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| **Table S1.** Quantitative leaf traits of tested almond clones / cultivars | | | | |
| Origin | Genotype | Leaf length | Leaf width | Petiole length | |
| Morocco | INRA/T1 | 70.3 ± 7.7 | 25.7 ± 2.7 | 18.0 ± 1.9 | |
|  | INRA/3134 | 61.7 ± 3.8 | 21.9 ± 1.2 | 15.6 ± 1.5 | |
|  | Timid/6R | 68.9 ± 4.3 | 23.1 ± 1.4 | 15.5 ± 2.1 | |
|  | B1/22R | 55.6 ± 5.3 | 18.5 ± 1.9 | 12.9 ± 1.0 | |
|  | B1/7R | 59.4 ± 8.8 | 21.8 ± 1.7 | 14.9 ± 1.5 | |
|  | B1/5R | 84.1 ± 6.1 | 32.1 ± 2.2 | 20.8 ± 2.2 | |
|  | B1/S2 | 53.1 ± 5.4 | 17.6 ± 1.8 | 12.5 ± 1.7 | |
|  | B2/14R | 73.4 ± 10.0 | 28.2 ± 8.0 | 16.2 ± 2.6 | |
|  | B2/11R | 62.6 ± 4.0 | 20.4 ± 1.4 | 14.1 ± 2.3 | |
|  | Toundout/1R | 51.3 ± 3.5 | 15.5 ± 1.0 | 15.0 ± 3.7 | |
|  | Tiliwine | 80.6 ± 4.5 | 25.5 ± 1.8 | 14.2 ± 2.0 | |
|  | Amekchoud/3J | 75.1 ± 5.7 | 28.4 ± 2.5 | 23.9 ± 2.7 | |
|  | Ircheg/2R | 79.9 ± 6.7 | 24.7 ± 2.0 | 20.8 ± 3.1 | |
|  | Ighri/1R | 78.8 ± 4.3 | 24.3 ± 1.5 | 16.4 ± 1.5 | |
|  | Ighri/12B | 70.2 ± 4.2 | 23.1 ± 1.6 | 17.3 ± 2.1 | |
|  | Hart/16 | 65.7 ± 5.9 | 21.8 ± 1.3 | 18.0 ± 3.7 | |
|  | Khorbat/3J | 80.9 ± 6.2 | 31.4 ± 2.6 | 18.0 ± 2.9 | |
|  | V4 | 67.3 ± 4.2 | 24.1 ± 1.7 | 19.6 ± 2.4 | |
|  | V7 | 63.4 ± 4.6 | 17.0 ± 1.7 | 18.2 ± 3.4 | |
|  | V23 | 80.4 ± 5.0 | 26.7 ± 1.9 | 13.3 ± 1.7 | |
|  | V24 | 73.2 ± 5.5 | 25.5 ± 1.5 | 18.8 ± 2.6 | |
|  | Rislane 2 | 63.2 ± 5.9 | 16.8 ± 1.5 | 12.2 ± 1.8 | |
|  | Ait Abdellah 6 | 45.1 ± 4.3 | 16.6 ± 1.6 | 11.4 ± 2.0 | |
|  | LI Meknes | 72.7 ± 4.4 | 30.9 ± 3.1 | 14.2 ± 2.2 | |
|  | Bualuzen | 97.6 ± 6.7 | 30.7 ± 2.6 | 20.8 ± 3.3 | |
|  | De Safi | 77.8 ± 4.7 | 28.5 ± 1.7 | 18.7 ± 1.7 | |
|  | Beni Ouklane | 100.0 ± 5.9 | 31.7 ± 2.8 | 22.9 ± 3.2 | |
|  | Sultane de Sefrou | 100.0 ± 7.1 | 32.2 ± 2.4 | 24.6 ± 2.4 | |
|  | CF5 | 78.5 ± 5.4 | 28.9 ± 2.1 | 21.1 ± 2.8 | |
|  | AT8 | 83.0 ± 5.1 | 34.4 ± 2.6 | 21.2 ± 4.2 | |
|  | Ksar Souk | 84.3 ± 6.3 | 25.1 ± 1.5 | 19.0 ± 1.5 | |
|  | AinLeuh | 89.5 ± 5.8 | 27.9 ± 4.1 | 22.7 ± 3.0 | |
|  | Molar de Sale | 72.3 ± 4.7 | 22.8 ± 2.1 | 14.9 ± 3.0 | |
|  | Average | 73.3 ± 5.5 | 25.0 ± 2.2 | 17.5 ± 2.4 | |
|  |  |  |  |  | |
| Tunisia | Abiod | 98.6 ± 5.8 | 31.6 ± 2.6 | 14.6 ± 1.6 | |
|  | Heich Ben Smail | 94.0 ± 4.9 | 32.2 ± 2.9 | 24.6 ± 3.5 | |
|  | Abiod Ras Djebel | 85.0 ± 14.4 | 22.4 ± 1.5 | 22.6 ± 2.5 | |
|  | Khoukhi | 88.6 ± 5.5 | 26.1 ± 1.6 | 20.9 ± 2.2 | |
|  | Average | 91.6 ± 7.7 | 28.1 ± 2.2 | 20.7 ± 2.5 | |
|  |  |  |  |  | |
| Spain | Desmayo Largueta | 112.5 ± 12.4 | 33.8 ± 2.8 | 24.4 ± 2.5 | |
|  | Atocha | 98.5 ± 5.5 | 32.5 ± 2.1 | 31.1 ± 10.2 | |
|  | Desmayo Rojo | 103.7 ± 6.4 | 25.2 ± 1.9 | 27.6 ± 1.8 | |
|  | Marcona | 78.9 ± 3.7 | 23.0 ± 1.2 | 17.4 ± 2.6 | |
|  | Guarrigues | 72.4 ± 5.9 | 25.6 ± 3.3 | 25.2 ± 6.5 | |
|  | Planeta | 71.3 ± 4.5 | 22.6 ± 2.2 | 13.6 ± 1.2 | |
|  | Vivot | 79.6 ± 6.0 | 23.1 ± 2.3 | 24.4 ± 2.7 | |
|  | Average | 88.1 ± 6.3 | 26.5 ± 2.3 | 23.3 ± 3.9 | |
| **Table S1.**Continued | | | | | |
| Origin | Genotype | Leaf length | Leaf width | Petiole length | |
| France | AI | 75.9 ± 3.5 | 24.7 ± 1.6 | 16.7 ± 1.4 | |
|  | Fournat de Brezenaud | 93.4 ± 6.4 | 26.9 ± 1.6 | 24.4 ± 3.3 | |
|  | Fourcouronne | 76.2 ± 3.9 | 30.5 ± 8.0 | 19.5 ± 1.7 | |
|  | Ardechoise | 102.8 ± 6.3 | 29.6 ± 2.3 | 19.9 ± 2.5 | |
|  | Cornichon | 95.0 ± 4.7 | 26.0 ± 1.6 | 23.6 ± 1.9 | |
|  | Ferragnes | 91.0 ± 5.8 | 26.8 ± 2.2 | 19.6 ± 1.7 | |
|  | Average | 89.1 ± 5.1 | 27.4 ± 2.9 | 20.6 ± 2.1 | |
|  |  |  |  |  | |
| Italy | Rachelle | 90.7 ± 4.3 | 27.0 ± 1.9 | 21.3 ± 2.5 | |
|  | Tuono | 104.4 ± 5.9 | 29.9 ± 2.5 | 23.6 ± 1.7 | |
|  | Cristomorto | 77.8 ± 3.9 | 31.3 ± 2.0 | 16.8 ± 2.3 | |
|  | Xantini | 89.2 ± 8.1 | 25.0 ± 2.8 | 22.8 ± 4.1 | |
|  | Average | 90.5 ± 5.5 | 28.3 ± 2.3 | 21.1 ± 2.7 | |
|  |  |  |  |  | |
| Ukraine | Morskoi | 95.2 ± 7.4 | 27.8 ± 2.1 | 27.0 ± 4.0 | |
|  | Primorskij | 98.3 ± 6.1 | 28.8 ± 2.4 | 26.4 ± 3.2 | |
|  | Average | 96.8 ± 6.7 | 28.3 ± 2.2 | 26.7 ± 3.6 | |
|  |  |  |  |  | |
| Greece | Retsou | 79.5 ± 5.3 | 32.0 ± 3.2 | 22.8 ± 4.1 | |
|  |  |  |  |  | |
| Bulgaria | Nesserbe | 50.7 ± 4.8 | 16.1 ± 1.2 | 11.0 ± 2.1 | |
|  |  |  |  |  | |
| Syria | Douma 22 | 90.9 ± 5.5 | 30.9 ± 1.9 | 22.0 ± 12.0 | |
|  | Homs | 89.8 ± 4.2 | 27.6 ± 2.2 | 25.0 ± 3.1 | |
|  | A 4-4 SF | 98.6 ± 6.0 | 24.8 ± 2.4 | 25.1 ± 4.3 | |
|  | Dafadii | 83.6 ± 4.1 | 28.6 ± 2.2 | 19.6 ± 3.7 | |
|  | A 13-12 SF | 77.1 ± 6.1 | 24.6 ± 2.4 | 19.3 ± 2.8 | |
|  | Average | 88.0 ± 5.2 | 27.3 ± 2.2 | 22.2 ± 5.2 | |
|  |  |  |  |  | |
| USA | Ne Plus Ultra | 110.6 ± 6.9 | 33.1 ± 2.2 | 25.6 ± 2.5 | |
|  | Nonpareil | 75.4 ± 4.3 | 24.4 ± 1.3 | 22.6 ± 2.5 | |
|  | Kapareil | 65.9 ± 4.7 | 23.6 ± 2.4 | 16.7 ± 2.1 | |
|  | Texas | 91.8 ± 4.4 | 28.2 ± 1.3 | 23.7 ± 1.6 | |
|  | Thompson | 86.5 ± 5.8 | 31.5 ± 2.5 | 24.0 ± 3.3 | |
|  | Average | 86.0 ± 5.2 | 28.2 ± 1.9 | 22.5 ± 2.4 | |

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| **Table S2.** Quantitative nut traits of tested almond clones / cultivars | Double kernels (%) | | 13.3 ± 34.6 | 26.6 ± 45.0 | 10.0 ± 30.5 | 16.6 ± 37.9 | 20.0 ± 40.7 | 22.7 ± 42.9 | 6.7 ± 25.4 | 13.0 ± 34.4 | 6.7 ± 25.4 | 3.3 ± 18.3 | 10.0 ± 30.5 | 26.7 ± 45 | 3.3 ± 18.3 | 6.7 ± 25.4 | 70.0 ± 46.6 | 3.3 ± 18.3 | 36.7 ± 49.0 | 3.3 ± 18.3 | 43.3 ± 50.4 | 42.3 ± 50.4 | 40.0 ± 49.8 | 0.0 ± 0.0 | 3.3 ± 18.3 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 3.3 ± 18.3 | 6.7 ± 25.4 |
| Empty nuts (%) | | 0.0 ± 0.0 | 0.0 ± 0.0 | 3.3 ± 18.3 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 3.3 ± 18.3 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 |
| Sphericity index | | 2.0 ± 0.2 | 2.0 ± 0.1 | 1.9 ± 0.1 | 1.8 ± 0.1 | 2.3 ± 0.1 | 2.0 ± 0.1 | 2.0 ± 0.1 | 1.9 ± 0.1 | 1.9 ± 0.1 | 1.5 ± 0.1 | 2.3 ± 0.1 | 1.7 ± 0.1 | 1.5 ± 0.1 | 1.5 ± 0.1 | 2.1 ± 0.2 | 1.5 ± 0.1 | 1.7 ± 0.1 | 1.7 ± 0.1 | 1.8 ± 0.2 | 1.6 ± 0.1 | 2.2 ± 0.2 | 1.7 ± 0.1 | 1.8 ± 0.1 | 1.5 ± 0.1 | 1.5 ± 0.1 | 1.5 ± 0.1 | 1.5 ± 0.1 | 2.1 ± 0.1 | 1.5 ± 0.1 |
| Kernel percentage (%) | | 39.2 ± 4.5 | 39.7 ± 3.4 | 36.8 ± 3.1 | 25.5 ± 1.9 | 46.1 ± 3.8 | 26.7 ± 2.2 | 35.8 ± 1.9 | 48.7 ± 2.7 | 47.4 ± 2.9 | 47.5 ± 4.9 | 21.4 ± 1.7 | 41.6 ± 3.5 | 52.0 ± 4.9 | 46.6 ± 2.7 | 63.2 ± 3.2 | 22.0 ± 1.5 | 26.2 ± 3.0 | 18.6 ± 2.5 | 27.4 ± 2.6 | 27.1 ± 2.3 | 28.0 ± 3.2 | 23.5 ± 3.7 | 23.6 ± 1.9 | 25.0 ± 1.9 | 50.7 ± 2.6 | 65.5 ± 5.4 | 35.5 ± 2.9 | 54.2 ± 3.3 | 26.6 ± 4.1 |
|  | Thickness (mm) | 8.2 ± 1.3 | 8.7 ± 1.2 | 7.8 ± 1.2 | 8.0 ± 0.7 | 8.5 ± 1.1 | 8.1 ± 1.3 | 7.8 ± 0.6 | 7.8 ± 1.2 | 8.1 ± 0.8 | 8.7 ± 0.7 | 6.9 ± 0.9 | 9.6 ± 1.5 | 8.4 ± 1.1 | 9.0 ± 0.7 | 10.3 ± 1.6 | 7.7 ± 0.8 | 8.2 ± 1.3 | 7.6 ± 0.8 | 9.1 ± 1.7 | 10.6 ± 2.3 | 9.7 ± 1.6 | 7.4 ± 0.4 | 8.0 ± 1.1 | 7.4 ± 0.6 | 9.8 ± 0.6 | 7.7 ± 0.9 | 8.5 ± 0.7 | 7.4 ± 0.6 | 7.5 ± 1.2 |
|  | Width (mm) | 12.6 ± 0.9 | 13.1 ± 0.9 | 12.0 ± 0.7 | 12.3 ± 0.7 | 10.7 ± 1.0 | 15.9 ± 1.3 | 11.5 ± 0.6 | 13.3 ± 1.0 | 12.4 ± 0.8 | 14.4 ± 0.7 | 13.0 ± 0.9 | 13.8 ± 0.7 | 13.3 ± 0.9 | 13.7 ± 1.0 | 12.9 ± 0.9 | 15.5 ± 0.8 | 13.2 ± 0.8 | 13.4 ± 0.6 | 13.6 ± 0.8 | 15.0 ± 1.3 | 13.2 ± 0.9 | 12.1 ± 0.7 | 13.2 ± 0.7 | 13.2 ± 0.7 | 13.9 ± 0.5 | 12.5 ± 0.4 | 16.0 ± 1.0 | 11.8 ± 0.6 | 13.4 ± 0.6 |
|  | Length (mm) | 25.7 ± 2.4 | 26.5 ± 1.9 | 23.2 ± 1.1 | 21.7 ± 1.0 | 24.4 ± 1.9 | 32.1 ± 2.2 | 23.1 ± 0.8 | 24.6 ± 1.8 | 23.7 ± 1.1 | 21.5 ± 1.1 | 30.4 ± 1.7 | 24.0 ± 1.1 | 19.7 ± 1.0 | 20.5 ± 1.0 | 27.1 ± 1.6 | 23.4 ± 0.9 | 22.3 ± 1.3 | 22.0 ± 1.3 | 23.8 ± 2.0 | 24.4 ± 1.8 | 28.8 ± 2.0 | 20.8 ± 1.0 | 23.6 ± 1.4 | 20.3 ± 1.4 | 20.9 ± 1.1 | 18.6 ± 1.1 | 24.6 ± 1.3 | 24.6 ± 1.5 | 20.4 ± 0.9 |
| Kernel | Weight (g) | 1.3 ± 0.3 | 1.5 ± 0.3 | 1.1 ± 0.2 | 1.1 ± 0.2 | 1.1 ± 0.3 | 2.0 ± 0.4 | 1.0 ± 0.1 | 1.3 ± 0.3 | 1.1 ± 0.2 | 1.2 ± 0.1 | 1.3 ± 0.3 | 1.4 ± 0.3 | 1.0 ± 0.2 | 1.1 ± 0.2 | 1.6 ± 0.3 | 1.2 ± 0.2 | 1.2 ± 0.2 | 1.1 ± 0.2 | 1.2 ± 0.3 | 1.8 ± 0.5 | 1.6 ± 0.4 | 0.8 ± 0.1 | 1.2 ± 0.2 | 1.0 ± 0.1 | 1.2 ± 0.1 | 0.9 ± 0.1 | 1.4 ± 0.2 | 1.0 ± 0.1 | 0.9 ± 0.2 |
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|  | Thickness (mm) | 17.1 ± 1.2 | 17.4 ± 1.1 | 16.4 ± 1.0 | 15.4 ± 0.7 | 14.9 ± 1.3 | 19.1 ± 1.5 | 15.7 ± 0.7 | 15.0 ± 1.5 | 14.1 ± 1.1 | 16.5 ± 0.6 | 15.7 ± 1.1 | 17.2 ± 1.1 | 14.5 ± 1.1 | 16.1 ± 0.9 | 14.5 ± 1.7 | 17.0 ± 1.1 | 15.4 ± 1.2 | 17.6 ± 0.8 | 16.1 ± 1.4 | 20.6 ± 2.5 | 17.3 ± 1.4 | 15.9 ± 0.7 | 17.1 ± 0.8 | 14.9 ± 0.7 | 16.3 ± 0.7 | 12.8 ± 0.7 | 17.9 ± 1.0 | 13.8 ± 0.6 | 16.2 ± 0.7 |
|  | Width (mm) | 22.0 ± 1.0 | 22.5 ± 1.0 | 21.8 ± 1.1 | 20.7 ± 0.8 | 18.7 ± 1.5 | 27.3 ± 1.7 | 20.8 ± 1.0 | 22.6 ± 1.2 | 21.4 ± 1.2 | 23.0 ± 1.1 | 24.3 ± 1.2 | 22.7 ± 1.2 | 20.8 ± 1.2 | 21.5 ± 1.1 | 20.7 ± 1.1 | 25.1 ± 1.1 | 21.5 ± 0.9 | 23.3 ± 1.0 | 21.6 ± 0.8 | 25.5 ± 1.8 | 22.2 ± 1.0 | 19.5 ± 1.1 | 22.1 ± 0.9 | 22.7 ± 1.2 | 21.7 ± 0.8 | 19.2 ± 0.7 | 25.9 ± 1.3 | 19.9 ± 1.2 | 21.5 ± 0.7 |
|  | Length (mm) | 36.2 ± 2.8 | 37.3 ± 1.9 | 33.2 ± 1.3 | 29.6 ± 1.2 | 34.3 ± 2.8 | 46.0 ± 3.2 | 32.3 ± 3.7 | 38.0 ± 2.1 | 34.5 ± 1.7 | 27.8 ± 1.6 | 44.4 ± 2.1 | 33.3 ± 1.8 | 26.0 ± 1.3 | 25.9 ± 1.3 | 38.2 ± 1.9 | 33.1 ± 1.0 | 32.4 ± 1.3 | 32.8 ± 1.4 | 31.1 ± 2.1 | 37.5 ± 2.7 | 39.1 ± 1.7 | 27.8 ± 1.4 | 34.3 ± 1.6 | 28.4 ± 2.3 | 29.2 ± 1.3 | 24.4 ± 2.3 | 33.5 ± 1.7 | 34.7 ± 2.2 | 28.4 ± 2.2 |
| Nut | Weight (g) | 3.4 ± 0.6 | 3.7 ± 0.6 | 2.9 ± 0.5 | 4.1 ± 0.4 | 2.4 ± 0.5 | 7.4 ± 1.3 | 2.7 ± 0.3 | 2.7 ± 0.6 | 2.4 ± 0.4 | 2.5 ± 0.2 | 6.2 ± 0.9 | 3.4 ± 0.6 | 1.9 ± 0.4 | 2.4 ± 0.4 | 2.6 ± 0.4 | 5.5 ± 0.6 | 4.5 ± 0.5 | 5.8 ± 0.6 | 4.4 ± 0.6 | 6.5 ± 1.4 | 5.7 ± 0.8 | 3.6 ± 0.5 | 5.0 ± 0.6 | 3.8 ± 0.5 | 2.5 ± 0.3 | 1.3 ± 0.2 | 4.0 ± 0.5 | 1.9 ± 0.3 | 3.4 ± 0.3 |
| Genotype | | INRA/T1 | INRA/3134 | Timid/6R | B1/22R | B1/7R | B1/5R | B1/S2 | B2/14R | B2/11R | Toundout/1R | Tiliwine | Amekchoud/3J | Ircheg/2R | Ighri/1R | Ighri/12B | Hart/16 | Khorbat/3J | V4 | V7 | V23 | V24 | Rislane 2 | AitAbdellah 6 | LI Meknes | Bualuzen | De Safi | Beni Ouklane | Sultane de Sefrou | CF5 |
| Origin | | Morocco |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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| **Table S2.** Continued | Double kernels (%) | | 6.7 ± 25.4 | 0.0 ± 0.0 | 10.0 ± 30.5 | 0.0 ± 0.0 | 13.8 ± 25.9 |  | 16.7 ± 37.9 | 0.0 ± 0.0 | 0.0 ± 0.0 | 10.0 ± 30.5 | 6.7 ± 17.1 |  | 0.0 ± 0.0 | 3.3 ± 18.3 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 16.7 ± 37.9 | 3.3 ± 18.3 | 3.3 ± 10.6 |  | 0.0 ± 0.0 | 3.3 ± 18.3 | 0.0 ± 0.0 | 20.0 ± 41.4 | 6.7 ± 25.4 | 0.0 ± 0.0 | 5.0 ± 14.2 |
| Empty nuts (%) | | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.2 ± 1.1 |  | 0.0 ± 0.0 | 0.0 ± 0.0 | 3.3 ± 18.3 | 0.0 ± 0.0 | 0.8 ± 4.6 |  | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 6.7 ± 25.4 | 3.3 ± 18.3 | 0.0 ± 0.0 | 1.4 ± 6.2 |  | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 |
| Sphericity index | | 1.9 ± 0.1 | 1.6 ± 0.1 | 1.7 ± 0.1 | 1.5 ± 0.1 | 1.8 ± 0.1 |  | 1.6 ± 0.1 | 1.6 ± 0.1 | 1.8 ± 0.1 | 1.6 ± 0.1 | 1.7 ± 0.1 |  | 1.8 ± 0.1 | 2.0 ± 0.1 | 1.6 ± 0.1 | 1.3 ± 0.1 | 1.5 ± 0.1 | 1.6 ± 0.1 | 1.8 ± 0.1 | 1.7 ± 0.1 |  | 2.3 ± 0.2 | 1.8 ± 0.1 | 1.9 ± 0.1 | 2.0 ± 0.2 | 1.8 ± 0.1 | 1.9 ± 0.1 | 1.9 ± 0.1 |
| Kernel percentage (%) | | 26.1 ± 2.7 | 25.3 ± 1.5 | 35.8 ± 2.8 | 23.6 ± 1.4 | 35.8 ± 2.9 |  | 42.8 ± 6.1 | 44.0 ± 2.7 | 27.5 ± 1.8 | 32.0 ± 2.5 | 36.6 ± 3.3 |  | 29.1 ± 1.3 | 28.5 ± 1.8 | 25.8 ± 2.0 | 24.6 ± 1.4 | 26.0 ± 4.0 | 29.5 ± 2.3 | 30.3 ± 1.5 | 27.7 ± 2.0 |  | 28.1 ± 1.1 | 38.1 ± 4.6 | 29.5 ± 2.1 | 53.5 ± 6.0 | 41.0 ± 3.4 | 31.1 ± 2.4 | 36.9 ± 3.3 |
|  | Thickness (mm) | 7.2 ± 1.1 | 8.0 ± 0.6 | 8.3 ± 1.0 | 8.3 ± 0.6 | 8.3 ± 1.0 |  | 9.1 ± 1.6 | 8.1 ± 0.4 | 7.3 ± 0.3 | 8.5 ± 0.9 | 8.3 ± 0.8 |  | 8.1 ± 0.4 | 8.1 ± 0.6 | 8.4 ± 0.5 | 7.5 ± 0.4 | 7.2 ± 1.1 | 9.4 ± 1.1 | 8.8 ± 0.7 | 8.2 ± 0.7 |  | 7.5 ± 0.2 | 7.7 ± 0.8 | 7.2 ± 0.4 | 8.2 ± 1.7 | 8.4 ± 0.9 | 8.2 ± 0.6 | 7.8 ± 0.8 |
|  | Width (mm) | 15.2 ± 1.0 | 14.8 ± 0.6 | 13.6 ± 0.6 | 17.7 ± 1.0 | 13.5 ± 0.8 |  | 15.2 ± 1.0 | 14.2 ± 0.7 | 12.7 ± 0.6 | 14.7 ± 1.0 | 14.2 ± 0.8 |  | 13.4 ± 0.7 | 13.4 ± 0.5 | 13.0 ± 0.7 | 15.6 ± 0.7 | 15.3 ± 1.1 | 12.5 ± 1.0 | 13.8 ± 0.7 | 13.8 ± 0.8 |  | 10.3 ± 0.5 | 15.2 ± 0.8 | 12.6 ± 0.7 | 14.2 ± 1.4 | 14.1 ± 0.6 | 14.4 ± 0.8 | 13.5 ± 0.8 |
|  | Length (mm) | 27.7 ± 2.3 | 23.3 ± 1.0 | 23.4 ± 0.9 | 26.3 ± 1.1 | 23.9 ± 1.4 |  | 24.1 ± 1.3 | 22.0 ± 1.3 | 22.8 ± 1.2 | 22.7 ± 1.2 | 22.9 ± 1.3 |  | 24.5 ± 1.3 | 26.6 ± 1.2 | 20.0 ± 1.1 | 20.0 ± 0.9 | 23.2 ± 2.0 | 20.5 ± 1.4 | 24.9 ± 0.9 | 22.8 ± 1.2 |  | 23.5 ± 0.9 | 27.0 ± 1.4 | 23.5 ± 0.9 | 27.7 ± 3.0 | 25.2 ± 1.1 | 27.5 ± 1.4 | 25.7 ± 1.4 |
| Kernel | Weight (g) | 1.4 ± 0.3 | 1.1 ± 0.1 | 1.2 ± 0.2 | 1.9 ± 0.2 | 1.3 ± 0.2 |  | 1.6 ± 0.4 | 1.2 ± 0.1 | 1.0 ± 0.1 | 1.4 ± 0.2 | 1.3 ± 0.2 |  | 1.2 ± 0.1 | 1.3 ± 0.1 | 1.0 ± 0.1 | 1.1 ± 0.1 | 1.2 ± 0.2 | 1.1 ± 0.3 | 1.4 ± 0.2 | 1.2 ± 0.2 |  | 0.9 ± 0.1 | 1.4 ± 0.2 | 1.1 ± 0.1 | 1.5 ± 0.5 | 1.3 ± 0.1 | 1.4 ± 0.2 | 1.3 ± 0.2 |
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|  | Thickness (mm) | 15.9 ± 1.0 | 16.6 ± 0.8 | 15.1 ± 0.8 | 20.3 ± 1.0 | 16.3 ± 1.0 |  | 18.6 ± 1.5 | 15.4 ± 0.6 | 13.3 ± 0.5 | 17.1 ± 0.9 | 16.1 ± 0.9 |  | 14.2 ± 2.5 | 16.2 ± 0.7 | 16.7 ± 0.7 | 17.6 ± 0.8 | 17.7 ± 1.3 | 16.2 ± 1.2 | 15.9 ± 0.7 | 16.4 ± 1.1 |  | 13.1 ± 0.4 | 16.5 ± 0.9 | 14.8 ± 0.6 | 13.7 ± 1.8 | 16.7 ± 0.8 | 16.6 ± 0.8 | 15.2 ± 0.9 |
|  | Width (mm) | 25.2 ± 1.3 | 23.3 ± 0.9 | 21.0 ± 0.7 | 29.2 ± 1.5 | 22.5 ± 1.1 |  | 26.2 ± 1.4 | 23.3 ± 1.2 | 19.8 ± 0.8 | 24.7 ± 1.3 | 23.5 ± 1.2 |  | 22.4 ± 1.2 | 21.5 ± 0.9 | 23.2 ± 1.3 | 25.0 ± 0.9 | 24.0 ± 1.4 | 22.1 ± 1.2 | 21.6 ± 0.9 | 22.8 ± 1.1 |  | 17.6 ± 0.8 | 25.1 ± 1.3 | 20.4 ± 0.9 | 22.8 ± 2.1 | 24.5 ± 1.2 | 23.7 ± 1.4 | 22.3 ± 1.3 |
|  | Length (mm) | 41.8 ± 2.3 | 32.6 ± 1.4 | 32.8 ± 1.1 | 41.6 ± 1.8 | 33.7 ± 1.9 |  | 34.8 ± 2.0 | 29.3 ± 1.6 | 31.8 ± 1.5 | 35.6 ± 1.8 | 32.9 ± 1.7 |  | 33.5 ± 2.4 | 35.0 ± 1.5 | 29.2 ± 1.4 | 29.2 ± 1.2 | 30.6 ± 2.3 | 27.5 ± 1.5 | 34.4 ± 1.8 | 31.4 ± 1.7 |  | 31.7 ± 1.5 | 35.9 ± 1.9 | 30.3 ± 1.4 | 44.7 ± 3.0 | 36.8 ± 1.8 | 37.7 ± 2.1 | 36.2 ± 2.0 |
| Nut | Weight (g) | 5.5 ± 0.9 | 4.5 ± 0.5 | 3.3 ± 0.3 | 7.9 ± 0.9 | 3.9 ± 0.6 |  | 3.6 ± 0.7 | 2.7 ± 0.3 | 3.4 ± 0.4 | 4.3 ± 0.7 | 3.5 ± 0.5 |  | 4.2 ± 0.5 | 4.7 ± 0.5 | 3.7 ± 0.4 | 4.3 ± 0.5 | 4.3 ± 0.8 | 3.6 ± 0.6 | 4.6 ± 0.5 | 4.2 ± 0.6 |  | 3.2 ± 0.3 | 3.8 ± 0.6 | 3.7 ± 0.4 | 2.7 ± 0.9 | 3.3 ± 0.4 | 4.6 ± 0.5 | 3.6 ± 0.5 |
| Genotype | | AT8 | Ksar Souk | AinLeuh | Molar de Sale | Average |  | Abiod | Heich Ben Smail | Abiod Ras Djebel | Khoukhi | Average |  | DesmayoLargueta | Atocha | DesmayoRojo | Marcona | Garrigues | Planeta | Vivot | Average |  | AI | Fournat de Brezenoud | Fourcouronne | Ardechoise | Cornichon | Ferragnes | Average |
| Origin | | Morocco |  |  |  |  |  | Tunisia |  |  |  |  |  | Spain |  |  |  |  |  |  |  |  | France |  |  |  |  |  |  |

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| **Table S2.** Continued | Double kernels (%) | | 0.0 ± 0.0 | 0.0 ± 0.0 | 13.3 ± 34.6 | 6.7 ± 25.4 | 5.0 ± 15.0 |  | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 |  | 10.0 ± 30.5 |  | 16.7 ± 37.9 |  | 6.7 ± 25.4 | 3.3 ± 18.3 | 6.7 ± 25.4 | 0.0 ± 0.0 | 0.0 ± 0.0 | 3.3 ± 13.8 |  | 10.0 ± 30.5 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 2.0 ± 6.1 |
| Empty nuts (%) | | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 3.3 ± 18.3 | 0.8 ± 4.6 |  | 0.0 ± 0.0 | 6.7 ± 25.4 | 3.3 ± 12.7 |  | 0.0 ± 0.0 |  | 0.0 ± 0.0 |  | 3.3 ± 18.3 | 0.0 ± 0.0 | 3.3 ± 18.3 | 0.0 ± 0.0 | 0.0 ± 0.0 | 1.3 ± 7.3 |  | 0.0 ± 0.0 | 0.0 ± 0.0 | 3.3 ± 18.3 | 0.0 ± 0.0 | 3.3 ± 18.3 | 1.3 ± 7.3 |
| Sphericity index | | 1.6 ± 0.1 | 1.5 ± 0.1 | 1.5 ± 0.1 | 1.7 ± 0.1 | 1.6 ± 0.1 |  | 1.9 ± 0.1 | 2.0 ± 0.1 | 1.9 ± 0.1 |  | 2.4 ± 0.1 |  | 1.9 ± 0.1 |  | 2.5 ± 0.2 | 1.5 ± 0.1 | 1.6 ± 0.1 | 2.1 ± 0.1 | 1.6 ± 0.1 | 1.9 ± 0.1 |  | 2.1 ± 0.1 | 1.8 ± 0.1 | 1.8 ± 0.1 | 1.6 ± 0.1 | 1.7 ± 0.1 | 1.8 ± 0.1 |
| Kernel percentage (%) | | 46.3 ± 3.3 | 30.8 ± 4.1 | 27.3 ± 2.5 | 24.1 ± 1.3 | 32.1 ± 2.8 |  | 51.1 ± 5.2 | 59.1 ± 3.9 | 55.1 ± 4.6 |  | 57.6 ± 3.2 |  | 48.9 ± 2.5 |  | 38.4 ± 3.6 | 47.9 ± 2.7 | 38.9 ± 1.6 | 21.0 ± 2.4 | 58.0 ± 2.7 | 40.8 ± 2.6 |  | 54.4 ± 3.6 | 59.2 ± 3.8 | 59.0 ± 3.2 | 50.1 ± 5.5 | 59.9 ± 5.3 | 56.5 ± 4.3 |
|  | Thickness (mm) | 7.8 ± 0.6 | 8.6 ± 0.7 | 7.8 ± 1.3 | 8.9 ± 0.8 | 8.3 ± 0.8 |  | 8.4 ± 0.5 | 9.3 ± 0.7 | 8.8 ± 0.6 |  | 9.1 ± 0.8 |  | 8.5 ± 1.0 |  | 8.3 ± 1.2 | 10.2 ± 0.7 | 8.0 ± 1.2 | 7.2 ± 0.4 | 8.1 ± 0.6 | 8.3 ± 0.8 |  | 7.7 ± 0.9 | 7.7 ± 0.3 | 7.2 ± 0.5 | 9.5 ± 0.6 | 7.9 ± 1.0 | 8.0 ± 0.7 |
|  | Width (mm) | 14.1 ± 0.6 | 13.0 ± 0.7 | 15.4 ± 0.9 | 15.5 ± 1.0 | 14.5 ± 0.8 |  | 13.0 ± 0.9 | 14.8 ± 1.0 | 13.9 ± 0.9 |  | 11.4 ± 0.6 |  | 13.5 ± 1.1 |  | 15.2 ± 1.0 | 12.9 ± 0.5 | 15.1 ± 1.0 | 15.9 ± 1.0 | 11.8 ± 0.4 | 14.2 ± 0.8 |  | 12.2 ± 0.7 | 12.0 ± 0.5 | 11.9 ± 0.7 | 12.9 ± 1.0 | 12.2 ± 0.7 | 12.2 ± 0.7 |
|  | Length (mm) | 21.8 ± 1.2 | 19.9 ± 1.0 | 23.5 ± 1.1 | 26.3 ± 1.5 | 22.9 ± 1.2 |  | 24.2 ± 1.2 | 29.5 ± 1.8 | 26.9 ± 1.5 |  | 26.8 ± 1.3 |  | 25.2 ± 1.5 |  | 38.5 ± 2.6 | 19.4 ± 0.8 | 24.7 ± 1.2 | 33.8 ± 1.3 | 18.6 ± 0.8 | 27.0 ± 1.3 |  | 25.4 ± 1.2 | 22.0 ± 1.1 | 21.9 ± 1.4 | 20.0 ± 1.2 | 21.1 ± 1.4 | 22.1 ± 1.2 |
| Kernel | Weight (g) | 1.1 ± 0.1 | 1.0 ± 0.2 | 1.3 ± 0.2 | 1.7 ± 0.3 | 1.2 ± 0.2 |  | 1.2 ± 0.2 | 1.8 ± 0.2 | 1.5 ± 0.2 |  | 1.3 ± 0.2 |  | 1.4 ± 0.3 |  | 2.4 ± 0.5 | 1.1 ± 0.1 | 1.3 ± 0.2 | 1.8 ± 0.3 | 0.9 ± 0.1 | 1.5 ± 0.2 |  | 1.1 ± 0.2 | 1.0 ± 0.1 | 0.9 ± 0.1 | 1.1 ± 0.2 | 1.0 ± 0.2 | 1.0 ± 0.1 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | Thickness (mm) | 16.5 ± 0.8 | 17.3 ± 0.6 | 17.0 ± 1.1 | 18.8 ± 0.9 | 17.4 ± 0.8 |  | 14.9 ± 0.8 | 14.3 ± 0.8 | 14.6 ± 0.8 |  | 13.3 ± 0.9 |  | 15.0 ± 1.3 |  | 17.3 ± 1.8 | 16.2 ± 0.7 | 16.6 ± 1.0 | 17.3 ± 0.8 | 13.9 ± 0.7 | 16.3 ± 1.0 |  | 14.1 ± 1.0 | 13.7 ± 0.7 | 13.3 ± 0.6 | 15.7 ± 0.7 | 13.8 ± 0.8 | 14.1 ± 0.8 |
|  | Width (mm) | 23.1 ± 0.9 | 22.0 ± 1.2 | 23.4 ± 1.1 | 27.0 ± 1.4 | 23.9 ± 1.2 |  | 20.2 ± 1.1 | 22.4 ± 1.3 | 21.3 ± 1.2 |  | 17.6 ± 0.9 |  | 20.8 ± 1.5 |  | 29.0 ± 2.4 | 20.1 ± 0.8 | 24.7 ± 1.3 | 28.9 ± 1.5 | 19.3 ± 0.7 | 24.4 ± 1.3 |  | 20.3 ± 1.2 | 20.2 ± 0.7 | 19.9 ± 1.2 | 20.4 ± 0.8 | 19.7 ± 0.6 | 20.1 ± 0.9 |
|  | Length (mm) | 31.1 ± 1.2 | 28.5 ± 1.7 | 34.9 ± 1.7 | 38.5 ± 2.2 | 33.2 ± 1.7 |  | 33.9 ± 1.7 | 38.9 ± 2.6 | 36.4 ± 2.2 |  | 32.9 ± 1.5 |  | 32.3 ± 1.7 |  | 71.1 ± 6.7 | 26.6 ± 1.0 | 34.6 ± 2.3 | 50.7 ± 2.7 | 25.9 ± 1.0 | 41.8 ± 2.7 |  | 35.5 ± 1.6 | 30.7 ± 1.7 | 30.9 ± 1.9 | 27.7 ± 1.1 | 28.8 ± 1.4 | 30.7 ± 1.6 |
| Nut | Weight (g) | 2.3 ± 0.3 | 3.2 ± 0.3 | 4.6 ± 0.6 | 6.8 ± 1.0 | 4.2 ± 0.6 |  | 2.4 ± 0.3 | 2.9 ± 0.6 | 2.7 ± 0.7 |  | 2.2 ± 0.3 |  | 2.8 ± 0.6 |  | 6.1 ± 1.4 | 2.3 ± 0.3 | 3.3 ± 0.6 | 8.6 ± 1.0 | 1.5 ± 0.1 | 4.4 ± 0.7 |  | 2.1 ± 0.3 | 1.7 ± 0.2 | 1.5 ± 0.2 | 2.1 ± 0.2 | 1.6 ± 0.3 | 1.8 ± 0.3 |
| Genotype | | Rachelle | Tuono | Cristomorto | Xantini | Average |  | Morskoi | Primorskij | Average |  | Retsou |  | Nesserbe |  | Douma 22 | Homs | A 4-4 SF | Dafadii | A 13-12 SF | Average |  | Ne Plus Ultra | Nonpareil | Kapareil | Texas | Thompson | Average |
| Origin | | Italy |  |  |  |  |  | Ukraine |  |  |  | Greece |  | Bulgaria |  | Syria |  |  |  |  |  |  | USA |  |  |  |  |  |

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| **Table S3.** Cluster means for 15 traits estimated in 68 genotypes of almond | | | | |
| Trait | Unit/code | Cluster | | |
| A | B1 | B2 |
| Leaf length | mm | 87.4 | 85.0 | 64.2 |
| Leaf width | mm | 29.3 | 27.2 | 21.1 |
| Petiole length | mm | 19.8 | 21.3 | 15.3 |
| Nut weight | g | 6.1 | 3.2 | 3.2 |
| Nut length | mm | 43.2 | 32.0 | 33.0 |
| Nut width | mm | 26.4 | 22.0 | 21.0 |
| Nut thickness | mm | 18.0 | 15.6 | 15.6 |
| Kernel weight | g | 1.7 | 1.2 | 1.2 |
| Kernel length | mm | 28.6 | 22.9 | 24.0 |
| Kernel width | mm | 15.3 | 13.5 | 12.6 |
| Kernel thickness | mm | 8.3 | 8.2 | 8.5 |
| Sphericity index | − | 1.9 | 1.7 | 1.9 |
| Kernel percentage | % | 28.6 | 39.6 | 39.7 |
| Empty nuts | % | 0.6 | 0.9 | 0.0 |
| Double kernels | % | 10.5 | 5.0 | 18.9 |