RESEARCH RESULTS THROUGH THE YEARS
Support shown by South Australian research findings for RLF's IFM Strategy

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This Insight (IN) supports the RLF Integrated Fertiliser Management (IFM) strategy of applying nutrients to seed, soil and foliage, over that of a soil-based fertiliser strategy alone. It also gives reference to similar research findings in Australia and overseas.

Background

Included in this Insight are two articles published in the Eyre Peninsula Farming System Summary of 2009 and 2013.

They are :

1. **Wheat seed source and seed size effects on grain yield**. Authors : Shafiya Hussein and Glenn McDonald.
2. **Potential for Foliar Applied Phosphorus in Australian Dryland Cropping : A Glasshouse Study**. Authors T.M. McBeath, S.R. Noack and M.J. McLaughlin.

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RLF's Role in the development of IFM

RLF is proud to be the instigator of technology and product for integrated fertiliser management (IFM) strategies, and has secured the advantages and benefits of these findings for its farmer and grower customers for almost 20 years.

The seed phosphorus article published in 2013 is yet more evidence supporting the mid 1970's finding of Dr Bolland of the Western Australian Department of Agriculture that seed phosphorus levels affect grain yield regardless of fertiliser input to the soil. And, again in the article that follows researchers show a strong correlation between grain phosphorus level and grain yield, which was statistically significant at $P<0.05$.

Also included is a foliar trial on the effect of foliar phosphate on grain yield, published in the Eyre Peninsula 2009 Farming System Summary.

This trial showed an increased grain yield of 25% when phosphoric acid was applied as foliar with adjuvant (LI700). This result was observed on Koppio soil (pH 6.2 and Colwell P of 29 PPM), but not in Maitland soil (with Colwell P of 83 PPM and pH 8.3).

The result of Koppio soil was statistically significant and was not observed with foliar application of ammonium polyphosphate and a commercial foliar fertiliser product with or without adjuvant.

Both articles contain information and interesting reading relevant to RLF's modern farming strategy of IFM. More information about IFM can be found at www.ruralliquidfertilisers.com.

Wheat seed source and seed size effects on grain yield

Shafiya Hussein[1] and Glenn McDonald[2]
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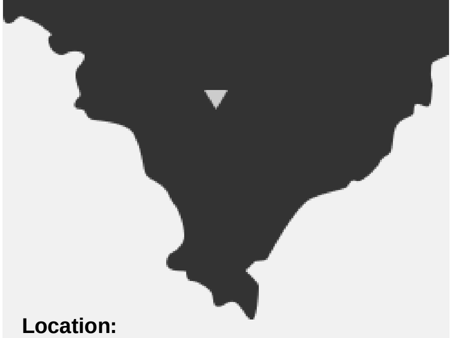
Searching for answers



Location:
Minnipa Agricultural Centre
Rainfall:
Av. Annual : 324 mm
Av. GSR : 241 mm
2013 Total: 334 mm
2013 GSR : 237 mm
Yield
Potential : (W) 2.73 t/ha
Actual : 2.89 t/ha (average)
Paddock History
2012 : Medic pasture
2011 : Medic pasture
2010 : Barley
Soil Type
Brown loam
Plot Size
1.5 m x 5 m x 3 reps
Yield Limiting Factors
Early finish and Boron

Key messages

- Large wheat seed (>2.8 mm) had a 6.6% plant density improvement over medium size seed (2.5 mm - 2.8 mm) but had no effect on yield in 2013.
- Seed source significantly affected grain yield with a 4-6% yield difference between the lowest and highest yields.
- Variation in yield due to seed source was associated with seed P and K concentrations.
- Mace out-yielded Scout, producing 3.2 t/ha and 2.7 t/ha respectively. Mace also had the highest plant establishment at 130 plants/m^2 and high vegetative growth.

Why do the trial ?

Good quality seed is necessary for improved crop establishment and yield. Larger seed provides more nutrients for early growth, leading to good establishment and vigorous growth, which is important for competitive ability against weeds and pests. The source of seed is also important since location can affect seed nutrient content as it is influenced by soil type, fertiliser applications and seasonal conditions. Larger seeds with high nutrient content, such as phosphorus (P), will produce better yield in a nutrient poor soil.

This trial was conducted to determine the influence of seed size and seed source on plant vigour and grain yield and quality in a low rainfall environment.

How was it done ?

Four wheat varieties (Emu Rock, Estoc, Mace and Scout) were selected from five diverse 2012 NVT sites across South Australia (Nangari, Nunjikompita, Turretfield, Wanbi and Penong).

Seed to be sown was sieved into two grain size fractions, being either greater than 2.8 mm diameter or 2.5 to 2.8 mm diameter, and sown at the Minnipa Agricultural Centre. The trial was conducted as a split plot design with the wheat variety as main plots, seed source as sub plots and seed size as sub-sub plots. This trial was replicated at Karoonda and Turretfield.

The trial was sown on 24 May 2013 at a rate of 150 plants/m^2 in 5 m plots by 6 rows and 24 cm row spacing. Fertiliser (19:13:0 S9%) was applied at 71 kg/ha. The trial received a chemical application on 15 May 2013 with Roundup Attack at 1 L/ha, + LI700 at 250 ml/ha, LV Ester 680 at 300ml/ha, Striker at 100 ml/ha. On 11 July the trial received an application of Tigrex at 300 ml/ha, Lontrel at 50 ml/ha, zinc sulphate at 2.5L/ha and on 20 August 2013 Prosaro at 150 ml/ha and Astound at 400 ml/ha was applied.

The trial was assessed for plant establishment, early vigour (Greenseeker hand held sensor used for normalised difference vegetation index - NDVI), grain yield and grain quality.

What happened ?

Large seed improved germination consistently at three replicated sites by 6-9%. Vegetative growth (measured by the Greenseeker) at early stem elongation was higher with larger seed at Minnipa; however, large and medium sized seed had no effect on yield.

Seed source affected yield at Minnipa. Yields were highest when seed from Penong, Turretfield and Wanbi was used at this trial site. The difference in yield between the best (Turretfield) and worst (Nangari) seed sources was 120 kg/ha at Minnipa and 190 kg/ha at Turretfield, equivalent to 4-6% yield difference. Variation in yield was most strongly associated with variation in grain P concentration among the seed sources (Figure 1, Table 1) and with grain potassium (K) concentration. Differences in mean grain size (37-44 mg) and grain protein concentration (11.4-17.0%) did not influence yield. In 2012, seed from Nangari also produced low yields (EPFS Summary 2012, p 35).

Soil tests (Colwell P) prior to seeding indicate adequate availability of P (41 mg/kg) in the top soil (0-10 cm) and very low availability (8 mg/kg) in sub soil (10-60 cm).

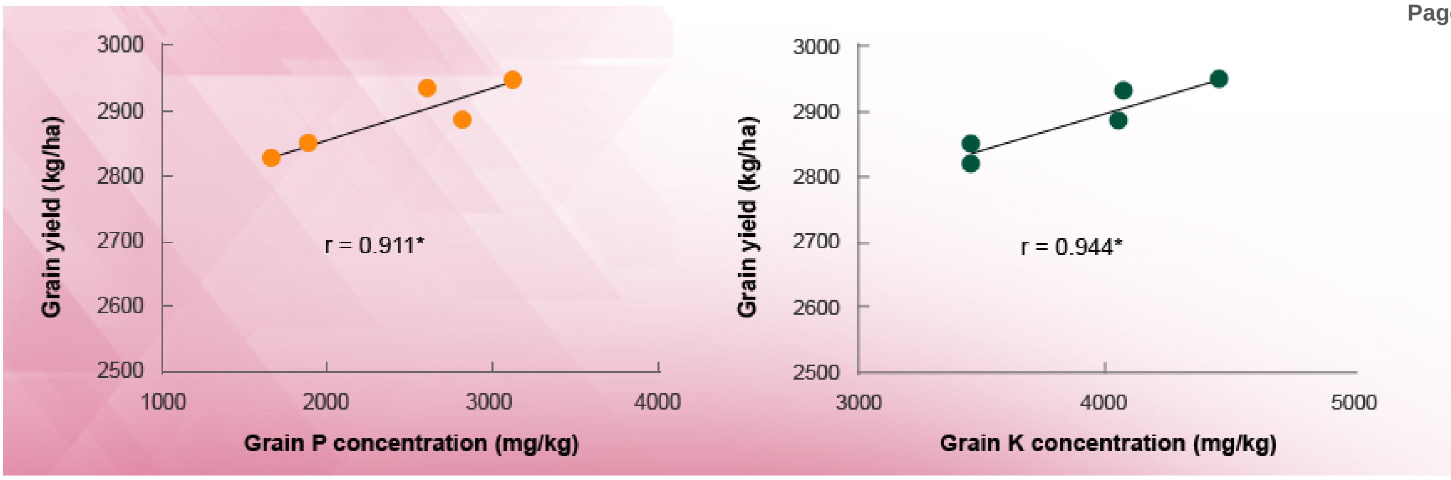


Figure 1 : The relationships between the average P and K concentration of grain from different sources and the grain yield at Minnipa in 2013. Each point is the average of four varieties. *significance at P=0.05.

Table 1 : Mean nutrient concentration of seed from different NVT trials in 2012

Seed Source	Thousand Grain wt (g)	GPC (%)	P	K	S	N:S ratio	Zn	Mn	Cu
			(mg/kg)				(mg/kg)		
Nangari	42.2	11.4	1668	3463	1389	14.4	8.9	29.3	4.5
Nunjikomita	37.6	14.7	1890	3467	1570	16.4	20.6	34.9	5.3
Penong	39.4	17.0	2613	4075	1810	16.5	19.7	55.2	3.4
Turretfield	43.6	11.9	3129	4457	1477	14.1	19.5	45.2	5.1
Wanbi	42.1	13.2	2817	4050	1612	14.4	21.1	28.2	3.2

Note : N:S ratio can be used to indicate sulphur (S) deficiency; if ratio >16 it suggests S is low (but not deficient)

Table 2 : Mean yields (kg/ha) of varieties grown at three sites in 2013

Seed Source	Site		
	Karoonda	Minnipa	Turretfield
Emu Rock	1923	3038	3608
Estoc	1673	2706	2927
Mace	1890	3151	3790
Scout	1758	2660	3394
	P <0.001	P <0.001	P <0.001
LSD (P=0.05)	***56.5***	***32.0***	***128.6***

Mace and Emu Rock yielded consistently more than Estoc and Scout across all the sites (Table 2). Grading seed did not alter the relative differences in yield significantly. The results are consistent with the results from 2012 when Emu Rock and Mace yielded well while Estoc and Scout produced lower yields.

Mace produced the highest yield at Minnipa when averaged across all treatments (3.15 t/ha) and Scout the lowest (2.66 t/ha). Seed size had no affect on yield: plump seeds (>2.8 mm) averaged 2.9 t/ha and medium sized seeds (2.5-2.8 mm) averaged 2.9 t/ha also.

What does this mean ?

Although larger sized seeds had a competitive edge over medium sized seeds in plant establishment and early plant vigour, any advantage was masked in yield. Early rain favoured varieties with larger seeds (Emu Rock and Mace) and these varieties continued to yield the highest in a dry seasonal finish. However, the seed size of each Emu Rock and Mace did not have any significant impact on yield at Minnipa in 2013.

Seed source can have a significant influence on yield and in this case low seed P and K were associated with lower yields. Ensuring that grain has high concentrations of nutrients will help ensure that a variety can express its potential yield.

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Potential for Foliar Applied Phosphorus in Australian Dryland Cropping : A Glasshouse Study

T.M. McBeath[1], S.R. Noack[1], M.J. McLaughlin[1;2]
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Key messages

- A yield response to foliar phosphoric acid plus adjuvant was measured in a P responsive soil type. Translocation to grain did not control the yield response but likely due to the increased ability of the tillers to survive and fill grain.
- Further evaluation is required of the; soil types, climatic conditions, timing, rate and formulations including adjuvants, in order to determine the best fit for foliar P fertilisation in agricultural systems having variable climate.

Why do the trial ?

It is important to apply some phosphorus (P) to the soil at the beginning of the crop growth cycle to provide essential P for early growth and to replace P exported in previous crops. With low rates of P added at sowing there may be sufficient P reserves to grow crops to tillering, but in seasons of increased yield potential a top-up application of P may be required. Foliar P application can be applied directly to the plant when required and in some cases has been shown to provide benefits for increasing P use efficiency. However, tests of foliar P fertilisation to date have had inconsistent results. Our aim was to accurately measure the ability of foliar P products to increase grain yield and contribute to grain P uptake using a radioactive tracing technique (with 33P) in the glasshouse.

How was it done ?

The experiment comprised two soils, seven P fertiliser treatments with one rate of P (equivalent to 1.65 kg P ha^{-1}), replicated three times. The seven P fertiliser treatments were: control of water only, control of water only but extra 1.65 kg ha^{-1} starter P added to soil (to balance extra P applied as foliar P), ammonium polyphosphate plus the adjuvant LI700, Top Up plus LI700, Top Up only, phosphoric acid plus LI700 and phosphoric acid. Solutions were added to the foliage at a water rate equivalent to 120 L/ha. There was a treatment of ammonium polyphosphate only but this is not presented as the concentration of fertiliser was found to not match the other treatments.

After five weeks of growth, at Zadoks growth stage 39, the foliar fertiliser solutions were applied. The fertiliser solutions were labelled with 33P as a radioactive tracer. The fertiliser - 33P spikes were applied to plants as 10 µL drops with 21 drops applied to each pot, with drops placed on as many leaves of each plant as possible. The spike rate is equivalent to an application of 1.65 kg P ha^{-1} in 120 L ha^{-1} total volume.

The foliar fertilisers were applied mid-morning at 29.5ºC and 57.9% relative humidity. Four days after the application of foliar fertiliser, the plants were rated for burn according to the methodology of Stein and Storey (1986) where 1 = no effect, 2 = slight surface burn on treated area, 3 = moderate burn, 4 = necrosis on affected area, 5 = necrosis on affected area and untreated parts of plant affected. After harvest, plant parts were weighed and digested samples of grain were analysed for P content and 33P radioactivity. All statistics were undertaken using the statistical package Genstat.

What happened ?

One week after adding the foliar fertiliser, the leaves were scored for scorch with a rating 1-5. The largest scorch effect was for the lowest. pH fertiliser (phosphoric acid) added with adjuvant. However, as indicated in Table 2 this was the highest yielding treatment in the Koppio soil.

The grain and plant yield data indicate that plants grown in the Koppio soil yielded 1.25 times more grain when supplied with foliar P fertiliser in the phosphoric acid form added with adjuvant compared to adding the extra 1.65 kg P to the soil at sowing. Phosphoric acid only yielded similarly to adding extra P at sowing while all other treatments yielded the same as the control (Table 3).

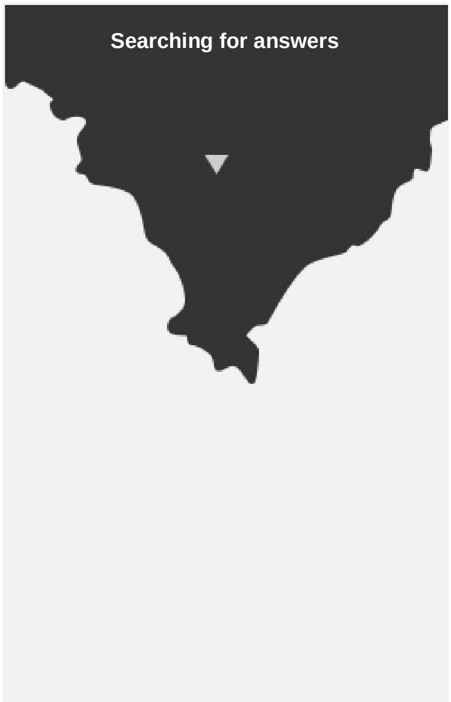

Table 1 : Soil Characteristics

Soil Characteristics	Units	Maitland	Koppio
pH	H_2O	8.3	6.2
$EC_{1:5}$	dS m^{-1}	0.22	0.13
$CaCO_3$	% w/w	14	0.18
Clay	% w/w	35.2	18.1
TOC	% w/w	2.3	3.9
DGT CE_P	µg L^{-1}	964	1275
Colwell P	mg kg^{-1}	68	29

EC *- electrical conductivity,* ***$CaCO_3$*** *- calcium carbonate,* ***TOC*** *- total organic carbon,* ***DGT CE_P*** *- diffusive gradient in thin film effective concentration phosphorus*

Table 2 : Foliar fertiliser pH and scorch score for each treatment measured four days after application of foliar fertiliser. Significantly different treatments are appended by a different letter (P<0.001, LSD 0.81). The treatment x soil interaction was not significant.

Treatment	PH	Scorch Score
Control (water)	5.95	1.0 a
Control (water) + soil P @ 1.65kg P/ha	5.95	1.0 a
Phosphoric acid	1.26	2.8 b
Phosphoric acid + adjuvant	1.27	3.6 b
Top Up	1.88	3.3 b
Top Up + adjuvant	1.89	3.3 b
Ammonium Polyphosphate + adjuvant	6.40	1.5 a

Table 3 : Grain weight (g/pot) and total plant weight (g/pot). Significantly different treatments are appended by a different letter (grain wt; soil x treatment P<0.001, LSD 2.3, total plant wt; soil x treatment P<0.001, LSD 5.3)

Treatment	Grain Weight (g/pot)	Total Plant Weight (g/pot)
Koppio		
Control (water)	15.7 c	47.0 d
Control (water) + top up soil P	16.9 bc	53.7 bc
Phosphoric acid	19.0 ab	58.7 ab
Phosphoric acid + adjuvant	21.2 a	64.0 a
Top Up	15.0 c	45.6 d
Top Up + adjuvant	15.4 c	48.3 d
Ammonium Polyphosphate + adjuvant	15.1 c	50.6 cd
Maitland		
Control (water)	7.4 d	23.1 e
Control (water) + top up soil P	7.8 d	24.7 e
Phosphoric acid	6.3 d	20.9 e
Phosphoric acid + adjuvant	6.6 d	21.4 e
Top Up	7.8 d	24.8 e
Top Up + adjuvant	6.1 d	20.4 e
Ammonium Polyphosphate + adjuvant	6.1 d	22.5 e

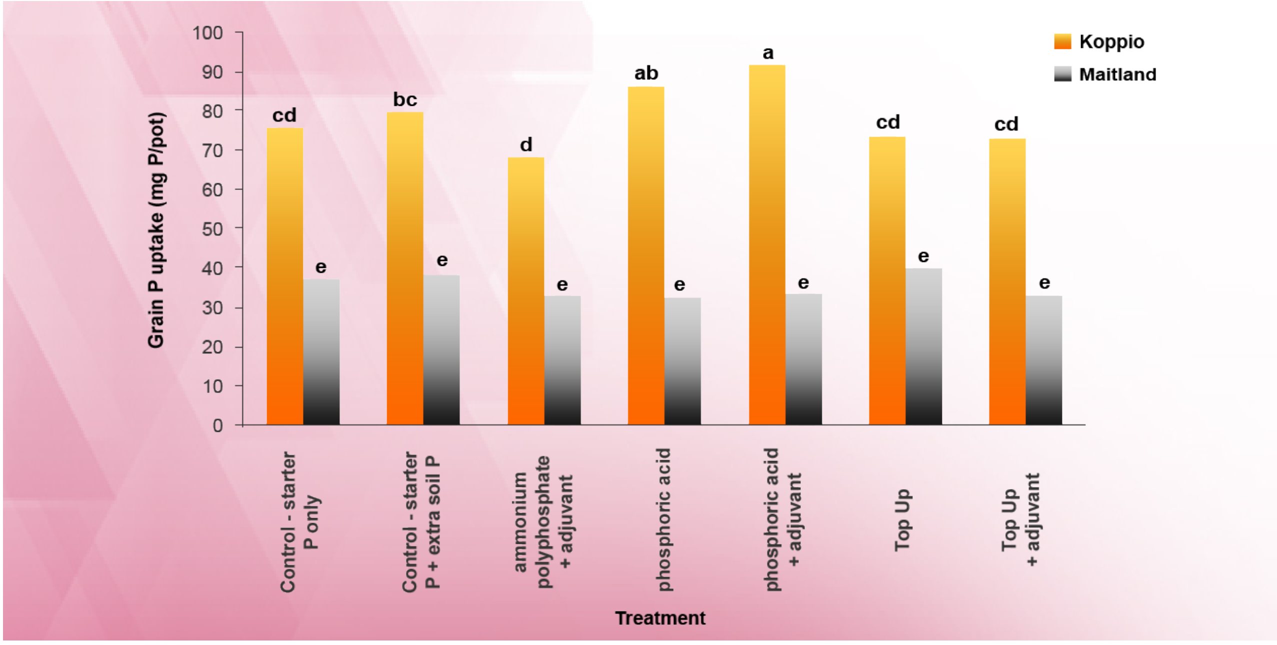

Figure 1 : Phosphorus in grain derived from the foliar fertiliser (mg P/pot). Significantly different treatments are appended by a different letter (treatment P=0.042, LSD 0.61).

Despite also having a marginal soil P test value. (DGT-P), the Maitland soil did not respond to foliar P application, demonstrating the importance of pre-screening for responsiveness to soil and foliar nutrient of a range of application rates. This lack of responsiveness to foliar P despite low initial soil test results was also observed by Mosali et al. (2006). The reliability of soil P testing methodology is vital for appropriate site selection and P testing is being researched by Mason and McNeill (2008).

The P in grain derived from the foliar fertiliser is a small amount of P (mg) and did not significantly differ between treatments (Figure 1). These data indicate that the foliar P addition does not have a function of loading the grain with P but rather supports the ability of the tillers to fill grain.

In-season P fertilisation prior to the emergence of the head allowed the plant to produce a higher number of fertile tillers per unit area resulting in a higher yield in a number of studies (Batten et al. 1986; Elliott et al. 1997; Goos 1995; Romer and Schilling 1986). In comparison, a P-deficient crop will conserve sufficient P to sustain the survival of just one fertile tiller on each plant (Romer and Schilling 1986).

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Top Up - registered product of SprayGro Liquid Fertilizers.
LI700 - registered product of Nufarm Australia Ltd.
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