SAGIT

FINAL REPORT 2014

PROJECT CODE	: S0711

PROJECT TITLE	Matching seed source and target environment to improve cereal production in SA

PROJECT DURATION

Project Start date	1 June 2011
Project End date	30 June 2014

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Project Code	
Project Type	

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PROJECT REPORT

Executive Summary

The project asked: Is crop performance affected by the source of seed? Can we agronomically capture this seed-source effect to improve crop yield and stress tolerance? To answer these questions, we combined chamber and field experiments.

In the chamber, two wheat varieties (KRL19, Krichauff) where grown under salinity or control conditions during four successive generations. We found that seed grown under salinity carried a yield penalty during 3-4 generations of growth under non-saline conditions.

In the field, four commercial varieties (Axe, Emu Rock, Wyalkatchem, Gladius) grown in six sites in SA (Cummins, Minnipa, Palmer, Pinnaroo, Streaky Bay, Turretfield) in 2011 and 2012, were used as "sources" of seed for crops grown in three sites in 2012 and 2013. All crops were sown, managed and harvested using NVT protocols. In 2012, the effect of seed source ranged from undetectable (Gladius) to 30% (Wyalkatchem). In 2013, the effect was significant and similar for all four varieties (approx. 18%).

Our preliminary recommendations are grow crops (i) using plump, healthy seed and (ii) avoiding using seed from saline soils for crops in non-saline soils. The benefit from this recommendation would range from neutral to positive depending on the actual responses in the field. A basic understanding of paddock variation (e.g. with EM38 or soil analysis) would help to avoid this potential yield penalty. Contrary to expectation, the effect of source of seed did not affect adaptation to stress in the field, but rather the ability of wheat to capture moderate to good growing conditions (above 2.5 t/ha). Changes in gene expression were likely involved in this response that warrant further research.

Project Objectives

1. Measure the gains in wheat yield derived from better matching seed source with target environments prevalent in SA.
2. Identify the changes in seed composition and gene regulation that explain pre-adaptation to stress.
3. Produce guidelines for growers to improve crop yield based on the matching of seed source and target environment.

Overall Performance

Achievement of objectives

Objective 1 was achieved. Over two seasons of field work using the NVT protocols to grow experimental crops, we found a cultivar-dependent response to seed source. In 2012, the effect of seed source ranged from undetectable (Gladius) to 30% (Wyalkatchem). In 2013, the effect was significant (18%) and similar for all four varieties (Axe, Emu Rock, Wyalkatchem, Gladius).

Objective 2 was achieved. Over three years of intensive experiments in controlled environments and two seasons of field work we separated the effect of seed size (by screening seed to uniform size), seed composition (by measuring all macro and micronutrient concentration in seed), and DNA methylation in seedlings. After discarding the effect of seed size and seed composition, a clear signature emerged of differential DNA methylation depending on the source of seed. Contrary to the initial expectation, the source of seed did not improve stress adaptation in the field (i.e. no response for percentile 10th yield) but dramatically changed the responsiveness to favourable growing conditions (percentile 90th yield).

Objective 3 was achieved. Cautious recommendations were published in a press release to industry. To increase visibility, this material is part of Ministerial releases for Royal Show week on September 2014. It should be noted however, that owing to the complex interaction between environment sourcing seed, cultivar and target environment it was difficult to identify specific traits that can be easily targeted to improve the matching of source seed by cultivar by environment. Growers already know that better crops require healthy, plump seed; the project reinforced this message. The main new recommendation is to avoid using seed from saline soil to raise wheat crops which might carry over yield penalties in several successive crops.

Personnel

SARDI: Victor Sadras, Yusuf Genc, Rob Wheeler, Klaus Oldach
University of Adelaide: Julian Taylor, Tim March

Key Performance Indicators (KPI)		
KPI	***Achieved (Y/N)***	***If not achieved, please state reason.***
1. Changes in seed composition and genetics in response to stress are determined.	Yes	
2. The role of stress pre-adaptation to improve stress tolerance is determined.	Yes	
3. Wheat yield gains associated with sourcing seed from specific environmental conditions is measured in field experiments across SA.	Yes	
4. Persistence of compositional and genetic changes in seeds underlying stress memory is measured across generations.	Yes	
5. Guidelines for growers to improve crop yield based on the matching of seed source and target environment	Yes	
6. Final report and industry extension material is published	Yes	

Technical Information

The project combined detailed work in growth chambers to elucidate physiological and molecular mechanisms of source-seed effect in wheat, and field trials to test the agronomic relevance of these mechanisms. Three mechanisms were considered. First, seed size; this effect was removed experimentally by using seed of uniform size. Second, macro and micronutrient concentration in seed was measured using Inductively Coupled Plasma Optical Emission Spectrometry (P, K, S, Fe, Mn, B, Cu, Zn, Ca, Mg, Mn, Na) and the combustion technique (Elementar Rapid N III Nitrogen Analyzer-Version J) for nitrogen. DNA was extracted from leaf tissue of six replications per seed source per treatment per cultivar. Plants were grown in a potting mix (University of California mix) up to leaf 3 stage (embryonic leaves) without treatment. Genome wide DNA methylation was assessed by Genotyping-by-Sequencing (GBS) using a double-digest with the methylation sensitive restriction enzymes *PstI* and *HpaII*. The GBS libraries were constructed in 95-plex pools of individual DNA samples and each pool sequenced on a single lane of an Illumina HiSeq 2000 with 100bp single end reads. Presence/absence markers, referred to as "epi-tags", were quantified from the sequence data using Tassel v3.0. Unique epi-tags were only included for further analysis if they had a minimum tag count of 100 across the merged tag count dataset.

Chamber studies

Plants were grown in a potting mix (University of California mix) in growth chambers. The objectives were to investigate (i) how the presence and absence of recurrent salinity stress affect plant performance in subsequent generations, and (ii) what roles seed composition and DNA methylation play in those responses. The effect of seed size on plant growth was minimized by using seed with similar sizes across four generations of salinity and control treatments. A soil salinity level of ECe=8 dS m^{-1} was imposed on plants mimicking salts generally present in South Australian subsoils.

Two wheat cultivars of contrasting salinity tolerance (Australian cv. Krichauff and Indian cv. KRL19) were grown for four successive generations in saline or hospitable control soils to generate seed with different life histories. We thus produced seed from one (S), two (SS), three (SSS) and four (SSSS) consecutive generations of salinity and their corresponding controls (C, CC, CCC, CCCC). All these generations were then grown together under control and salinity conditions to study transgenerational effects. There were three replicates per seed source per cultivar per treatment. Plants were grown to maturity by maintaining field capacity daily. A number of traits were measured (grain yield, grain weight, grain number, days to heading, plant height, leaf nutrient concentration). Here we focus on two key agronomic traits: time of heading (Appendix 1 Figure 1) as a marker of phenological development relevant for plant adaptation and seed yield (Appendix 1 Figure 2). It should be stressed, however, that plant yield in chambers and yield of field crops are not necessarily correlated.

For plants with a family history of control conditions, salinity shortened the time to heading in comparison to the controls (Appendix 1 Figure 1). The average difference in time to heading between salt stressed and control plants was 1.3 days for Krichauff and 3.9 days for KRL19. Plants with a family history of salinity recovered gradually; for each generation of exposure to salinity, time to heading was extended by 0.3 days in Krichauff, and 1-2 days in KRL19. With these rates, plants with a family history of salinity reached a similar time of heading than their counterparts with a control history in about four generations (Appendix 1 Figure 1).

For plants with a family history of control conditions, salinity reduced yield by 48% in Krichauff and 56% in KRL19 (Appendix 1 Figure 2). This response was stable across generations. In contrast, the responses shifted with generation for plants with a family history of salinity. To further analyse these shifts, we explored the relationship between yield and number of generations under stress in plants exposed to salinity. No pattern was apparent for Krichauff; the flat relationship between yield and number of generations under both control and salinity conditions reflects the lack of residual salinity effects across generations (Appendix 1 Figure 2C). In contrast, generational changes in yield were apparent for KRL19. Plants exposed to salinity and returned to control conditions carried a yield penalty during three generations and recover the yield level of their counterparts with a history of control conditions in the fourth generation; a piece-wise model fitted to the data returned an inflection point at 2.9 ±

1.07 generations, thus providing an objective estimate of the generations required for full recovery under our experimental conditions (Appendix 1 Figure 2F). Under salinity, the seed yield of plants with a family history of salinity increased linearly with number of generations of exposure to stress; the rate of yield improvement was 0.3 g per generation, which was equivalent to 6% per generation (Appendix 1 Figure 2).

The more marked responsiveness to salt of KRL19 in comparison to Krichauff reflected in the shortened time to heading, the rate of response to successive generations of salinity in both time of heading and yield corresponded with differences in salt content in plant tissues, i.e. KRL19 had higher concentration of sodium in leaves that Krichauff (Appendix 1 Figure 3).

Field Studies

Trial at Turretfield, July 2013

The aim of these studies was to measure the actual responses of wheat yield to seed source in agronomically realistic settings. The trial comprised the 4 x 6 x 3 factorial combination of genotypes, maternal environments and target environments, and was repeated during two seasons (2012, 2013). Four locally adapted wheat genotypes were compared: Axe, Emu Rock, Wyalkatchem, Gladius (Appendix 2 Table 1). Seed to grow crops in the three target environments (Minnipa, Pinnaroo, Turretfield) was sourced from six maternal environments (Cummins, Minnipa, Palmer, Pinnaroo, Streaky Bay, Turretfield). In each target environment, the combinations of genotypes and seed sources were laid out in a randomized block design with three replicates in 2012. In 2013, treatments were laid out in a split-plot design with four replicates; main plot was assigned to genotype and maternal environment to subplots. Target crops were grown using screened seed (>2.8 mm) to eliminate small, deficient seed and minimise maternal effects associated with seed size. For both maternal and target environments, crop husbandry, harvest operations and grain yield determination followed the protocol of the National Variety Trial in accordance with best farmer practice for the district. We measured grain yield in the field, macro and micro nutrient composition of the seed used to grow crops, and DNA methylation in seedlings derived from seed using to grow the crops.

Agronomically, wheat is the backbone of the cropping system, and is grown in rotation with pastures, barley, fallow, grain legumes and oilseed crops; all these rotations were represented in this study. Rainfall is a major source of variation in grain yield; it ranged from 156 to 397 mm in the growing season and from 5 to 256 mm in the fallow period. Soils were slightly alkaline in most cases, and textures varied widely from sandy loam to clay. Our study thus captured the main agronomic, rainfall and soil aspects of the cropping systems (Appendix 2 Table 2).

Across sites, varieties and seed sources yield averaged 2.1 t/ha in 2012 and 3.0 t/ha in 2013. We analysed the effect of seed source on three measures of yield: mean yield, yield in favourable conditions (90th percentile) and yield under stressful conditions (10th percentile). Seed source had no effect on mean yield or, contrary to expectation, yield under stress. Unexpectedly, there was a large and consistent effect of seed source on the yield of crops under the more favourable conditions (Appendix 2 Figure 4). In seven out of eight cases, seed source had a significant effect on yield (Table 1). In 2012, the effect ranged from nil in Gladius to 30% in Wyalkatchem. In 2013, we found a significant and consistent effect in all four varieties, in the order of 15-18%.

Table 1 Effect of seed source on the 90th percentile yield of four wheat varieties over two seasons. The 90th percentile yield is a measure of yield under favourable conditions (> 2.5 t/ha).

Season	Variety	Source-seed effect on yield (%)
2012	Axe	9
	Emu Rock	12
	Gladius	not significant
	Wyalkatchem	30
2013	Axe	19
	Emu Rock	18
	Gladius	15
	Wyalkatchem	18

After demonstrating a substantial effect of seed source on yield in realistic agronomic settings, we explored both the mechanisms and the practical opportunities to exploit this effect. Of the three potential mechanisms, we discarded seed size, which was manipulated experimentally, and seed composition. Whereas seed composition varied with seed source, there was no consistent impact on yield (Appendix 2 Table 4). We found substantial experimental evidence that the profiles of DNA methylation changed with the source of seed. This is encouraging in the progress of understanding the drivers of source seed effects but it is unlikely that this type of markers would be useful for selecting seed to match particular environments in the near future. We then explored the association of practical markers with yield responses. We investigated standard measures of grain quality including thousand grain weight, protein, screenings and hectolitre weight. None of these traits had capacity to predict which seed source would provide the higher yield.

Conclusions Reached &/or Discoveries Made

In seven out of eight cases, seed source had a significant effect on yield under favourable cropping conditions (> 2.5 t/ha). In 2012, the effect ranged from nil in Gladius to 30% in Wyalkatchem. In 2013, we found a significant and consistent effect in all four varieties, in the order of 15-18%. This effect was unrelated to seed size and seed composition, and was likely related to the patterns of DNA methylation, a process that regulates gene expression.

In chamber experiments, exposure of wheat plants to soil salinity had a carryover effect which persisted during four generations in variety KRL19, but not in Krichauff. Lasting yield penalties might arise from seed raised in saline soils. In responsive varieties, this hidden effect of salinity can be avoided by using seed from non-saline sites. As we do not have the tools to identify responsive varieties at present, avoiding using seed from saline soils to grow new crops is recommended as a precaution.

Intellectual Property

No IP was generated in this project.

Application / Communication of Results

Main findings of the project in a dot point form suitable for use in communications to farmers

- The source of seed used to grow your crop can have a large impact on yield.
- Depending on variety and cropping conditions, the source of the seed can generate variation in yield from small (8%) to large (30%).
- Variations in yield with seed source are more likely to show under favourable conditions (> 2.5 t/ha) than under stress.
- Seed from crops raised on saline soil might depress yield of successive crops; this effect may last for several seasons.
- To grow your crops, select healthy, plump seed and try to avoid seed from saline soils as a precaution for hidden yield penalties.

A statement of potential industry impact

This 3-year project demonstrated a moderate to large and consistent impact of seed source on grain yield of wheat in realistic agronomic conditions. Effect as large as 30% was recorded, and a conservative estimate would be 10% (Table 1). As these effects mostly show under good conditions (> 2.5 t/ha), these percentages translate to economically interesting gains. For this potential to be realized, however, practical markers are required to predict the performance of the crop depending on the source of the seed. A preliminary assessment failed to find such practical markers.

Publications and extension articles delivered as part of the project

The project was discussed with SAGIT staff and industry representatives 6/10/11, 5/10/12 and 31/10/12. Aims and results of the project were communicated as follows:

- Stock Journal article (11 Aug 2011)
- Presentation at the 6th International Crop Science Congress, Brazil (August 2012)
- SARDI Media Release (10 Sep 2013)
- Stock Journal article (26 Sep 2013)
- Yorke Peninsula Country Times, Kadina (17 Sep 2013)

- Seminar at Genomics Research Centre, Fiorenzuola d'Arda, Italy (October 2013).
- Meeting of Minister for Agriculture, Food and Fisheries Gail Gago and Minister for Water Ian Hunter with grain-growers at the Golden Grains Pavilion, Wayville Showground (17 Sep 2013)
- ABC North and West SA Country Hour (19 Sep 2013)
- SARDI Media release summarising the project's results (27 August 2014) (see Appendix 3).
- Two scientific papers are being written reporting the results from chamber and field experiments. It is planned to complete the papers by February 2015. Likewise, communication with industry will be extended during the second semester of 2014 and early part of 2015. SAGIT will be updated on additional media and scientific communication produced after the submission of this report.

Suggested path to market for the results including barriers to adoption

The practice of selecting healthy, plump seed and avoid using seed from soil with chemical problems is relatively straightforward, and in principle involves no additional costs. Application of these simple precautions could be neutral to moderately positive for farm's bottom line, hence barriers for adoption are not apparent.

POSSIBLE FUTURE WORK

The responses to source seed were dependent on genotype. However, we only compared 2 (chamber) and 4 (field) genotypes. Further research screening larger number of genotypes would be useful to refine estimates of yield gains associated with major commercial lines available to SA growers.

The project identified a link between yield reduction under salinity, and the propagation of this effect in successive crops over several seasons. Testing this pattern in the field is more likely to return practical markers to select seed from sources delivering higher yield.

AUTHORISATION	
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Signature:	
Date:	27 August 2014

Appendix 1: Growth Chamber Studies

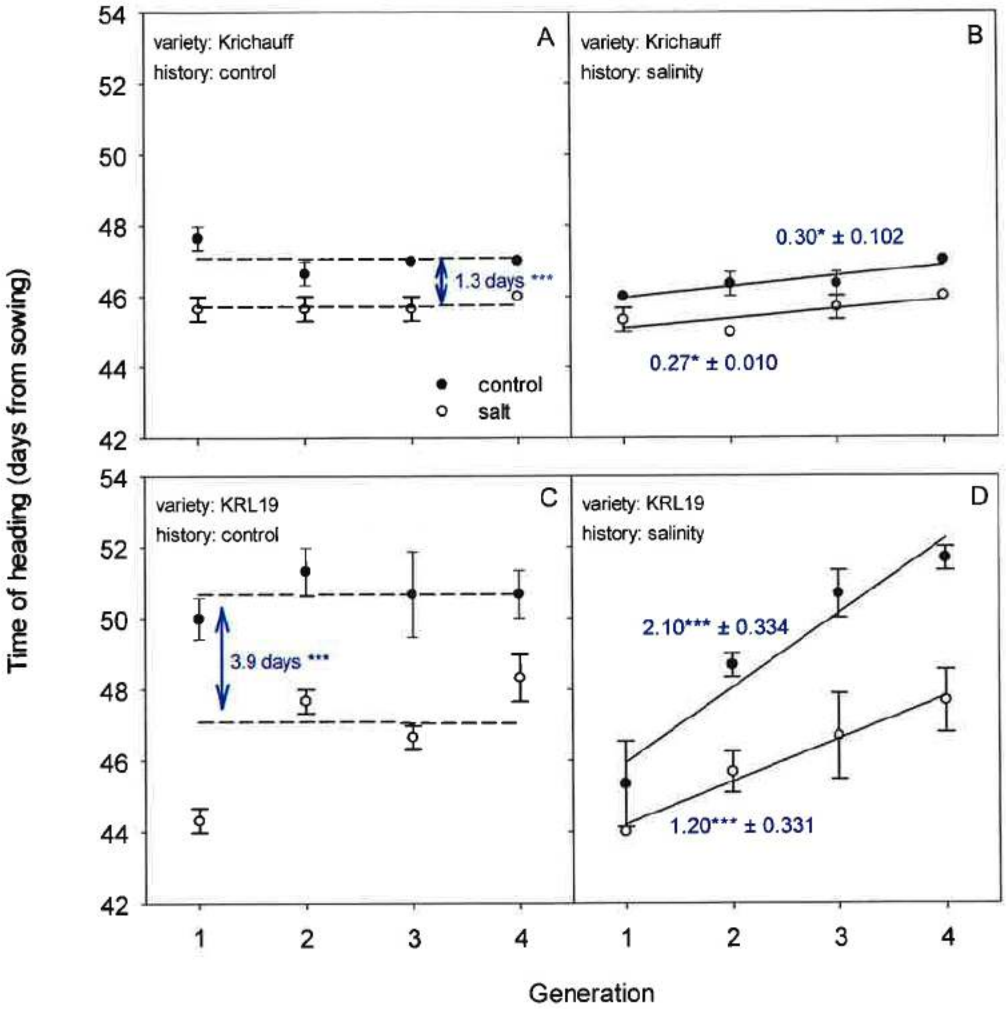

Figure 1. Effect of family history on the phenological development of wheat. (A,B) In plants with a family history of control conditions, salt stress shortened the time to heading by 1.3 or 3.9 days depending on the variety. Dashed lines indicate the average time of heading for plants grown under control (closed symbols) and salinity (open symbols). (C,D) In plants with a family history of salt stress, time of heading recovered linearly with successive generations of treatment. Solid lines are linear regressions and numbers indicate slopes (± standard error) in days per generation. Error bars are two standard errors and asterisks indicate significant difference from zero at P < 0.05 (*), P < 0.01 (**), and P< 0.0001 (***).

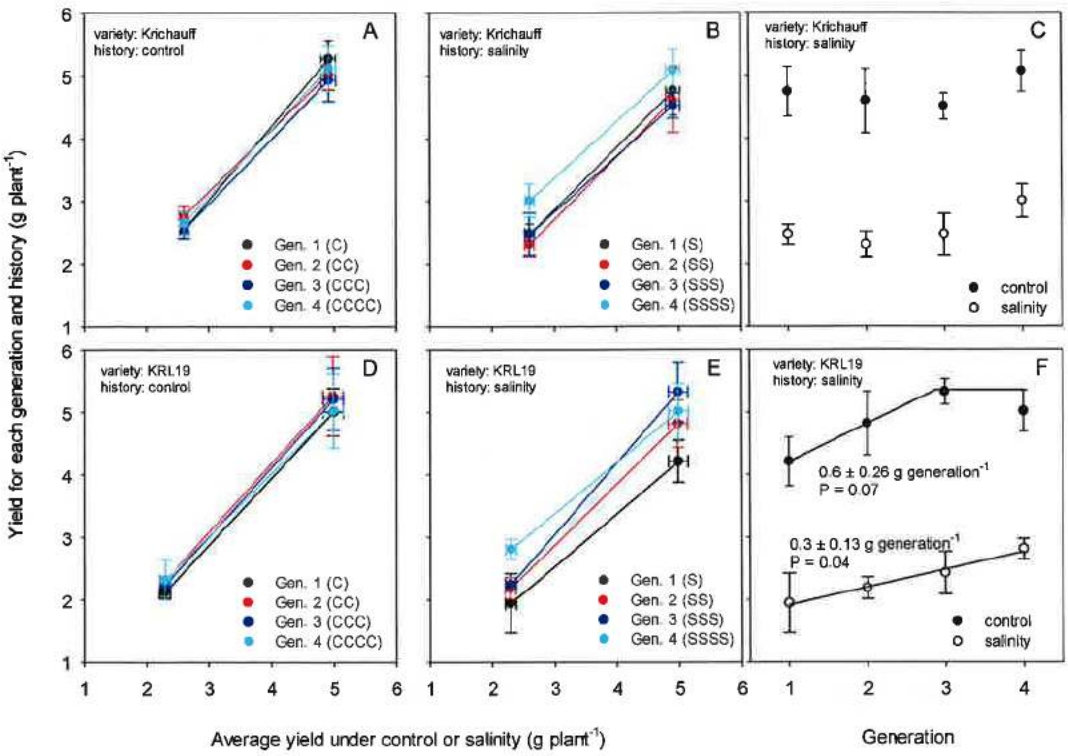

Figure 2. Effect of family history on the seed yield of two wheat cultivars KRL 19 and Krichauff. Reaction norms of seed yield in plants with a family history of (A, D) control and (B, E) salinity conditions. Reaction norms relate the yield for each generation and history treatment with the average yield measured under control or salinity conditions. (C,F) Seed yield as a function of number of generations under salinity. Error bars are two standard errors.

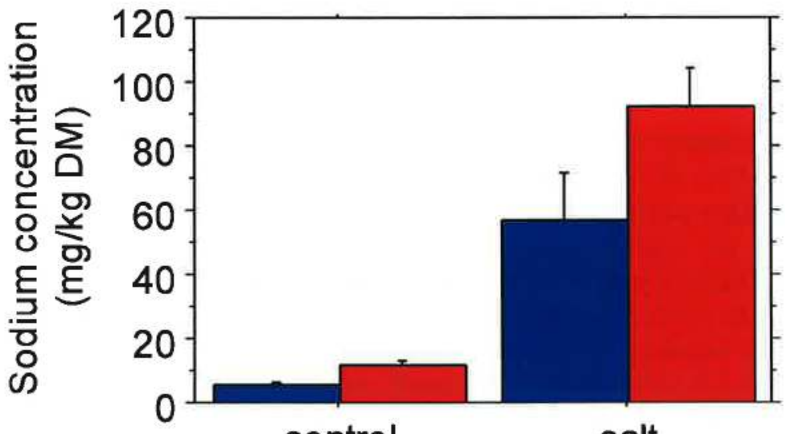

Figure 3. Under soil salinity, the Australian wheat cultivar Krichauff (blue bars) has lower sodium concentration in leaves than its Indian counterpart KRL19 (red bars).

Appendix 2: Field Studies

Table 2. Four commercial genotypes used in the trials. All four varieties are well adapted agronomically and are widely used by local farmers. Axe and Gladius share parents but have a significant phenological difference. Phenology is characterised by the average (± standard error) thermal duration of the sowing-to-flowering stage measured in field crops in the National Variety Trials (www.nvtonline.com.au/).

Genotype	Pedigree	Thermal time from sowing to flowering (°Cd)
Axe	Kukri, RAC875, Excalibur	1118 ± 21.0
Emu Rock	Kukri, Westonia, Perenjori, Ajana	1144 ± 27.1
Gladius	Kukri, RAC875, Excalibur, Krichauff, Trident	1288 ± 49.6
Wyalkatchem	RAC177, Madden, Gutha, Jacup*2/11Isepton135	1247 ± 24.6

Table 3. Maternal and target environments. Each environment is defined by the combination of location and season. The maternal environments in 2011 were the sources of seed for target crops in 2012, and the maternal environments for 2012 were the sources of seed for target crops in 2013. Rainfall is total for the fallow period (January-March) and growing season (April-October). Soil types are S=sand, L=loam, C=clay, Li=light, M=medium. Average yield of 22-25 genotypes is a crop-based index of the global agronomic, weather and soil conditions in each environment. (Finlay and Wilkinson 1963).

Environment*	Rainfall (mm)		Soil type	top-soil pH_{water}	Previous crop	Sowing date	Average yield (t ha^{-1})
	fallow	season					
Maternal 2011							
Cummins	79	254	CL	8.1	lentil	15 May	6.6 [23]†
Minnipa	129	252	L	8.3	pasture	6 May	4.2 [23]
Palmer	242	190	SL/SCL	7.5	pasture	23 May	4.7 [23]
Piednippie	124	242	SCL	7.8	fallow	20 May	2.1 [23]
Pinnaroo	256	156	SL/LC	8.1	wheat	14 May	4.3 [23]
Turretfield	141	320	SCL/LiC	7.4	pasture	14 June	3.6 [23]
Maternal 2012							
Cummins	28	256	CL	7.5	canola	14 May	4.7 [25]
Minnipa	63	185	L	8.6	barley	27 May	1.7 [24]
Palmer	90	268	SL/SCL	6.6	pea	26 May	3.6 [25]
Piednippie	5	181	LSCL	8.5	pasture	7 June	1.2 [24]
Pinnaroo	131	214	SL/LC	8.3	wheat	31 May	2.1 [25]
Turretfield	74	288	LC/LMC	6.8	pasture	15 June	2.9 [25]
Target 2012							
Minnipa	63	185	L	8.6	barley	27 May	1.7 [24]
Pinnaroo	131	214	SL/LC	8.3	wheat	31 May	2.1 [25]
Turretfield	74	288	LC/LMC	6.8	pasture	15 June	2.9 [25]
Target 2013							
Minnipa	66	237	L	8.4	pasture	17 May	3.1 [22]
Pinnaroo	25	204	C	8.6	wheat	20 May	1.8 [23]
Turretfield	43	397	LC/LMC	7.9	pasture	9 June	3.1 [25]

*Cummins: 34°16′ S, 135°44′ E; Minnipa: 32° 51′ S, 135° 9′ E; Palmer: 34° 51′ S, 139° 9′ E; Piednippie: 32° 45′ S, 134° 24′ E; Pinnaroo: 35° 15′ S, 140° 54′ E; Turretfield: 34° 32′ S, 138° 50′ E.
† number of genotypes.

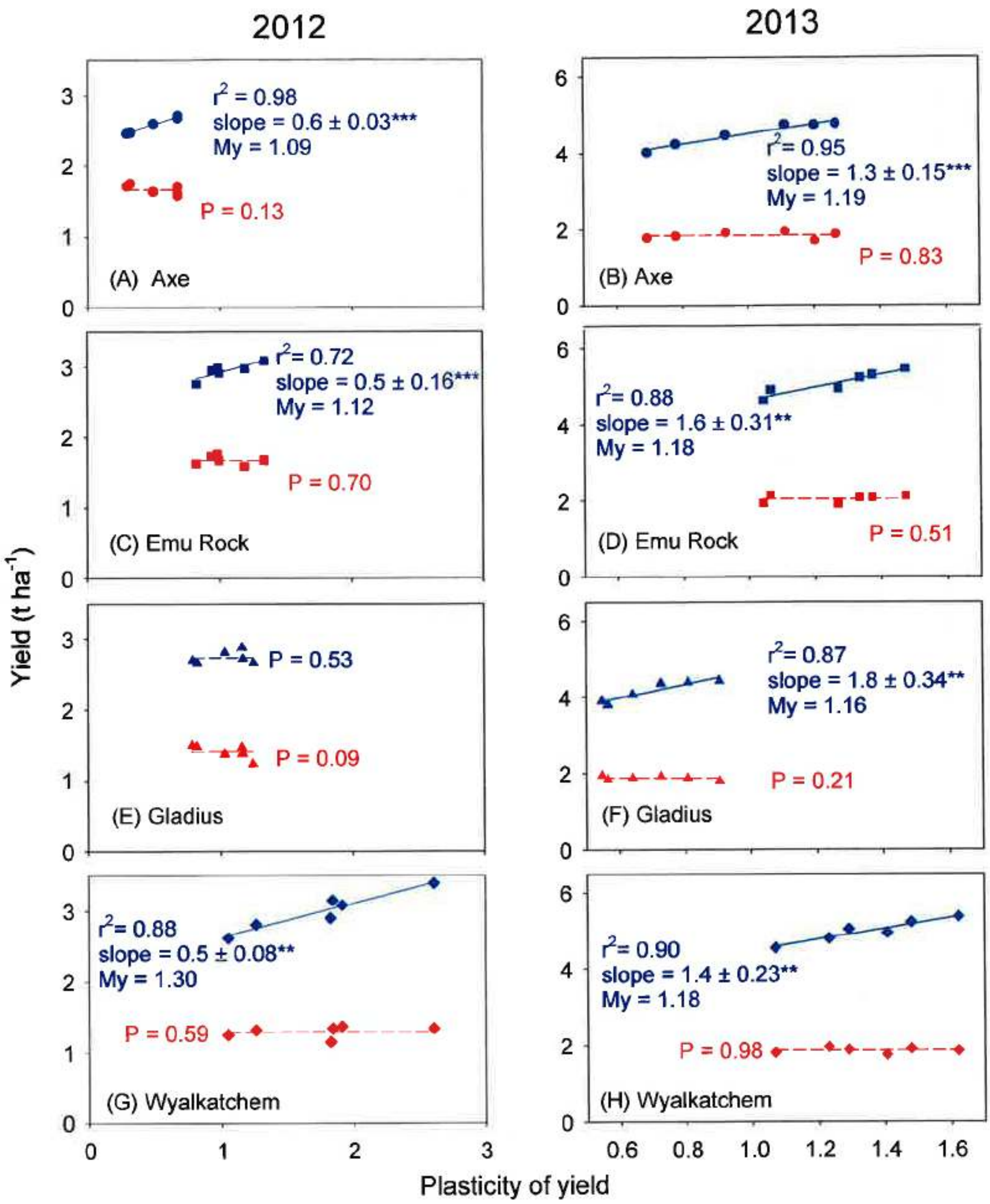

Figure 4. Yield of four wheat varieties under favourable (blue) and stressful (red) conditions as a function of plasticity of yield. Plasticity is calculated as a ratio of variances as explained in Sadras and Richards (Journal Experimental Botany 65:1981-1995). The range of plasticities is fully attributable to seed source. *My* is the maternal effect on yield, calculated as the variation between lowest and highest yield. These values are presented as percentages in Table 1 of main report.

Table 4. Correlation coefficients for the association between yield traits in target crops and concentration of macro and micronutrients in seed derived from six maternal environments. Coefficients in bold are significant at P <0.05. *P* values from ANOVA account for the effect of genotype, maternal environment and their interaction on seed nutrient

Season	Genotype	Yield traits	Seed composition											
			N	P	K	S	Fe	Mn	B	Cu	Zn	Ca	Mg	Na
2012	Axe	Yield Plasticity	0.58	-0.19	-0.01	0.30	0.24	0.17	-0.23	0.24	0.48	0.00	-0.57	-0.28
		Yield 90th	0.67	-0.16	-0.02	0.39	0.28	0.27	-0.19	0.33	0.43	0.07	-0.52	-0.31
		Yield 10th	-0.12	-0.26	-0.27	-0.03	-0.50	0.27	0.45	-0.08	-0.37	0.10	0.40	0.50
	Emu Rock	Yield Plasticity	0.35	**0.92**	-0.08	0.43	0.15	-0.01	-0.54	-0.11	0.00	0.45	0.56	0.20
		Yield 90th	0.51	**0.97**	0.16	0.53	0.30	-0.04	-0.48	0.15	0.44	0.70	0.34	0.12
		Yield 10th	0.31	0.12	0.32	0.25	0.58	-0.03	0.08	0.61	0.64	0.44	-0.51	-0.45
	Gladius	Yield Plasticity	-0.52	-0.33	0.30	-0.36	-0.70	-0.11	**0.87**	-0.14	0.25	0.13	0.12	0.42
		Yield 90th	-0.18	-0.13	0.46	-0.69	-0.21	-0.71	-0.06	-0.80	0.32	0.04	-0.30	0.75
		Yield 10th	0.66	0.12	-0.29	-0.06	0.50	-0.11	-0.66	-0.44	-0.49	-0.43	0.15	0.16
	Wyalkcatchmen	Yield Plasticity	0.24	-0.75	0.20	-0.60	-0.79	-0.26	-0.39	-0.80	0.33	-0.19	-0.73	**0.89**
		Yield 90th	0.09	-0.73	0.07	-0.55	-0.61	-0.29	-0.58	-0.85	0.27	-0.25	-0.67	0.79
		Yield 10th	-0.27	-0.26	-0.43	-0.38	0.18	-0.62	-0.80	-0.70	0.06	-0.37	-0.34	0.14
		P genotype	*0.0237*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*0.0007*	*<0.0001*
		P maternal	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
		P inter.	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*0.0003*	*<0.0001*
2013	Axe	Yield Plasticity	-0.46	0.64	**0.88**	-0.50	0.19	0.06	0.11	-0.31	-0.72	0.07	0.12	0.20
		Yield 90th	-0.48	0.65	**0.92**	-0.34	0.31	0.27	0.25	-0.13	-0.75	0.03	0.24	0.31
		Yield 10th	-0.62	0.13	0.27	-0.04	0.27	0.57	0.15	0.03	-0.24	0.55	0.19	0.52
	Emu Rock	Yield Plasticity	-0.18	-0.01	0.08	0.10	-0.14	0.01	0.07	-0.36	0.40	-0.01	-0.35	0.33
		Yield 90th	-0.05	-0.21	-0.03	0.32	0.07	0.08	0.26	-0.11	0.42	-0.24	-0.24	0.32
		Yield 10th	0.26	-0.49	-0.18	0.69	0.54	0.28	0.56	0.56	0.29	-0.61	0.21	0.16
	Gladius	Yield Plasticity	0.44	-0.49	-0.43	0.53	-0.31	0.05	-0.16	0.16	**0.92**	0.42	0.08	-0.23
		Yield 90th	0.37	-0.30	-0.32	0.46	-0.06	0.15	-0.03	0.25	0.80	0.30	0.28	-0.25
		Yield 10th	-0.62	0.72	0.57	-0.66	0.58	-0.01	0.07	-0.11	-0.64	-0.20	0.20	-0.06
	Wyalkcatchmen	Yield Plasticity	-0.75	0.03	-0.46	-0.54	-0.29	-0.53	-0.25	-0.11	-0.65	0.00	0.06	-0.78
		Yield 90th	-0.86	-0.19	-0.67	-0.62	-0.53	-0.69	-0.31	-0.27	-0.59	0.01	-0.22	-0.74
		Yield 10th	-0.41	-0.05	-0.47	-0.39	-0.35	-0.61	-0.03	-0.26	-0.47	-0.62	-0.37	-0.26
		P genotype	*0.0034*	*<0.0001*	*<0.0001*	*<0.0001*	*0.0601*	*<0.0001*	*<0.0001*	*<0.0001*	*0.0002*	*<0.0001*	*0.0127*	*<0.0001*
		P maternal	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
		P inter.	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*

Appendix 3: End-of-Project Media Release

MEDIARELEASE

Wednesday, 27 August 2014

Contact Tania Bawden, SARDI Communications, 0423 292 867

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SOUTH AUSTRALIAN RESEARCH & DEVELOPMENT INSTITUTE
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Higher wheat yield and seed source

Promising new research in South Australia is making inroads into proving that the source of the seed can influence crop yield when planted in moderate to good growing conditions.

The inherited qualities or 'memory' of several wheat varieties grown in different conditions was put to the test by the State Government's research institute SARDI over three years of field and laboratory trials.

Funded by the SA Grain Industry Trust (SAGIT), the latest epigenetics research project, or study of traits transferred from the mother crop to the performance of the offspring crop, is another step in maintaining productivity gains in the State's cropping sector.

"Along with excellent plant breeding programs, our agricultural researchers continue to look for novel technologies and low-cost ways to lift productivity and farm profits," said SAGIT chairman Jim Heaslip.

"Work in the emerging area of epigenetics could emerge as a handy shortcut to higher yield in future years," he said.

Researchers tested seed produced from four commercial wheat varieties in various locations for better crop yield and stress tolerance.

The source of the seed did not affect the crop's tolerance to stresses such as drought and salinity, but did result in improved yields under favourable growing conditions.

SARDI crop physiologist Associate Professor Victor Sadras said the research would build on earlier work on other varieties which pointed to better yield potential from seed produced in tough conditions.

"It is important we look for a range of scientific options because cropping in Southern Australia is facing hotter, dryer conditions now and in the future," A/Prof Sadras said.

Since the 1980s, South Australian broadacre crop production has risen from potential 20kg of wheat per hectare for each millimetre of water available – to 25kg of wheat per ha.

"Together with better varieties and improved agronomic practices, we are also working to improve farm production through crop ecology and physiology, genetics and crop protection," Assoc Prof Sadras said

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"Screening crops for adaptation to water, heat, salinity stress is part of this trend."

He said the results of this research have raised some useful information about seed source which is worthy of further investigation.

SUMMARY OF THE PROJECT:

Matching seed source and target environment to improve cereal production in SA

SARDI researchers Victor Sadras, Yusuf Genc, Rob Wheeler and Klaus Oldach – and Julian Taylor and Tim March (University of Adelaide) – asked two questions: Is crop performance affected by the source of seed? Can we agronomically capture this seed-source effect to improve crop yield and stress tolerance? To answer these questions, chamber and field experiments were combined over three years.

In the chamber, two wheat varieties (KRL19, Krichauff) were grown under salinity or control conditions during four successive generations. We found that seed grown under salinity carried a yield penalty during 3-4 generations of growth under non-saline conditions.

In the field, four commercial varieties (Axe, Emu Rock, Wyalkatchem, Gladius) grown in six sites in South Australia (Cummins, Minnipa, Palmer, Pinnaroo, Streaky Bay, Turretfield) in 2011 and 2012, were used as "sources" of seed for crops grown in three sites in 2012 and 2013. All crops were sown, managed and harvested using New Variety Trial protocols. In 2012, the effect of seed source ranged from undetectable (Gladius) to 30% (Wyalkatchem). In 2013, the effect was significant (18%) and similar for all four varieties.

Our preliminary recommendations are to grow crops (i) using plum, healthy seed and (ii) avoiding using seed from saline soils for crops in non-saline soils. The benefit from this recommendation would range from neutral to positive depending on the actual responses in the field. A basic understanding of paddock variation (e.g. with EM38 or soil analysis) would help to avoid this potential yield penalty. Contrary to expectation, the effect of source of seed did not affect adaptation to stress in the field, but rather the ability of wheat to capture moderate to good growing conditions (above 2.5 t/ha). Changes in gene expression were likely involved in this response that warrant further research.

The South Australian Research and Development Institute (SARDI) is a division of Primary Industries and Regions South Australia (PIRSA).