Supplementary Text

We performed a parallel experiment under aCO_2 where we grew six additional plants, in larger 5 L pots, filled with soil, to test whether our findings also apply to natural soil conditions The experimental design was identical to the perlite medium experiment. The only difference was that instead of perlite we used local sandy “Hamra” soil that is common in the Israeli coastal plains. The soil was chosen based on its extremely low P levels and was taken from a depth of 10 meters (no labile or NaOH extractable P and ~50 µg g^{-2} HCl extractable P). The Six plants were fertigated with -P solution: two were used as the control group, two plants were applied with desert dust on their foliage, and two plants had desert dust that was gently mixed on the top 5 cm of the pot, to let the fresh dust settle deeper towards the roots system.

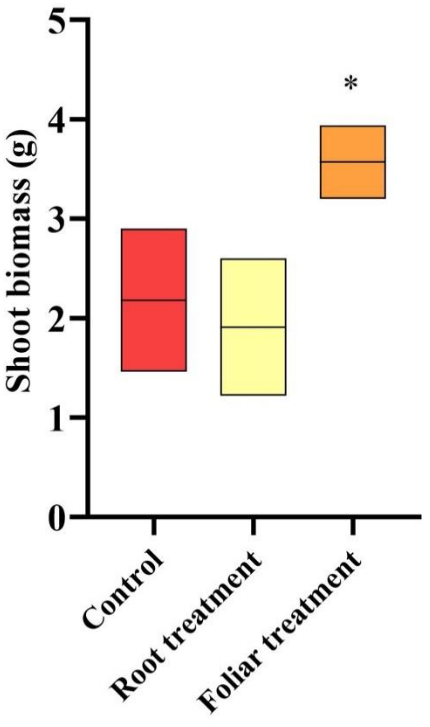

Fig. S1 Shoot biomass of experiment setting on sandy soil. Control plants (red, no dust application), plants that were applied with desert dust on the roots (yellow, root treatment), and on the foliage (orange, foliar treatment) that were grown on local natural soil. The foliar treated plants show an increase in biomass whereas the root treatment does not. This suggests that mineral nutrient uptake via the foliage is the only mechanism that enables plants to uptake nutrients from freshly deposited dust.

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Dust holding capacity

One of our challenges in conducting dust application experiments is to quantify the dust interacting with the foliage, as not all the dust that was sprinkled remains on the leaves. Quantifying the dust that interacts with the foliage will allow to distinguish the plant variants that are more capable and fit to acquire mineral nutrients from their foliage. Furthermore, this quantification will enable us to determine the optimal dust coverage/weight with minimum decreases in photosynthesis and maximum mineral nutrient acquisition.

The estimate that we used is the dust holding capacity, i.e., a visual evaluation of the dust coverage following application of 1g of dust. The values were given to plants by the same person and range between 0-5, where 0 had no dust visible on the leaves and 5 was fully covered by dust. This method can only be used within one species between different variants. In our chickpea lines experiment where we compared two variants, one wild type (CR934, inefficient) and a common domesticated variety ("Zehavit", efficient), we noticed differences between the two varieties where the CR934 received a value of 2 and *Zehavit* received a value of 3 (Fig. S3).

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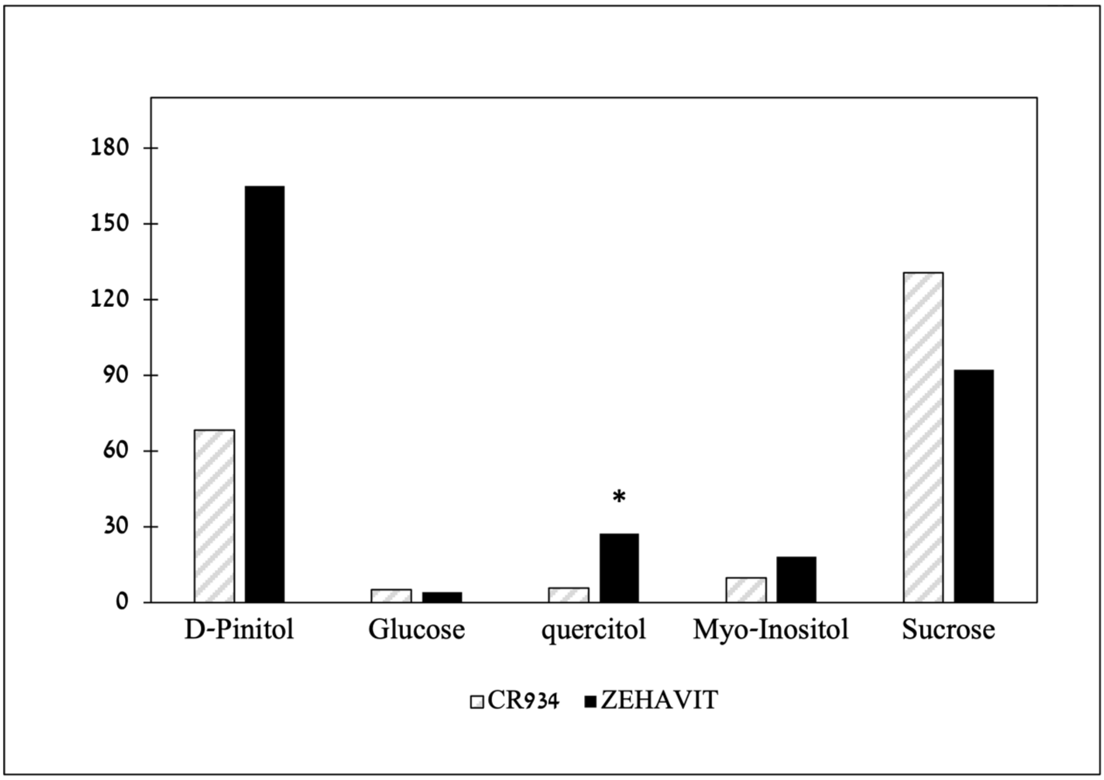

Fig. S2 Phyllosphere sugars profile when compared to an internal lab standard. Values on the y-axis represents the ratio of the metabolite peak area to the Ribitol peak area (normalized to wet weight).

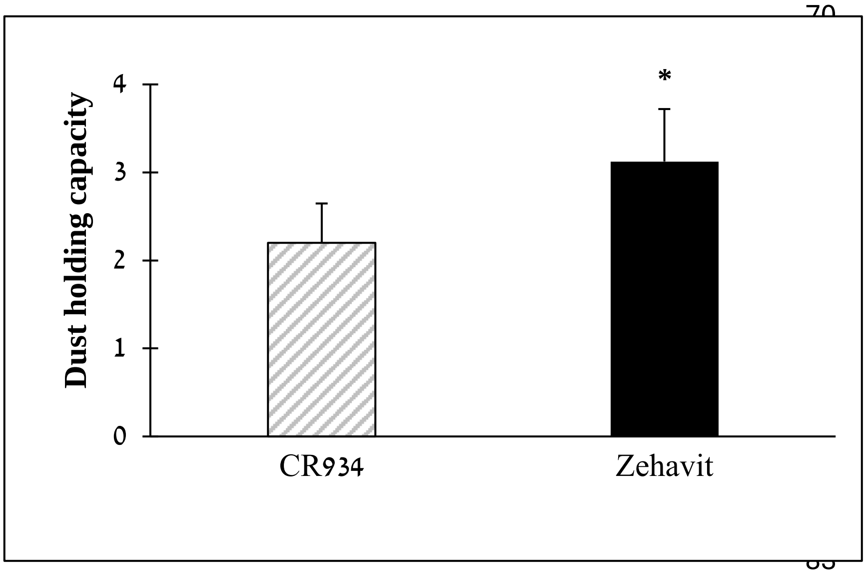

Fig. S3 Dust holding capacity in two chickpea types. The wild CR934 showed less dust following dust application compared with the cultivated Zehavit. This is probably due to higher density of trichomes and their properties (see Fig. 3 in main paper). The values 0-4 were qualitatively evaluated by visually observing the amount of dust retained on the foliage (Y-axis).

Supplementary Table

Table S1: Radiogenic Nd isotopes compositions of control plants, foliar-treated plants, desert dust and volcanic ash

sample	Nd ppb	Sm ppb	Normalized 143/144	2 SE	Epsilon Nd	2SE in Epsilon
412 ppm room						
Control 412 #1	59	14	0.512680	0.000007	0.8	0.13
Control 412 #2	54	9.9	0.512574	0.000006	-1.2	0.11
Control 412 #4	31	7.7	0.512548	0.000005	-1.8	0.10
Control 412 #6	28	5.6	0.512623	0.000007	-0.3	0.14
850 ppm room						
Control 850 #1	74	9.3	combined with #6 due to low recovery			
Control 850 #2	50	8.6	0.512607	0.000007	-0.6	0.13
Control 850 #3	25	3.8	combined with #6 due to low recovery			
Control 850 #5	54	11	0.512703	0.000038	1.3	0.77
Control 850 #6 *	54	11	0.512650	0.000006	0.2	0.12
412 ppm room						
desert dust foliar-trated 412 ppm #1	92	18	0.512290	0.000006	-6.8	0.12
desert dust foliar-trated 412 ppm #2	75	16	0.512206	0.000007	-8.4	0.13
desert dust foliar-trated 412 ppm #3	77	16	0.512223	0.000007	-8.1	0.15
desert dust foliar-trated 412 ppm #5	48	8.1	0.512355	0.000006	-5.5	0.12
850 ppm room						
desert dust foliar-treated 850 ppm #1	93	19	0.512381	0.000007	-5.0	0.14
desert dust foliar-treated 850 ppm #2	115	22	0.512241	0.000006	-7.7	0.12
desert dust foliar-treated 850 ppm #4	139	29	0.512251	0.000004	-7.5	0.09
desert dust foliar-treated 850 ppm #5	111	20	0.512190	0.000007	-8.7	0.15
desert dust foliar-treated 850 ppm #6	128	25	0.512213	0.000008	-8.3	0.15
412 ppm room						
volcanic ash foliar-treated 412 ppm #1	109	20				
volcanic ash foliar-treated 412 ppm #2	205	33	0.512815	0.000006	3.5	0.11
volcanic ash foliar-treated 412 ppm #3	109	24	0.512845	0.000005	4.0	0.10
volcanic ash foliar-treated 412 ppm #5	128	30	0.512810	0.000005	3.4	0.11
volcanic ash foliar-treated 412 ppm #6	103	20	0.512838	0.000007	3.9	0.15
850 ppm room						
volcanic ash foliar-treated 850 ppm #2	134	25	0.512838	0.000007	3.9	0.13
volcanic ash foliar-treated 850 ppm #4	134	27	0.512828	0.000007	3.7	0.14
volcanic ash foliar-treated 850 ppm #5	113	19	0.512832	0.000007	3.8	0.13
volcanic ash foliar-treated 850 ppm #6	112	18	0.512828	0.000010	3.7	0.21
Dust types						
Desert dust	17157	3490	0.512072	0.000005	-11	0.09
Volcanic ash #1	41299	7654	0.512863	0.000006	4.4	0.12
Volcanic ash #2	39974	7613	0.512872	0.000007	4.6	0.14