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Endo Fuse™

Introduction and Trial Data

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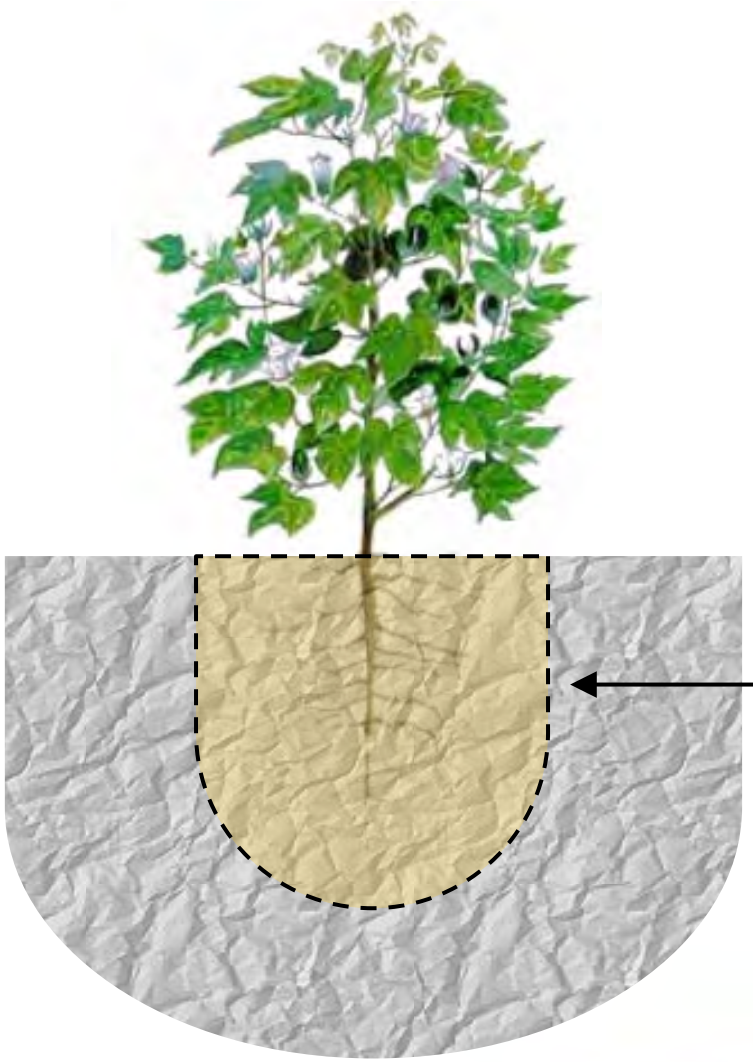
What is EndoFuse and what is Mycorrhizae?

- EndoFuse from Sumitomo is an Arbuscular Mycorrhizal Fungi (AMF) inoculant
- Mycorrhizae are beneficial fungi that naturally exist in soils colonizing the root systems of plants.
- EndoFuse includes 4 high performing endo-mycorrhizae species that have been proven to increase crop productivity and overall plant and soil health.

EndoFuse comes in 500 mL packs

How Do Mycorrhizae Work?



- Within the soil, plant roots are limited in the area they can absorb nutrients (referred to as the depletion zone).
- Mycorrhizal hyphae grow out well beyond the depletion zone.
- Absorption area increases up to 50x.

Depletion Zone

Extension of soil volume explored by mycorrhizal hyphae

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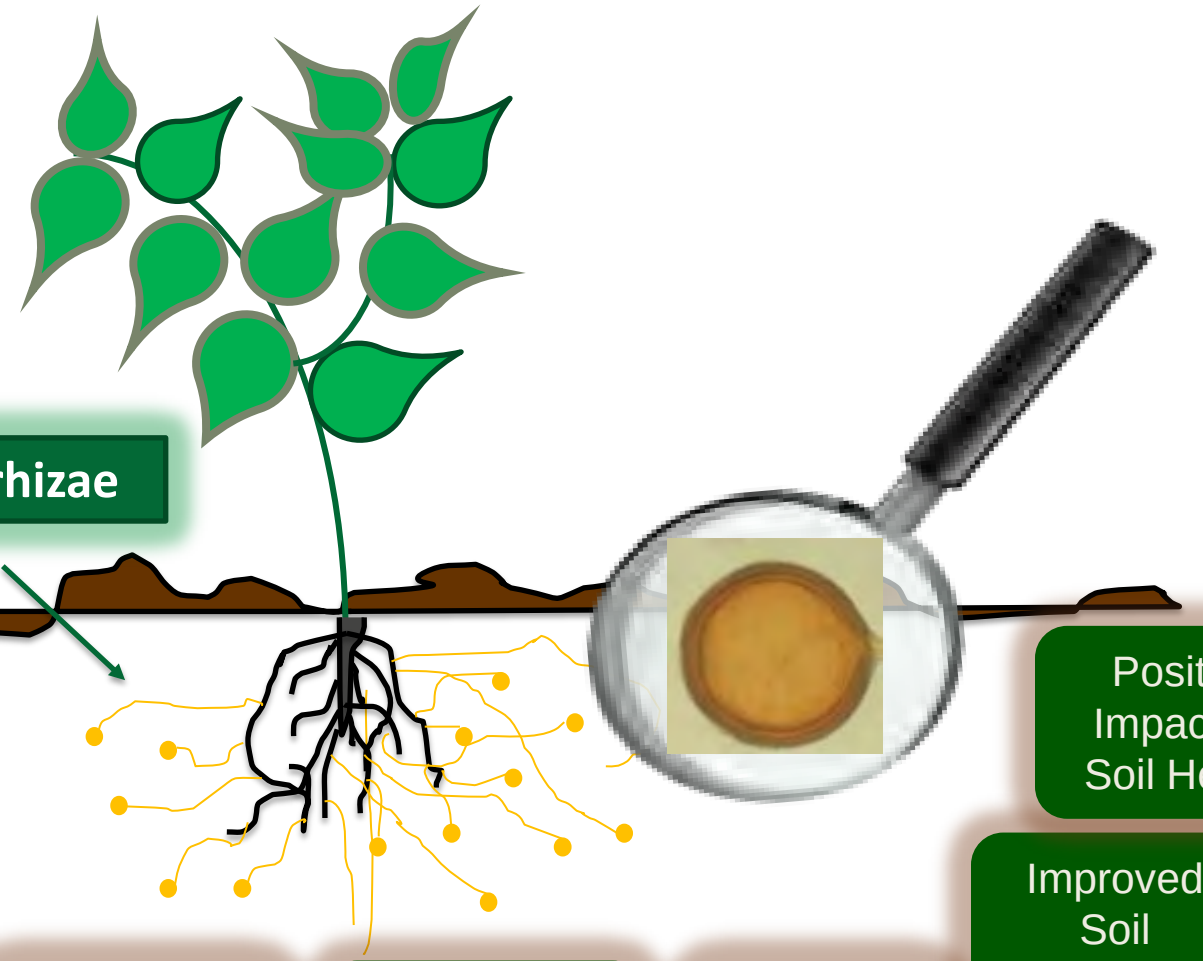
Mycorrhiza helps with



- Improved Nutrient Uptake
- Optimized Growth
- Metal, Sodicity & Salinity Tolerance
- Greater Drought Tolerance
- Glomalin Production & soil carbon %
- Improved Soil Structure
- Positive Impact on Soil Health

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What impacts Mycorrhizae levels in soils?

- Previous crop or rotations with non-mycorrhizal plants (Brassica, Canola, Lupins etc.)
- Frequent, repeated or extended fallow periods (6 months or longer)
- Continual wetting/drying cycles
- Tillage
- Once depleted, mycorrhizal populations are slow to recolonize naturally as propagules have to migrate from nearby reservoirs (plant hosts).

Growing canola can significantly reduce mycorrhizae levels in the soil, which can lead to poor growth in subsequent crops

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Directions for use

APPLICATION INSTRUCTIONS FOR CROP CATEGORIES

Sorghum, Cotton, Mungbeans, Soybeans, Wheat, Barley, Oats, Corn, Chickpeas, Faba beans, Lentils, Rice, Sugarcane, Pigeon Peas, Lablab, Sunflowers, Linseed, Field Peas, Triticale, Navy beans, Peanuts, Hemp, Poppies, Pyrethrum, Grass Pastures, Lucerne, and Clover Pastures	In-furrow or seed treatment	10-15 mL/ha	Apply in-furrow with seed (or cane billets) with the goal for the solution to come in contact with the seed (or cane billets) and roots when germination occurs. OR Apply as a seed treatment at a sufficient rate per kg of seed to give 10-15mL of product per hectare when seeding rate is accounted for. If applying as a seed treatment, mix with water at a sufficient dilution to adequately cover all the seeds. 10-15mL of EndoFuse mixed with a minimum of 100 mL and a maximum of 1 Litre of water per hectare of seed equivalent s recommended. Refer to COMPATIBILITY WITH OTHER AGRICULTURAL PRODUCTS section when mixing with other products. Maintain continuous agitation in mix tank during mixing and application to assure a uniform suspension.

Use the higher rate where growing more intensive crops with higher density plant stands such as irrigated crops

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When should EndoFuse be used?

- When growing a highly mycorrhizae dependent crop
- When field has been devoid of vegetation for any length of time, 6 months or more.
- When soil moisture is not expected to be abundant or crop is non - irrigated.
- When soil constraints are present such as sodicity or salinity.
- When soil structure is in decline and needs improving.
- When a non-mycorrhizal crop like canola has been grown previously
- When soil carbon is low and increased carbon levels is desired.
- When soil cultivation has been used
- When trying to optimize yield and quality.

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EndoFuse trial data

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Mycorrhizae: EndoMaxx on **barley**

Seed treated and crop sown 4 June 2019
50kg seed / Ha Variety La Trobe
EndoMaxx 10g/Ha
Product mixed in 700mL water and sprayed onto seed
0.9Ha strips sown per treatment
Very sandy loam, pasture & fallow previous season

EndoMaxx is WP (Wettable Powder) version of EndoFuse.

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	Trial harvest area (Ha)	Barley Yield (kg/Ha)	Diff to UTC (%)
UTC	0.42	4,836	
EndoMaxx 10g/Ha	0.38	5,130	+6.1

EndoMaxx is WP (Wettable Powder) version of EndoFuse.

-Seed weight
-No. seeds per head
-yield

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Mycorrhizae: EndoMaxx on **faba bean**

Seed treated and crop sown 14 May 2019
110kg seed/Ha, Variety Samira
EndoMaxx 10g/Ha
Product mixed in 1L water and sprayed onto seed
0.9Ha strips sown per treatment
Sandy loam, Wheat previous crop

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Mycorrhizae: EndoMaxx on **faba bean**

	Seedling emergence (seedlings/10m row)	Faba bean mass at harvest (g/100 beans)	Bean mass Diff to UTC (%)
UTC	35.8 a	73.04 a	
EndoMaxx 10g/Ha	35.2 a	74.99 a (P=0.12)	+2.7

	Trial harvest area (Ha)	Yield (kg/Ha)	Diff to UTC (%)
UTC	0.86	4,024	
EndoMaxx 10g/Ha	0.86	4,348	+8.1

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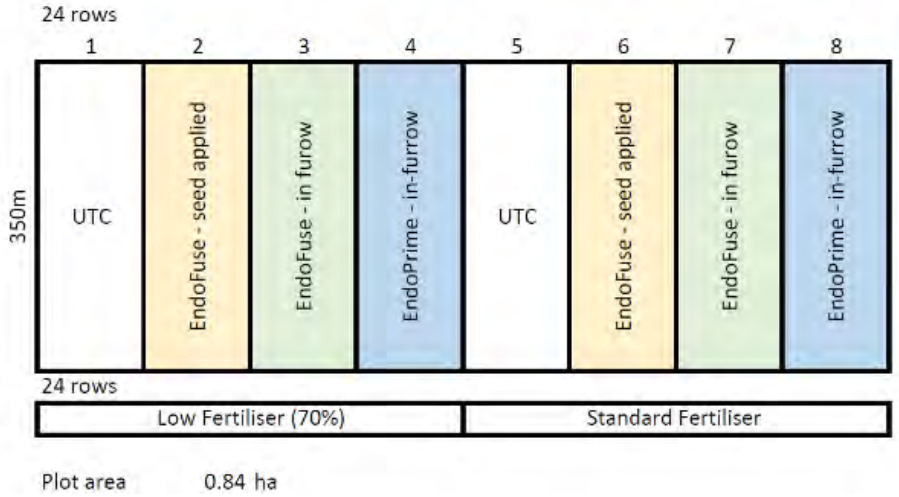
EndoFuse cotton trial – Darlington Point, NSW 2020

- Sown October 2019
- Irrigated
- Canola 2018 (irrigated) fb fallow
- Seed treatment D2C (Dynasty+Cruiser)
- EndoFuse 15 mL/ha IF and ST
- EndoPrime 150 g/ha IF only



Volunteer Canola pre-sowing

EndoFuse cotton trial – Darlington Point, NSW 2020

NORTHERN REGION

PREDICTA B
DNA Soilborne disease tests

SARDI Plant & Soil Health
Gate 2B, Hartley Gr. P 08 8303 9360
URRBRAE SA 5064 F 08 8303 9393

Sample: ANB2760
Trading Name: **SUMMIT AG**
Farm: **SUMIFOMO TRIAL**
Field: **RPN**
Nearest town: **DARLINGTON POINT**

Report date: 18/10/2019
Sampling strategy: **Random**
Stubble added: **No**
Region: **Southern**

Paddock history	2 years ago	Last year	This year
Crop / variety	Canola	Fallow	Cotton

TEST	RESULT		POPULATION DENSITY** (Not Detected / Low / Med / High)
Pratylenchus neglectus	<0.1	nematodes /g soil	Not Detected
Crown Rot (F. culmorum/graminearum)	0.84	log(pg DNA/g soil)	Med
Common root rot	1.44	log(pg DNA/g soil)	Med
Rhizoctonia	<0.5	log(pg DNA/g soil)	Not Detected
Pythium clade f	1.63	log(pg DNA/g soil)	Med
Yellow leaf spot	1.18	log(kDNA copies/g soil)	Low
White grain disorder	<0.3	log(kDNA copies/g soil)	Not Detected
AMF (Long fallow disorder)	3.48	kDNA copies/g soil	Low
Ascochyta blight of chickpea	<0.05	log(kDNA copies/g soil)	Not Detected
Phytophthora root rot of chickpea	<0.1	log(kDNA copies/g soil)	Not Detected
Charcoal rot	2.08	log(kDNA copies/g soil)	High
Fusarium stalk rot	<0.3	log(kDNA copies/g soil)	Not Detected
Sclerotinia stem rot	<0.1	log(kDNA copies/g soil)	Not Detected

**Population densities are based on the distribution of pathogen levels detected in PreDicta samples over several years. These are not disease risk categories.

Pathogen comments:

High Crown Rot: High risk of yield loss in durum wheat and up to 20 % in bread wheats. Consider break crops for 2 to 3 years to reduce inoculum levels.

Caution AMF levels low, high risk of long fallow disorder if AMF dependent crop is grown.

Previous canola had reduced the AMF level down to a very low level

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EndoFuse cotton trial – Darlington Point, NSW 2020

IF = In-Furrow
ST = Seed Treatment

Root colonisation at 4 weeks

Higher fertiliser rates slowed down the AMF colonisation

UTC – low fert

	Yours	Guide
Total Mycorrhizal (VAM) Colonisation (% root length)	33.8	70.0

EndoFuse ST – low fert

	Yours	Guide
Total Mycorrhizal (VAM) Colonisation (% root length)	34.6	70.0

EndoFuse IF – low fert

	Yours	Guide
Total Mycorrhizal (VAM) Colonisation (% root length)	32.9	70.0

UTC – full fert

	Yours	Guide
Total Mycorrhizal (VAM) Colonisation (% root length)	8.7	70.0

EndoFuse ST – full fert

	Yours	Guide
Total Mycorrhizal (VAM) Colonisation (% root length)	21.0	70.0

EndoFuse IF – full fert

	Yours	Guide
Total Mycorrhizal (VAM) Colonisation (% root length)	21.1	70.0

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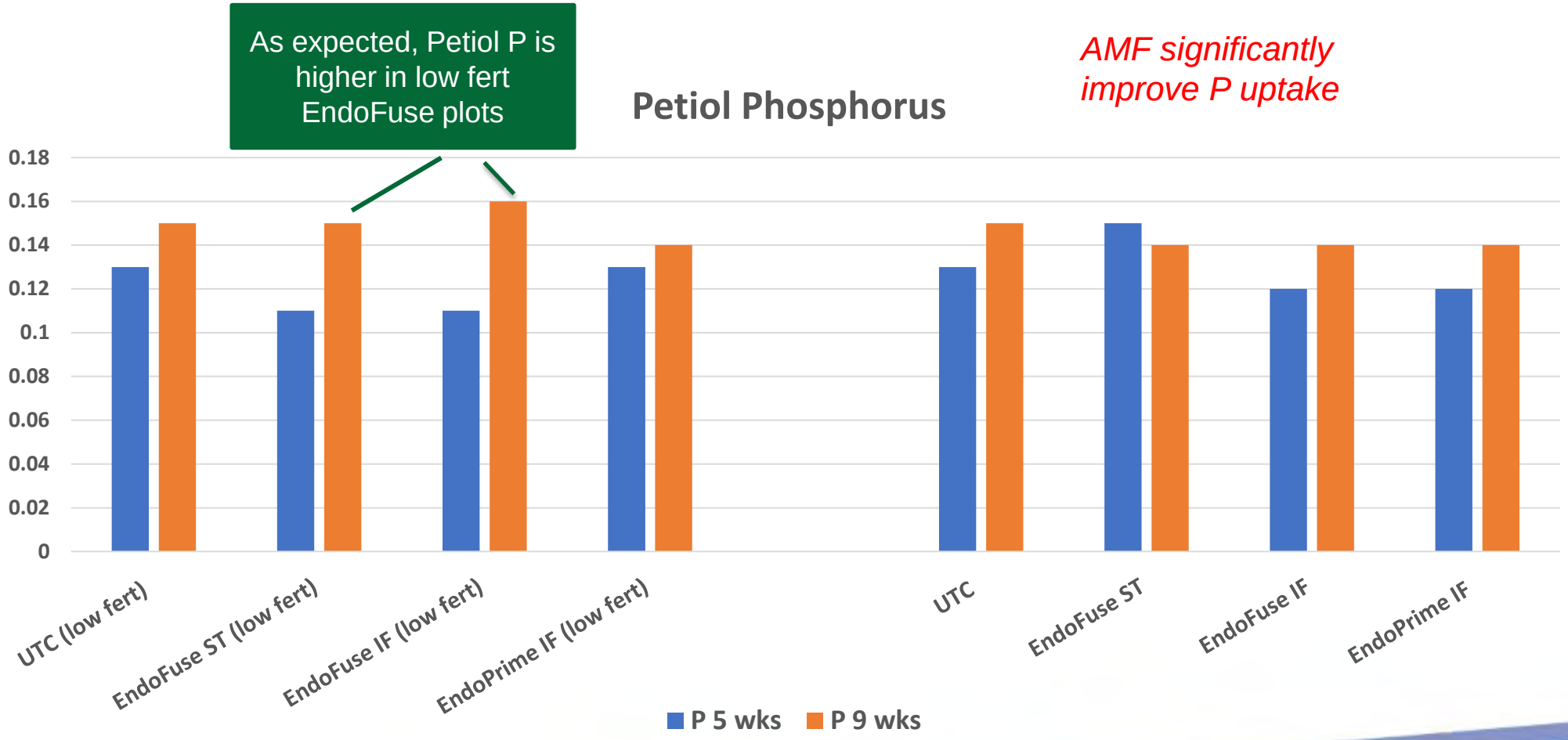
EndoFuse cotton trial – Darlington Point, NSW 2020



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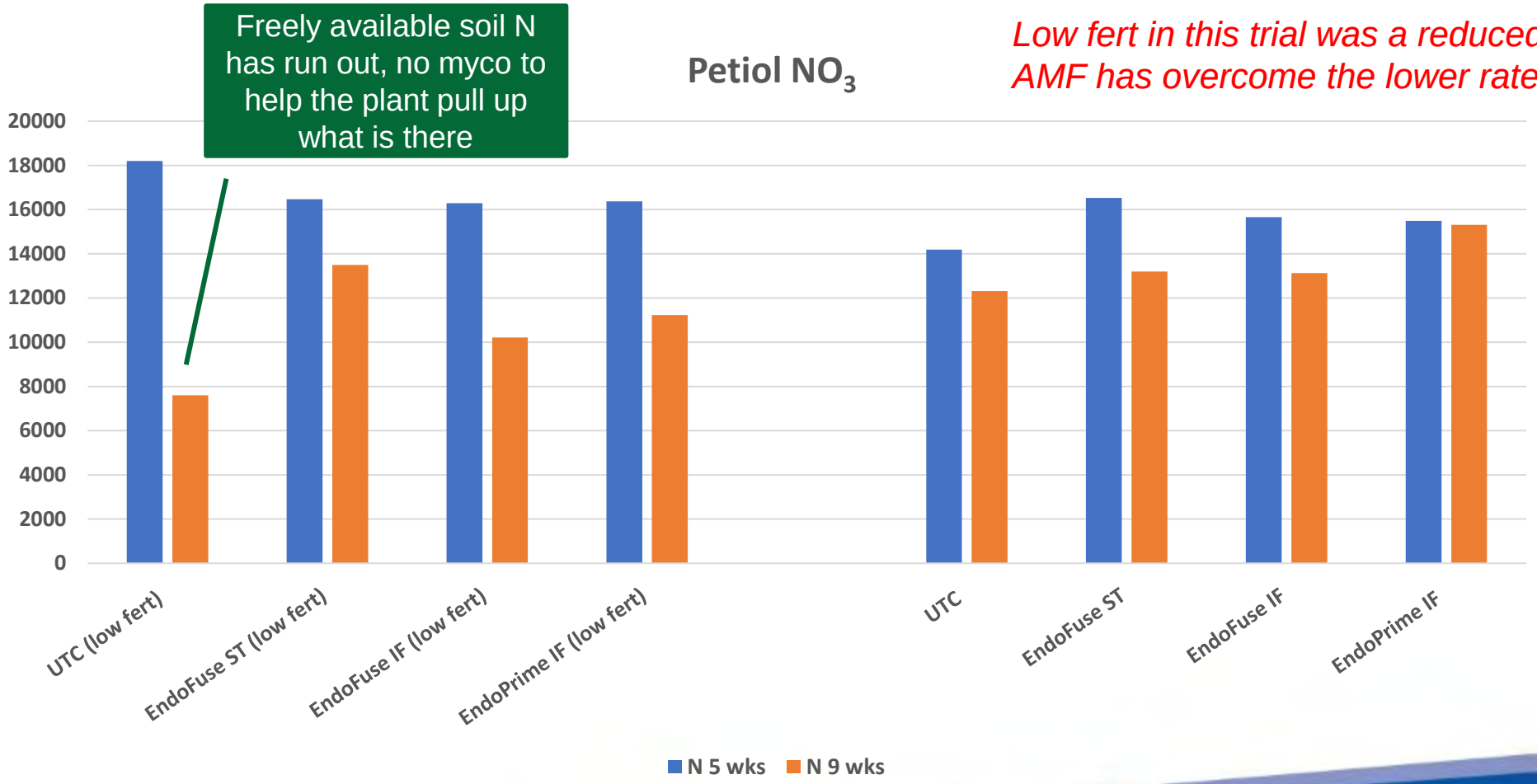
EndoFuse cotton trial – Darlington Point, NSW 2020

Freely available soil N has run out, no myco to help the plant pull up what is there

Low fert in this trial was a reduced rate of N fertiliser. AMF has overcome the lower rate by 9 weeks



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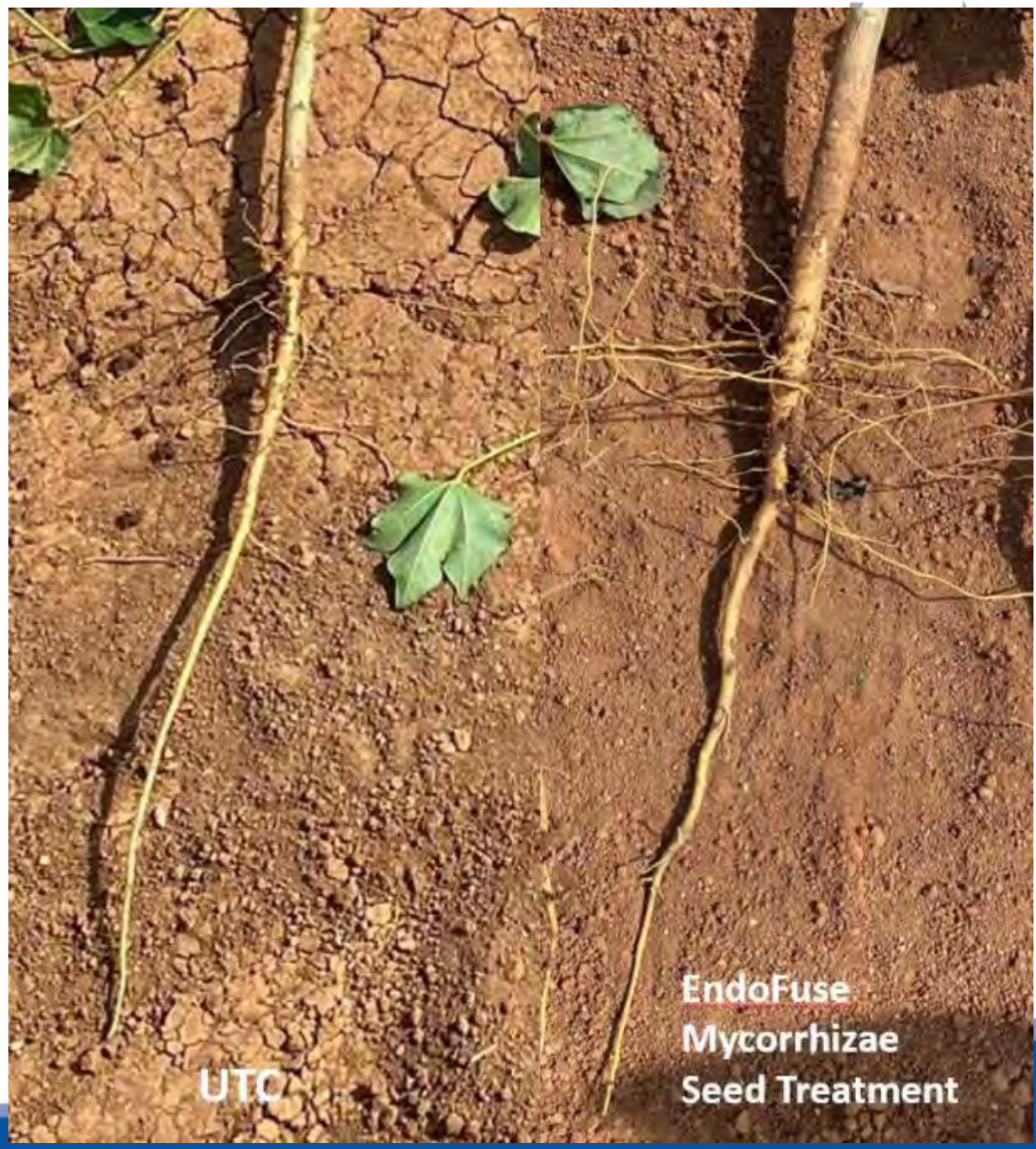
EndoFuse cotton trial – Darlington Point, NSW 2020

5th Feb



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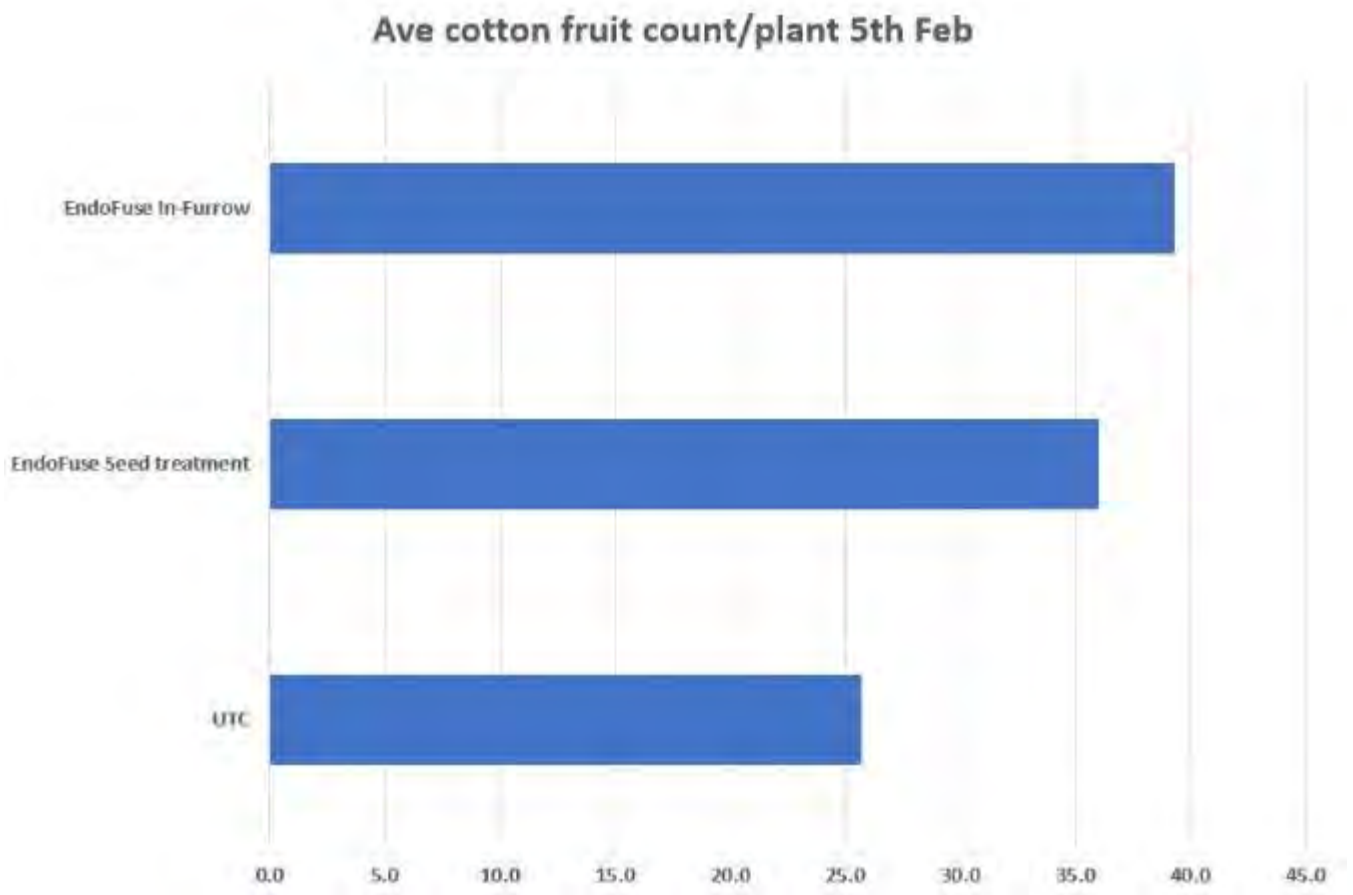
EndoFuse cotton trial – Darlington Point, NSW 2020 (5th Feb)



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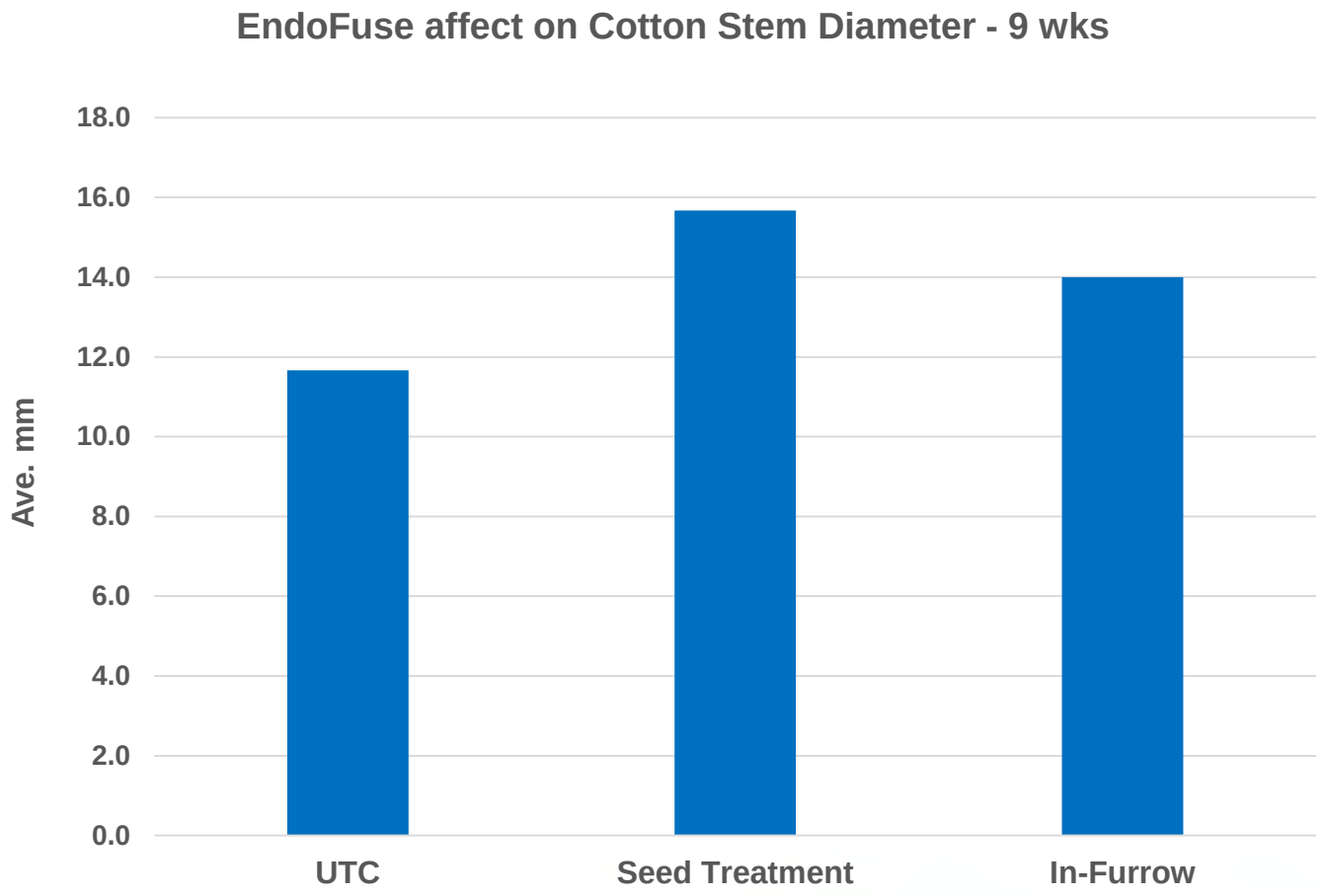
EndoFuse cotton trial – Darlington Point, NSW 2020 (5th Feb)



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Resilience

EndoFuse SC

UTC

Dryland Cotton Trial Kinston, Alabama (2018)

MA EndoFuse SC effect on drought stress tolerance of cotton plants in dryland growing conditions

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Effect of EndoPrime on Wheat at Ogilvie, WA – 2018

- EndoPrime applied at 100g/ha at sowing
- 80 km North West of Geraldton
- Little visual difference through 1st half of the season
- Visible difference at the end due to a sharper finish.
- It is important to note that both controls as well as one other biological product had Flexi-N at seeding, EndoPrime didn't.
- EndoPrime did not have an issue maintaining protein despite having no UAN at seeding
- 55kg MAP across all treatments at planting
- 200mm growing season rainfall. Fell evenly except for a dry finish
- Applied as a liquid in furrow
- Grey non-wetting sands
- UAN at sowing rate was 40L / ha
- 250g Copper Chelate across all treatments at sowing
- All biological treatments were on Wyalkatchum

Treatment	Yield (t/ha)	Protein (%)	Hectoliter Weight (g)	Screenings (%)	Grade
NIL - Cobra	3.42	10.3	79.2	5	APW1
NIL - Wyalkatchem	3.45	10.1	81.2	3.88	APW1
Product X	3.68	10.1	80.28	4.6	APW1
EndoPrime	4.1	10.1	81.94	4.32	APW1
Product Y	3.7	9.9	80.74	7.3	AGP1
Product Y + Flexi N	3.41	10.2	84.18	5.08	AGP1

Grower was very impressed with result and looking to purchase the product in the coming season

EndoPrime is WP version of EndoFuse with 10 x lower concentration

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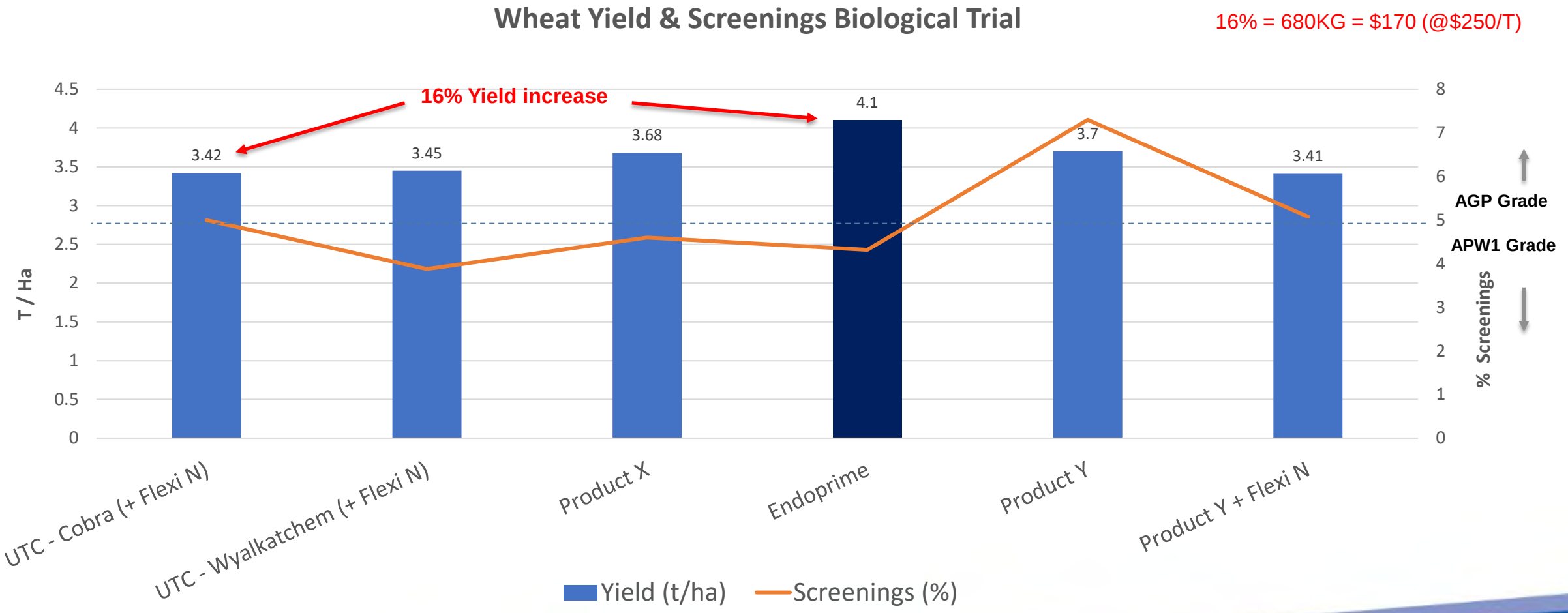
Effect of EndoPrime on Wheat at Ogilvie, WA – 2018

16% = 680KG = $170 (@$250/T)



EndoPrime achieved screening below 5% and APW1 Grade vs AGP1 for treatments above 5%

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Long Fallow Sorghum EndoPrime Trial, Mullaley N-NSW, 2019

- Previous crop: Long Fallow (2 years)
  - Chickpeas 2016 on one section
  - Durum wheat 2016 on another section
- Very low AMF situation
- Sowing date: 14th Nov 2018
- Soil: Self mulching heavy black soil
- Treatment: EndoPrime at 100g/ha (as seed treatment)
  - Difficult to apply this Vol. on seed.
- Rain grown (< 50% of ave. in crop rainfall)
- Moisture stressed

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Long Fallow Sorghum EndoPrime Trial, Mullaley N-NSW

EndoPrime 100 g/ha

UTC

Photos: 15th Jan - 9 WAT

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Long Fallow Sorghum EndoPrime Trial, Mullaley N-NSW

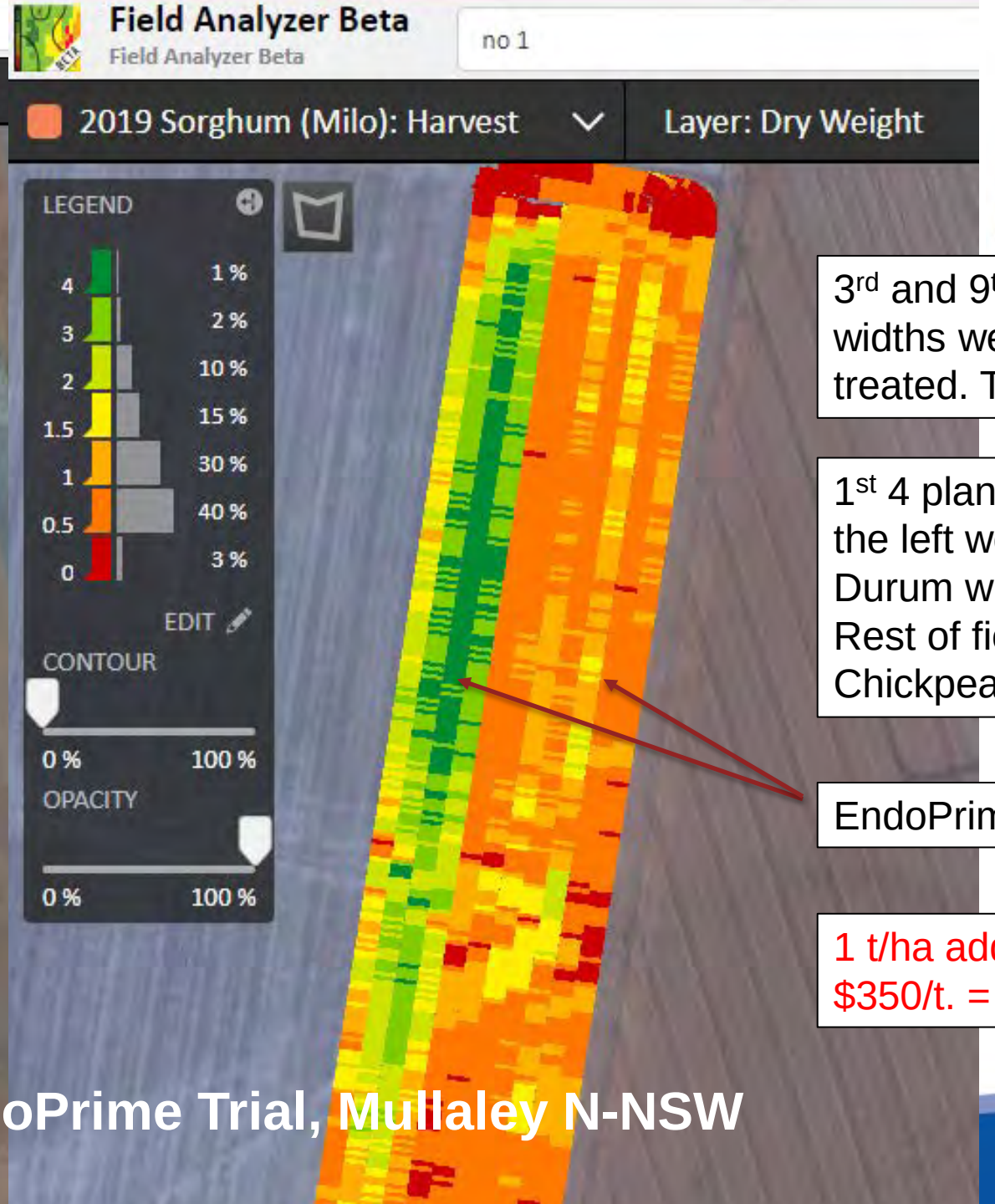
UTC

EndoPrime 100 g/ha

EndoPrime 100 g/ha

UTC

Photos: 15th Jan - 9 WAT



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3rd and 9th planter widths were EndoPrime treated. The rest UTC

1st 4 planter widths from the left were 2016 Durum wheat stubble. Rest of field was 2016 Chickpea stubble

EndoPrime 100g/ha

1 t/ha additional yield at $350/t. = ROI of $303/ha

Long Fallow Sorghum EndoPrime Trial, Mullaley N-NSW

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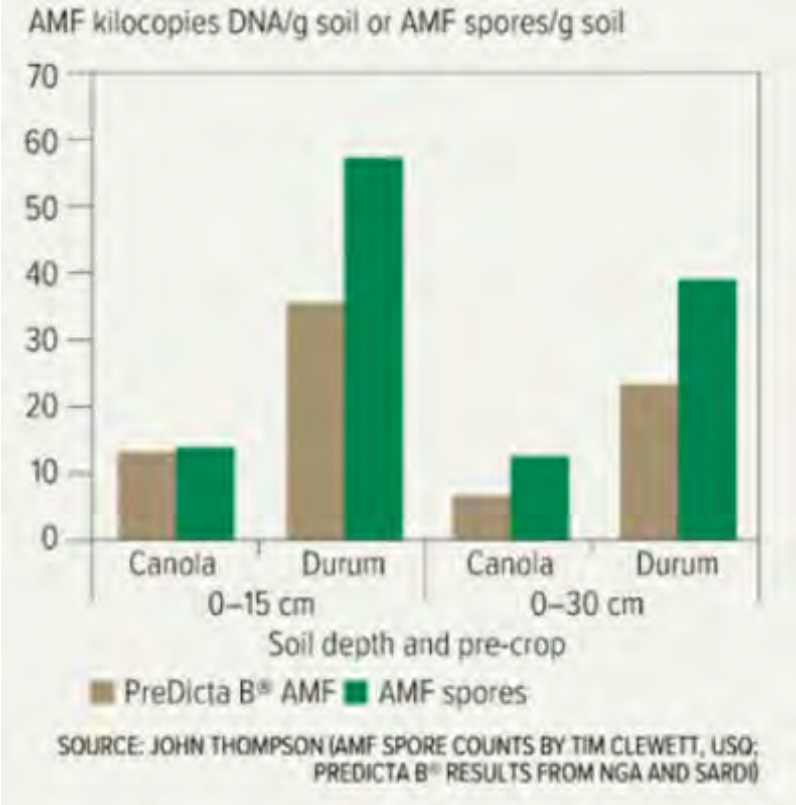
NGA & SARDI AMF Trials

FIGURE 1 In soil collected before sorghum was sown, fewer AMF spores were present in the soil after canola than after durum, and this was reflected in the PreDicta B® results, which measured copies of AMF DNA.



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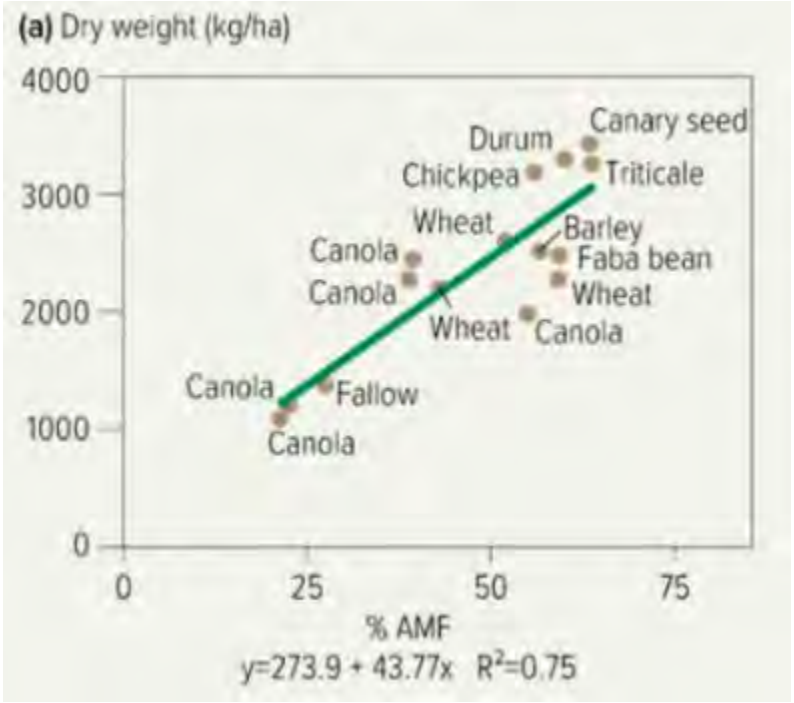
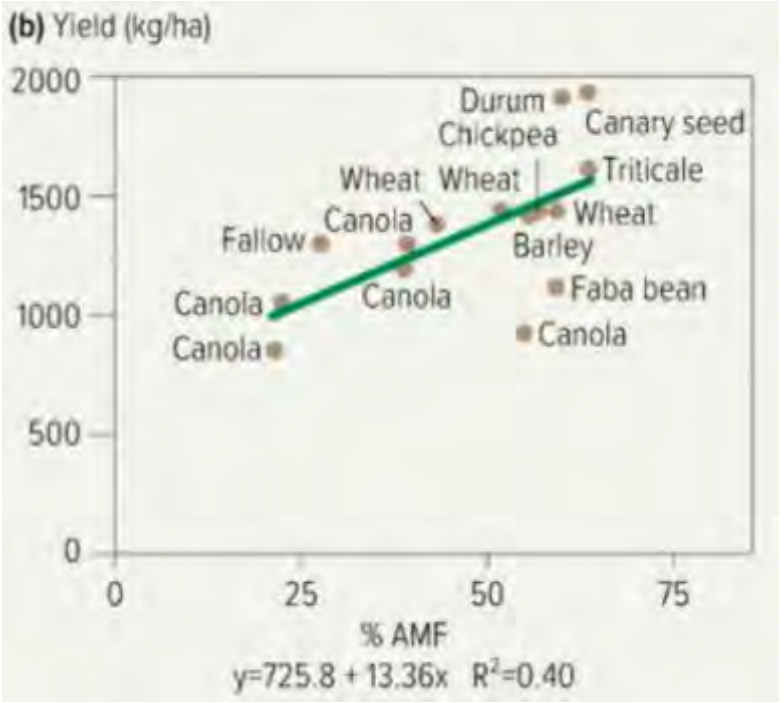
NGA & SARDI AMF Trials

FIGURE 2 Effects of various crop varieties in winter 1999 at Formartin, Queensland, on the mycorrhizal colonisation of wheat roots in the next year and its effects on (a) the growth and (b) yield of that wheat crop. The wheat was grown after six months' fallow from all previous crops, and 18 months for the point labelled 'fallow'.





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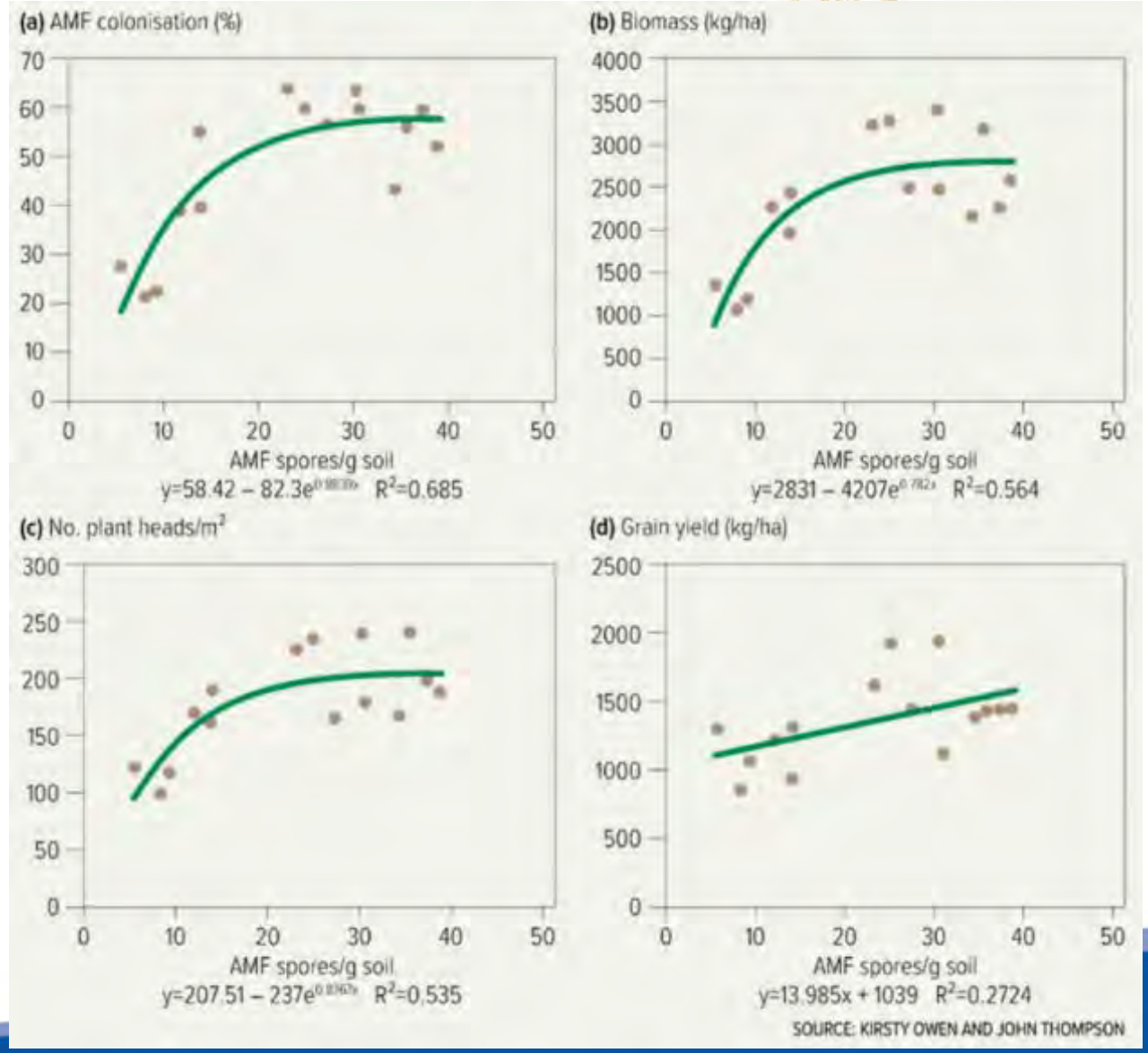
GRDC AMF Trials

FIGURE 3 In an experiment with wheat in 2000 at Formartin, Queensland, the number of AMF spores in the soil at planting affected the (a) colonisation of the wheat roots, (b) biomass, (c) number of plant heads and (d) grain yield of the wheat.



"These results showed us there is a relationship between wheat growth and yield and the number of AMF spores at sowing."

GRDC Research Codes DAV00128, DAS00137-BA, NGA00004

More information: Kirsty Owen, 07 4631 1239, kirsty.owen@usq.edu.au; John Thompson, 07 4631 1148, john.thompson@usq.edu.au

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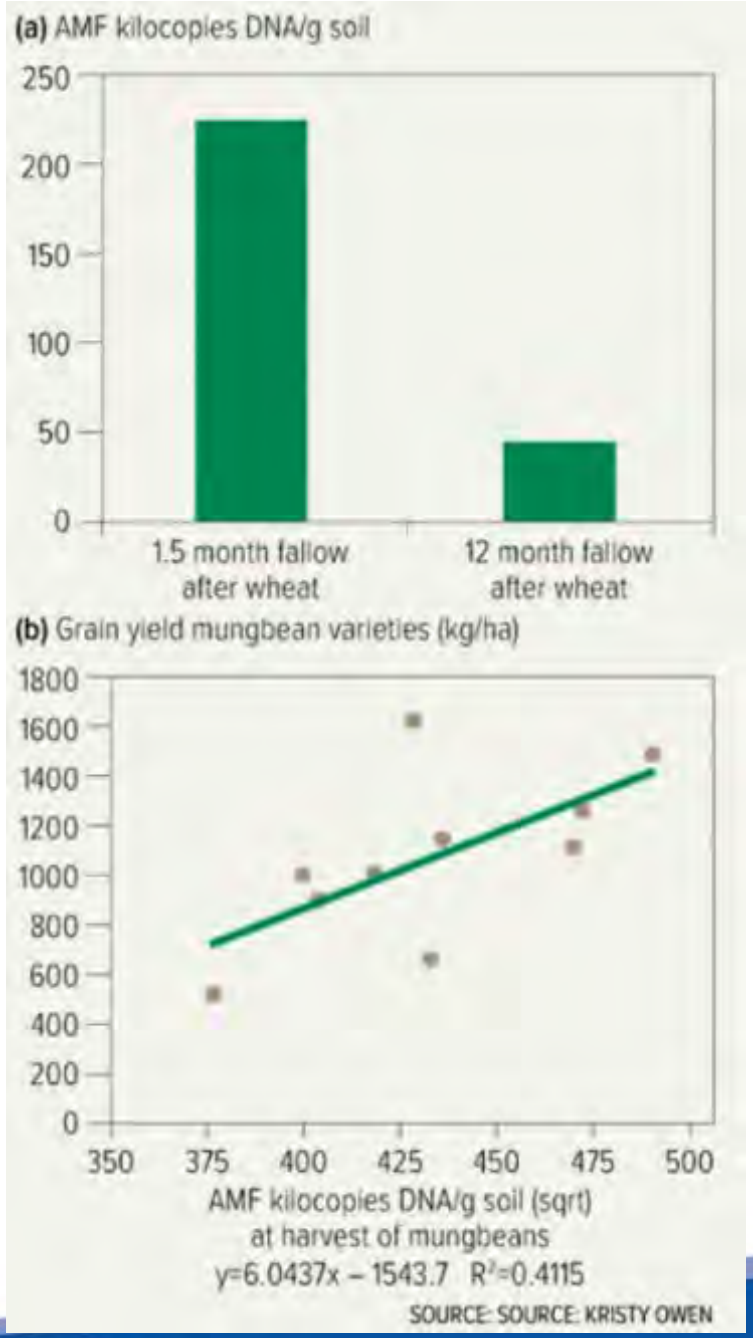
NGA & SARDI AMF TRIALS

"When harvested, the mungbean crops showed grain yield increased with AMF levels.

FIGURE 4 An experiment at Formartin over the 2014-15 summer shows (a) AMF decreased five-fold after a 12-month fallow compared with a 1.5-month fallow after wheat in a field to be used for mungbean variety trials; and (b) at harvest of the mungbeans planted on the 12-month fallow site, levels of AMF had increased compared with the initial populations and fallow treatment and the initial levels at planting.



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Northern Grower Alliance
"Grower needs first"

Sorghum Performance after Canola

The concern raised

- "Sorghum following canola often appears less thrifty"
- Possible reasons ?
- Less soil water than after cereals
- Soil nutrition differences
- Residual herbicide carryover
- **Reduced arbuscular mycorrhizae (AMF or VAM)**

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What we tested ?

	Results	Conclusion
Soil water	Both trials ~ 270mm PAW	No difference
Comprehensive eg P, K, S, Zn	Colwell P 22-24 mg/kg at 0-15cm Colwell P 5-6 mg/kg at 15-60cm Zn at ~1mg/kg then 0.2-0.3	No difference apparent
Nitrogen	Both trials ~130kg N/ha	No difference
Residual herbicides	Tested for wide range including imazapyr and imazamox	No detection
Pythium	Low levels in both	No difference
AM	**Manual - Durum 3-4x canola PreDicta B – Durum 3-5x canola**	**Significant differences**

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What was done ?

- Paddock sown to canola in 2014 but with marginal moisture
- Sections sprayed out and re-sown with durum
- Duplicate sorghum trials sown late Nov 2015, in canola vs durum stubble
  - 2 hybrids: MR Buster and G33
  - 4 rates of Granulock Z Extra: 0, 20, 24 or 80kg/ha
  - N rates balanced with urea

Crop Impact on AMF Levels

Spring Ridge:

Strips of wheat v canola v fallow in 2016

AMF: 180 v 13 v 16 (kilocopies DNA/g)

Macalister 2015:

13 mth fallow after durum AMF 11 (kilocopies DNA/g)

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Conclusions

- 2015/16 ~proof of concept
- Results ‘supported’ agronomist comments
- No impact from Granulock Z Extra to 80 kg/ha
- **AMF probable cause of differences– but not proven**

Commercial sorghum, Dec 2015

Ex Canola 2014
Low AMF
(13 kilocopies DNA/g)

Ex Durum 2014
Medium AMF
(36 kilocopies DNA/g)

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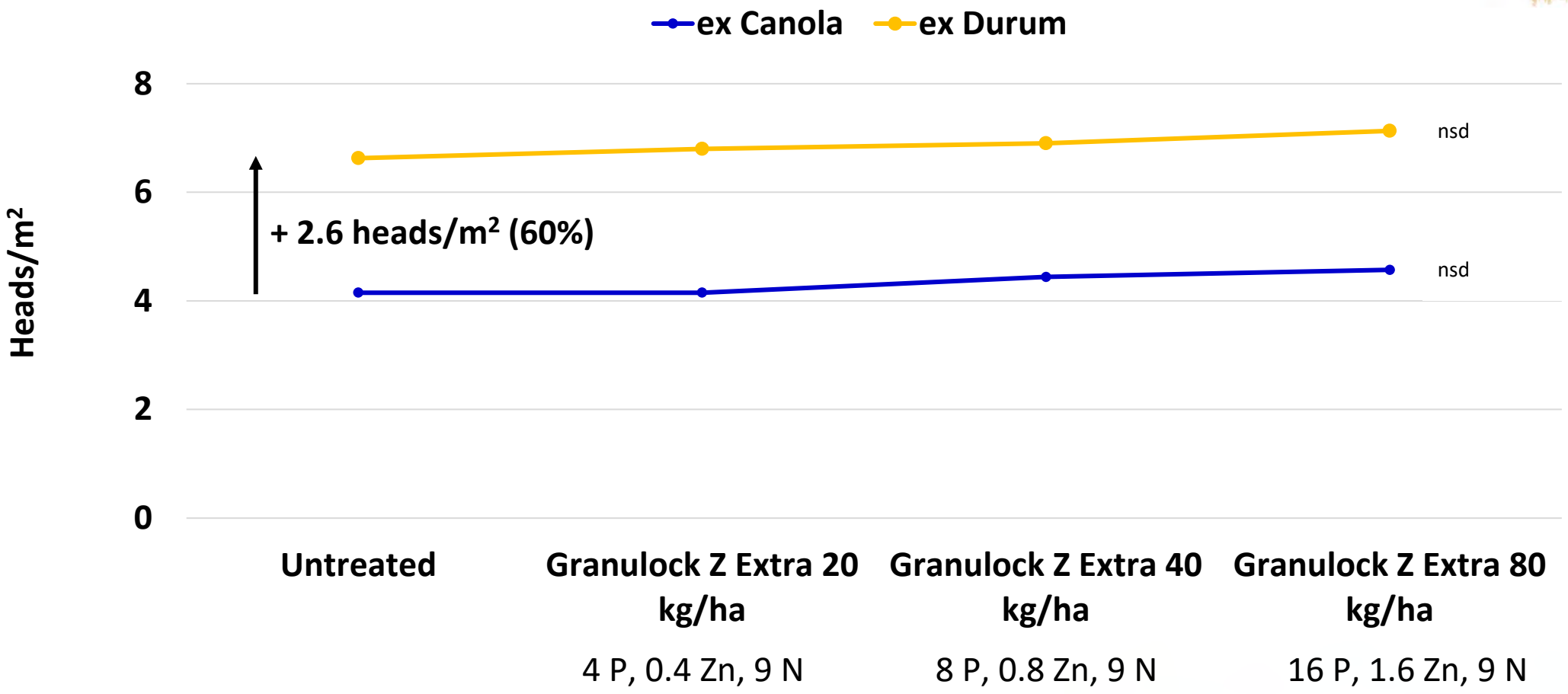
Head counts (74 DAP)



NB Emergence counts similar ~40,000/ha

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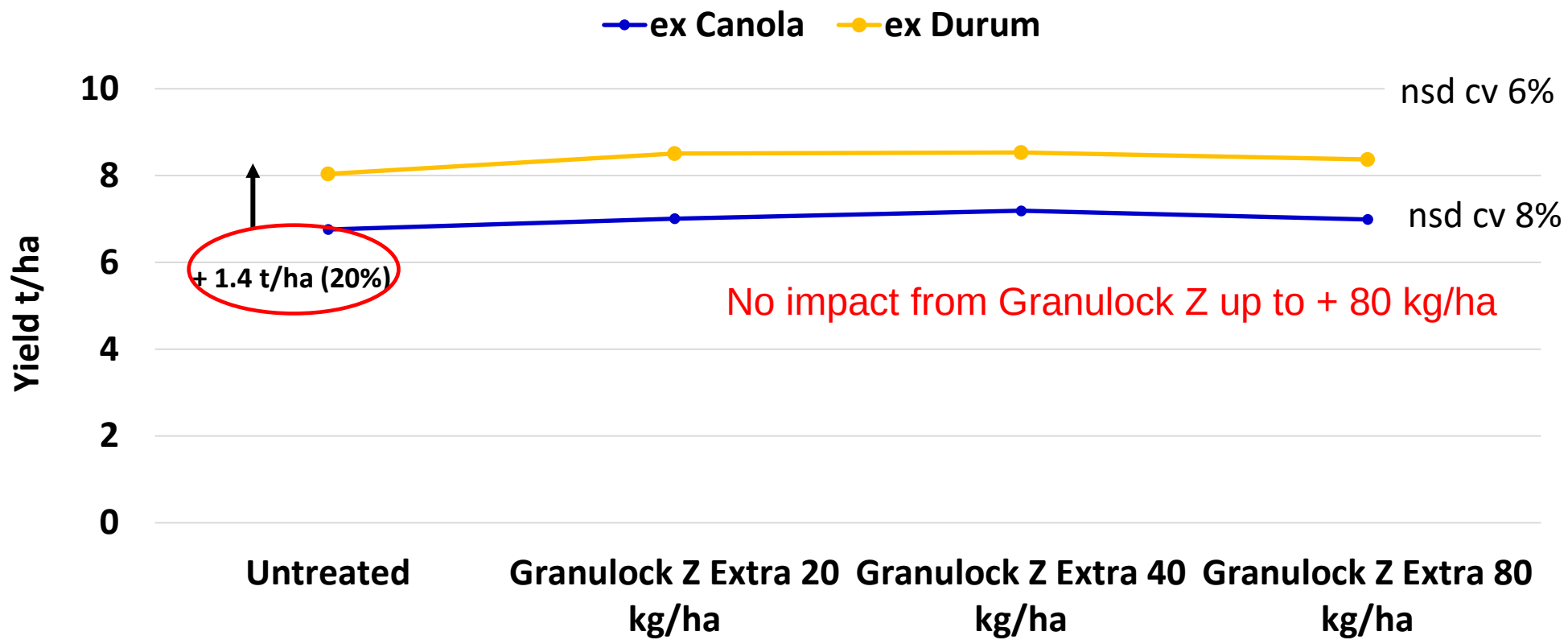
Sorghum Yield



Spring Ridge, NSW - 2015

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AMF levels - Macalister Qld