**Supplementary Table:**

**Table S1:** Pedigree and Origin of 158 lentil germplasm lines used in the study

|  |  |  |  |
| --- | --- | --- | --- |
| **Sr.no.** | **Germplasm** | **Pedegree/Key feature/Method** | **Origin** |
| **1** | IC 560181 | Indian germplasm lines | NBPGR, New Delhi, India |
| **2** | P13119 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **3** | L7920 | Resistance to Fusarium | IARI, New Delhi, India |
| **4** | DPL15 | Resistance to rust disease | - |
| **5** | IG69568 | Advanced breeding lines | ICARDA, Aleppo, Syria |
| **6** | KLS218 | Resistance to rust disease | CSAU, Kanpur |
| **7** | P14105 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **8** | P3235 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **9** | P3234 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **10** | P8112 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **11** | PL639 | high yielder with more protein percentage | GBPUAT, Pantnagar, India |
| **12** | NDL1 | High Yielding variety | India  |
| **13** | LL1122 | Elite breeding line (DPL15 × No. 303) | India  |
| **14** | L4649 | Advanced breeding lines | IARI, New Delhi, India |
| **15** | ILWL118 | Advanced breeding lines | - |
| **16** | ILL10832 | Mediterranean landraces | ICARDA, Aleppo, Syria |
| **17** | P117 | Advanced breeding lines | GBPUAT, Pantnagar, India |
| **18** | IC346092 | High Zn content | NBPGR, New Delhi, India |
| **19** | 10-3-1-26 | Advanced breeding lines | - |
| **20** | P13133 | Advanced breeding lines | ICARDA, Aleppo, Syria |
| **21** | P13145 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **22** | P15111 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **23** | P14903 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **24** | P13122 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **25** | P16205 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **26** | P8103 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **27** | P13123 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **28** | P14109 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **29** | P13107 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **30** | P13108 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **31** | IPL321 | Resistance to Wilt | AICRP MULLaRP, IIPR, Kanpur India |
| **32** | MC6 | Advanced breeding lines | India  |
| **33** | PL97 | Advanced breeding lines | GBPUAT, Pantnagar, India |
| **34** | LH7-26 | Resistance to Wilt | India  |
| **35** | P13135 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **36** | P3236 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **37** | P15213 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **38** | P13138 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **39** | P13112 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **40** | P13143 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **41** | P15115 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **42** | P13142 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **43** | P13130 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **44** | P15104 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **45** | L11-223 | Advanced breeding lines | AICRP MULLaRP, IIPR, Kanpur India |
| **46** | P13115 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **47** | P15121 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **48** | P8110 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **49** | P13157 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **50** | EC223212-A | Exotic germplasm | - |
| **51** | EC223209-B | Exotic germplasm | - |
| **52** | EC223207 | Exotic germplasm | - |
| **53** | EC223205-B | Exotic germplasm | - |
| **54** | EC223201 | Exotic germplasm | - |
| **55** | P13109 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **56** | P13128 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **57** | L11-292 | Advanced breeding lines | AICRP MULLaRP, IIPR, Kanpur India |
| **58** | P15207 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **59** | P13131 | ICARDA Nursery selection | ICARDA, Aleppo, Syria |
| **60** | EC78414 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **61** | EC78426 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **62** | EC223199-B | Exotic germplasm | ICARDA, Aleppo, Syria |
| **63** | EC223197-A | Exotic germplasm | ICARDA, Aleppo, Syria |
| **64** | EC223197-B | Exotic germplasm | ICARDA, Aleppo, Syria |
| **65** | EC223191 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **66** | EC223150 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **67** | EC223221 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **68** | EC223220 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **69** | EC223215 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **70** | EC78545 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **71** | EC78543 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **72** | EC78541-A | Exotic germplasm | ICARDA, Aleppo, Syria |
| **73** | EC78539 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **74** | EC78532 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **75** | EC78529 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **76** | EC78528 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **77** | EC267634 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **78** | EC78395 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **79** | EC78408 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **80** | EC78453 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **81** | EC78446 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **82** | EC78441-B | Exotic germplasm | ICARDA, Aleppo, Syria |
| **83** | EC78438 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **84** | EC78437 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **85** | EC78434 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **86** | EC139824-A | Exotic germplasm | ICARDA, Aleppo, Syria |
| **87** | EC78933 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **88** | EC78554 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **89** | EC329166 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **90** | EC267709 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **91** | EC267696 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **92** | EC223230 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **93** | EC223229-B | Exotic germplasm | ICARDA, Aleppo, Syria |
| **94** | EC223229-A | Exotic germplasm | ICARDA, Aleppo, Syria |
| **95** | EC223226 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **96** | EC223223 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **97** | EC223222 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **98** | EC78459 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **99** | EC267641 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **100** | EC267638 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **101** | EC267636 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **102** | EC267628-A | Exotic germplasm | ICARDA, Aleppo, Syria |
| **103** | EC267625-C | Exotic germplasm | ICARDA, Aleppo, Syria |
| **104** | EC267609 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **105** | EC267604 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **106** | EC267605 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **107** | EC267595-C | Exotic germplasm | ICARDA, Aleppo, Syria |
| **108** | EC267567 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **109** | EC78498 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **110** | EC267676 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **111** | EC267544-A | Exotic germplasm | ICARDA, Aleppo, Syria |
| **112** | EC78511 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **113** | EC78513 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **114** | EC78509 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **115** | EC78506 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **116** | EC78505 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **117** | EC78499 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **118** | EC255491 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **119** | EC2675770 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **120** | EC267573 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **121** | EC2675471 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **122** | EC267569-B | Exotic germplasm | ICARDA, Aleppo, Syria |
| **123** | EC267569-A | Exotic germplasm | ICARDA, Aleppo, Syria |
| **124** | EC267563 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **125** | EC267557-D | Exotic germplasm | ICARDA, Aleppo, Syria |
| **126** | EC267554 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **127** | EC267545-D | Exotic germplasm | ICARDA, Aleppo, Syria |
| **128** | EC225501 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **129** | EC223242 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **130** | EC223188 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **131** | EC78551-A | Exotic germplasm | ICARDA, Aleppo, Syria |
| **132** | EC267540 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **133** | EC223397 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **134** | EC267539 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **135** | EC267536 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **136** | EC267533 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **137** | EC267529 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **138** | EC78488 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **139** | EC78474 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **140** | EC78472 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **141** | EC78542-A | Exotic germplasm | ICARDA, Aleppo, Syria |
| **142** | EC78477-A | Exotic germplasm | ICARDA, Aleppo, Syria |
| **143** | EC78476 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **144** | EC78425 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **145** | EC78423 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **146** | EC78421 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **147** | EC241476 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **148** | EC78397 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **149** | EC78524-A | Exotic germplasm | ICARDA, Aleppo, Syria |
| **150** | EC78520 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **151** | EC78519 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **152** | EC78518 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **153** | EC78517 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **154** | EC78515 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **155** | EC78487 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **156** | EC78495 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **157** | EC78491 | Exotic germplasm | ICARDA, Aleppo, Syria |
| **158** | EC78490 | Exotic germplasm | ICARDA, Aleppo, Syria |

**Table S2:** Estimates of general statistical parameters such as range, means, slandered error, standard deviation, skewness and kurtosis for different characters

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Trait** | **Min** | **Max** | **Mean** | **Standard deviations** | **Standard errors** | **Skewness** | **Kurtosis** |
| Plant height (cm) | 35.01 | 43.44 | 38.48 | 1.57 | 0.13 | -0.17 ns | 4.10\* |
| Days to 50% flowering  | 67 | 90 | 77 | 5.42 | 0.43 | 0.58\*\* | 2.54 ns |
| Days to maturity | 109 | 122 | 115 | 2.58 | 0.21 | -0.27 ns | 5.34\*\* |
| Number of pods per plant | 33 | 110 | 58 | 14.5 | 1.15 | 0.71\*\* | 3.41 ns |
| Hundred seed weight (g) | 1.69 | 2.68 | 2.11 | 0.21 | 0.02 | 0.27 ns | 2.38\* |
| Grain yield per plant (g) | 0.86 | 3.67 | 1.6 | 0.48 | 0.04 | 1.00\*\* | 4.53\*\* |
|  |  |  |  |  |  |  |  |
| **Note:** nsNonsignificant, \*Significant at 5% probability level, \*\*Significant at 1% probability level. |

**Table S3:** Cluster composition for clusters constructed using hierarchical clustering

|  |  |
| --- | --- |
| **Cluster** | **Accessions** |
| **Cluster I** | P13130, EC78395, MC6, EC223191, IG69568, KLS218, P8110, EC223229-A, L4649, EC329166, EC223197-B, EC241476, L7920, P13157, L11-292, EC78437, P3235, EC78532, EC225501, EC78551-A, EC78490, EC78541-A, EC267625-C, EC223229-B, PL97, EC78423, EC267676, EC78472, EC78453, EC267605, EC223215, EC223188, EC78524-A, EC78511, EC267545-D, P13131, EC78488, EC78414, EC78477-A, P16205, P13109, 10-3-1-26, P13107, P13123, ILL10832, P15207, L11-223, ILWL118, EC223220, EC78528, PL639, P13122, P13135, EC78554, EC78543, P13145, EC78542-A, EC78434, EC267628-A, EC267709, EC78397, EC78495, EC78426, EC78539, EC78421, EC223226, IC 560181, EC78499, EC78545, P14903, P117 and EC267569-B. |
| **Cluster II** | EC267563, EC223209-B, EC223230, EC78506, EC223222, EC267567, EC255491, EC267569-A, EC267536, EC78441-B, EC223223, EC78515, EC78487, EC78519, EC78933, EC267638, EC267573, EC267554, EC78474, EC267595-C, EC78446, EC78520, P8112, EC223197-A, EC267696, EC223242, EC267557-D, EC267529, P14109, EC78425, EC223205-B, EC267634, EC267609, EC267533, EC267540, EC78505, EC267539, EC267641, EC2675770, EC78459, EC78517, EC267636, EC78518, EC139824-A, EC2675471, EC223199-B, EC223207, EC78476, EC223397, EC267604, EC78509, EC223150, EC78513, EC78529, LH7-26, EC223221, P13119, P15104, P13108, P3236, LL1122, EC223212-A, DPL15, EC223201, EC267544-A, P15213, P15115, P15121, P13128, P8103, P13138, IC346092, P13133, P13142, P3234 and P15111. |
| **Cluster III** | EC78438 |
| **Cluster IV** | EC78491, EC78408, P13112, EC78498, P13115, DL1, P13143, P14105 and IPL321. |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **PC1** | **PC2** | **PC3** | **PC4** | **PC5** | **PC6** |
| **Plant height**  | 19.38 | 2.37 | 8.84 | 69.11 | 0.13 | 0.17 |
| **Days to 50% flowering** | 22.53 | 17.26 | 4.16 | 7.96 | 47.65 | 0.45 |
| **Days to maturity** | 27.15 | 12.79 | 0.45 | 8.67 | 49.03 | 1.92 |
| **Number of pods per plant** | 15.30 | 27.46 | 10.49 | 0.18 | 0.95 | 45.62 |
| **Hundred seed weight** | 3.27 | 3.30 | 75.36 | 13.38 | 0.52 | 4.17 |
| **Grain yield per plant**  | 12.37 | 36.82 | 0.71 | 0.70 | 1.73 | 47.68 |

**Table S4:** Summarizing the percentage contribution of variables for principal component.

**Supplementary Figure:**



**Figure S1:** Pearson correlation matrix for pair-wise combinations of six traits among 158 lentil accessions. The color denotes the correlation, where 1 represents a complete positive correlation (dark orange) and −1 represents a complete negative correlation (dark purple) between two traits. Values indicate the magnitude of association and \* represents the significance level. \* and \*\*Significant at 5% and 1% probability, respectively. Note: Plant height (PH), Days to 50% flowering (DF) Days to maturity (DM), Number of pods per plant (PPP), Hundred seed weight (HSW), Grain yield per plant (YPP).