**Electronic Supplementary Materials**

**Table S1.** The coordinates and altitudes of field test locations and minimum temperatures recorded during growing seasons at these locations. (Abbreviations: Latitude LA, Longitude LO, Altitude AL and Minimum Temperature MT)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Location** | **LA** | **LO** | AL (m) | **MT (°C)** |
| COLDU | 39.27 N | 37.03 E | 1400 | -12.8 |
| COLDH | 39.09 N | 32.51 E | 952 | -9.1 |
| COLDY | 39.58 N | 32.10 E | 850 | -15.2 |

**Table S2.** Time schedule for the tests carried out in controlled conditions.

|  |  |
| --- | --- |
| **DAY** | **ACTIVITIES** |
| 1 | Sowing was completed and all the boxes were irrigated with the same amount of water. Then incubation at +20 C in dark was started for germination. |
| 2-6 | Incubation at +20 C in dark. |
| 7 | Following the completion of germination of all lines (2 - 4 cm seedlings above the soil), temperature was decreased to +15 °C and 16 h light / 8 h dark photoperiod was started to apply. |
| 8 | Temperature was decreased to +10 C. |
| 9 | All the boxes were irrigated with the same amount of water. |
| 10 | Evaluation of the material at +10 C. |
| 11 | Temperature was decreased to +5 C.  Incubation at +5 C. |
| 12 | Temperature was decreased to 0 C.  Incubation at 0 C. |
| 13 | Temperature was decreased to -5 C.  Evaluation of the material at -5 C. |
| 154 | Temperature was decreased to -10 C.  Evaluation of the material at -10 C. |
| 15 | Temperature was decreased to -15 C.  Evaluation of the material at -15 C. |

**Table S3.** The *Spearman* (*S*) correlation values of gliadin and glutenin protein fragments with biotic and abiotic factors, and quality traits analysed in the study (Abbreviations: cold scores in COLDH Cs-H, cold scores in COLDU Cs-U, cold scores in COLDY Cs-Y)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Gliadin/Glutenin Fragments** |  | ***S*** | **Cs-H** | **Cs-U** | **Cs-U** | **Fv/Fm (+10 °C)** | **Fv/Fm (-5°C)** | **Fv/Fm (-10°C)** | **Fv/Fm**  **(-15°C)** |
| ω-gliadin | 1 | *r*S | 0.134 | 0.051 | -0.08 | 0.003 | 0.046 | 0.107 | 0.082 |
| *p* | 0.112 | 0.549 | 0.344 | 0.969 | 0.588 | 0.206 | 0.332 |
| ω-gliadin | 2 | *r*S | 0.058 | 0.051 | 0.048 | 0.109 | 0.077 | -0.1 | -0.047 |
| *p* | 0.498 | 0.549 | 0.575 | 0.2 | 0.361 | 0.239 | 0.581 |
| ω-gliadin | 3 | *r*S | -0.03 | -0.09 | -0.08 | 0.003 | 0.007 | -0.06 | -0.047 |
| *p* | 0.735 | 0.305 | 0.344 | 0.969 | 0.931 | 0.477 | 0.581 |
| ω-gliadin | 4 | *r*S | 0.003 | -0.07 | 0.008 | 0.068 | -0.11 | -0.005 | -0.02 |
| *p* | 0.971 | 0.409 | 0.923 | 0.426 | 0.195 | 0.949 | 0.817 |
| ω-gliadin | 5 | *r*S | **-0.294\*\*** | -0.05 | 0.092 | -0.017 | -0.019 | -0.126 | -0.06 |
| *p* | **0** | 0.575 | 0.276 | 0.844 | 0.823 | 0.135 | 0.479 |
| ω-gliadin | 6 | *r*S | -0 | 0.001 | 0.046 | 0.096 | **-0.167\*** | 0.007 | -0.035 |
| *p* | 0.967 | 0.99 | 0.588 | 0.259 | **0.048** | 0.934 | 0.678 |
| ω-gliadin 33 | 7 | *r*S | 0.027 | -0.02 | 0.008 | 0.005 | -0.079 | -0.054 | -0.076 |
| *p* | 0.747 | 0.845 | 0.926 | 0.951 | 0.354 | 0.527 | 0.368 |
| ω-gliadin 35 | 8 | *r*S | 0.046 | -0.03 | 0.111 | 0.108 | -0.095 | -0.115 | -0.153 |
| *p* | 0.591 | 0.738 | 0.189 | 0.202 | 0.26 | 0.174 | 0.071 |
| ω-gliadin 38 | 9 | *r*S | -0.08 | 0.001 | 0.125 | 0.152 | -0.133 | -0.136 | -0.121 |
| *p* | 0.354 | 0.992 | 0.141 | 0.073 | 0.116 | 0.109 | 0.152 |
| γ-gliadin 45 | 10 | *r*S | -0.05 | -0.01 | 0.011 | 0.044 | -0.116 | -0.093 | -0.124 |
| *p* | 0.539 | 0.866 | 0.898 | 0.608 | 0.169 | 0.275 | 0.141 |
| γ-gliadin 42 | 11 | *r*S | 0.094 | -0.07 | -0.04 | 0.032 | -0.051 | 0.073 | 0.067 |
| *p* | 0.27 | 0.42 | 0.612 | 0.703 | 0.546 | 0.388 | 0.431 |
| γ-gliadin triplet | 12 | *r*S | 0.028 | **-0.167\*** | -0.01 | 0.009 | **-0.219\*\*** | -0.076 | -0.021 |
| *p* | 0.74 | **0.048** | 0.893 | 0.915 | **0.009** | 0.369 | 0.8 |
| 13 | *r*S | -0.03 | 0.051 | 0.1 | 0.109 | 0.125 | -0.012 | -0.102 |
| *p* | 0.735 | 0.549 | 0.236 | 0.2 | 0.141 | 0.883 | 0.228 |
| 14 | *r*S | 0.126 | -0.09 | 0.146 | 0.055 | -0.162 | 0.03 | 0.021 |
| *p* | 0.136 | 0.318 | 0.084 | 0.515 | 0.055 | 0.726 | 0.806 |
| In β-gliadin region second triplet group as in Cham 1 | 15 | *r*S | -0.02 | 0.09 | -0.14 | 0.001 | -0.002 | 0.126 | -0.047 |
| *p* | 0.774 | 0.286 | 0.097 | 0.986 | 0.985 | 0.136 | 0.584 |
| 16 | *r*S | -0.02 | 0.09 | -0.14 | 0.001 | -0.002 | 0.126 | -0.047 |
| *p* | 0.774 | 0.286 | 0.097 | 0.986 | 0.985 | 0.136 | 0.584 |

**Table S3.** The *Spearman* (*S*) correlation values of gliadin and glutenin protein fragments with biotic and abiotic factors, and quality traits analysed in the study (Abbreviations: cold scores in COLDH Cs-H, cold scores in COLDU Cs-U, cold scores in COLDY Cs-Y)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Gliadin/Glutenin Fragments** |  | ***S*** | **Cs-H** | **Cs-U** | **Cs-U** | **Fv/Fm (+10 °C)** | **Fv/Fm (-5°C)** | **Fv/Fm (-10°C)** | **Fv/Fm**  **(-15°C)** |
|  | 17 | *r*S | -0.01 | 0.066 | -0.12 | 0.002 | -0.027 | 0.139 | -0.036 |
| *p* | 0.876 | 0.437 | 0.157 | 0.98 | 0.749 | 0.099 | 0.668 |
| In β-gliadin region the duplet as in Kunduru 1149 | 18 | *r*S | 0.024 | -0.09 | 0.14 | -0.001 | 0.002 | -0.126 | 0.047 |
| *p* | 0.774 | 0.286 | 0.097 | 0.986 | 0.985 | 0.136 | 0.584 |
| 19 | *r*S | 0.024 | -0.09 | 0.14 | -0.001 | 0.002 | -0.126 | 0.047 |
| *p* | 0.774 | 0.286 | 0.097 | 0.986 | 0.985 | 0.136 | 0.584 |
| In β-gliadin region third triplet group as in Cham 1 | 20 | *r*S | -0.09 | 0.011 | 0.085 | 0.156 | 0.008 | -0.005 | -0.021 |
| *p* | 0.284 | 0.894 | 0.314 | 0.065 | 0.922 | 0.951 | 0.802 |
| 21 | *r*S | -0.09 | 0.011 | 0.085 | 0.156 | 0.008 | -0.005 | -0.021 |
| *p* | 0.284 | 0.894 | 0.314 | 0.065 | 0.922 | 0.951 | 0.802 |
| 22 | *r*S | -0.09 | 0.011 | 0.085 | 0.156 | 0.008 | -0.005 | -0.021 |
| *p* | 0.284 | 0.894 | 0.314 | 0.065 | 0.922 | 0.951 | 0.802 |
| In β-gliadin region the second duplet as in Kunduru 1149 | 23 | *r*S | 0.091 | -0.01 | -0.09 | -0.156 | -0.008 | 0.005 | 0.021 |
| *p* | 0.284 | 0.894 | 0.314 | 0.065 | 0.922 | 0.951 | 0.802 |
| 24 | *r*S | 0.091 | -0.01 | -0.09 | -0.156 | -0.008 | 0.005 | 0.021 |
| *p* | 0.284 | 0.894 | 0.314 | 0.065 | 0.922 | 0.951 | 0.802 |
| In α-gliadin region the first duplet group as in Cham 1 | 25 | *r*S | -0.08 | **-0.203\*** | 0.147 | 0.009 | **-0.166\*** | -0.069 | 0.065 |
| *p* | 0.379 | **0.016** | 0.083 | 0.92 | **0.048** | 0.419 | 0.447 |
| 26 | *r*S | -0.08 | **-0.203\*** | 0.147 | 0.009 | **-0.166\*** | -0.069 | 0.065 |
| *p* | 0.379 | **0.016** | 0.083 | 0.92 | **0.048** | 0.419 | 0.447 |
| In α-gliadin region the second duplet group as in Cham 1 | 27 | *r*S | -0.08 | **-0.199\*** | 0.149 | 0.008 | **-0.168\*** | -0.081 | 0.056 |
| *p* | 0.32 | **0.018** | 0.079 | 0.925 | **0.047** | 0.338 | 0.51 |
| 28 | *r*S | -0.08 | **-0.199\*** | 0.149 | 0.008 | **-0.168\*** | -0.081 | 0.056 |
| *p* | 0.32 | **0.018** | 0.079 | 0.925 | **0.047** | 0.338 | 0.51 |
| In α-gliadin region the single fragment as in Kunduru 1149 | 29 | *r*S | 0.084 | **0.199\*** | -0.15 | -0.008 | **0.168\*** | 0.081 | -0.056 |
| *p* | 0.32 | **0.018** | 0.079 | 0.925 | **0.047** | 0.338 | 0.51 |
| HMWG | Subunite 1 | *r*S | 0.065 | 0.053 | 0.024 | 0.123 | 0.154 | 0.021 | 0.049 |
| *p* | 0.441 | 0.535 | 0.774 | 0.146 | 0.069 | 0.806 | 0.56 |
| HMWG | Subunite Null | *r*S | -0.07 | -0.05 | -0.02 | -0.123 | -0.154 | -0.021 | -0.049 |
| *p* | 0.441 | 0.535 | 0.774 | 0.146 | 0.069 | 0.806 | 0.56 |
| HMWG | Subunite 7+8 | *r*S | -0.07 | -0.06 | -0.1 | 0.049 | 0.08 | 0.042 | 0.003 |
| *p* | 0.436 | 0.521 | 0.251 | 0.569 | 0.346 | 0.623 | 0.973 |

**Table S3.** The *Spearman* (*S*) correlation values of gliadin and glutenin protein fragments with biotic and abiotic factors, and quality traits analysed in the study (Abbreviations: cold scores in COLDH Cs-H, cold scores in COLDU Cs-U, cold scores in COLDY Cs-Y)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Gliadin/Glutenin**  **Fragments** |  | ***S*** | **Cs-H** | **Cs-U** | **Cs-U** | **Fv/Fm (+10 °C)** | **Fv/Fm (-5°C)** | **Fv/Fm (-10°C)** | **Fv/Fm**  **(-15°C)** |
| HMWG | Subunite 20 | *r*S | 0.072 | 0.085 | 0.096 | -0.056 | -0.098 | -0.075 | -0.027 |
| *p* | 0.396 | 0.318 | 0.256 | 0.507 | 0.247 | 0.379 | 0.749 |
| HMWG | Subunite 7+Null | *r*S | -0.08 | -0.07 | -0.1 | 0.057 | 0.091 | 0.053 | 0.004 |
| *p* | 0.365 | 0.439 | 0.245 | 0.502 | 0.284 | 0.535 | 0.961 |
| HMWG | Subunite 8+Null | *r*S | -0.08 | -0.07 | -0.1 | 0.057 | 0.091 | 0.053 | 0.004 |
| *p* | 0.365 | 0.439 | 0.245 | 0.502 | 0.284 | 0.535 | 0.961 |
| N |  |  | 141 | 141 | 141 | 141 | 141 | 141 | 141 |

**Table S4.** The *Spearman* (*S*) correlation values of RAPD loci with biotic and abiotic stress factors, and quality traits analysed in the study (Abbreviations: cold scores in COLDH Cs-H, cold scores in COLDU Cs-U, cold scores in COLDY Cs-Y)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **RAPD Loci** | ***S*** | **Cs-H** | **Cs-U** | **Cs-U** | **Fv/Fm +10°C** | **Fv/Fm -5°C** | **Fv/Fm -10°C** | **Fv/Fm -15°C** |
| E-9/1600 | *r*S | -0.068 | -0.118 | 0.021 | -0.079 | -0.162 | 0.049 | 0.017 |
| *p* | 0.424 | 0.162 | 0.807 | 0.352 | 0.055 | 0.56 | 0.843 |
| E-9/1000 | *r*S | -0.135 | -0.157 | 0.119 | -0.015 | -0.024 | 0.089 | 0.054 |
| *p* | 0.11 | 0.063 | 0.159 | 0.859 | 0.78 | 0.295 | 0.526 |
| E-9/900 | *r*S | 0.007 | -0.045 | 0.071 | -0.029 | -0.029 | -0.042 | -0.047 |
| *p* | 0.932 | 0.597 | 0.404 | 0.732 | 0.733 | 0.624 | 0.583 |
| E-13/1100 | *r*S | **00.167\*** | **00.207\*** | **00.249\*\*** | 0.101 | -0.008 | 0.029 | -0.013 |
| *p* | **0.047** | **0.014** | **0.003** | 0.234 | 0.924 | 0.734 | 0.881 |
| E-13/900 | *r*S | **00.205\*** | 0.05 | **00.259\*\*** | 0.145 | -0.034 | -0.003 | -0.052 |
| *p* | **0.015** | 0.554 | **0.002** | 0.087 | 0.693 | 0.967 | 0.54 |
| M-18/1800 | *r*S | 0.008 | 0.079 | 0.155 | 0.024 | 0.064 | 0.044 | -0.067 |
| *p* | 0.928 | 0.35 | 0.066 | 0.779 | 0.45 | 0.605 | 0.429 |
| M-18/1250 | *r*S | -0.06 | 0.02 | 0.063 | 0.017 | 0.058 | 0.01 | -0.072 |
| *p* | 0.481 | 0.814 | 0.456 | 0.839 | 0.496 | 0.904 | 0.397 |
| M-18/900 | *r*S | -0.032 | 0.031 | -0.008 | -0.005 | 0.128 | 0.088 | -0.016 |
| *p* | 0.71 | 0.717 | 0.927 | 0.949 | 0.129 | 0.3 | 0.855 |
| K-9/1750 | *r*S | -0.106 | 0.125 | -0.092 | 0.032 | -0.012 | -0.03 | -0.103 |
| *p* | 0.212 | 0.14 | 0.276 | 0.707 | 0.886 | 0.727 | 0.224 |
| K-9/1650 | *r*S | -0.113 | 0.098 | -0.075 | 0.003 | 0 | 0.024 | -0.092 |
| *p* | 0.183 | 0.248 | 0.374 | 0.971 | 0.996 | 0.777 | 0.277 |
| K-9/650 | *r*S | -0.038 | 0.109 | -0.049 | 0.038 | -0.142 | 0.042 | -0.066 |
| *p* | 0.656 | 0.2 | 0.563 | 0.652 | 0.093 | 0.62 | 0.44 |
| K-9/600 | *r*S | 0.029 | 0.082 | -0.021 | -0.023 | 0.004 | 0.055 | -0.092 |
| *p* | 0.73 | 0.334 | 0.805 | 0.783 | 0.964 | 0.518 | 0.276 |
| K-9/500 | *r*S | -0.073 | 00.193\* | -0.097 | 0.065 | -0.046 | -0.024 | -0.085 |
| *p* | 0.387 | 0.022 | 0.254 | 0.441 | 0.588 | 0.779 | 0.318 |
| E-8/500 | *r*S | -0.053 | 0.12 | 0.055 | -0.042 | -0.082 | -0.021 | 0.025 |
| *p* | 0.529 | 0.155 | 0.518 | 0.622 | 0.332 | 0.805 | 0.771 |
| A-11/350 | *r*S | 0.036 | 0.025 | -0.072 | -0.041 | -0.023 | -0.041 | 0.062 |
| *p* | 0.674 | 0.77 | 0.396 | 0.63 | 0.784 | 0.632 | 0.468 |
| A-11/300 | *r*S | -0.021 | 0.081 | -0.066 | 0.036 | 0.08 | 0.02 | -0.074 |
| *p* | 0.807 | 0.34 | 0.436 | 0.675 | 0.345 | 0.816 | 0.384 |
| B-11/730 | *r*S | 0.009 | -0.062 | **00.176\*** | 0.109 | 0.039 | -0.161 | -0.125 |
| *p* | 0.914 | 0.464 | **0.037** | 0.199 | 0.649 | 0.056 | 0.141 |
| B-11/510 | *r*S | -0.083 | -0.019 | **00.240\*\*** | **00.237\*\*** | 0.071 | 0.078 | 0.08 |
| *p* | 0.326 | 0.823 | **0.004** | **0.005** | 0.4 | 0.361 | 0.344 |

**Table S4.** The *Spearman* (*S*) correlation values of RAPD loci with biotic and abiotic stress factors, and quality traits analysed in the study (Abbreviations: cold scores in COLDH Cs-H, cold scores in COLDU Cs-U, cold scores in COLDY Cs-Y)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **RAPD Loci** | ***S*** | **Cs-H** | **Cs-U** | **Cs-U** | **Fv/Fm +10°C** | **Fv/Fm -5°C** | **Fv/Fm -10°C** | **Fv/Fm -15°C** |
| C-7/1800 | *r*S | 0.043 | **00.244\*\*** | 0.127 | 0.126 | 0.062 | -0.031 | -0.154 |
| *p* | 0.61 | **0.004** | 0.133 | 0.135 | 0.468 | 0.717 | 0.067 |
| C-7/1600 | *r*S | 0.112 | **0.185\*** | 0.067 | 0.109 | -0.009 | -0.112 | **-0.237\*\*** |
| *p* | 0.185 | **0.028** | 0.432 | 0.196 | 0.92 | 0.188 | **0.005** |
| C-7/1450 | *r*S | -0.011 | **0.284\*\*** | 0.114 | 0.154 | 0.073 | -0.078 | **-0.188\*** |
| *p* | 0.897 | **0.001** | 0.179 | 0.068 | 0.39 | 0.36 | **0.025** |
| E-17/700 | *r*S | -0.124 | -0.104 | -0.091 | -0.103 | -0.031 | 0.048 | 0.077 |
| *p* | 0.144 | 0.22 | 0.283 | 0.224 | 0.717 | 0.572 | 0.367 |
| E-17/340 | *r*S | -0.04 | 0.057 | -0.141 | -0.078 | 0.076 | 0.084 | 0.061 |
| *p* | 0.635 | 0.5 | 0.095 | 0.359 | 0.369 | 0.322 | 0.473 |
| G-11/620 | *r*S | -0.019 | 0.001 | 0.009 | -0.095 | -0.141 | 0.025 | 0.009 |
| *p* | 0.824 | 0.992 | 0.92 | 0.264 | 0.096 | 0.765 | 0.914 |
| G-11/500 | *r*S | -0.026 | 0.058 | -0.022 | -0.176\* | -0.016 | 0.039 | 0.022 |
| *p* | 0.755 | 0.492 | 0.797 | 0.037 | 0.847 | 0.643 | 0.793 |
| J-9/1650 | *r*S | 0.085 | 0.001 | 0.13 | -0.054 | 0.048 | -0.074 | -0.043 |
| *p* | 0.317 | 0.988 | 0.125 | 0.524 | 0.574 | 0.383 | 0.609 |
| J-9/1550 | *r*S | 0.099 | 0.078 | 0.102 | -0.116 | 0.058 | 0.014 | 0.024 |
| *p* | 0.243 | 0.355 | 0.231 | 0.17 | 0.496 | 0.869 | 0.781 |
| J-9/1250 | *r*S | 0.03 | 0.069 | 0.158 | -0.073 | -0.088 | -0.11 | -0.097 |
| *p* | 0.722 | 0.418 | 0.062 | 0.393 | 0.298 | 0.194 | 0.253 |
| J-9/1050 | *r*S | **0.196\*** | 0.015 | 0.081 | -0.159 | -0.083 | -0.046 | -0.033 |
| *p* | **0.02** | 0.864 | 0.34 | 0.06 | 0.33 | 0.586 | 0.694 |
| J-12/550 | *r*S | 0.125 | 0.143 | 0.084 | 0.009 | 0.049 | -0.065 | -0.131 |
| *p* | 0.139 | 0.09 | 0.32 | 0.914 | 0.565 | 0.443 | 0.122 |
| L-3/2300 | *r*S | 0.145 | 0.089 | 0.158 | -0.009 | 0.008 | 0.004 | -0.118 |
| *p* | 0.086 | 0.296 | 0.062 | 0.916 | 0.928 | 0.959 | 0.163 |
| L-3/1550 | *r*S | 0.097 | 0.026 | 0.073 | -0.065 | -0.088 | 0.004 | -0.016 |
| *p* | 0.254 | 0.759 | 0.39 | 0.446 | 0.302 | 0.958 | 0.85 |
| L-3/500 | *r*S | 0.161 | -0.024 | **0.187\*** | 0.107 | **-0.168\*** | -0.14 | **-0.228\*\*** |
| *p* | 0.057 | 0.778 | **0.026** | 0.207 | **0.046** | 0.099 | **0.007** |
| N |  | **141** | **141** | **141** | **141** | **141** | **141** | **141** |