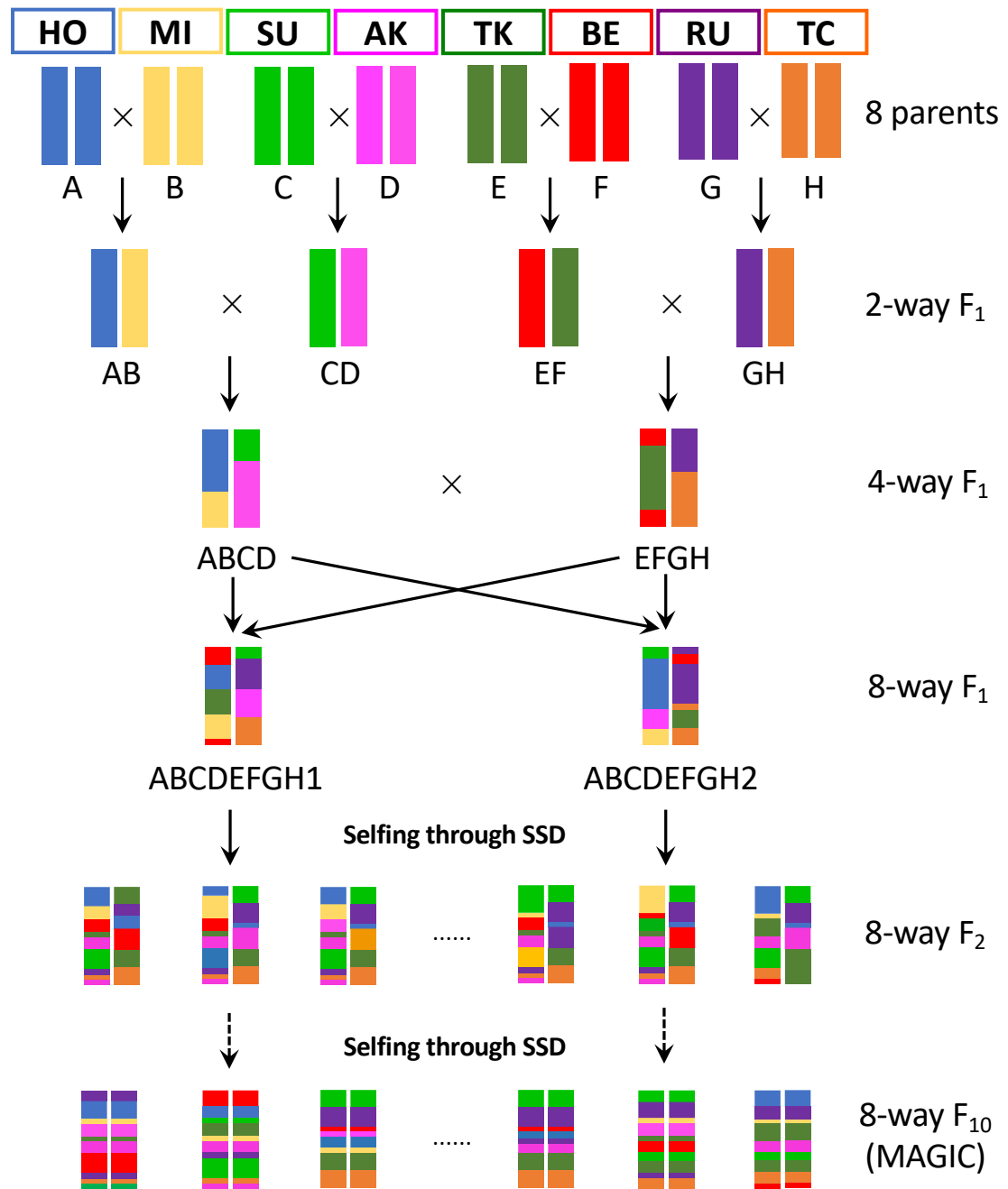
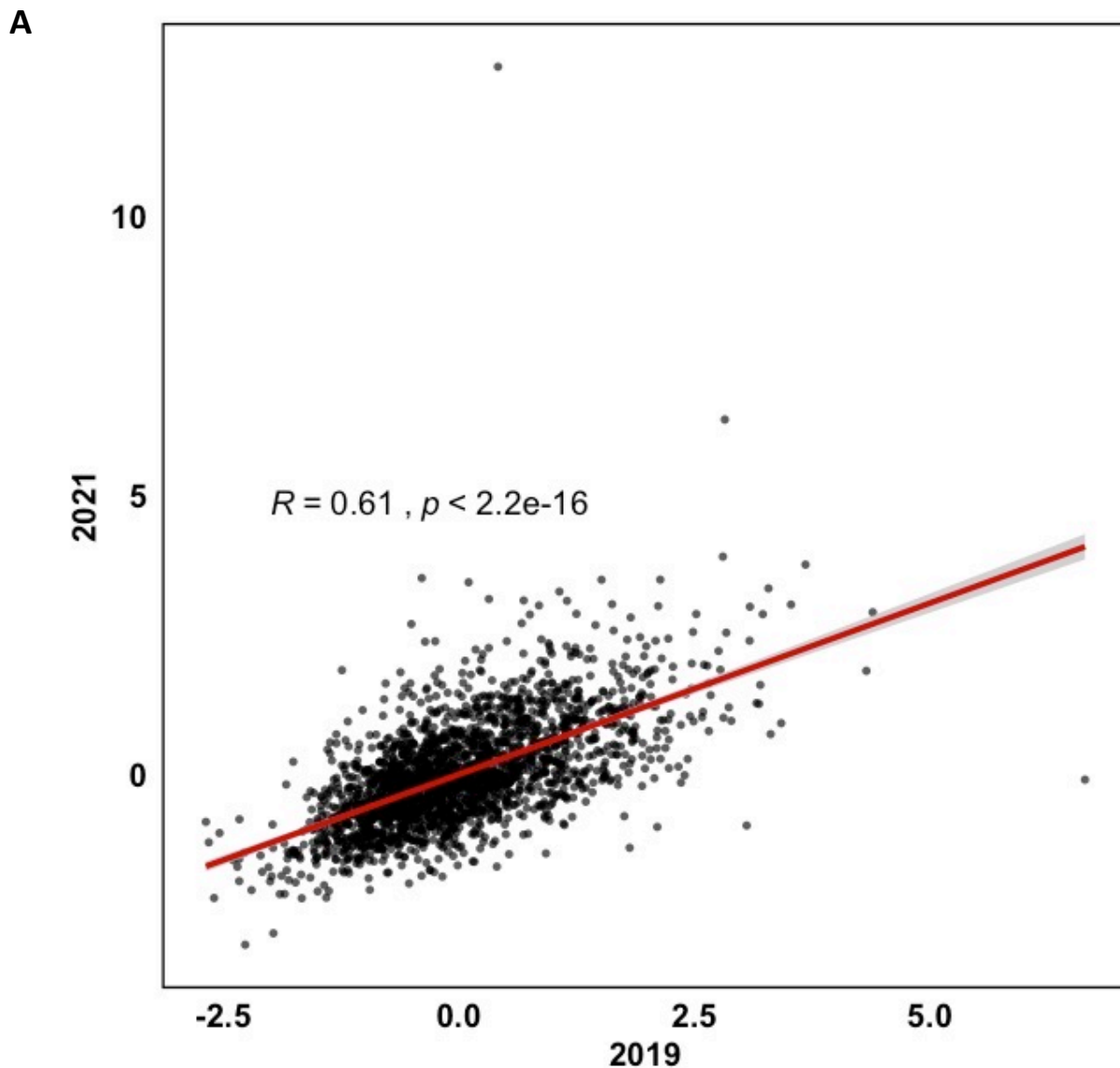




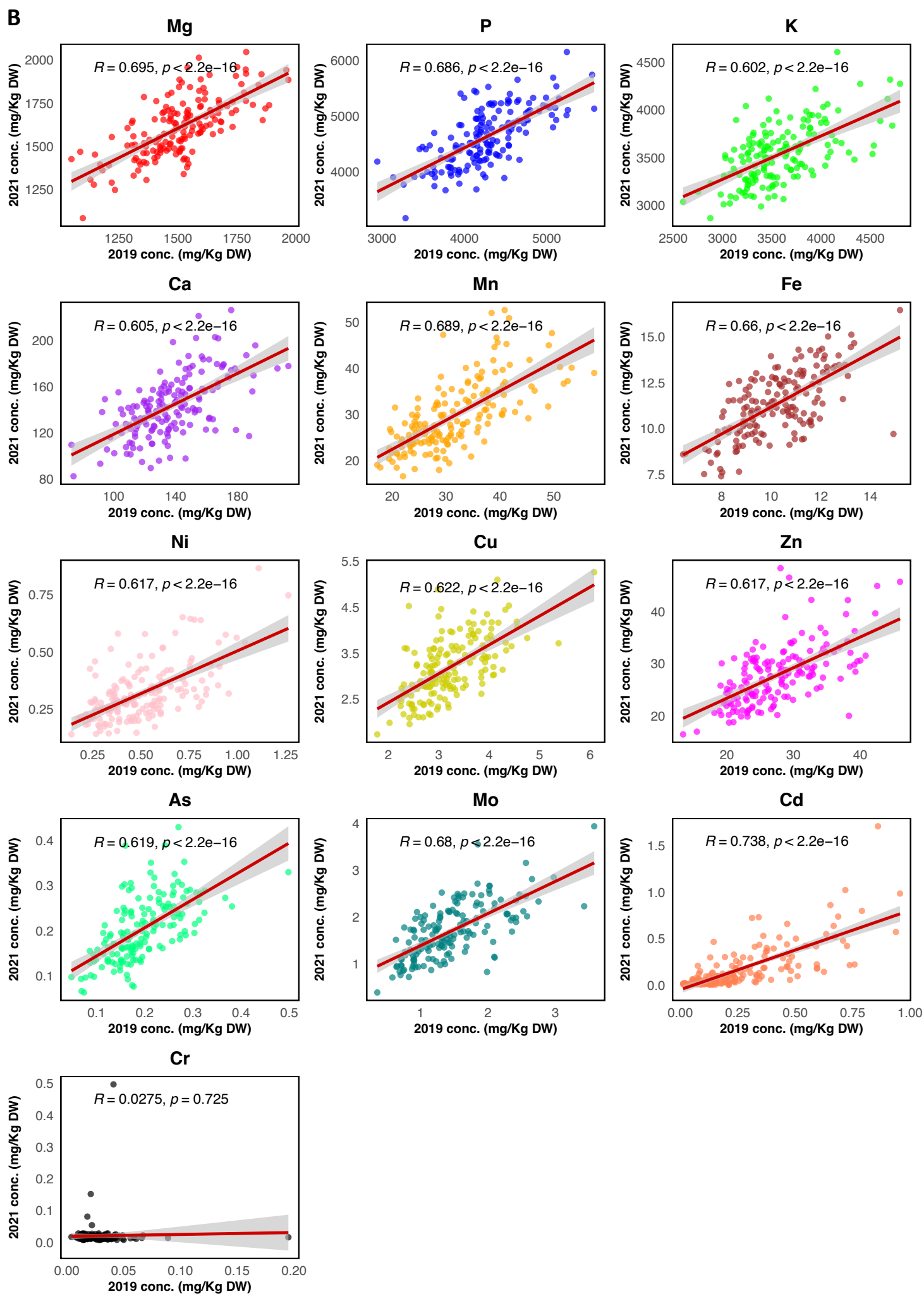
Supplementary Fig. S1 Genetic structure of the MAGIC population.

This figure was adapted from Ogawa et al. (2018a) with modifications. The development of the MAGIC population was initiated in 2010, and the F₁₀ generation was obtained in 2021. Four two-way hybrids (AB, CD, EF, and GH) were generated, followed by two four-way hybrids (ABCD and EFGH) and two eight-way hybrids (ABCDEFGH).

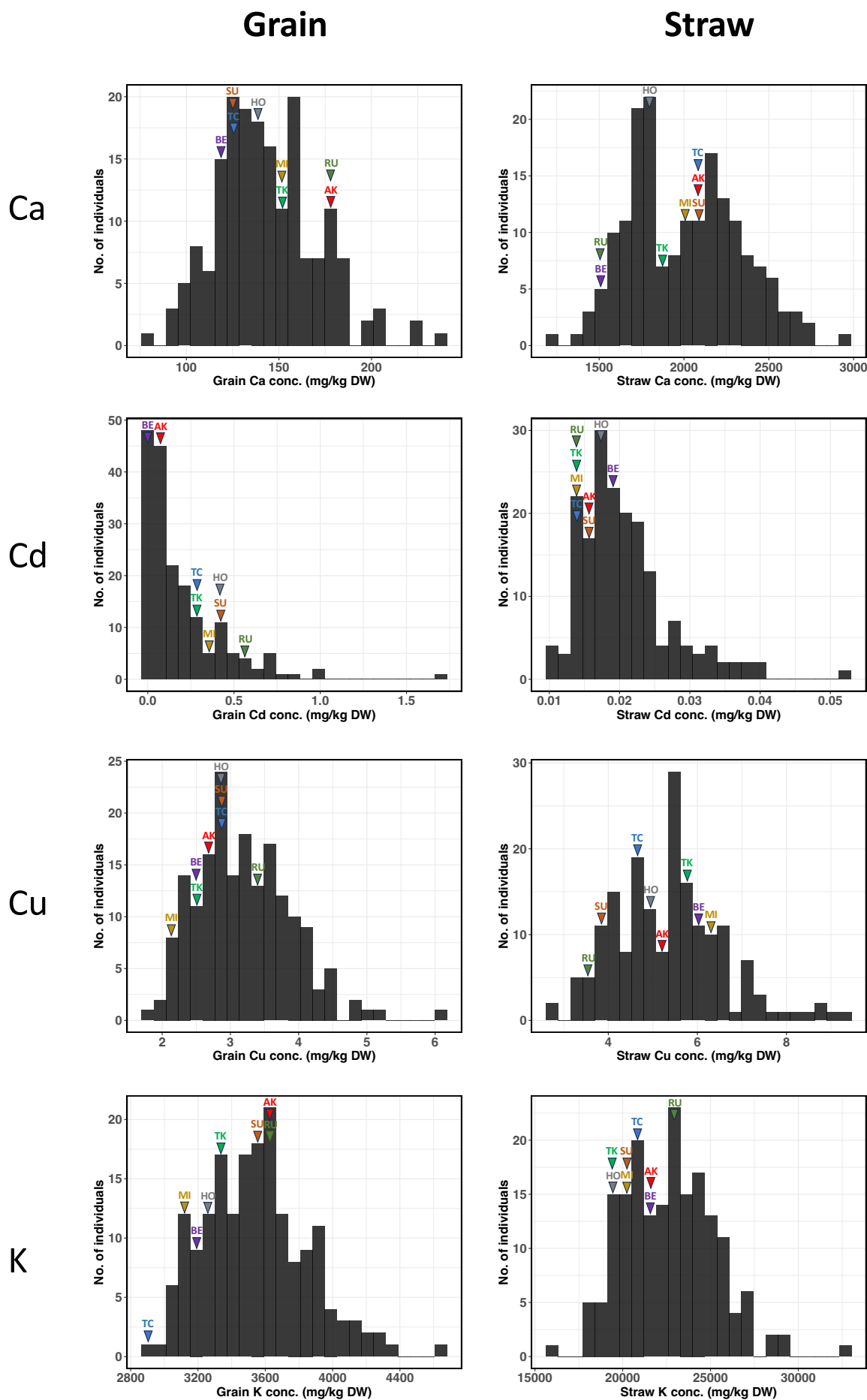


Supplementary Fig. S2 Comparison of the 13 elemental concentrations in grain of the MAGIC population between 2019 and 2021.

In both panels, each point represents one MAGIC line, and the solid line denotes the linear regression fit. (A) Bivariate plot of composite elemental profiles between two years. Axes represent Z-scores derived from factor analysis of multi-element data. Each of the 12 elements is displayed as one point, illustrating the overall coordination of the element contents across the years. (B) Scatterplots of elemental concentrations for each of the 12 analyzed elements. Axes show actual concentrations (mg/kg DW) in 2019 and 2021.

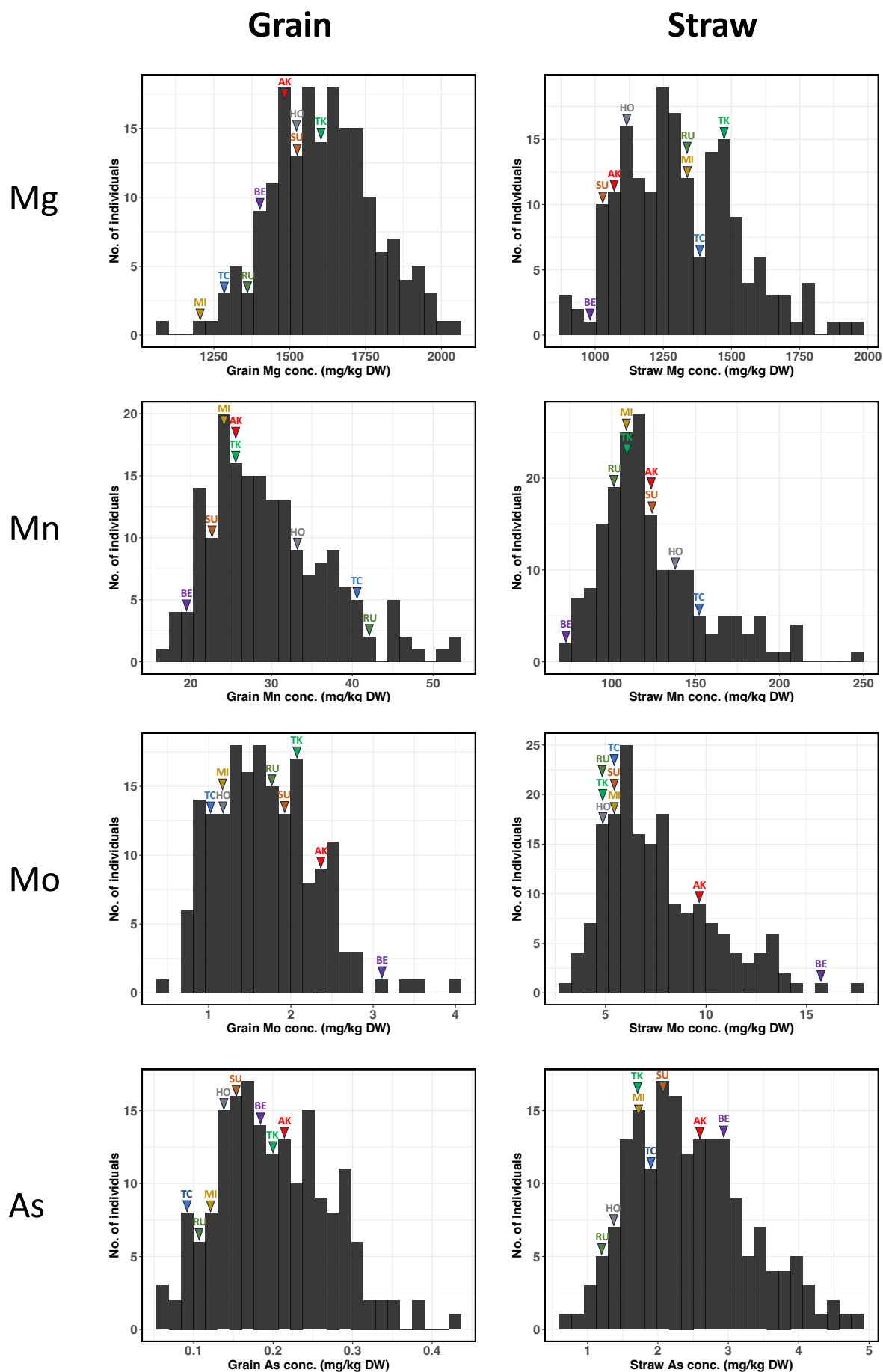


Supplementary Fig. S2 (continued)

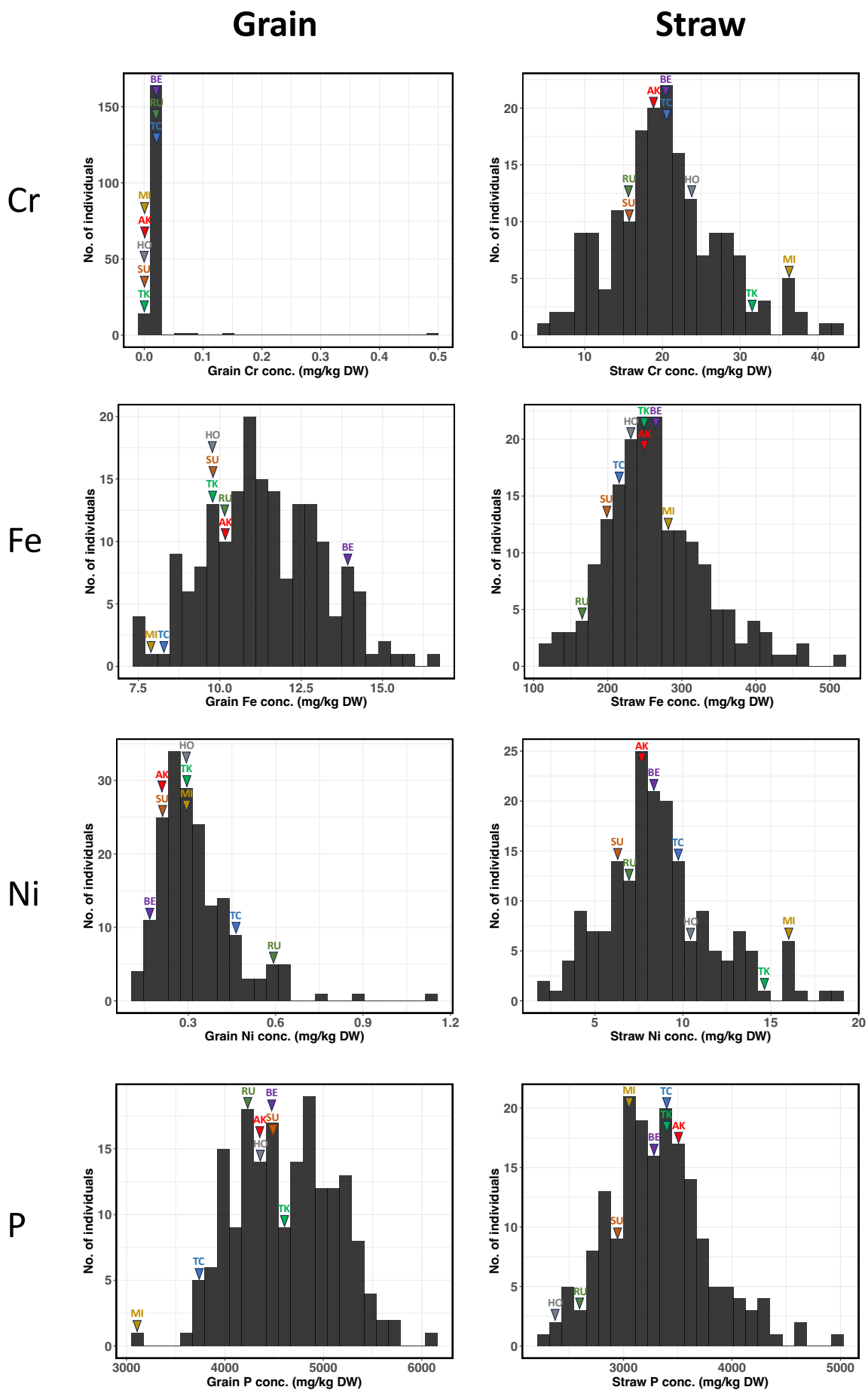


Supplementary Fig. S3 Frequency distributions of the 13 elemental concentrations in grain and straw of MAGIC population.

The horizontal axis represents the element concentration, and the vertical axis indicates the number of individuals. The arrows in different colors with various codes represent the values of the eight founder lines.



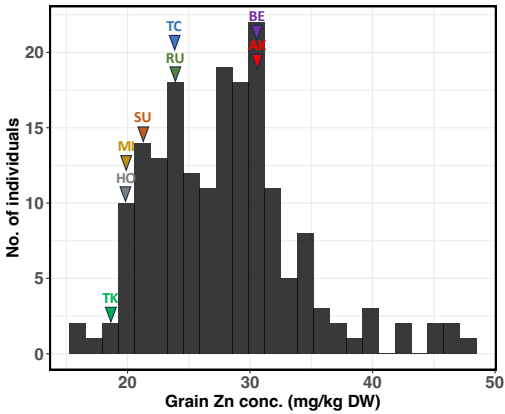
Supplementary Fig. S3 (continued)



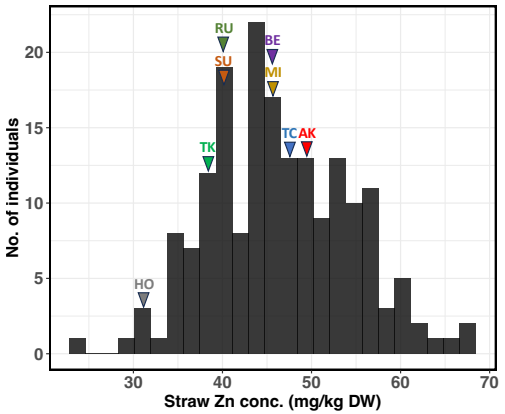
Supplementary Fig. S3 (continued)

Zn

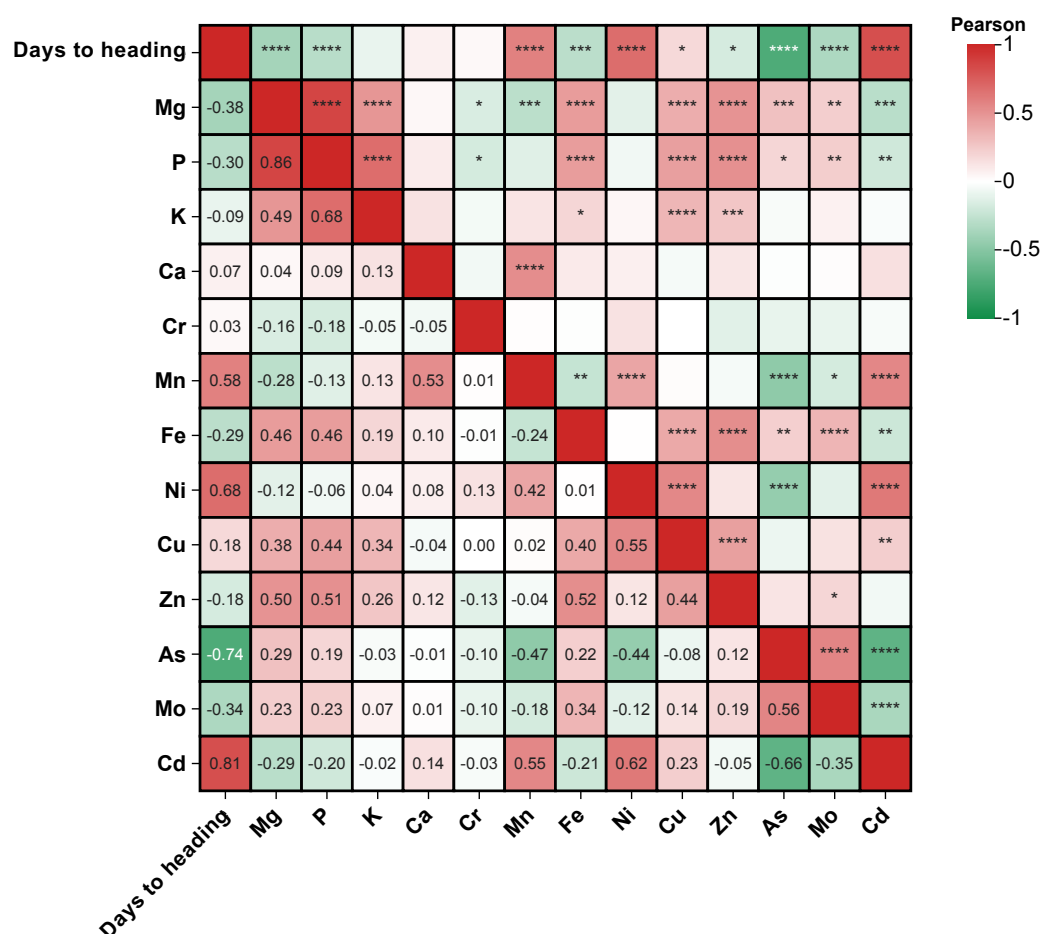
Grain



Straw



Supplementary Fig. S3 (continued)

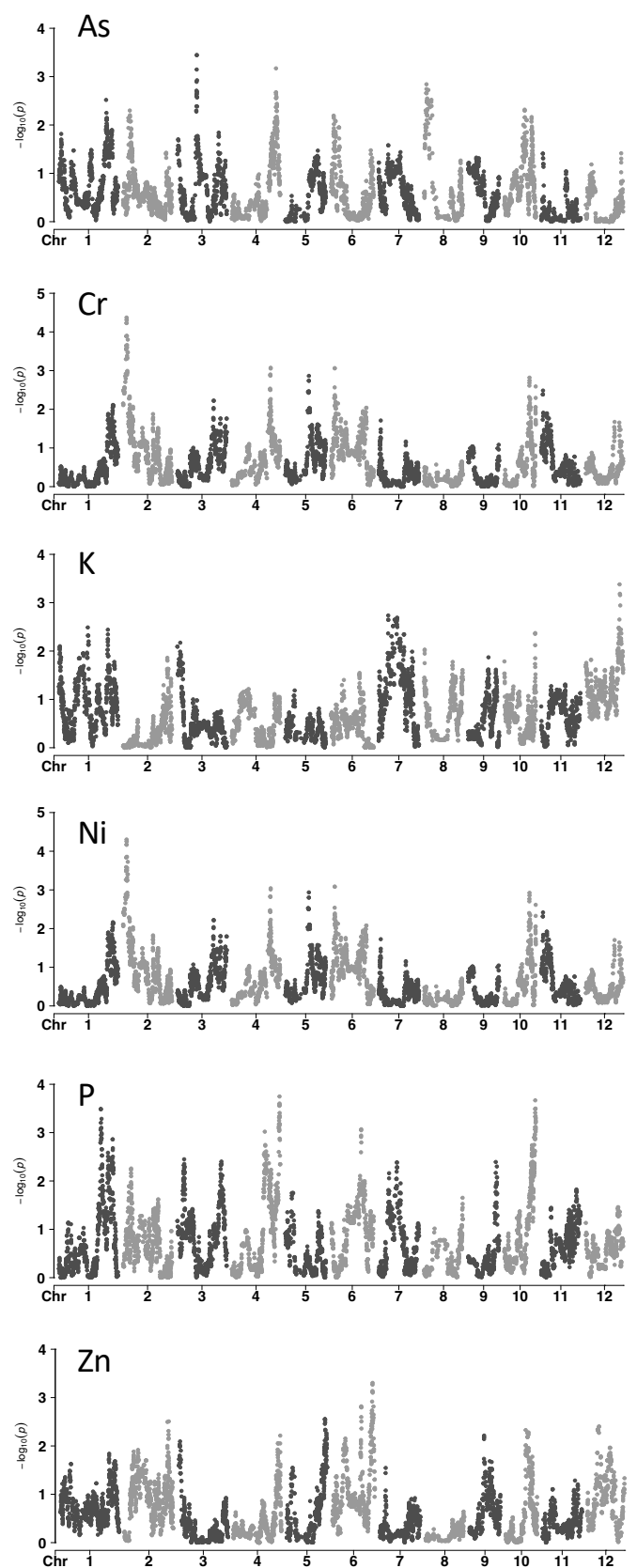
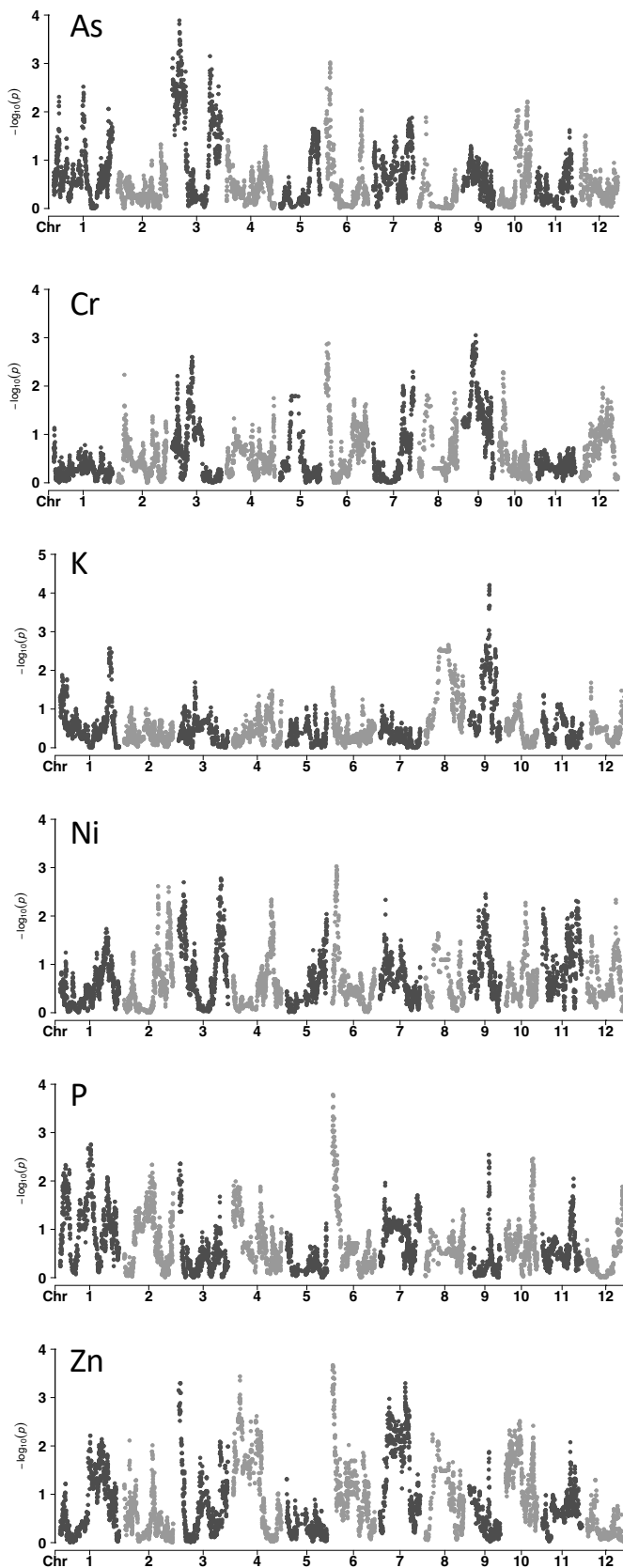


Supplementary Fig. S4 Correlation coefficient matrix between the 13 elements of grain and days to heading in the MAGIC population in 2019.

Matrix heat maps were created based on data from the MAGIC grain in 2019. According to the Pearson coefficient (r), red indicates a positive correlation, while green indicates a negative correlation. The intensity of the color reflects the strength of the correlation. The bottom-left and top-right sections of the matrix display the correlation coefficients and significance levels (****: 0.0001, ***: 0.001, **: 0.01, and *: 0.05, respectively).

Grain

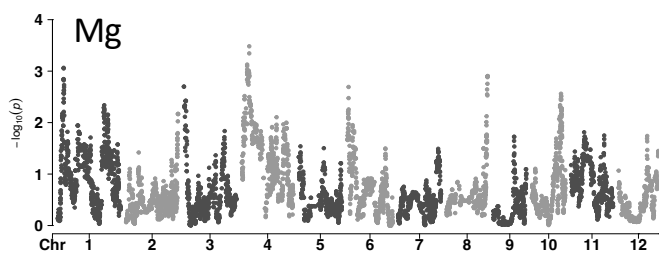
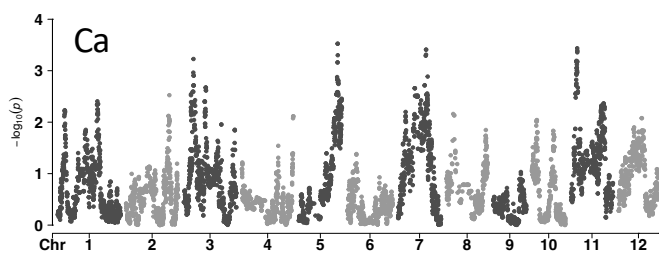
Straw



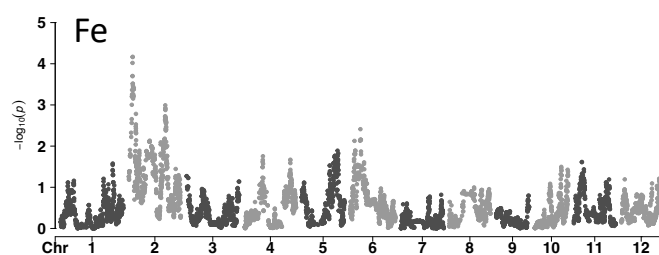
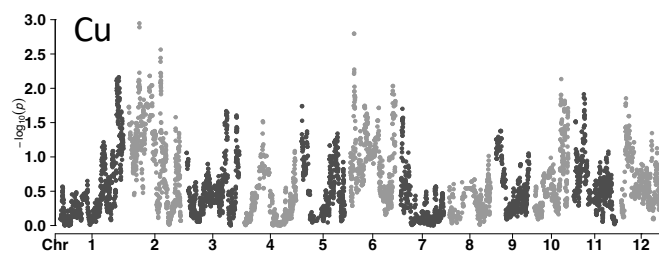
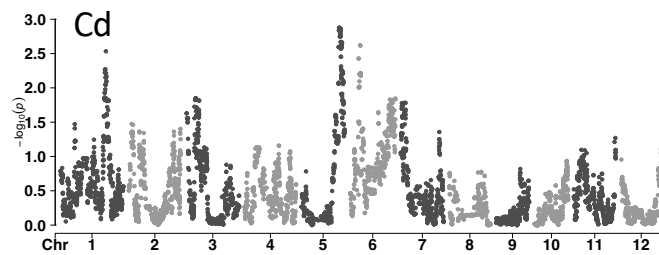
Supplementary Fig. S5 Manhattan plots for the elements and parts (straw/grain) combination showing no significant QTLs.

Chromosome names are shown on the horizontal axis, while the p -values ($-\log_{10}(P)$) are shown on the vertical axis.

Grain



Straw



Supplementary Fig. S5 (continued)