Supplementary Material

1 Supplementary methods and models

For both SNP array and GBS markers, the calculation is based on each locus, but for SSR markers, every allele from every marker is considered as a locus.

1.1 Minor Allele Frequency (MAF)

For SNP array and GBS datasets, the marker values were coded as 0, 1, 2 and NA. Therefore, if there are n genotypes across one locus, then,

\[ n = n_2 + n_1 + n_0 \]  \hspace{1cm} (1)

in which, \( n_2, n_1, \) and \( n_0 \) are the amounts for the values “2”, “1”, and “0”, respectively.

The allele frequency (AF) and the MAF for the \( i \)-th marker is:

\[ \text{AF}_i = \frac{2 \times n_2 + 1 \times n_1 + 0 \times n_0}{2n} = \frac{\sum_{k=1}^{n} g_k}{n} = \frac{\bar{g}_i}{2} \]  \hspace{1cm} (2)

and

\[ \text{MAF}_i = \min(\text{AF}_i, (1 - \text{AF}_i)). \]  \hspace{1cm} (3)

in which, \( k \) is the \( k \)-th genotype, and \( g_k \) refers to the marker value of the \( k \)-th genotype.

For each SSR allele, the allele frequency is in fact the occurring frequency, which is always not higher than 0.5, thereby,

\[ \text{MAF}_i = \text{AF}_i = \bar{g}_i. \]  \hspace{1cm} (4)

We used the average of MAF from one SSR marker as the MAF of that marker.

1.2 Population Heterozygosity (H)

Once the allele frequency of each allele is determined, H will be retrieved to measure the gene-frequency variation. H is applicable in any population regardless of the number of alleles at a locus or the pattern of evolutionary forces, as well as in any organism without considering its reproduction (breeding) way or chromosome ploidy (Nei, 1973). H is calculated as the following (Nei, 1973, Nagy et al., 2012):

\[ H = 1 - \sum_{i=1}^{l} \text{AF}_i^2 \]  \hspace{1cm} (5)

where \( \text{AF}_i \) is the frequency of the \( i \)-th allele and \( l \) corresponds to the total number of alleles.

The biallelic nature (\( \text{AF}_1 + \text{AF}_2 = 1 \)) of SNPs markers (SNP array and GBS datasets), reduces H to:
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\[ H = 1 - \sum_{i=1}^{2} AF_i^2 = 1 - (AF_1^2 + AF_2^2) = 2AF_1 \times AF_2. \]  \hspace{1cm} (6)

1.3 Polymorphism Information Content (PIC)

For each marker locus, PIC is defined as (Botstein et al., 1980, Nagy et al., 2012):

\[ PIC = 1 - \sum_{i=1}^{l} AF_i^2 - \sum_{i=1}^{l-1} \sum_{j=i+1}^{l} 2 AF_i^2 \times AF_j^2 \]

\[ = H - \sum_{i=1}^{l-1} \sum_{j=i+1}^{l} 2 AF_i^2 \times AF_j^2. \]  \hspace{1cm} (7)

PIC is thereby considered as the corrected heterozygosity with the information from partially mating (Hildebrand et al., 1992).

For both, SNP array and GBS datasets:

\[ PIC = 2AF_1 \times AF_2 - 2AF_1^2 \times AF_2^2 = H - 2AF_1^2 \times AF_2^2 \]  \hspace{1cm} (8)

The maximum PIC for biallelic markers is 0.375. Markers having more alleles will be more informative, and their corresponding PIC is higher.

1.4 Rogers’ Distance (RD)

The Rogers’ Distance (RD) is used as an index for measuring the genetic distance between two genotypes according to the alleles within each marker system as:

\[ RD = \frac{1}{m} \sum_{l=1}^{m} \frac{1}{n_l} \sum_{j=1}^{n_l} (p_{lj} - q_{lj})^2, \]  \hspace{1cm} (9)

with \( m \) referring to the number of loci, \( n_l \) being the number of alleles at the \( l \)th loci, while \( p_{lj} \) and \( q_{lj} \) correspond to the allele frequencies of the \( j \)th allele at the \( l \)th locus from two genotypes. RD is a measurement of gene diversity. Moreover, we estimated also the genetic similarity as 1 - RD.

1.5 Single-Kernel model

The general form of the single kernel model is the following:

\[ Y = 1_n \mu + Z_A \alpha + e \]  \hspace{1cm} (10)

in which, \( \mu \) is the overall mean, \( \alpha \) corresponds to additive effects, \( n \) denotes the number of lines, \( p \) indicates the number of markers, \( Z_A \) represents the design matrix with the dimension of \((n \times p)\) for the additive effects of the marker SNP array, GBS, SSR, individually, and \( 1_n \) is the vector of length \( n \) containing only ones.

The additive model (10) is equivalent to a GBLUP model:

\[ Y = 1_n \mu + g + e \]  \hspace{1cm} (11)
where $g \sim N(0, A \ast \sigma^2_G)$, and $e \sim N(0, \sigma^2_e)$, and $A$ is the numerator relationship matrix, and is calculated according to VanRaden (2008). This $A$ matrix will be used as kernel matrix ($K$) for the single kernel method in the R BGLR-Package.

1.6 Multi-Kernel model

In order to test whether the different marker system can be complementary to each other, we also used a model combining two or three marker data together. In general, the multi-kernel model uses all of three marker data:

$$Y = 1_n \mu + Z_{SNP} \alpha + Z_{GBS} \beta + Z_{SSR} \gamma + e$$

(12)

Here $\alpha$, $\beta$ and $\gamma$ are additive effects for SNP array, GBS, and SSR marker, respectively. $Z_{SNP}$, $Z_{GBS}$ and $Z_{SSR}$ are the design matrix with the dimension of $(n \times p)$ for the related additive effects of each marker data. The row dimension of $Z_{SNP}$, $Z_{GBS}$ and $Z_{SSR}$ is $n$, and $n$ is number of genotypes. The column dimensions of them are the number of markers (p) for each type of marker data.

The equivalent GBLUP model of multi-kernel model (11) will be:

$$Y = 1_n \mu + g_{SNP} + g_{GBS} + g_{SSR} + e$$

(13)

While $g_{SNP} \sim N(0, A_{SNP} \sigma^2_{G_1})$, $g_{GBS} \sim N(0, A_{GBS} \sigma^2_{G_2})$, $g_{SSR} \sim N(0, A_{SSR} \sigma^2_{G_3})$, and $e \sim N(0, \sigma^2_e)$, and $A_{SNP}$, $A_{GBS}$, $A_{SSR}$ are the numerator relationship matrix also calculated according to VanRaden (2008). These numerator relationship matrices will be used as kernel matrix for the multi-kernel methods in the R BGLR-package.

We also tested all three possible combinations of two marker data: SNP array plus GBS markers, SNP array plus SSR markers, and SSR plus GBS markers. For this purpose, we just needed to remove the unused marker effect from the model (13).

1.7 Linkage disequilibrium

Linkage disequilibrium (LD) in the form of the squared Pearson coefficient of correlation ($r^2$) was used as a measure of non-random association between two different loci (Hill and Robertson, 1968).
## Supplementary Tables and Figures

**Supplementary Table 1.** The raw reads per sample during the sequencing of GBS markers.

| No. | Genotype Name | Reads  | No. | Genotype Name | Reads  |
|-----|---------------|--------|-----|---------------|--------|
| 1   | Achat         | 3,621,856 | 190 | TRI11372      | 2,649,516 |
| 2   | Adler         | 2,456,605 | 191 | TRI11374      | 7,622,673 |
| 3   | Alceste       | 3,578,069 | 192 | TRI11439      | 2,092,928 |
| 4   | Alchemy       | 1,644,484 | 193 | TRI11469      | 4,590,339 |
| 5   | Ambition      | 2,560,500 | 194 | TRI11767      | 3,231,833 |
| 6   | Ambrosia      | 8,044,290 | 195 | TRI11784      | 1,782,905 |
| 7   | Amundsen      | 2,527,594 | 196 | TRI11826      | 1,929,382 |
| 8   | Andi          | 1,764,812 | 197 | TRI119        | 1,546,514 |
| 9   | Antonius      | 1,066,850 | 198 | TRI12010      | 2,588,285 |
| 10  | Aperitiv      | 2,360,246 | 199 | TRI12072      | 3,081,806 |
| 11  | Apollo        | 1,498,365 | 200 | TRI1218       | 2,727,415 |
| 12  | Ares          | 2,478,162 | 201 | TRI12313      | 3,669,136 |
| 13  | Arina         | 1,748,463 | 202 | TRI12594      | 2,177,919 |
| 14  | B19           | 5,463,066 | 203 | TRI12707      | 4,291,796 |
| 15  | B47           | 2,585,870 | 204 | TRI1273       | 4,660,388 |
| 16  | B52           | 3,167,027 | 205 | TRI12829      | 3,103,135 |
| 17  | B87           | 2,706,501 | 206 | TRI13098      | 3,112,168 |
| 18  | B98           | 4,330,448 | 207 | TRI13141      | 2,921,678 |
| 19  | Baguette11    | 3,996,399 | 208 | TRI13212      | 2,166,360 |
| 20  | Banderola     | 2,458,957 | 209 | TRI13344      | 5,024,556 |
| 21  | Banquet       | 5,581,020 | 210 | TRI1340       | 3,994,957 |
| 22  | Battalion     | 2,012,527 | 211 | TRI13430      | 2,855,090 |
| 23  | Batuta        | 4,407,480 | 212 | TRI13672      | 2,653,439 |
| 24  | Bill          | 2,101,068 | 213 | TRI1388       | 1,657,390 |
| 25  | Bogatka       | 2,106,821 | 214 | TRI14052      | 3,772,499 |
| 26  | Boregar       | 3,368,843 | 215 | TRI14068      | 1,592,321 |
| 27  | Brompton      | 2,070,234 | 216 | TRI14280      | 1,899,906 |
| 28  | Bryza         | 3,961,502 | 217 | TRI14318      | 3,092,516 |
| 29  | Caesar        | 1,540,384 | 218 | TRI14868      | 2,763,915 |
| 30  | Capo          | 1,487,832 | 219 | TRI14884      | 3,984,938 |
| 31  | Cassiopeia    | 3,257,032 | 220 | TRI14887      | 2,014,369 |
| 32  | Consort       | 4,579,806 | 221 | TRI14895      | 2,775,942 |
| 33  | Contur        | 4,541,109 | 222 | TRI14905      | 2,222,273 |
| 34  | Cordiale      | 2,784,914 | 223 | TRI14934      | 3,518,964 |
| 35  | Corsaire      | 1,198,837 | 224 | TRI14997      | 1,638,323 |
| 36  | CPBTW130      | 3,718,315 | 225 | TRI15098      | 3,181,676 |
| 37  | Deben         | 1,792,766 | 226 | TRI1571       | 2,435,964 |
| 38  | Duxford       | 1,762,599 | 227 | TRI1591       | 3,473,771 |
| 39  | Einstein      | 2,420,913 | 228 | TRI16         | 3,277,508 |
|   | Name     | Code     | Size   | Code   |
|---|----------|----------|--------|--------|
| 40| Eriwan   | 4,688,976| 229    | TRI1601| 3,380,321|
| 41| Estica   | 4,685,454| 230    | TRI16546| 3,396,113|
| 42| Eurojet  | 2,296,198| 231    | TRI16553| 1,503,646|
| 43| Expert   | 2,780,237| 232    | TRI16644| 3,336,969|
| 44| Exsept   | 2,415,202| 233    | TRI16696| 2,955,098|
| 45| Fastnet  | 2,469,749| 234    | TRI16698| 2,880,213|
| 46| Fidelius | 2,859,296| 235    | TRI16767| 3,551,402|
| 47| Figura   | 4,053,400| 236    | TRI16818| 3,287,540|
| 48| Finezja  | 3,527,465| 237    | TRI16935| 5,096,841|
| 49| Fregata  | 2,544,266| 238    | TRI16948| 1,917,757|
| 50| Fridolin | 2,234,913| 239    | TRI17248| 4,064,615|
| 51| Frument  | 7,255,066| 240    | TRI19517| 3,735,811|
| 52| Gallant  | 3,568,801| 241    | TRI19607| 1,838,600|
| 53| Gatsby   | 5,429,109| 242    | TRI19890| 2,023,497|
| 54| Gladiator| 3,154,784| 243    | TRI20134| 2,640,862|
| 55| Glasgow  | 4,682,545| 244    | TRI20159| 4,632,390|
| 56| Glauces  | 3,521,772| 245    | TRI20885| 2,174,491|
| 57| Globus   | 2,153,738| 246    | TRI21165| 2,063,041|
| 58| Gulliver | 1,897,292| 247    | TRI21173| 2,660,532|
| 59| H05606   | 4,383,065| 248    | TRI21181| 1,829,014|
| 60| Hanseat  | 2,571,823| 249    | TRI21330| 1,486,907|
| 61| Haven    | 3,942,631| 250    | TRI21379| 4,756,600|
| 62| Hereford | 3,914,920| 251    | TRI21447| 3,317,361|
| 63| Hereward | 2,872,166| 252    | TRI21847| 1,392,242|
| 64| Herzog   | 1,260,288| 253    | TRI21888| 1,872,073|
| 65| Humber   | 1,238,478| 254    | TRI22325| 4,129,777|
| 66| Hussar   | 2,840,966| 255    | TRI22800| 2,004,659|
| 67| Hyperion | 3,246,259| 256    | TRI2287 | 2,587,022|
| 68| Ibis     | 1,616,597| 257    | TRI23047| 3,987,360|
| 69| Instinct | 1,937,267| 258    | TRI23126| 2,890,851|
| 70| Intact   | 3,114,204| 259    | TRI23266| 2,421,319|
| 71| Intense  | 2,956,576| 260    | TRI23279| 3,574,510|
| 72| Isengrain| 1,425,552| 261    | TRI2342 | 2,274,206|
| 73| Istdabraq| 4,007,347| 262    | TRI2353 | 3,006,312|
| 74| Izyda    | 1,527,813| 263    | TRI23671| 3,282,643|
| 75| Jantarka | 3,606,674| 264    | TRI23739| 1,197,241|
| 76| Kampana  | 2,678,655| 265    | TRI23767| 3,173,234|
| 77| Kanzler  | 2,183,069| 266    | TRI23983| 4,741,564|
| 78| Ketchum  | 3,359,826| 267    | TRI24049| 3,108,512|
| 79| Kingdom  | 2,353,094| 268    | TRI24071| 3,183,872|
| 80| Kleber   | 2,185,349| 269    | TRI24096| 2,540,372|
| 81| Kobiera  | 2,236,380| 270    | TRI2411 | 4,214,298|
| 82| KobraPlus| 2,983,658| 271    | TRI2422 | 4,532,510|
| 83| Kohelia  | 2,506,917| 272    | TRI24232| 2,900,086|
|   | Variety            | 10000 Grains (kg) | 20000 Grains (kg) |
|---|--------------------|-------------------|-------------------|
| 84| Korweta            | 6,667,730         | 273               |
| 85| Kosack             | 4,785,684         | 274               |
| 86| KWSAurumLP819404   | 2,100,241         | 275               |
| 87| KWSChamsinLP779    | 3,123,669         | 276               |
| 88| KWSErasmus         | 4,451,781         | 277               |
| 89| KWSOzon            | 2,328,551         | 278               |
| 90| KWSSciroccoLP509304 | 3,092,327       | 279               |
| 91| Lars               | 3,039,392         | 280               |
| 92| Legenda            | 4,878,642         | 281               |
| 93| Limerick           | 3,594,101         | 282               |
| 94| Lona               | 1,500,409         | 283               |
| 95| Lynx               | 2,587,205         | 284               |
| 96| Macro              | 4,791,086         | 285               |
| 97| Malacca            | 6,851,497         | 286               |
| 98| Marin              | 1,484,124         | 287               |
| 99| Markiza            | 2,921,687         | 288               |
| 100| Marksmann         | 1,495,472         | 289               |
| 101| Mascot             | 3,098,510         | 290               |
| 102| Mewa               | 2,291,694         | 291               |
| 103| Mikon              | 3,201,468         | 292               |
| 104| Monsun             | 2,075,043         | 293               |
| 105| Monty              | 1,484,069         | 294               |
| 106| Muskat             | 3,858,160         | 295               |
| 107| Musketeer          | 4,200,598         | 296               |
| 108| Muszelka           | 1,389,031         | 297               |
| 109| Muza               | 7,045,164         | 298               |
| 110| Nadobna            | 1,192,420         | 299               |
| 111| Naridana           | 4,721,997         | 300               |
| 112| Nateja             | 2,637,684         | 301               |
| 113| Natula             | 5,445,339         | 302               |
| 114| Nutka              | 2,227,445         | 303               |
| 115| Oakley             | 3,915,843         | 304               |
| 116| Orestis            | 2,857,585         | 305               |
| 117| OstkaStrzelecka    | 4,929,945         | 306               |
| 118| Ostroga            | 2,113,469         | 307               |
| 119| P05311             | 322,285           | 308               |
| 120| P05312             | 3,653,197         | 309               |
| 121| P06079             | 3,222,518         | 310               |
| 122| Philius            | 5,027,613         | 311               |
| 123| Portland           | 2,037,364         | 312               |
| 124| Position           | 4,049,529         | 313               |
| 125| Potenzial          | 2,699,885         | 314               |
| 126| Prinz              | 2,629,221         | 315               |
| No. | Name         | Value   | Place | Code     | Value      |
|-----|--------------|---------|-------|----------|------------|
| 127 | Rainer       | 2,432,251| 316   | TRI5153  | 2,293,675  |
| 128 | Ramiro       | 2,026,692| 317   | TRI5164  | 2,447,613  |
| 129 | Renan        | 2,692,876| 318   | TRI5167  | 2,501,208  |
| 130 | Rialto       | 3,527,482| 319   | TRI5180  | 3,333,282  |
| 131 | Robigus      | 3,346,228| 320   | TRI52    | 1,240,751  |
| 132 | Rubens       | 4,834,977| 321   | TRI5400  | 2,690,182  |
| 133 | Rywalka      | 3,960,823| 322   | TRI56    | 1,424,481  |
| 134 | Sailor       | 1,353,444| 323   | TRI58    | 1,854,431  |
| 135 | Sakura       | 3,183,102| 324   | TRI63    | 2,007,843  |
| 136 | Satyna       | 4,247,533| 325   | TRI6729  | 3,319,329  |
| 137 | Savannah     | 2,996,141| 326   | TRI6787  | 2,233,448  |
| 138 | Semper       | 2,709,966| 327   | TRI6811  | 1,479,513  |
| 139 | Senat        | 1,654,169| 328   | TRI6816  | 3,799,456  |
| 140 | Skalmeje     | 4,519,010| 329   | TRI6838  | 2,373,654  |
| 141 | Smuga        | 3,540,325| 330   | TRI6840  | 1,350,186  |
| 142 | Smuggler     | 3,883,807| 331   | TRI6876  | 3,389,997  |
| 143 | Sobi         | 3,369,595| 332   | TRI6989  | 2,882,215  |
| 144 | Soissons     | 2,487,493| 333   | TRI7028  | 2,986,961  |
| 145 | Sokrates     | 4,266,854| 334   | TRI7399  | 2,628,868  |
| 146 | Solist       | 3,998,516| 335   | TRI75    | 2,766,893  |
| 147 | Solitaer     | 3,244,292| 336   | TRI7709  | 4,055,209  |
| 148 | Solstice     | 3,826,632| 337   | TRI7838  | 3,216,067  |
| 149 | Sophytra     | 2,813,906| 338   | TRI7893  | 4,855,432  |
| 150 | Sperber      | 4,658,344| 339   | TRI7918  | 1,907,717  |
| 151 | Stava        | 2,686,837| 340   | TRI8      | 3,496,604  |
| 152 | Striker      | 2,679,345| 341   | TRI8030  | 2,181,813  |
| 153 | Sukces       | 1,424,725| 342   | TRI8097  | 2,393,806  |
| 154 | Sultan       | 2,595,681| 343   | TRI8130  | 2,969,458  |
| 155 | SWHarnesk    | 3,664,215| 344   | TRI8134  | 2,594,365  |
| 156 | SWHarpoon    | 1,485,849| 345   | TRI8137  | 3,263,341  |
| 157 | SWHurtig     | 3,470,890| 346   | TRI8280  | 1,695,400  |
| 158 | SWSkotte     | 3,982,545| 347   | TRI8301  | 1,845,074  |
| 159 | SWTataros    | 4,178,868| 348   | TRI84    | 1,615,703  |
| 160 | SWTopper     | 2,517,664| 349   | TRI8402  | 1,386,462  |
| 161 | Symbol       | 3,801,217| 350   | TRI9      | 2,402,380  |
| 162 | Taifun       | 3,216,003| 351   | TRI9332  | 4,473,896  |
| 163 | Tambor       | 2,736,812| 352   | TRI9366  | 2,415,614  |
| 164 | Tarkus       | 1,722,523| 353   | TRI9389  | 5,368,655  |
| 165 | Tarso        | 3,009,408| 354   | TRI9397  | 2,826,564  |
| 166 | Timber       | 2,391,875| 355   | TRI9410  | 1,675,162  |
| 167 | Tommi        | 1,792,725| 356   | TRI9433  | 3,581,090  |
| 168 | Tonacja      | 5,318,414| 357   | TRI9670  | 2,203,954  |
| 169 | Toras        | 2,285,671| 358   | TRI9968  | 5,523,978  |
| 170 | Torkil       | 3,766,767| 359   | TRI9993  | 1,831,002  |
| #  | City     | Value 1  | Value 2 | City     | Value 1  |
|----|----------|---------|---------|----------|---------|
| 171| Toronto  | 2,693,228| 360     | Trintella| 2,457,146|
| 172| Torrild  | 4,604,507| 361     | Tuareg   | 3,407,801|
| 173| Tower    | 4,509,378| 362     | Tuerkis  | 2,146,844|
| 174| Transit  | 3,826,600| 363     | Tukan    | 4,445,462|
| 175| Trappe   | 2,616,527| 364     | Tulsa    | 2,511,746|
| 176| Travix   | 1,657,491| 365     | Tuscan   | 3,414,422|
| 177| TRI10149 | 3,882,685| 366     | Vanek    | 3,481,589|
| 178| TRI10316 | 1,083,530| 367     | Velocity | 3,646,481|
| 179| TRI10384 | 2,524,376| 368     | ViscountCPBTW136 | 3,797,464|
| 180| TRI10401 | 3,462,662| 369     | Vitus    | 2,517,378|
| 181| TRI1068  | 2,032,574| 370     | Vivant   | 4,270,094|
| 182| TRI1081  | 3,078,915| 371     | Welford  | 3,916,213|
| 183| TRI10924 | 2,349,698| 372     | Winnetou | 4,171,168|
| 184| TRI10952 | 1,609,912| 373     | Wydma    | 2,478,829|
| 185| TRI11057 | 1,936,425| 374     | Xenos    | 2,321,703|
| 186| TRI1109  | 10,758,745| 375   | Xi19     | 1,929,533|
| 187| TRI11226 | 1,754,750| 376     | Zanatan  | 1,822,008|
| 188| TRI11301 | 4,899,017| 377     | Zawisza  | 1,818,627|
| 189| TRI1135  | 3,514,249| 378     | Zebedee  | 2,294,901|
**Supplementary Table 2.** The explained percentage of molecular variation of the first 10 principal coordinates derived for SNP array (SNP), genotyping-by-sequencing (GBS) and SSR markers. Results are shown for the total population (All), the elite lines (Elite), and the plant genetic resources (PGR).

| Principal Coordinate (%) | All |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |         |
|-------------------------|-----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|                         | SNP | GBS    | SSR     | SNP     | GBS     | SSR     | SNP     | GBS     | SSR     | SNP     | GBS     | SSR     | SNP     | GBS     | SSR     | SNP     | GBS     | SSR     |
| 1                       | 10.42 | 5.73 | 4.08 | 9.90 | 5.91 | 5.52 | 11.43 | 9.19 | 6.23 | 2                   | 2.31 | 2.99 | 2.19 | 1.74 | 2.10 | 1.81 | 1.10 | 1.57 | 1.35 | 1.23 | 29.94 | 17.62 | 23.82 |
| 2                       | 4.62 | 2.31 | 3.09 | 5.14 | 3.22 | 4.41 | 6.57 | 5.23 | 4.20 | 3                   | 1.74 | 2.99 | 2.19 | 1.42 | 2.10 | 1.81 | 1.10 | 1.57 | 1.35 | 1.23 | 29.94 | 17.62 | 23.82 |
| 3                       | 2.95 | 1.74 | 2.99 | 3.60 | 3.06 | 3.55 | 4.40 | 3.73 | 3.49 | 2                   | 1.74 | 2.99 | 2.19 | 1.42 | 2.10 | 1.81 | 1.10 | 1.57 | 1.35 | 1.23 | 29.94 | 17.62 | 23.82 |
| 4                       | 2.19 | 1.42 | 2.29 | 3.24 | 2.24 | 3.31 | 2.90 | 2.88 | 3.45 | 2                   | 1.74 | 2.99 | 2.19 | 1.42 | 2.10 | 1.81 | 1.10 | 1.57 | 1.35 | 1.23 | 29.94 | 17.62 | 23.82 |
| 5                       | 2.10 | 1.37 | 2.11 | 2.69 | 1.92 | 3.18 | 2.28 | 2.61 | 3.06 | 2                   | 1.74 | 2.99 | 2.19 | 1.42 | 2.10 | 1.81 | 1.10 | 1.57 | 1.35 | 1.23 | 29.94 | 17.62 | 23.82 |
| 6                       | 1.81 | 1.20 | 2.04 | 2.67 | 1.87 | 2.94 | 2.21 | 2.01 | 2.89 | 2                   | 1.74 | 2.99 | 2.19 | 1.42 | 2.10 | 1.81 | 1.10 | 1.57 | 1.35 | 1.23 | 29.94 | 17.62 | 23.82 |
| 7                       | 1.71 | 1.10 | 1.97 | 2.49 | 1.74 | 2.80 | 1.79 | 1.84 | 2.69 | 2                   | 1.74 | 2.99 | 2.19 | 1.42 | 2.10 | 1.81 | 1.10 | 1.57 | 1.35 | 1.23 | 29.94 | 17.62 | 23.82 |
| 8                       | 1.57 | 0.99 | 1.81 | 2.11 | 1.49 | 2.54 | 1.74 | 1.64 | 2.49 | 2                   | 1.74 | 2.99 | 2.19 | 1.42 | 2.10 | 1.81 | 1.10 | 1.57 | 1.35 | 1.23 | 29.94 | 17.62 | 23.82 |
| 9                       | 1.35 | 0.92 | 1.72 | 1.92 | 1.43 | 2.41 | 1.70 | 1.59 | 2.38 | 2                   | 1.74 | 2.99 | 2.19 | 1.42 | 2.10 | 1.81 | 1.10 | 1.57 | 1.35 | 1.23 | 29.94 | 17.62 | 23.82 |
| 10                      | 1.23 | 0.83 | 1.71 | 1.85 | 1.40 | 2.22 | 1.58 | 1.52 | 2.26 | 2                   | 1.74 | 2.99 | 2.19 | 1.42 | 2.10 | 1.81 | 1.10 | 1.57 | 1.35 | 1.23 | 29.94 | 17.62 | 23.82 |

Sum: 29.94 17.62 23.82 35.61 24.27 32.88 36.62 32.23 33.15
**Supplementary Figure 1.** Distributions of population heterozygosity (x-axis) for SNP array (SNP), genotyping-by-sequencing (GBS) and SSR markers. Results are shown for the total population (All), the elite lines (Elite), and the plant genetic resources (PGR).
Supplementary Figure 2. Distributions of polymorphism information content (PIC) (x-axis) for SNP array (SNP), genotyping-by-sequencing (GBS) and SSR markers. Results are shown for the total population (All), the elite lines (Elite), and the plant genetic resources (PGR).
**Supplementary Figure 3.** Heat map plots of genetic similarity (1 - Rogers’ distances) estimated based on SNP array (SNP), genotyping-by-sequencing (GBS) and SSR markers. Results are shown for the total population (All), the elite lines (Elite), and the plant genetic resources (PGR).
Supplementary Figure 4. Histograms of best linear unbiased estimations for (A) Grain yield (Mg/ha) and (B) Heading date (days since 1 January) for 339 wheat genotypes.

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