

Supplementary files

Table S1. Mean values and standard errors (12 replications) of the assessed seminal root traits for the 37 durum wheat genotypes.

Genotypes	TRL	Surface	Volume	Diameter	PRL	SDW	MRA	MVA	LVA	RN
Belioni	97.96±4.67	16.36±0.94	0.2241±0.02	0.0536±0.00	29.87±0.93	19.37±2.26	33.45±2.43	9.40±4.44	44.60±4.04	5.00±0.00
Bidi 17	113.55±10.12	20.31±2.17	0.2954±0.04	0.0558±0.00	26.95±1.61	18.28±1.75	28.44±5.10	12.76±6.50	40.46±8.13	6.00±0.00
Djenah Khotifa	102.22±7.56	17.76±1.60	0.2518±0.03	0.0552±0.00	29.57±1.11	17.70±1.32	26.17±2.89	9.14±5.16	41.27±4.90	5.00±0.00
Gloire de Montgolfier	112.47±8.20	18.13±1.40	0.2371±0.02	0.0504±0.00	27.58±1.64	16.45±2.01	20.10±6.69	9.76±4.39	31.38±7.63	5.42±0.51
Guemgoum R'khem	122.73±8.13	20.80±1.24	0.2857±0.02	0.0534±0.00	28.52±1.47	18.21±1.44	23.90±3.94	6.79±5.04	37.41±5.61	5.83±0.39
Hedba 3	114.61±12.68	19.31±2.50	0.2650±0.04	0.0536±0.00	26.63±1.87	16.58±2.09	22.73±3.22	12.90±4.31	33.14±4.62	5.33±0.49
Langlois	108.24±5.08	18.49±1.20	0.2560±0.02	0.0539±0.00	28.06±0.96	14.48±1.90	22.71±4.77	9.25±7.69	34.22±5.93	5.08±0.29
Mohammed Ben Bachir	99.30±6.90	16.50±1.36	0.2230±0.03	0.0527±0.00	27.53±1.01	17.81±1.81	32.37±4.24	12.88±6.53	45.91±6.77	5.08±0.29
Montpellier	83.41±8.48	13.90±1.90	0.1895±0.03	0.0516±0.00	23.43±2.50	11.17±1.38	15.94±6.51	3.69±6.97	36.82±4.05¥	5.08±0.29
Oued Zenati 368	108.45±13.56	19.17±2.80	0.2767±0.05	0.0555±0.00	27.03±2.35	16.08±3.07	27.29±3.19	9.83±7.05	41.75±7.26	5.83±0.39
Acsad 65	97.63±9.59	17.33±1.66	0.2495±0.03	0.0568±0.00	26.88±1.25	15.45±1.84	30.87±4.10	10.02±5.53	48.62±7.33	5.00±0.00
Altar 84	95.35±15.76	16.63±2.67	0.2370±0.04	0.0553±0.00	27.01±1.34	13.46±1.76	26.96±10.03	10.70±7.27	43.24±6.86¥	5.17±0.39
Ammar 6	87.73±10.83	15.38±1.84	0.2205±0.03	0.0559±0.00	22.74±2.59	12.83±2.07	36.33±3.18	23.27±4.00	45.70±4.96	5.33±0.49
Bousselem	86.07±11.72	14.81±1.86	0.2071±0.02	0.0548±0.00	26.17±3.51	13.81±1.42	38.00±4.84	20.09±3.74	49.73±8.38	4.92±0.51
Boutaleb	97.70±6.09	17.23±1.42	0.2476±0.03	0.0560±0.00	25.97±1.73	15.13±1.25	31.97±5.79	16.58±5.96	44.19±7.33	5.00±0.00
Capeiti	107.02±10.62	18.17±2.10	0.2517±0.04	0.0536±0.00	25.91±1.64	14.59±1.69	32.13±3.15	17.12±6.59	45.61±8.66	5.58±0.51
Chen's	90.66±9.14	14.72±1.47	0.1964±0.02	0.0515±0.00	24.30±2.72	11.47±1.34	38.62±4.24	16.19±5.64	50.74±9.66¥	6.00±0.00
Ciccio	90.64±11.32	14.79±1.94	0.1972±0.03	0.0517±0.00	23.43±3.00	11.07±2.54	25.84±6.93	11.29±10.19	37.30±6.31¥	5.08±0.29
Cirta	96.13±9.98	17.48±1.62	0.2588±0.02	0.0577±0.00	25.73±2.42	15.43±1.39	32.10±4.19	12.31±4.68	44.79±8.70	5.25±0.45
Core	91.27±14.74	14.66±2.53	0.1935±0.04	0.0512±0.00	23.42±3.53	10.48±1.41	31.92±6.32	15.49±6.51	47.13±11.86	5.67±0.65
GTA Dur	95.48±12.76	16.62±2.17	0.2338±0.03	0.0548±0.00	25.92±2.76	14.28±1.56	34.70±4.65	21.05±8.56	47.01±8.27	5.42±0.51
INRAT 69	101.69±11.29	17.26±2.20	0.2378±0.04	0.0534±0.00	25.18±1.60	14.38±2.38	22.08±7.41	11.83±6.10	32.91±8.84	5.58±0.51
Korifla	89.04±15.74	15.05±3.48	0.2077±0.06	0.0528±0.00	24.03±4.17	12.14±3.90	26.70±2.58	13.01±4.25	38.18±4.67	5.17±0.39
Mansourah	103.44±9.07	16.86±1.56	0.2240±0.03	0.0514±0.00	28.71±0.97	15.85±1.44	32.92±4.07	10.12±2.99	48.97±6.02	5.42±0.51
Massinissa	89.84±5.11	15.63±0.96	0.2207±0.02	0.0547±0.00	25.92±1.34	13.19±1.12	37.40±4.05	22.90±5.24	46.97±5.24	5.00±0.00
Megress	102.24±12.84	17.45±2.06	0.2423±0.03	0.0538±0.00	27.36±1.97	15.48±1.50	31.92±5.69	16.42±5.33	44.91±8.14	5.42±0.51

Continued Table S1

Mexicali 75	103.04±7.96	18.30±1.47	0.2637±0.02	0.0559±0.00	28.50±1.12	15.12±1.62	36.60±3.83	16.72±4.22	45.00±6.22¥	5.83±0.39
Ofanto	100.23±8.07	17.37±1.37	0.2443±0.02	0.0543±0.00	26.88±1.23	13.94±1.82	25.35±5.25	14.56±5.34	35.40±7.77	4.92±0.29
Oued El Berd	98.40±10.28	17.48±1.70	0.2518±0.02	0.0564±0.00	29.82±1.10	15.58±1.34	35.04±3.46	12.16±3.66	46.79±6.77	5.08±0.29

Polonicum	100.42±8.40	17.05±1.88	0.2357±0.03	0.0534±0.00	23.86±1.84	14.78±2.46	24.44±5.71	12.26±4.56	36.27±9.04	5.67±0.49
Sahell	89.40±9.39	14.63±1.84	0.1952±0.03	0.0517±0.00	25.59±2.45	15.62±1.41	39.46±3.97	24.08±4.18	48.25±5.61	5.42±0.51
Simeto	86.25±7.57	14.40±1.45	0.1954±0.03	0.0526±0.00	24.40±1.63	13.69±1.46	31.07±4.87	20.35±3.79	40.81±7.49	5.00±0.00
Sitifis	93.31±8.46	16.06±1.68	0.2242±0.03	0.0542±0.00	29.97±2.18	16.00±2.46	35.23±5.94	15.66±2.66	46.63±6.35	5.17±0.39
Vitron	87.21±5.56	14.77±1.08	0.2039±0.02	0.0541±0.00	27.10±1.53	14.67±1.13	40.34±2.54	18.65±4.68	52.95±5.78	5.17±0.39
Waha	102.90±7.49	17.42±1.59	0.2403±0.03	0.0534±0.00	28.65±2.36	13.80±1.31	31.71±2.99	11.15±3.50	42.29±8.57	5.58±0.51
Wahbi	90.39±14.41	14.63±2.67	0.1933±0.04	0.0514±0.00	25.49±4.58	11.73±1.84	33.84±5.84	18.01±4.54	45.80±10.42	5.08±0.29
ZB × Fg	107.64±10.22	17.41±1.41	0.2296±0.02	0.0513±0.00	26.66±1.81	14.63±1.14	26.73±4.16	13.41±4.34	37.05±8.63	5.25±0.45

TRL: total root length, Surface: total root surface area, Volume: total root volume, Diameter: mean root diameter, PRL: primary root length, SDW: shoot dry weight, MRA: mean root angle, MVA: maximal vertical angle; LVA, least vertical angle, RN: root number. Values in the table represent mean ± standard deviation. Coefficient of variation (CV%) can be calculated following the formula (standard error/mean) *100. ¥: Mean and standard error of LVA were calculated based on 11 replications for the corresponding genotypes.

Table S2. Descriptive statistics and correlation coefficients for seedling traits, calculated separately for the cultivar and landrace groups.

	Traits	Min	Mean	Max	CV	TRL	Surface	Volume	Diameter	PRL	SDW	MRA	LVA	MVA	RN
Cultivar (n=27)	TRL (cm)	54.28	95.60	128.75	12.54	1	***	***	ns	***	***	***	**	**	***
	Surface (cm ²)	8.25	16.28	21.69	13.70	0.83	1	***	***	***	***	***	*	*	***
	Volume (cm ³)	0.0962	0.2260	0.3034	16.02	0.80	0.96	1	***	***	***	*	ns	ns	**
	Diameter (cm)	0.0447	0.0538	0.0620	5.28	0.06	0.39	0.61	1	***	***	***	ns	**	***
	PRL (cm)	14.32	26.13	32.06	11.26	0.55	0.56	0.51	0.16	1	***	ns	**	***	ns
	SDW (g)	5.70	14.02	19.10	16.52	0.45	0.58	0.63	0.49	0.53	1	***	**	ns	ns
	MRA (°)	1.20	32.23	45.69	21.24	-0.38	-0.31	-0.23	0.15	0.01	0.10	1	***	***	ns
	LVA (°)	20.40	44.20	61.47	16.19	-0.14	-0.16	-0.12	0.08	0.14	0.12	0.73	1	***	ns
	MVA (°)	0.00	15.75	43.49	53.91	-0.19	-0.18	-0.13	0.11	-0.26	0.02	0.57	0.18	1	ns
	RN (no.)	4.00	5.30	6.00	9.17	0.24	0.22	0.15	-0.29	0.02	-0.03	-0.04	0.06	-0.16	1
Landrace (n=10)	TRL (cm)	90.40	106.29	137.22	12.80	1	***	***	ns	ns	**	***	**	ns	***
	Surface (cm ²)	14.18	18.07	24.82	14.50	0.95	1	***	***	*	***	**	ns	ns	***
	Volume (cm ³)	0.1710	0.2504	0.3721	17.16	0.85	0.97	1	***	*	***	ns	ns	ns	***
	Diameter (cm)	0.0481	0.0536	0.0588	4.95	0.24	0.51	0.67	1	ns	***	**	*	ns	ns
	PRL (cm)	21.98	27.52	31.38	8.45	0.49	0.48	0.46	0.28	1	***	ns	**	*	*
	SDW (g)	11.00	16.61	23.50	17.67	0.54	0.58	0.39	0.43	0.68	1	**	**	ns	ns
	MRA (°)	9.69	25.31	37.45	26.56	-0.02	0.05	0.57	0.35	0.34	0.47	1	***	***	ns
	LVA (°)	22.91	38.71	59.01	19.03	-0.17	-0.10	0.11	0.22	0.23	0.28	0.70	1	ns	ns
	MVA (°)	0.14	9.64	26.03	66.87	0.11	0.13	-0.04	0.16	0.01	0.14	0.53	0.09	1	ns
	RN (no.)	5.00	5.37	6.00	9.02	0.53	0.52	0.49	0.03	-0.03	0.20	-0.05	-0.01	-0.01	1

TRL: total root length, Surface: total root surface area, Volume: total root volume, Diameter: mean root diameter, PRL: primary root length; SDW: shoot dry weight, MRA: mean root angle, LVA: least vertical angle, MVA: maximal vertical angle, RN: root number. *, **, ***, ns, indicate P-values lower than 0.05, 0.01, 0.001, and non-significant, respectively.

Table S3. Results of linear regressions of traits over years of release. Positive slopes indicate increase of the trait with year of release; negative slopes indicate decrease of the traits over years of release. Other columns show the standard errors (s.e.) of the slopes, variance ratio tests (F) and the probability of the slope being different from 0 (F pr.). Traits abbreviations are explained in Table 1.

Traits	slope	s.e.	F	F pr.
Diameter	0.0000023	0.0000108	0.04	0.836
LVA	0.0724	0.0313	2.31	0.020
MRA	0.0896	0.0313	8.18	0.007
MVA	0.0687	0.0256	7.18	0.011
PRL	-0.0140	0.0114	1.50	0.228
RN	-0.00249	0.00183	1.85	0.182
SDW	-0.0355	0.0110	10.39	0.003
Surface	-0.03094	0.00869	12.67	0.001
TRL	-0.1728	0.0462	14.00	<0.001
Volume	-0.000447	0.000144	9.66	0.004

Table S4. Contribution (%) and coordinates of the traits to the first four principal components (PC1, PC2, PC3, PC4). Traits abbreviations as in Table S1.

Traits	Contributions				Coordinates			
	PC1	PC2	PC3	PC4	PC1	PC2	PC3	PC4
TRL	19.04	0.08	3.44	2.42	0.93	-0.04	0.20	0.14
Surface	20.19	0.77	1.96	0.97	0.96	0.13	0.15	-0.09
Volume	18.16	2.91	1.03	8.39	0.91	0.26	0.11	-0.27
Diameter	1.82	16.8	2.44	50.19	0.29	0.63	-0.17	-0.67
PRL	7.53	9.63	12.80	20.43	0.59	0.47	-0.39	0.43
SDW	11.51	7.35	3.46	7.91	0.72	0.41	-0.20	0.26
MRA	5.65	28.16	2.34	2.76	-0.51	0.81	0.17	0.16
MVA	7.97	9.89	7.46	1.63	-0.60	0.48	0.30	-0.12
LVA	5.65	24.30	0.49	3.23	-0.51	0.75	0.07	0.17
RN	2.44	0.00	64.53	2.03	0.33	-0.00	0.89	0.13

Table S5. Means comparison between groups formed by hierarchical clustering for the traits assessed.

Groups	TRL	Surface	Volume	Diameter	PRL	RN	SDW	LVA	MRA	MVA	MRL	PRL-MRL
G1	109.98 a	18.66 a	0.26 a	0.0534 b	26.72 b	5.56 a	15.98 a	36.07 c	24.27 c	10.97 c	18.43 a	8.29 b
G2	98.74 b	17.01 b	0.24 b	0.0546 a	27.57 a	5.21 b	15.43 a	44.93 b	31.98 b	13.93 b	16.97 b	10.60 a
G3	90.15 c	15.16 c	0.21 c	0.0533 b	25.37 c	5.34 b	13.28 c	47.14 a	36.10 a	19.13 a	15.00 c	10.37 a
G4	87.70 c	14.58 c	0.20 c	0.0520 c	23.63 d	5.11 c	11.46 d	37.45 c	22.83 c	9.33 c	15.69 c	7.94 b
Significance	***	***	***	***	***	***	***	***	***	***	***	***

TRL: total root length, Surface: total root surface area, Volume: total root volume, Diameter: mean root diameter, PRL: primary root length, RN: root number, SDW: shoot dry weight, LVA: least vertical angle, MRA: mean root angle, MVA: maximal vertical angle, RL: mean root length was calculated based on the length of roots, (primary root was not included), PRL-MRL: difference between length of the primary root and mean length of the other roots. At each column, means followed by the same letter indicate that they did not differ significantly for $P=0.05$. ***, difference between groups was significant at $P<0.001$.

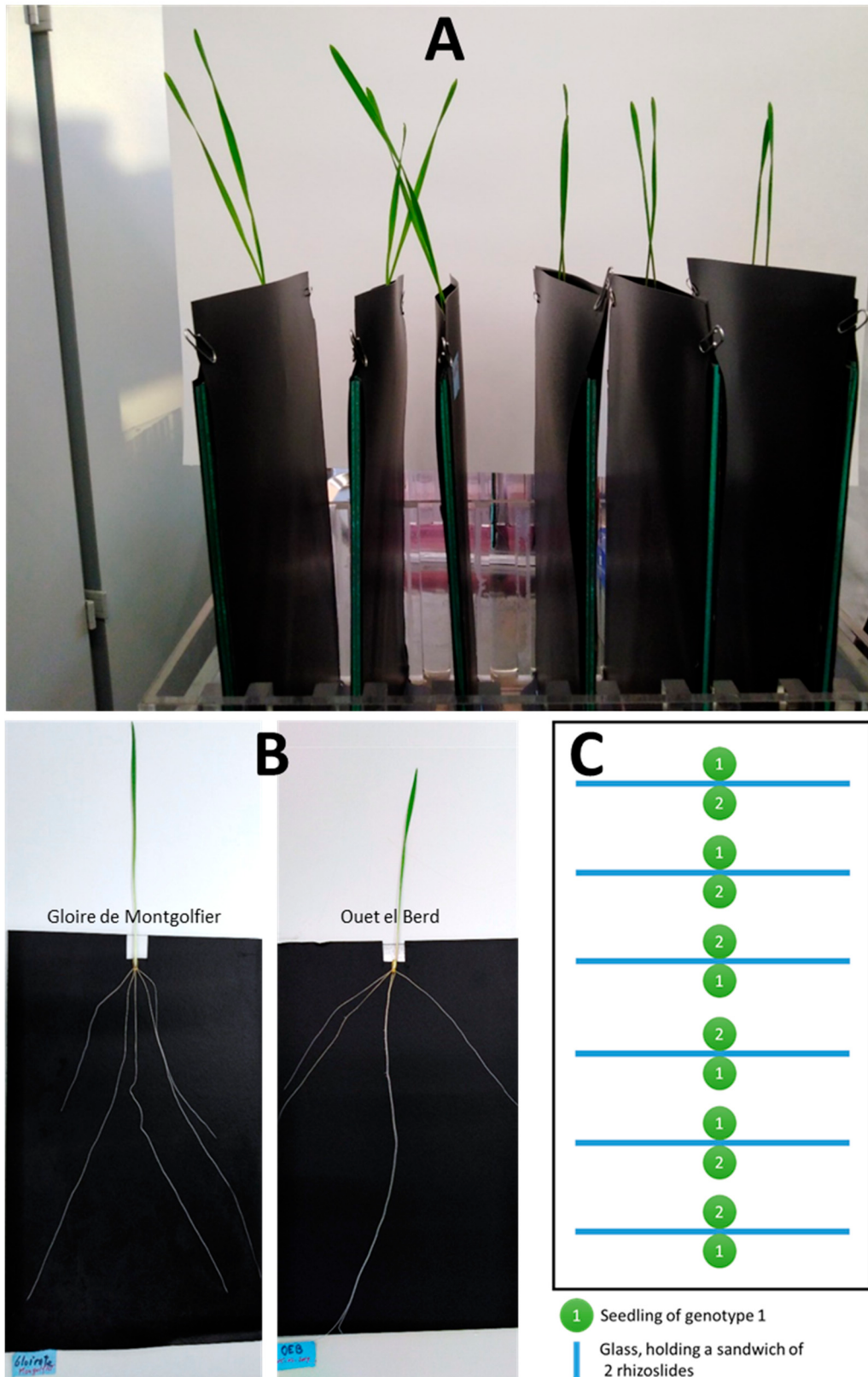


Figure S1. A) One-week-old durum wheat seedlings in the rhizoslide system; B) pictures of two genotypes contrasting for root angle, landrace Gloire de Montgolfier (left) and cultivar Oued El Berd (right); C) schematic representation of a glass box, holding 6 glass plates, each holding two rhizoslides.

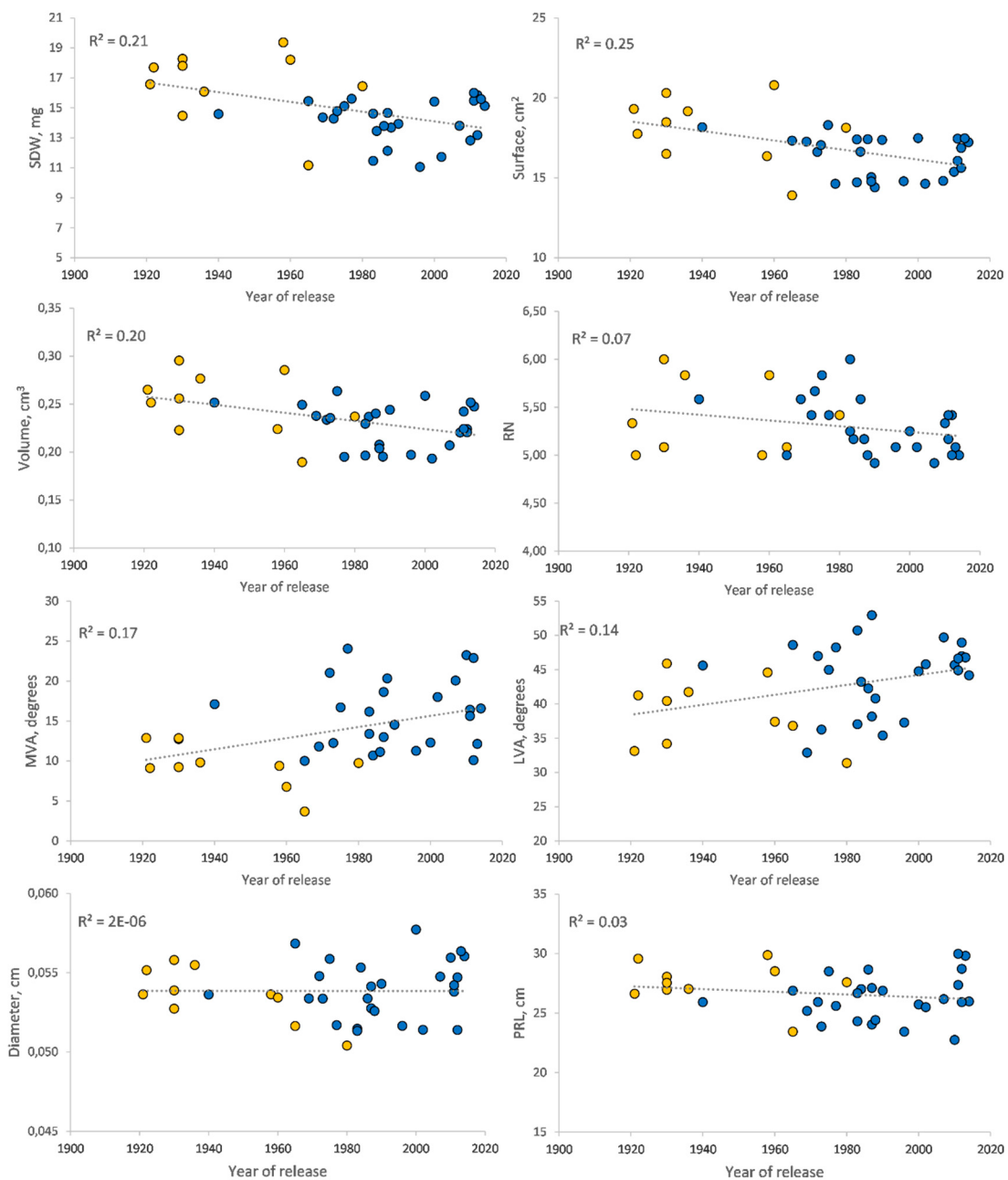


Figure S2. Time trends of seminal root traits over years of release of the varieties. The coefficients of determination of the regression lines are indicated in each graph. Landraces are indicated with yellow symbols; modern cultivars are indicated with blue symbols.