Optimising grain yield of canola in Western Australia accounting for the risk of frost and heat stress

Imma Farre, Mark Seymour, Martin Harries, Bob French and Jackie Bucat

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Department of Primary Industries and Regional Development

Tactical Break Crop Agronomy Project (DAW00227)

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Take home message

- Optimum Sowing Windows and duration defined for different locations
- Early sowing, key to maximise production
- Be prepared to accept some level of frost risk
- If late sowing opportunity, assess risk of achieving certain yield

Background

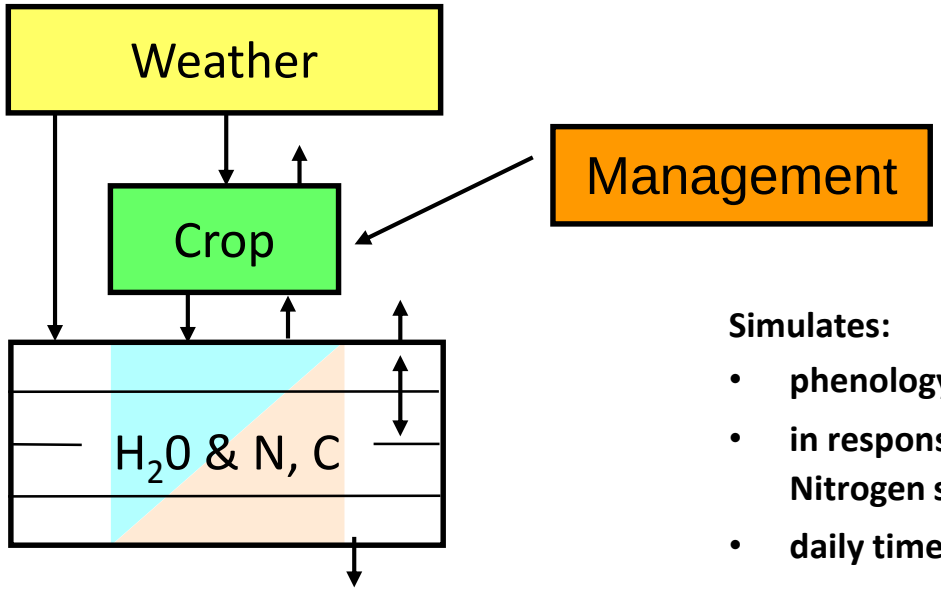
- Yield declines with delay in sowing
- Trade-off : frost and heat
- Lack of data on frost and heat
- Lack of data on very early sowings
- Sowing=germination (no dry sowing)

➢ Aim: Optimum sowing window to maximise yield

Modelling

- Limited field experiments
- Crop simulation modelling
  - Add value to field trials
  - Extend to many locations, years, soil types & agronomic management

APSIM- Canola model



Simulates:

- **phenology, growth and yield of crop**
- **in response to Temperature, radiation, Water and Nitrogen supply**
- **daily time steps**
- **Water-limited yield**
- **BUT, not pests, diseases**
- **Well managed field trial**

http://www.apsim.info/

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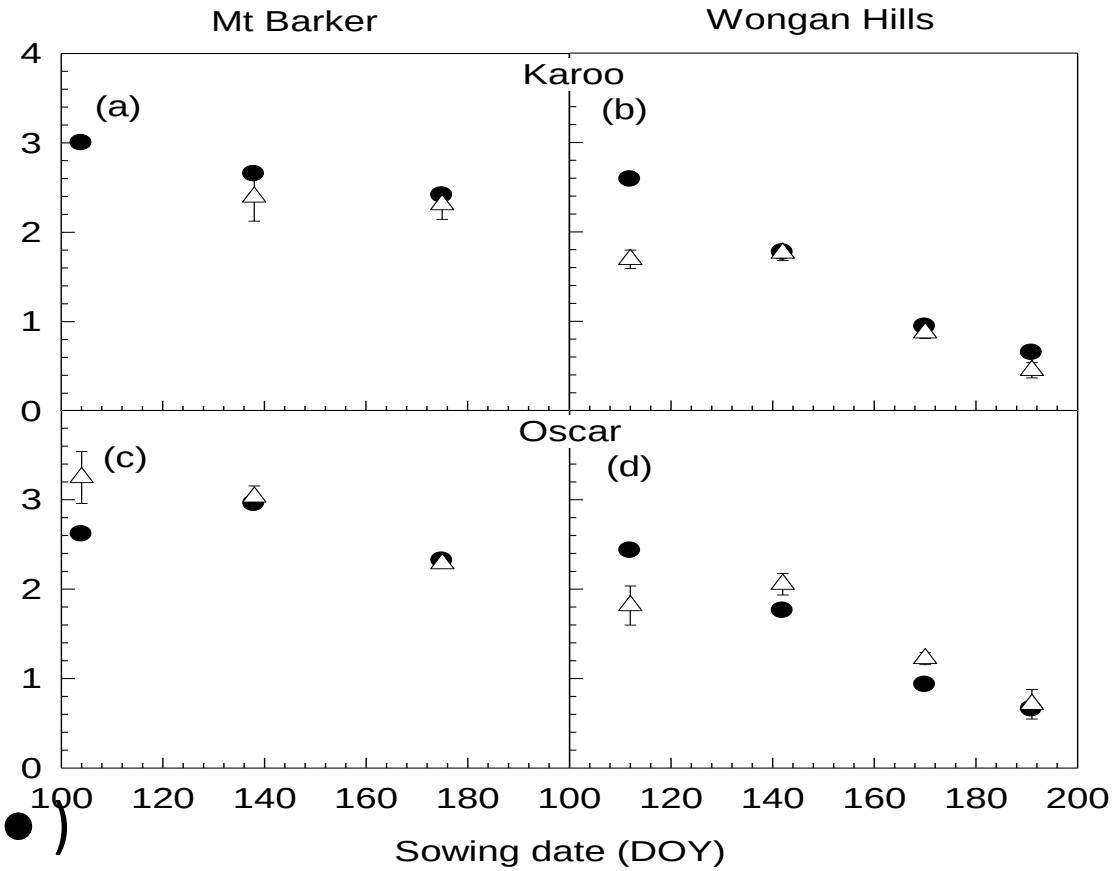
Model testing - Yield response to sowing date

1998



cv. Karoo TT short

cv. Oscar, non TT medium

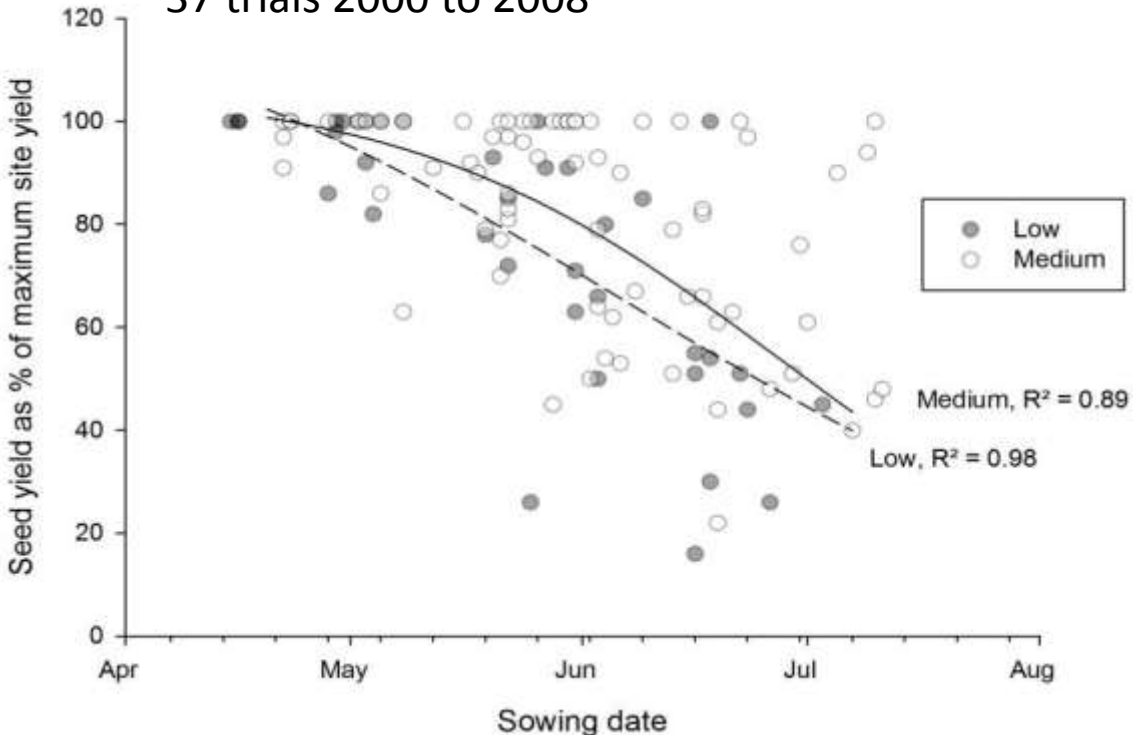
Simulated (●)

Observed (△)

In: Farre *et al*. 2002, AJAR, 53, 1155-1164

Early sowing becoming more critical…

37 trials 2000 to 2008

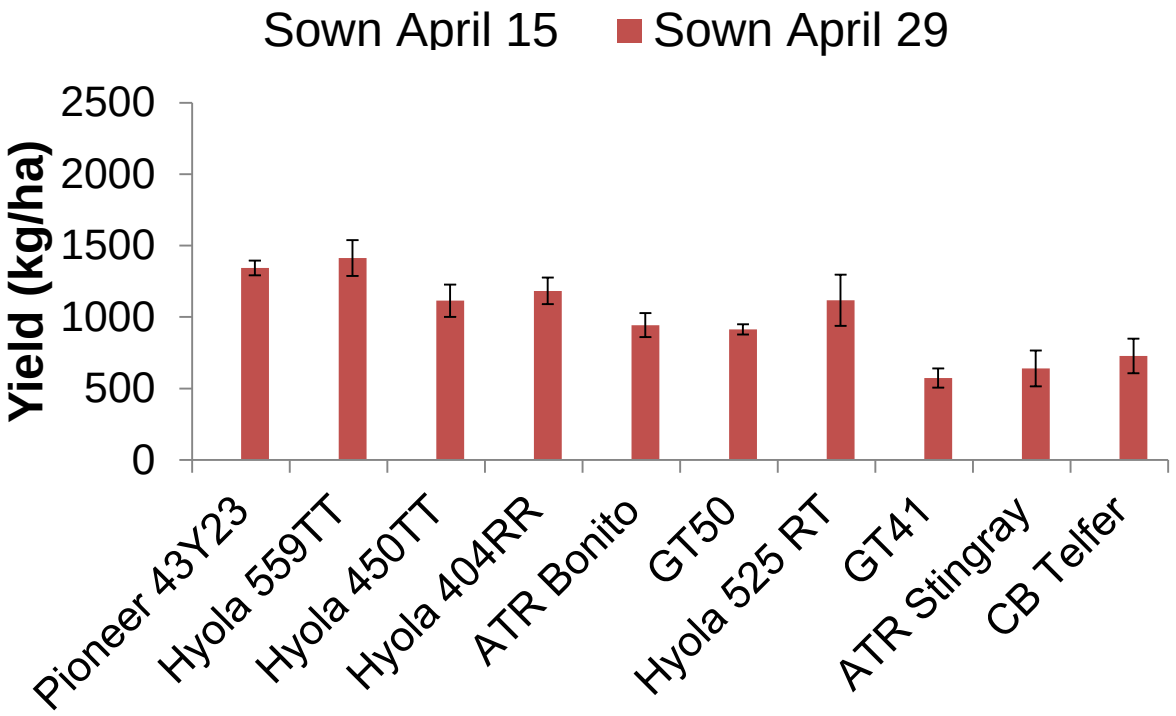


Few trials Mid April or earlier

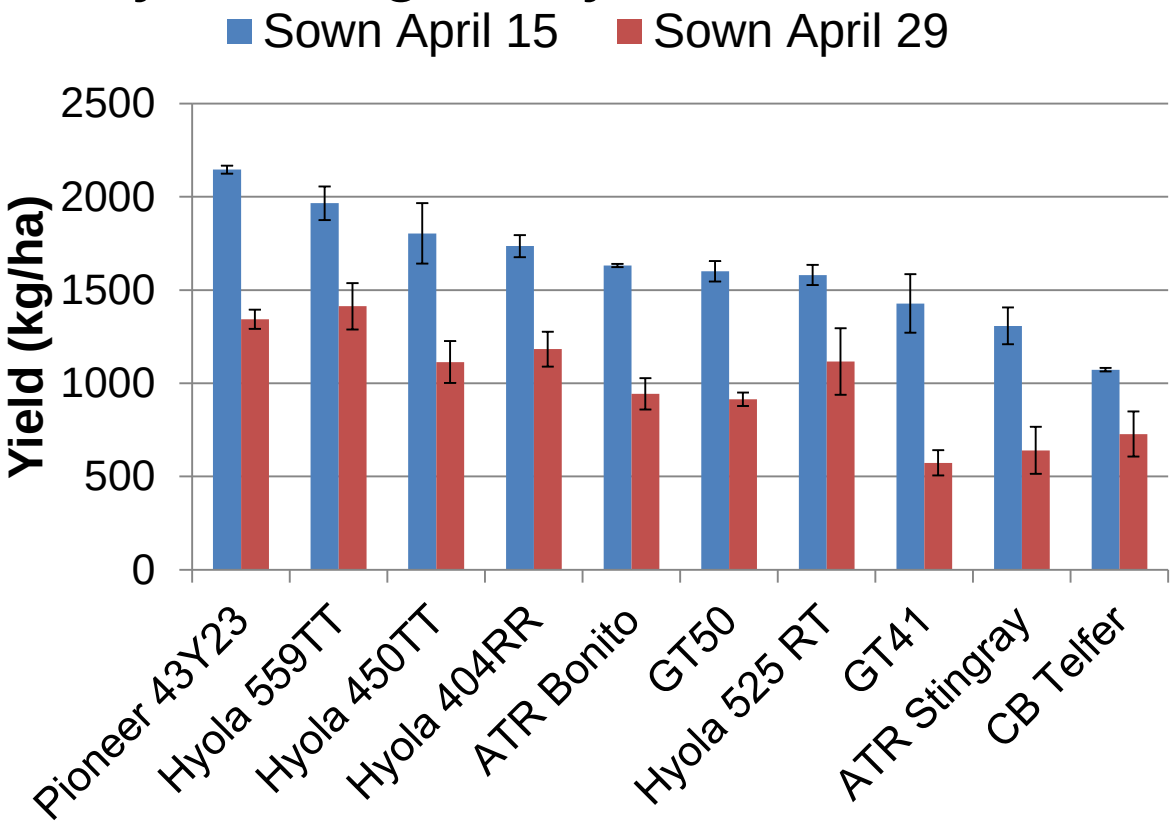
How early is too early?

Early or very early = March

Early sowing and yield (Binnu 2015)

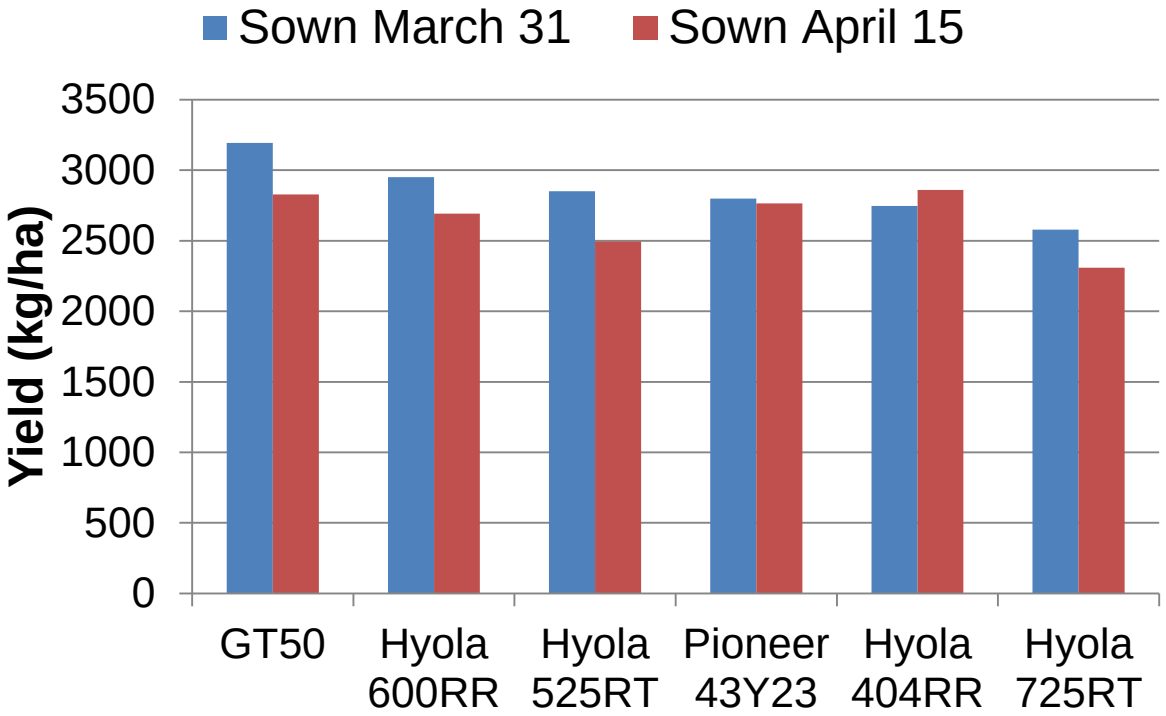


Early sowing and yield (Binnu 2015)



Mid April vs late April
15th 1.6 t/ha
29th 1.0 t/ha
~ 40 kg/ha/day benefit
No TOS X Variety effect

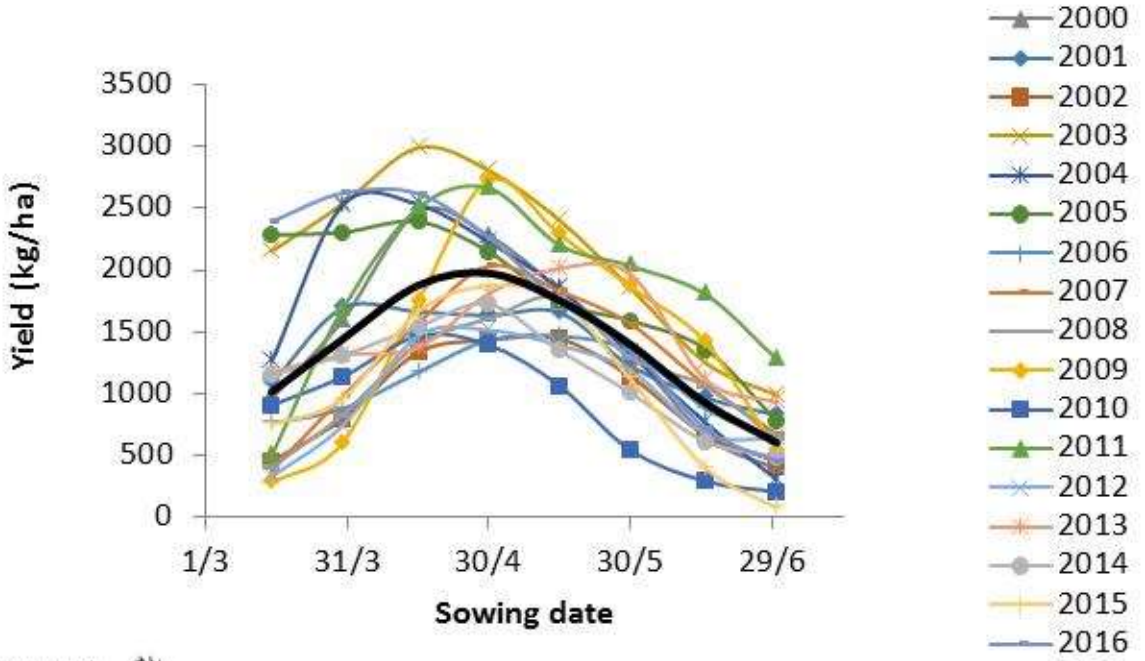
Early sowing and yield (Wongan 2016)



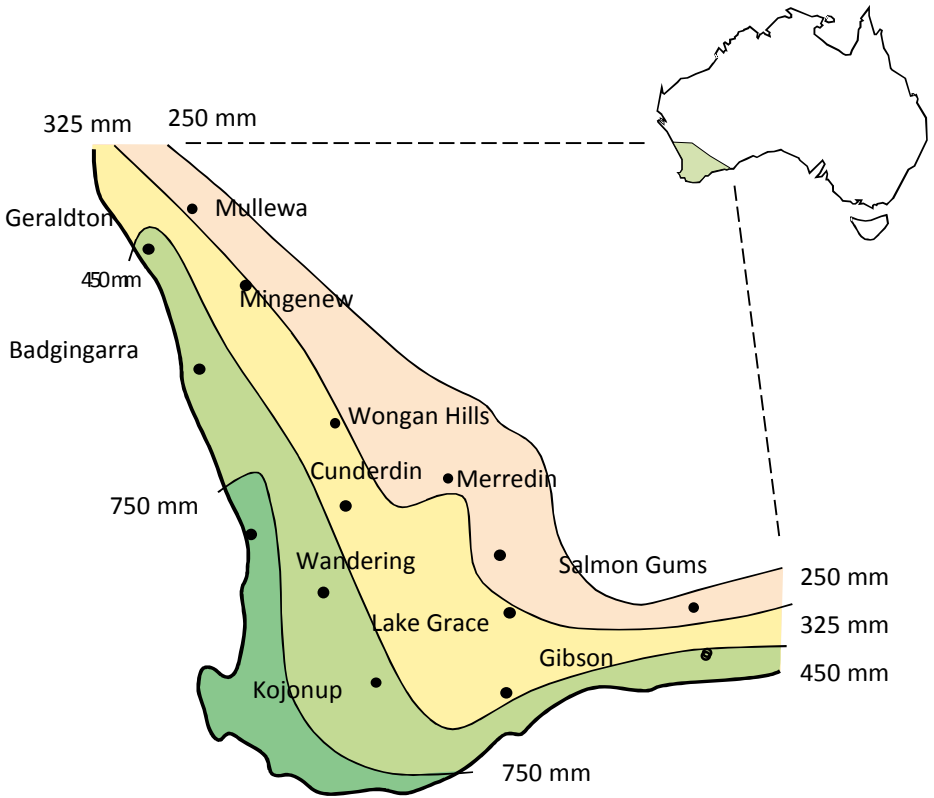
Late March vs Mid April
31st = 2.9 t/ha
15th = 2.7 t/ha
~ 10 kg/ha/day benefit

Model validation

Wongan Hills 2016			
TOS	Obs	Sim	Long term
31 Mar	2.9	3.2	1.8
15 Apr	2.7	2.8	2.1



Simulation experiment: APSIM-Canola model



- 12 Locations
- 3 Soil types (sand, duplex, clay)
- 3 Cultivars (long, medium, short)
- 8 Sowing dates (15Mar- 30 Jun)
- Climate (1976-2016)

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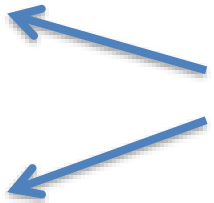
Modelling assumptions

Pest
Diseases
Weeds

Sowing= germination
(no dry sowing)

Frost and Heat effects in yield in APSIM Canola

Stress	Level	Sensitive stage	Yield reduction per day (%)
Frost	Moderate	Early pod filling	2
	Severe		10
Heat	Mild	During flowering	10
	Moderate		18
	Severe		35

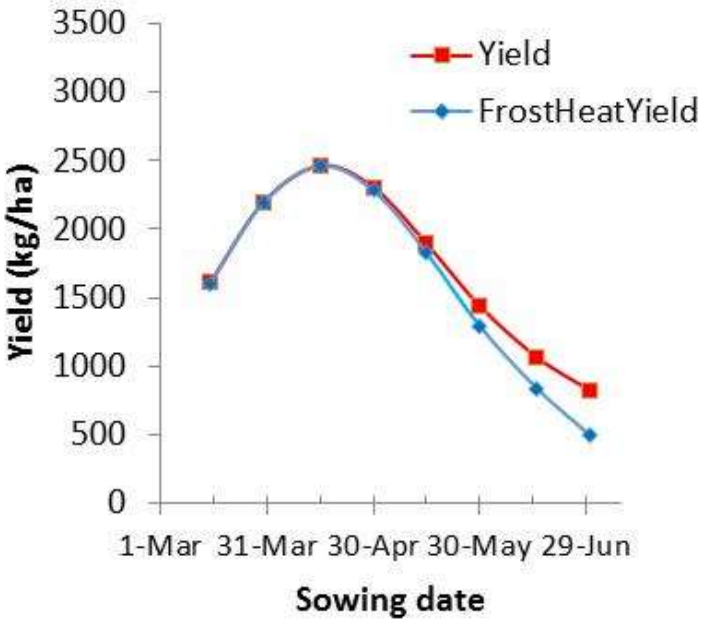


In: Lilley et al. 2006.
Crop&PastureScience, 66, 349-364

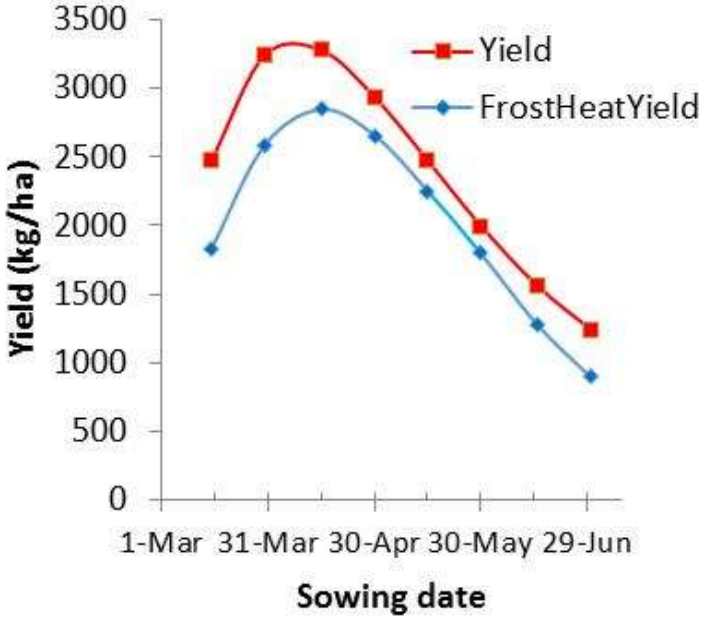
Frost and Heat yield penalties in APSIM

Medium cultivar (Bonito)

Wongan Hills

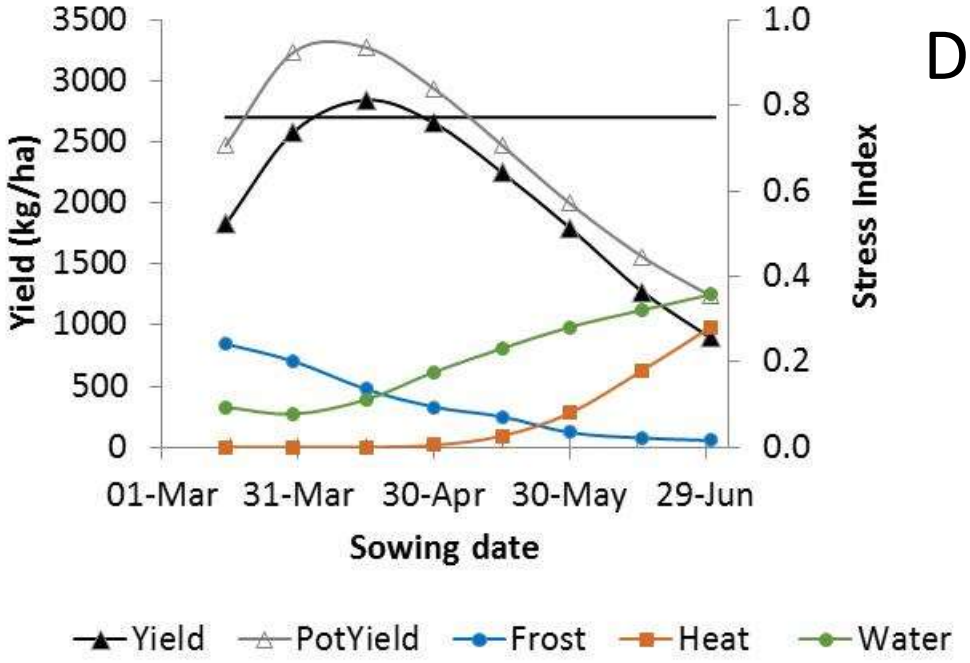


Wandering



Optimal Sowing Window

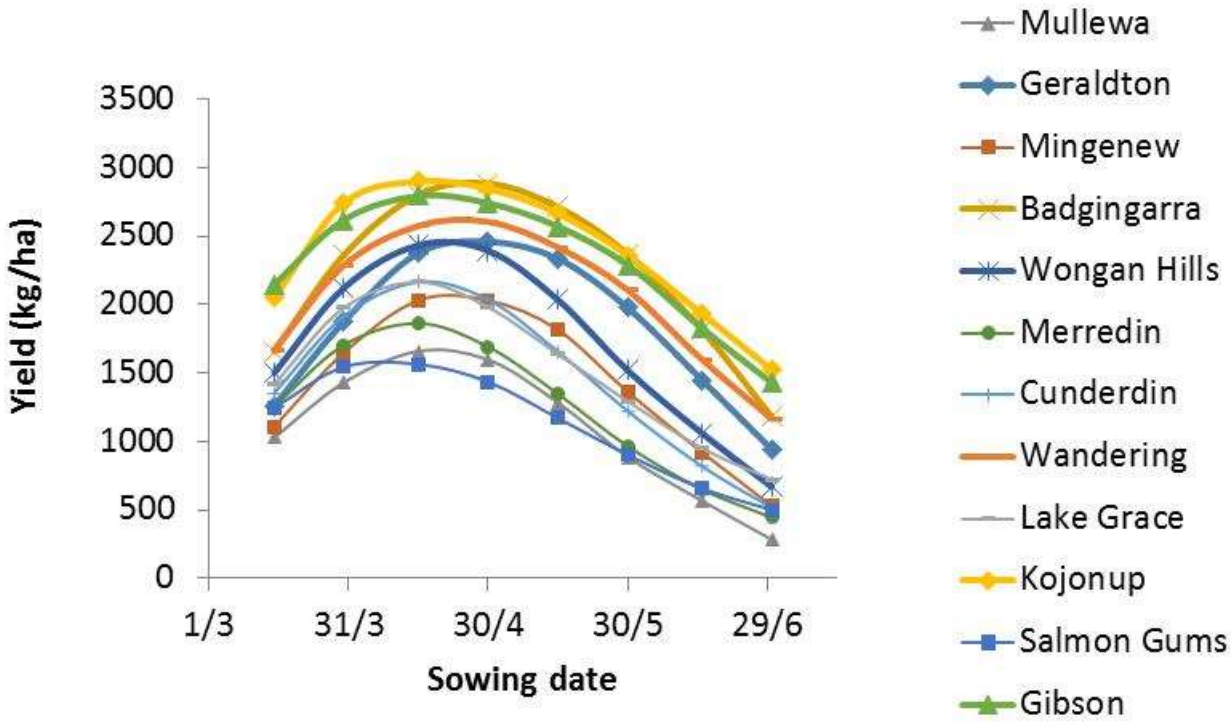
(Wandering, cv Bonito)



Determined by:

- Water stress
- Frost stress
- Heat stress
- Potential yield

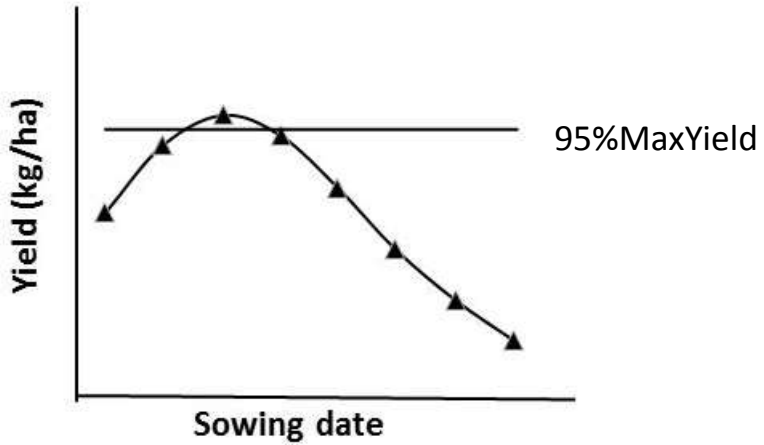
Yield response to sowing date



Optimum Sowing Window

Location	Medium cultivar	Duration (days)
Mullewa	5 Apr – 1 May	26
Geraldton	12 Apr – 15 May	33
Mingenew	9 Apr – 9 May	30
Badgingarra	11 Apr – 14 May	33
Wongan Hills	6 Apr - 4 May	28
Merredin	1 Apr – 25 Apr	24
Cunderdin	4 Apr – 29 Apr	25
Wandering	5 Apr – 11 May	36
Lake Grace	2 Apr – 25 Apr	23
Kojonup	30 Mar – 7 May	38
Salmon Gums	25 Mar – 24 Apr	30
Gibson	30 Mar – 9 May	40

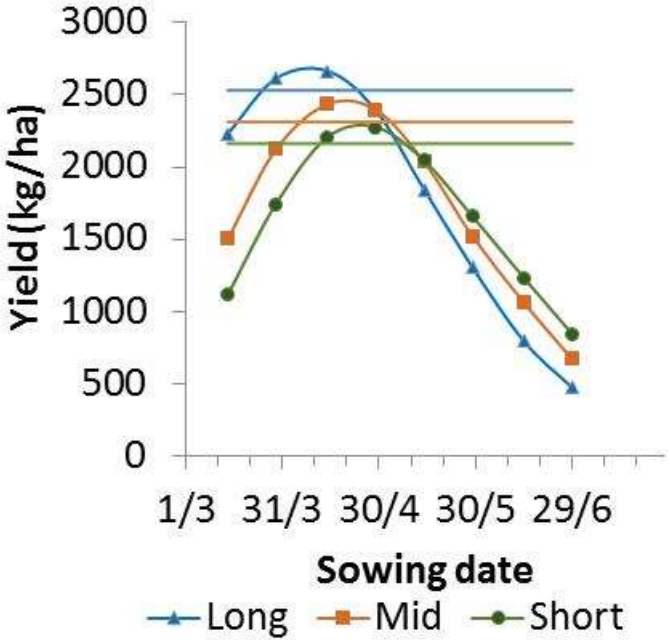
Medium cultivar (Bonito)



Optimum Start of Flowering

	Optimum Start of Flowering
Location	**Medium cultivar (Bonito)**
Wongan Hills	**2 Jul- 27 Jul**
Kojonup	**1 Jul - 15 Aug**
Gibson	**23 Jun- 6 Aug**

Canola cultivars



Wongan Hills
Sandy soil

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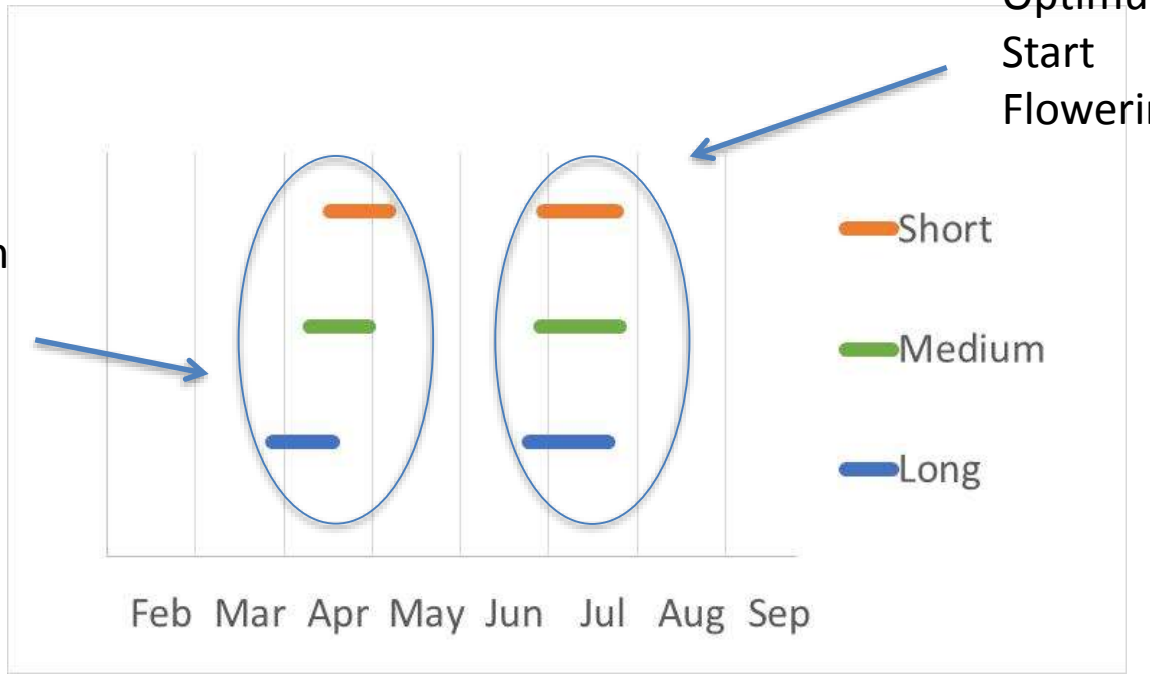
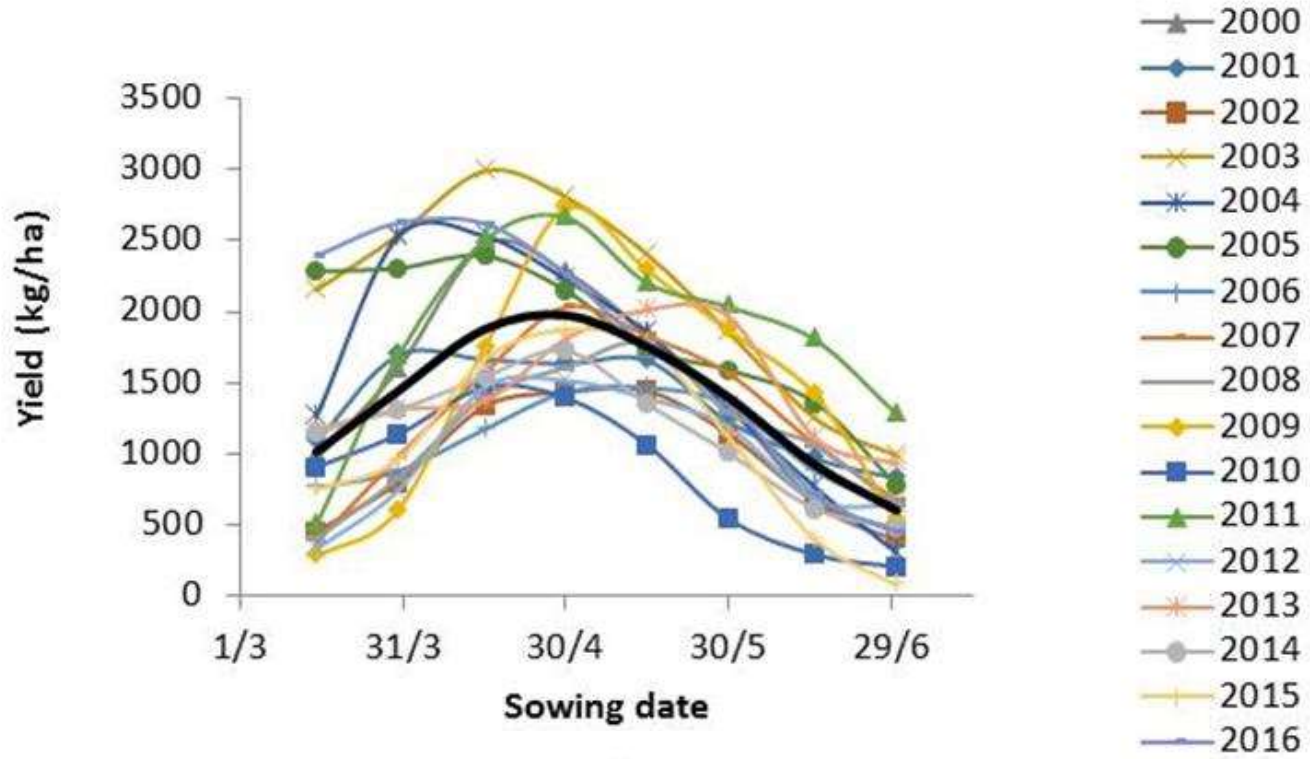
Matching cultivar choice and environment

(Geraldton)



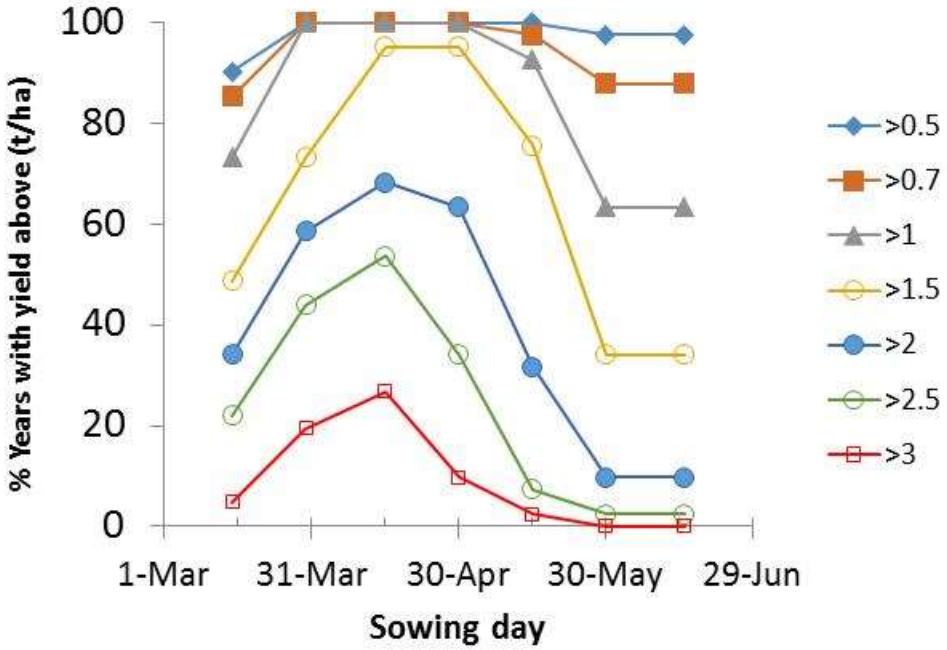
Year to year variability

Wongan Hills; sandy soil; mid maturity cultivar

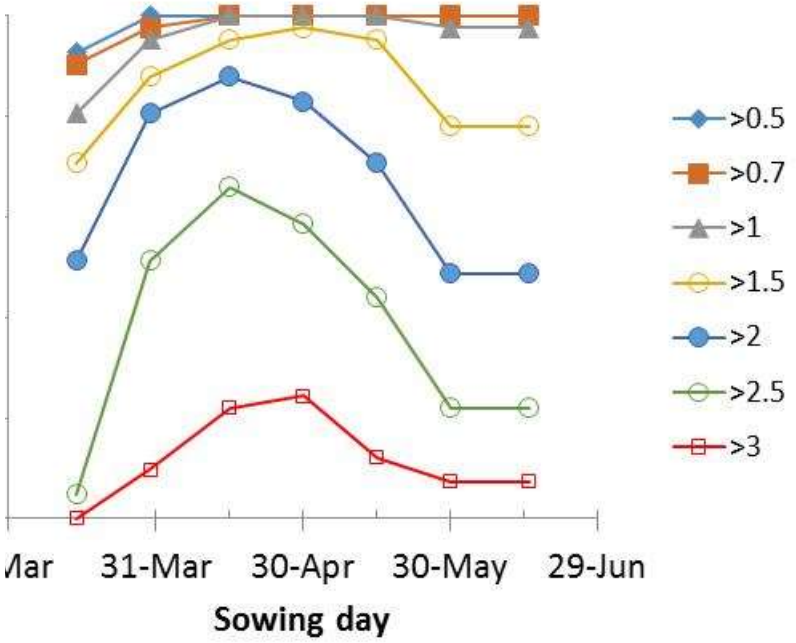


RISK: Probability of achieving certain yield by TOS

Wongan Hills; cv Bonito



Gibson; cv Bonito



Conclusions

Optimum sowing windows for maximum grain yield

- As a rule of thumb:
    - April sowing for low and medium rainfall
    - April until mid May for high rainfall
- For average climate
- Trade-off: Frost, Heat, Water Stress
- If late sowing opportunity, assess risk of achieving certain yield

Acknowledgments

DIPRD's Tactical Break Crop Agronomy team

Project leader: Mark Seymour/ Jackie Bucat

Thank you

Grains Research and Development Corporation (GRDC)

A Level 4, East Building, 4 National Circuit, Barton, ACT 2600 Australia

P PO Box 5367 Kingston, ACT 2604 Australia

T +61 2 6166 4500

F +61 2 6166 4599

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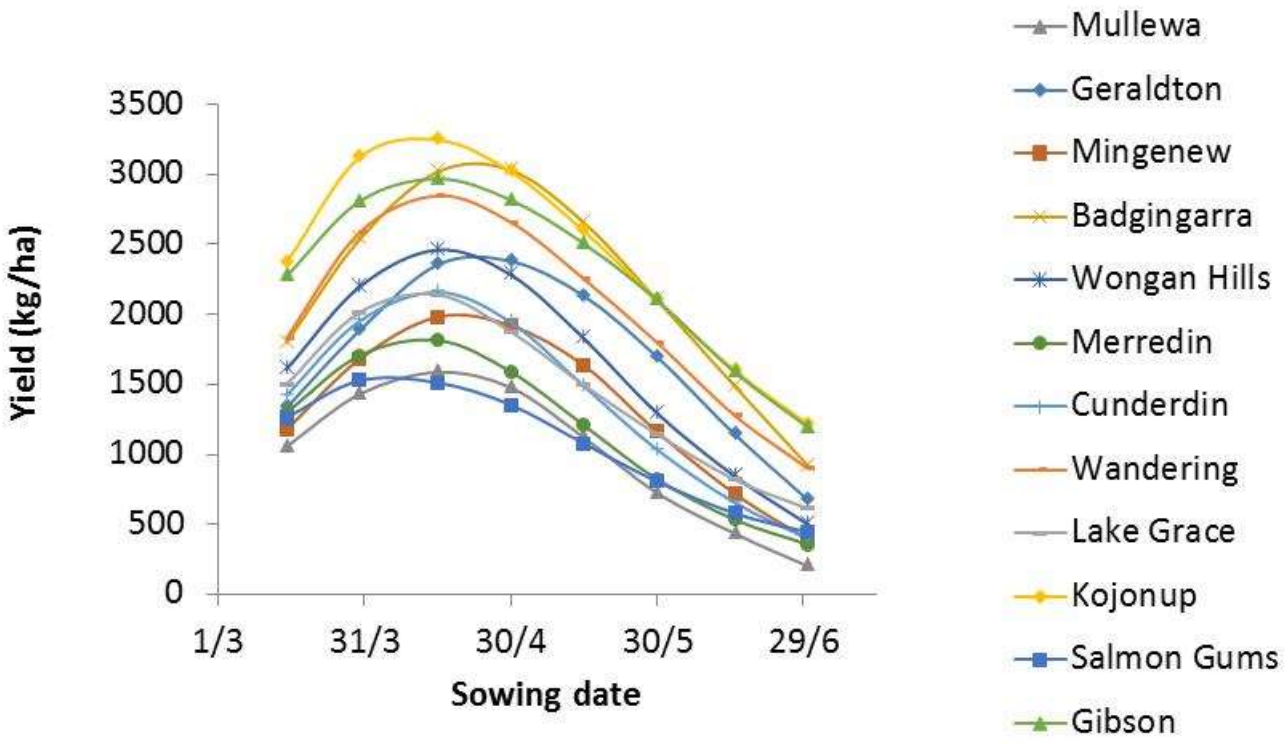
Yield response to sowing date



Cv Bonito

Optimum Sowing Window

Location	Long cultivar	Medium cultivar	Short cultivar	Long	Medium	Short
Mullewa	22 Mar – 17 Apr	5 Apr – 1 May	2 Apr – 7 May	26	26	35
Geraldton	30 Mar – 4 May	12 Apr – 15 May	19 Apr – 21 May	35	33	32
Mingenew	29 Mar – 24 Apr	9 Apr – 9 May	14 Apr – 14 May	26	30	30
Badgingarra	30 Mar – 4 May	11 Apr – 14 May	14 Apr – 21 May	35	33	37
Wongan Hills	25 Mar – 24 Apr	6 Apr - 4 May	13 Apr – 7 May	30	28	24
Merredin	21 Mar – 12 Apr	1 Apr – 25 Apr	7 Apr – 4 May	22	24	27
Cunderdin	23 Mar – 19 Apr	4 Apr – 29 Apr	9 Apr – 7 May	27	25	28
Wandering	29 Mar – 3 May	5 Apr – 11 May	15 Apr – 11 May	35	36	26
Lake Grace	22 Mar – 17 Apr	2 Apr – 25 Apr	7 Apr – 1 May	26	23	24
Kojonup	23 Mar – 5 May	30 Mar – 7 May	2 Apr – 17 May	43	38	45
Salmon Gums	15 Mar – 14 Apr	25 Mar – 24 Apr	4 Apr – 29 Apr	30	30	25
Gibson	20 Mar – 1 May	30 Mar – 9 May	5 Apr – 17 May	42	40	42

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