

Supplementary Table 1 Details of landraces with their IG number, origin and DOI

Genotype	Scientific Name	IG No.	Origin	DOI
IG5860	<i>Cicer arietinum</i> L.	IG 5860	JORDAN	10.18730/5TH2G
ILC0 (Moldova)	<i>Cicer arietinum</i> L.	IG 145243	MOLDOVA	10.18730/9TTF2
ILC1906	<i>Cicer arietinum</i> L.	IG 7744	SYRIAN ARAB REPUBLIC	10.18730/5WB4R
IG5889	<i>Cicer arietinum</i> L.	IG 5889	IRAQ	10.18730/5THZ8
IG5858	<i>Cicer arietinum</i> L.	IG 5858	JORDAN	10.18730/5TH0E
IG5985	<i>Cicer arietinum</i> L.	IG 5985	SPAIN	10.18730/5TMXW
ILC0 (Russia)	<i>Cicer arietinum</i> L.	IG 145171	RUSSIAN FERDERATION	10.18730/9TPV\$
IG5862	<i>Cicer arietinum</i> L.	IG 5862	JORDAN	10.18730/5TH4J
IG5876	<i>Cicer arietinum</i> L.	IG 5876	SYRIAN ARAB REPUBLIC	10.18730/5THJ*
IG5848	<i>Cicer arietinum</i> L.	IG 5848	JORDAN	10.18730/5TGP4
ILC0 (CR)	<i>Cicer arietinum</i> L.	-	CZECH REPUBLIC	-
ILC12022	<i>Cicer arietinum</i> L.	IG 131610	KRYGZYSTAN	10.18730/9AE4N
ILC595	<i>Cicer arietinum</i> L.	IG 6433	ALGERIA	10.18730/5V2VY
ILC1932	<i>Cicer arietinum</i> L.	IG 7770	JORDAN	10.18730/5WBXC
ILC10729	<i>Cicer arietinum</i> L.	IG 128767	ROMANIA	10.18730/97TB4
ILC238	<i>Cicer arietinum</i> L.	IG 6076	SPAIN	10.18730/5TQQ7
ILC10771	<i>Cicer arietinum</i> L.	IG 126448	TURKMENISTAN	10.18730/966TM
ILC11913	<i>Cicer arietinum</i> L.	IG 132006	KENYA	10.18730/9AQR~
ILC180	<i>Cicer arietinum</i> L.	IG 6018	MOROCCO	10.18730/5TNXQ
ILC11889	<i>Cicer arietinum</i> L.	IG 131982	EGYPT	10.18730/9AQ09

Supplementary Table 2 Summary of ANOVA results (F-value) of investigated traits

Traits	Genotype	P level	Genotype X P level
PRL	9.496***	0.148	0.607
TRL	41.843***	5.038*	0.836
TSA	45.901***	10.556**	1.288
AVD	4.702***	0.643	2.845**
RVL	47.628***	13.608***	2.259*
RDW	14.325***	54.476***	2.796**
SDW	30.483***	6.634*	1.428
TDW	27.508***	2.534	1.032
RMR	4.4***	141.276***	5.977***
PCON	15.62***	633.99***	13.71***
TPU	30.398***	41.883***	1.604
PUpE	18.52***	1190.56***	22.61***
PUtE	17.757***	54.318***	2.557**

Significance ***, significance**, and significance * at, $p < 0.001$, $p < 0.01$, and $p < 0.05$ respectively, NS – Non-Significant.

PRL, Primary root length (cm/plant); TRL, Total root length (cm/plant); TSA, Total surface area (cm²/plant); AVD, Average root diameter (mm); RVL, Root volume (cm³/plant); RDW, Root dry weight (g/plant); SDW, Shoot dry weight (g/plant); TDW, Total dry weight (g/plant); RMR, Root mass ratio; PCON, Phosphorus concentration (mg P/g dry matter); TPU, Total phosphorus uptake (mg P/plant); PUpE, Phosphorus uptake efficiency (mg P/root dry weight); PUtE, Phosphorus utilization efficiency.

Supplementary Table 3 Eigenvalues, explained variance, and factorial loadings after varimax rotation, communality and uniquenesses obtained in the factor analysis under low P conditions and adequate P conditions

Variable	FA1		FA2		FA3		Communality		Uniquenesses	
	LP	AP	LP	AP	LP	AP	LP	AP	LP	AP
PRL	-0.84	-0.43	-0.18	-0.67	-0.35	-0.02	0.86	0.64	0.14	0.36
TRL	-0.96	-0.75	0.09	-0.6	0.08	0.14	0.94	0.94	0.06	0.06
TSA	-0.98	-0.82	0.08	-0.52	-0.01	0.1	0.97	0.96	0.03	0.04
AVD	-0.08	0.22	-0.09	0.88	-0.88	-0.14	0.8	0.84	0.2	0.16
RVL	-0.98	-0.86	0.09	-0.46	-0.09	0.05	0.98	0.94	0.02	0.06
RDW	-0.94	-0.81	-0.21	-0.23	0.2	0.48	0.97	0.95	0.03	0.05
SDW	-0.89	-0.94	0.39	-0.3	-0.08	0.06	0.95	0.97	0.05	0.03
TDW	-0.98	-0.93	0.17	-0.29	0.04	0.18	0.98	0.98	0.02	0.02
RMR	-0.12	-0.09	-0.77	0.08	0.53	0.96	0.88	0.95	0.12	0.05
PCON	-0.12	0.13	0.85	0.9	0.42	-0.05	0.91	0.82	0.09	0.18
TPU	-0.8	-0.97	0.53	0.07	0.2	0.16	0.96	0.97	0.04	0.03
PU _p E	-0.05	0.29	0.99	0.49	0.03	-0.75	0.98	0.88	0.02	0.12
PU _t E	-0.96	-0.73	-0.18	-0.57	-0.13	0.18	0.96	0.89	0.04	0.11
Eigenvalues	7.88	8.68	2.81	1.63	1.45	1.4	-	-	-	-
Variance (%)	60.6	66.8	21.6	12.5	11.1	10.8	-	-	-	-
Cumulative variance (%)	60.6	66.8	82.2	79.3	93.4	90.1	-	-	-	-

PRL, Primary root length (cm/plant); TRL, Total root length (cm/plant); TSA, Total surface area (cm²/plant); AVD, Average root diameter (mm); RVL, Root volume (cm³/plant); RDW, Root dry weight (g/plant); SDW, Shoot dry weight (g/plant); TDW, Total dry weight (g/plant); RMR, Root mass ratio; PCON, Phosphorus concentration (mg P/g dry matter); TPU, Total phosphorus uptake (mg P/plant); PU_pE, Phosphorus uptake efficiency (mg P/root dry weight); PU_tE, Phosphorus utilization efficiency.

Supplementary Table 4 Selection differential and selection gains based on the MGIDI under low P conditions

Variable	Factor	X _o	X _s	SD	SD (%)	h ²	SG	SG (%)
PRL	FA1	38.2	42.5	4.34	11.4	0.792	3.44	9
TRL	FA1	715	1027	313	43.8	0.952	298	41.7
TSA	FA1	136	200	64	47	0.949	60.7	44.6
RVL	FA1	2.09	3.28	1.19	57	0.948	1.13	54.1
RDW	FA1	0.186	0.244	0.0574	30.8	0.894	0.0513	27.5
SDW	FA1	0.288	0.541	0.254	88.2	0.965	0.245	85.1
TDW	FA1	0.473	0.784	0.311	65.8	0.949	0.295	62.4
TPU	FA1	1.57	2.71	1.15	73.2	0.96	1.1	70.3
PU _t E	FA1	15.2	22.9	7.61	50	0.893	6.8	44.6
RMR	FA2	0.39	0.327	-0.0629	-16.1	0.816	-0.0513	-13.2
PCON	FA2	3.15	3.42	0.265	8.42	0.883	0.234	7.43
PU _p E	FA2	8.85	11	2.11	23.9	0.926	1.96	22.1
AVD	FA3	0.596	0.588	-0.0076	-1.27	0.546	-0.0041	-0.693

PRL, Primary root length (cm/plant); TRL, Total root length (cm/plant); TSA, Total surface area (cm²/plant); AVD, Average root diameter (mm); RVL, Root volume (cm³/plant); RDW, Root dry weight (g/plant); SDW, Shoot dry weight (g/plant); TDW, Total dry weight (g/plant); RMR, Root mass ratio; PCON, Phosphorus concentration (mg P/g dry matter); TPU, Total phosphorus uptake (mg P/plant); PU_pE, Phosphorus uptake efficiency (mg P/root dry weight); PU_tE, Phosphorus utilization efficiency.

Supplementary Table 5 Selection differential and selection gains based on the MGIDI under adequate P conditions

Variable	Factor	Xo	Xs	SD	SD (%)	h ²	SG	SG (%)
TRL	FA1	640	1014	374	58.4	0.954	357	55.8
TSA	FA1	117	192	74.3	63.3	0.971	72.2	61.5
RVL	FA1	1.77	2.99	1.23	69.3	0.988	1.21	68.4
RDW	FA1	0.107	0.192	0.0849	79.4	0.889	0.0755	70.6
SDW	FA1	0.328	0.561	0.233	70.8	0.911	0.212	64.5
TDW	FA1	0.435	0.754	0.319	73.3	0.91	0.29	66.7
TPU	FA1	2.23	4.6	2.37	106	0.919	2.17	97.4
PUtE	FA1	9.08	12.6	3.54	39	0.92	3.26	35.9
PRL	FA2	37.5	36.1	-1.47	-3.9	0.807	-1.18	-3.15
AVD	FA2	0.588	0.588	0.00072	0.122	0.86	0.00062	0.105
PCON	FA2	5.5	6.07	0.575	10.5	0.955	0.549	9.98
RMR	FA3	0.235	0.256	0.0214	9.12	0.852	0.0182	7.77
PUpE	FA3	27.2	24.4	-2.79	-10.3	0.974	-2.72	-10

PRL, Primary root length (cm/plant); TRL, Total root length (cm/plant); TSA, Total surface area (cm²/plant); AVD, Average root diameter (mm); RVL, Root volume (cm³/plant); RDW, Root dry weight (g/plant); SDW, Shoot dry weight (g/plant); TDW, Total dry weight (g/plant); RMR, Root mass ratio; PCON, Phosphorus concentration (mg P/g dry matter); TPU, Total phosphorus uptake (mg P/plant); PUpE, Phosphorus uptake efficiency (mg P/root dry weight); PUtE, Phosphorus utilization efficiency.