Characterising the interactive effects of photoperiod and vernalising temperature on the flowering time responses of annual pasture legumes

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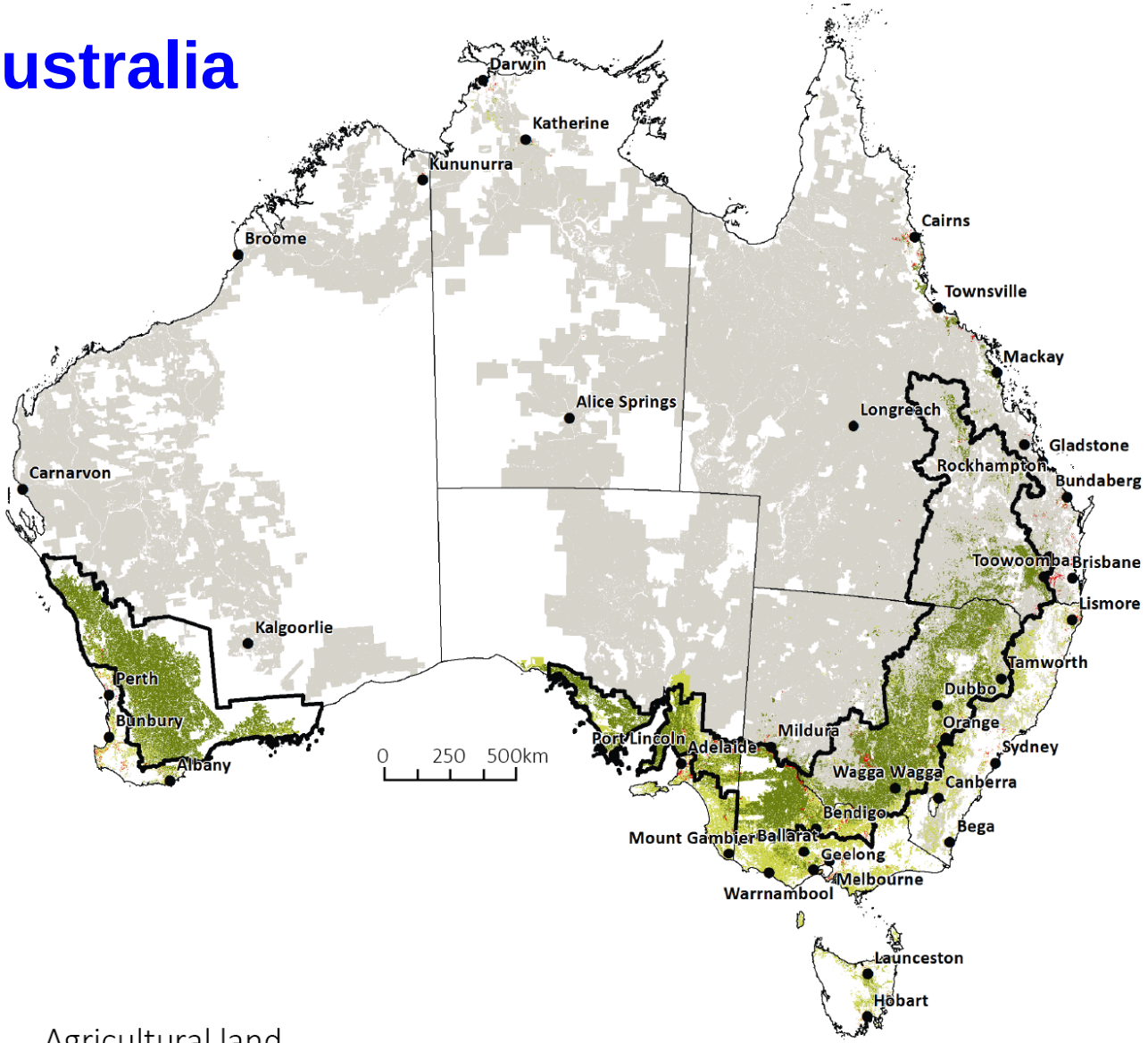
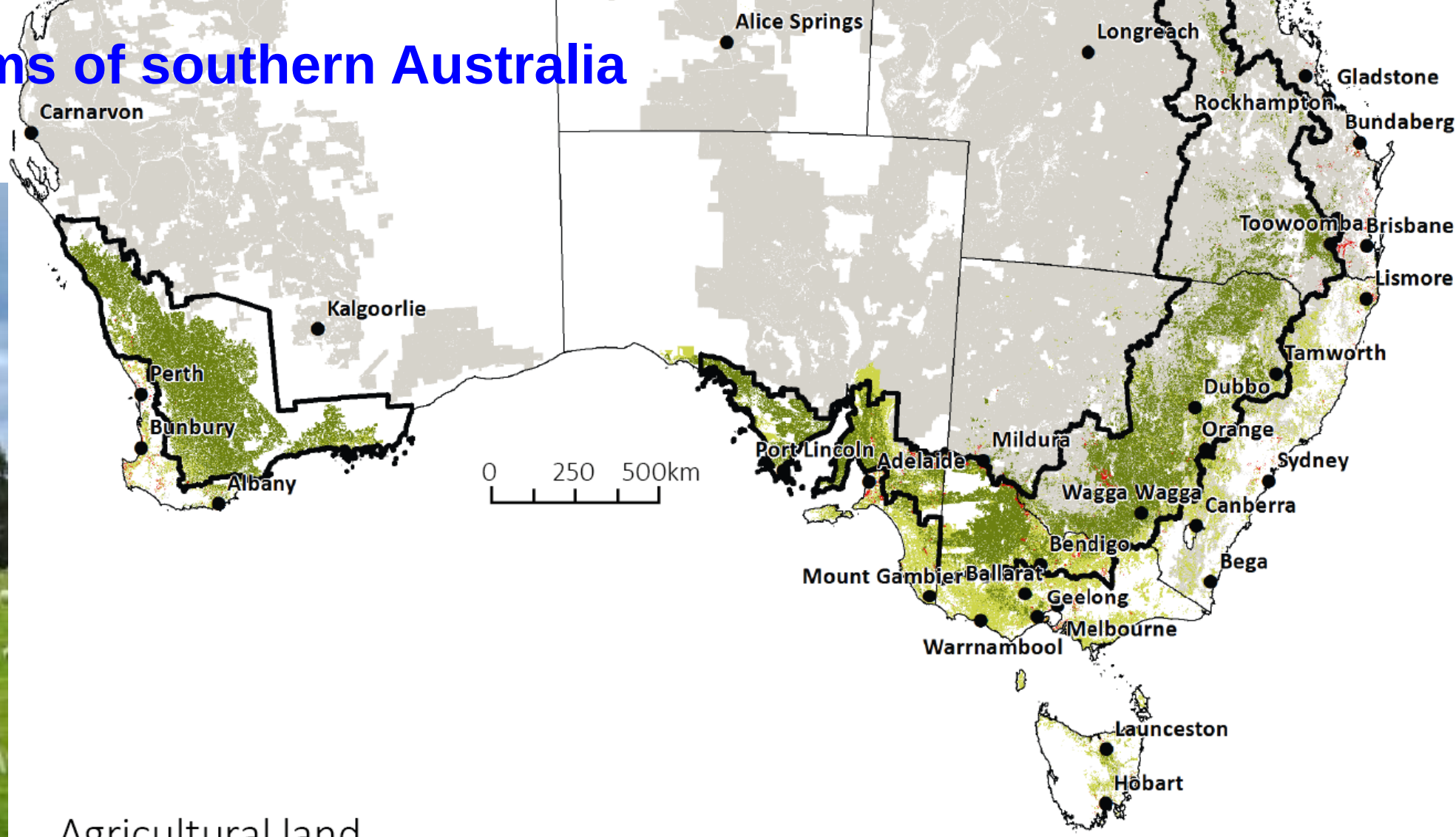
Pasture systems of southern Australia



Source: ABARES, 2023

Pasture systems of southern Australia

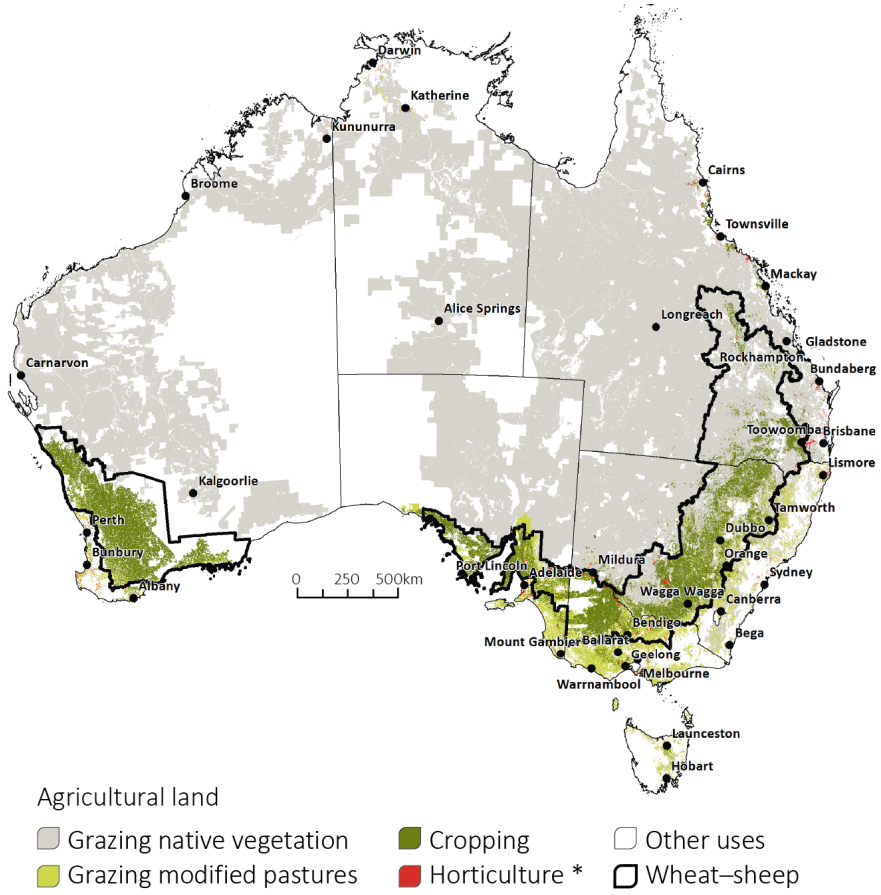


Pasture systems of southern Australia

- The pastures are a mixture of grasses with an annual legume
- Legume provides a cost-effective source of N
- Subterranean clover (*Trifolium subterraneum* L.) is the main legume

→ *highly productive and adapted to a wide range of environments*

Subterranean clover-based pastures grown across 30M ha



Serradellas: alternative pasture legumes for these systems

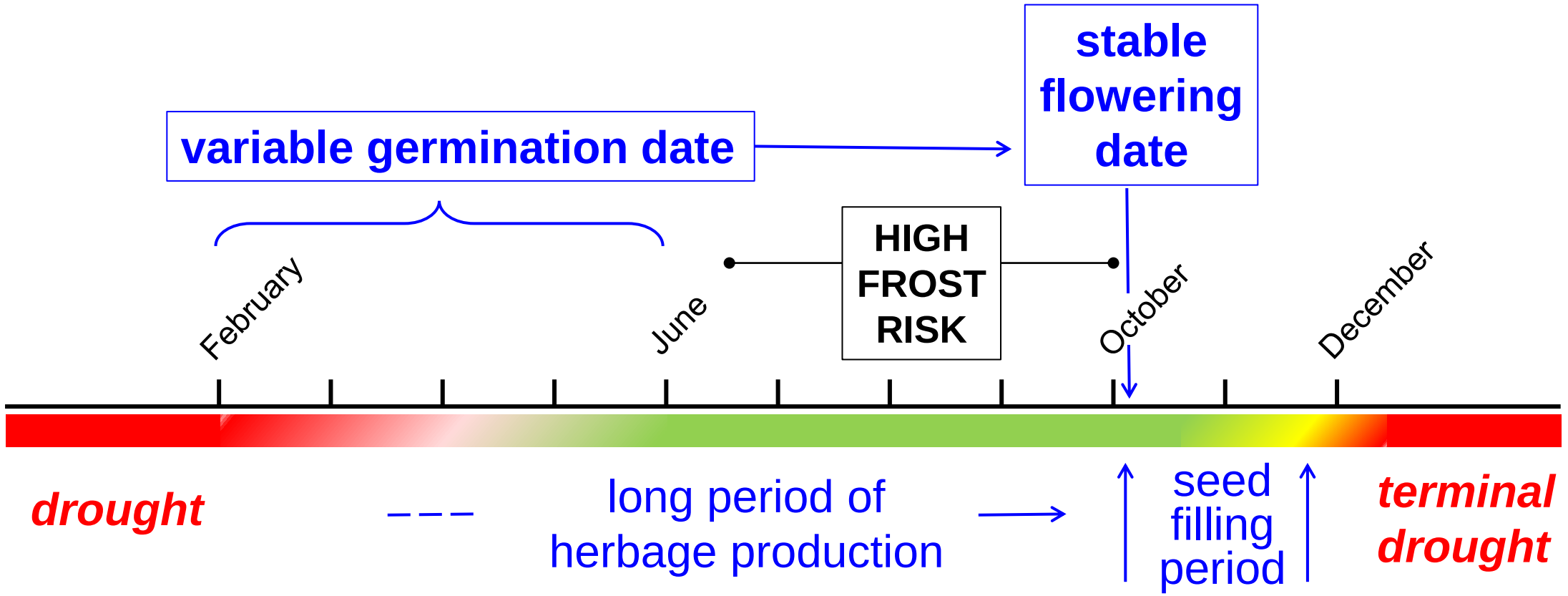
Advantages of serradella:

- lower phosphorus inputs
- low bloat risk
- few disease/insect issues
- comparable productivity value
- deeper roots → drought resilience
- good acid soil tolerance

Yellow serradella
(*Ornithopus compressus*)

French serradella
(*Ornithopus sativus*)

Annual legume production & persistence



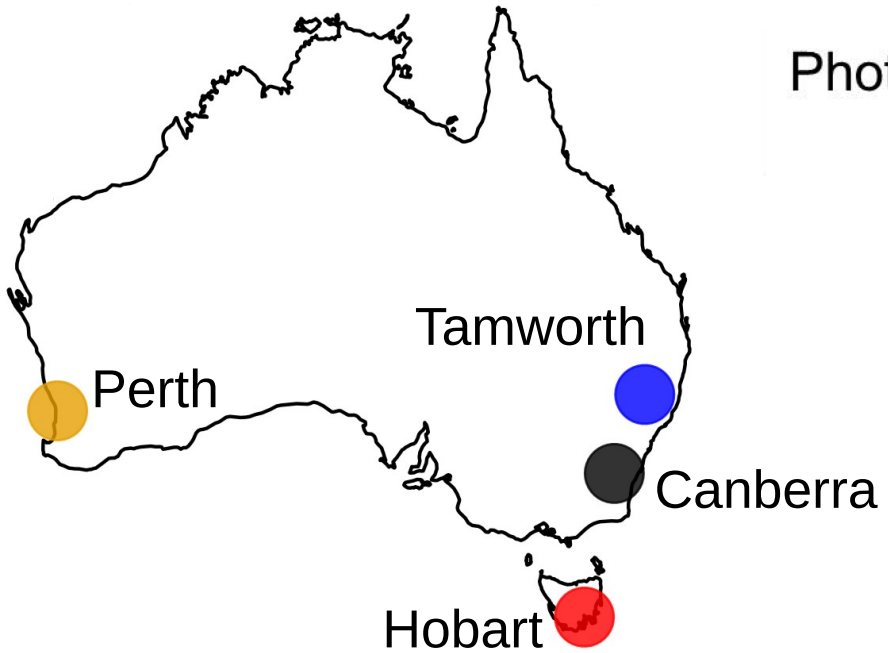
Adapted legumes flower a similar date each year regardless of germination date

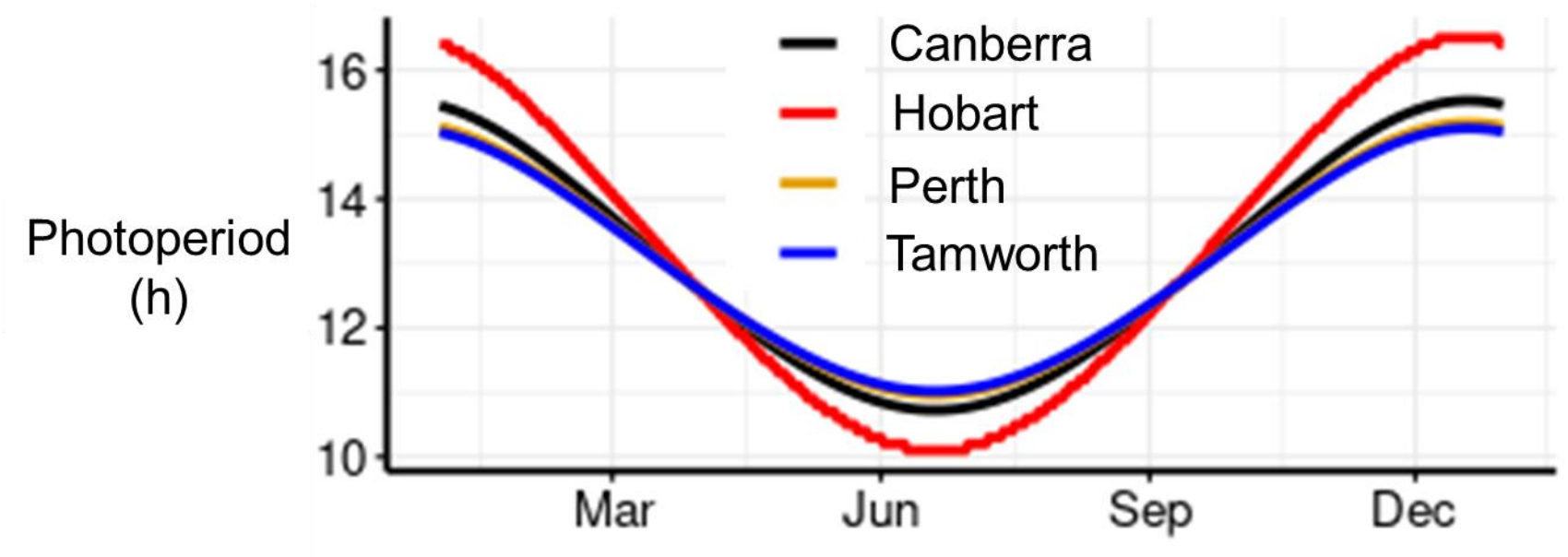
Stable flowering dates: **subterranean clover** ☑

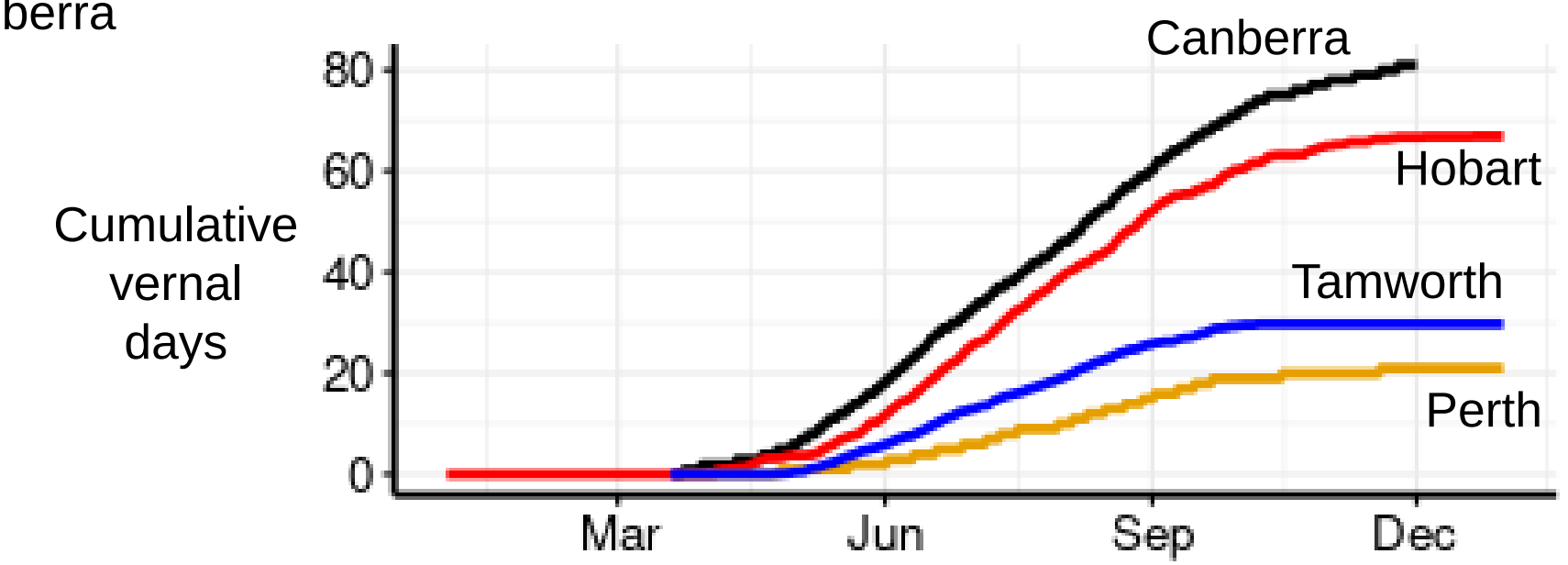
(Boschma *et al.* 2019)

serradellas ☒

Photoperiod and vernalisation conditions in southern Australia







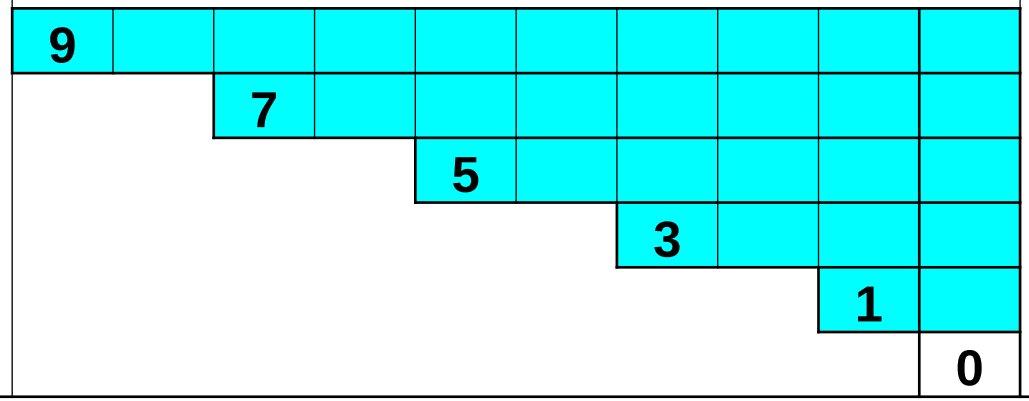
Experimental design

3 species –

2 cultivars of each

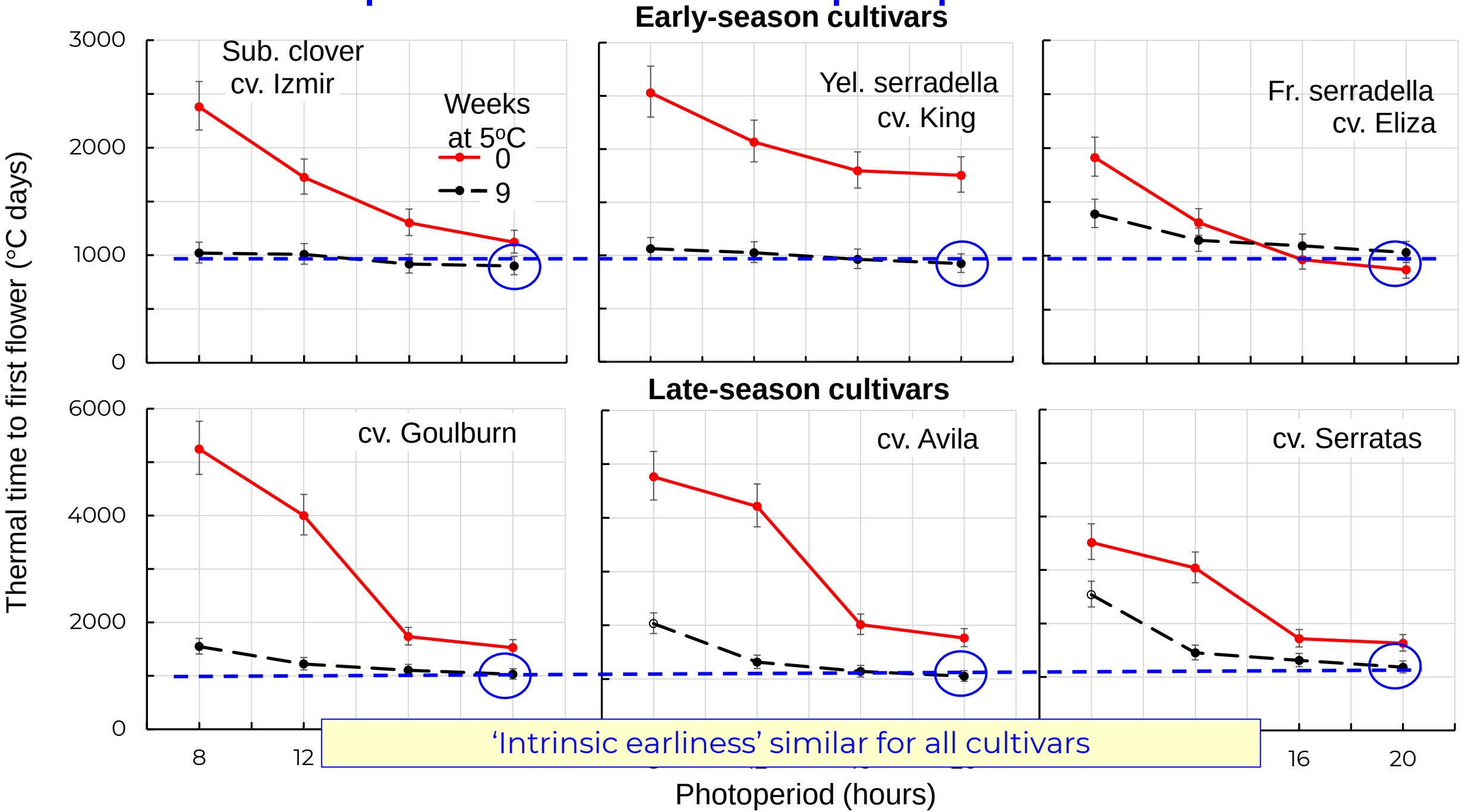
- Subterranean clover (cv. Izmir, cv. Goulburn)
- Yellow serradella (cv. King, cv. Avila)
- French serradella (cv. Eliza, cv. Serratas)

- 6 vernalisation treatments (0, 1, 3, 5, 7 & 9 weeks at 5^{o}C)
- 4 photoperiod treatments (8, 12, 16 & 20 h daylengths)
- 6 reps

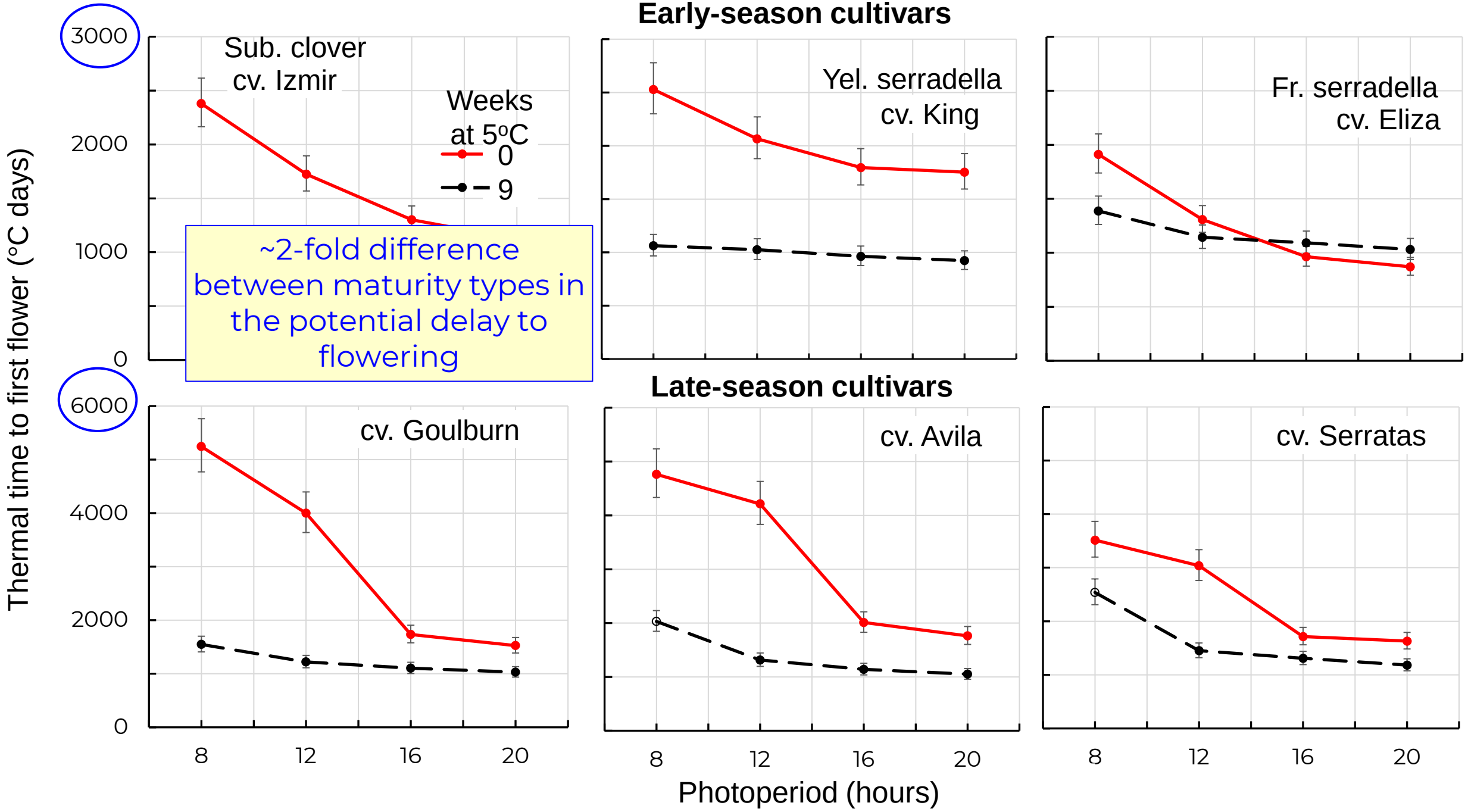
Establishment	**Vernalisation treatment** (weeks at 5^{o}C)	**Photoperiod treatment**
All plants at 17/21^{o}C for 14 days		Plants enter 1 of 4 trts (8, 12, 16 or 20 h) at 17/21^{o}C on the same day

Goward *et al.* 2023 *Crop & Pasture Science*

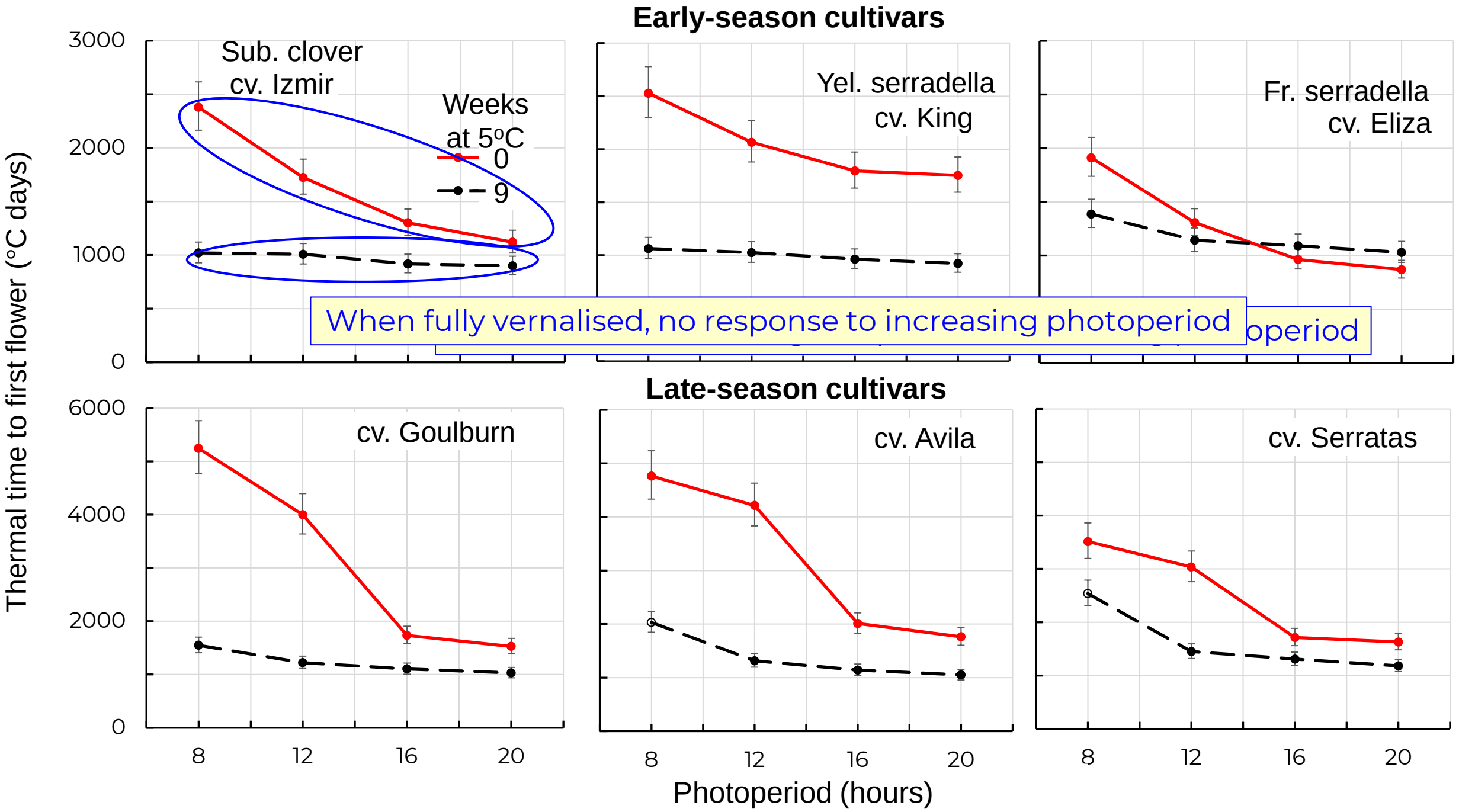
Results – cultivar responses to vernalisation x photoperiod treatments



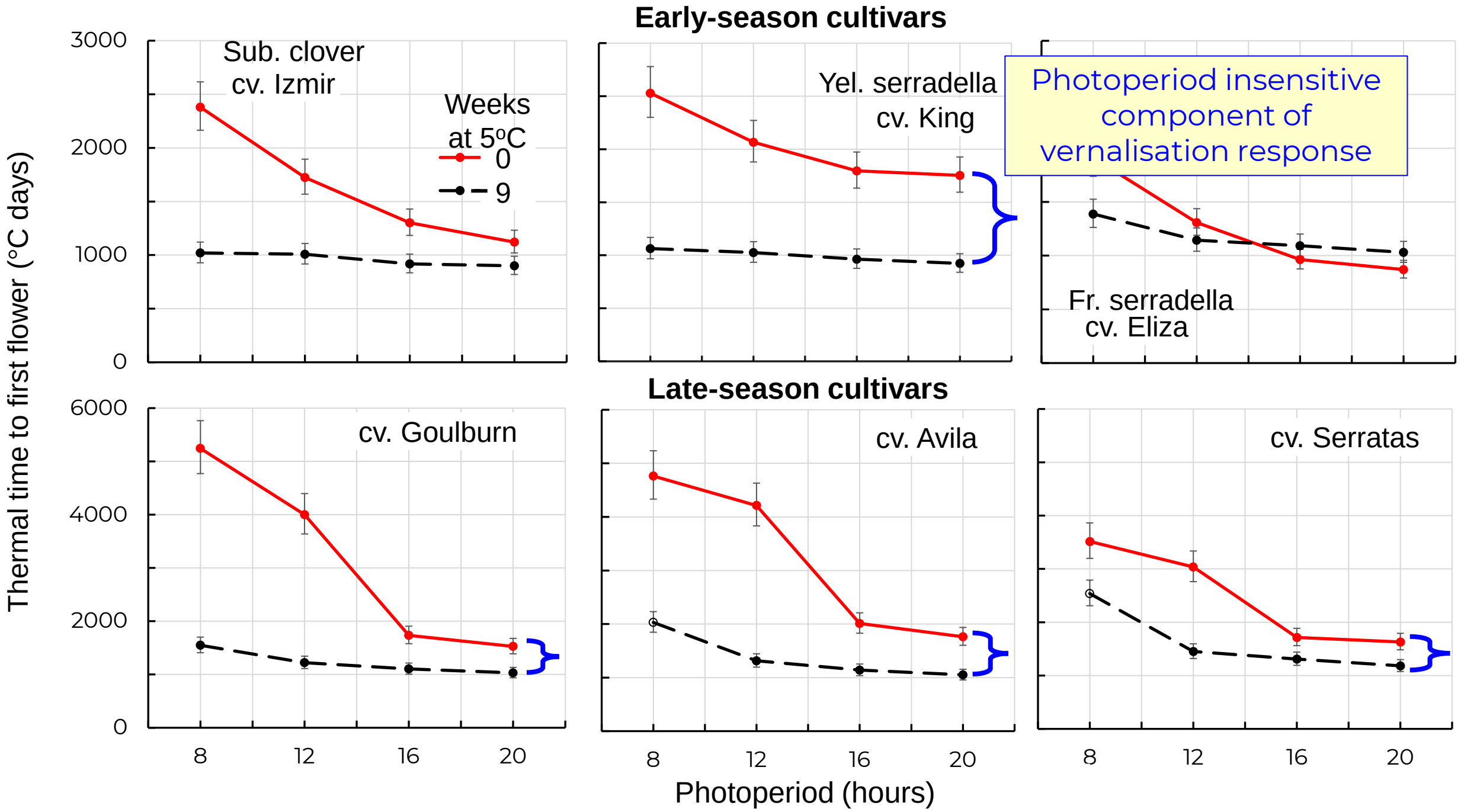
Results


Early-season cultivars
Late-season cultivars
Sub. clover
cv. Izmir
Weeks
at 5ºC
0
9
Yel. serradella
cv. King
Fr. serradella
cv. Eliza
cv. Goulburn
cv. Avila
cv. Serratas
~2-fold difference between maturity types in the potential delay to flowering
Thermal time to first flower (°C days)
Photoperiod (hours)
0
1000
2000
3000
4000
6000
8
12
16
20

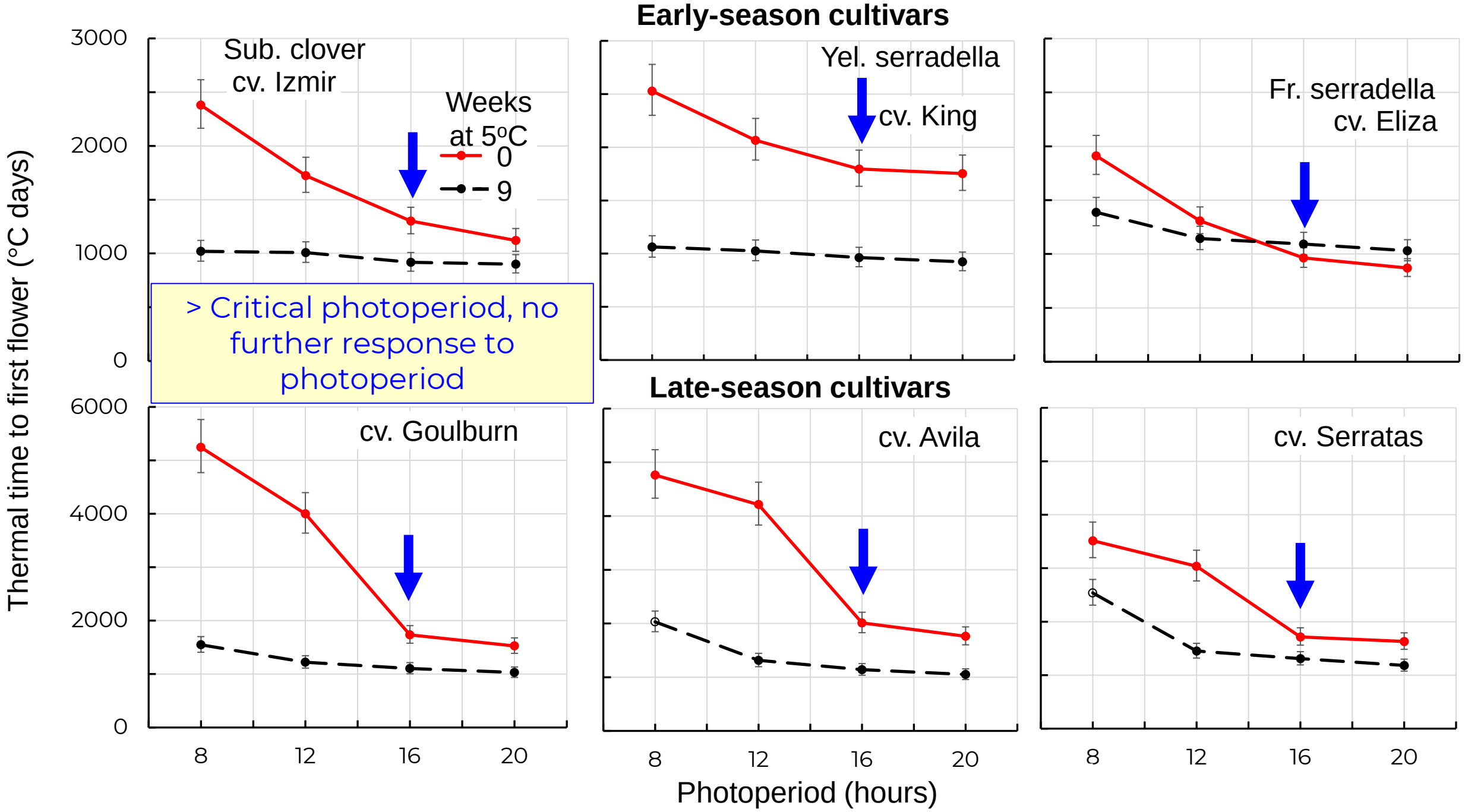
Results


Early-season cultivars
Late-season cultivars
Sub. clover
cv. Izmir
Weeks
at 5ºC
0
9
Yel. serradella
cv. King
Fr. serradella
cv. Eliza
When fully vernalised, no response to increasing photoperiod
cv. Goulburn
cv. Avila
cv. Serratas
Thermal time to first flower (°C days)
Photoperiod (hours)
0
1000
2000
3000
4000
6000
8
12
16
20

Results

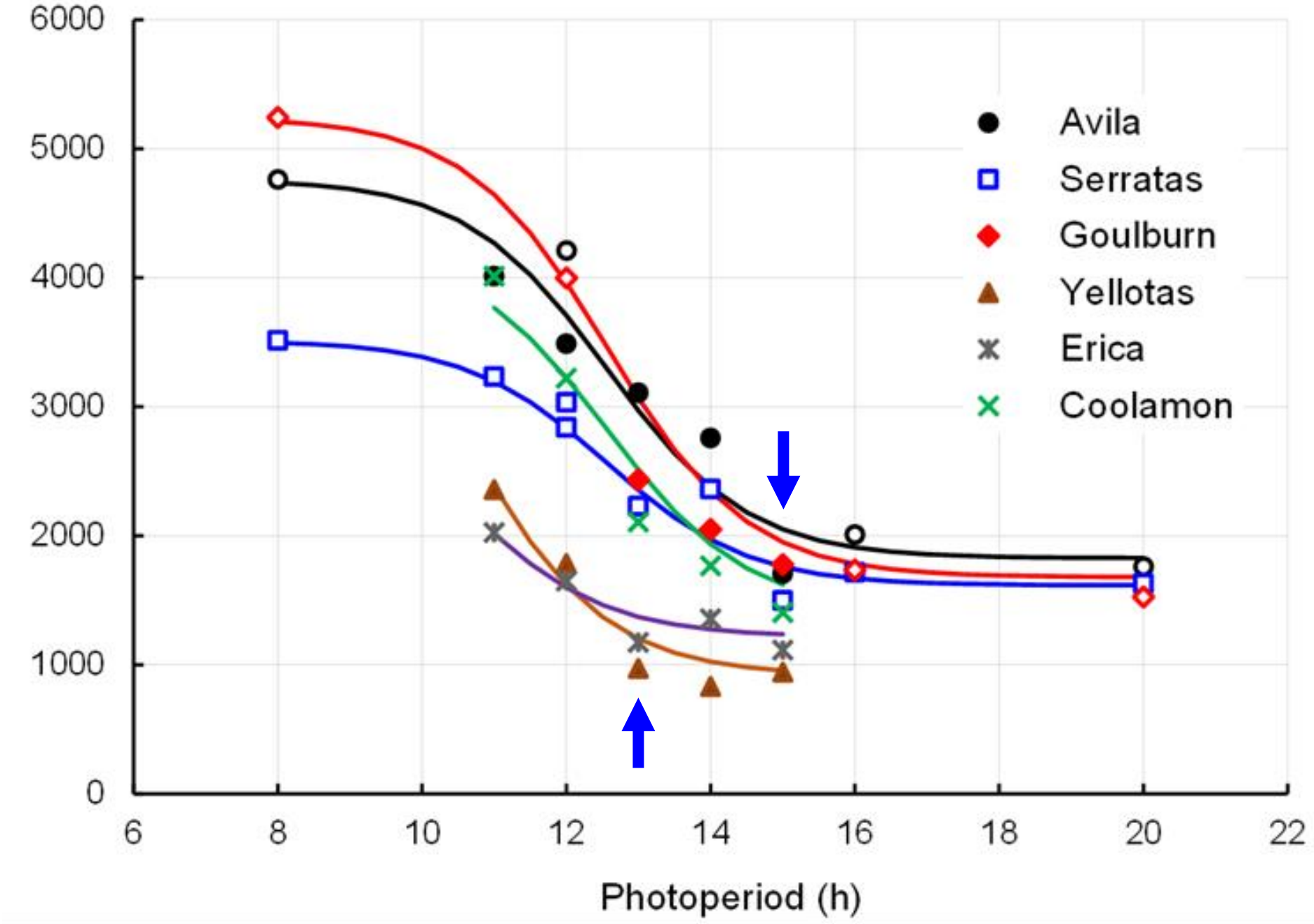

Early-season cultivars
Late-season cultivars
Sub. clover
cv. Izmir
Weeks
at 5ºC
0
9
Yel. serradella
cv. King
Fr. serradella
cv. Eliza
cv. Goulburn
cv. Avila
cv. Serratas
Photoperiod insensitive component of vernalisation response
Thermal time to first flower (°C days)
Photoperiod (hours)
3000
2000
1000
0
6000
4000
2000
0
8
12
16
20

Results


Early-season cultivars
Late-season cultivars
Sub. clover
cv. Izmir
Weeks at 5ºC
0
9
Yel. serradella
cv. King
Fr. serradella
cv. Eliza
cv. Goulburn
cv. Avila
cv. Serratas
> Critical photoperiod, no further response to photoperiod
Thermal time to first flower (°C days)
Photoperiod (hours)
0
1000
2000
3000
4000
6000
8
12
16
20

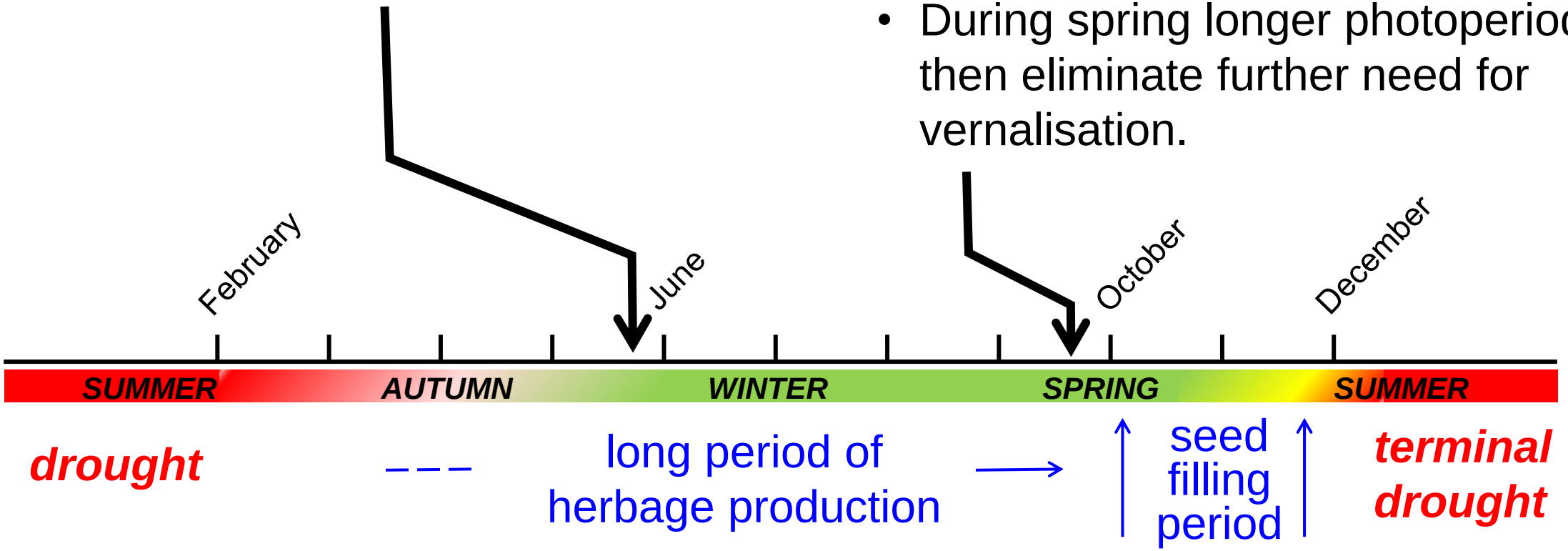
Critical photoperiod varies for some cultivars

Thermal time to first flower appearance (°C days)



Conclusions

- ‘Intrinsic earliness’ is similar for all cultivars → flowering date is primarily determined by response to photoperiod and vernalisation.
  - Autumn-winter germination: premature flowering prevented by need for vernalisation.
  - During spring longer photoperiods then eliminate further need for vernalisation.

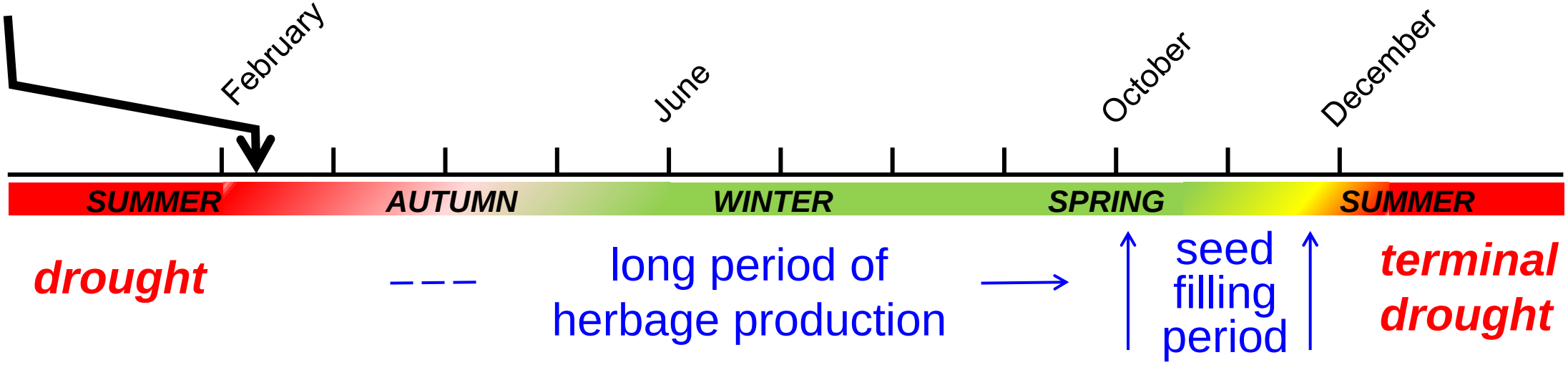


Conclusions

- ‘Intrinsic earliness’ is similar for all cultivars → flowering date is primarily determined by response to photoperiod and vernalisation.

- Autumn-winter germination: premature flowering prevented by vernalisation.
- During spring longer photoperiods then eliminate further need for vernalisation.

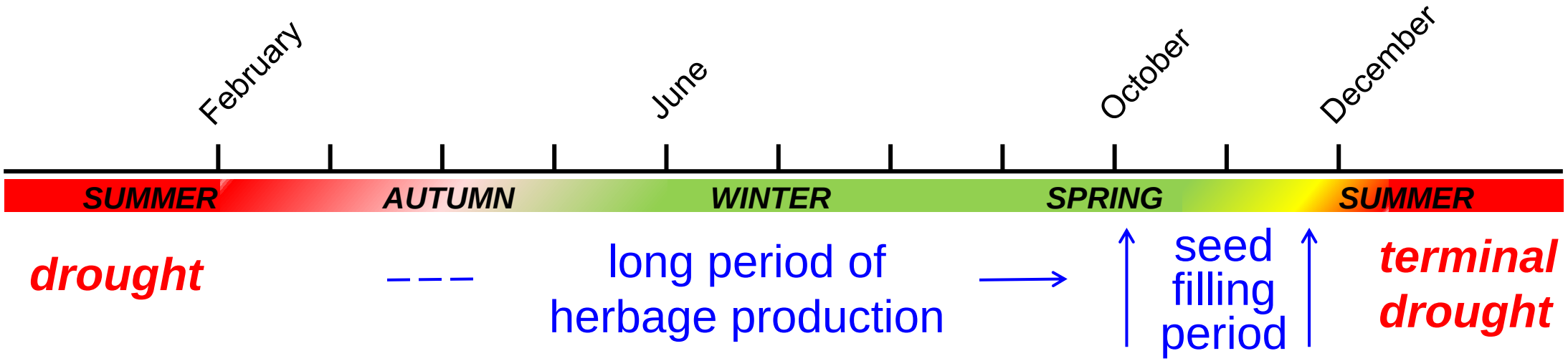
- Very early germination: premature flowering is prevented by a cultivar’s photoperiod-insensitive component of vernalisation response.



Conclusions

Stable flowering dates are achieved by:

- Vernalisation responses that prevent flowering before winter ends.
- Longer photoperiods (in spring) then eliminate further need for vernalisation.
- A photoperiod-insensitive vernalisation component protects against premature flowering when germination is ***very*** early.



Acknowledgments