Adaptive Peas for Low Rainfall Environments

RESEARCH

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Searching for answers

Location: Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2009 Total: 421 mm
2009 GSR: 333 mm
Yield
Potential: 3.6 t/ha (peas)
Actual: 2.2 t/ha Kaspa peas
Paddock History
2008: Wheat
2007: Wheat
2006: Wheat
Soil Type
Red calcareous sandy loam
Diseases
Blackspot moderate to high infection, moderate powdery mildew infection
Plot size
10 m x 1.5 m x 3 reps
Yield Limiting Factors
Blackspot (moderate), powdery mildew (low), water logging (exacerbated blackspot infection)

Key messages

- **Variation for boron and salt tolerance in field pea germplasm was not associated with grain yield differences at Minnipa as a likely consequence of very low rainfall in 2008 and very high rainfall and Blackspot disease in 2009.**
- **Under favourable growing conditions the late flowering advanced PBA field pea line, 94-425*2b produced very high dry matter yields at the flat pod stage compared to other lines evaluated.**
- **Advanced field pea lines with a combination of higher dry matter and grain yield production were identified and potentially offer a dual purpose (grain and hay/silage/green manuring) option for growers in low rainfall environments and a way of managing some of the risk of production.**
- **Findings require further validation across years and environments.**

Why do the trial?

All current break crop options have adaptation limitations in low rainfall environments. Ongoing genetic improvements in field peas through plant breeding combined with agronomic management strategies based upon innovative modern farming systems offer potential for farming to be more flexible, adaptive and ultimately economic in variable seasons and environments.

Pulse Breeding Australia (PBA) field peas has been screening early generation breeding lines in glass house experiments to identify improved tolerance to soil boron and salinity ($NaCl_2$). These experiments have been conducted in soil boxes containing light sandy loam soils with the addition of boron at 10 mg/kg and in pots of sandy gravel where $NaCl_2$ was applied in water solution at a final concentration of 16 dS^{-1} at the seedling stage. Kaspa and Parafield are both rated as relatively susceptible to boron toxicity and Kaspa relatively susceptible to salinity. The performance of field peas, rated as tolerant to these constraints in glass house experiments, under high boron and salt field conditions is currently not well understood. Anecdotal evidence suggests some related lines with higher tolerance to either boron or salinity may perform relatively better on soils classified as having more boron or salt in the profile, however results are variable and field assessment is difficult due to the confounding affects caused by the transient toxicity of boron and salinity both within and across the soil profile, over the growth cycle of the plant and also due to plant interactions with rainfall and disease. Upper EP has a vast area of soils that have inherently high boron, sometimes as shallow as 30-40 cm. Performance of field peas on these soil types is unreliable and grain yields produced are often uneconomical. In 2008 and 2009 experiments were conducted at Minnipa to evaluate field pea breeding lines ranging in their glass house tolerance to boron and salinity, for their ability to perform under high field soil boron levels. The same lines were also evaluated in the same paddock at Minnipa but on a contrasting site where lower boron levels were identified.

Due to their ability to produce high amounts of good quality dry matter, field peas can be used for forage as well as grain. In low rainfall environments like upper EP peas are vulnerable to high grain yield loss from moisture stress, high temperatures and frost during the flowering and grain fill stages.

Field pea lines which have a dual purpose option i.e. have higher dry matter production compared with conventional varieties, while maintaining moderate to high grain yields are being investigated to spread grower risk in variable seasonal conditions. Forage type field peas will still provide the break effect in rotation and may reduce risk to growers by providing grain, hay or green manure options depending upon the season outcome.

Advanced PBA breeding lines exhibiting good early vigour, high dry matter production and boron tolerance are being evaluated for grain and dry matter yield potential and being compared against grain only pea varieties under low rainfall conditions.

How was it done?

Two trial sites were chosen in paddock S5 at Minnipa Agricultural Centre. Smaller differences in boron levels existed between the two sites in 2009 compared with the sites used in paddock N9 in 2008. Both sites in 2009 had similar and high boron levels (25-35 mg/kg) at depth (40-120 cm). However the high site had soil boron levels ranging from 5.5 – 22.8 mg/kg between 10 and 40 cm compared with lower levels (3.4 to 13.9 mg/kg) for the same depth range at the low boron site. The forage trial was sown at the low boron site.

All trials were sown on 8 May after 26 mm of rain. Varieties were sown at approximately 90 kg/ha, with 70 kg/ha DAP. All trials received standard weed management practices.

The boron tolerant pea trial consisted of 21 varieties (Table 1) and 15 varieties were chosen for the forage pea trial (Table 2), both experiments were replicated 3 times. Measurements included visual scores, flowering dates, dry matter production at the flat pod stage for each variety (forage trial only), grain yield and 100 grain weight.

What happened?

In stark contrast to season 2008, extremely high growing season rainfall was recorded at Minnipa in 2009. Surprisingly, symptoms of waterlogging were observed during winter and a moderate to high infection of Blackspot disease occurred during winter and early spring. Powdery mildew also occurred during late spring but had little impact on grain yield. Field pea growth in all trials was not suppressed by moisture stress so vegetative growth and yield potential was high. Only minor boron toxicity symptoms during spring were identified on plants at the high boron site and no symptoms were observed on plants at the low boron site. Plants at the high boron site generally matured later than plants at the low boron site. This is likely to have been due to do an increased moisture holding capacity of the soil type at the high boron experiment site rather than relatively smaller changes in soil boron levels between the two sites.

Boron tolerant trial

High and similar grain yields occurred at both sites (Table 1). Genotype performance at both sites was highly correlated for grain yield and yield rank ($R^2=0.87$, $P<0.001$). There was no yield advantage at the high boron site for lines with either one or both of the soil tolerances. The highest yielding line at both sites was 03H264P-04H2009, rated as sensitive to both constraints. Kaspa, also sensitive to both constraints, was the second highest yielding line at both sites. The early flowering line 02-256-5 (highly tolerant to boron) was one of two high yielding lines at the high boron site in 2008 and was the third highest yielding line at both sites in 2009.

Forage and dual purpose pea trial

Grain yields in 2009 (1.45 to 2.56 t/ha) and dry matter yields (3.4 – 7.44 t/ha) were very high compared to those achieved in 2008 (averages of 0.2 t/ha and 1.1 t/ha for grain and dry matter respectively). Dry matter production was poorly correlated with grain yield in 2009 unlike in the dry 2008 year where there was a stronger link between dry matter and grain yield. The very late flowering 'true' forage pea line 94-425*2b produced the highest dry matter yield at 7.4 t/ha, 23% higher than Kaspa and 37% higher than the current standard Morgan. However this line had by far the lowest grain yield at 1.45 t/ha, 35% less than Kaspa and 28% less than Morgan. The line 05H207-06HOS2002 (not evaluated in 2008) produced higher grain yields than Kaspa and Morgan and higher dry matter yields than Morgan (equivalent to Kaspa). The lines 03H033P-04HO2008 and 03H562P-04H02008 produced the highest grain and dry matter yields in 2008 however both lines were only average performers in 2009, indicating a strong influence of seasonal conditions on variety performance.

What does this mean?

Variation in boron and salt tolerance identified in field peas are likely to be important on Eyre Peninsula in most years, but were not relevant in these studies due to either extreme drought in 2008 or very high rainfall in 2009. These studies highlight the difficulty in validating abiotic stress tolerance in the field. The transient nature of both boron toxicity and salinity, spatially and temporally along with the confounding affects of climate (particularly rainfall) and disease need to be considered. However experimentally in the field these factors are difficult and expensive to manage.

In addition, genetic interactions with all these factors can be occurring in the field when comparing unrelated lines. Currently the PBA program is developing recombinant inbred lines (related lines that vary in both boron and salinity tolerance but otherwise are very similar) to reduce genetic interactions for field assessment. Yield nurseries and field screening at Minnipa remain very important in selecting for higher field tolerance to boron and salinity toxicity in seasons where these soil factors are limiting water uptake.

Table 1 Boron and salt rating, grain yield and weight of PBA breeding lines and commercial field peas on contrasting soils for boron toxicity, Minnipa 2009

Variety/Line	Boron tolerance#	Salt tolerance#	t/ha	Grain Yield %Kaspa	Rank	g/100 seeds	t/ha	Grain yield % Kaspa	Rank	g/100 seeds
Kaspa	S	S	2.19	100	2	18.91	2.32	100	2	18.91
OZP0601	S	S	1.86	85	14	17.38	1.88	81	15	17.11
OZP0602	S	MT-HT	1.95	89	10	18.11	2.03	87	10	17.80
OZP0703	S	MT-HT	1.85	85	15	15.73	1.99	82	14	15.74
00-254-26	S	MT-HT	1.76	80	18	16.51	1.88	81	16	15.21
01H071P-02HO2003-04HO5005	MT	MT-HT	1.88	86	12	16.09	1.76	76	18	16.64
02-093-1	MT-HT	MT-HT	1.84	84	16	14.16	1.91	82	13	14.51
02-220-3	S	MS	1.48	67	21	17.09	1.65	71	21	17.10
02-262-3	HT		2.04	93	6	18.98	2.24	96	5	19.86
02-323-3	MT-HT	MT-HT	2.17	99	4	18.44	2.20	95	6	17.48
02-356-5	HT		2.19	100	3	17.92	2.31	99	3	18.25
02-393-3	S	S	1.63	74	20	15.28	1.73	74	19	15.49
03H061-04HO2001	MT-HT	MT-HT	2.13	97	5	18.98	2.09	90	8	17.62
03H078P-04H2003	MT-HT	S	1.83	84	17	18.30	1.93	83	11	17.76
03H264P-04H2009	S	S	2.34	107	1	18.37	2.57	111	1	18.91
03H627-04HO2009	MS	MT-HT	2.01	92	8	17.80	2.26	97	4	18.81
03H348P-04HO2011	MT-HT	MT-HT	2.02	92	7	18.68	1.92	82	12	18.42
03H382-04HO2007	HT	MT	1.87	85	13	18.24	2.03	87	9	18.15
03H534-04HO2004	S	MT-HT	2.00	91	9	19.56	2.19	94	7	19.98
03H536-04HO2010	MT-HT	MS	1.89	86	11	16.34	1.85	80	17	15.83
03H562P-04HO2008	HT	MT-HT	1.66	76	19	16.78	1.67	72	20	15.86
Site mean yield			1.93			17.51	2.01			17.37
CV %			7.04			3.31	4.98			4.14
LSD (P<0.05)			*0.23*			*0.99*	*0.18*			*1.19*

 # derived from glass house pot experiments using boron at 10 ppm and $NaCl_2$ in water solution at a final concentration of dS^{-1}

Table 2 Flowering dates, grain yield, plant dry matter at early podding stage and grain weight of dual purpose PBA field pea breeding lines and commercial checks, Minnipa 2009

	Flower		Grain yield		Dry matter		
Variety/Line	Start Date	Days	t/ha	% Kaspa	t/ha	% Kaspa	g/100 seeds
Kaspa	14 August	24	2.24	100	6.06	100	19.00
Morgan	14 August	35	2.08	93	5.19	86	17.68
03A158P-04CH2001	10 August	39	1.87	84	4.62	76	22.05
03H033P-04HO2008	7 August	42	2.01	90	5.75	95	18.18
03H072P-04H2009	7 August	35	2.06	92	4.87	80	20.80
03H376P-04H2005	10 August	35	1.82	81	4.02	66	19.15
03H547P-04HO2014	7 August	42	1.90	85	6.20	102	17.45
03H554P-04HO2015	31 July	49	2.32	104	3.40	56	24.03
03H562P-04H2008	7 August	38	1.96	88	4.98	82	19.20
04H084P-05HO2003	10 August	39	1.97	88	4.73	78	19.47
04H090P-05HO2007	10 August	39	1.62	72	4.65	77	17.14
04H186P-05HO2002	14 August	35	1.61	72	4.78	79	22.01
05H170-06HOS2003	14 August	28	1.91	85	4.40	73	20.94
05H207-06HOS2002	14 August	28	2.56	114	6.39	105	21.79
94-425*2b	4 September	39	1.45	65	7.44	123	13.80
Site mean yield			1.96		5.16		19.51
CV %			4.26		10.46		3.22
LSD (P<0.05)			*0.14*		*0.96*		*1.1*

The advanced line, 94-425*2b, produced significantly higher dry matter production by the flat pod stage (ideal time for cutting peas for hay) than all other lines evaluated under favourable growing conditions in 2009 in contrast to its poor performance in 2008. However it has low grain yield potential in these environments which may limit its value as a dual purpose type for these regions. Results from 2008 and 2009 indicate there is potential to select field pea lines that have higher dry matter and grain yields than the current dual purpose field pea Morgan e.g. 05H207-06HOS2002. Further evaluation over seasons and in different environments is required to validate these findings. Additional work is also required to understand the key morphological and phenological traits required in field peas to provide high biomass in conjunction with high grain yield in low rainfall environments, as traditional high biomass types generally have low grain yields in these environments.

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Canola and Juncea Canola for Low Rainfall Areas in 2010

INFORMATION

RESEARCH

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Searching for answers

Location: Minnipa Ag Centre
Rainfall
Av. Annual: 325 mm
Av. GSR: 242 mm
2009 Total: 421 mm
2009 GSR: 333 mm
Yield
Potential: 2.7 t/ha (canola)
Actual: 2.3 t/ha 45Y77 canola
Paddock History
2008: Wheat
2007: Wheat
2006: Wheat
Soil Type
Red calcareous sandy loam
Plot size
10 m x 1.5 m x 3 reps

What a difference a year makes. No canola or juncea yields at Minnipa in 2008 and the sky is the limit in 2009. What are you going to do to us in 2010? As yields were so high in 2009, we have also used 2008 and earlier data to give an understanding of what is likely to happen in a normal year.

Variety selection

The choice of most suitable canola variety for any situation will often follow a consideration of maturity, herbicide tolerance, blackleg resistance and early vigour together with relative yield and oil content. In relation to some of these issues the following points can be made:

- The weed species expected may dictate the need for a herbicide tolerant production system (e.g. triazine tolerant or Clearfield). Remember that a triazine tolerant variety will incur a yield and oil penalty when grown in situations where they are not warranted.
- Varietal blackleg resistance and/or fungicide use should be considered, particularly when rotations are close, although blackleg is less of a factor in low rainfall systems.

The following are early or early-mid flowering varieties that may be suitable for lower rainfall areas.

New varieties released in 2008

Triazine tolerant (TT) varieties

Hurricane TT. New release (coded PacT2202). Early-mid maturing variety. Pacific Seeds indicate good yield, oil and protein content. Ideally fits low to medium rainfall areas, exhibits good vigour. Blackleg rating MR provisional. First year of testing in NVT in 2007. Bred and marketed by Pacific Seeds.

Tawriffic TT (coded BLN3697TT) is an Early-mid, Triazine Tolerant Canola variety developed by the Canola Alliance. Tawriffic TT has a blackleg rating of MR-MS provisional and is medium in height. The Canola Alliance have indicated that Tawriffic TT has high yield and oil potential. Marketed by PlantTech Pty Ltd.