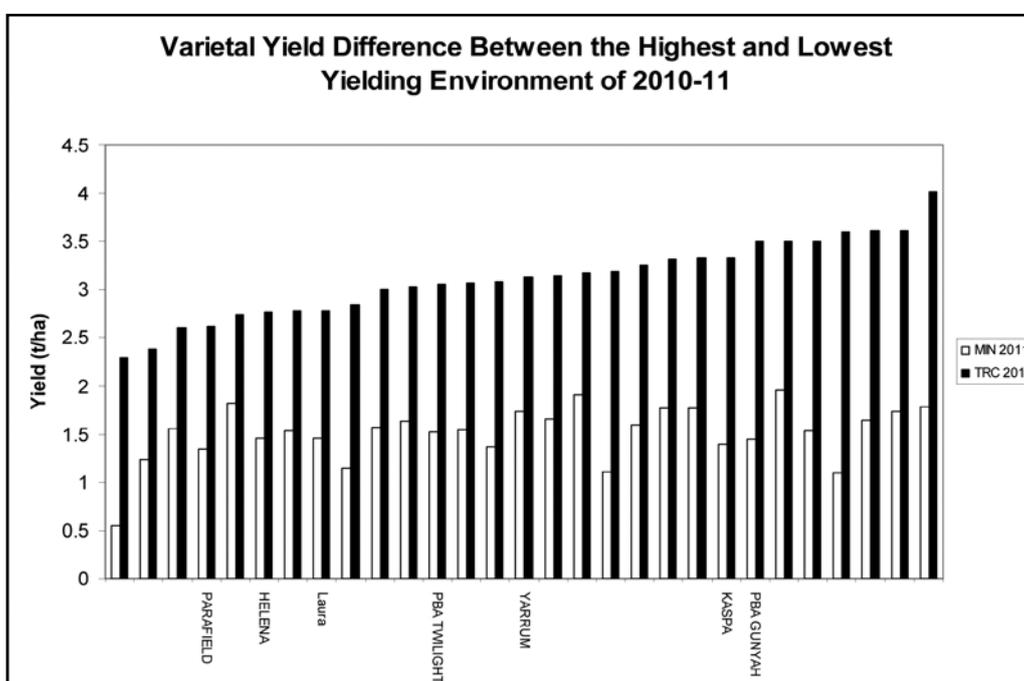


Figure 1 Difference in varietal yield between environments (MIN = Minnipa, TRC = Turretfield)

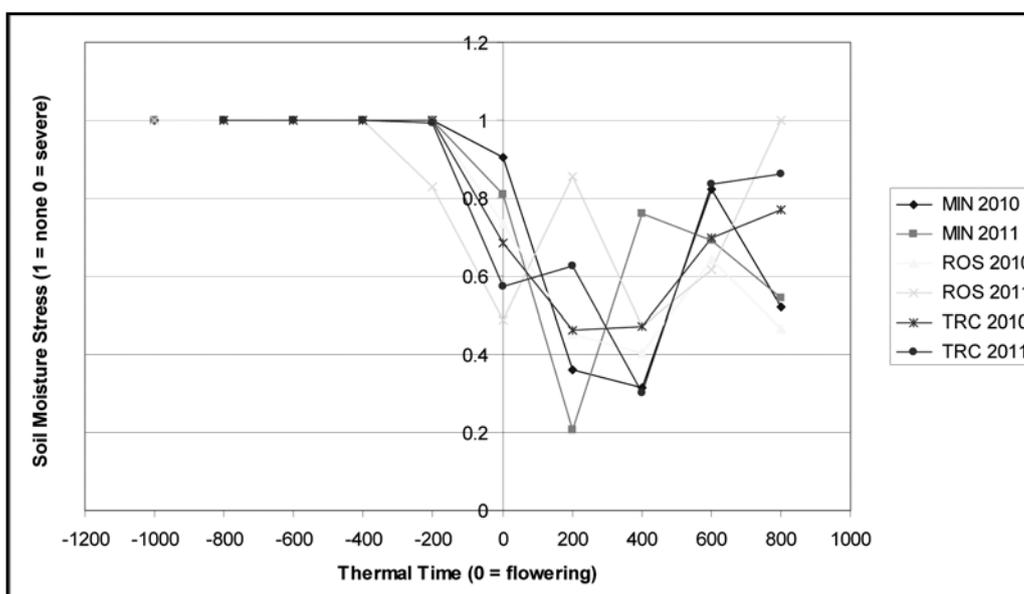


Figure 2 Soil water stress levels and thermal time to flowering (0 = flowering) (MIN = Minnipa, ROS = Roseworthy, TRC = Turretfield)

2010 sowing was Minnipa (1 June), Mallala (8 and 22 June), Roseworthy (8 June) and Turretfield (15 June). Sowing in 2011 included Turretfield (8 June), Roseworthy (3 June), Pinery (early sown 23 May and late sown 22 June), Minnipa (23 May) and Willamulka (19 May). These sites were chosen for their rainfall gradient with expectations of Minnipa being at the driest and Turretfield the wettest end of the scale. We also had two times of sowing at Mallala (2010) and Pinery (2011) to increase the effects of terminal moisture stress. Sowing density was 50 plants/m² (seed treated with PPT and Apron). 80 kg/ha MAP was applied with seed. Herbicide was a post-sowing pre-emergent application of metribuzin and then a group A grass spray pre flowering. Insecticides applied were endosulphan at sowing, Karate® at flowering and fortnightly until the completion of pod fill. Fungicides applied were chlorothalonil fortnightly 6-8 weeks after sowing in line with rain fronts.

Measurements taken:

- Plant development – timing of first flower, fifty percent flowering, and last flower
- Canopy traits – temperature, chlorophyll content (SPAD), NDVI (biomass)
- Yield and yield components – yield, harvest index, pods per plant, seed per plant, seed per pod, pods per peduncle, 100 seed weight, and pod weight proportion.

APSIM was used to model crop water use and soil moisture stress (Figure 2).

What happened?

The 2011 season was drier than the 2010 season and as a result all sites yielded less than 3 t/ha. Minnipa had some very low yields but all other sites yielded between 2 and 2.8 t/ha. Yield was affected, as expected, by location, variety and variety x location interaction. The differences between the environments and years are shown in Table 1.

The differences in performance of field pea varieties in the best and worst yielding environments are illustrated in Figure 1.

We are currently analysing the results from the 2011 plant and yield component measurements to identify further links between consistently high yielding varieties and plant and crop traits. Data from 2010 indicates that higher yielding lines have; higher SPAD (greenness), higher NDVI

(biomass), lower pod weight proportion, more seed per pod and a higher harvest index.

What does this mean?

By measuring the phenology, canopy traits and yield of field peas in a broad range of environments we aim to determine which common adaptive traits enhance crop's ability to produce reliable yield in dry environments whilst maintaining yield in good environments.

After validation of our measuring techniques, traits of interest can be utilised by PBA field peas for enhanced pea varieties.

Once practical phenotyping techniques are established and tested, they can potentially be applied to other major Australian pulse species.

Acknowledgments

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