



Supplementary Figure S1. Map of Egypt indicating the sampling sites of *Ricinus communis*.

Supplementary Table S1. Qualitative characters of *Ricinus communis* vegetative morphometry. The plant's stature ranks: very tall “>2.50 m”, tall “2.0–2.5 m”, medium “1.51–2.0 m”, and short “1.0–1.5 m”.

Site	Sample	Plant stature	Stem coloration	Blade class	First lobe shape	Second lobe shape	Third lobe shape	Fifth lobe shape
1	1	Tall	Purple	Macro-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
	2	Tall	Purple	Meso-phyll	Oblong	Lanceolate	Lanceolate	Lanceolate
	3	Short	Purple	Macro-phyll	Oblong	Lanceolate	Lanceolate	Lanceolate
	4	Short	Purple	Meso-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
2	5	Short	Grayish-green	Meso-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
	6	Very Tall	Grayish-green	Meso-phyll	Oblong	Lanceolate	Lanceolate	Lanceolate
	7	Very Tall	Grayish-green	Meso-phyll	Oblong	Lanceolate	Lanceolate	Lanceolate
3	8	Very Tall	Grayish-green	Macro-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
	9	Medium	Grayish-green	Macro-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
4	10	Tall	Grayish-green	Meso-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
	11	Short	Grayish-green	Meso-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
5	12	Short	Purple	Meso-phyll	Oblong	Lanceolate	Lanceolate	Lanceolate
	13	Very Tall	Purple	Meso-phyll	Oblong	Lanceolate	Lanceolate	Lanceolate
6	14	Medium	Grayish-green	Macro-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
	15	Medium	Grayish-green	Meso-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
7	16	Medium	Grayish-green	Macro-phyll	Oblong	Oblong	Lanceolate	Lanceolate
8	17	Tall	Grayish-green	Macro-phyll	Lanceolate	Lanceolate	Lanceolate	Linear-Lanceolate
	18	Short	Grayish-green	Meso-phyll	Oblong	Lanceolate	Lanceolate	Lanceolate
	19	Tall	Grayish-green	Macro-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
9	20	Very Tall	Purple	Meso-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
	21	Tall	Purple	Meso-phyll	Lanceolate	Lanceolate	Lanceolate	Lanceolate
10	22	Medium	Grayish-green	Meso-phyll	Oblong	Oblong	Lanceolate	Lanceolate
	23	Tall	Grayish-green	Meso-phyll	Oblong	Lanceolate	Lanceolate	Lanceolate
11	24	Very Tall	Grayish-green	Macro-phyll	Oblong	Oblong	Oblong	Lanceolate
	25	Very Tall	Grayish-green	Meso-phyll	Oblong	Lanceolate	Lanceolate	Lanceolate

Supplementary Table S2. Quantitative characteristics of Abaxial leaf (AB) and Adaxial leaf (AD) surface ultrastructure of *Ricinus communis*.

	Variable	Mean±StDev	SE Mean	Min.	Q1	Median	Q3	Max.	IQR
Abaxial	Number of stomata	19±9.12	3.22	8	16.25	17.5	18	40	1.75
	Closed stomata length (µm)	13.69±4.59	1.08	7.66	10.68	13.32	15.21	27.74	4.52
	Closed stomata width (µm)	5.678±2.144	0.505	2.943	4.457	5.107	5.867	12.045	1.41
	Closed stomata length/width ratio	2.536±0.852	0.201	1.642	2.063	2.357	2.683	5.142	0.62
	Closed stomata area (µm ²)	64.2±53.3	12.6	27	30.5	48.4	69	246.6	38.5
	Opened stomata length (µm)	17.335±3.349	0.714	11.239	15.554	16.977	19.693	24.535	4.139
	Opened stomata width (µm)	8.71±1.892	0.403	4.813	7.47	8.667	10.122	13.203	2.652
	Opened stomata length/width ratio	2.0245±0.3216	0.0686	1.4931	1.721	2.0022	2.3131	2.565	0.5922
	Opened stomata area (µm ²)	117.49±41.46	8.84	42.04	94.48	111.26	132.86	207.88	38.38
	Stomatal pore length (µm)	11.809±3.156	0.673	6.987	9.325	11.389	13.418	19.983	4.093
	Stomatal pore width (µm)	4.147±1.534	0.327	2.23	2.989	3.907	5.066	8.553	2.077
	Stomatal pore length/width ratio	3.064±0.987	0.21	1.743	2.248	2.896	3.752	5.176	1.504
	Stomatal pore area (µm ²)	34.12±20.05	4.27	12.58	19.86	25.78	44.16	90.1	24.3
	Epidermal cell length (µm)	28.64±6.9	1.58	19.28	23.62	28.16	32.77	44.13	9.15
	Epidermal cell width (µm)	13.84±4.78	1.1	7.11	9.29	13.18	18.86	22.89	9.56
	Epidermal cell length/width ratio	2.191±0.517	0.119	1.532	1.648	2.195	2.699	3.145	1.051
	Epidermal cell area (µm ²)	415.6±244.8	56.2	151	198.1	317	636.7	889.7	438.5
Adaxial	Number of stomata	15.33±4.15	1.38	12	13.5	14	15.5	26	2
	Closed stomata length (µm)	9.708±2.728	0.704	5.815	7.457	9.503	12.8	13.172	5.343
	Closed stomata width (µm)	4.045±1.291	0.333	2.663	2.853	3.5	5.499	6.296	2.646
	Closed stomata length/width ratio	2.463±0.525	0.135	1.87	2.141	2.248	2.912	3.57	0.771
	Closed stomata area (µm ²)	29.77±15.65	4.04	10.24	16.53	22.82	40.3	56.13	23.77
	Opened stomata length (µm)	22.85±29.38	6.57	6.75	10.93	15.23	18.22	132.49	7.29
	Opened stomata width (µm)	11.92±14.54	3.25	3.38	5.88	8	9.98	65.73	4.11
	Opened stomata length/width ratio	1.8996±0.3309	0.074	1.3737	1.5725	1.9724	2.1504	2.6039	0.578
	Opened stomata area (µm ²)	587±1642	367	17	45	82	155	6780	110
	Stomatal pore length (µm)	17.49±26.38	5.9	4.13	6.49	10.07	13.97	116.03	7.48
	Stomatal pore width (µm)	5.89±7.41	1.66	1.13	2.63	3.65	5.34	33.07	2.71
	Stomatal pore length/width ratio	2.794±0.698	0.156	1.549	2.147	2.802	3.388	3.91	1.241
	Stomatal pore area (µm ²)	205±583	130	3	15	22	53	2403	38
	Epidermal cell length (µm)	26.51±9.23	1.85	11.77	15.86	30.24	34.36	39.96	18.5
	Epidermal cell width (µm)	16.47±6.09	1.22	6.83	12.08	15.86	18.78	32.3	6.7
	Epidermal cell length/width ratio	1.677±0.527	0.105	0.707	1.281	1.577	2.129	2.674	0.848
	Epidermal cell area (µm ²)	464.6±291.3	60.7	74.5	158	417.5	695.8	1063.7	537.9

Supplementary Table S3. One-way ANOVA analysis of abaxial leaf and adaxial leaf surface ultrastructure characters of *Ricinus communis*.

Variable	Abaxial	Adaxial
Number of stomata	19±9.12 ^a	15.33±4.15 ^a
Closed stomata length (µm)	13.69±4.59 ^a	9.708±2.728 ^b
Closed stomata width (µm)	5.678±2.144 ^a	4.045±1.291 ^b
Closed stomata length/width ratio	2.536 ± 0.852 ^a	2.463 ± 0.525 ^a
Closed stomata area (µm ²)	64.2±53.3 ^a	29.77±15.65 ^b
Opened stomata length (µm)	17.335±3.349 ^a	22.85±29.38 ^a
Opened stomata width (µm)	17.335±3.349 ^a	22.85±29.38 ^a
Opened stomata length/width ratio	2.0245 ± 0.3216 ^a	1.8996 ± 0.3309 ^a
Opened stomata area (µm ²)	117.49±41.46 ^a	587±1642 ^a
Stomatal pore length (µm)	11.809±3.156 ^a	17.49±26.38 ^a
Stomatal pore width (µm)	4.147±1.534 ^a	5.89±7.41 ^a
Stomatal pore length/width ratio	3.064 ± 0.987 ^a	2.794 ± 0.698 ^a
Stomatal pore area (µm ²)	34.12±20.05 ^a	205±583 ^a
Epidermal cell length (µm)	28.64±6.9 ^a	26.51±9.23 ^a
Epidermal cell width (µm)	13.84±4.78 ^a	16.47±6.09 ^a
Epidermal cell length/width ratio	2.191 ± 0.517 ^a	1.677 ± 0.527 ^b
Epidermal cell area (µm ²)	415.6±244.8 ^a	464.6±291.3 ^a

Supplementary Table S4. The one-way ANOVA of the soil traits showed non-significant variation for the three studied groups.

Variable	Group1 (site 3,8)	Group2 (site 1,5)	Group3 (site 4,10)
Gravel (%)	3.2 ± 0.849 ^a	3.65 ± 2.76 ^a	3.75 ± 0.0707 ^a
Sand (%)	82.5 ± 3.54 ^a	62 ± 2.83 ^a	76 ± 19.8 ^a
Silt (%)	12.5 ± 3.54 ^a	27 ± 4.24 ^a	17.5 ± 13.44 ^a
Clay (%)	5 ± 0 ^a	11 ± 1.41 ^a	6.5 ± 6.36 ^a
SP (%)	50 ± 2.83 ^a	54.5 ± 6.36 ^a	47.5 ± 12.02 ^a
pH	38.5 ± 14.8 ^a	260 ± 289 ^a	56.5 ± 2.12 ^a
EC (dS/m)	20.3 ± 8.06 ^a	137 ± 155 ^a	32.5 ± 0.707 ^a
Ca ⁺⁺ (meq/l)	23.8 ± 5.94 ^a	176 ± 197 ^a	37.5 ± 2.12 ^a
Mg ⁺⁺ (meq/l)	2.65 ± 0.778 ^a	3.65 ± 1.48 ^a	3.35 ± 1.061 ^a
Na ⁺ (meq/l)	5.85 ± 0.919 ^a	12.15 ± 5.44 ^a	9.55 ± 1.344 ^a
K ⁺ (meq/l)	25.6 ± 7.64 ^a	157 ± 172 ^a	36.85 ± 2.33 ^a
HCO ₃ ⁻ (meq/l)	53.8 ± 21.1 ^a	407 ± 465 ^a	83.45 ± 2.33 ^a
Cl ⁻ (meq/l)	4.4 ± 0.283 ^a	11.25 ± 7.71 ^a	5.65 ± 0.212 ^a
SO ₄ ⁻ (meq/l)	0.985 ± 0.445 ^a	0.83 ± 0.382 ^a	0.975 ± 0.0636 ^a
SAR	10.15 ± 2.62 ^a	6.65 ± 0.919 ^a	12.15 ± 5.44 ^a
N (ppm)	167 ± 25.5 ^a	251 ± 137.2 ^a	158.5 ± 30.4 ^a
P (ppm)	0.59 ± 0.198 ^a	0.69 ± 0.255 ^a	0.65 ± 0.523 ^a
K (ppm)	0.38 ± 0.099 ^a	0.305 ± 0.0495 ^a	0.28 ± 0 ^a
Fe (ppm)	0.33 ± 0.212 ^a	0.305 ± 0.1061 ^a	0.23 ± 0 ^a
Zn ⁺⁺ (ppm)	0.175 ± 0.0778 ^a	0.2 ± 0.24 ^a	0.265 ± 0.276 ^a
Mn ⁺⁺ (ppm)	7.605 ± 0.431 ^a	7.55 ± 0.0141 ^a	7.49 ± 0.099 ^a
Cu ⁺⁺ (ppm)	7.57 ± 4.99 ^a	36.1 ± 41.7 ^a	8.25 ± 0.636 ^a
O.M. (%)	0.175 ± 0.0778 ^a	0.06 ± 0 ^b	0.145 ± 0.0919 ^a
CaCO ₃ (%)	16.85 ± 1.63 ^a	22.5 ± 3.54 ^a	19.65 ± 3.32 ^a

Supplementary Table S5. The one-way ANOVA of the phytochemical's concentration exhibited non-significant variation for the three studied groups.

Phytochemical compounds	Group1 (site 3, 8)	Group2 (site 1, 5)	Group3 (site 4, 10)
Isophytol	0.935 ± 0.587^a	2.165 ± 1.294^a	1.05 ± 0.891^a
n-Hexadecanoic acid	30.86 ± 5.66^a	35.365 ± 1.252^a	23.12 ± 1.53^a
9,12,15-Octadecatrienoic acid	22.56 ± 4.29^a	22.09 ± 6.75^a	23.3 ± 3.35^a
Oleic acid	0.31 ± 0.255^a	0.18 ± 0.0566^a	0.17 ± 0.0141^a
Octadecanoic acid	4.105 ± 1.181^a	3.555 ± 0.0212^a	3.23 ± 0.325^a
Tributyl acetylcitrate	0.275 ± 0.177^a	2.7 ± 1.146^a	1.86 ± 2.39^a