

**Table S1.** Name, code, subspecies, geographic origin and environmental conditions of 18 populations of European black pine (*Pinus nigra*) grown in a common garden experiment located in Valsain (Spain).

| Population      | Code | Subspecies        | Country   | Latitude      | Longitude     | Altitude<br>(m, a.s.l) | MAT<br>(°C) | TAR<br>(°C) | TWQ<br>(°C) | TCQ<br>(°C) | MAP<br>(mm) | PwtQ<br>(mm) | PdrQ<br>(mm) | P <sub>w</sub><br>(mm) | P <sub>s</sub><br>(mm) | PsP<br>(%) |
|-----------------|------|-------------------|-----------|---------------|---------------|------------------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|------------------------|------------------------|------------|
| Ena             | 1    | <i>salzmannii</i> | Spain     | 42° 31' 15" N | 0° 45' 15" E  | 920                    | 11.6        | 26.7        | 19.4        | 4.9         | 700         | 211          | 126          | 188                    | 126                    | 18         |
| Solsonés        | 3    | <i>salzmannii</i> | Spain     | 42° 02' 33" N | 1° 31' 37" E  | 645                    | 11.2        | 26.8        | 19.0        | 4.4         | 765         | 241          | 132          | 132                    | 206                    | 27         |
| Cuenca          | 71   | <i>salzmannii</i> | Spain     | 39° 59' 59" N | 2° 03' 13" E  | 994                    | 12.1        | 31.9        | 21.0        | 4.5         | 506         | 159          | 72.          | 143                    | 79                     | 16         |
| Los             |      |                   |           |               |               |                        |             |             |             |             |             |              |              |                        |                        |            |
| Palancares      | 72   | <i>salzmannii</i> | Spain     | 40° 01' 34" N | 1° 58' 34" W  | 1221                   | 10.7        | 31.6        | 19.7        | 3.3         | 545         | 172          | 80           | 148                    | 89                     | 16         |
| Los Cadorzos    | 73   | <i>salzmannii</i> | Spain     | 39° 50' 29" N | 2° 00' 31" W  | 766                    | 11.7        | 31.8        | 20.7        | 4.2         | 499         | 160          | 72           | 137                    | 79                     | 16         |
| Paterna del     |      |                   |           |               |               |                        |             |             |             |             |             |              |              |                        |                        |            |
| Madera          | 81   | <i>salzmannii</i> | Spain     | 37° 54' 60" N | 2° 54' 25" W  | 1389                   | 11.4        | 32.4        | 20.9        | 3.5         | 522         | 186          | 41           | 177                    | 46                     | 9          |
| Navahondona     | 82   | <i>salzmannii</i> | Spain     | 38° 34' 42" N | 2° 19' 05" W  | 1125                   | 11.9        | 33.9        | 21.7        | 3.8         | 475         | 161          | 48           | 145                    | 54                     | 11         |
| Cazorla-        |      |                   |           |               |               |                        |             |             |             |             |             |              |              |                        |                        |            |
| Alcaraz         | 83   | <i>salzmannii</i> | Spain     | 38° 13' 60" N | 2° 37' 60" W  | 1329                   | 11.0        | 33.2        | 20.7        | 3.0         | 530         | 181          | 46           | 170                    | 53                     | 10         |
| Huéscar         | 84   | <i>salzmannii</i> | Spain     | 37° 56' 55" N | 2° 34' 48" W  | 1795                   | 9.0         | 34.0        | 19.0        | 0.9         | 662         | 226          | 58           | 217                    | 65                     | 10         |
| Gagnières       | 150  | <i>salzmannii</i> | France    | 44° 06' 60" N | 4° 17' 00" E  | 277                    | 12.9        | 26.8        | 21.0        | 5.7         | 826         | 285          | 137          | 206                    | 137                    | 17         |
| Grancia         | 201  | <i>calabrica</i>  | Italy     | 39° 24' 59" N | 16° 35' 09" E | 1496                   | 8.6         | 21.4        | 16.2        | 1.8         | 843         | 332          | 84           | 300                    | 84                     | 10         |
| Macchia della   |      |                   |           |               |               |                        |             |             |             |             |             |              |              |                        |                        |            |
| tavola          | 202  | <i>calabrica</i>  | Italy     | 39° 22' 20" N | 16° 35' 18" E | 1544                   | 7.6         | 21.6        | 15.3        | 0.8         | 831         | 323          | 86           | 292                    | 86                     | 10         |
|                 |      |                   | France    |               |               |                        |             |             |             |             |             |              |              |                        |                        |            |
| Noceta          | 302  | <i>laricio</i>    | (Corsica) | 42° 09' 60" N | 9° 11' 00" E  | 684                    | 12.4        | 21.7        | 19.6        | 6.0         | 772         | 299          | 72           | 248                    | 104                    | 13         |
|                 |      |                   | France    |               |               |                        |             |             |             |             |             |              |              |                        |                        |            |
| Sorba           | 303  | <i>laricio</i>    | (Corsica) | 42° 07' 60" N | 9° 12' 00" E  | 1032                   | 11.5        | 21.0        | 18.7        | 5.2         | 818         | 313          | 76           | 266                    | 106                    | 13         |
|                 |      |                   | France    |               |               |                        |             |             |             |             |             |              |              |                        |                        |            |
| Ghisoni         | 304  | <i>laricio</i>    | (Corsica) | 42° 04' 60" N | 9° 12' 00" E  | 699                    | 12.4        | 21.3        | 19.6        | 6.1         | 747         | 290          | 68           | 241                    | 99                     | 13         |
| Parabluerbeg    | 402  | <i>nigra</i>      | Austria   | /             | /             | /                      | /           | /           | /           | /           | /           | /            | /            | /                      | /                      | /          |
| Milea           | 405  | <i>nigra</i>      | Greece    | 39° 45' 55" N | 21° 11' 41" E | 1111                   | 9.4         | 27.1        | 17.7        | 1.6         | 879         | 315          | 114          | 278                    | 114                    | 13         |
| Villetta Barrea | 407  | <i>nigra</i>      | Italy     | 41° 46' 60" N | 13° 46' 03" E | 1360                   | 8.0         | 24.2        | 16.2        | 0.7         | 787         | 254          | 166          | 175                    | 166                    | 21         |

MAT = Mean annual temperature; TAR = Annual range temperature; TWQ = Temperature of the warmest quarter; TCQ = Temperature of the coldest quarter; MAP Mean annual precipitation; PwtQ = Precipitation of the wettest quarter; PdrQ = Precipitation of the driest quarter; P<sub>w</sub> = Winter precipitation; P<sub>s</sub> = Summer precipitation; PsP = Summer to annual precipitation ratio.

**Table S2.** Name, code, ecotype, geographic origin, and environmental conditions of 56 populations of Aleppo pine (*Pinus halepensis*) grown in a common garden experiment located in Valdeolmos (Spain).

| Population                    | Code | Ecotype | Country | Latitude | Longitude | Altitude<br>(m, a.s.l) | MAT<br>(°C) | TAR<br>(°C) | TWQ<br>(°C) | TCQ<br>(°C) | MAP<br>(mm) | PwtQ<br>(mm) | PdrQ<br>(mm) | P <sub>w</sub><br>(mm) | P <sub>s</sub> (mm) | PsP<br>(%) |
|-------------------------------|------|---------|---------|----------|-----------|------------------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|------------------------|---------------------|------------|
| Cabanelles                    | 11   | WHC     | Spain   | 42°15' N | 2° 47' E  | 250                    | 13.7        | 25.3        | 21.0        | 7.4         | 684         | 218          | 135          | 154                    | 155                 | 23         |
| Tivissa                       | 21   | WST     | Spain   | 42°20' N | 0° 50' E  | 417                    | 14.1        | 26.9        | 21.8        | 7.2         | 601         | 209          | 80           | 142                    | 108                 | 18         |
| Sant<br>Salvador<br>Guardiola | 31   | WHC     | Spain   | 41°40' N | 1° 45' E  | 378                    | 13.7        | 26.1        | 21.3        | 6.8         | 623         | 199          | 118          | 118                    | 154                 | 25         |
| Zuera                         | 61   | WST     | Spain   | 41°55' N | 0° 55' E  | 582                    | 13.1        | 28.5        | 21.4        | 5.7         | 441         | 146          | 87           | 98                     | 95                  | 22         |
| Valdeconcha                   | 82   | DSC     | Spain   | 40°27' N | 2° 52' W  | 873                    | 12.8        | 31.2        | 21.8        | 5.2         | 449         | 157          | 53           | 131                    | 54                  | 12         |
| Alcantud                      | 83   | DSC     | Spain   | 40°34' N | 2° 18' W  | 683                    | 13.6        | 32.7        | 22.7        | 5.8         | 422         | 164          | 45           | 125                    | 45                  | 11         |
| Colmenar<br>de Oreja          | 84   | DSC     | Spain   | 40°05' N | 3° 20' W  | 1155                   | 11.4        | 30.6        | 20.3        | 4.0         | 545         | 180          | 70           | 163                    | 75                  | 14         |
| Cirat                         | 91   | DSC     | Spain   | 40°03' N | 0° 28' W  | 606                    | 13.5        | 28.1        | 21.2        | 6.8         | 407         | 127          | 72           | 82                     | 84                  | 21         |
| Tuéjar                        | 92   | DSC     | Spain   | 39°49' N | 1° 09' W  | 713                    | 13.4        | 29.6        | 21.6        | 6.3         | 369         | 121          | 63           | 71                     | 81                  | 22         |
| Enguidanos                    | 93   | DSC     | Spain   | 39°38' N | 1° 39' W  | 1009                   | 12.1        | 31.9        | 21.2        | 4.5         | 443         | 148          | 76           | 103                    | 82                  | 19         |
| Tibi                          | 101  | DSC     | Spain   | 38°31' N | 0° 39' W  | 976                    | 12.4        | 32.3        | 21.5        | 4.7         | 420         | 138          | 61           | 95                     | 61                  | 15         |
| Altura                        | 102  | DSC     | Spain   | 39°47' N | 0° 37' W  | 604                    | 14.0        | 29.1        | 21.9        | 7.1         | 405         | 128          | 73           | 81                     | 81                  | 20         |
| Villa de Ves                  | 103  | DSC     | Spain   | 39°11' N | 1° 15' W  | 817                    | 13.1        | 31.5        | 22.1        | 5.4         | 394         | 133          | 69           | 83                     | 70                  | 18         |
| Jarafuel                      | 104  | DSC     | Spain   | 39°10' N | 1° 01' W  | 564                    | 14.4        | 30.0        | 22.9        | 7.0         | 376         | 120          | 60           | 80                     | 60                  | 16         |
| Bicorp                        | 105  | DSC     | Spain   | 39°06' N | 0° 51' W  | 652                    | 13.7        | 29.5        | 22.0        | 6.5         | 382         | 124          | 64           | 80                     | 64                  | 17         |
| Commercial<br>Seed            | 109  |         | Spain   | /        | /         |                        |             |             |             |             |             |              |              |                        |                     |            |
| Benicàssim                    | 111  | WST     | Spain   | 40°05' N | 0° 01' E  | 361                    | 15.1        | 26.2        | 22.5        | 8.8         | 469         | 165          | 76           | 109                    | 103                 | 22         |
| Gilet                         | 112  | DST     | Spain   | 39°40' N | 0° 21' W  | 734                    | 14.0        | 33.0        | 23.5        | 6.0         | 422         | 154          | 46           | 130                    | 47                  | 11         |
| Villajoyosa                   | 131  | DST     | Spain   | 38°30' N | 0° 18' W  | 50                     | 17.6        | 26.1        | 24.5        | 11.5        | 308         | 124          | 31           | 72                     | 50                  | 16         |
| Ricote                        | 141  | DST     | Spain   | 38°09' N | 1° 26' W  | 882                    | 13.8        | 31.9        | 22.8        | 6.2         | 388         | 124          | 47           | 100                    | 48                  | 12         |
| Monovar                       | 142  | DST     | Spain   | 38°23' N | 0° 57' W  | 778                    | 13.9        | 31.9        | 22.7        | 6.2         | 385         | 125          | 52           | 89                     | 52                  | 14         |
| Monovar II                    | 143  | DST     | Spain   | 38°24' N | 0° 55' W  | 493                    | 15.2        | 30.0        | 23.5        | 7.9         | 350         | 117          | 43           | 79                     | 50                  | 14         |

[illegible]

|                                 |     |     |         |          |         |     |      |      |      |      |     |     |    |     |    |    |
|---------------------------------|-----|-----|---------|----------|---------|-----|------|------|------|------|-----|-----|----|-----|----|----|
| Villavieja Tordesillas          | 203 |     | Spain   | /        | /       |     |      |      |      |      |     |     |    |     |    |    |
| Istaia-eyboia                   | 211 | DHT | Greece  | 38°44' N | 23°31'E | 70  | 16.4 | 24.9 | 24.7 | 8.8  | 501 | 209 | 35 | 112 | 68 | 14 |
| Amfilohia (likely seed orchard) | 212 | DHT | Greece  | 38°53' N | 21°18'E | 529 | 14.0 | 28.1 | 22.2 | 6.4  | 863 | 364 | 65 | 144 | 69 | 8  |
| Tatoi-attica                    | 213 | DHT | Greece  | 38°27' N | 23°28'E | 252 | 15.3 | 27.9 | 23.9 | 7.6  | 532 | 226 | 36 | 134 | 66 | 12 |
| Kassandra                       | 214 | DHT | Greece  | 40°05' N | 23°54'E | 347 | 14.2 | 25.4 | 23.0 | 6.1  | 507 | 187 | 65 | 205 | 35 | 7  |
| Gemenos                         | 221 | WHC | France  | 43°25' N | 5°40'E  | 392 | 13.3 | 25.8 | 20.9 | 6.6  | 708 | 243 | 93 | 197 | 93 | 13 |
| Litorale Tarantino              | 231 | WST | Italy   | 40°37' N | 17°07'E | 205 | 14.8 | 25.8 | 22.9 | 7.7  | 589 | 213 | 78 | 187 | 78 | 13 |
| Gargano Monte Pucci             | 232 | WST | Italy   | 41°54' N | 15°57'E | 457 | 15.2 | 22.6 | 21.8 | 8.6  | 204 | 68  | 36 | 48  | 36 | 18 |
| Gargano Marzini                 | 233 | WST | Italy   | 41°33' N | 15°51'E | 0   | 16.2 | 26.7 | 24.4 | 9.0  | 443 | 146 | 76 | 117 | 76 | 17 |
| Thala                           | 241 | DST | Tunisia | 35°34' N | 8°39'E  | 949 | 15.4 | 30.8 | 24.7 | 7.3  | 423 | 131 | 60 | 122 | 60 | 14 |
| Tabarka                         | 242 | DHT | Tunisia | 36°30' N | 9°04'E  | 266 | 17.6 | 30.2 | 26.2 | 10.0 | 539 | 222 | 37 | 222 | 37 | 7  |

MAT = Mean annual temperature; TAR = Annual range temperature; TWQ = Temperature of the warmest quarter; TCQ = Temperature of the coldest quarter; MAP Meanannual precipitation; PwtQ = Precipitation of the wettest quarter; PdrQ = Precipitation of the driest quarter; P<sub>w</sub> = Winter precipitation; P<sub>s</sub>= Summer precipitation; PsP = Summer to annual precipitation ratio.

**Table S3.** Treetops accuracy detection of the local maxima algorithm applied to LiDAR and RGB canopy height models. Recall (R), precision (P) and F-score (F) are shown.

| Species              | LiDAR                            |                                |                            |       |       |       | RGB                              |                                |                            |       |       |       |
|----------------------|----------------------------------|--------------------------------|----------------------------|-------|-------|-------|----------------------------------|--------------------------------|----------------------------|-------|-------|-------|
|                      | Correctly detected treetops (TP) | Falsely detected treetops (FP) | Non-detected treetops (FN) | R     | P     | F     | Correctly detected treetops (TP) | Falsely detected treetops (FP) | Non-detected treetops (FN) | R     | P     | F     |
| <i>P. nigra</i>      | 317                              | 3                              | 28                         | 0.919 | 0.991 | 0.953 | 314                              | 6                              | 31                         | 0.910 | 0.981 | 0.944 |
| <i>P. halepensis</i> | 540                              | 18                             | 43                         | 0.926 | 0.968 | 0.947 | 518                              | 38                             | 65                         | 0.889 | 0.932 | 0.910 |

**Table S4.** Validation of *h* and *dbh* derived from LiDAR and RGB canopy height models against *h* and *dbh* measured *in situ*. Root mean square error (RMSE) and mean absolute error (MAE) are shown.

|               |            | <i>P. nigra</i> |      | <i>P. halepensis</i> |      |
|---------------|------------|-----------------|------|----------------------|------|
|               | Traits     | RMSE            | MAE  | RMSE                 | MAE  |
| LiDAR-derived | <i>h</i>   | 0.36            | 0.24 | 0.43                 | 0.31 |
|               | <i>dbh</i> | 1.61            | 1.25 | 1.67                 | 1.26 |
| RGB-derived   | <i>h</i>   | 0.40            | 0.29 | 0.45                 | 0.34 |
|               | <i>dbh</i> | 1.74            | 1.37 | 1.76                 | 1.26 |