**Supplementary table 1 The** **polish wheat cultivars and the collecting location for testing**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| No. | Material number | Origin | No. | | Material number | Origin |
| B1 | PI29447 | Ukraine | B29 | PI298572 | | Ethiopia |
| B3 | PI384265 | Ethiopia | B30 | PI306548 | | Romania |
| B4 | PI384345 | Ethiopia | B31 | CItr13919-1 | | Ethiopia |
| B5 | PI290512 | Portugal | B32 | PI566593 | | United States |
| B6 | PI225334 | Iran | B33 | PI272565 | | Hungary |
| B7 | PI190951 | Portugal | B34 | PI272565-1 | | Hungary |
| B8 | CItr14140 | Unknown | B35 | PI352488 | | Italy |
| B9 | PI387479 | Ethiopia | B36 | PI210845 | | Iran |
| B10 | PI185309 | Argentina | B37 | PI210845-1 | | Iran |
| B11 | PI608017 | United States | B38 | PI566593-1 | | United States |
| B12 | PI266846 | Britain | B39 | PI384340 | | Ethiopia |
| B13 | PI191823 | Portugal | B40 | PI384340-1 | | Ethiopia |
| B14 | PI366117 | Egypt | B41 | PI352489 | | Cyprus |
| B15 | PI223171 | Jordan | B42 | PI56261-1 | | Portugal |
| B16 | PI384268 | Ethiopia | B43 | PI306548-1 | | Romania |
| B17 | CItr14139 | Unknown | B44 | PI352489-1 | | Cyprus |
| B18 | PI352487-1 | Germany | B45 | PI56261 | | Portugal |
| B19 | PI134945 | Portugal | B46 | PI387457 | | Ethiopia |
| B21 | PI352488-1 | Italy | B49 | PI387457-1 | | Ethiopia |
| B25 | PI42209-1 | Australia | B50 | CItr17442-1 | | United States |
| B27 | PI272564-1 | Hungary | B51 | CItr17442 | | United States |
| B28 | CItr13919 | Ethiopia | B52 | PI298572-1 | | Ethiopia |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Collecting location | | Number and percentage of materials (%) | Number and percentage of materials (%) | Material |
| Africa | Egypt | 13(29.55) | 1(2.27) | B14 | |
|  | Ethiopia |  | 12(27.27) | B3, B4, B9, B16, B28, B29, B31, B39, B40, B46, B49, B52 |
| Asia | Argentina | 7(15.91) | 1(2.27) | B10 |
|  | Cyprus |  | 2(4.55) | B41, B44 |
|  | Iran |  | 3(6.82) | B6, B36, B37 |
|  | Jordan |  | 1(2.27) | B15 |
| Europe | Britain | 16(36.36) | 1(2.27) | B12 |
|  | Germany |  | 1(2.27) | B18 |
|  | Hungary |  | 3(6.82) | B27, B33, B34 |
|  | Italy |  | 2(4.55) | B21, B35 |
|  | Portugal |  | 6(13.64) | B5, B7, B13, B19, B42, B45 |
|  | Romania |  | 2(4.55) | B30, B43 |
|  | Ukraine |  | 1(2.27) | B1 |
| North America | United States | 5(11.36) | 5(11.36) | B11, B32, B38, B50, B51 |
| Oceania | Australia | 1(2.27) | 1(2.27) | B25 |
| Unknown |  | 2(4.55) | 2(4.55) | B8, B17 |

Supplementary table 2 polish wheat materials for test

**Supplementary table 3 Changes in** **plant phenotypic morphology of different** **materials of polish wheat in 2020-2022**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Year | Characters | Mean | Max. | Min. | Range | CV (%) | *H’* |
| 2020 | PH（cm） | 126.7 | 160 | 51 | 109 | 17.79 | 3.74 |
|  | SPL (cm) | 12.07 | 20 | 7 | 13 | 24.12 | 3.73 |
|  | SNL (cm) | 52.15 | 66 | 21 | 45 | 16.38 | 3.75 |
|  | Tiller(number) | 33.14 | 68 | 2 | 66 | 48.25 | 3.64 |
| 2021 | PH（cm） | 136.75 | 170.2 | 104.2 | 66 | 11.31 | 3.78 |
|  | SPL (cm) | 12.68 | 22.96 | 7 | 15.96 | 26.07 | 3.75 |
|  | SNL (cm) | 68.9 | 78.9 | 55.64 | 23.26 | 9.48 | 3.78 |
|  | Tiller(number) | 17.47 | 27.2 | 7.9 | 19.3 | 29.77 | 3.74 |
| 2022 | PH（cm） | 141.04 | 167.2 | 110.2 | 57 | 11.46 | 3.78 |
|  | SPL (cm) | 12.36 | 17.32 | 7 | 10.32 | 19.95 | 3.76 |
|  | SNL (cm) | 52 | 73.6 | 35.92 | 37.68 | 15.47 | 3.77 |
|  | Tiller(number) | 15.67 | 35.64 | 9.6 | 26.04 | 32.39 | 3.74 |

Abbreviations: PH, plant height(cm); SPL, spike length(cm); SNL, spike neck node length(cm); *CV*, Coefficient of Variation; *H’*,Genetic diversity index

**Supplementary table 4 Changes in grain phenotypic traits of different materials of polish wheat in 2020-2022**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Year | Trait | Mean | Max. | Min. | Range | CV (%) | *H’* |
|  |
| 2020 | SL（mm） | 8.9 | 10.54 | 5.47 | 5.07 | 13 | 3.75 |  |
|  | SW (mm） | 2.96 | 3.5 | 1.7 | 1.8 | 12.14 | 3.75 |  |
|  | SSA (mm2） | 22.17 | 26.83 | 16.2 | 10.63 | 12.74 | 3.75 |  |
|  | TGW (g) | 48.79 | 71.8 | 9.33 | 62.46 | 26.68 | 3.72 |  |
| 2021 | SL（mm） | 8.6 | 9.97 | 6.87 | 3.1 | 9.52 | 3.78 |  |
|  | SW (mm） | 3.06 | 3.4 | 2.5 | 0.9 | 7.45 | 3.78 |  |
|  | SSA (mm2） | 22.45 | 26.8 | 16.6 | 10.2 | 12.29 | 3.78 |  |
|  | TGW (g) | 43.52 | 61.88 | 15.4 | 46.48 | 23.09 | 3.76 |  |
| 2022 | SL (mm） | 8.91 | 10.18 | 7.14 | 3.04 | 8.67 | 3.78 |  |
|  | SW (mm） | 3.2 | 3.58 | 2.82 | 0.76 | 6.74 | 3.78 |  |
|  | SSA (mm2） | 24.23 | 29.8 | 17.8 | 12 | 10.65 | 3.78 |  |
|  | TGW (g) | 50.29 | 66.23 | 37.4 | 28.83 | 14.4 | 3.77 |  |

Abbreviations: SL, seed length(mm); SW, seed width(mm); SSA, seed surface area(mm2); TGW, thousand grain weight(g); *CV*, Coefficient of Variation; *H’,* Genetic diversity index

**Supplementary table 5 Changes in grain quality trait of different materials of polish wheat in 2020-2022**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Year | Trait | Mean | Max. | Min. | Range | CV (%) | *H’* |
| 2020 | SMC (%) | 9.78 | 12.12 | 9.08 | 3.04 | 4.88 | 3.76 |
|  | SCPC (%) | 21.79 | 25.84 | 18.32 | 7.53 | 9.25 | 3.76 |
|  | SWAR (%) | 58.76 | 64.41 | 37.82 | 26.6 | 8.94 | 3.76 |
|  | SHI (%) | 66.41 | 82.26 | 47.75 | 34.51 | 9.98 | 3.76 |
|  | SBD (g L-1) | 790.34 | 900 | 739.33 | 160.67 | 3.74 | 3.76 |
| 2021 | SMC (%) | 6.39 | 6.85 | 5.67 | 1.18 | 4.8 | 3.78 |
|  | SCPC (%) | 19.36 | 26.16 | 14.73 | 11.44 | 10.44 | 3.78 |
|  | SWAR (%) | 64.82 | 68.34 | 57.95 | 10.39 | 2.77 | 3.78 |
|  | SHI (%) | 73.91 | 78.93 | 51.29 | 27.64 | 5.87 | 3.78 |
|  | SBD (g L-1) | 790.88 | 821.48 | 750.12 | 71.36 | 2.06 | 3.78 |
| 2022 | SMC (%) | 10.47 | 11.26 | 9.28 | 1.98 | 3.83 | 3.78 |
|  | SCPC (%) | 19.85 | 22.33 | 16.67 | 5.67 | 7.48 | 3.78 |
|  | SWAR (%) | 53.88 | 58.15 | 47.76 | 10.38 | 4.93 | 3.78 |
|  | SHI (%) | 52.48 | 119.98 | 40.82 | 79.16 | 21.99 | 3.77 |
|  | SBD (g L-1) | 766.82 | 789.06 | 742.56 | 46.5 | 1.33 | 3.78 |

Abbreviations: SMC, seed moisture content (%); SCPC, seed crude protein content (%); SWAR, seed water absorption rate (%); SHI, seed hardness index; *CV*, Coefficient of Variation; *H’,* Genetic diversity index.

**Supplementary table 6 Results of the dichotomous analysis between years and varieties of different tested materials in 2020-2022**

|  |  |  |  |
| --- | --- | --- | --- |
| Trait | Years | Varieties | Years\*Varieties |
| PH (cm) | ns | \*\*\* | ns |
| SPL (cm) | ns | \*\*\* | ns |
| SNL (cm) | \* | \*\*\* | ns |
| Tiller(number) | \*\*\* | \*\*\* | ns |
| SL(mm） | ns | \*\*\* | \*\*\* |
| SW (mm) | ns | \*\*\* | \*\*\* |
| SSA (mm2) | ns | \*\*\* | \*\*\* |
| TGW(g) | ns | \*\*\* | \*\*\* |
| SMC (%) | ns | \*\*\* | \*\*\* |
| SCPC (%) | \* | \*\* | ns |
| SWAR (%) | ns | \*\*\* | \*\*\* |
| SHI (%) | ns | \*\*\* | \*\*\* |
| SBD (g L-1) | ns | \*\*\* | \*\*\* |

**Abbreviations:** PH, plant height(cm); SPL, spike length(cm); SNL, spike neck node length(cm); SL, seed length(mm); SW, seed width(mm); SSA, seed surface area(mm2); TGW, thousand grain weight(g); SMC, seed moisture content (%); SCPC, seed crude protein content (%); SWAR, seed water absorption rate (%); SHI, seed hardness index; SBD, seed bulk density (g L-1). Years, Years effect; Varieties, Varieties effect; Years\*Varieties, the interaction effect between years and varieties. “\*”: *P*<0.05，“\*\*”: *P*<0.01, “\*\*\*”: *P*<0.001, ns: *P*>0.05.

**Supplementary table 7 Total variance explained by each indicator for polish wheat**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| PC | Initial eigenvalue | | |  | | Extract Square and Load | | |
| LR | CR /% | CCR /% | |  | LR | CR /% | CCR/% |
| 1 | 4.018 | 30.909 | 30.909 | |  | 4.018 | 30.909 | 30.909 |
| 2 | 3.026 | 23.28 | 54.189 | |  | 3.026 | 23.28 | 54.189 |
| 3 | 2.192 | 16.865 | 71.054 | |  | 2.192 | 16.865 | 71.054 |
| 4 | 1.235 | 9.50 | 80.554 | |  | 1.235 | 9.50 | 80.554 |
| 5 | 0.973 | 7.484 | 88.038 | |  |  |  |  |
| 6 | 0.524 | 4.034 | 92.072 | |  |  |  |  |
| 7 | 0.346 | 2.661 | 94.733 | |  |  |  |  |
| 8 | 0.259 | 1.991 | 96.724 | |  |  |  |  |
| 9 | 0.165 | 1.27 | 97.994 | |  |  |  |  |
| 10 | 0.106 | 0.818 | 98.812 | |  |  |  |  |
| 11 | 0.08 | 0.617 | 99.429 | |  |  |  |  |
| 12 | 0.045 | 0.346 | 99.775 | |  |  |  |  |
| 13 | 0.029 | 0.225 | 100.00 | |  |  |  |  |

Abbreviations: PC, principal Component; LR, latent root; CR, contribution rate; CCR, cumulative contribution rate

**Supplementary table 8 Component loading matrix after rotation**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Index | PC1 | PC2 | P C3 | P C4 |
| PH (cm) | 0.830 | -0.195 | -0.204 | 0.348 |
| SPL (cm) | 0.397 | -0.043 | 0.545 | 0.512 |
| SNL (cm) | 0.702 | -0.273 | -0.438 | 0.14 |
| Tiller (number) | -0.670 | 0.238 | -0.136 | 0.225 |
| SL (mm) | 0.719 | 0.572 | 0.217 | 0.118 |
| SW (mm) | -0.355 | 0.781 | -0.271 | -0.215 |
| SSA (mm2) | 0.437 | 0.760 | 0.371 | -0.209 |
| TGW (g) | 0.476 | 0.848 | 0.027 | -0.130 |
| SMC (%) | 0.576 | -0.653 | 0.053 | -0.258 |
| SCPC (%) | -0.231 | 0.147 | 0.696 | 0.491 |
| SWAR (%) | 0.366 | 0.343 | -0.682 | 0.391 |
| SHI (%) | 0.440 | 0.152 | -0.454 | -0.066 |
| SBD (g L-1) | 0.675 | -0.180 | 0.475 | -0.444 |

Abbreviations: PC1, Principal Component 1; PC2, Principal Component 2; PC3, Principal Component 3; PC4, Principal Component 4; PH, plant height(cm); SPL, spike length(cm); SNL, spike neck node length(cm); SL, seed length(mm); SW, seed width(mm); SSA, seed surface area(mm2); TGW, thousand grain weight(g); SMC, seed moisture content(%); SCPC, seed crude protein content(%); SWAR, seed water absorption rate(%); SHI, seed hardness index; SBD, seed bulk density(g/L); SD, standard deviation; *CV* , coefficient of variation; *H’* , genetic diversity index

**Supplementary table 9 Component score coefficient matrix**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Index | PC1 | PC2 | PC3 | PC4 |
| PH (cm) | 0.207 | -0.064 | -0.093 | 0.282 |
| SPL (cm) | 0.099 | -0.014 | 0.249 | 0.414 |
| SNL (cm) | 0.175 | -0.090 | -0.200 | 0.113 |
| Tiller (number) | -0.167 | 0.079 | -0.062 | 0.182 |
| SL (mm) | 0.179 | 0.189 | 0.099 | 0.095 |
| SW (mm) | -0.088 | 0.258 | -0.124 | -0.174 |
| SSA (mm) | 0.109 | 0.251 | 0.169 | -0.169 |
| TGW (g) | 0.119 | 0.280 | 0.012 | -0.105 |
| SMC (%) | 0.143 | -0.216 | 0.024 | -0.209 |
| SCPC (%) | -0.057 | 0.049 | 0.317 | 0.398 |
| SWAR (%) | 0.091 | 0.113 | -0.311 | 0.316 |
| SHI (%) | 0.109 | 0.050 | -0.207 | -0.053 |
| SBD (g L-1) | 0.168 | -0.060 | 0.216 | -0.359 |

Abbreviations: PH, plant height(cm); SPL, spike length(cm); SNL, spike neck node length(cm); SL, seed length(mm); SW, seed width(mm); SSA, seed surface area(mm2); TGW, thousand grain weight(g); SMC, seed moisture content (%); SCPC, seed crude protein content (%); SWAR, seed water absorption rate (%); SHI, seed hardness index; SBD, seed bulk density(g L-1); SD, standard deviation; *CV*, coefficient of variation; *H’*, genetic diversity index.

**Supplementary formula I**

Expression of principal components (1) ~ (5):

*F*1=0.207*X*1+0.099*X*2+0.175*X*3-0.167*X*4+0.179*X*50.088*X*6+0.109*X*7+0.119*X8*+0.143*X9*-0.057*X10*+0.091*X11*+0.109*X12*+0.168*X13-------* (1)

*F*2=-0.064*X*1-0.014*X*2-0.09*X*3+0.079*X*4+0.189*X*5+0.258*X*6+0.251*X*7+0.28*X8*-0.216*X9+*0.049*X10*+0.113*X11*+0.05*X12*-0.06*X13---------* (2)

*F*3=-0.093*X*1+0.249*X*2-0.2*X*3-0.062*X*4+0.099*X*5-0.124*X*6+0.169*X*7+0.012*X8*+0.024*X9+*0.317*X10*-0.311*X11*-0.207*X12*+0.216*X13* ------(3)

*F4=*0.282*X*1+0.414*X*2+0.113*X*3+0.182*X*4+0.095*X*5-0.174*X*6-0.169*X*7-0.105*X8*-0.209*X9+*0.398*X10*+0.316*X11*-0.053*X12*-0.359*X13------* (4)

*F* synthesis(S) =(30.909*F*1+23.28*F*2+16.865*F*3+9.5F4)/80.554 ------(5)

**Supplementary table 10 Clustering diagram specificity**

|  |  |  |  |
| --- | --- | --- | --- |
| Trait | Cluster Ⅰ | Cluster Ⅱ | Cluster Ⅲ |
| PH（cm） | 106.45 | 120.39 | 143.41 |
| SL（cm） | 13.01 | 11.42 | 12.71 |
| SNL（cm） | 47.47 | 52.47 | 60.85 |
| Tiller (number) | 15.73 | 29.86 | 18.78 |
| SL（mm） | 7.44 | 8.15 | 9.19 |
| SW（mm） | 2.88 | 3.23 | 3.02 |
| SSA（mm2） | 23.01 | 21.71 | 23.54 |
| TGW（g） | 35.70 | 44.74 | 49.65 |
| SMC (%) | 9.04 | 8.61 | 8.97 |
| SCPC (%) | 21.42 | 20.79 | 20.03 |
| SWAR (%) | 50.21 | 59.08 | 59.82 |
| SHI (%) | 57.74 | 62.78 | 65.34 |
| SBD (g L-1) | 807.58 |  | 788.13 |

Abbreviations: PH, plant height(cm); SPL, spike length(cm); SNL, spike neck node length(cm); SL, seed length(mm); SW, seed width(mm); SSA, seed surface area(mm2); TGW, thousand grain weight(g); SMC, seed moisture content (%); SCPC, seed crude protein content (%); SWAR, seed water absorption rate (%); SHI, seed hardness index; SBD, seed bulk density (g L-1).

**Supplementary formula Ⅱ**

Fn=n1\*x1+ n2\*x2+ n3\*x3+ n4\*x4+ n5\*x5+ n6\*x6+ n7\*x7+ n8\*x8+ n9\*x9+ n10\*x10+ n11\*x11+ n12\*x12+ n13\*x13 (i=1,2,3…) ------(6)

In the expression, “n” denotes the corresponding principal component, “i” denotes the indicator corresponding to the principal component, “ni” denotes the indicator coefficient corresponding to the principal component, “xi” denotes the indicator value corresponding to the principal component.

**Abbreviations of the corresponding parts of the article**

|  |  |
| --- | --- |
| Abbreviation | Detailed information |
| PH | plant height |
| SPL | spike length |
| SNL | spike neck node length |
| SL | seed length |
| SW | seed width |
| SSA | seed surface area |
| TGW | thousand grain weight |
| SMC | seed moisture content |
| SCPC | seed crude protein content |
| SWAR | seed water absorption rate |
| SHI | seed hardness index |
| SBD | seed bulk density |
| *CV* | coefficient of variation |
| *H’* | genetic diversity index |
| PC | principal component |
| PC1 | principal component 1 |
| PC2 | principal component 2 |
| PC3 | principal component 3 |
| PC4 | principal component 4 |
| LR | latent root |
| CR | contribution rate |
| CCR | cumulative contribution rate |