**Supplementary Material**

**Table S1**. Geographic origin of 40 *Lathyrus* accessions.

| Sample ID | Section | *Lathyrus* spp | Mating system | Origin |
|---|---|---|---|---|
| 1 | Lathyrus | *Lathyrus sativus* | Mainly autogamous | Syria |
| 2 | | | | Ethiopia |
| 3 | | | | Ethiopia |
| 4 | | | | Ethiopia |
| 5 | | | | Ethiopia |
| 6 | | | | Ethiopia |
| 7 | | | | Ethiopia |
| 8 | | | | Italy |
| 9 | | | | Ethiopia |
| 10 | | | | Ethiopia |
| 11 | | | | Ethiopia |
| 12 | | | | Ethiopia |
| 13 | | | | Ethiopia |
| 14 | Lathyrus | *Lathyrus cicera* | Mainly autogamous | Australia |
| 15 | | | | Greece |
| 16 | | | | Australia |
| 17 | | | | Greece |
| 18 | | | | Syria |
| 19 | | | | Greece |
| 20 | | | | Greece |
| 21 | | | | Greece |
| 22 | | | | Greece |
| 23 | | | | Greece |
| 24 | | | | Greece |
| 25 | | | | Greece |
| 26 | | | | Greece |
| 27 | | | | Greece |
| 28 | | | | Greece |
| 29 | Clymenum | *Lathyrus ochrus* | Autogamous | Greece |
| 30 | | | | Germany |
| 31 | | | | Greece |
| 32 | | | | Cyprus |
| 33 | | | | Greece |
| 34 | | | | Cyprus |
| 35 | | | | Greece |
| 36 | | | | Greece |
| 37 | | | | Greece |
| 38 | | | | Cyprus |
| 39 | | | | Greece |
| 40 | | | | Cyprus |

**Table S2.** Traits measured in the evaluation of the forty (40) *Lathyrus* accessions from seven diverse origins in 2013/14, 2014/15 and 2015/16 seasons

| **Traits** | **Definition** | **Unit** |
|---|---|---|
| Days to flowering (DF) | From planting to 50% plants flowering | Days |
| Biomass production (Biomass) | Aboveground dry biomass weight per hectare | t $ha^{-1}$ |
| Grain yield (GY) | Grains weight per hectare at 13% humidity | t $ha^{-1}$ |
| seed weight (1000SW) | Weight of 1000 seeds randomly sampled from each plot | g |
| Harvest index | Ratio of grain yield and total dry above ground biomass | # |
| Protein content | Estimated according to Kjeldahl method (Tkachuk, 1969) | % |

**Table S3.** Microsatellite primer pairs (SSR), motif and expected size range used for the genetic characterization of *Lathyrus* collection.

| SSR | Repeat motif | Forward primer | Revers primer | Size range |
|---|---|---|---|---|
| G5 | (AAC)10 | CACAACCAGTTGCATCAGTG | TGGCTCACATGATGGTTTGT | 200-220 (Wand et al. 2015) |
| G26 | (AC)16 | CCACCAAATTTCCCTTTTTG | GGTACGAGAGGTTGACTTTTGTTT | 160-197 (this study) |
| G67 | (AC)9 | CACCCTCTTCACTGCCTAGC | TTGGGGGTTGTAGAAGGAAC | 132-150 (this study) |
| G157 | (CAA)6 | ACATCCAATCCCCACCATAA | AATGCATGGTTGTTGCTTGA | 189-234 (this study) |
| G245 | (TG)6 | CGTTGGTTGTTAGTCGGTCA | GAACGAAACAACGACGACAA | 220-240 (Wang et al. 2015) |
| G17922 | (CCA)5 | CACCACCATAACCACCTCCT | ATGCGATTGAAGGGATGAAC | 177-228 (this study) |
| G18078 | (TGT)8 | TTCAGATGCAGGTGGTTCAG | AACGGTGCGACTCTTGCTAT | 108-154 (this study) |
| G18109 | (CGA)5 | GACAGACACACGGCAAACAC | ACGTCGTCGTGTCGTTGTT | 170-200 (Wang et al. 2015) |
| G18549 | (GTT)5 | TGAGGGTGTTTGAACGTGAG | CACCACAACAACAACAACCAC | 140-170 (Wang et al. 2015) |
| G19207 | (AAG)5 | ATCGTAAACCGTGAGGGTCA | AAGCTTGTGGTGGCTACTGC | 200-210 (Wang et al. 2015) |

**Table S4** Three-years means of agro-morphological traits in the accessions of three *Lathyrus* spp.

| Specie | Acc. | Origin | 1000SW | GY | Biomass | DF | Protein | HI |
|---|---|---|---|---|---|---|---|---|
| ***L. sativus*** | 1 | Syria | 77.48ab | 2.91ab | 8.19a | 96.22ab | 30.96ab | 0.36ab |
| | 2 | Ethiopia | 76.45ab | 3.11a | 8.37a | 96.55ab | 30.36b | 0.37a |
| | 3 | Ethiopia | 76.75ab | 2.81ab | 8.16a | 95b | 31.17a | 0.36ab |
| | 4 | Ethiopia | 71.32b | 3.06a | 7.28b | 99.22a | 30.62ab | 0.36ab |
| | 5 | Ethiopia | 76.35ab | 2.58b | 6.94c | 96.33ab | 30.98ab | 0.36ab |
| | 6 | Ethiopia | 74.75ab | 2.96a | 7.21b | 96.66ab | 30.52b | 0.39a |
| | 7 | Ethiopia | 80.02ab | 2.49b | 7.21bc | 95.55b | 31.23a | 0.35b |
| | 8 | Italy | 72.17b | 2.55b | 7.19bc | 97.88ab | 31.08a | 0.34b |
| | 9 | Ethiopia | 76.54ab | 2.53b | 6.93c | 94.33b | 30.32b | 0.34b |
| | 10 | Ethiopia | 74.27ab | 2.76ab | 7.62ab | 95b | 30.19 | 0.35b |
| | 11 | Ethiopia | 81.54a | 2.58b | 7.55ab | 95.77b | 30.1b | 0.36ab |
| | 12 | Ethiopia | 74.86ab | 2.42b | 8.3a | 98a | 30.52b | 0.3c |
| | 13 | Ethiopia | 72.24b | 2.76ab | 7.33b | 99.11a | 30.67ab | 0.35b |
| ***L. cicera*** | 1 | Australia | 70.7bc | 3.7a | 8.7a | 99a | 26.98b | 0.43ab |
| | 2 | Greece | 71.1bc | 3.7a | 8.63a | 99.66a | 28.84a | 0.42b |
| | 3 | Australia | 69.2bc | 3.8a | 8.85a | 98.11ab | 27.36b | 0.42b |
| | 4 | Greece | 68.9bc | 3.2c | 7.93b | 98.22ab | 28.93a | 0.38c |
| | 5 | Syria | 70.3bc | 3.3b | 7.59c | 98.77a | 27.69ab | 0.4bc |
| | 6 | Greece | 76.2ab | 3.5ab | 8.04b | 97.88b | 26.23c | 0.45a |
| | 7 | Greece | 73.0abc | 3.4ab | 8.08b | 97.55b | 27.08b | 0.43ab |
| | 8 | Greece | 64.2c | 3.78a | 8.38ab | 99.11a | 27.62ab | 0.44a |
| | 9 | Greece | 69.4bc | 3.3b | 8.14b | 98.77a | 26.64bc | 0.45a |
| | 10 | Greece | 70.7bc | 3.36b | 7.97b | 100.11a | 28.8a | 0.38c |
| | 11 | Greece | 71.7bc | 3.2c | 7.73bc | 97.33bc | 27.87ab | 0.41b |
| | 12 | Greece | 69.4bc | 3.27bc | 7.81bc | 98.33ab | 27.62ab | 0.42b |
| | 13 | Greece | 70.6bc | 3.5ab | 8.43ab | 97.44b | 27.33b | 0.4bc |
| | 14 | Greece | 82a | 3.5ab | 8.51ab | 96.33c | 27.47b | 0.39bc |
| | 15 | Greece | 75.5bc | 3.29bc | 7.99b | 98.44ab | 27.08b | 0.41b |
| ***L. ochrus*** | 1 | Greece | 107.72b | 2.07b | 6.19d | 93.88c | 29.32b | 0.36ab |
| | 2 | Germany | 101.4c | 2.3ab | 6.93b | 97.77ab | 30.36ab | 0.32b |
| | 3 | Greece | 115.89a | 2.36ab | 6.15d | 93.77c | 29.75b | 0.36ab |
| | 4 | Cyprus | 95.4cd | 2.2b | 7.33a | 96.33b | 29.63b | 0.3bc |
| | 5 | Greece | 106.58b | 2.52a | 7.46a | 95.44bc | 29.18b | 0.35ab |
| | 6 | Cyprus | 98.32c | 2.09b | 7.39a | 99.66a | 31.4a | 0.29c |
| | 7 | Greece | 106.13b | 2.09b | 7b | b | 30.89ab | 0.31b |
| | 8 | Greece | 92.04d | 2.44a | 6.38c | 92.88c | 29.54b | 0.38a |
| | 9 | Greece | 102.07bc | 2.24b | 6.81b | 96.22b | 30.72ab | 0.33b |
| | 10 | Cyprus | 103.8bc | 2.01c | 6.58bc | 95.22bc | 30.72ab | 0.29c |
| | 11 | Greece | 110.62ab | 2.37ab | 7.43a | 95.55bc | 30.37ab | 0.33b |
| | 12 | Cyprus | 102.14bc | 2.23b | 7.37a | 96b | 30.57ab | 0.3bc |

1000SW, 1000 seed weight (g); GY, Grain Yield (t $ha^{-1}$); Biomass, Biomass production (t $h^{-1}$); Protein (%); DF, Day to Flowering (day); Protein, protein content (%); HI, Harvest Index.

**Table S5**. Pearson's correlation between agronomic traits for each *Lathyrus* spp.

| | | 1000SW | GY | Biomass | DF | HI |
|---|---|---|---|---|---|---|
| ***L. sativus*** | 1000SW | | | | | |
| | GY | -0.2967 | | | | |
| | Biomass | 0.1513 | 0.3060 | | | |
| | DF | **-0.6752** | 0.2087 | -0.0122 | | |
| | HI | 0.0925 | **0.7015** | -0.2162 | -0.1506 | |
| | Protein | -0.0383 | -0.1369 | -0.0640 | 0.0921 | -0.0452 |
| ***L. cicera*** | 1000SW | | | | | |
| | GY | -0.1390 | | | | |
| | Biomass | 0.0233 | **0.8722** | | | |
| | DF | **-0.5874** | 0.1191 | 0.0006 | | |
| | HI | -0.1503 | 0.4066 | 0.2096 | 0.0600 | |
| | Protein | -0.2797 | -0.1714 | -0.1026 | 0.3855 | **-0.7341** |
| ***L. ochrus*** | 1000SW | | | | | |
| | GY | 0.0741 | | | | |
| | Biomass | -0.2019 | 0.1293 | | | |
| | DF | -0.2181 | -0.3620 | **0.6572** | | |
| | HI | 0.1907 | **0.5927** | **-0.5891** | **-0.7457** | |
| | Protein | -0.0954 | -0.5488 | 0.3154 | **0.7246** | **-0.7187** |

1000SW, 1000 seed weight (g); GY, Grain Yield (t $ha^{-1}$);Biomass, Biomass production (t $h^{-1}$); DF, Day to Flowering (day); Protein, protein content (%); HI, Harvest Index.

**Table S6**. Nei genetic distances.

| | ***S.S*** | ***S.I*** | ***S.E*** | ***C.A*** | ***C.S*** | ***C.G*** | ***O.GR*** | ***O.G*** | ***O.C*** |
|---|---|---|---|---|---|---|---|---|---|
| ***S.S*** | 0.000 | | | | | | | | |
| ***S.I*** | 0.367 | 0.000 | | | | | | | |
| ***S.E*** | 0.098 | 0.167 | 0.000 | | | | | | |
| ***C.A*** | 0.269 | 0.343 | 0.162 | 0.000 | | | | | |
| ***C.S*** | 0.267 | 0.367 | 0.145 | 0.124 | 0.000 | | | | |
| ***C.G*** | 0.231 | 0.304 | 0.127 | 0.034 | 0.092 | 0.000 | | | |
| ***O.GR*** | 0.520 | 0.573 | 0.360 | 0.447 | 0.516 | 0.417 | 0.000 | | |
| ***O.G*** | 0.274 | 0.307 | 0.147 | 0.258 | 0.286 | 0.218 | 0.172 | 0.000 | |
| ***O.C*** | 0.307 | 0.385 | 0.195 | 0.219 | 0.289 | 0.193 | 0.203 | 0.059 | 0.000 |

The first letters S, C and O indicates *L. sativus*, *L. cicera* and *L. ochrus*, respectively; while the second one S, I, E, A, G, GR and C indicates Syria, Italy, Ethiopia, Australia, Greece, Germany and Cyprus, respectively.

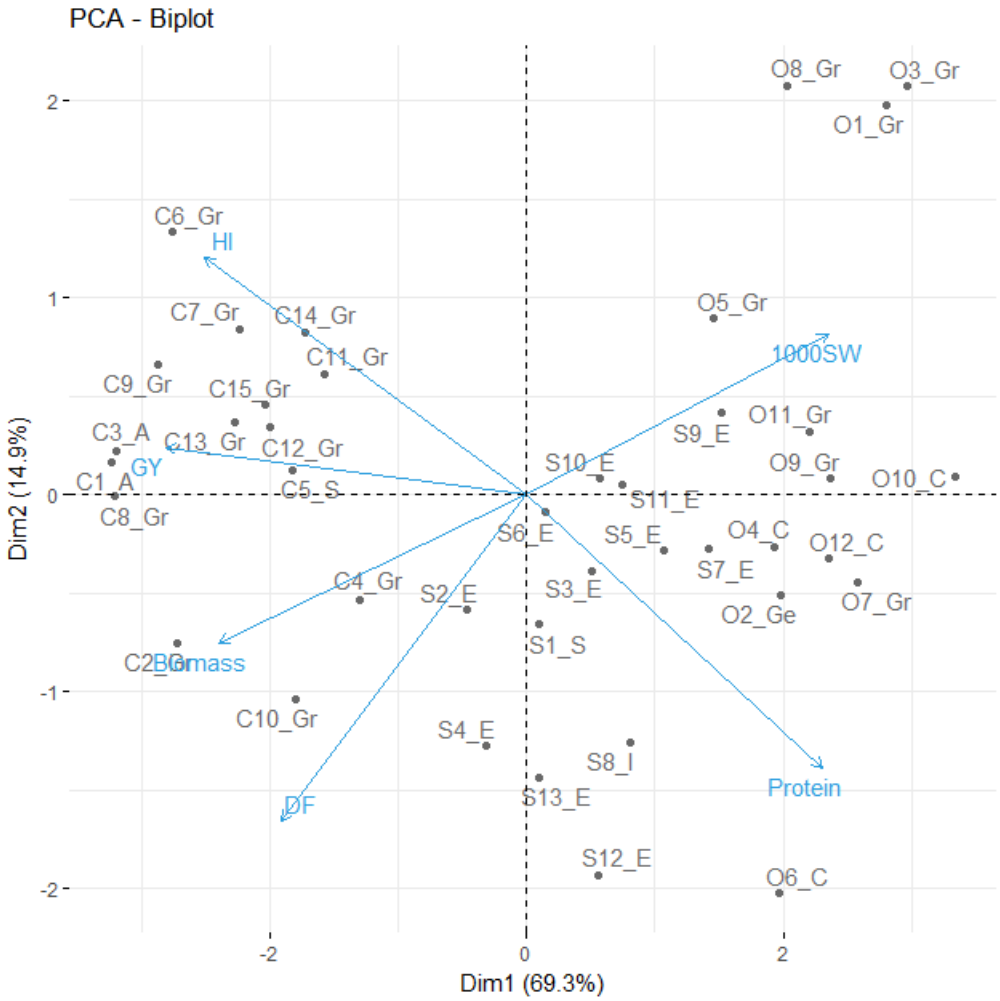


**Figure S1**. Principal component analysis of forty *Lathyrus* spp. accessions (C, S and O indicates *L. cicera*, *L. sativus* and *L. ochrus*, respectively; Gr, A, S, E, I, C and Ge indicates Greece, Australia, Syria, Ethiopia, Italy, Cyprus and Germany, respectively). 1000SW, 1000 seed weight (g); GY, Grain Yield (t $ha^{-1}$);Biomass, Biomass production (t $h^{-1}$); DF, Day to Flowering (day); Protein, protein content (%); HI, Harvest Index.

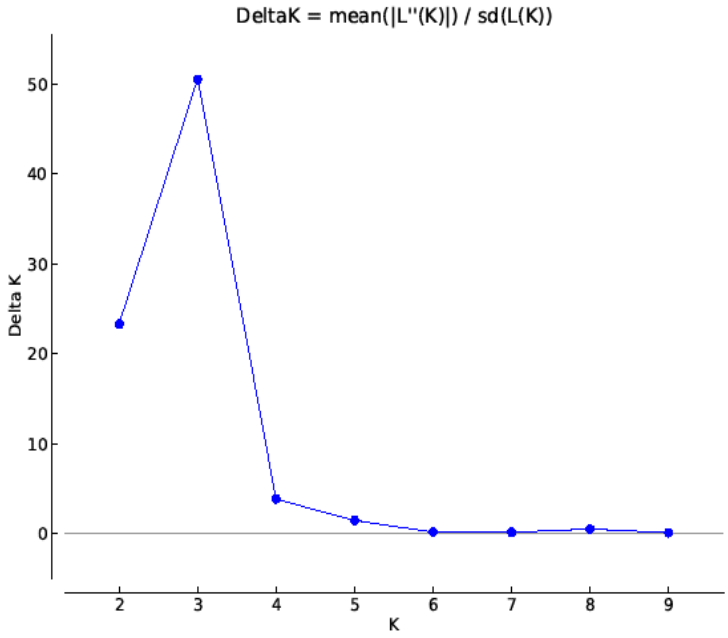


**Figure** S2 Analysis of the population structure of the 40 *Lathyrus* accessions: ΔK value related to different K.

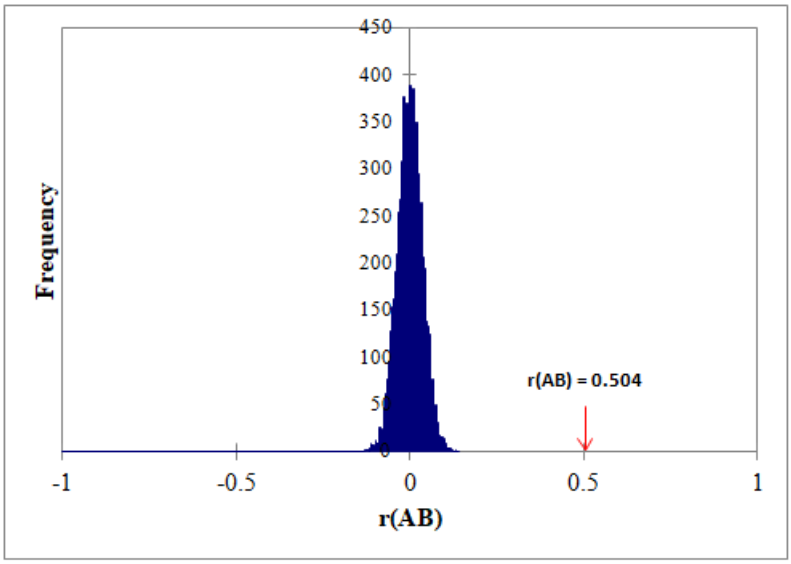


**Figure S3.** Mantel statistical values for the null hypothesis for the correlation between genetic and agronomic distance matrices. The red arrow shows the position of the statistical value (r(AB) = 0.504, in the zone of rejection of the null hypothesis; $p<0.05$). The data in the frequency distribution curve were generated from 9999 random permutation.