

**Supplementary Table 1.** List of traits measured in the multi-environment soybean trials, including agronomic traits, nutritional quality attributes, climatic and geographic variables, as well as soil properties. These variables were used to characterize genotype performance under diverse environmental conditions and to support the modeling of genotype-by-environment interaction (G×E). The table includes the variable ID used in the dataset, a brief description, and the measurement units. Bioclimatic variables (BIO1–BIO19) were retrieved from the WorldClim database at three soil depths (0–5 cm, 5–15 cm, and 15–30 cm) and represent aggregated climate indicators. Soil bioclimatic indices (SBIO1–SBIO19) were extracted from SoilGrids.

ID	Description	Units
<b>Agronomic features</b>		
PLEMERG_COUNT	Plant emergence (count)	plants/plot
PLEMERG_PCT	Plant emergence (percentage)	%
FLW_DAYS	Days to flowering	days
FLW_CL	Flower color	categorical
PH_R8	Plant height at maturity	cm
PUB_CL	Pubescence color	categorical
LOD	Lodging score	1–5 scale
POD_SHATTERING	Pod shattering	score
SY	Seed yield	kg/ha (13% moisture)
W100G	100-seed weight	g
R6_BB_Sev	Bacterial blight severity	1–5 scale
R6_BP_Sev	Bacterial pustule severity	1–5 scale
R6_BTS_Sev	Brown/tan spot severity	1–5 scale
R6_CLB_Sev	Cercospora leaf blight severity	1–5 scale
R6_DM_Sev	Downy mildew severity	1–5 scale
R6_MLS_Sev	Mustard leaf spot severity	1–5 scale
R6_FELS_Sev	Frogeye leaf spot severity	1–5 scale
R6_RLB_Sev	Red leaf blotch severity	1–5 scale
R6_RUST_Sev	Rust severity	1–5 scale
R6_RUST_RRT	Rust reaction type	categorical
<b>Nutritional Quality</b>		
SEED_PROT	Seed protein content	g/kg (dry matter)
SEED_OIL	Seed oil content	g/kg (dry matter)
SEED_MOIST	Moisture content	% (as-is)
<b>Weather Variables</b>		
ALLSKY_SFC_LW_DWN	Surface longwave radiation	W/m <sup>2</sup>
ALLSKY_SFC_SW_DWN	Surface shortwave radiation	W/m <sup>2</sup>
PRECTOTCORR	Precipitation (corrected)	mm/day
RH2M	Relative humidity at 2m	%
T2M	Mean air temperature at 2m	°C
T2MDEW	Dew point temperature at 2m	°C
T2M_MAX	Maximum temperature	°C
T2M_MIN	Minimum temperature	°C
WS2M	Wind speed at 2m	m/s
<b>Geographic Variable</b>		
ALT	Altitude	m
LAT	Latitude	graus

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ID	Description	Units
LON	Longitude	graus
<b>Bioclimatic Variables</b>		
BIO1	Annual Mean Temperature	$^{\circ}\text{C} \times 100$
BIO2	Mean Diurnal Range (Mean of monthly (max - min temp))	$^{\circ}\text{C} \times 100$
BIO3	Isothermality ( $\text{BIO2}/\text{BIO7} \times 100$ )	–
BIO4	Temperature Seasonality ( $\text{SD} \times 100$ )	$^{\circ}\text{C}$
BIO5	Max Temperature of Warmest Month	$^{\circ}\text{C} \times 100$
BIO6	Min Temperature of Coldest Month	$^{\circ}\text{C} \times 100$
BIO7	Temperature Annual Range ( $\text{BIO5}-\text{BIO6}$ )	$^{\circ}\text{C} \times 100$
BIO8	Mean Temperature of Wettest Quarter	$^{\circ}\text{C} \times 100$
BIO9	Mean Temperature of Driest Quarter	$^{\circ}\text{C} \times 100$
BIO10	Mean Temperature of Warmest Quarter	$^{\circ}\text{C} \times 100$
BIO11	Mean Temperature of Coldest Quarter	$^{\circ}\text{C} \times 100$
BIO12	Annual Precipitation	mm
BIO13	Precipitation of Wettest Month	mm
BIO14	Precipitation of Driest Month	mm
BIO15	Precipitation Seasonality (Coefficient of Variation)	mm
BIO16	Precipitation of Wettest Quarter	mm
BIO17	Precipitation of Driest Quarter	mm
BIO18	Precipitation of Warmest Quarter	mm
BIO19	Precipitation of Coldest Quarter	mm
<b>Soil properties</b>		
bdod	Bulk density	$\text{g}/\text{cm}^3$
ocd, soc	Organic carbon	$\text{g}/\text{kg}$
nitrogen	Total nitrogen	$\text{g}/\text{kg}$
phh2o	pH in water	pH units
clay	Clay fraction	%
silt	Silt fraction	%
sand	Sand fraction	%
cfvo	Coarse fragments	%
soilT	Soil temperature	$^{\circ}\text{C}$
FAO	Soil bioclimatic indices (FAO)	various