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| **Table S1.** The name, origin and pedigree of the four emmer wheat and eight durum wheat used as parents for full diallel analysis | | | | |
| **Genotype code** | **Name of parents** | **subspecies** | **Origin** | **Pedigree/Synonym** |
| 1 | Shabrang | Durum | CYMMYT | Sora/2\*Plata12 |
| 2 | Dena | Durum | CYMMYT | Tarro-3 |
| 3 | Ariya | Durum | ICARDA | Stork |
| 4 | Behrang | Durum | CYMMYT | Zhong Zuo/2\*Green-3 |
| 5 | Yavaros | Durum | CYMMYT | Yavaros-79 |
| 6 | Shwa | Durum | ICARDA | Shwa |
| 7 | Karkheh | Durum | ICARDA | Shwa/Mald//Anz |
| 8 | Saji | Durum | ICARDA | Mrb11//Snipe/Magh/3/Rufom-7 |
| 9 | Khoyghan | Emmer | Iran | - |
| 10 | Ozonbelagh | Emmer | Iran | - |
| 11 | Zarneh | Emmer | Iran | - |
| 12 | Singerd | Emmer | Iran | - |
| CYMMYT, International maize and wheat improvement center.  ICARDA, International center for agricultural research in the dry areas. | | | | |

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| **TABLE S2** Mean squares from the combined analysis of variance for the studied traits of the 132 crosses and their 12 parents in two irrigation regimes | | | | | | | | | | | | | | |
| **Source of variation** | **df** | **Mean squares** | | | | | | | | | | | | |
| **PH** | **PL** | **NT** | **NPT** | **DH** | **DM** | **SL** | **NKS** | **GWS** | **KL** | **KD** | **GY** | **HI** |
| Block | 1 | 3968\*\* | 471.6\*\* | 1223.7\*\* | 462.1\*\* | 70.1\*\* | 10.1 ns | 3.56\*\* | 137.2 ns | 1.54\*\* | 0.002 ns | 0.78\*\* | 12.1 ns | 5.8 ns |
| Irrigation | 1 | 68532\*\* | 18353\*\* | 2214.5\*\* | 2.2 ns | 14.3 ns | 10438\*\* | 15.15\*\* | 2499.0\*\* | 32.60\*\* | 1.093\*\* | 3.87\*\* | 37577\*\* | 764.5\*\* |
| Block(Irri) | 2 | 1004.2 | 296.0 | 580.1 | 13.83 | 3.5 | 16.3 | 1.92 | 0.69 | 0.18 | 0.003 | 0.0001 | 1457.1 | 75.1 |
| Genotypes | 143 | 645.1\*\* | 147.4\*\* | 489.3\*\* | 152.3\*\* | 175.5\*\* | 17.8\*\* | 4.54\*\* | 913.6\*\* | 3.35\*\* | 1.250\*\* | 0.40\*\* | 225.1\*\* | 140.1\*\* |
| Parents | 11 | 492.0\*\* | 48.7\* | 768.4\*\* | 58.91\*\* | 364.8\*\* | 38.0\*\* | 3.58\*\* | 1372\*\* | 5.67\*\* | 1.52\*\* | 0.88\*\* | 153.4\*\* | 341.7\*\* |
| Crosses | 131 | 641.9\*\* | 140.1\*\* | 465.3\*\* | 151.3\*\* | 159.4\*\* | 15.8\*\* | 4.43\*\* | 880.9\*\* | 3.11\*\* | 1.180\*\* | 0.36\*\* | 190.6\*\* | 123.8\*\* |
| P vs. C | 1 | 2741\*\* | 2198.4\*\* | 560.1 ns | 131.0\*\* | 206.2\* | 50.5\* | 29.66\*\* | 137.4 ns | 9.36\*\* | 6.850\*\* | 0.68\* | 5628.5\*\* | 36.5 ns |
| Gen×Irri | 143 | 114.8\*\* | 33.1\*\* | 36.3 ns | 32.0\* | 11.8 ns | 7.8\* | 0.44 ns | 70.1\*\* | 0.27\*\* | 0.064 ns | 0.03 ns | 83.9 ns | 23.7\* |
| P×Irri | 11 | 64.6 ns | 20.2 ns | 9.6 ns | 32.1\*\* | 12.9\*\* | 4.7 ns | 0.29 ns | 39.3 ns | 0.19 ns | 0.094 ns | 0.03 ns | 24.8 ns | 20.9 ns |
| C×Irii | 131 | 116.6\*\* | 33.4\*\* | 38.5 ns | 32.2 ns | 11.7 ns | 8.1\* | 0.45 ns | 72.9\*\* | 0.29\*\* | 0.063 ns | 0.03 ns | 85.5 ns | 24.1\*\* |
| P vs. C×Irii | 1 | 436.1 ns | 129.7 ns | 38.5 ns | 9.3 ns | 16.1 ns | 9.7 ns | 0.83 ns | 36.9ns | 0.15 ns | 0.005 ns | 0.001 ns | 520.9\* | 0.31 ns |
| Error | 286 | 51.3 | 17.2 | 35.9 | 24.7 | 9.9 | 5.76 | 0.40 | 45.7 | 0.19 | 0.065 | 0.03 | 80.9 | 17.1 |
| **CV** |  | 7.3 | 9.5 | 17.9 | 20.0 | 2.1 | 1.2 | 6.9 | 10.5 | 12.6 | 2.9 | 5.4 | 22.4 | 10.6 |
| **R2** |  | 0.92 | 0.90 | 0.88 | 0.79 | 0.90 | 0.89 | 0.86 | 0.91 | 0.91 | 0.91 | 0.89 | 0.78 | 0.83 |
| *Abbreviations*: C; Crosses; CV, coefficient of variation; df, Degree of Freedom; DH, day to heading; DM, day to maturity; Gen, Genotypes; GWS, grain weight per spike (g); GY, grain yield per plant (g); HI, harvest index (%); KD, Irri, irrigation; kernel diameter (mm); KL, kernel length (mm); NKS, number of kernels per spike; NPT, number of productive tillers per plant; NT, number of tillers per plant; P, Parents; PH, plant height (cm); P vs. C, Parents versus Crosses; PL, peduncle length (cm); R2, Coefficient of determination; SL, spike length (cm).  *Note:* \*\*, \* and ns indicate significant at 0.01 and 0.05 probability levels and non-significant, respectively | | | | | | | | | | | | | | |

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| **TABLE S3** Estimates of stress tolerance indices for 132 crosses and their 12 parents resulting from a (12×12) full diallel | | | | | | | | | |
| **Crosses** | **Yp** | **Ys** | **SSI** | **TOL** | **MP** | **GMP** | **STI** | **YSI** | **YI** |
| 1×1(P1) | 39.97 | 34.85 | 0.38 | 5.12 | 37.41 | 37.32 | 0.60 | 0.87 | 1.09 |
| 1×2 | 63.27 | 35.92 | 1.29 | 27.35 | 49.60 | 47.67 | 0.98 | 0.57 | 1.12 |
| 1×3 | 52.10 | 30.91 | 1.21 | 21.19 | 41.50 | 40.13 | 0.69 | 0.59 | 0.97 |
| 1×4 | 40.58 | 19.29 | 1.56 | 21.29 | 29.93 | 27.97 | 0.34 | 0.48 | 0.60 |
| 1×5 | 49.18 | 44.86 | 0.26 | 4.32 | 47.02 | 46.97 | 0.95 | 0.91 | 1.40 |
| 1×6 | 47.68 | 29.79 | 1.12 | 17.88 | 38.73 | 37.69 | 0.61 | 0.62 | 0.93 |
| 1×7 | 49.58 | 40.54 | 0.54 | 9.05 | 45.06 | 44.83 | 0.87 | 0.82 | 1.27 |
| 1×8 | 44.76 | 38.38 | 0.42 | 6.38 | 41.57 | 41.45 | 0.74 | 0.86 | 1.20 |
| 1×9 | 46.40 | 35.56 | 0.70 | 10.85 | 40.98 | 40.62 | 0.71 | 0.77 | 1.11 |
| 1×10 | 51.95 | 25.75 | 1.50 | 26.20 | 38.85 | 36.57 | 0.58 | 0.50 | 0.80 |
| 1×11 | 64.90 | 31.83 | 1.52 | 33.07 | 48.36 | 45.45 | 0.89 | 0.49 | 0.99 |
| 1×12 | 53.57 | 35.52 | 1.00 | 18.05 | 44.54 | 43.62 | 0.82 | 0.66 | 1.11 |
| 2×1 | 61.90 | 27.48 | 1.66 | 34.41 | 44.69 | 41.25 | 0.73 | 0.44 | 0.86 |
| 2×2 (P2) | 37.79 | 28.47 | 0.74 | 9.32 | 33.13 | 32.80 | 0.46 | 0.75 | 0.89 |
| 2×3 | 56.41 | 37.55 | 1.00 | 18.86 | 46.98 | 46.02 | 0.91 | 0.67 | 1.17 |
| 2×4 | 60.59 | 32.58 | 1.38 | 28.01 | 46.59 | 44.43 | 0.85 | 0.54 | 1.02 |
| 2×5 | 39.87 | 34.49 | 0.40 | 5.38 | 37.18 | 37.08 | 0.59 | 0.86 | 1.08 |
| 2×6 | 54.70 | 26.83 | 1.52 | 27.87 | 40.77 | 38.31 | 0.63 | 0.49 | 0.84 |
| 2×7 | 48.23 | 34.82 | 0.83 | 13.41 | 41.53 | 40.98 | 0.72 | 0.72 | 1.09 |
| 2×8 | 42.98 | 31.45 | 0.80 | 11.53 | 37.22 | 36.77 | 0.58 | 0.73 | 0.98 |
| 2×9 | 43.35 | 32.64 | 0.74 | 10.72 | 37.99 | 37.61 | 0.61 | 0.75 | 1.02 |
| 2×10 | 45.30 | 33.16 | 0.80 | 12.14 | 39.23 | 38.76 | 0.65 | 0.73 | 1.04 |
| 2×11 | 55.70 | 36.57 | 1.02 | 19.13 | 46.14 | 45.13 | 0.88 | 0.66 | 1.14 |
| 2×12 | 46.27 | 45.06 | 0.08 | 1.21 | 45.66 | 45.66 | 0.90 | 0.97 | 1.41 |
| 3×1 | 38.84 | 29.58 | 0.71 | 9.26 | 34.21 | 33.90 | 0.50 | 0.76 | 0.92 |
| 3×2 | 46.80 | 30.48 | 1.04 | 16.32 | 38.64 | 37.77 | 0.61 | 0.65 | 0.95 |
| 3×3 (P3) | 40.60 | 31.21 | 0.69 | 9.39 | 35.90 | 35.59 | 0.55 | 0.77 | 0.98 |
| 3×4 | 64.25 | 32.62 | 1.47 | 31.63 | 48.43 | 45.78 | 0.90 | 0.51 | 1.02 |
| 3×5 | 61.05 | 32.37 | 1.40 | 28.68 | 46.71 | 44.45 | 0.85 | 0.53 | 1.01 |
| 3×6 | 62.80 | 29.91 | 1.56 | 32.89 | 46.35 | 43.34 | 0.81 | 0.48 | 0.93 |
| 3×7 | 52.70 | 38.83 | 0.78 | 13.87 | 45.77 | 45.24 | 0.88 | 0.74 | 1.21 |
| 3×8 | 29.86 | 29.26 | 0.06 | 0.60 | 29.56 | 29.56 | 0.38 | 0.98 | 0.91 |
| 3×9 | 52.51 | 41.04 | 0.65 | 11.47 | 46.78 | 46.42 | 0.93 | 0.78 | 1.28 |
| 3×10 | 55.05 | 42.87 | 0.66 | 12.18 | 48.96 | 48.58 | 1.02 | 0.78 | 1.34 |
| 3×11 | 49.39 | 26.00 | 1.41 | 23.39 | 37.70 | 35.84 | 0.55 | 0.53 | 0.81 |
| 3×12 | 51.85 | 30.73 | 1.21 | 21.12 | 41.29 | 39.92 | 0.69 | 0.59 | 0.96 |
| 4×1 | 35.25 | 30.39 | 0.41 | 4.86 | 32.82 | 32.73 | 0.46 | 0.86 | 0.95 |
| 4×2 | 40.83 | 27.57 | 0.97 | 13.26 | 34.20 | 33.55 | 0.49 | 0.68 | 0.86 |
| 4×3 | 53.59 | 35.62 | 1.00 | 17.97 | 44.60 | 43.69 | 0.82 | 0.66 | 1.11 |

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| **TABLE S3 (**Continued) | | | | | | | | | |
| **Crosses** | **Yp** | **Ys** | **SSI** | **TOL** | **MP** | **GMP** | **STI** | **YSI** | **YI** |
| 4×4 (P4) | 41.73 | 27.39 | 1.02 | 14.34 | 34.56 | 33.81 | 0.49 | 0.66 | 0.86 |
| 4×5 | 51.33 | 36.01 | 0.89 | 15.32 | 43.67 | 42.99 | 0.80 | 0.70 | 1.13 |
| 4×6 | 60.85 | 42.02 | 0.92 | 18.83 | 51.44 | 50.57 | 1.10 | 0.69 | 1.31 |
| 4×7 | 34.73 | 33.54 | 0.10 | 1.19 | 34.14 | 34.13 | 0.50 | 0.97 | 1.05 |
| 4×8 | 41.78 | 30.62 | 0.80 | 11.16 | 36.20 | 35.76 | 0.55 | 0.73 | 0.96 |
| 4×9 | 63.89 | 40.94 | 1.07 | 22.95 | 52.42 | 51.14 | 1.13 | 0.64 | 1.28 |
| 4×10 | 39.08 | 28.44 | 0.81 | 10.65 | 33.76 | 33.34 | 0.48 | 0.73 | 0.89 |
| 4×11 | 57.20 | 42.64 | 0.76 | 14.57 | 49.92 | 49.38 | 1.05 | 0.75 | 1.33 |
| 4×12 | 49.00 | 35.96 | 0.79 | 13.04 | 42.48 | 41.98 | 0.76 | 0.73 | 1.12 |
| 5×1 | 63.87 | 27.82 | 1.68 | 36.04 | 45.84 | 42.15 | 0.77 | 0.44 | 0.87 |
| 5×2 | 51.15 | 31.31 | 1.16 | 19.84 | 41.23 | 40.02 | 0.69 | 0.61 | 0.98 |
| 5×3 | 55.20 | 38.33 | 0.91 | 16.86 | 46.77 | 46.00 | 0.91 | 0.69 | 1.20 |
| 5×4 | 72.79 | 35.86 | 1.51 | 36.94 | 54.32 | 51.09 | 1.13 | 0.49 | 1.12 |
| 5×5 (P5) | 42.80 | 31.68 | 0.77 | 11.12 | 37.24 | 36.82 | 0.58 | 0.74 | 0.99 |
| 5×6 | 62.00 | 38.39 | 1.14 | 23.61 | 50.20 | 48.79 | 1.03 | 0.62 | 1.20 |
| 5×7 | 51.74 | 40.76 | 0.63 | 10.98 | 46.25 | 45.92 | 0.91 | 0.79 | 1.27 |
| 5×8 | 50.44 | 30.01 | 1.21 | 20.43 | 40.22 | 38.90 | 0.65 | 0.59 | 0.94 |
| 5×9 | 58.70 | 40.23 | 0.94 | 18.47 | 49.46 | 48.59 | 1.02 | 0.69 | 1.26 |
| 5×10 | 59.20 | 43.41 | 0.80 | 15.79 | 51.31 | 50.70 | 1.11 | 0.73 | 1.36 |
| 5×11 | 39.45 | 29.75 | 0.73 | 9.71 | 34.60 | 34.26 | 0.51 | 0.75 | 0.93 |
| 5×12 | 51.43 | 51.20 | 0.01 | 0.22 | 51.31 | 51.31 | 1.14 | 1.00 | 1.60 |
| 6×1 | 56.25 | 29.04 | 1.44 | 27.21 | 42.65 | 40.42 | 0.70 | 0.52 | 0.91 |
| 6×2 | 59.24 | 37.60 | 1.09 | 21.64 | 48.42 | 47.20 | 0.96 | 0.63 | 1.17 |
| 6×3 | 54.51 | 39.62 | 0.81 | 14.89 | 47.06 | 46.47 | 0.93 | 0.73 | 1.24 |
| 6×4 | 35.37 | 29.39 | 0.50 | 5.97 | 32.38 | 32.24 | 0.45 | 0.83 | 0.92 |
| 6×5 | 60.42 | 39.13 | 1.05 | 21.29 | 49.77 | 48.62 | 1.02 | 0.65 | 1.22 |
| 6×6 (P6) | 40.95 | 19.83 | 1.54 | 21.12 | 30.39 | 28.50 | 0.35 | 0.48 | 0.62 |
| 6×7 | 53.35 | 29.60 | 1.33 | 23.75 | 41.48 | 39.74 | 0.68 | 0.55 | 0.92 |
| 6×8 | 53.96 | 32.32 | 1.20 | 21.63 | 43.14 | 41.76 | 0.75 | 0.60 | 1.01 |
| 6×9 | 58.61 | 33.53 | 1.28 | 25.08 | 46.07 | 44.33 | 0.85 | 0.57 | 1.05 |
| 6×10 | 46.18 | 39.22 | 0.45 | 6.96 | 42.70 | 42.56 | 0.78 | 0.85 | 1.23 |
| 6×11 | 53.64 | 50.88 | 0.15 | 2.76 | 52.26 | 52.24 | 1.18 | 0.95 | 1.59 |
| 6×12 | 50.92 | 30.24 | 1.21 | 20.68 | 40.58 | 39.24 | 0.66 | 0.59 | 0.94 |
| 7×1 | 45.39 | 26.84 | 1.22 | 18.55 | 36.11 | 34.90 | 0.53 | 0.59 | 0.84 |
| 7×2 | 35.36 | 32.09 | 0.28 | 3.27 | 33.72 | 33.68 | 0.49 | 0.91 | 1.00 |
| 7×3 | 45.12 | 17.43 | 1.83 | 27.69 | 31.27 | 28.04 | 0.34 | 0.39 | 0.54 |
| 7×4 | 56.32 | 33.92 | 1.19 | 22.40 | 45.12 | 43.71 | 0.82 | 0.60 | 1.06 |
| 7×5 | 44.26 | 36.14 | 0.55 | 8.12 | 40.20 | 40.00 | 0.69 | 0.82 | 1.13 |
| 7×6 | 43.91 | 31.76 | 0.82 | 12.15 | 37.84 | 37.35 | 0.60 | 0.72 | 0.99 |
| 7×7 (P7) | 30.30 | 26.83 | 0.34 | 3.47 | 28.57 | 28.51 | 0.35 | 0.89 | 0.84 |

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| **Table S3** (Continued) | | | | | | | | | | |
| **Crosses** | **Yp** | **Ys** | **SSI** | **TOL** | **MP** | **GMP** | **STI** | **YSI** | **YI** |
| 7×8 | 50.13 | 34.06 | 0.96 | 16.08 | 42.10 | 41.32 | 0.74 | 0.68 | 1.06 |
| 7×9 | 52.80 | 23.51 | 1.65 | 29.29 | 38.16 | 35.23 | 0.54 | 0.45 | 0.73 |
| 7×10 | 43.85 | 43.32 | 0.04 | 0.53 | 43.58 | 43.58 | 0.82 | 0.99 | 1.35 |
| 7×11 | 43.60 | 28.85 | 1.01 | 14.75 | 36.22 | 35.46 | 0.54 | 0.66 | 0.90 |
| 7×12 | 61.67 | 31.01 | 1.48 | 30.66 | 46.34 | 43.73 | 0.82 | 0.50 | 0.97 |
| 8×1 | 50.16 | 30.70 | 1.16 | 19.46 | 40.43 | 39.24 | 0.66 | 0.61 | 0.96 |
| 8×2 | 45.08 | 35.55 | 0.63 | 9.53 | 40.31 | 40.03 | 0.69 | 0.79 | 1.11 |
| 8×3 | 46.72 | 34.50 | 0.78 | 12.21 | 40.61 | 40.15 | 0.69 | 0.74 | 1.08 |
| 8×4 | 48.78 | 39.33 | 0.58 | 9.46 | 44.06 | 43.80 | 0.83 | 0.81 | 1.23 |
| 8×5 | 55.40 | 34.48 | 1.13 | 20.92 | 44.94 | 43.70 | 0.82 | 0.62 | 1.08 |
| 8×6 | 43.53 | 39.55 | 0.27 | 3.98 | 41.54 | 41.49 | 0.74 | 0.91 | 1.24 |
| 8×7 | 51.86 | 28.98 | 1.32 | 22.88 | 40.42 | 38.77 | 0.65 | 0.56 | 0.91 |
| 8×8 (P8) | 38.21 | 23.25 | 1.17 | 14.97 | 30.73 | 29.81 | 0.38 | 0.61 | 0.73 |
| 8×9 | 52.76 | 30.54 | 1.26 | 22.22 | 41.65 | 40.14 | 0.69 | 0.58 | 0.95 |
| 8×10 | 44.85 | 30.13 | 0.98 | 14.73 | 37.49 | 36.76 | 0.58 | 0.67 | 0.94 |
| 8×11 | 52.19 | 30.73 | 1.23 | 21.45 | 41.46 | 40.05 | 0.69 | 0.59 | 0.96 |
| 8×12 | 43.60 | 31.12 | 0.85 | 12.48 | 37.36 | 36.83 | 0.58 | 0.71 | 0.97 |
| 9×1 | 52.34 | 31.20 | 1.20 | 21.14 | 41.77 | 40.41 | 0.70 | 0.60 | 0.97 |
| 9×2 | 50.87 | 36.91 | 0.82 | 13.96 | 43.89 | 43.33 | 0.81 | 0.73 | 1.15 |
| 9×3 | 51.90 | 28.91 | 1.32 | 22.99 | 40.40 | 38.73 | 0.65 | 0.56 | 0.90 |
| 9×4 | 56.80 | 20.66 | 1.90 | 36.15 | 38.73 | 34.25 | 0.51 | 0.36 | 0.65 |
| 9×5 | 54.05 | 33.46 | 1.14 | 20.59 | 43.75 | 42.53 | 0.78 | 0.62 | 1.05 |
| 9×6 | 63.20 | 35.72 | 1.30 | 27.49 | 49.46 | 47.51 | 0.97 | 0.57 | 1.12 |
| 9×7 | 56.98 | 41.21 | 0.82 | 15.76 | 49.09 | 48.46 | 1.01 | 0.72 | 1.29 |
| 9×8 | 49.73 | 36.61 | 0.79 | 13.12 | 43.17 | 42.67 | 0.78 | 0.74 | 1.14 |
| 9×9 (P9) | 24.83 | 18.27 | 0.79 | 6.56 | 21.55 | 21.30 | 0.20 | 0.74 | 0.57 |
| 9×10 | 36.66 | 25.27 | 0.93 | 11.39 | 30.97 | 30.44 | 0.40 | 0.69 | 0.79 |
| 9×11 | 27.85 | 22.57 | 0.57 | 5.28 | 25.21 | 25.07 | 0.27 | 0.81 | 0.71 |
| 9×12 | 33.32 | 22.81 | 0.94 | 10.51 | 28.07 | 27.57 | 0.33 | 0.68 | 0.71 |
| 10×1 | 43.88 | 28.16 | 1.07 | 15.71 | 36.02 | 35.15 | 0.53 | 0.64 | 0.88 |
| 10×2 | 47.22 | 35.70 | 0.73 | 11.52 | 41.46 | 41.06 | 0.73 | 0.76 | 1.12 |
| 10×3 | 43.64 | 25.74 | 1.22 | 17.91 | 34.69 | 33.51 | 0.48 | 0.59 | 0.80 |
| 10×4 | 57.93 | 29.78 | 1.45 | 28.14 | 43.85 | 41.53 | 0.74 | 0.51 | 0.93 |
| 10×5 | 51.76 | 27.70 | 1.39 | 24.07 | 39.73 | 37.87 | 0.62 | 0.54 | 0.87 |
| 10×6 | 52.41 | 38.01 | 0.82 | 14.40 | 45.21 | 44.63 | 0.86 | 0.73 | 1.19 |
| 10×7 | 32.96 | 28.77 | 0.38 | 4.19 | 30.86 | 30.79 | 0.41 | 0.87 | 0.90 |
| 10×8 | 47.86 | 31.09 | 1.04 | 16.77 | 39.47 | 38.57 | 0.64 | 0.65 | 0.97 |
| 10×9 | 38.27 | 32.38 | 0.46 | 5.89 | 35.32 | 35.20 | 0.53 | 0.85 | 1.01 |
| 10×10 (P10) | 24.72 | 18.59 | 0.74 | 6.13 | 21.65 | 21.44 | 0.20 | 0.75 | 0.58 |
| 10×11 | 31.88 | 20.65 | 1.05 | 11.23 | 26.27 | 25.66 | 0.28 | 0.65 | 0.65 |
| 10×12 | 34.41 | 20.66 | 1.19 | 13.75 | 27.54 | 26.66 | 0.31 | 0.60 | 0.65 |
| 11×1 | 65.63 | 24.73 | 1.86 | 40.89 | 45.18 | 40.29 | 0.70 | 0.38 | 0.77 |

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| **TABLE S3** (Continued) | | | | | | | | | |
| **Crosses** | **Yp** | **Ys** | **SSI** | **TOL** | **MP** | **GMP** | **STI** | **YSI** | **YI** |
| 11×2 | 56.30 | 43.36 | 0.69 | 12.94 | 49.83 | 49.41 | 1.05 | 0.77 | 1.35 |
| 11×3 | 54.03 | 25.17 | 1.59 | 28.87 | 39.60 | 36.88 | 0.59 | 0.47 | 0.79 |
| 11×4 | 55.93 | 32.85 | 1.23 | 23.08 | 44.39 | 42.87 | 0.79 | 0.59 | 1.03 |
| 11×5 | 39.16 | 29.99 | 0.70 | 9.17 | 34.58 | 34.27 | 0.51 | 0.77 | 0.94 |
| 11×6 | 52.55 | 31.65 | 1.19 | 20.90 | 42.10 | 40.78 | 0.72 | 0.60 | 0.99 |
| 11×7 | 54.87 | 24.89 | 1.63 | 29.98 | 39.88 | 36.95 | 0.59 | 0.45 | 0.78 |
| 11×8 | 36.38 | 32.37 | 0.33 | 4.01 | 34.38 | 34.32 | 0.51 | 0.89 | 1.01 |
| 11×9 | 48.21 | 19.70 | 1.76 | 28.51 | 33.95 | 30.81 | 0.41 | 0.41 | 0.62 |
| 11×10 | 26.51 | 25.14 | 0.15 | 1.37 | 25.83 | 25.82 | 0.29 | 0.95 | 0.79 |
| 11×11 (P11) | 28.18 | 18.33 | 1.04 | 9.85 | 23.26 | 22.73 | 0.22 | 0.65 | 0.57 |
| 11×12 | 32.36 | 19.59 | 1.18 | 12.77 | 25.97 | 25.18 | 0.27 | 0.61 | 0.61 |
| 12×1 | 54.98 | 28.90 | 1.41 | 26.08 | 41.94 | 39.86 | 0.68 | 0.53 | 0.90 |
| 12×2 | 50.17 | 39.84 | 0.61 | 10.32 | 45.00 | 44.71 | 0.86 | 0.79 | 1.24 |
| 12×3 | 43.13 | 30.25 | 0.89 | 12.88 | 36.69 | 36.12 | 0.56 | 0.70 | 0.95 |
| 12×4 | 72.00 | 40.99 | 1.28 | 31.01 | 56.50 | 54.33 | 1.27 | 0.57 | 1.28 |
| 12×5 | 70.51 | 35.57 | 1.48 | 34.94 | 53.04 | 50.08 | 1.08 | 0.50 | 1.11 |
| 12×6 | 39.15 | 38.19 | 0.07 | 0.96 | 38.67 | 38.66 | 0.64 | 0.98 | 1.19 |
| 12×7 | 45.00 | 39.04 | 0.40 | 5.97 | 42.02 | 41.91 | 0.76 | 0.87 | 1.22 |
| 12×8 | 39.78 | 32.91 | 0.52 | 6.87 | 36.35 | 36.18 | 0.56 | 0.83 | 1.03 |
| 12×9 | 34.82 | 17.93 | 1.45 | 16.89 | 26.37 | 24.99 | 0.27 | 0.51 | 0.56 |
| 12×10 | 28.80 | 17.09 | 1.21 | 11.72 | 22.95 | 22.18 | 0.21 | 0.59 | 0.53 |
| 12×11 | 30.49 | 26.62 | 0.38 | 3.87 | 28.55 | 28.49 | 0.35 | 0.87 | 0.83 |
| 12×12 (P12) | 25.57 | 18.81 | 0.79 | 6.77 | 22.19 | 21.93 | 0.21 | 0.74 | 0.59 |
| *Abbreviation****:*** TOL, tolerance index; MP, mean productivity; GMP, geometric mean productivity; STI, stress tolerance index; YI, yield Index; YSI, yield stability index; SSI, stress susceptibility index; Ys, grain yield under stressed conditions; Yp, grain yield under non-stresses conditions  *Parents***:** Shabrang (P1), Dena (P2), Ariya (P3), Behrang (P4), Yavaros (P5), Shwa (P6), Karkheh (P7), Saji (P8), Khoyghan (P9), Ozonbelagh (P10), Zarneh (P11), Singerd (P12)  *Example***:** 2×11: Dena×Zarneh | | | | | | | | | |

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| **TABLE S4** Estimation of specific combining ability and reciprocal effect for the studied traits in 132 cross combinations obtained from a 12×12 full-diallel cross of tetraploied wheat under the non-stressed condition | | | | | | | | | | | | | |
| **Crosses** | **PH** | **PL** | **NT** | **NPT** | **DH** | **DM** | **SL** | **NKS** | **GWS** | **KL** | **KD** | **GY** | **HI** |
| S - 1×2 | -3.9 | -2.3 | 1.81 | 1.07 | 2.56 | 0.32 | 0.02 | 2.6 | -0.33 | -0.11 | -0.08 | 10.97\* | 0.72 |
| S - 1×3 | -8.81\* | -2.38 | -1.63 | -3.14 | 0.2 | 0.11 | -0.49 | -8.40\*\* | -0.48\* | -0.1 | -0.08 | -6.99 | 2.96 |
| S - 1×4 | -9.97\* | -7.13\*\* | -2.48 | -3.19 | 4.66\*\* | 0.53 | -0.54 | 2.27 | 0.05 | -0.19 | -0.16\* | -15.79\*\* | -4.92\*\* |
| S - 1×5 | -4.04 | -2.44 | 0.28 | -0.28 | 1.74 | 0.22 | -0.55 | 4.53 | -0.31 | -0.04 | -0.11 | 0.89 | 1.66 |
| S - 1×6 | -4.27 | -3.21 | -2.13 | -4.86 | 2.03 | 0.36 | -0.2 | 4.55 | 0.13 | -0.15 | -0.06 | -2.36 | -1.21 |
| S - 1×7 | -3.6 | -0.56 | -1.28 | -0.17 | 2.22 | 0.26 | 0.27 | 5.75 | -0.22 | -0.18 | -0.09 | -1.33 | -3.55\* |
| S - 1×8 | 1.18 | 1 | 0.76 | 0.55 | 2.22 | 0.05 | 0 | 4.7 | 0.21 | -0.12 | -0.02 | -0.69 | -3.97\* |
| S - 1×9 | 13.36\*\* | 8.09\*\* | -5.58 | -0.21 | -2.19 | -0.3 | 0.18 | -5.02 | 0.35 | 0.26\* | 0.18\* | -0.22 | 3.60\* |
| S - 1×10 | 7.56\*\* | 6.24\*\* | 5.08 | 3.32 | -6.69\*\* | -0.49 | 0.74\* | -2 | 0.33 | 0.27\* | 0.2\* | 3.51 | -1.37 |
| S - 1×11 | 12.71\*\* | 7.07\*\* | 5.43 | 4.83\* | -0.99 | 0.09 | 0.96\*\* | -2.33 | 0.29 | 0.43\*\* | 0.09 | 17.51\*\* | 4.66\*\* |
| S - 1×12 | 15.33\* | 11.91\*\* | 4.52 | 7 | -2.71 | -1.1 | 0.41 | -10.49 | 0.05 | 0.43\* | 0.15 | 20.31\* | 7.21\* |
| S - 2×3 | -2.97 | -0.33 | 0.04 | -1.53 | 2.03 | -0.28 | -0.46 | 0.84 | 0.13 | -0.3 | 0.13 | 0.4 | 1.81 |
| S - 2×4 | -3.94 | -2.61 | 0.2 | -1.28 | 2.74\* | 1.39 | 0.03 | 5.16 | -0.14 | -0.11 | -0.09 | -1.73 | 0.41 |
| S - 2×5 | -8.79\* | -4.35\* | -1.42 | -2.12 | 3.33\* | 0.57 | -0.28 | 2.71 | -0.5\* | -0.2 | -0.12 | -8.86 | -2.34 |
| S - 2×6 | -2.74 | -2.41 | -0.15 | -2.49 | 3.87\*\* | 1.47 | -0.25 | 2.86 | 0.42\* | 0 | 0.08 | 3.91 | 0.52 |
| S - 2×7 | -10.47\* | -4.64\* | 3.27 | 1.06 | -0.19 | 2.61\*\* | -0.08 | 7.02\* | 0.11 | -0.19 | -0.09 | -5.76 | 0.26 |
| S - 2×8 | -0.67 | 0.37 | -0.31 | 0.26 | -0.19 | 0.16 | -0.39 | 0.14 | -0.32 | -0.09 | -0.09 | -2.86 | 0.31 |
| S - 2×9 | 8.32\* | 4.66\* | -3.57 | -2.14 | -4.61\*\* | -2.2\*\* | 0.26 | -7.16\* | 0.001 | 0.37\*\* | 0.14 | -1.23 | -0.33 |
| S - 2×10 | 9.76\* | 4.71\* | -5.07 | 1.11 | -1.86 | -1.64\* | 0.56 | -11.09\*\* | 0.02 | 0.30\* | 0.01 | 3.12 | -0.16 |
| S - 2×11 | 10.93\*\* | 6.70\*\* | 4.79 | 5.54\* | -1.9 | -0.55 | 1.10\*\* | 3.51 | 0.72\*\* | 0.32\*\* | 0.24\*\* | 12\*\* | -0.63 |
| S - 2×12 | 16.33\* | 10.02\*\* | 5.08 | 10.34\* | -1.04 | 1.79 | 1.75\*\* | 4.7 | 0.83\* | 0.45\* | 0.19 | 15.17 | -2.57 |
| S - 3×4 | -1.09 | -0.92 | 1.69 | 2.16 | 0.89 | -0.07 | 0 | 2.17 | 0.24 | -0.16 | 0.05 | 5.62 | 1.12 |
| S - 3×5 | -1.36 | -2.57 | 1.42 | -0.24 | -0.03 | 0.36 | 0.02 | 1.3 | 0.44\* | -0.05 | 0.09 | 2.9 | 0.6 |
| S - 3×6 | -1.58 | -2.41 | 2.78 | 2.11 | 2.01 | 1.26 | -0.22 | -0.29 | -0.16 | -0.09 | -0.02 | 4.74 | 1.21 |
| S - 3×7 | -1.72 | -0.41 | -1.51 | -2.08 | 3.7\*\* | 1.16 | 0.07 | 0.96 | -0.11 | -0.09 | 0 | 0.5 | 0.16 |
| S - 3×8 | -5.6 | -2.36 | -2.98 | -2.94 | -1.3 | -0.3 | -0.03 | 6.26\* | 0.44\* | -0.18 | 0.06 | -9.45\* | -7.33\*\* |
| S - 3×9 | -5.06 | -3.1 | 3.82 | 7.11\*\* | -2.22 | -0.66 | 0.32 | 5.62 | -0.15 | 0.07 | -0.26\*\* | 3.02 | -1.77 |
| S - 3×10 | 12.38\*\* | 5.73\*\* | 3.02 | -0.16 | -1.22 | 0.41 | 0.42 | 0.05 | 0.01 | 0.5\*\* | -0.02 | 5.35 | -1.22 |
| S - 3×11 | 15.36\*\* | 7.40\*\* | -5.49 | 0.52 | -2.26 | -0.76 | 0.39 | -0.29 | 0.06 | 0.38\*\* | 0 | 4.36 | 1.75 |
| S - 3×12 | 8.46 | 6.89 | 1.58 | 1.16 | -2.69 | -0.75 | 0.49 | 4.5 | 0.68 | 0.57\*\* | -0.1 | 12.49 | 1.55 |
| S - 4×5 | -7.45 | -4.04\* | 1.73 | -0.41 | -1.07 | 0.53 | -0.23 | 1.06 | 0.32 | 0.09 | 0.04 | 5.6 | 1.23 |
| S - 4×6 | -3.32 | -2.71 | -1.7 | -5.37\* | 1.47 | -0.57 | -0.01 | -5.09 | -0.22 | -0.28\* | -0.07 | -7.04 | -4.3 |
| S - 4×7 | -1.83 | -2.98 | 1.82 | -1.39 | -0.34 | 1.32 | -0.48 | -2.31 | -0.09 | -0.23\* | 0.09 | -4.12 | -1.08 |
| S - 4×8 | -8.40\* | -3.92\* | -1.08 | -1.22 | -0.09 | -0.14 | -0.17 | -6.16\* | -0.07 | 0.08 | 0.06 | -3.7 | 0.13 |
| S - 4×9 | 15.09\*\* | 6.87\*\* | 5.75 | 0.56 | 2.49 | 1.26 | 0.71 | 7.65\* | 0.39 | 0.29\* | 0.07 | 9.92\* | -0.47 |
| S - 4×10 | 6.43 | 8.68\*\* | -1.3 | 3.38 | -3.51\* | -1.68\* | 0.63\* | -0.78 | 0.21 | 0.38\*\* | 0.09 | 3.27 | 0.78 |

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| **TABLE S4** (Continued) | | | | | | | | | | | | | |
| **Crosses** | **PH** | **PL** | **NT** | **NPT** | **DH** | **DM** | **SL** | **NKS** | **GWS** | **KL** | **KD** | **GY** | **HI** |
| S - 4×11 | 7.41 | 8.63\*\* | 0.61 | 4.13 | -2.3 | -0.09 | -0.02 | 2.52 | 0.15 | 0.11 | 0.02 | 7.98 | 1.11 |
| S - 4×12 | 11.64 | 7.18\* | 3.93 | 7.69 | 2.35 | 0.33 | 0.95 | 16.16\*\* | 1.07\*\* | 0.36 | 0.15 | 25.60\*\* | -1.53 |
| S - 5×6 | -6.12 | -4.6\* | 3.02 | 1.49 | 5.31\*\* | 0.86 | -0.33 | 8.06\*\* | 0.50\* | -0.03 | -0.01 | 4.13 | 1.71 |
| S - 5×7 | -7.93 | -3.9\* | -1.37 | -3.23 | 0.99 | 0.26 | -0.03 | 9.36\*\* | 0.1 | -0.09 | -0.07 | -3.57 | -0.89 |
| S - 5×8 | 3.38 | 0.86 | 4.2 | -0.12 | 0.74 | 1.3 | 0.2 | 3.92 | 0.06 | -0.14 | 0.04 | 2.01 | -3.42\* |
| S - 5×9 | 13.20\*\* | 6.76\* | -1.42 | 2.06 | -3.17\* | -0.05 | 0.34 | -10.05\*\* | -0.25 | 0.06 | 0.1 | 4.02 | 0.5 |
| S - 5×10 | 15.39\*\* | 7.7\* | -0.02 | 0.64 | -1.67 | -0.74 | 0.68\* | -3.13 | 0.27 | 0.49\*\* | 0.02 | 8.32 | 0.16 |
| S - 5×11 | -5.15 | 1.14 | -9.74\*\* | -1.75 | -4.47\*\* | -2.16\*\* | 0.18 | -11.16\*\* | -0.13 | 0.30\* | 0.13 | -11.21\* | 0.49 |
| S - 5×12 | 15.34\* | 14.96\*\* | 8.92 | 11.29\*\* | 4.27 | 3.90\*\* | 1.18\* | -3.34 | 0.98\*\* | 0.63\*\* | 0.35\* | 26.93\*\* | -0.13 |
| S - 6×7 | -2.04 | -1.82 | 2.09 | 1.62 | 1.03 | 0.16 | -0.05 | 1.92 | 0.31 | -0.05 | -0.03 | -1.63 | -1.03 |
| S - 6×8 | -2.03 | -1.02 | 0.97 | -1.55 | -0.47 | 0.2 | -0.57\* | -4.03 | -0.15 | -0.04 | -0.01 | -0.85 | 1.47 |
| S - 6×9 | 9.46\* | 7.17\*\* | -1.85 | 2.02 | -4.88\*\* | -1.41 | 0.43 | -0.72 | 0.11 | 0.34\*\* | 0.23\*\* | 9.87\* | 3.70\* |
| S - 6×10 | 8.7\* | 7.71\*\* | -0.45 | 3.8 | 0.62 | 0.16 | 0.71\* | 5.54 | 0.28 | 0.14 | 0.01 | 3.45 | 1.31 |
| S - 6×11 | 6.01 | 5.39\*\* | -0.22 | 1.96 | -1.92 | -1.51 | 0.3 | 2.51 | 0.16 | 0.05 | 0.18\* | 3.89 | 1.08 |
| S - 6×12 | 16.83\* | 12.77\*\* | -1.85 | 3.09 | 3.73 | 3.50\* | 0.77 | 4.76 | 0.33 | 0.32 | 0.07 | 11.53 | 0.56 |
| S - 7×8 | -4.46 | 0.08 | 0.99 | -0.35 | -0.03 | -0.41 | 0.24 | 7.55\* | 0.60\*\* | -0.13 | 0.02 | 6.91 | 3.17 |
| S - 7×9 | 12.17\*\* | 8.12\*\* | 4.78 | 1.78 | -0.69 | -0.51 | 0.48 | -4.59 | 0.22 | 0.53\*\* | 0.07 | 9.35\* | 1.4 |
| S - 7×10 | -5.28 | -1.89 | -3.04 | -0.2 | -1.69 | -1.2 | -0.87\*\* | -11.47\*\* | -0.49\* | 0.14 | 0.01 | -1.94 | 2.28 |
| S - 7×11 | 14.09\*\* | 7.87\*\* | 1.27 | 3.28 | -1.99 | -1.36 | 0.24 | -6.73\* | 0.13 | 0.36\* | 0.07 | 5.53 | 1.46 |
| S - 7×12 | 8.94 | 10.69\*\* | 3.78 | 6.35 | 2.04 | 0.6 | 0.55 | -0.93 | 0.90\* | 0.42 | 0.19 | 24.98\*\* | 7.37\* |
| S - 8×9 | 3.78 | 6.38\*\* | 3.96 | 6.4\*\* | -0.69 | -0.72 | 0.37 | -4.82 | -0.12 | 0.33\*\* | 0.05 | 6.37 | 0.02 |
| S - 8×10 | 3.02 | 1.67 | 2.92 | 6\*\* | 0.06 | -0.41 | 0.14 | -1.45 | 0.01 | 0.19 | 0.1 | 6.68 | 2.9 |
| S - 8×11 | 9.13\* | -0.39 | -0.66 | -2.42 | 2.51 | 1.43 | 0.72\*\* | -3.26 | -0.45\* | 0.3\* | -0.09 | 1.25 | -0.61 |
| S - 8×12 | 10.48 | 4.73 | 1.22 | 3.98 | 2.29 | -0.44 | 0.84 | -8.98 | -0.1 | 0.69\*\* | 0.15 | 4.75 | -2.28 |
| S - 9×10 | -13.92\*\* | -6.92\*\* | -4.39 | 0.97 | 4.39\*\* | 1.74\* | -0.94\*\* | 6.25\* | 0.11 | -0.53\*\* | -0.03 | -3.66 | 0.32 |
| S - 9×11 | -20.07\*\* | -12.76\*\* | 4.95 | 2 | 4.35\*\* | 1.82\* | -0.63\* | 5.34 | -0.24 | -0.51\*\* | -0.26\*\* | -6.45 | -1.91 |
| S - 9×12 | 0.52 | 15.36\*\* | 16.82\* | 17.78\*\* | 0.96 | -2.83\* | 0.99 | 7.53 | 0.38 | 0.16 | 0.06 | 11.96 | 0.95 |
| S - 10×11 | -15.54\*\* | -10.10\*\* | -0.17 | -5.95\*\* | 4.1 | 2.39\*\* | -0.56 | 1.79 | -0.39\* | -0.68\*\* | -0.13 | -10.09\* | -1.64 |
| S - 10×12 | 9.93 | 3.74 | 8.86 | 0.52 | 5.21 | 0.35 | 1.86\*\* | 8.68 | 0.001 | -0.07 | -0.03 | 4.42 | -0.37 |
| S - 11×12 | 7.67 | -1.63 | -3.33 | -4.07 | 2.75 | 1.27 | 0.77 | 6.93 | 0.58 | 0.51\* | 0.17 | 4.13 | -1.66 |
| R - 1×2 | 1.44 | -0.65 | -0.38 | -1.6 | 2.5 | 0.25 | 0.38 | 0.72 | 0.58\*\* | 0.07 | 0.1 | 0.69 | -0.25 |
| R - 1×3 | 3.88 | 3.55 | 0.75 | 0.45 | 1.25 | 0.25 | 0.41 | 5.77 | 0.29 | 0.36\*\* | -0.1 | 6.63 | 0.38 |
| R - 1×4 | 0.1 | 1.15 | 2 | 1.55 | -5.25\*\* | -0.5 | -0.05 | -9.43\*\* | -0.36 | -0.05 | 0 | 2.66 | 1.06 |
| R - 1×5 | -6.13 | -1.23 | -2.38 | -1.7 | 0.25 | 0.5 | -0.06 | -2.13 | -0.32 | -0.29\* | -0.08 | -7.35 | -4.36\* |
| R - 1×6 | 5.3 | -0.15 | -2.05 | -0.55 | -3.75\* | 0 | -0.36 | -10.10\*\* | -0.39 | 0 | 0.11 | -4.29 | 4.72\* |
| R - 1×7 | 3.93 | 1.48 | -1.27 | -0.36 | -2.25 | 0 | 0.73\* | -5.76 | -0.16 | 0.03 | 0.06 | 2.1 | 2.27 |
| R - 1×8 | 2.33 | 1.85 | 0.4 | -0.8 | -0.5 | 0.75 | 0.2 | -3.45 | -0.42 | 0.11 | -0.11 | -2.7 | 0.02 |

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| **TABLE S4** (Continued) | | | | | | | | | | | | | |
| **Crosses** | **PH** | **PL** | **NT** | **NPT** | **DH** | **DM** | **SL** | **NKS** | **GWS** | **KL** | **KD** | **GY** | **HI** |
| R - 1×9 | -5.91 | -1.24 | -4.09 | -2.53 | -2.25 | -0.5 | -0.31 | 2.28 | 0.04 | 0.02 | -0.02 | -2.97 | 0.74 |
| R - 1×10 | -4.41 | -1.45 | 2.2 | 0.91 | -2.75 | -0.5 | 0.47 | 4.43 | 0.02 | 0.07 | -0.04 | 4.04 | 1.25 |
| R - 1×11 | 6.98 | -0.14 | 3.54 | 1.16 | 1 | 0.5 | 0.01 | 1.08 | 0 | -0.17 | -0.01 | -0.36 | -4.56\* |
| R - 1×12 | -0.33 | -1.22 | 2.17 | 2.54 | 0.5 | 0 | -0.3 | 4 | 0.31 | -0.06 | -0.03 | -0.7 | -0.21 |
| R - 2×3 | 3.3 | 1.2 | 1.6 | 1.85 | 1.5 | 0.75 | 0.25 | 4.75 | 0.26 | 0.04 | 0.04 | 4.81 | -3.78 |
| R - 2×4 | 5.2 | 2.53 | 4.6 | 3.4 | 3.25\* | 2.25\*\* | 0.33 | -3.8 | -0.01 | 0.18 | 0.01 | 9.88\* | -2.88 |
| R - 2×5 | 0.1 | -0.48 | -0.6 | -2.25 | -1.25 | 1.25 | 0.03 | 1.25 | -0.02 | -0.05 | -0.06 | -5.64 | -2.29 |
| R - 2×6 | -1.5 | 0.05 | 1.4 | 1.9 | 1 | -1 | -0.38 | -7.05\* | -0.52\* | 0 | -0.03 | -2.27 | -0.41 |
| R - 2×7 | 9.34 | 2.76 | -0.84 | 0.38 | 2.25 | -1.75\* | 0.71 | 9.98\*\* | 0.3 | 0.07 | 0.06 | 6.44 | -1.41 |
| R - 2×8 | -2.2 | -0.23 | 1.8 | 1.4 | -1 | -0.25 | -0.03 | -0.36 | -0.2 | -0.07 | -0.06 | -1.05 | -1.45 |
| R - 2×9 | -7.65 | -1.82 | 2.43 | 1.47 | 0.75 | -0.5 | -0.2 | 1.03 | 0.11 | 0.04 | -0.07 | -3.76 | -1.37 |
| R - 2×10 | -5.82 | -2.98 | -2.52 | 1.47 | -2 | -0.75 | -0.49 | -6.61\* | -0.16 | 0 | -0.01 | -0.96 | 5.1 |
| R - 2×11 | -4.88 | -1.93 | -0.5 | 3.44 | 1 | -0.75 | 0.34 | -2.69 | -0.05 | 0.09 | -0.04 | -2.8 | 0.69 |
| R - 2×12 | 2.49 | -0.2 | -3.45 | 0.02 | 1.75 | -1 | -0.38 | -3.44 | -0.25 | -0.07 | -0.09 | -1.95 | -2 |
| R - 3×4 | -2.92 | -0.34 | 2.91 | 1.03 | 0.5 | -0.5 | 0.25 | 6.35 | 0.59\*\* | 0.16 | 0.23\*\* | 5.33 | 1.01 |
| R - 3×5 | 1.11 | -0.8 | 1.81 | 0.53 | 0.5 | 0.25 | 0.14 | 3.64 | 0.16 | -0.01 | -0.05 | 2.93 | 1.01 |
| R - 3×6 | 2 | -0.91 | 0.35 | 0.6 | 2.75 | 1 | -0.15 | 4.75 | 0.04 | 0.01 | 0.04 | 4.15 | -1.38 |
| R - 3×7 | 2.95 | 2.81 | -0.58 | -0.48 | 2.25 | 1 | 0.48 | 6.28 | 0.46\* | 0.23 | 0.13 | 3.79 | 0.26 |
| R - 3×8 | 4.05 | 1.19 | -4.35 | -2.75 | 0.5 | 0.5 | -0.44 | -0.3 | -0.26 | -0.05 | 0.05 | -8.43 | -7.75\*\* |
| R - 3×9 | -12.8\*\* | -8.61\*\* | 13.28\*\* | 6.48\*\* | -3.25\* | -1.25 | -0.13 | 5.2 | 0.45\* | 0.02 | 0.02 | 0.3 | -2.12 |
| R - 3×10 | 1.33 | -0.19 | -1.63 | 2.13 | 0.75 | -0.5 | 0.43 | 0.75 | -0.04 | -0.04 | -0.05 | 5.7 | -0.4 |
| R - 3×11 | 1.21 | -1.51 | -3.14 | -4.51 | 1.75 | -0.25 | 0.08 | 4.44 | 0.12 | -0.22 | -0.05 | -2.32 | 0.68 |
| R - 3×12 | -0.05 | -2.05 | 0 | 0.83 | -1 | -0.25 | 0.25 | 2.58 | 0.09 | 0.01 | 0.03 | 4.36 | 3.95 |
| R - 4×5 | -3.18 | -1.55 | -0.02 | -0.75 | 0.5 | 0.75 | -0.49 | 0.29 | -0.08 | 0.09 | -0.11 | -10.73\* | 0.25 |
| R - 4×6 | -2.73 | 0.93 | 3.48 | 4.65 | 2.75 | 1.5 | 0.03 | 4.48 | 0.15 | -0.15 | -0.08 | 12.74\* | 0.67 |
| R - 4×7 | 3.28 | 0.45 | -4.5 | -5.92\* | 0.75 | -0.5 | 0.23 | -4.63 | 0.03 | 0.22 | 0 | -10.80\* | -3.15 |
| R - 4×8 | -5.05 | -3.95 | -1.83 | 0.82 | -1.75 | 1.5 | -0.33 | -1.32 | -0.29 | -0.11 | -0.06 | -3.5 | -1.5 |
| R - 4×9 | -0.63 | -3.65 | 4.25 | 1.98 | 3.5\* | 0.5 | 0.36 | 4.67 | 0.16 | 0 | -0.05 | 3.54 | -0.97 |
| R - 4×10 | 0.5 | -2.15 | 0.25 | -2.7 | 1 | -0.25 | 0.23 | -2.95 | -0.26 | -0.14 | -0.05 | -9.42 | -4.73\* |
| R - 4×11 | 10.18\* | 1.15 | -1.58 | -1.02 | -2.25 | 0.25 | -0.06 | -3 | -0.03 | -0.06 | 0.09 | 0.63 | -2.09 |
| R - 4×12 | -7.33 | -2.6 | -2.38 | -1.1 | -4\*\* | -1.5 | -0.58 | -7.04\* | -0.11 | -0.1 | 0 | -11.5\* | 2.41 |
| R - 5×6 | -2.68 | -1.39 | 3.02 | 2 | 0.5 | 1.25 | -0.16 | 1.03 | -0.23 | 0.09 | -0.09 | 0.79 | 1.22 |
| R - 5×7 | 4.66 | 1.66 | 0.74 | 2.06 | 0.5 | 1.25 | 0.12 | 0 | -0.06 | 0.16 | -0.06 | 3.74 | -1.07 |
| R - 5×8 | 0.9 | -0.4 | -0.4 | 2.1 | -2 | -0.25 | -0.35 | -3.1 | -0.14 | 0.01 | 0 | -2.48 | -1.99 |
| R - 5×9 | 4.66 | 1.45 | 1.35 | 4.64 | -2.75 | -0.5 | 0.36 | -0.51 | -0.2 | -0.13 | -0.16 | 2.33 | -1.06 |
| R - 5×10 | 4.1 | 2.2 | 5.45 | 1.05 | -1.25 | -0.5 | -0.03 | 2.4 | 0.47\* | 0.07 | -0.05 | 3.72 | -2.46 |
| R - 5×11 | 5.53 | 1.5 | 0 | -1.63 | 0.5 | -0.5 | -0.06 | 4.23 | 0.28 | -0.01 | 0.08 | 0.14 | -0.22 |
| R - 5×12 | 2.36 | -0.18 | -5.88 | -5.13\* | -2.5 | 0.75 | -0.28 | -5.18 | -0.29 | -0.12 | -0.01 | -9.54 | -0.74 |

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| **TABLE S4** (Continued) | | | | | | | | | | | | | |
| **Crosses** | **PH** | **PL** | **NT** | **NPT** | **DH** | **DM** | **SL** | **NKS** | **GWS** | **KL** | **KD** | **GY** | **HI** |
| R - 6×7 | -3.31 | -1.44 | 2.88 | 0.66 | -2.25 | -0.5 | -0.18 | -1.91 | 0.004 | -0.04 | 0.05 | 4.72 | 0.94 |
| R - 6×8 | 3.75 | 0.4 | -0.7 | 2 | 2.5 | 1 | 0.25 | 6.6\*\* | 0.4 | -0.01 | 0.05 | 5.21 | 0.09 |
| R - 6×9 | -16.30\*\* | -7.4\*\* | 1.3 | -1.1 | -3.25\* | -1.5 | 0.05 | -2.45 | -0.08 | 0.03 | -0.04 | -2.3 | 1.2 |
| R - 6×10 | -0.67 | 2.2 | -1.26 | -4.33 | -5.75\*\* | -1.25 | -0.23 | -5.92 | -0.15 | -0.08 | 0.08 | -3.11 | 2.88 |
| R - 6×11 | -0.18 | -1.47 | 0.5 | 0.77 | 0.75 | 0.001 | -0.25 | 0.65 | 0.1 | -0.25 | -0.01 | 0.54 | -0.52 |
| R - 6×12 | -1.75 | 1.5 | -0.13 | -2.35 | 1.75 | 2\* | 0.16 | -2.35 | -0.06 | -0.15 | 0.01 | 5.88 | 2.74 |
| R - 7×8 | 6.08 | 3.43 | -2.28 | 0.58 | 0.25 | 0.5 | -0.1 | 0.55 | -0.09 | -0.07 | 0.03 | -0.86 | -0.43 |
| R - 7×9 | 2.83 | 0.56 | 3.6 | -1.98 | -0.25 | 1 | 0.13 | 7.28\*\* | 0.47\* | -0.29\* | 0.11 | -2.09 | -1.87 |
| R - 7×10 | -2.88 | -1.32 | 4.97 | -0.25 | -0.25 | 0.001 | 0.36 | 0.12 | 0.1 | 0.32\* | -0.02 | 5.44 | 0.49 |
| R - 7×11 | -1.59 | 1.36 | -3.46 | 1.4 | -1.5 | -0.25 | 0.16 | 0.03 | -0.08 | 0.001 | -0.06 | -5.63 | 2.03 |
| R - 7×12 | -0.43 | 1.9 | 8.83\* | 4.8 | -3.25\* | -0.5 | 0.4 | 0.8 | 0.16 | 0.02 | 0 | 8.33 | 1.2 |
| R - 8×9 | 9.05\* | 3.8 | 2.13 | -1.73 | -0.5 | -0.25 | 0.08 | 1.45 | -0.13 | -0.09 | -0.14 | 1.52 | -0.09 |
| R - 8×10 | -0.18 | 3.75 | -0.92 | -0.62 | -0.25 | -0.25 | -0.31 | 5.83 | 0.23 | -0.21 | 0.03 | -1.5 | 0.68 |
| R - 8×11 | 5.49 | 5.23\* | -1.63 | 3.13 | -2.25 | 4\*\* | -0.44 | -2.33 | 0.4 | -0.09 | 0.09 | 7.9 | 2.61 |
| R - 8×12 | 9.53 | 5.33\* | 2.62 | -1.4 | 0.75 | 0.5 | 0.76\* | 1.68 | -0.01 | -0.02 | -0.05 | 1.91 | -3.67\* |
| R - 9×10 | -2.73 | -2.24 | 10\* | -2.45 | 2.25 | 0.001 | 0.21 | -3.27 | -0.55\* | -0.02 | -0.36\*\* | -0.8 | -0.77 |
| R - 9×11 | -0.02 | -1.58 | -11.21\*\* | -11.08\*\* | 2.75 | 0.5 | -0.16 | -0.12 | -0.12 | 0.19 | -0.11 | -10.18\* | -1.58 |
| R - 9×12 | 4.08 | -1.56 | 4.71 | -3.43 | 0.25 | -0.5 | 0.72\* | 6.52\* | -0.25 | -0.43\*\* | -0.23\*\* | -0.75 | -0.15 |
| R - 10×11 | 5.90\* | 2.83 | 7.53 | 4.62 | -1.5 | -0.25 | 0.33 | -4.85 | -0.01 | -0.07 | 0 | 2.69 | -0.64 |
| R - 10×12 | 10.96 | 6.48\*\* | 5.33 | 0.79 | -1 | -1 | 0.22 | -3.83 | 0.19 | 0 | 0.09 | 2.8 | -0.14 |
| R - 11×12 | 2.26 | 2.61 | 8.4\* | 1.89 | 0 | 0.5 | 0.16 | 4.85 | -0.01 | -0.08 | 0.06 | 0.94 | 0.32 |
| Intercept | 108.26 | 49.32 | 35.34 | 24.75 | 10.59 | 26.53 | 3.23 | 66.36 | 3.69 | 8.59 | 3.23 | 66.36 | 20.05 |
| LSD sij† | 6.17 | 3.46 | 6.90 | 4.30 | 2.69 | 1.47 | 0.55 | 5.91 | 0.42 | 0.23 | 0.14 | 8.90 | 3.27 |
| LSD rij‡ | 6.71 | 3.76 | 6.35 | 4.67 | 2.92 | 1.59 | 0.60 | 6.42 | 0.38 | 0.25 | 0.15 | 9.67 | 3.55 |
| SEs**§** | 4.03 | 1.95 | 3.58 | 2.27 | 1.36 | 0.77 | 0.28 | 3.00 | 0.19 | 0.11 | 0.076 | 4.58 | 1.67 |
| SEr**¶** | 4.38 | 2.12 | 3.88 | 2.47 | 1.48 | 0.84 | 0.31 | 3.25 | 0.21 | 0.12 | 0.082 | 4.98 | 1.82 |
| *Abbreviations:* DH, day to heading; DM, day to maturity; GWS, grain weight per spike (g); GY, grain yield per plant (g); HI, harvest index (%); KD, kernel diameter (mm); KL, kernel length (mm); NKS, number of kernels per spike; NPT, number of productive tillers per plant; NT, number of tillers per plant; PH, plant height (cm); PL, peduncle length (cm); SL, spike length (cm).  *Note:* Parent of crosses: Shabrang (1), Dena (2), Ariya (3), Behrang (4), Yavaros (5), Shwa (6), Karkheh (7), Saji (8), Khoyghan (9), Ozonbelagh (10), Zarneh (11), Singerd (12),  *Note:* S, Specific combining ability; R, Reciprocal effect;  **†** LSD sij, Differences between SCA effects of the ijth F1 Hybrid in 0.05 level  **‡** LSD rji, Differences between reciprocal effects of the jith F1 Hybrid in 0.05 level  **§** SEs, Standard error of specific combining ability effects  **¶** SEr, Standard error of reciprocal effects | | | | | | | | | | | | | |

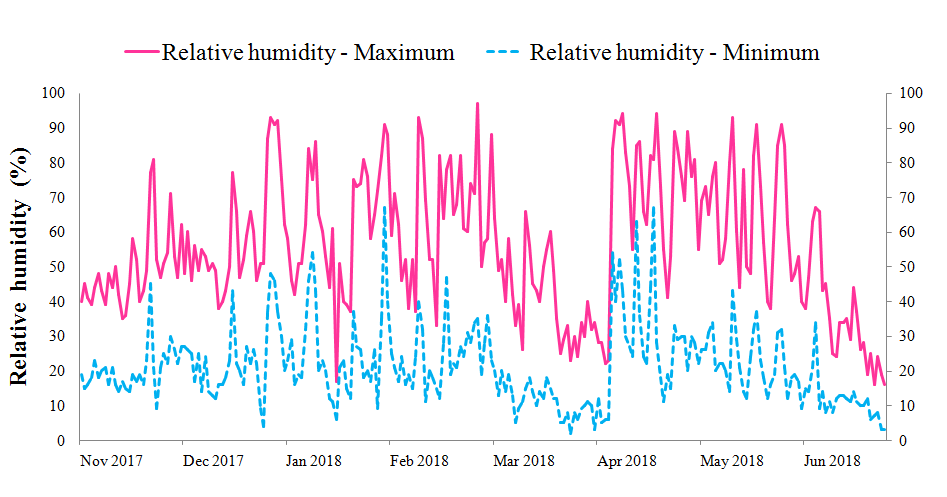
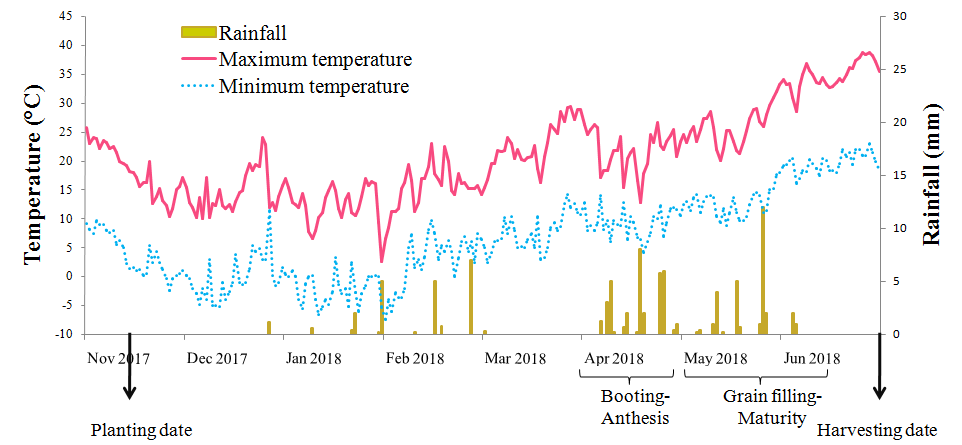
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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **TABLE S5** Estimation of specific combining ability and reciprocal effect for the studied traits in 132 cross combinations obtained from a 12×12 full-diallel cross of tetraploied wheat under the stressed condition | | | | | | | | | | | | | |
| **Crosses** | **PH** | **PL** | **NT** | **NPT** | **DH** | **DM** | **SL** | **NKS** | **GWS** | **KL** | **KD** | **GY** | **HI** |
| S - 1×2 | -5.24 | -2.29 | 0.97 | -0.27 | 1.62 | -0.5 | -0.3 | 10.07\*\* | 0.08 | -0.19 | -0.18\* | -2.07 | -2.43 |
| S - 1×3 | -2.66 | 1.15 | 0.63 | 0.25 | 0.93 | 2.04 | -0.31 | 5.36 | 0.08 | -0.06 | -0.05 | -1.21 | -0.49 |
| S - 1×4 | -5.58 | -2.24 | -1.03 | -0.71 | 1.58 | -1.44 | -0.73\* | -13.94\*\* | -0.79\*\* | -0.14 | 0.02 | -7.27 | -1.35 |
| S - 1×5 | -0.54 | -2.16 | 1.88 | -0.37 | -0.27 | -0.3 | -0.41 | -1.2 | -0.04 | -0.2 | 0.0007 | 1.37 | -0.93 |
| S - 1×6 | -3.47 | -1.21 | -0.8 | -2.05 | 8.64\*\* | 3.39\* | -0.04 | 5.68 | 0.04 | 0.07 | -0.23\* | -3.78 | -1.92 |
| S - 1×7 | -1.18 | -0.45 | -1.2 | -1.03 | 2.73 | 4.45\*\* | -0.07 | 1.4 | -0.22 | 0.01 | -0.12 | 2.09 | -0.08 |
| S - 1×8 | -1.35 | -1.03 | 0.43 | -0.05 | -1.86 | 2.31 | 0.51 | 8.54\*\* | 0.33 | -0.02 | 0.08 | 3.04 | 1.79 |
| S - 1×9 | 7.74\* | 5.63\*\* | -3.2 | 2.05 | -3.42\* | 0.12 | 0.76\* | -2.66 | 0.22 | 0.32\*\* | 0.17 | 4.02 | -0.13 |
| S - 1×10 | -3.07 | -0.26 | 1.02 | 1.9 | -1.98 | -2.36 | -0.52 | -10.38\*\* | -0.50\* | -0.14 | -0.14 | -1.98 | -0.62 |
| S - 1×11 | 7.51\* | 0.09 | 4.53\* | 1.82 | -2.3 | -2.77\* | 0.08 | -7.73\* | -0.08 | 0.39\*\* | 0.15 | -0.38 | -2.32 |
| S - 1×12 | 2.03 | 1.46 | -0.57 | 1.73 | -1.25 | -1.44 | -0.64 | -10.95 | -0.3 | 0.12 | 0.26 | -2.05 | 1.71 |
| S - 2×3 | -2.98 | -0.88 | -0.61 | -1.34 | 2.52 | 1.04 | -0.32 | 1.84 | 0.2 | -0.09 | 0.05 | -0.49 | 0.64 |
| S - 2×4 | -1.16 | -2.82 | 0.79 | -0.47 | 1.41 | 0.31 | -0.14 | 3.56 | 0.02 | -0.25\* | 0.08 | -5.07 | -3.32 |
| S - 2×5 | -4.93 | -1.66 | -0.14 | -1.72 | 1.56 | 1.2 | -0.26 | 6.21 | -0.16 | -0.14 | -0.11 | -5.12 | -0.14 |
| S - 2×6 | -2.57 | -2.42 | -0.57 | -1.72 | 2.98 | 2.14 | -0.53 | 1.86 | -0.06 | -0.07 | -0.18 | -4.03 | -1.67 |
| S - 2×7 | -1.82 | -1.6 | -0.46 | -1.16 | -0.44 | 1.2 | -0.1 | 2.9 | -0.22 | -0.21 | -0.1 | -1.18 | 2.37 |
| S - 2×8 | 1.84 | -0.24 | 1.54 | 0.08 | 1.73 | 0.06 | -0.16 | 3.47 | -0.17 | -0.16 | -0.13 | -1.04 | -2.81 |
| S - 2×9 | 4.54 | 0.98 | -0.76 | 1.28 | -3.09\* | -1.88 | 0.1 | -4.77 | 0.09 | 0.28\* | 0.14 | 2.37 | 1.08 |
| S - 2×10 | 3.53 | 3.86 | -1.56 | -0.39 | -3.9\* | -2.36 | 0.37 | -7.40\* | 0.03 | 0.42\*\* | 0.21\* | 2.46 | 1.27 |
| S - 2×11 | 7.63\* | 6.97\*\* | 2.58 | 2.77 | 0.04 | 1.98 | 0.95\*\* | 0.4 | 0.41 | 0.38\*\* | 0.16 | 13.26\*\* | 1.64 |
| S - 2×12 | 20.50\*\* | 14.71\*\* | -2.41 | 2.44 | -0.33 | 4.31 | 1.18\* | -6.2 | 0.98\* | 0.78\*\* | 0.33\* | 17.61\* | 4.87 |
| S - 3×4 | 4.94 | 0.15 | 0.24 | -1.65 | 3.73\* | 4.35\*\* | -0.04 | 4.62 | 0.31 | -0.13 | -0.02 | 1.3 | 0.37 |
| S - 3×5 | -2.23 | -1.88 | 1.84 | -0.41 | -0.88 | -0.75 | -0.3 | -1.21 | -0.15 | -0.02 | 0.01 | -0.34 | 0.88 |
| S - 3×6 | -1.52 | 0.48 | 1.39 | 1.14 | 0.54 | 0.68 | 0.04 | -3.42 | -0.09 | -0.11 | 0.07 | 0.84 | 1.2 |
| S - 3×7 | -8.70\* | -2.76 | -0.63 | -3.07 | 1.87 | 1.75 | 0.19 | 0.99 | 0.18 | -0.08 | -0.15 | -4.18 | -2.87 |
| S - 3×8 | 1.1 | -1.48 | -0.03 | -1.25 | -0.71 | -2.4 | 0.03 | 3.27 | 0.06 | -0.24\* | -0.09 | -0.33 | 1.36 |
| S - 3×9 | 0.57 | 3.93 | 7.58\*\* | 4.87 | -0.52 | -0.09 | -0.12 | 8.72\*\* | 0.4 | 0.07 | 0.08 | 4.9 | -1.75 |
| S - 3×10 | 4.97 | 3.85 | -3.7 | 0.96 | -3.84 | -0.57 | 0.46 | -6.70\* | -0.21 | 0.38\*\* | 0.09 | 4.65 | 3.99 |
| S - 3×11 | 0.46 | -0.31 | -6.19\*\* | -1.02 | -2.65 | -2.98\* | 0.24 | -6.89\* | -0.2 | 0.19 | 0.09 | -3.8 | -0.54 |
| S - 3×12 | 0.29 | 4.35 | -1.8 | 0.69 | -2.15 | -3.73 | 0.51 | 2.38 | 0.17 | 0.34 | 0.03 | 0.59 | -0.61 |
| S - 4×5 | -3.55 | -2.05 | -0.91 | -2.05 | 1.27 | 2.77\* | -0.28 | -3.85 | -0.14 | -0.05 | 0.02 | -0.41 | 1.61 |
| S - 4×6 | -1.22 | -0.87 | -0.68 | -2.33 | 0.68 | 2.45 | -0.29 | 1.42 | 0.19 | -0.01 | 0.07 | 1.14 | 1.53 |
| S - 4×7 | -0.34 | 0.19 | 0.8 | 0.56 | 0.27 | -0.23 | -0.03 | 3.21 | -0.08 | -0.05 | -0.04 | 0.76 | -1.99 |
| S - 4×8 | -3.5 | -3.47 | -0.3 | -0.64 | -0.32 | -1.88 | -0.53 | -2.34 | -0.18 | -0.18 | -0.09 | 2.1 | 2.6 |
| S - 4×9 | -1.97 | 1.2 | -0.41 | 1.09 | -3.63\* | -2.32 | 0.35 | 1.49 | 0.32 | 0.1 | -0.07 | 0.07 | 0.83 |
| S - 4×10 | 7.57\* | 4.31\* | 1.31 | -0.44 | -0.19 | -1.8 | 1.08\*\* | 7.11\* | 0.23 | 0.26\* | 0.11 | -1.19 | -4.08 |

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| **TABLE S5** (Continued) | | | | | | | | | | | | | |
| **Crosses** | **PH** | **PL** | **NT** | **NPT** | **DH** | **DM** | **SL** | **NKS** | **GWS** | **KL** | **KD** | **GY** | **HI** |
| S - 4×11 | 2.92 | 4.39\* | -1.34 | 3.27 | -4.75\* | -2.96\* | 0.49 | 3.07 | 0.58\*\* | 0.23 | 0.14 | 7.71\* | 4.02 |
| S - 4×12 | 0.12 | 3.5 | 2.41 | 7.45 | 1.21 | -2 | 0.69 | 6.17 | 0.1 | 0.73\*\* | -0.05 | 13.04 | 3.72 |
| S - 5×6 | -1.61 | -3.8 | -0.03 | -1.86 | 2.33 | 0.1 | 0.15 | 13.55\*\* | 0.57\*\* | -0.12 | -0.04 | 1.32 | -2.67 |
| S - 5×7 | -0.38 | 0.17 | 1.01 | -0.69 | 0.16 | 1.16 | -0.4 | 2.55 | 0.13 | -0.35\*\* | 0.04 | 2.62 | 0.13 |
| S - 5×8 | -1.95 | -1.31 | 0 | -2.28 | 0.33 | 3.02\* | -0.17 | 1.95 | -0.04 | -0.04 | -0.09 | -3.49 | -2.22 |
| S - 5×9 | 11.47\* | 8.13\*\* | -2.17 | 1.22 | 0.77 | -0.17 | 0.69\* | -6.40\* | -0.26 | 0.03 | 0.06 | 3.25 | 0.84 |
| S - 5×10 | 2.3 | 2.73 | -0.59 | 3.61 | 0.2 | 0.35 | 0.44 | -6.04 | 0.07 | 0.37\*\* | 0.16 | 2.39 | 0.83 |
| S - 5×11 | 3.42 | 3.77 | -2.02 | 3.11 | -2.61 | -2.07 | 0.65\* | -10.03\*\* | -0.13 | 0.50\*\* | 0.17\* | -3.04 | -1 |
| S - 5×12 | 7.83 | 9.28\* | 3.2 | 7.38 | 0.81 | 4.35 | 1.18\* | 1.03 | 0.91\* | 0.86\*\* | 0.35\* | 16.53\* | -2.38 |
| S - 6×7 | -5.68 | -2.64 | 0.17 | -1.73 | 1.83 | 0.35 | -0.58 | -7.32\* | -0.3 | -0.06 | -0.13 | -3.38 | -0.1 |
| S - 6×8 | 3.82 | 1.68 | -0.73 | -1.62 | -0.25 | -0.05 | 0.07 | 5.82 | 0.61\*\* | 0.03 | 0.09 | 1.97 | 0.02 |
| S - 6×9 | 4.94 | 2.4 | 0.06 | 1.45 | -6.32\*\* | -4.48\*\* | 0.74\* | -2.6 | -0.17 | 0.2 | 0.16 | 2.8 | 1.72 |
| S - 6×10 | 4.13 | 5.85\*\* | 5.48\* | 6.52\*\* | -1.38 | -2.21 | 0.28 | -3.03 | 0.07 | 0.15 | 0.06 | 7.22 | 2.24 |
| S - 6×11 | 2.75 | 4.16\* | -0.1 | 4.81 | -2.94 | 0.12 | 0.45 | -2.31 | 0.05 | -0.04 | 0.12 | 10.13\* | 5.81\*\* |
| S - 6×12 | 11.32 | 11.44\*\* | 3.97 | 6.48 | 5.9\* | 1.42 | 0.3 | 2.93 | 1.03\*\* | 0.58\*\* | 0.07 | 17.43\* | 10.23\*\* |
| S - 7×8 | 2.51 | 1.74 | -0.22 | -2.94 | -0.17 | 0.27 | -0.05 | 4.72 | 0.43\* | -0.18 | 0.04 | -0.84 | -1.47 |
| S - 7×9 | 6.6 | 1.78 | -3.33 | 1.19 | 1.27 | -0.42 | -0.03 | -2.83 | 0.27 | 0.45\*\* | 0.15 | 2.14 | 6\*\* |
| S - 7×10 | 8.43\* | 3.94 | 0.64 | 3.89 | -1.3 | 0.85 | 0.31 | -5.75 | 0.09 | 0.33\*\* | 0.11 | 6.25 | 2.29 |
| S - 7×11 | 6.76 | 2.67 | 1.59 | 2.48 | 1.14 | -2.32 | 0.22 | -0.74 | -0.12 | 0.09 | -0.05 | -2.66 | -3.28 |
| S - 7×12 | 1.97 | 3.47 | 3.89 | 7.05 | 1.31 | -0.4 | 1.01 | 2.54 | 0.59 | 0.70\*\* | -0.03 | 9.64 | -0.91 |
| S - 8×9 | 4.53 | 5.58\*\* | 5.65\* | 8.03\*\* | 1.18 | 1.68 | 0.85\*\* | -5.1 | -0.1 | 0.22 | 0.09 | 3.45 | -2.92 |
| S - 8×10 | -0.88 | 0.74 | -0.42 | 2.67 | 2.12 | -0.55 | 0.09 | -2.16 | -0.01 | 0.003 | 0.15 | 0.91 | -0.18 |
| S - 8×11 | 7.12\* | 4.99\* | -1.1 | 2.4 | 0.31 | 2.04 | 0.55 | -3.93 | 0.08 | 0.61\*\* | -0.05 | 2.13 | -1.67 |
| S - 8×12 | 21.01\*\* | 11.27\*\* | 2.54 | 8.53 | 4.65 | 9.75\*\* | 1.68\*\* | 10.36 | 0.92 | 0.4 | 0.26 | 10.12 | -2.53 |
| S - 9×10 | -7.40\* | -5.55\*\* | 0.2 | -5.11\* | 4.81\*\* | 2.52 | -0.46 | 9.20\*\* | 0.19 | -0.44\*\* | -0.15 | 1.27 | 1.14 |
| S - 9×11 | -13.67\*\* | -9.03\*\* | 0.55 | -5.15\* | 6.50\*\* | 1.85 | -0.99\*\* | 2.94 | -0.29 | -0.58\*\* | -0.26\*\* | -6.15 | -2.35 |
| S - 9×12 | -10.4 | -0.79 | 6.01 | -1.42 | 5.71\* | 0.19 | 0.91 | 3.08 | 0.12 | -0.36 | 0.11 | 1.31 | -0.59 |
| S - 10×11 | -5.98 | -4.87\* | -1.27 | -4.3 | 3.18\* | 2.62 | -0.03 | 11.83\*\* | 0.13 | -0.49\*\* | -0.24\*\* | -3.96 | 1.17 |
| S - 10×12 | -3.69 | -2.12 | 3.74 | 4.55 | 8.77\*\* | 2.42 | 0.76 | -0.36 | -0.05 | 0.11 | -0.02 | -0.93 | -0.5 |
| S - 11×12 | 1.22 | 2.3 | 7.98 | 10.15\* | 5.83\* | 2.08 | -0.05 | -1.61 | -0.01 | -0.04 | 0.08 | 3.29 | -2.05 |
| R - 1×2 | 1.7 | -0.79 | 3.03 | 1.68 | 1.5 | 1 | 0.28 | 7.50\* | 0.33 | 0.18 | -0.17 | 4.22 | -0.48 |
| R - 1×3 | -2.04 | -0.08 | 0.25 | 0 | 1.5 | -0.25 | 0.08 | -5.88 | -0.50\* | 0.03 | -0.08 | 0.66 | 0.28 |
| R - 1×4 | -4.88 | -4.38 | -0.38 | -1 | -3.75\* | -3.25\* | -0.88\*\* | -11.79\*\* | -0.84\*\* | -0.2 | -0.09 | -5.55 | 1.03 |
| R - 1×5 | 2.63 | 0.54 | 1.55 | 2.35 | -0.5 | 2.25 | 0.37 | 6.88 | 0.51\* | 0.05 | 0.02 | 8.52\* | 3.5 |
| R - 1×6 | -0.55 | 0.28 | -0.98 | -0.65 | -6.75\*\* | -2.5 | -0.25 | -12\*\* | -0.35 | 0.08 | 0.26\*\* | 0.37 | 3.61 |
| R - 1×7 | 3.56 | 0.25 | 3.13 | 2.69 | -0.75 | -3.00\* | -0.06 | -5.17 | -0.02 | -0.26\* | -0.04 | 6.85 | 1.85 |
| R - 1×8 | 2.48 | 1.33 | 1.62 | 1.8 | 0 | -2.5 | -0.72 | -3.43 | -0.49\* | -0.2 | -0.01 | 3.84 | 1.8 |
| R - 1×9 | -5.42 | -2.73 | 1.33 | 3.82 | -1 | -1.5 | -0.52 | -4.97 | -0.23 | 0.09 | -0.13 | 2.18 | -0.62 |

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| **TABLE S5** (Continued) | | | | | | | | | | | | | |
| **Crosses** | **PH** | **PL** | **NT** | **NPT** | **DH** | **DM** | **SL** | **NKS** | **GWS** | **KL** | **KD** | **GY** | **HI** |
| R - 1×10 | -1.5 | -3.29 | 6.25\* | 2.17 | -0.5 | -0.75 | 0.04 | 7.54\* | -0.08 | -0.12 | -0.07 | -1.21 | -6.20\*\* |
| R - 1×11 | -0.42 | -0.92 | 0.67 | 3.21 | -0.5 | 0.75 | -0.25 | 1.71 | -0.15 | -0.17 | -0.1 | 3.55 | 1.4 |
| R - 1×12 | -4.74 | -2.48 | 3.72 | 4.52 | -2 | -2.25 | -0.07 | -0.13 | -0.24 | 0.14 | -0.02 | 3.31 | -0.02 |
| R - 2×3 | -0.43 | 0.02 | -0.36 | 0.5 | -1.25 | 0 | -0.08 | -3.14 | -0.3 | 0.05 | -0.06 | 3.53 | 2.58 |
| R - 2×4 | -1.93 | -3.05 | -1.65 | -0.68 | -1.75 | -1.75 | -0.25 | 1.23 | 0.28 | -0.01 | 0.06 | 2.51 | 3.88 |
| R - 2×5 | -0.01 | -1 | 0.42 | 1.38 | 1 | 1 | -0.04 | -0.84 | 0.08 | 0.12 | -0.05 | 1.59 | 1.02 |
| R - 2×6 | -3.19 | -1.69 | 0.19 | 0.94 | -0.25 | -2 | -0.03 | -2.94 | -0.18 | -0.07 | -0.02 | -5.39 | -3.61 |
| R - 2×7 | -1.35 | -0.87 | 0.35 | -0.49 | 0.75 | 0 | -0.47 | 3.43 | 0.39 | 0.15 | 0.19\* | 1.37 | 1.67 |
| R - 2×8 | 5.21 | 1.35 | 1.13 | 0.74 | 2.25 | 0 | -0.14 | -2.47 | -0.19 | -0.19 | 0.03 | -2.05 | -2.9 |
| R - 2×9 | -3.04 | -1.21 | -0.13 | -3.17 | -1 | -0.75 | 0.02 | 0.83 | 0.33 | 0.11 | 0.12 | -2.14 | -0.3 |
| R - 2×10 | -4.45 | -3.84 | 1.15 | -0.04 | -0.75 | -0.5 | 0.19 | 6.25 | 0.16 | 0.1 | 0.01 | -1.27 | -1.11 |
| R - 2×11 | -0.55 | -0.75 | -8.27\* | -4.92 | 2 | 0.75 | 0.08 | 1.06 | 0.11 | -0.02 | 0.01 | -8.39\* | -0.52 |
| R - 2×12 | 2.18 | 0.4 | 2.67 | 1.43 | 0.25 | 0.25 | 0.08 | 5.97 | -0.11 | 0.26\* | -0.03 | 2.61 | -0.72 |
| R - 3×4 | -1.26 | 0.63 | 0.01 | -0.97 | -2.75 | -1 | -0.12 | -0.43 | -0.02 | -0.01 | 0.01 | -1.5 | 0.14 |
| R - 3×5 | 1.9 | 0.87 | -0.35 | 0.04 | -0.25 | 0.75 | -0.11 | -3.91 | -0.62\*\* | -0.01 | -0.07 | -2.98 | -1.92 |
| R - 3×6 | -1.36 | -0.43 | 2.44 | 1.81 | 0.5 | -4.25\*\* | -0.08 | -6.99\* | -0.56\* | -0.21 | -0.02 | -4.85 | -3.21 |
| R - 3×7 | -2.08 | 0 | 1.67 | 1.33 | -2.25 | 0.25 | 0.43 | -5.33 | 0.22 | 0.02 | 0.08 | 10.70\* | 10.08\*\* |
| R - 3×8 | 0.15 | 0.44 | -1.54 | -1.13 | 1.5 | -0.75 | -0.07 | -2.3 | -0.07 | -0.03 | 0.01 | -2.62 | 0 |
| R - 3×9 | 12.88\*\* | 6.47\*\* | 2.25 | 5.19 | 3.25 | -0.25 | 1.16\*\* | 13.32\*\* | 0.52\* | 0.22 | 0.01 | 6.07 | -2.01 |
| R - 3×10 | 5.42 | 1.38 | 6.50\* | 7.67\*\* | 1.5 | 0 | 0.75\* | 8.85\* | 0.70\*\* | -0.06 | 0.15 | 8.57\* | 0.18 |
| R - 3×11 | 7.04 | 2.83 | 0.88 | 0.44 | 2.5 | 1.5 | 0.48 | 2.73 | 0.05 | -0.04 | -0.19\* | 0.42 | -0.17 |
| R - 3×12 | -0.6 | 0.35 | 0.42 | 1.1 | -0.25 | 1 | 0.17 | 0.92 | 0.09 | 0.02 | 0 | 0.24 | -0.78 |
| R - 4×5 | -1.91 | 0.15 | -0.93 | -1.25 | 1 | 3.25\* | -0.09 | 1.3 | 0.36 | -0.07 | 0 | 0.08 | -0.76 |
| R - 4×6 | -0.25 | -0.44 | -1.48 | 0.85 | 0.75 | 1 | 0.06 | -1 | 0.16 | 0.12 | 0.04 | 6.31 | 5.45 |
| R - 4×7 | 0.8 | -1.34 | -1.09 | 0.23 | 1.75 | 2.25 | -0.29 | -2.06 | -0.31 | -0.11 | -0.03 | -0.19 | 1.44 |
| R - 4×8 | -0.29 | -2.25 | -4.08 | -2.76 | -3 | -2.75 | -0.03 | -8.59\* | -0.37 | 0.01 | 0.06 | -4.36 | -0.23 |
| R - 4×9 | 7.08 | 3.5 | 4.67 | 0.58 | 2.25 | 4.50\*\* | 0.25 | 5.17 | 0.95\*\* | 0.23 | 0.04 | 10.14\* | 3.14 |
| R - 4×10 | 2.94 | -0.81 | -0.5 | -1.94 | -2.25 | -0.75 | -0.38 | -3.04 | 0.31 | 0 | -0.03 | -0.67 | 0.56 |
| R - 4×11 | -4.96 | -1.5 | 1.92 | 0.98 | 0 | 0.5 | 0.02 | 1.77 | 0.26 | -0.11 | 0.08 | 4.89 | 3.27 |
| R - 4×12 | 2.58 | 0.92 | 2.71 | 2.29 | -1.5 | -0.25 | 0.54 | 3.71 | 0.09 | 0.08 | -0.06 | -2.52 | -4.33 |
| R - 5×6 | 0.31 | 1.21 | -0.9 | -0.75 | -2.5 | -1 | -0.43 | -6.11 | -0.3 | -0.1 | -0.08 | -0.37 | 1.18 |
| R - 5×7 | 2.46 | -0.5 | 1.09 | 0.24 | -1.25 | 0.5 | -0.21 | 6.36 | 0.04 | 0.11 | 0.17 | 2.31 | 1.47 |
| R - 5×8 | -0.35 | -1.1 | 1.77 | 1.52 | -1.75 | -2 | -0.46 | -3.07 | -0.45 | 0.03 | -0.14 | -2.24 | -1.89 |
| R - 5×9 | 1.81 | 2.19 | -0.08 | -2.1 | -4.75\*\* | -3.50\* | 0.25 | 2.75 | 0.37 | 0.21 | 0.02 | 3.38 | 1.95 |
| R - 5×10 | 6.38 | 2.94 | 6.19\* | 7.50\*\* | -1.75 | -1.25 | -0.06 | 1 | 0.37 | 0.11 | 0.13 | 7.86 | -0.18 |
| R - 5×11 | 1.17 | -1.17 | 2 | 0.83 | -0.25 | 0.25 | -0.17 | 0.06 | 0.02 | 0.16 | -0.13 | -0.12 | -0.09 |
| R - 5×12 | 5.69 | 0.31 | 2.75 | 1.81 | 0.5 | 0.25 | 0.25 | 3.39 | 0.1 | 0.08 | 0.03 | 7.82 | 0.99 |
| R - 6×7 | -2.08 | -1.75 | 2.5 | 3 | 3.75\* | -2.25 | -0.3 | -9.83\*\* | -0.52\* | 0.03 | -0.07 | -1.08 | -3.51 |

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| **TABLE S5** (Continued) | | | | | | | | | | | | | |
| **Crosses** | **PH** | **PL** | **NT** | **NPT** | **DH** | **DM** | **SL** | **NKS** | **GWS** | **KL** | **KD** | **GY** | **HI** |
| R - 6×8 | -4.13 | -3.06 | 1 | 0.13 | -2.5 | -3\* | -0.3 | -6.61 | -0.26 | 0.14 | 0.03 | -3.61 | -3.13 |
| R - 6×9 | -8.70\* | -3.98 | -6.86\*\* | -1.61 | -1 | -1.75 | -0.3 | -5.29 | 0.02 | -0.07 | 0.06 | -1.09 | 4.79\* |
| R - 6×10 | 2.22 | 2.33 | -4.7 | 1.22 | 0 | 0.75 | -0.03 | -0.05 | 0 | -0.08 | 0.03 | 0.61 | 0.37 |
| R - 6×11 | -0.25 | 0.13 | 2.13 | 4 | -0.25 | -2 | -0.25 | 4.81 | 0.08 | 0.01 | 0.07 | 9.62\*\* | 1.78 |
| R - 6×12 | -2.42 | -2.05 | -0.92 | -0.03 | 0.75 | -0.75 | -0.46 | 0.7 | -0.02 | -0.17 | -0.18 | -3.97 | -0.03 |
| R - 7×8 | 1.51 | -0.11 | 0.24 | 1.04 | 1 | 2.75 | -0.31 | -0.41 | 0.06 | -0.04 | 0.02 | 2.54 | 0.78 |
| R - 7×9 | -1.4 | -3.13 | -3.63 | -3.69 | 1.5 | 0.75 | -0.77\* | -0.46 | -0.39 | -0.18 | -0.14 | -8.85\* | 2.48 |
| R - 7×10 | -2.67 | 1.52 | 3.63 | 4.02 | -0.5 | -0.25 | 0.13 | -7.08\* | -0.31 | 0.23 | -0.1 | 7.28 | 3.43 |
| R - 7×11 | -0.17 | -2.02 | -0.43 | 2.61 | -3.75\* | -0.5 | 0.23 | -1.14 | -0.03 | 0.11 | 0.03 | 1.98 | 1.79 |
| R - 7×12 | 1.21 | -4.44\* | -3.79 | -2.31 | -0.75 | 0 | -0.15 | -2.06 | 0.03 | 0.33 | 0.08 | -4.01 | -0.59 |
| R - 8×9 | 0.88 | -0.83 | -3.88 | -5.71\* | 0.75 | 2 | 0.13 | 0.21 | 0.06 | 0 | -0.1 | -3.04 | 2.04 |
| R - 8×10 | 3.83 | 0.06 | -3.21 | -0.06 | -2.75 | -1.5 | 0.17 | -0.38 | 0.18 | 0.14 | 0.18 | -0.48 | -0.44 |
| R - 8×11 | 0.95 | 0.88 | -3.53 | -3.83 | -2.25 | -0.5 | 0.07 | -0.81 | -0.07 | -0.22 | 0.06 | -0.82 | 2.5 |
| R - 8×12 | -6.17 | -2.71 | -2.67 | -1.54 | -0.75 | -1 | -0.08 | -3.33 | -0.12 | -0.16 | -0.06 | -0.9 | 0.9 |
| R - 9×10 | 2.35 | 1.9 | 7.81\*\* | -0.77 | -0.5 | 0.25 | 0.19 | 0.68 | -0.18 | 0.07 | -0.15 | -3.55 | -1.04 |
| R - 9×11 | 8.25\* | -0.23 | 0.9 | 0.56 | 0.5 | 1.5 | 0.6 | 0.83 | 0.08 | 0.06 | -0.1 | 1.44 | 0.63 |
| R - 9×12 | 0.42 | 3 | -3.75 | 1.58 | -0.25 | 0.75 | 0 | 4.58 | 0.08 | -0.27\* | -0.08 | 2.44 | 2.71 |
| R - 10×11 | -4.75 | 0.88 | -5.40\* | -3.63 | -0.25 | 2 | -0.12 | -6.4 | -0.08 | 0.19 | 0.09 | -2.24 | 0.88 |
| R - 10×12 | 7.87\* | 2.75 | -2 | -4.33 | -4.75 | 1.25 | 0.34 | 3.15 | 0.36 | 0.02 | 0.1 | 1.79 | -0.27 |
| R - 11×12 | -1.25 | -2.79 | -6.21\* | -0.67 | 1 | 0 | -1.00\*\* | -3 | -0.21 | -0.22 | 0.08 | -3.52 | -0.6 |
| Intercept | 86.45 | 38.03 | 31.42 | 24.87 | 153.75 | 195.91 | 8.92 | 62.19 | 3.22 | 8.5 | 3.07 | 32.01 | 37.96 |
| LSD sij† | 6.84 | 4.05 | 4.36 | 4.73 | 3.03 | 2.71 | 0.59 | 6.37 | 0.40 | 0.23 | 0.16 | 7.40 | 4.19 |
| LSD rij‡ | 7.44 | 4.41 | 4.74 | 5.14 | 3.29 | 2.94 | 0.64 | 6.92 | 0.44 | 0.25 | 0.17 | 8.04 | 4.56 |
| SEs**§** | 3.55 | 2.06 | 2.22 | 2.43 | 1.55 | 1.36 | 0.3 | 3.22 | 0.21 | 0.11 | 0.085 | 3.89 | 2.12 |
| SEr**¶** | 3.86 | 2.24 | 2.41 | 2.64 | 1.68 | 1.48 | 0.32 | 3.5 | 0.22 | 0.12 | 0.093 | 4.23 | 2.30 |
| *Abbreviations:* DH, day to heading; DM, day to maturity; GWS, grain weight per spike (g); GY, grain yield per plant (g); HI, harvest index (%); KD, kernel diameter (mm); KL, kernel length (mm); NKS, number of kernels per spike; NPT, number of productive tillers per plant; NT, number of tillers per plant; PH, plant height (cm); PL, peduncle length (cm); SL, spike length (cm).  *Note:* Parent of crosses: Shabrang (1), Dena (2), Ariya (3), Behrang (4), Yavaros (5), Shwa (6), Karkheh (7), Saji (8), Khoyghan (9), Ozonbelagh (10), Zarneh (11), Singerd (12),  *Note:* S, Specific combining ability; R, Reciprocal effect;  **†** LSD sij, Differences between SCA effects of the ijth F1 Hybrid in 0.05 level  **‡** LSD rji, Differences between reciprocal effects of the jith F1 Hybrid in 0.05 level  **§** SEs, Standard error of specific combining ability effects  **¶** SEr, Standard error of reciprocal effects | | | | | | | | | | | | | |

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| **TABLE S6** Adequacy test of additive-dominance model for the studied traits in a 12×12 diallel cross of tetraploid wheat under two irrigation regimes. | | | | | | |
| **Non-stressed** | | | | | | |
| **Traits** | **R2** | **b** | **t2** | **H0: b=0** | **H0: b=1** | **Model Adequacy** |
| PH | 0.97 | 0.84±0.04 | 8.32\*\* | 17.71\*\* | 3.39\*\* | Not adequate |
| PL | 0.70 | 0.63±0.13 | 2.95 ns | 4.93\*\* | 2.89\* | partially adequate**†** |
| NT | 0.54 | 0.76±0.22 | 0.03 ns | 3.39\*\* | 1.06 ns | fully adequate**‡** |
| NPT | 0.42 | 0.60±0.21 | 0.16 ns | 2.72\* | 1.86 ns | fully adequate |
| DH | 0.97 | 1.09±0.06 | 3.48 ns | 17.96\*\* | -1.49 ns | fully adequate |
| DM | 0.76 | 1.21±0.21 | 4.52\* | 5.63\*\* | -0.96 ns | partially adequate |
| SL | 0.94 | 0.81±0.06 | 5.49\* | 12.35\*\* | 2.95\* | Not adequate |
| NKS | 0.97 | 0.97±0.05 | 0.14 ns | 19.29\*\* | 0.63 ns | fully adequate |
| GWS | 0.94 | 0.95±0.07 | 0.07 ns | 12.48\*\* | 0.65 ns | fully adequate |
| KL | 0.96 | 1.08±0.06 | 3.01 ns | 17.01\*\* | -1.35 ns | fully adequate |
| KD | 0.96 | 0.90±0.06 | 1.70 ns | 15.11\*\* | 1.67 ns | fully adequate |
| GY | 0.73 | 0.71±0.13 | 1.25 ns | 5.21\*\* | 2.11 ns | fully adequate |
| HI | 0.83 | 1.07±0.15 | 1.60 ns | 6.99\*\* | -0.48 ns | fully adequate |
| **Stressed** | | | | | | |
| **Traits** | **R2** | **b** | **t2** | **H0: b=0** | **H0: b=1** | **Model Adequacy** |
| PH | 0.9 | 1.31±0.13 | 11.30\*\* | 9.78\*\* | -2.32 ns | partially adequate |
| PL | 0.61 | 0.64±0.41 | 1.86 ns | 1.53ns | 0.87 ns | partially adequate |
| NT | 0.64 | 0.78±0.18 | 0.02 ns | 4.15\*\* | 1.20 ns | fully adequate |
| NPT | 0.94 | 0.87±0.06 | 2.41 ns | 13.31\*\* | 2.01 ns | fully adequate |
| DH | 0.91 | 0.83±0.08 | 2.21 ns | 10.10\*\* | 2.07 ns | fully adequate |
| DM | 0.76 | 1.08±0.19 | 1.97 ns | 5.70\*\* | -0.43 ns | fully adequate |
| SL | 0.95 | 0.91±0.06 | 0.86 ns | 13.99\*\* | 1.31 ns | fully adequate |
| NKS | 0.94 | 0.85±0.07 | 2.74 ns | 12.19\*\* | 2.16 ns | fully adequate |
| GWS | 0.92 | 1.05±0.09 | 1.20 ns | 11.08\*\* | -0.60 ns | fully adequate |
| KL | 0.91 | 1.05±0.11 | 1.00 ns | 9.87\*\* | -0.46 ns | fully adequate |
| KD | 0.97 | 1.01±0.05 | 0.26 ns | 18.55\*\* | -0.23 ns | fully adequate |
| GY | 0.57 | 0.52±0.14 | 3.31 ns | 3.62\*\* | 3.33\*\* | partially adequate |
| HI | 0.87 | 0.96±0.11 | 0.04 ns | 8.33\*\* | 0.37 ns | fully adequate |
| *Note:* R2, Coefficient of determination; b, Regression coefficient; b=0, is coefficient of regression deviating from zero; b=1, coefficient of regression deviating from unity; t2, uniformity test of covariance (Wr) and variance (Vr) of arrays,  *Abbreviation:* DH, day to heading; DM, day to maturity; GWS, grain weight per spike (g); GY, grain yield per plant (g); HI, harvest index (%); KD, kernel diameter (mm); KL, kernel length (mm); NKS, number of kernels per spike; NPT, number of productive tillers per plant; NT, number of tillers per plant; PH, plant height (cm); PL, peduncle length (cm); SL, spike length (cm).  **†** Partially adequate, if one of the tests fulfills the assumptions.  **‡** Fully adequate, if all the scaling tests are found in favor of assumptions;  *Note:* \*\*, \* and ns indicate significant at 0.01 and 0.05 probability levels and non-significant, respectively | | | | | | |



(a)

(b)

**Fig. S1.** The minimum and maximum of daily air temperature, Rainfall distribution **(a)** and minimum and maximum relative air humidity **(b)** during the crop growth period between November 2017 to June 2018.



(a)



(b)

**Fig. S2.** Principal components analysis for the studies traits in 132 crossings and twelve of their parental of tetraploid wheat genotypes under non-stress condition: **(a)** association of all measured traits based on correlation matrix, **(b)** scattering of the parent and their crosses. *Abbreviations****:*** Biological yield per plant (BY), Days to anthesis (DA), Day to heading (DH), Day to maturity (DM), Flag leaf area (FLA), Flag leaf length (FLL), Flag leaf width (FLW), Grain weight per spike (GWS), Grain yield per plant (GY), Harvest index (HI), Kernel diameter (KD), Kernel length (KL), Number of kernels per spike (NKS), Number of kernel per spikelet (NKSL), Number of productive tillers per plant (NPT), Number of sterile tillers (NST), Number of spikelet per spike (NSLS), Number of tillers per plant (NT), Peduncle extrusion (PE), Plant height (PH), Peduncle length (PL), and Spike length (SL).



(a)



(b)

**Fig. S3.** Principal components analysis for the studies traits in 132 crossings and twelve of their parental of tetraploid wheat genotypes under water stress condition: **(a)** association of all measured traits based on correlation matrix, **(b)** scattering of the parent and their crosses. *Abbreviations****:*** Biological yield per plant (BY), Days to anthesis (DA), Day to heading (DH), Day to maturity (DM), Flag leaf area (FLA), Flag leaf length (FLL), Flag leaf width (FLW), Grain weight per spike (GWS), Grain yield per plant (GY), Harvest index (HI), Kernel diameter (KD), Kernel length (KL), Number of kernels per spike (NKS), Number of kernel per spikelet (NKSL), Number of productive tillers per plant (NPT), Number of sterile tillers (NST), Number of spikelet per spike (NSLS), Number of tillers per plant (NT), Peduncle extrusion (PE), Plant height (PH), Peduncle length (PL), and Spike length (SL).

PH

PL

NT

NPT

DH

DM

SL

NKS

GWS

KL

KD

GY

**Fig. S4.** Regression of Wr on Vr graphs for traits Day to heading (DH), Day to maturity (DM), Grain weight per spike (GWS), Grain yield per plant (GY), Kernel diameter (KD), Kernel length (KL), Number of kernels per spike (NKS), Number of productive tillers per plant (NPT), Number of tillers per plant (NT), Plant height (PH), Peduncle length (PL), and Spike length (SL) in a 12 × 12 full diallel crosses of tetraploeid wheat under non-stressed condition. Dispersion of the points around regression line refer to Shabrang (1), Dena (2), Ariya (3), Behrang (4), Yavaros (5), Shwa (6), Karkheh (7), Saji (8), Khoyghan (9), Ozonbelagh (10), Zarneh (11), Singerd (12).

PH

PL

NT

NPT

DH

DM

SL

NKS

GWS

KL

KD

GY

**Fig. S5.** Regression of Wr on Vr graphs for traits Day to heading (DH), Day to maturity (DM), Grain weight per spike (GWS), Grain yield per plant (GY), Kernel diameter (KD), Kernel length (KL), Number of kernels per spike (NKS), Number of productive tillers per plant (NPT), Number of tillers per plant (NT), Plant height (PH), Peduncle length (PL), and Spike length (SL) in a 12×12 full diallel crosses of tetraploid wheat under water stress condition. Dispersion of the points around regression line refer to Shabrang (1), Dena (2), Ariya (3), Behrang (4), Yavaros (5), Shwa (6), Karkheh (7), Saji (8), Khoyghan (9), Ozonbelagh (10), Zarneh (11), Singerd (12).