**Table S1:** Phenology of 12 diverse wheat genotypes grown under ambient and elevated CO2 for each year.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | Days to heading |  | Days to maturity |  | Days to flag leaf senescence |
|  | 2014 |  | 2015 |  | 2014 |  | 2015 |  | 2014 |  | 2015 |
| Genotype | Ambient | Elevated |  | Ambient | Elevated |  | Ambient | Elevated |   | Ambient | Elevated |  | Ambient | Elevated |   | Ambient | Elevated |
| C342-74 | 125 ± 2.4 | 125 ± 3.1 |  | 129 ± 1.2 | 128 ± 0.5 |  | 164 ± 2.9 | 168 ± 1 |  | 167 ± 3.1 | 166 ± 2.6 |  | 157 ± 5.3 | 160 ± 2.2 |  | 164 ± 8.2 | 156 ± 7.5 |
| Cudesnaja | 149 ± 3 | 141 ± 12.4 |  | 154 ± 1.3 | 153 ± 1.2 |  | 178 ± 6.1 | 185 ± 4.4 |  | 188 ± 0.8 | 185 ± 3.0 |  | 165 ± 3 | 164 ± 16 | 176 ± 0.8 | 175 ± 1.9 |
| EGA Gregory | 128 ± 1.4 | 127 ± 2.9 |  | 134 ± 1.3 | 132 ± 1.0 |  | 167 ± 2.4 | 169 ± 4.1 |  | 172 ± 1.9 | 171 ± 1.0 |  | 160 ± 3.5 | 162 ± 4 | 166 ± 3.6 | 164 ± 2.5 |
| Excalibur | 123 ± 0.8 | 123 ± 0.5 |  | 130 ± 0.5 | 128 ± 2.9 |  | 161 ± 1.9 | 164 ± 4.8 |  | 165 ± 1.9 | 165 ± 1.9 |  | 155 ± 4.1 | 158 ± 7.1 | 158 ± 7.6 | 157 ± 5.8 |
| Federation | 132 ± 1.3 | 131 ± 1.5 |  | 138 ± 0.5 | 138 ± 0.0 |  | 168 ± 1.9 | 170 ± 2.2 |  | 173 ± 0.8 | 171 ± 0.5 |  | 161 ± 3.5 | 162 ± 5.3 | 170 ± 1.4 | 166 ± 3.7 |
| Fusion | 119 ± 0.5 | 118 ± 1.3 |  | 123 ± 0.5 | 123 ± 0.0 |  | 165 ± 1.5 | 166 ± 1.2 |  | 164 ± 2.3 | 164 ± 2.7 |  | 156 ± 5.7 | 155 ± 4.9 | 159 ± 2.9 | 153 ± 7.2 |
| IWA860 | 145 ± 2.5 | 142 ± 2.7 |  | 146 ± 1.0 | 146 ± 0.6 |  | 171 ± 1.7 | 172 ± 3.3 |  | 180 ± 0.5 | 179 ± 1.0 |  | 163 ± 1.9 | 164 ± 4.1 | 175 ± 1.0 | 173 ± 1.7 |
| WB4-1-12 | 122 ± 0.6 | 120 ± 1.5 |  | 130 ± 2.4 | 127 ± 2.5 |  | 161 ± 1.5 | 161 ± 2.9 |  | 164 ± 1.4 | 164 ± 1.6 |  | 156 ± 4.6 | 154 ± 6.4 | 163 ± 4.5 | 161 ± 1.2 |
| WB4-1-16 | 121 ± 1.0 | 121 ± 1.3 |  | 131 ± 1.0 | 129 ± 2.0 |  | 161 ± 1.0 | 165 ± 4.3 |  | 167 ± 2.2 | 166 ± 2.5 |  | 157 ± 2.2 | 160 ± 9.6 | 163 ± 2.0 | 160 ± 2.9 |
| Westonia | 118 ± 0.8 | 118 ± 1.0 |  | 126 ± 1.5 | 125 ± 2.4 |  | 161 ± 1.7 | 162 ± 3.8 |  | 164 ± 2.1 | 162 ± 1.7 |  | 155 ± 3.1 | 154 ± 6.6 | 161 ± 2.2 | 154 ± 4.6 |
| Y334-05 | 151 ± 1.0 | 151 ± 0 |  | 140 ± 0.5 | 140 ± 1.3 |  | 161 ± 2.4 | 161 ± 4.5 |  | 162 ± 2.9 | 160 ± 4.9 |  | 153 ± 6.8 | 157 ± 14.2 | 158 ± 6.2 | 154 ± 6.1 |
| Yipti | 124 ± 1.3 | 124 ± 1.0 |  | 132 ± 0.5 | 131 ± 0.5 |  | 168 ± 5.1 | 170 ± 2.5 |  | 170 ± 0.8 | 168 ± 1.7 |  | 162 ± 6.1 | 162 ± 3.8 | 165 ± 2.2 | 163 ± 2.7 |
| Mean | 129.8 | 128.4 |  | 134.4 | 133.3 |  | 165.5 | 167.8 |  | 169.7 | 168.4 |  | 158.3 | 159.3 | 164.8 | 161.3 |
| CO2 main effect | NS (p=0.07) |  | \* |  | \*\* |  | NS (p=0.06) |  | NS |  | \* |
| Genotype main effect | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |
| CO2 × genotype interaction | NS |  | NS |  | NS |  | NS |  | NS |  | NS |

Data is mean ± s.d.

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; NS not significant

**Table S2a:** Biomass related traits of 12 diverse wheat genotypes grown under ambient and elevated CO2 for each year.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | Plant height (cm) |  | Tiller weight (g m-2) |  | Spike weight (g m-2) |
|  | 2014 |  | 2015 |  | 2014 |  | 2015 |  | 2014 |  | 2015 |
| Genotype | Ambient | Elevated |  | Ambient | Elevated |  | Ambient | Elevated |   | Ambient | Elevated |  | Ambient | Elevated |   | Ambient | Elevated |
| C342-74 | 56.7 ± 5.8 | 60.3 ± 2.7 |  | 56.7 ± 3.1 | 61.8 ± 3.7 |  | 173 ± 26 | 275 ± 102 |  | 369 ± 69 | 422 ± 47 |  | 293 ± 30 | 434 ± 158 |  | 557 ± 15 | 561 ± 40 |
| Cudesnaja | 69.6 ± 5.3 | 82.8 ± 15.3  |  | 80.5 ± 8.6 | 97.9 ± 12.4 |  | 217 ± 625 | 448 ± 72 |  | 324 ± 44 | 338 ± 71 |  | 86 ± 45 | 186 ± 100 |  | 86 ± 32 | 85 ± 31 |
| EGA Gregory | 68.9 ± 6.1 | 78.2 ± 6.9 |  | 71.2 ± 2.2 | 76.0 ± 4.7 |  | 274 ± 213 | 388 ± 132 |  | 461 ± 159 | 454 ± 56 |  | 293 ± 172 | 461 ± 126 |  | 524 ± 183 | 507 ± 99 |
| Excalibur | 64.7 ± 4.8 | 67.9 ± 3.6 |  | 66.8 ± 4.0 | 71.9 ± 1.5 |  | 250 ± 57  | 375 ± 67 |  | 454 ± 49 | 457 ± 124 |  | 313 ± 81 | 491 ± 98 |  | 555 ± 127 | 577 ± 151 |
| Federation | 69.6 ± 6.3 | 81.6 ± 1.3 |  | 74.2 ± 3.0 | 82.1 ± 8.3 |  | 264 ± 42 | 407 ± 154 |  | 475 ± 759 | 522 ± 99 |  | 225 ± 24 | 337 ± 82 |  | 350 ± 40 | 395 ± 76 |
| Fusion | 78.1 ± 5.7 | 91.2 ± 9.8 |  | 83.8 ± 4.7 | 89.5 ± 7.4 |  | 458 ± 74 | 613 ± 173 |  | 586 ± 85 | 614 ± 128 |  | 451 ± 50 | 657 ± 157 |  | 662 ± 78 | 627 ± 145 |
| IWA860 | 75.3 ± 7.5 | 90.6 ± 16.1 |  | 90.9 ± 4.6 | 93.7 ± 3.4 |  | 217 ± 68  | 327 ± 74 |  | 292 ± 122 | 456 ± 141 |  | 92 ± 7 | 131 ± 33 |  | 103 ± 29 | 130 ± 46 |
| WB4-1-12 | 51.4 ± 4.9 | 62.2 ± 2.7 |  | 58.7 ± 10 | 67.8 ± 3.1 |  | 262 ± 80 | 349 ± 74 |  | 339 ± 154 | 417 ± 67 |  | 332 ± 79 | 457 ± 100 |  | 345 ± 149 | 435 ± 46 |
| WB4-1-16 | 59.5 ± 4.7 | 61.7 ± 1.9 |  | 60.3 ± 3.6 | 65.3 ± 4.0 |  | 289 ± 40 | 452 ± 201 |  | 277 ± 64 | 427 ± 139 |  | 372 ± 47 | 634 ± 297 |  | 303 ± 44 | 475 ± 143 |
| Westonia | 63.1 ± 3.6 | 75.3 ± 4.2 |  | 68.8 ± 7.3 | 73.2 ± 4.4 |  | 316 ± 87  | 499 ± 115 |  | 381 ± 60 | 446 ± 34 |  | 354 ± 57 | 641 ± 204 |  | 480 ± 116 | 534 ± 78 |
| Y334-05 | 20.5 ± 3.5 | 20.8 ± 5.5 |  | 23.2 ± 3.4 | 27.8 ± 4.7 |  | 179 ± 81 | 212 ± 12 |  | 217 ± 38 | 291 ± 108 |  | 123 ± 60 | 190 ± 19 |  | 102 ± 35 | 225 ± 49 |
| Yipti | 73.0 ± 3.4 | 74.2 ± 5.6 |  | 63.7 ± 5.5 | 72.7 ± 5.2 |  | 313 ± 14 | 435 ± 26 |  | 394 ± 128 | 517 ± 42 |  | 343 ± 56 | 457 ± 60 |  | 366 ± 105 | 521 ± 41 |
| Mean | 62.5 | 70.6 |  | 66.6 | 73.3 |  | 268 | 398 |  | 381 | 447 |  | 273 | 423 |  | 369 | 423 |
| CO2 main effect | \*\*\* |  | \* |  | \* |  | NS |  | \*\* |  | NS (p=0.09) |
| Genotype main effect | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |
| CO2 × genotype interaction | NS |   | NS |  | NS |   | NS |  | NS |   | NS |

Data is mean ± s.d.

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; NS not significant

**Table S2b:** Biomass related traits of 12 diverse wheat genotypes grown under ambient and elevated CO2 for each year.

|  |  |  |  |
| --- | --- | --- | --- |
|   | Aboveground biomass (g m-2) |   | Harvest Index |
|  | 2014 |  | 2015 |  | 2014 |  | 2015 |
| Genotype | Ambient | Elevated |   | Ambient | Elevated |   | Ambient | Elevated |   | Ambient | Elevated |
| C342-74 | 466 ± 55.9 | 709 ± 259.7 | 926 ± 231.9 | 983 ± 73.3 | 0.43 ± 0.02 | 0.42 ± 0.01 | 0.40 ± 0.06 | 0.37 ± 0.05 |
| Cudesnaja | 303 ± 91.8 | 634 ± 152.5 | 410 ± 72.1 | 423 ± 96.9 | 0.15 ± 0.08 | 0.16 ± 0.08 | 0.07 ± 0.03 | 0.09 ± 0.04 |
| EGA Gregory | 567 ± 383.1 | 849 ± 257.7 | 984 ± 336.4 | 961 ± 155.0 | 0.38 ± 0.04 | 0.39 ± 0.02 | 0.39 ± 0.03 | 0.40 ± 0.02 |
| Excalibur | 563 ± 134.1 | 866 ± 164.5 | 1009 ± 168.7 | 1034 ± 268.8 | 0.39 ± 0.03 | 0.41 ± 0.01 | 0.40 ± 0.06 | 0.40 ± 0.03 |
| Federation | 489 ± 52.6 | 744 ± 235.7 | 825 ± 106.1 | 917 ± 141.1 | 0.31 ± 0.03 | 0.32 ± 0.04 | 0.31 ± 0.03 | 0.31 ± 0.06 |
| Fusion | 909 ± 91.8 | 1270 ± 320.1 | 1247 ± 159.0 | 1241 ± 262.2 | 0.37 ± 0.04 | 0.39 ± 0.03 | 0.40 ± 0.02 | 0.36 ± 0.02 |
| IWA860 | 308 ± 74.7 | 458 ± 96.9 | 395 ± 150.5 | 586 ± 185.3 | 0.17 ± 0.05 | 0.17 ± 0.05 | 0.09 ± 0.03 | 0.06 ± 0.04 |
| WB4-1-12 | 594 ± 155.3 | 807 ± 169.9 | 684 ± 300.8 | 852 ± 104.5 | 0.39 ± 0.04 | 0.40 ± 0.01 | 0.33 ± 0.05 | 0.32 ± 0.05 |
| WB4-1-16 | 662 ± 84.1 | 1086 ± 496.5 | 580 ± 101.7 | 902 ± 282.0 | 0.40 ± 0.02 | 0.43 ± 0.02 | 0.36 ± 0.04 | 0.35 ± 0.02 |
| Westonia | 671 ± 141.0 | 1139 ± 317.7 | 861 ± 172.7 | 980 ± 104.6 | 0.37 ± 0.04 | 0.40 ± 0.02 |  | 0.40 ± 0.04 | 0.38 ± 0.03 |
| Y334-05 | 302 ± 135.5 | 401 ± 17.7 | 319 ± 71.4 | 516 ± 153.2 | 0.14 ± 0.03 | 0.18 ± 0.03 | 0.03 ± 0.02 | 0.13 ± 0.06 |
| Yipti | 656 ± 69.6 | 893 ± 84.9 | 760 ± 224.2 | 1038 ± 71.7 | 0.37 ± 0.03 | 0.35 ± 0.02 | 0.33 ± 0.07 | 0.36 ± 0.02 |
| Mean | 541 | 821 | 750 | 869 | 0.32 | 0.34 | 0.29 | 0.30 |
| CO2 main effect | \* |  | NS |  | NS (p=0.06) |  | NS |
| Genotype main effect | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |
| CO2 × genotype interaction | NS |   | NS |   | NS |   | \*\* |

Data is mean ± s.d.

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; NS not significant

**Table S3a:** Yield components of 12 diverse wheat genotypes grown under ambient and elevated CO2 for each year.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | Spikes (number m-2) |   |  | Grains (spike-1) |
|  | 2014 |  | 2015 |  |  | 2014 |  | 2015 |
| Genotype | Ambient | Elevated | Ambient | Elevated |  | Ambient | Elevated | Ambient | Elevated |
| C342-74 | 231 ± 32 | 289 ± 100 | 463 ± 71 | 494 ± 71 |  | 26.3 ± 2.0 | 27.6 ± 4.5 | 22.2 ± 5.0 | 20.3 ± 2.8 |
| Cudesnaja | 124 ± 12 | 206 ± 31 | 156 ± 65 | 150 ± 40 |  | 10.5 ± 6.4 | 13.5 ± 6.8 |  | 6.1 ± 2.2 | 7.0 ± 2.3 |
| EGA Gregory | 264 ± 180 | 345 ± 95 | 444 ± 166 | 429 ± 71 |  | 25.4 ± 3.3 | 26.4 ± 0.8 | 24.1 ± 2.4 | 23.7 ± 2.6 |
| Excalibur | 289 ± 47 | 356 ± 69 | 488 ± 46 | 476 ± 117 |  | 21.9 ± 3.0 | 25.4 ± 3.3 | 23.3 ± 4.7 | 23.3 ± 3.0 |
| Federation | 222 ± 23 | 313 ± 109 |  | 401 ± 48 | 403 ± 64 |  | 21.3 ± 4.1 | 20.0 ± 2.0 | 17.0 ± 1.9 | 19.3 ± 6.5 |
| Fusion | 291 ± 23 | 322 ± 76 | 391 ± 56 | 390 ± 83 |  | 29.4 ± 4.2 | 38.7 ± 4.6 | 31.8 ± 1.9 | 29.4 ± 4.3 |
| IWA860 | 124 ± 15 | 144 ± 32 | 183 ± 54 | 257 ± 70 |  | 14.2 ± 2.3 | 17.6 ± 4.6 | 5.3 ± 1.4 | 2.82 ± 2.6 |
| WB4-1-12 | 250 ± 91 | 302 ± 79 | 332 ± 117 | 388 ± 66 |  | 23.3 ± 2.9 | 25.3 ± 2.8 | 16.6 ± 2.8 | 17.6 ± 4.2 |
| WB4-1-16 | 276 ± 38 | 373 ± 141 | 301 ± 33 | 400 ± 95 |  | 22.8 ± 2.2 | 26.6 ± 2.1 | 16.5 ± 2.0 | 18.5 ± 1.5 |
| Westonia | 297 ± 43 | 394 ± 56 | 369 ± 51 | 418 ± 58 |  | 21.7 ± 2.3 | 26.0 ± 3.7 | 23.9 ± 4.2 | 22.6 ± 3.6 |
| Y334-05 | 231 ± 82 | 286 ± 41 | 277 ± 61 | 386 ± 92 |  | 5.4 ± 1.3 | 7.2 ± 1.6 |  | 1.40 ± 0.4 | 4.7 ± 1.6 |
| Yipti | 271 ± 16 | 347 ± 50 | 385 ± 108 | 475 ± 49 |  | 23.1 ± 2.4 | 22.5 ± 2.4 | 16.7 ± 4.5 | 18.6 ± 1.5 |
| Mean | 239 | 306 | 349 | 389 |  | 20.4 | 23.1 | 17.1 | 17.4 |
| CO2 main effect | NS (p=0.07) |  | NS (p=0.08) |  | \* |  | NS |
| Genotype main effect | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |
| CO2 × genotype interaction | NS |  | NS |  | NS |  | NS |

Data is mean ± s.d.

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; NS not significant

**Table S3b:** Yield components of 12 diverse wheat genotypes grown under ambient and elevated CO2 for each year.

|  |  |  |  |
| --- | --- | --- | --- |
|   | Grains (number m-2) |   | Yield (g m-2) |
|  | 2014 |  | 2015 |  | 2014 |  | 2015 |
| Genotype | Ambient | Elevated |   | Ambient | Elevated |   | Ambient | Elevated |   | Ambient | Elevated |
| C342-74 | 6037 ± 509 | 8069 ± 3485 |  | 10383 ± 3398 | 9894 ± 641 | 198 ± 21.8 | 301 ± 114 | 374 ± 121 | 366 ± 46.0 |
| Cudesnaja | 1279 ± 744 | 2840 ± 1673 |  | 957 ± 421 | 1112 ± 518 | 46.6 ± 35.6 | 108 ± 75.9 | 31.0 ± 14.1 | 41.0 ± 19.3 |
| EGA Gregory | 6465 ± 3812 | 9093 ± 2544 |  | 10703 ± 4176 | 10243 ± 2487 | 204 ± 112 | 331 ± 94.9 | 388 ± 138 | 384 ± 81.6 |
| Excalibur | 6426 ± 1832 | 9215 ± 2853 |  | 11494 ± 3081 | 11157 ± 3601 | 219 ± 63 | 353 ± 69.3 | 406 ± 112.2 | 413 ± 106 |
| Federation | 4650 ± 345 | 6098 ± 1582 |  | 6784 ± 813 | 7574 ± 1877 | 150 ± 19.7 | 233 ± 44.4 | 252 ± 31.0 | 288 ± 68.8 |
| Fusion | 8503 ± 564 | 12441 ± 3295 |  | 12481 ± 2104 | 11610 ± 3398 | 334 ± 43.8 | 495 ± 111 | 498 ± 68.3 | 448 ± 100 |
| IWA860 | 1736 ± 137  | 2550 ± 981 |  | 912 ± 65 | 840 ± 810 | 50.3 ± 4.9 | 76.9 ± 23.9 | 32.9 ± 3.2 | 33.3 ± 27.3 |
| WB4-1-12 | 5698 ± 1594 | 7654 ± 2226 |  | 5506 ± 2262 | 6658 ± 1073 | 230 ± 49.6 | 321 ± 65.9 | 219 ± 96.2 | 272 ± 36.5 |
| WB4-1-16 | 6320 ± 1375 | 10135 ± 4583 |  | 4978 ± 916 | 7511 ± 2318 | 267 ± 32.2 | 461 ± 213 | 207 ± 35.3 | 317 ± 93.1 |
| Westonia | 6471 ± 1296 | 10397 ± 3108 |  | 8909 ± 2449 | 9554 ± 2674 | 246 ± 35.1 | 458 ± 143 | 344 ± 97.8 | 373 ±71.8 |
| Y334-05 | 1305 ± 686 | 2010 ± 246 |  | 408 ± 88 | 1790 ± 601 | 42.6 ± 23.2 | 73.0 ± 14.7 | 10.5 ± 6.3 | 65.2 ± 24.1 |
| Yipti | 6271 ± 877 | 7823 ± 1652 |  | 6209 ± 1854 | 8850 ± 1481 | 243 ± 47.7 | 317 ± 45.0 | 251 ± 78.6 | 373 ± 37.3 |
| Mean | 5097 | 7360 |  | 6644 | 7233 | 186 | 294 | 251 | 281 |
| CO2 main effect | \* |  | NS |  | \* |  | NS |
| Genotype main effect | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |
| CO2 × genotype interaction | NS |   | NS |   | NS |   | NS |

Data is mean ± s.d.

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; NS not significant

**Table S4a:** Grain quality characteristics of 12 diverse genotypes grown under ambient and elevated CO2 for each year.

|  |  |  |  |
| --- | --- | --- | --- |
|   | Below 2 mm (%) |   | 2.0-2.5 mm (%) |
|  | 2014 |   |  | 2015 |   |  | 2014 |  | 2015 |
| Genotype | Ambient | Elevated |   | Ambient | Elevated |  | Ambient | Elevated |  | Ambient | Elevated |
| C342-74 | 0.93 ± 0.75 | 0.93 ± 0.82 |  | 0.40 ± 0.24 | 0.43 ± 0.43 |  | 24.8 ± 9.7 | 20.5 ± 14.6 |  | 17.5 ± 13.6 | 17.2 ± 13.3 |
| Cudesnaja | 2.08 ± 1.94 | 2.75 ± 1.67 |  | na | na |  | 19.7 ± 10.3  | 19.9 ± 5.2 |  | na | na |
| EGA Gregory | 2.00 ± 2.77 | 1.53 ± 1.97 |  | 0.43 ± 0.34 | 0.20 ± 0.14 |  | 15.2 ± 6.8 | 14.1 ± 11.6 |  | 9.52 ± 0.90 | 5.97 ± 0.80 |
| Excalibur | 1.83 ± 2.01 | 0.60 ± 0.64 |  | 0.40 ± 0.14 | 0.23 ± 0.29 |  | 20.6 ± 11.2 | 13.7 ± 10.5 |  | 14.5 ± 2.7 | 10.5 ± 6.5 |
| Federation | 1.03 ± 1.11 | 0.80 ± 0.89 |  | 0.10 ± 0.12 | 0.13 ± 0.13 |  | 17.3 ± 12.6 | 8.17 ± 6.0 |  | 6.02 ± 1.0 | 6.08 ± 2.2 |
| Fusion | 2.35 ± 1.85 | 1.35 ± 0.84 |  | 0.20 ± 0.08 | 0.43 ± 0.34 |  | 18.9 ± 9.5 | 17.1 ± 10.0 |  | 10.3 ± 5.2 | 16.2 ± 12.2 |
| IWA860 | 5.15 ± 3.03 | 2.73 ± 1.84 |  | na | na |  | 24.2 ± 8.3 | 19.4 ± 8.7 |  | na | na |
| WB4-1-12 | 0.60 ± 0.90 | 0.23 ± 0.19 |  | 0.15 ± 0.13 | 0.05 ± 0.06 |  | 7.55 ± 6.8 | 6.37 ± 7.3 |  | 7.98 ± 3.2 | 4.52 ± 1.3 |
| WB4-1-16 | 0.23 ± 0.33 | 0.13 ± 0.13 |  | 0.15 ± 0.13 | 0.05 ± 0.06 |  | 4.37 ± 2.9 | 2.55 ± 1.4 |  | 4.12 ± 0.4 | 3.05 ± 1.9 |
| Westonia | 0.53 ± 0.73 | 0.15 ± 0.10 |  | 0.03 ± 0.05 | 0.05 ± 0.06 |  | 11.4 ±9.0 | 4.67 ± 3.0 |  | 4.20 ± 3.1 | 5.80 ± 5.3 |
| Y334-05 | 1.28 ± 0.83 | 0.88 ± 0.36 |  | na | na |  | 26.4 ± 3.5 | 23.7 ± 14.7 |  | na | na |
| Yipti | 0.45 ± 0.54 | 0.53 ± 0.55 |  | 0.13 ± 0.05 | 0.05 ± 0.06 |  | 8.30 ± 5.8 | 10.2 ± 10.5 |  | 4.60 ± 1.7 | 2.28 ± 1.3 |
| Mean | 1.54 | 1.05 |  | 0.22 | 0.18 |  | 16.6 | 13.4 |  | 8.8 | 8.0 |
| CO2 main effect | NS |  | NS |  | NS |  | NS |
| Genotype main effect | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |
| CO2 × genotype interaction | NS |   | NS |   | NS |   | NS |

Data is mean ± s.d.

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; NS not significant

na = not available

**Table S4b:** Grain quality characteristics of 12 diverse genotypes grown under ambient and elevated CO2 for each year.

|  |  |  |  |
| --- | --- | --- | --- |
|   | 2.5-2.8 mm (%) |   | Above 2.8 mm (%) |
|  | 2014 |   |  | 2015 |   |  | 2014 |  | 2015 |
| Genotype | Ambient | Elevated |   | Ambient | Elevated |  | Ambient | Elevated |  | Ambient | Elevated |
| C342-74 | 44.1 ± 2.1 | 32.1 ± 11.2 |  | 35.7 ± 9.0 | 33.5 ± 13.7 |  | 30.2 ± 10.2 | 46.5 ± 26.4 |  | 46.4 ± 22.7 | 48.9 ± 27.3 |
| Cudesnaja | 31.2 ± 7.4  | 29.6 ± 2.0 |  | na | na |  | 47.0 ± 17.2 | 47.7 ± 8.0 |  | na | na |
| EGA Gregory | 28.9 ± 7.7 | 27.6 ± 12.3 |  | 28.6 ± 4.9 | 21.2 ± 0.50 |  | 53.9 ± 13.2 | 56.8 ± 25.7 |  | 61.5 ± 4.9 | 72.6 ± 0.5 |
| Excalibur | 36.8 ± 14.6 | 28.2 ± 17.5 |  | 37.8 ± 8.4 | 35.0 ± 14.8 |  | 40.8 ± 26.3 | 57.5 ± 28.1 |  | 47.4 ± 8.2 | 54.3 ± 21.6 |
| Federation | 32.8 ± 14.1 | 27.4 ± 15.3 |  | 27.2 ± 2.0 | 21.4 ± 2.2 |  | 48.8 ± 25.0 | 63.6 ± 20.8 |  | 66.7 ± 2.8 | 72.4 ± 4.0 |
| Fusion | 34.8 ± 9.6 | 33.3 ± 6.9 |  | 32.3 ± 8.0 | 37.4 ± 14.4 |  | 44.0 ± 20.0 | 48.3 ± 17.2 |  | 57.2 ± 13.2 | 46.0 ± 26.8 |
| IWA860 | 31.4 ± 5.7 | 28.8 ± 5.2 |  | na | na |  | 39.3 ± 10.5 | 49.0 ± 14.9 |  | na | na |
| WB4-1-12 | 23.1 ± 11.3 | 20.5 ± 15.8 |  | 33.2 ± 6.0 | 24.9 ± 5.1 |  | 68.8 ± 18.3 | 72.9 ± 23.1 |  | 58.7 ± 8.7 | 70.5 ± 5.8 |
| WB4-1-16 | 17.5 ± 7.1 | 12.7 ± 10.0 |  | 18.7 ± 2.8 | 17.4 ± 8.8 |  | 77.9 ± 9.6 | 84.6 ± 11.3 |  | 77.1 ± 2.5 | 79.6 ± 10.6 |
| Westonia | 26.7 ±11.0 | 20.4 ± 7.3 |  | 25.2 ± 12.0 | 30.8 ± 16.5 |  | 61.3 ± 19.8 | 74.8 ± 10.3 |  | 70.6 ± 14.7 | 63.4 ± 21.5 |
| Y334-05 | 40.2 ± 1.3 | 34.5 ± 3.5 |  | na | na |  | 32.1 ± 4.7 | 41.0 ± 16.9 |  | na | na |
| Yipti | 25.2 ± 12.3 | 25.8 ± 18.6 |  | 21.9 ± 6.9 | 15.2 ± 8.0 |  | 66.0 ± 17.4 | 63.4 ± 29.3 |  | 73.4 ± 8.6 | 82.5 ± 9.2 |
| Mean | 31.1 | 26.7 |  | 29.0 | 26.3 |  | 50.9 | 58.9 |  | 62.1 | 65.6 |
| CO2 main effect | NS |  | NS |  | NS |  | NS |
| Genotype main effect | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |
| CO2 × genotype interaction | NS |   | NS |   | NS |   | NS |

Data is mean ± s.d.

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; NS not significant

na = not available

**Table S4c:** Grain quality characteristics of 12 diverse genotypes grown under ambient and elevated CO2 for each year.

|  |  |  |  |
| --- | --- | --- | --- |
|   | Thousand grain weight (g) |   | Grain nitrogen concentration (%) |
|  | 2014 |   |  | 2015 |   |  | 2014 |  | 2015 |
| Genotype | Ambient | Elevated |   | Ambient | Elevated |  | Ambient | Elevated |  | Ambient | Elevated |
| C342-74 | 34.2 ± 1.8 | 39.7 ± 5.9 |  | 37.9 ± 4.1 | 38.5 ± 4.3 |  | 2.30 ± 0.18 | 2.06 ± 0.52 |  | 2.58 ± 1.29 | 2.26 ± 2.47 |
| Cudesnaja | 35.4 ± 5.9 | 37.4 ± 5.1 |  | 33.5 ± 1.2 | 38.5 ± 2.4 |  | 2.72 ± 0.52 | 2.71 ± 0.44 |  | 3.88 ± 0.94 | 2.90 ± 1.30 |
| EGA Gregory | 33.3 ± 1.8 | 38.1 ± 5.5 |  | 38.2 ± 1.5 | 39.3 ± 1.4 |  | 2.08 ± 0.47 | 1.95 ± 0.42 |  | 2.62 ± 1.26 | 2.15 ± 1.05 |
| Excalibur | 35.8 ± 4.4 | 41.3 ± 7.8 |  | 36.7 ± 0.9 | 39.2 ± 3.1 |  | 2.18 ± 0.34 | 2.07 ± 0.49 |  | 2.76 ± 1.04 | 2.47 ± 1.53 |
| Federation | 33.8 ± 4.9 | 40.4 ± 4.9 |  | 38.7 ± 0.6 | 39.7 ± 0.41 |  | 2.28 ± 0.47 | 2.18 ± 0.37 |  | 3.04 ± 1.52 | 2.53 ± 2.38 |
| Fusion | 40.9 ± 4.9 | 41.9 ± 2.9 |  | 41.8 ± 2.4 | 41.1 ± 4.9 |  | 2.20 ± 0.21 | 2.06 ± 0.37 |  | 2.36 ± 0.42 | 2.17 ± 1.30 |
| IWA860 | 30.2 ± 2.5 | 32.1 ± 3.9 |  | 37.6 ± 1.1 | 34.9 ± 4.7 |  | 2.56 ± 0.50 | 2.38 ± 0.49 |  | 3.61 ± 1.71 | 3.42 ± 2.46 |
| WB4-1-12 | 42.7 ± 4.0 | 44.8 ± 5.8 |  | 41.0 ± 1.9 | 42.8 ± 1.4 |  | 2.36 ± 0.51 | 2.15 ± 0.53 |  | 3.31 ± 0.61 | 3.00 ± 1.68 |
| WB4-1-16 | 44.6 ± 3.7 | 47.7 ± 4.3 |  | 43.3 ± 0.7 | 44.1 ± 1.7 |  | 2.25 ± 0.35 | 2.06 ± 0.51 |  | 3.07 ± 1.05 | 2.73 ± 1.46 |
| Westonia | 40.2 ± 4.8 | 45.8 ± 1.9 |  | 40.3 ± 2.3 | 41.4 ± 3.8 |  | 2.15 ± 0.30 | 1.99 ± 0.32 |  | 2.74 ± 0.71 | 2.33 ± 0.97 |
| Y334-05 | 33.9 ± 2.5 | 37.6 ± 3.2 |  | 33.7 ± 2.0 | 37.6 ± 2.5 |  | 3.72 ± 0.35 | 3.42 ± 0.42 |  | 4.63 ± 3.24 | 4.23 ± 0.57 |
| Yipti | 40.9 ± 9.1 | 43.1 ± 8.3 |  | 41.9 ± 1.8 | 44.3 ± 3.0 |  | 2.35 ± 0.43 | 2.15 ± 0.48 |  | 2.98 ± 1.34 | 2.47 ± 1.34 |
| Mean | 37.1 | 40.8 |  | 38.7 | 40.1 |  | 2.43 | 2.26 |  | 3.13 | 2.72 |
| CO2 main effect | \* |  | NS (p=0.09) |  | NS |  | \* |
| Genotype main effect | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |
| CO2 × genotype interaction | NS |   | NS |   | NS |   | NS |

Data is mean ± s.d.

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; NS not significant

**Table S4d:** Grain quality characteristics of 12 diverse genotypes grown under ambient and elevated CO2 for each year.

|  |  |  |  |
| --- | --- | --- | --- |
|   | Milling yield (%) |   | Grain hardness (SKCS units) |
|  | 2014 |   |  | 2015 |   |  | 2014 |  | 2015 |
| Genotype | Ambient | Elevated |   | Ambient | Elevated |  | Ambient | Elevated |  | Ambient | Elevated |
| C342-74 | 71.4 ± 1.2 | 72.1 ± 1.5 |  | 70.3 ± 1.3 | 68.0 ± 0.6 |  | 76.7 ± 3.1 | 72.6 ± 5.3 |  | 71.1 ± 3.0 | 74.6 ± 2.5 |
| Cudesnaja | 65.6 ± 5.4 | 67.4 ± 3.8 |  | na | na |  | 63.0 ± 5.6 | 55.0 ± 6.2 |  | 48.8 ± 7.0 | 55.5 ± 13.3 |
| EGA Gregory | 74.6 ± 1.5 | 75.6 ± 1.8 |  | 75.3 ± 0.9 | 75.1 ± 1.0 |  | 80.4 ± 6.0 | 74.8 ± 11.5 |  | 73.7 ± 3.8 | 77.5 ± 1.6 |
| Excalibur | 73.0 ± 2.5 | 74.0 ± 1.3 |  | 73.4 ± 1.5 | 71.1 ± 0.7 |  | 84.2 ± 5.5 | 76.6 ± 15.2 |  | 80.4 ± 2.7 | 81.2 ± 6.0 |
| Federation | 70.8 ± 1.4 | 72.1 ± 2.1 |  | 67.3 ± 1.5 | 68.2 ± 1.7 |  | 44.6 ± 2.8 | 42.8 ± 5.8 |  | 33.6 ± 1.4 | 35.9 ± 3.2 |
| Fusion | 66.1 ± 2.0 | 67.2 ± 1.0 |  | 66.2 ± 0.8 | 65.1 ± 1.9 |  | 57.0 ± 1.8 | 47.5 ± 13.1 |  | 59.0 ± 2.9 | 56.7 ± 1.5 |
| IWA860 | 62.7 ± 4.9 | 62.7 ± 2.0 |  | na | na |  | 86.2 ± 11.2 | 82.2 ± 8.9 |  | 80.0 ± 4.4 | 76.8 ± 5.9 |
| WB4-1-12 | 73.2 ± 1.2 | 73.9 ± 1.0 |  | 72.1 ± 2.1 | 72.1 ± 2.0 |  | 72.3 ± 7.9 | 70.6 ± 8.4 |  | 58.4 ± 3.4 | 61.1 ± 4.8 |
| WB4-1-16 | 73.9 ± 0.6 | 75 ± 1.4 |  | 72.0 ± 1.4 | 72.1 ± 1.4 |  | 74.1 ± 4.2 | 68.4 ± 10.1 |  | 58.8 ± 5.0 | 63.7 ± 3.8 |
| Westonia | 74.1 ± 0.7 | 74.4 ± 1.0 |  | 74.5 ± 0.5 | 71.9 ± 0.6 |  | 81.9 ± 1.8 | 78.9 ± 3.6 |  | 76.3 ± 3.4 | 75.6 ± 6.2 |
| Y334-05 | 66.6 ± 4.0 | 70.6 ± 1.6 |  | na | na |  | 59.4 ± 1.5 | 58.2 ± 4.4 |  | 65.2 ± 4.6 | 59.3 ± 3.5 |
| Yipti | 74.7 ± 1.1 | 73.9 ± 0.7 |  | 72.4 ± 1.6 | 72.4 ± 0.7 |  | 78.9 ± 6.9 | 78.5 ± 7.1 |  | 65.6 ± 2.6 | 70.3 ± 6.6 |
| Mean | 70.5 | 71.6 |  | 71.5 | 70.7 |  | 71.5 | 67.2 |  | 64.2 | 65.7 |
| CO2 main effect | NS |  | NS |  | NS |  | NS |
| Genotype main effect | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |
| CO2 × genotype interaction | NS |   | \*\* |   | NS |   | NS |

Data is mean ± s.d.

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; NS not significant

na = not available

**Table S5a:** Dough characteristics of 12 diverse genotypes grown under ambient and elevated CO2 for each year.

|  |  |  |  |
| --- | --- | --- | --- |
|   | Water absorption (%) |   | Dough development time (min) |
|  | 2014 |   |  | 2015 |   |  | 2014 |  | 2015 |
| Genotype | Ambient | Elevated |   | Ambient | Elevated |  | Ambient | Elevated |  | Ambient | Elevated |
| C342-74 | 61.8 ± 1.8 | 60.2 ± 3.5 |  | 63.8 ± 1.0 | 61.4 ± 2.2 |  | 5.6 ± 1.0 | 5.0 ± 2.2 |  | 6.6 ± 1.7 | 5.4 ± 2.5 |
| Cudesnaja | 62.2 ± 3.1 | 61.5 ± 2.0 |  | na | na |  | 4.8 ± 2.5 | 4.6 ± 2.2 |  | na | na |
| EGA Gregory | 60.9 ± 4.3 | 59.9 ± 2.9 |  | 63.3 ± 1.6 | 62.2 ± 1.5 |  | 5.0 ± 1.8 | 4.1 ± 1.9 |  | 5.9 ± 1.3 | 4.4 ± 1.2 |
| Excalibur | 61.8 ± 1.8 | 59.7 ± 3.4 |  | 64.7 ± 1.5 | 62.9 ± 1.6 |  | 5.3 ± 1.4 | 4.4 ± 1.8 |  | 6.8 ± 0.9 | 6.3 ± 1.6 |
| Federation | 59.7 ± 3.7 | 58.6 ± 2.9 |  | 65.1 ± 2.6 | 62.2 ± 3.0 |  | 3.5 ± 1.9 | 3.1 ± 1.9 |  | 7.5 ± 1.2 | 4.9 ± 2.4 |
| Fusion | 57.7 ± 0.9 | 56.0 ± 3.8 |  | 57.8 ± 1.1 | 56.7 ± 1.0 |  | 3.3 ± 0.7 | 3.0 ± 1.2 |  | 3.4 ± 0.7 | 2.3 ± 1.0 |
| IWA860 | 62.5 ± 1.8 | 62.4 ± 3.7 |  | na | na |  | 5.2 ± 2.1 | 4.7 ± 3.1 |  | na | na |
| WB4-1-12 | 61.7 ± 2.6 | 61.2 ± 3.5 |  | 65.5 ± 1.3 | 64.8 ± 1.5 |  | 6.1 ± 2.0 | 5.4 ± 2.1 |  | 9.3 ± 1.0 | 8.3 ± 1.5 |
| WB4-1-16 | 61.4 ± 2.5 | 60.6 ± 3.2 |  | 64.9 ± 1.6 | 63.2 ± 1.6 |  | 5.5 ± 1.7 | 4.9 ± 1.9 |  | 8.8 ± 1.3 | 7.1 ± 1.1 |
| Westonia | 62.1 ± 2.4 | 60.7 ± 2.7 |  | 64.7 ± 2.1 | 63.4 ± 0.6 |  | 4.7 ± 1.3 | 4.4 ± 1.1 |  | 6.8 ± 0.7 | 6.0 ± 0.6 |
| Y334-05 | 69.6 ± 0.4 | 68.4 ± 2.3 |  | na | na |  | 11.3 ± 0.6 | 9.5 ± 1.5 |  | na | na |
| Yipti | 61.9 ± 2.5 | 61.4 ± 2.9 |  | 65.3 ± 1.5 | 62.5 ± 1.6 |  | 5.9 ± 1.8 | 5.6 ± 1.6 |  | 8.0 ± 1.0 | 5.7 ± 1.1 |
| Mean | 61.9 | 60.9 |  | 63.9 | 62.1 |  | 5.5 | 4.9 |  | 7.0 | 5.6 |
| CO2 main effect | NS |  | \* |  | NS |  | \* |
| Genotype main effect | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |
| CO2 × genotype interaction | NS |   | NS |   | NS |   | NS |

Data is mean ± s.d.

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; NS not significant

na = not available

**Table S5b:** Dough characteristics of 12 diverse wheat genotypes grown under ambient and elevated CO2 for each year.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   | Dough stability (BU\*) |  | Dough extensibility (cm) |  | Dough Rmax (BU\*) |
|  | 2014 |  | 2015 |  | 2014 |  | 2015 |  | 2014 |  | 2015 |
| Genotype | Ambient | Elevated |  | Ambient | Elevated |  | Ambient | Elevated |   | Ambient | Elevated |  | Ambient | Elevated |   | Ambient | Elevated |
| C342-74 | 9.5 ± 2.2 | 8.2 ± 2.9 |  | 9.4 ± 2.1 | 9.8 ± 2.7 |  | 22.2 ± 1.8 | 20.5 ± 3.6 |  | 23.1 ± 1.8 | 20.9 ± 2.1 |  | 529 ± 55.2 | 514 ± 53.6 |  | 499 ± 31.1 | 550 ± 69.5 |
| Cudesnaja | 3.5 ± 0.6 | 3.0 ± 1.2 |  | na | na |  | 19.7 ± 1.9 | 18.8 ± 1.2 |  | na | na |  | 384 ± 15.9 | 339 ± 22.7 |  | na | na |
| EGA Gregory | 7.7 ± 1.7 | 6.2 ± 2.5 |  | 6.1 ± 1.6 | 5.6 ± 0.8 |  | 20.3 ± 3.4 | 19.3 ± 2.5 |  | 21.6 ± 1.8 | 21.8 ± 1.3 |  | 548 ± 57.8 | 537 ± 66.0 |  | 413 ± 20.1 | 473 ± 35.7 |
| Excalibur | 9.4 ± 1.5 | 6.7 ± 2.2 |  | 8.0 ± 1.4 | 8.2 ± 2.6 |  | 20.7 ± 2.1 | 19.1 ± 3.2 |  | 22.7 ± 1.8 | 21.9 ± 1.6 |  | 574 ± 97.6 | 537 ± 72.2 |  | 464 ± 27.1 | 509 ± 36.8 |
| Federation | 4.8 ± 0.8 | 4.2 ± 1.5 |  | 5.2 ± 1.2 | 3.4 ± 0.6 |  | 17.9 ± 3.3 | 16.9 ± 2.7 |  | 22.5 ± 1.9 | 19.8 ± 2.3 |  | 438 ± 64.0 | 418 ± 46.2 |  | 366 ± 14.9 | 387 ± 84.1 |
| Fusion | 6.0 ± 1.3 | 5.5 ± 1.8 |  | 6.2 ± 1.6 | 5.3 ± 2.7 |  | 14.1 ± 0.5 | 13.6 ± 1.9 |  | 14.3 ± 0.6 | 13.3 ± 0.6 |  | 506 ± 78.4 | 488 ± 36.0 |  | 552 ± 85.1 | 571 ± 109.4 |
| IWA860 | 4.3 ± 1.6 | 3.7 ± 0.6 |  | na | na |  | 18.6 ± 0.8 | 18.2 ± 2.4 |  | na | na |  | 417 ± 46.7 | 395 ± 28.6 |  | na | na |
| WB4-1-12 | 10.0 ± 2.8 | 8.4 ± 2.7 |  | 13.2 ± 2.0 | 10.1 ± 2.1 |  | 21.2 ± 2.7 | 20.9 ± 2.9 |  | 22.4 ± 0.6 | 22.5 ± 1.0 |  | 548 ± 48.9 | 499 ± 27.4 |  | 512 ± 51.3 | 498 ± 50.0 |
| WB4-1-16 | 9.6 ± 1.8 | 7.8 ± 2.9 |  | 13.1 ± 2.1 | 9.7 ± 0.6 |  | 21.0 ± 2.3 | 20.5 ± 2.5 |  | 23.3 ± 1.5 | 21.8 ± 1.2 |  | 550 ± 34.2 | 518 ± 34.5 |  | 520 ± 40.4 | 493 ± 20.9 |
| Westonia | 6.8 ± 0.5 | 6.1 ± 1.9 |  | 8.3 ± 0.8 | 9.1 ± 2.3 |  | 21.2 ± 2.1 | 20.0 ± 2.5 |  | 23.1 ± 2.5 | 22.6 ± 0.7 |  | 521 ± 21.1 | 539 ± 37.7 |  | 464 ± 31.8 | 521 ± 52.7 |
| Y334-05 | 11.2 ± 0.3 | 9.6 ± 2.7 |  | na | na |  | 23.6 ± 1.1 | 23.9 ± 0.6 |  | na | na |  | 419 ± 26.6 | 407 ± 28.4 |  | na | na |
| Yipti | 8.9 ± 2.7 | 7.5 ± 0.4 |  | 10.4 ± 0.9 | 7.9 ± 1.5 |  | 20.9 ± 1.9 | 20.6 ± 2.0 |  | 22.8 ± 1.2 | 20.8 ± 1.1 |  | 563 ± 67.4 | 554 ± 34.0 |  | 491 ± 27.4 | 502 ± 27.6 |
| Mean | 7.6 | 6.4 |  | 8.9 | 7.7 |  | 20.1 | 19.3 |  | 21.7 | 20.6 |  | 500 | 479 |  | 476 | 500 |
| CO2 main effect | NS |  | \* |  | NS |  | \* |  | NS |  | \* |
| Genotype main effect | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |  | \*\*\* |
| CO2 × genotype interaction | NS |   | NS |  | NS |   | NS |  | NS |   | NS |

Data is mean ± s.d.

\*P < 0.05; \*\*P < 0.01; \*\*\*P < 0.001; NS not significant

na = not available

\* BU Brabendar Units (see text)