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| Supplementary Table 1. Parameters of chickpea cultivar PBA BoundaryPBR symbol in APSIMw  |
| Model parameters | **Range minimum** | **Range maximum** | **Units** | **Description** |
| x\_pp\_hi\_incr | 1 | 24 | hours | Photoperiod |
| y\_hi\_incr | 0.014 | 0.014 | 1/days | Rate of HI increase |
| x\_hi\_max\_pot\_stress | 0 | 1 | NA | Average stress at flowering |
| y\_hi\_max\_pot | 0.5 | 0.5 | NA | Maximum harvest index potential |
| cum\_vernal\_days | 0 | 100 | days | Cumulative days since sowing |
| tt\_emerg\_to\_endjuv | 540 | 540 | °Cd | TT from emergence to end of juvenile phase |
| est\_days\_emerg\_to\_init | 83 | days | Estimated days from emergence to floral initiation |
| x\_pp\_endjuv\_to\_init | 11.11a | 12.6b | hours | Photoperiod |
| y\_tt\_endjuv\_to\_init | 456c | 0 | °Cd | TT from end juvenile to floral initiation |
| x\_pp\_init\_to\_flower | 1 | 24 | hours | Photoperiod |
| y\_tt\_init\_to\_flower | 33 | 33 | °Cd | TT from initiation to flowering |
| tt\_flower\_to\_podset | 200 | °Cd | TT from flowering to initiation of pod-set |
| tt\_podset\_to\_start\_grain | 450 | °Cd | TT from start grain fill to end grain fill |
| tt\_start\_to\_end\_grain | 690 | °Cd | TT from end grain fill to maturity |
| tt\_maturity\_to\_ripe | 60 | °Cd | TT from maturity to harvest ripe |
| x\_stem\_wt | 10 | g/plant | Stem weight |
| y\_height | 800 | mm | Plant height |

Abbreviations used in Table 1: NA = not applicable, tt or TT = thermal time, pp = photoperiod, wt = weight, init = initiation, endjuv = end of juvenile phase, emerg = emergence, cum = cumulative sum, hi = harvest index. The values for tt-emergence. Changed from a10.7h, b17h and c446 °Cd for APSIMc.

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| Supplementary Table 2. The cultivar parameters of PBA Boundary PBR symbolfor the APSIMxa |
| Model parameters | Minimum | Maximum | Unit | Description |
| Emergence | 100 | °Cd | Cumulative degree days since sowing |
| Vegetative | 400 | °Cd | TT from emergence to end of juvenile phase |
| Floral initiation | 250 | °Cd | TT from vegetative to floral initiation |
|  x-photoperiod | 10 | 12.4 | 17 | hours | Photoperiod |
| y-Budding | 502 | 50 | 50 | °Cd |  TT for budding |
| Flowering | 100 |  |  |
| x-value | 0 | 14 | 15  | 16 | °C | Mean ambient temperature  |
| y-Pod initiation | 0 | 0 | 1(10) | 1(5) |  (days) |  0 = no pod set, 1 = pod set (days) |
| Grain filling | 300 | °Cd | Early grain filling |
| Grain filling | 250 | °Cd | Mid grain filling |
| Grain filling | 250 | °Cd | Late grain filling |
| Maturity | 60 | °Cd | Maturing |
| Harvesting | 60 | °Cd | Ripening |

aSee https://builds.apsim.info/api/nextgen/docs/Chickpea.pdf for more details

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| **Supplementary Table 3.** Mean Maximum (MaxT) and minimum (MinT) ambient temperatures, in-crop rainfall, across 54 sowings in 10 locations. Ranges are given for locations with more than one sowing. |
| Location (sowings) | MaxT (°C) | MinT (°C) | Rainfall (mm) |
| Breeza (1) | 20.6 | 3.9 | 71 |
| Horsham (1) | 17.1 | 3.9 | 218 |
| Kingaroy (1) | 21.0 | 5.7 | 100 |
| Leeton (9) | 15.9 - 20.2 | 3.9 - 9.2 | 83 - 161 |
| Narrabri (3) | 19.7 - 22.7 | 4.5 – 5.8 | 28 -137 |
| Roseworthy (8) | 16.7 - 18.0 | 5.1 - 7.2 | 91 - 171 |
| Tamworth (5) | 18.9 - 20.3 | 3.3 - 5.5 | 149 -232 |
| Trangie (8) | 18.3 - 22.4 | 5.0 - 9.4 | 27 - 134 |
| Wagga Wagga (14) | 15.8 - 20.2 | 1.3 - 5.6 | 171 - 300 |
| Yanco (4) | 16.6 - 20.2 | 5.6 - 7.8 | 70 - 87 |
| Average | 18.1 - 20.3 | 4.2 - 6.4 | 101 - 161 |

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| **Supplementary Table 4.** Comparison of observed and predicted values of mean days to flowering, pod set, post-flowering frost and post-flowering heat events in early (n=28), mid (n = 20), and late (n = 6) sowings. |
|  |  | **Model** |
| **Sowing time** | **Observed** | APSIMw | APSIMc | APSIMx |
|  | Flowering (days after sowing) |
| Early (< 16 May) | 123 ± 16.8 | 125 ± 16.6 | 97 ± 11.6 | 105 ± 15.6 |
| Mid (16 May – 15 June) | 108 ± 9.0 | 107 ± 7.7 | 97 ± 5.2 | 103 ± 5.5 |
| Late (> 16 June) | 78 ± 14.6 | 74± 14.1 | 78 ± 8.7 | 74 ± 12.0 |
|  | Pod-set (days after sowing) |
| Early (< 16 May) | 142 ± 16.7 | 141 ± 16.3 | 117 ± 14.0 | 137 ± 19.4 |
| Mid (16 May – 15 June) | 121 ± 12.2 | 122 ± 9.0 | 115 ± 6.7 | 117 ± 6.1 |
| Late (>16June) | 88 ± 14.6 | 87 ± 14.7 | 91 ± 11.5 | 80 ± 12.8 |
|  | Post-flowering frost (#) |
| Early (< 16 May) | 3 ± 2.8 | 3 ± 2.7 | 7 ± 6.6 | 4 ± 4.9 |
| Mid (16 May – 15 June) | 1 ± 1.0 | 1 ± 1.0 | 3 ± 1.0 | 3 ± 1.0 |
| Late (> 16 June) | 1 ± 1.3 | 1 ± 1.3 | 1 ± 3.5 | 1 ± 3.0 |
|  | Post-flowering heat stress (#) |
| Early (< 16 May) | 7 ± 4.8 | 7 ± 4.9 | 7 ± 5.0 | 5 ± 3.7 |
| Mid (16 May – 15 June) | 8 ± 3.1 | 8 ± 2.9 | 9 ± 2.9 | 6 ± 3.5 |
| Late (> 16 June) | 17 ± 5.0 | 17 ± 4.9 | 21 ± 5.5 | 10 ± 3.9 |

± Standard deviation reflecting the range of variation within the sowing range