# **'Topping Up' Wheat with Foliar P Does it Work?**

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## **Project rationale**

- *P* fertiliser is a major input and putting it all 'up-front' increases the risk of the P investment
- Crop demand for P varies according to in-season rainfall=In-season supply and application
- Maintenance P management strategies = reduced starter inputs
- Can we reduce starter P in grain cropping and develop a "tactical" P fertilisation regime (similar to topdressed N)?
- Scoping suggested variability in responses but phosphoric acid (PA) the most likely candidate P source
- Farmers have started to use PA for foliar P top ups
- Does it really work?



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Previous reports showed •Variable responses to foliar P •Phosphoric acid appears a more effective source of P

McBeath, T. M.; McLaughlin, M. J.; Noack, S. R., Wheat grain yield response to and translocation of foliar-applied phosphorus. *Crop and Pasture Science* 2011, 62, 58-65.

# Project background



 Multi-disciplinary- soil and physical chemists, plant physiologists, agronomists and consultants







- What level of plant fertility?
- What adjuvant to use?
- When to apply?
- Field evaluation
- What level of soil fertility?
- What combination of P source and adjuvant?



## Factors that affect efficiency

#### **Plant-related factors**

- Leaf wettability
- Leaf surface morphology

- Crop surface cover
- Crop growth stage & nutritional status





## What level of P fertility?

- Does a wheat leaf change with P nutritional status?
- Does this affect the foliar uptake of P?





CSIRO Flagship Collaboration Fellowship Fernández V, et al. 2014 Plant Soil, 384:7-20

# What level of P fertility?



Soil P added (kg P/ha)	Stomata per mm²	Trichomes per mm²	Contact angle of water (°)	Foliar P absorption (%)	Foliar P translocated from treated leaf (%)
24	77	59	143	10 c	33 b
8	55	41	139	5 b	35 b
0	36	5	123	0.a	0 a
Fernandez et	al. 2014 P	24 Plant and Sol	il, 384:7-20	8 Severely defic will not take u	cient leaves p foliar P

## What to apply?



- Contact angle measurements of water and fertilisers on wheat leaves
  - GS early booting to early ear emergence
  - Concentrations ranging from 0.01 0.3 % w v<sup>-1</sup>
  - Adjuvants:
    - Agral® (Active ingredient: 63% nonyl phenol ethylene oxide condensate)
    - LI 700<sup>®</sup> (Active ingredients: 35% w v<sup>-1</sup> soyal phospholipids, 35% w v<sup>-1</sup> propionic acid)
    - Genapol® X-080 (Polyethylene glycol monoalkyl ether)





# What to apply?

### Adjuvants and uptake of foliar P

- Adjuvants
  - Agral<sup>®</sup> (label rate)
  - LI 700<sup>®</sup> (label rate)
  - Genapol<sup>®</sup> X-080 (0.1% w v<sup>-1</sup>)
- 1.9 % P w v<sup>-1</sup> foliar applied PA
- <sup>33</sup>P tracer added to fertilisers application at two growth stages
  - Tillering GS22 or
  - Early booting GS41
- Harvested at maturity
  - Plant separated into parts after washing to measure translocation from treated area





- 79 % of the foliar fertiliser was adsorbed and/or absorbed by the leaves with 24-57 % redistributed within the plant
- Higher translocation to grain with a later application

0 -							
	Agral	Genapol	LI700	Agral	Genapol	LI700	
	GS22			GS41			





- Wheat leaves are difficult to wet without adjuvants
- Contact angle of fertilisers vary with different adjuvants BUT
- Uptake (>80%) of P does not vary for different adjuvants with PA
- More P translocated to grain when applied later



- Foliar P that hits ground is likely to be ineffective (topdressed P)
- Surface cover controls maximum possible interception (efficacy) of foliar P
- Canopy closure and peak P demand intersect near booting

Wheat P and leaf area index (LAI) at different growth stage (GS)



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Foliar PA applied at booting caused a biomass and P uptake response 10 days after application



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Response to timing of application of PA not measurable at maturity



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- Transient effect on shoot dry weight and P uptake when foliar P applied at booting
- No effect on biomass or grain yield at maturity in this soil
- Trade-offs between convenience/ logistics and maximal recovery







# Field evaluation of when, what and

#### how much?



Location	Soil type	Soil P status	Sowing P kg/ha	Foliar P kg/ha	Adjuvants	Grain yield t/ha	
Replicated small plots							
Edillilie	Ironstone	Marginal	0, 15, 30	0, 1.5, 3	L1700®,	3.5±0.2	
Lock	Silic. sand	Marginal	10	0, 1.5, 3	Hasten®,	2.7±0.2	
Cummins	Deep clay	Deficient	15	0, 1.5, 3	Superstick®	8.0±0.2	
Replicated paddock strips							
Nhill	Crack. clay	Marginal	0, 12	0, 0.95	L1700®	3.3±0.3	
Natimuk	Crack. clay	Adequate	0, 11	0, 0.95		2.2±0.4	
Paddock demo strips							
Lock	Calc. sand	Marginal	10	0, 3	<i>L1700</i> ®	2.9±0.2	
Dimboola	Crack. clay	Deficient	0, 5	0, 0.95	Spreadwet®	1.8±0.2	
Telangatuk	Duplex	Marginal	0, 6, 11	0, 0.95	<i>L1700</i> ®	2.4±0.2	
Kaniva	Crack. clay	NA	6, 12	0, 0.95	L1700®	2.0±0.2	

# Field evaluation of when, what and how much?

#### Lock







#### What level of P fertility?





In all cases, the relationship between anthesis dry weight and sowing applied P did not significantly differ between different inputs of foliar applied P

16

## What to apply?



Formulations	Formulation pH	N	Р	K		
		% w/w				
Phosphoric acid	1.3	0	26.9	0		
Ammonium phosphate AR	4.3	12.2	27	0		
Maxi Phos Neutral	4.3	7.8	12.5	0		
Ammonium polyphosphate	6.6	16	23	0		
PeKacid	2.2	8	22	16.6		
Sodium phosphate AR	6.5	0	22.5	0		
Potassium phosphate AR	4.4	0	22.8	28.7		
Pick	8.7	0	9.4	26.3		
Adjuvants						
L1700 <sup>®</sup>	Acidifying, penetrating surfactant					
Hasten®	Esterified vegetable oil, non-ionic surfactant					
Spreadwet1000®	Non-ionic surfactant					

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## What to apply?



C control (no foliar fertiliser); H Hasten; L LI700; S Spreadwet 1000. \* Significantly different from the control (P≤0.05, LSD 0.33).

## Conclusions



- The fertiliser needs to stick to the leaf for uptake, you need an adjuvant
- Foliar P recovery appears better when applied at a later growth stage (flag leaf emergence to mid-boot)
- Achieving consistent responses to foliar P remains a challenge but recent formulation testing gives some direction for 2015 field testing.

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# Soil P response curves



#### Something about methodology



Boom spray

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## Where to now?

- Careful spatial evaluation of in-season and maturity responses from 2014
- Field testing of formulations in 2015
- Can we get to the bottom of the transience in response?
- Mechanisms of scorch is it a problem or a solution?