Opportunities for sowing wheat early in WA

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Acknowledgements & co-authors

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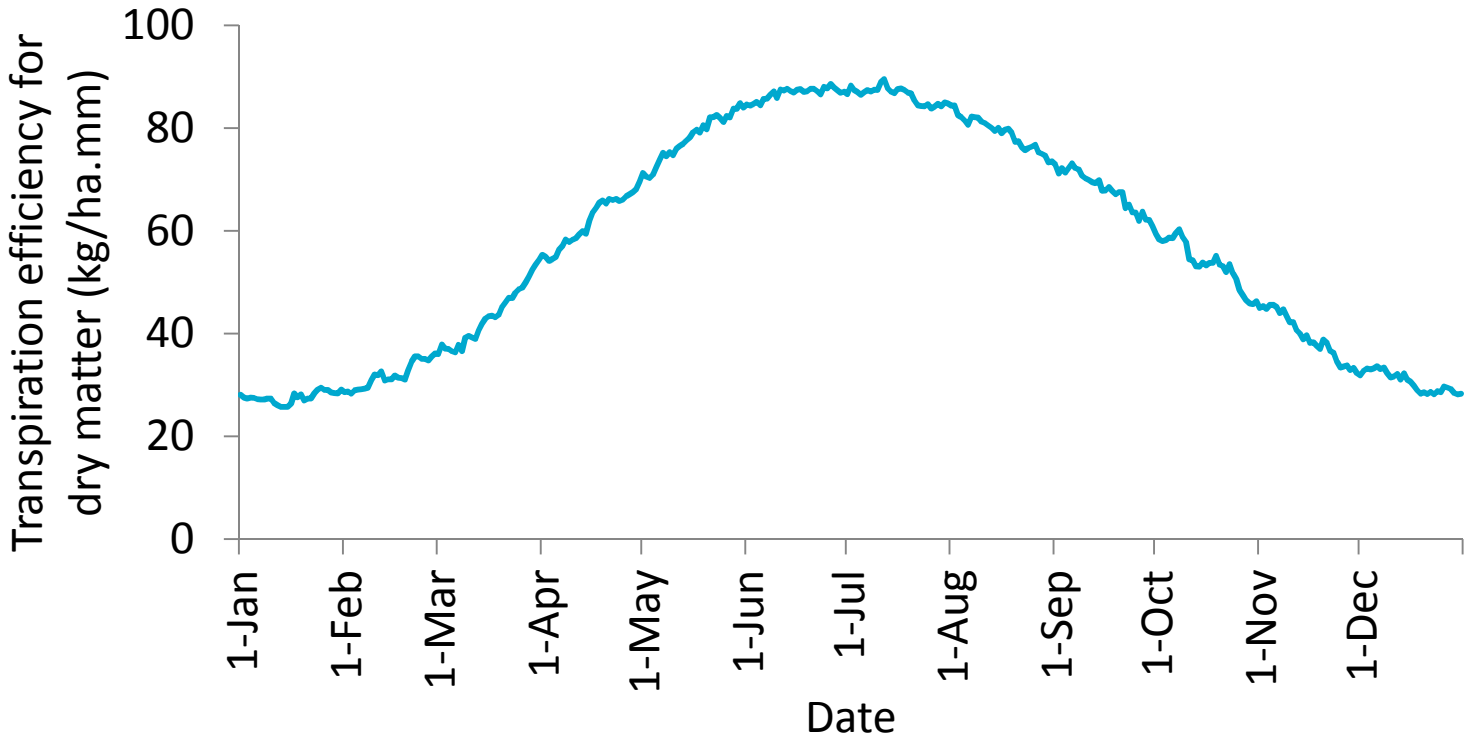
- Eurofins
- WANTFA, Facey Group
- Ben Biddulph DAFWA, trial hosts

Why sow wheat early?

- Cropped areas are increasing
- Sowing opportunities are decreasing
- Need to start earlier to get program in on time
- Need to sow early to take advantage of stored soil water from summer rain, long fallow etc.
- Because we can;
  - No-till
  - Summer fallow management
  - Cheap insecticides & fungicides
  - Effective pre-emergent herbicides
- No-till + dry sowing very effective – is there more we can do?

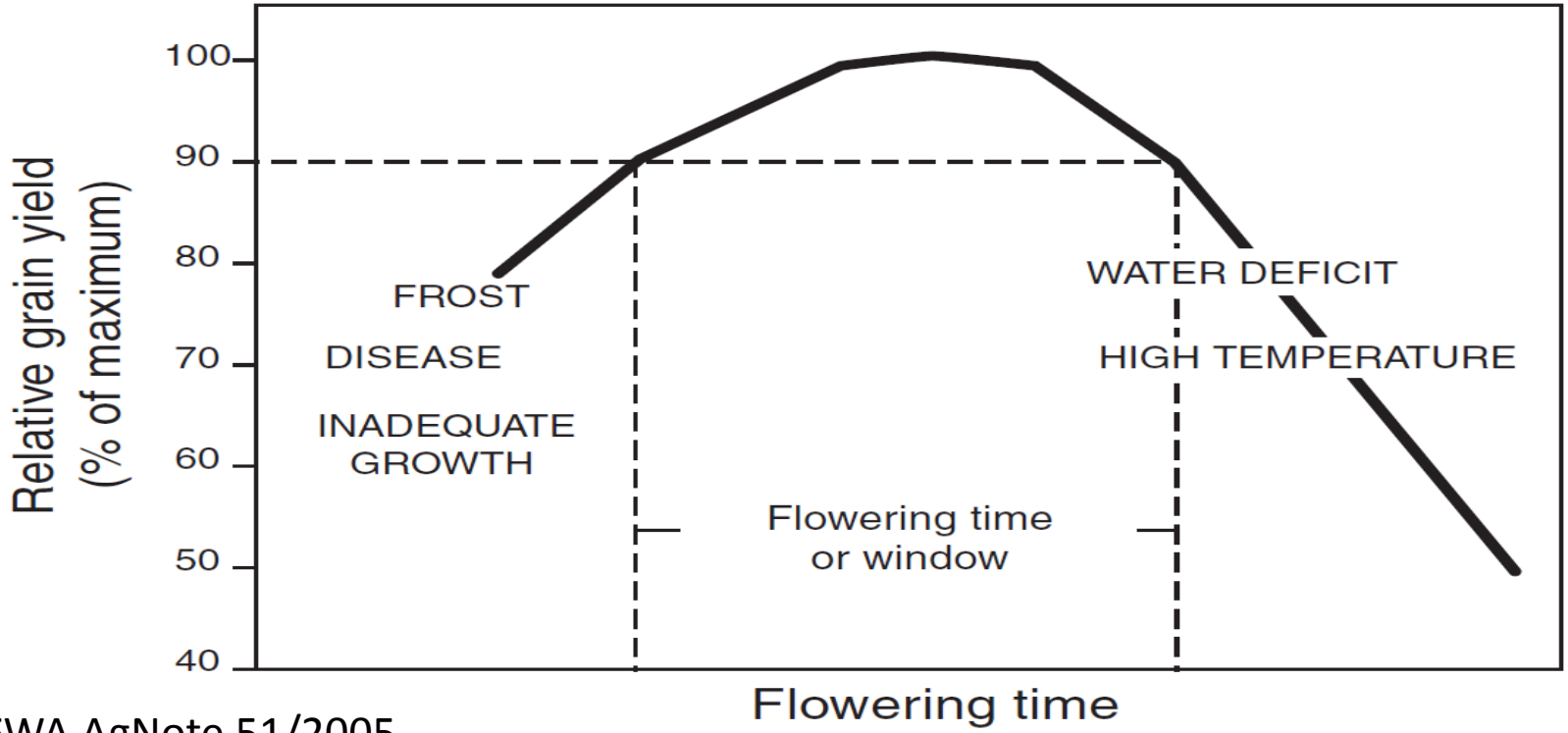
Time of sowing – what are we trying to achieve?

- As much growth as efficiently as possible



Time of sowing – what are we trying to achieve?

- Anthesis (flowering) to occur during optimal period for yield
- Trade-off – drought, heat and frost (Anderson & Smith 1990)



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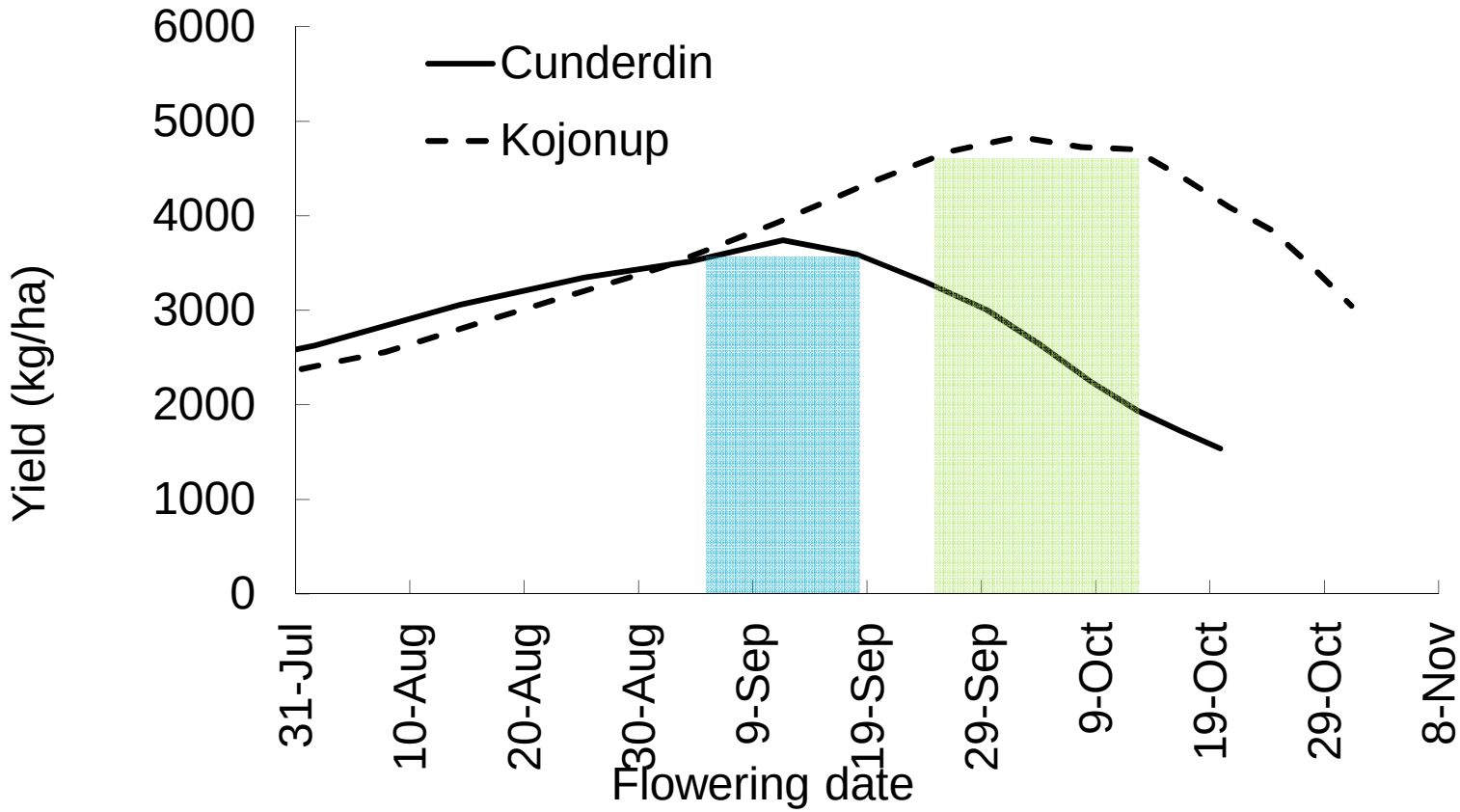
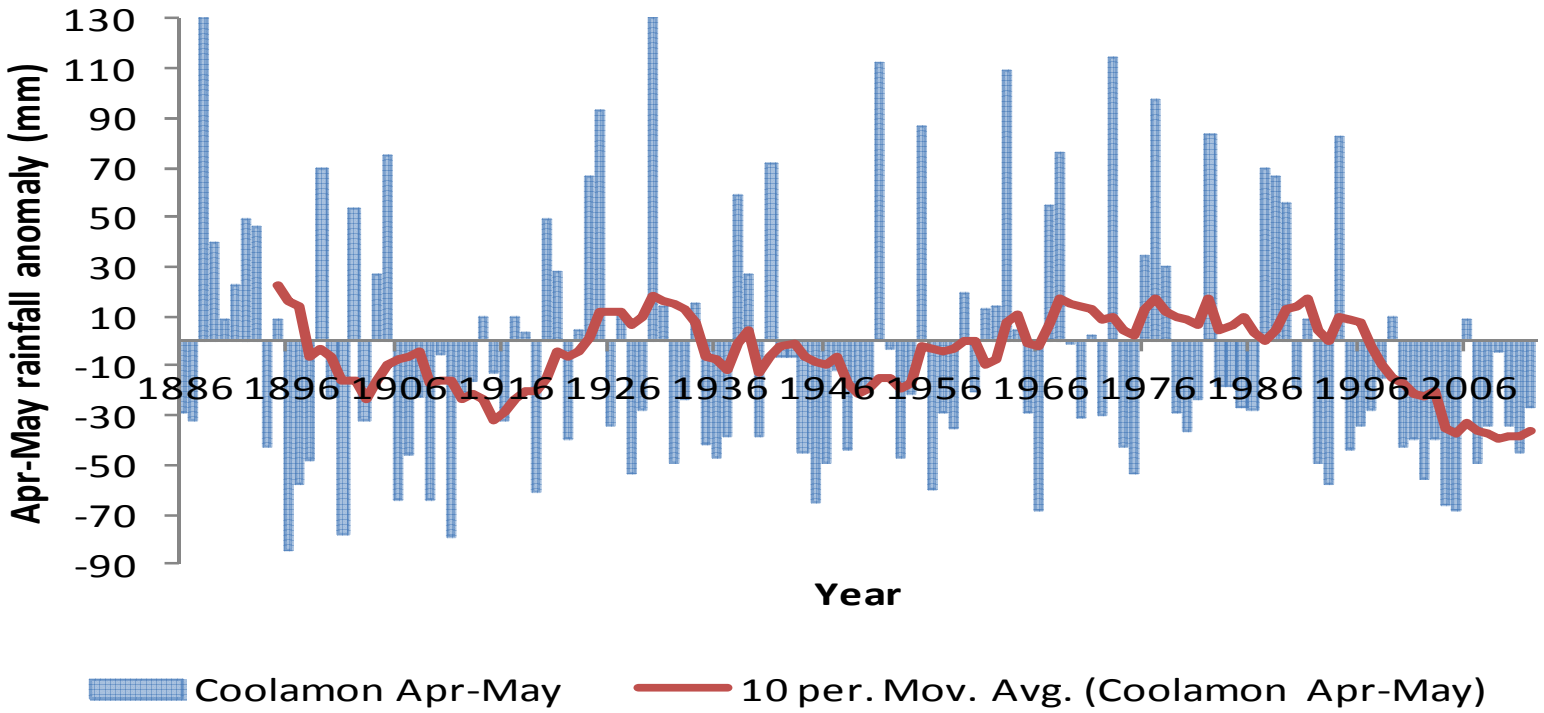
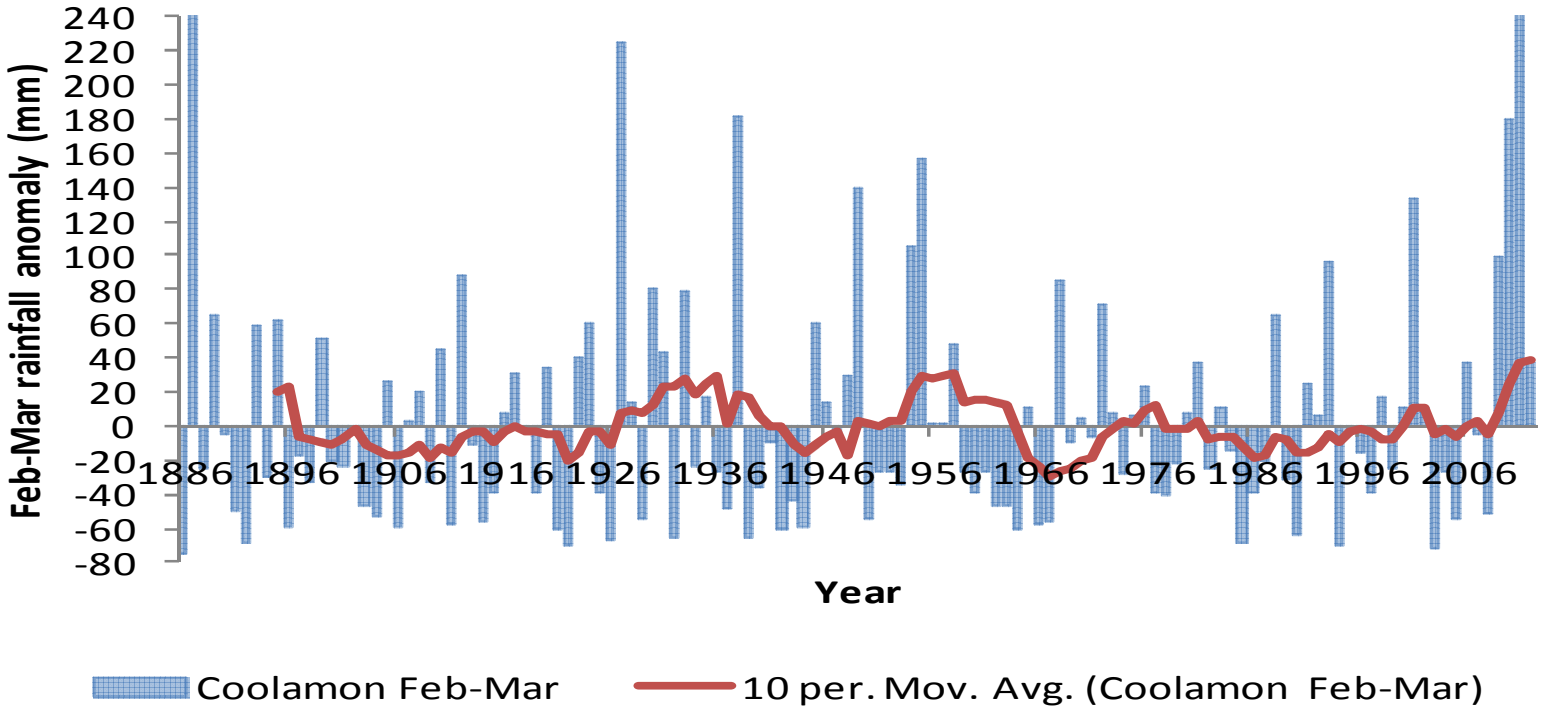
Optimal flowering periods - APSIM



Changing environment – SE Australian wheat belt

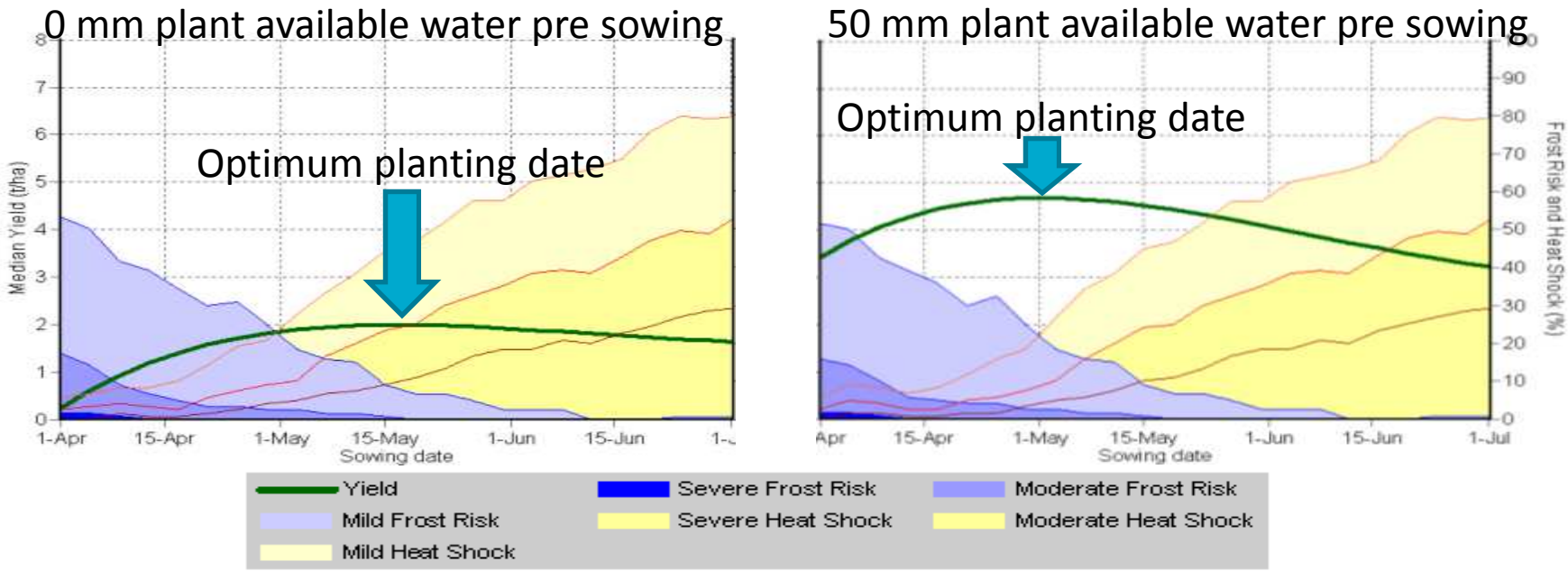


Summer fallow rain – an opportunity



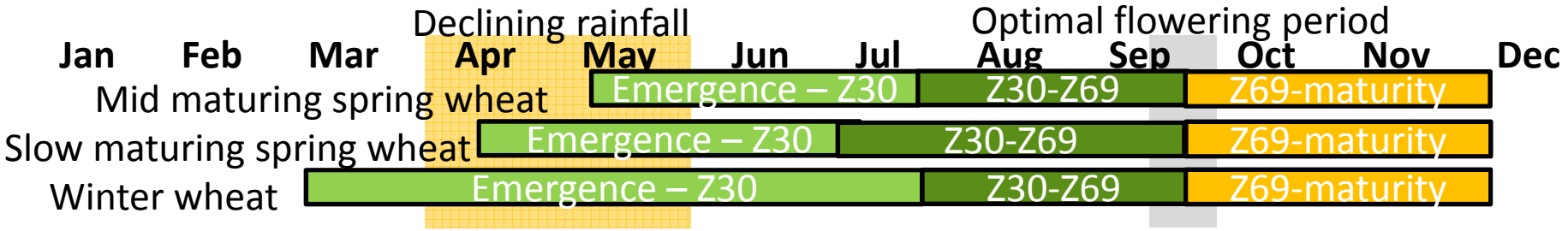
Soil water and sowing time

- Optimal planting date changes when stored soil water present



Summer rain - capturing an opportunity

- Summer rain can substitute for April-May rain and be used to establish crops much earlier than previously practiced
- Need to use slower maturing cultivars



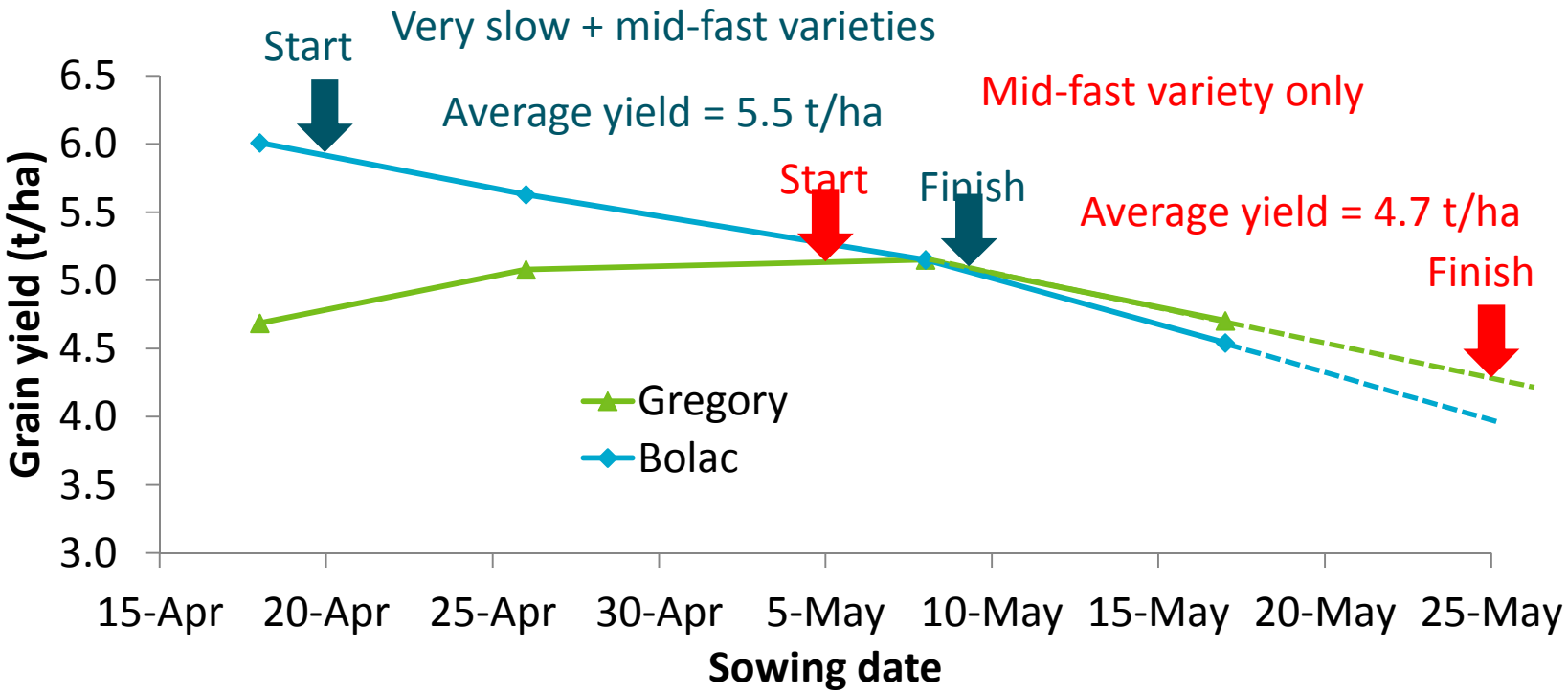
Early sowing needs slower maturing cultivars

- Slow maturing cultivars sown early yield more than fast maturing varieties sown later
- Grow deeper roots, less evaporation, higher TE and WUE

CSIRO & FarmLink experiment Junee 2012

Variety & sow date	Grain yield (t/ha)	Depth of water extraction (m)	Water-use (mm)	Estimated evaporation (mm)	Transpiration efficiency for dry matter (kg/ha.mm)	Water-use efficiency (kg/ha.mm)
Eaglehawk (18 April)	**5.8**	1.55	330	59	42	17.6
Bolac (26 April)	**5.6**	1.53	334	59	44	16.8
Gregory (8 May)	**5.1**	1.35	332	64	35	15.4
Lincoln (17 May)	**4.1**	1.26	310	69	37	13.2
P-value	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
LSD (p=0.05)	**0.3**	**0.14**	**12**	**1.8**	**1.9**	**0.10**

Effects scale up at whole-farm level




Charlie & Lou Clemson – Ardlethan NSW
"Bolac over three farms averaged 3.5 t/ha (sown 4 April 2013 to 18 April 2013). Other wheats averaged 2.1 t/ha (sown 1 May 2013 to 7 June 2013)"

What about WA?

- Adapted varieties untested or unavailable
- Mediterranean rainfall – less sowing opportunities
- Can use APSIM to evaluate effect on average farm wheat yield of sowing slow maturing varieties early

Frost yield reduction (after Farre et al. 2010)

- Minimum temperature between 0 and 2°C during Zadoks stage 60-69 = 10% yield loss
- Minimum temperature between -2 and 0°C during Zadoks stage 60-75 = 20% yield loss
- Minimum temperature less than -2°C during Zadoks stage 60-79 = 90% yield loss

Heat yield reduction

- Maximum temperature between 32 and 34°C during Zadoks stage 60-79 = 10% yield loss
- Maximum temperature between 34 and 36°C during Zadoks stage 60-79 = 20% yield loss
- Maximum temperature more than 36°C during Zadoks stage 60-79 = 30% yield loss

APSIM analysis – 20 day wheat program

1. **Current practice - mid-fast variety only**.
   - Mid-fast variety only (e.g. Mace)
   - Sowing starts in May and only if seed bed moisture
   - Dry sowing starts on 25 May
2. **New early-sowing strategy - very slow variety sown early + mid-fast varieties**.
   - Mid-fast variety only + winter wheat (phenology varies with location)
   - Winter wheat sowing starts from 1 April when seed bed moisture was sufficient (>50% PAWC in the top two layers of soil)
   - Mid-fast sowing uses rules as above
   - Proportion of each variety changes from year to year

APSIM analysis - assumptions

- Current sowing times vary with location
- In WA not much rain required to trigger early sowing

LOCATION	PAWC (MM) TO DEPTH (M)	PAWC OF TOP TWO LAYERS (MM)	START OF CURRENT PRACTICE SOWING WINDOW	SLOW MATURING VARIETY
Cunderdin	61 (1.3)	18	10-May	Fast winter wheat
Esperance	69 (1.4)	12	20-May	Mid winter wheat
Kojonup	114 (1.7)	19	15-May	Mid winter wheat
Mingenew	148 (2.5)	16	10-May	Fast winter wheat
Wongan Hills	140 (2.5)	8	10-May	Fast winter wheat

APSIM analysis – yield results

- Slow maturing wheat + early sowing = increased farm wheat yield
- Winter wheats don't work in warm, coastal environments

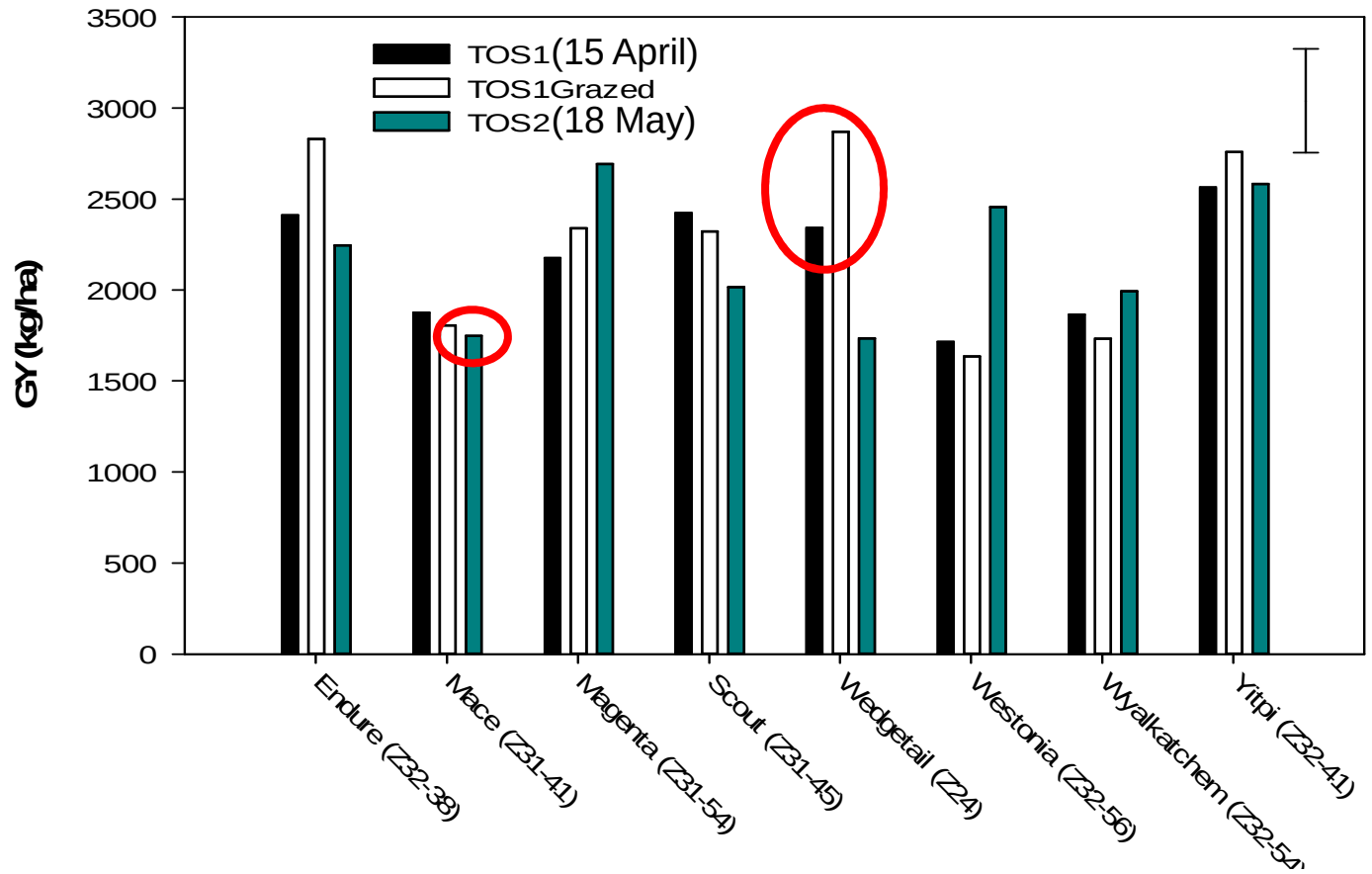
LOCATION	AVERAGE FARM YIELD – CURRENT PRACTICE (T/HA)	AVERAGE FARM YIELD – EARLY SOWING (T/HA)	YIELD BENEFIT FROM EARLY SOWING (T/HA)	YIELD BENEFIT FROM EARLY SOWING (%)
Cunderdin	1.9	2.4	0.5	26%
Esperance	3.6	4.4	0.8	21%
Kojonup	2.2	3.4	1.2	55%
Mingenew	3.2	2.4	-0.8	-25%
Wongan Hills	3.1	3.5	0.4	13%

Past WA experiments - Merredin

- Armstrong 1998
- Osprey (fast winter) vs. Janz (mid-fast spring) ~70% isogenic
- Average yield advantage of early sown winter = 0.12 t/ha

Grain yield (t/ha)	1994		1995		1996	
	19-Apr	25-May	19-Apr	29-May	12-Apr	13-Jun
Osprey (winter)	1.34	0.53	1.77	1.23	2.36	2.15
Janz (spring)	1.09	0.85	1.72	1.62	1.42	2.65
Advantage of winter sown early (t/ha)		0.49		0.15		-0.29

Seymour & Ryan 2012 - Esperance



2014 experiment details

- 4 sites (rainfall gradient)
  - Doodlakine
  - Cunderdin
  - Wickepin
  - Kojonup
- 3 times of sowing (watered up if no seed bed moisture)
  - Mid April
  - Early-Mid May
  - Late May
- 6 ‘best bet’ commercial cultivars of varying maturity
- 4 near-isogenic lines developed by Dr Ben Trevaskis (CSIRO)

Commercial cultivars

Cultivar	Maturity
Wedgetail	Mid maturing winter (strong vernalisation moderate photoperiod)
Whistler	Fast maturing winter (strong vernalisation weak photoperiod)
Eaglehawk	Very slow maturing spring (moderate vernalisation, very strong photoperiod)
Lancer	Slow maturing spring (moderate vernalisation, weak photoperiod)
Magenta	Mid maturing spring (moderate vernalisation, moderate photoperiod)
Mace	Fast maturing spring (weak vernalisation, weak photoperiod)

Near isogenic lines (NILs)

- Different major maturity genes crossed into the same background (Sunstate)
- Backcrossed until 97% genetically identical
- Tool to compare wheat maturity without other genetic baggage

2014 Results - Doodlakine

- Low rainfall
- Low frost
- First to flower yields most
- Whistler sown 17 April = Mace sown 21 May

Yield (t/ha)	Time of sowing		
Cultivar	**17-Apr**	**5-May**	**21-May**
Wedgetail	0.6	0.5	0.5
Whistler	1.2	0.9	0.7
Eaglehawk	1.0	0.7	0.4
Lancer	1.6	1.1	0.8
Magenta	1.4	1.1	0.9
Mace	1.5	1.3	1.1
P-value		<0.001	
LSD (P=0.05)		0.1	

2014 Results - Cunderdin

- Wheat on wheat
- Volunteers – worse in first time of sowing
- Rhizoctonia – worse in winter wheats

Yield (t/ha)	Time of sowing		
Cultivar	**15-Apr**	**30-Apr**	**15-May**
Wedgetail	1.4	1.9	1.3
Whistler	1.5	1.3	1.3
Eaglehawk	2.2	2.2	1.6
Lancer	2.0	2.4	2.0
Magenta	2.9	2.5	2.2
Mace	2.2	2.9	2.6
P-value		0.004	
LSD (P=0.05)		0.6	

2014 Results - Wickepin

- Very little frost!!!
- Very kind spring
- Whistler sown 16 April > Mace sown 20 May with less frost risk

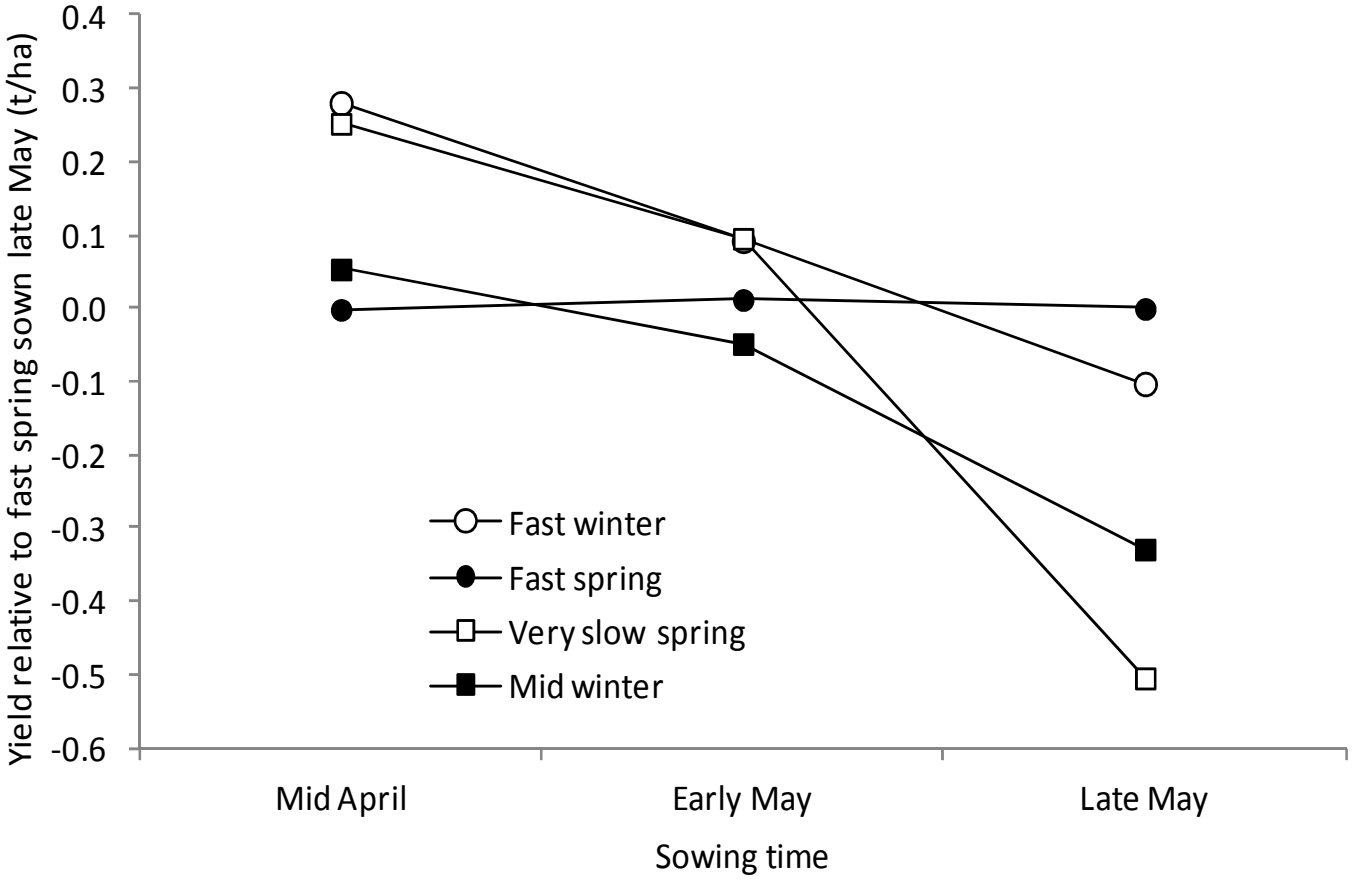
Yield (t/ha)	Time of sowing		
Cultivar	**16-Apr**	**6-May**	**20-May**
Wedgetail	4.0	3.5	3.5
Whistler	4.2	3.9	3.5
Eaglehawk	3.8	3.7	3.3
Lancer	3.9	3.6	3.3
Magenta	4.2	3.9	3.9
Mace	3.6	3.9	3.5
P-value		<0.001	
LSD (P=0.05)		0.3	

2014 Results - Kojonup

- First ToS overrun by annual ryegrass, winter wheats worse
- Very kind spring
- Highest yield = Magenta sown 2 June
- Whistler sown 16 April = Mace sown 2 June

Yield (t/ha)	Time of sowing		
Cultivar	**16-Apr**	**11-May**	**2-Jun**
Wedgetail	4.1	4.2	4.7
Whistler	4.5	4.3	4.8
Eaglehawk	4.8	4.5	4.4
Lancer	3.8	4.4	4.5
Magenta	4.5	4.4	5.2
Mace	4.5	4.9	4.9
P-value		<0.001	
LSD (P=0.05)		0.5	

2014 results – near isogenic lines

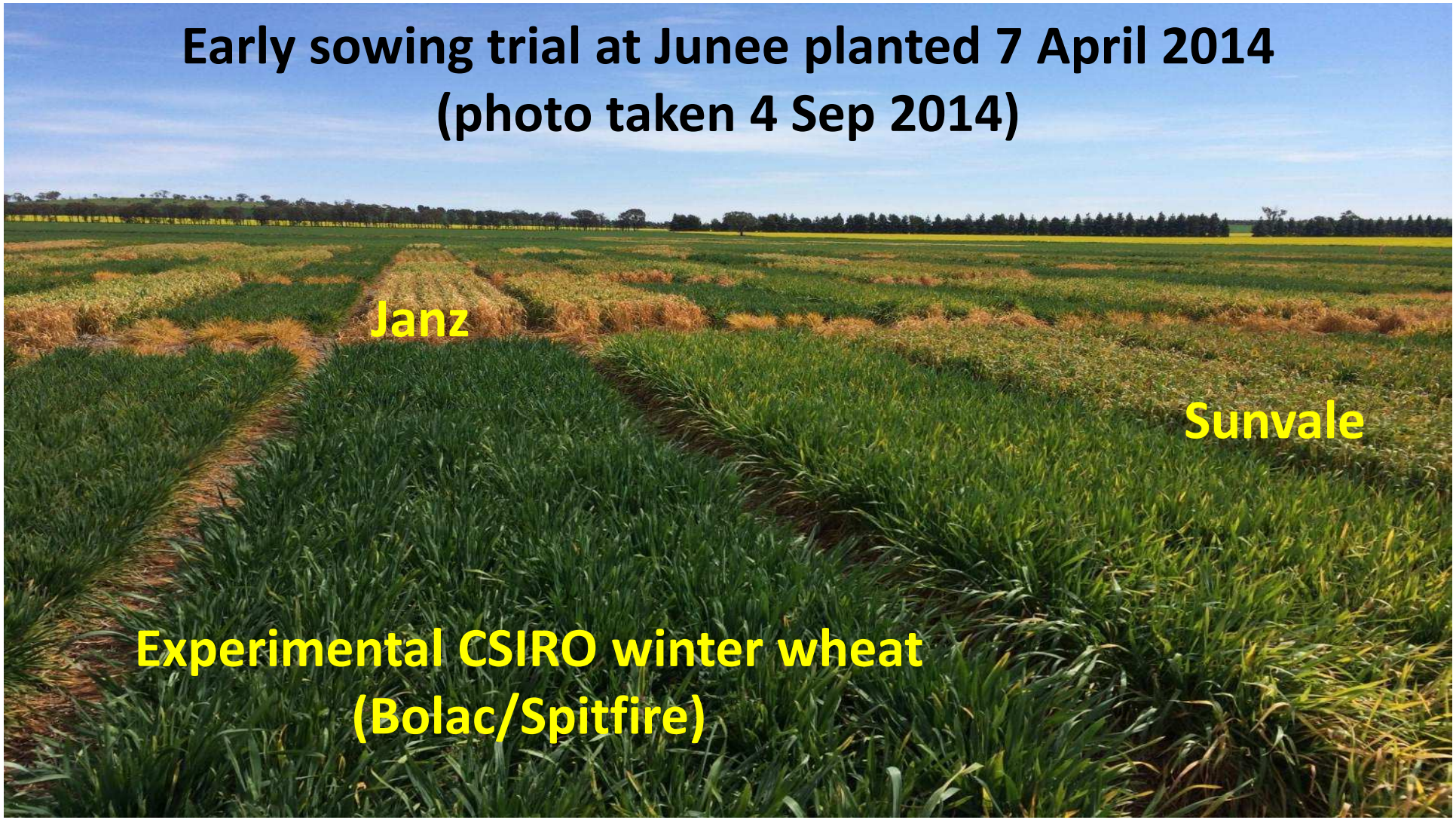


Fast maturing winter wheats

- Fast winter wheats seem well suited to early sowing in central wheat belt
- Lots of advantages;
  - Stable flowering time = wide sowing window, low frost risk
  - Better resist stem frost
  - Excellent for dual purpose (grain and graze)
- Bad news – there aren't any!
- Whistler is AGP and good luck finding seed in WA
- Only Australian milling quality winter wheat breeding program (DPI NSW Temora) shut in 2002
- Good news – AGT, Advantage (Dow) and Longreach have all started selecting winter lines
- Some likely to have WA adaption

Hope for the future – CSIRO winter wheats

Entry	Cross derived from	Habit	Yield (t/ha)
SDWW-0008-1-3	Espada/Gregory	Winter	4.0
SDWW-0009-3-3	Mace/Sunvale	Winter	3.4
SDWW-0012-3-3	Derrimut/Magenta	Winter	3.3
SDWW-0009-1-3	Mace/Sunvale	Winter	3.3
SDWW-0043-3-3	Forrest/Gregory	Winter	3.0
SDWW-0008-3-3	Espada/Gregory	Winter	3.0
SDWW-0043-2-3	Forrest/Gregory	Winter	3.0
SDWW-0043-4-3	Forrest/Gregory	Winter	2.8
SDWW-0008-2-3	Espada/Gregory	Winter	2.7
Wylah		Winter	2.7
SDWW-0005-6-3	Bolac/Spitfire	Winter	2.6
Osprey		Winter	2.6
Whistler		Winter	2.5
SDWW-0043-7-3	Forrest/Gregory	Winter	2.5
SDWW-0043-5-3	Forrest/Gregory	Winter	2.5
SDWW-0005-1-3	Bolac/Spitfire	Winter	2.3
Wedgetail		Winter	2.2
Trojan		Mid spring	2.1
SDWW-0007-2-3	Spitfire/Sunvale	Winter	2.1
Forrest		Very slow spring	1.9
Lancer		Slow spring	1.8
P-value			**<0.001**


Early sowing trial at Junee planted 7 April 2014
(photo taken 4 Sep 2014)
Janz
Sunvale
Experimental CSIRO winter wheat
(Bolac/Spitfire)

Thank you

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Cultivar maturity – genetic control

- Green = slower maturity

	Photoperiod		Vernalisation		
Cultivar	Ppd-B1	Ppd-D1	Vrn-A1	Vrn-B1	Vrn-D1
Wedgetail	*b*	*a*	*v*	*v*	*v*
Whistler	*d*	*a*	*v*	*v*	*v*
Eaglehawk	*b*	*b*	*b*	*v*	*a*
Lancer	*a*	*a*	*a*	*v*	*v*
Magenta	*b*	*a*	*v*	*a*	*v*
Mace	*a*	*a*	*v*	*a*	*v*

Cultivar maturity – genetic control

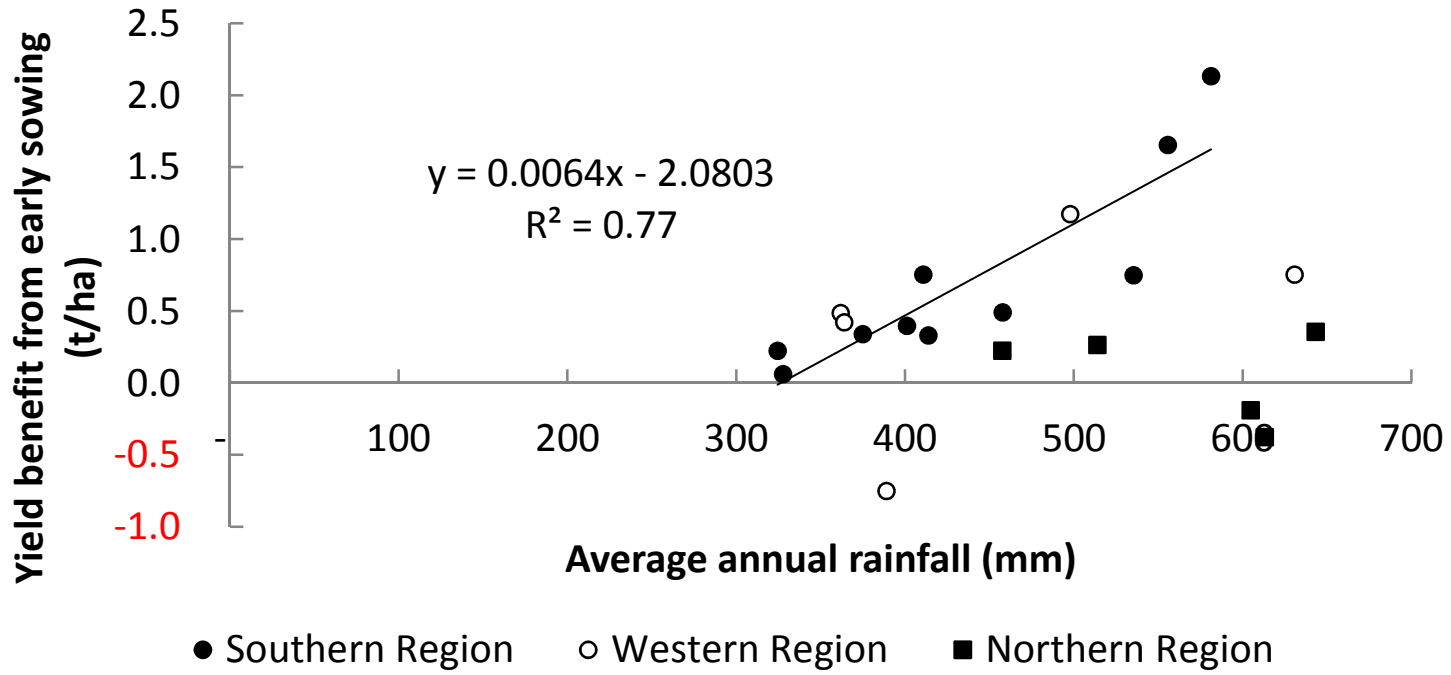
	Photoperiod		Vernalisation		
Cultivar	Ppd-B1	Ppd-D1	Vrn-A1	Vrn-B1	Vrn-D1
Mid winter	*a*	*b*	*v*	*v*	*v*
Fast winter	*a*	*a*	*v*	*v*	*v*
Very slow spring	*b*	*b*	*a*	*a*	*a*
Fast spring	*a*	*a*	*v*	*a*	*a*

APSIM analysis – frequency of opportunity

- Early sowing opportunities frequent

LOCATION	YIELDS < 1 T/HA – CURRENT PRACTICE (T/HA)	YIELDS < 1 T/HA – EARLY SOWING (T/HA)	YEARS IN WHICH SLOW MATURING VARIETY IS SOWN (%)	PADDOCKS IN WHICH SLOW MATURING VARIETY IS SOWN (%)
Cunderdin	16%	8%	95%	88%
Esperance	0%	0%	98%	91%
Kojonup	2%	0%	77%	65%
Mingenew	0%	12%	74%	57%
Wongan Hills	1%	1%	72%	60%

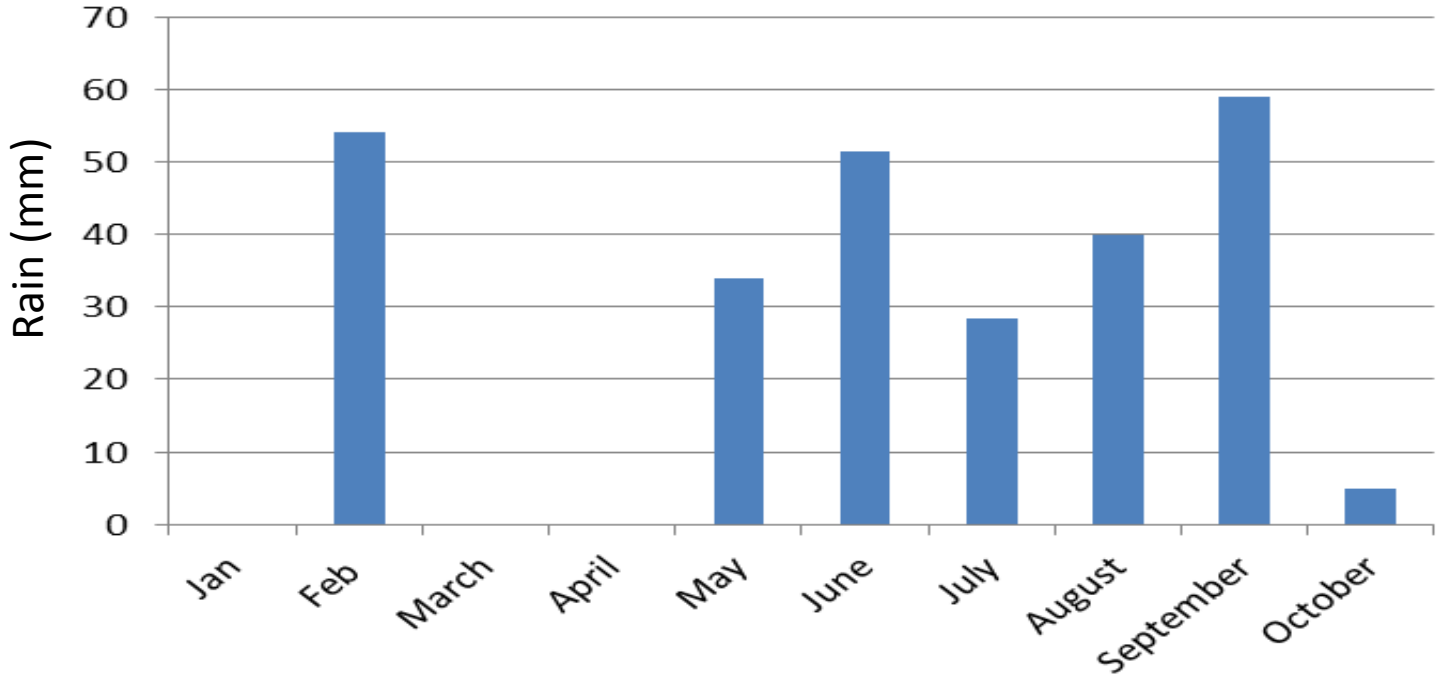
Benefit greater in higher rainfall areas



How far can you push it?

- Winter wheats can be sown in late summer/early autumn
  - Stabilise flowering date
  - Fill autumn/winter feed gap
- BCG trial at Curyo, north of Birchip (~340 mm annual rainfall)
  - 54 mm storm in mid-February
  - Trial sown on 26 February on chickpea stubble (74 mm PAW including rain)

Curyo – 2013 rain




Early April


May

20 August 2013

Zadoks stage - 12 September 2013

Variety	Ungrazed		Grazed	
	Zadoks code	Growth stage	Zadoks code	Growth stage
YW443	46	Booting	39	Flag leaf emerged
Whistler	63	Early anthesis	51	Early heading
Wylah	61	Early anthesis	64	Mid anthesis
Wedgetail	66	Mid anthesis	61	Early anthesis
Rosella	60	Early anthesis	51	Early heading
		Flag leaf emerged		Three nodes on main stem
Revenue	39		33	
CSIROW8A	53	Early heading	51	Early heading
CSIROW7A	67	Late anthesis	63	Early anthesis

Winter wheat and summer rain

- Grazing reduced yield of all varieties by 0.3 t/ha
- Surrounding paddock Kord sown 18 May averaged 3.6 t/ha

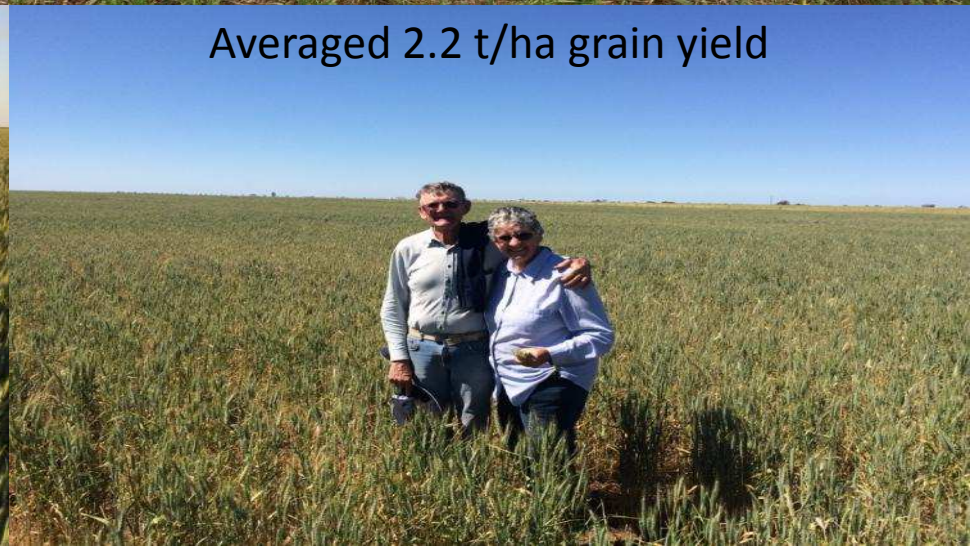
Variety	Grain yield (t/ha)	Protein (%)	Screenings (%)	Test weight (kg/hl)
Revenue	3.4	11.5	4.6	76
Rosella	3.3	12.2	2.7	81
Whistler	3.0	11.8	4.3	79
Wedgetail	2.8	12.4	2.5	77
Wylah	2.8	13.1	2.6	76
CSIROW7A	2.7	13.7	1.9	80
CSIROW8A	2.4	13.3	4.3	80
YW443	1.7	15.4	3.7	74
P-value	*<0.001*	*<0.001*	*<0.001*	*<0.001*
LSD (P=0.05)	*0.3*	*0.9*	*1.2*	*3*
CV%	*6.5*	*4.6*	*24.1*	*2.3*

Sowing Wedgetail @ Quambatook (340 mm AAR) 9 March

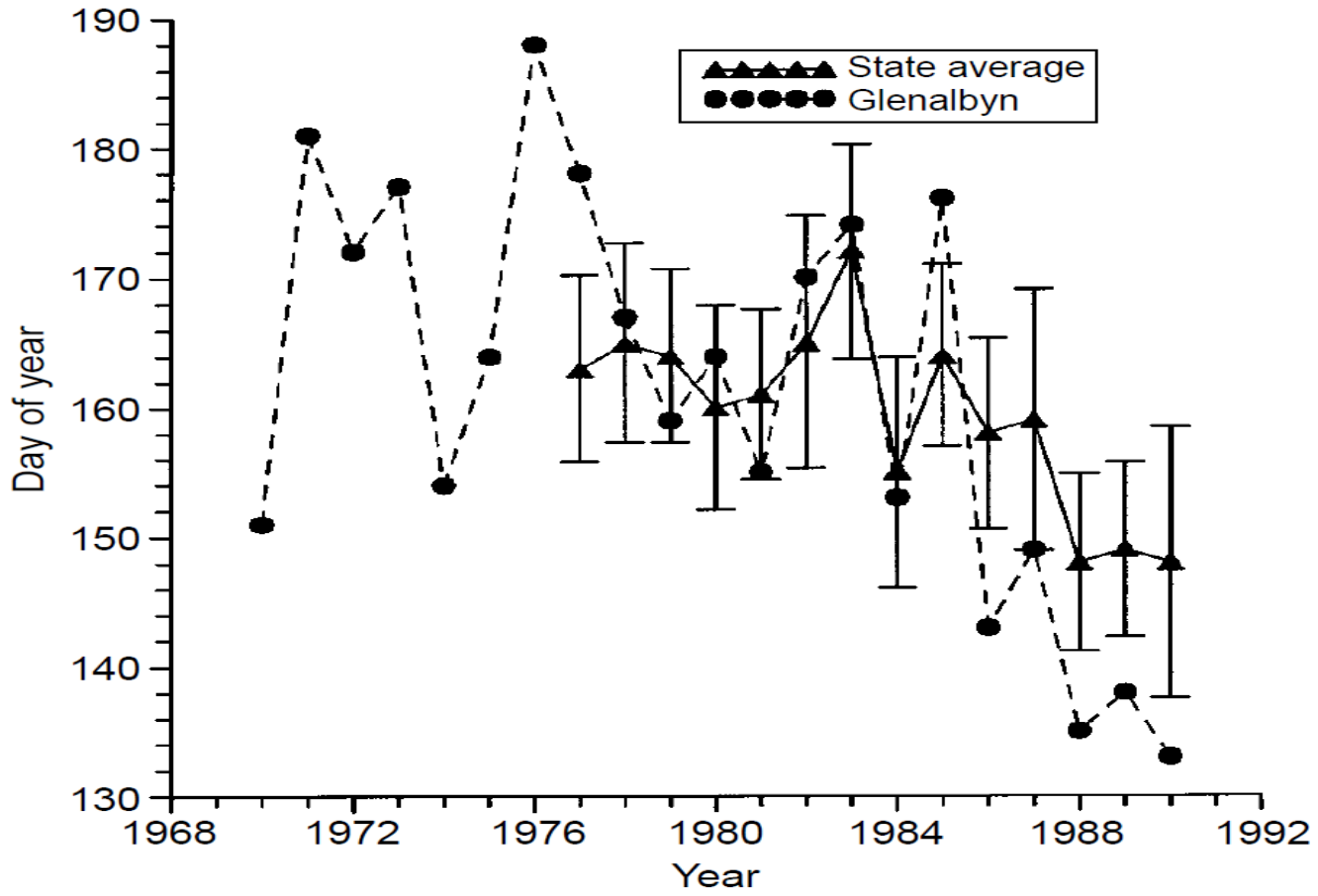
19 June after grazing ~18 DSE/ha for 5 weeks

Anthesis mid September

Averaged 2.2 t/ha grain yield



Sowing time in WA - Stephens & Lyons 1998



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