

Additional file 1

Table S1 Soil characteristics in the pot experiment with *Solanum lycopersicum* L. cv. Micro Tom in this study

Fig. S1 Enrichment of all metabolites identified under non-target metabolome under soluble phosphorus (KH_2PO_4) and insoluble phosphorus ($\text{Ca}_3(\text{PO}_4)_2$) conditions in the KEGG database. A, Enrichment results in KEGG compound. B, Enrichment results in KEGG pathway.

Fig. S2 Comparison of biological characteristics of *Pseudomonas* sp. NK2 and GFP labeled NK2 strain (NK2-GFPuv). A, Available phosphorus content in NBRIP liquid medium for 1-5 days. Bars indicate one standard deviation (SD) from the mean ($n = 3$), while significant differences ($P < 0.05$) derived from a two-way ANOVA in conjunction with Bonferroni's multiple-comparison test in comparison with available phosphorus at the same time points. ns, no significant differences. B, HPLC chromatogram after 2 days of culture. C, Types and contents of organic acids cultured for 2 days. Bars indicate one standard deviation (SD) from the mean ($n = 3$), while significant differences ($P < 0.05$) derived from a two-way ANOVA in conjunction with Bonferroni's multiple-comparison test in comparison with organic acid concentration at same organic acid type. ns, no significant differences. D, Types and contents of organic acids at 1, 2, 3, 4, and 5 days. Bars correspond to one standard deviation (SD) from the mean ($n = 3$), while different letters indicate significant differences ($P < 0.05$) among samples at different time points in each strain according to a one-way ANOVA in conjunction with Tukey's multiple-comparison test.

Fig. S3 NK2-GFPuv was immobilized by biochar. Bar is 10 μm .

Fig. S4 Standard curve of available phosphorus content in the soil. The absorbance was

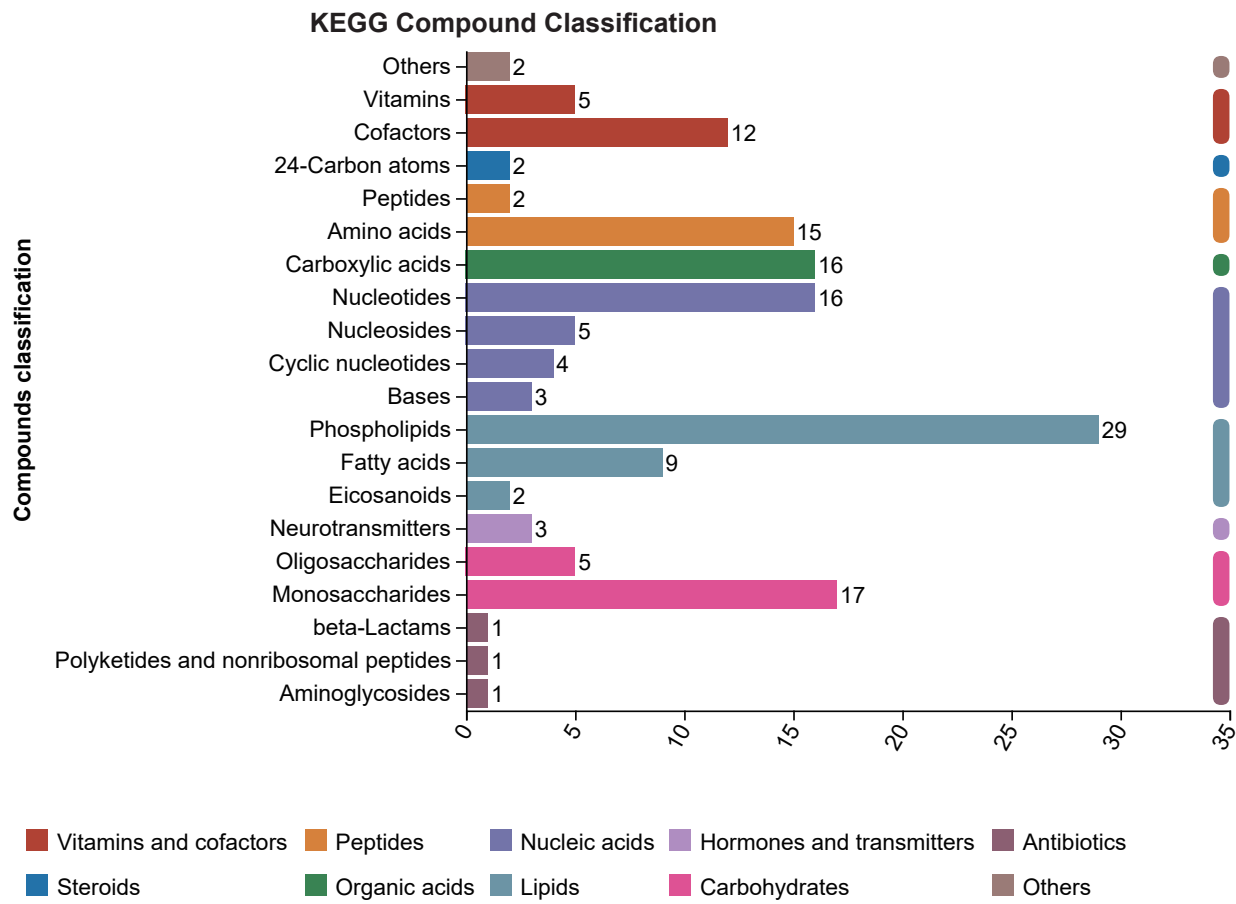
measured at 720 nm.

Table S1 Soil characteristics in the pot experiment with *Solanum lycopersicum* L. cv. Micro Tom in this study

Parameter	Soil
pH	7.62±0.08
Total N (g/kg soil)	0.56±0.05
Total P (g/kg soil)	1.39±0.04
Total K (g/kg soil)	15.40±0.35
Alkeline-N (g/kg soil)	3.24±0.12
Available P (g/kg soil)	1.25±0.03
Available K (g/kg soil)	157.5±3.04
Organic carbon (g/kg soil)	13.33±0.21
Water capacity	120.7%-125.2%

Figure S1

A



B

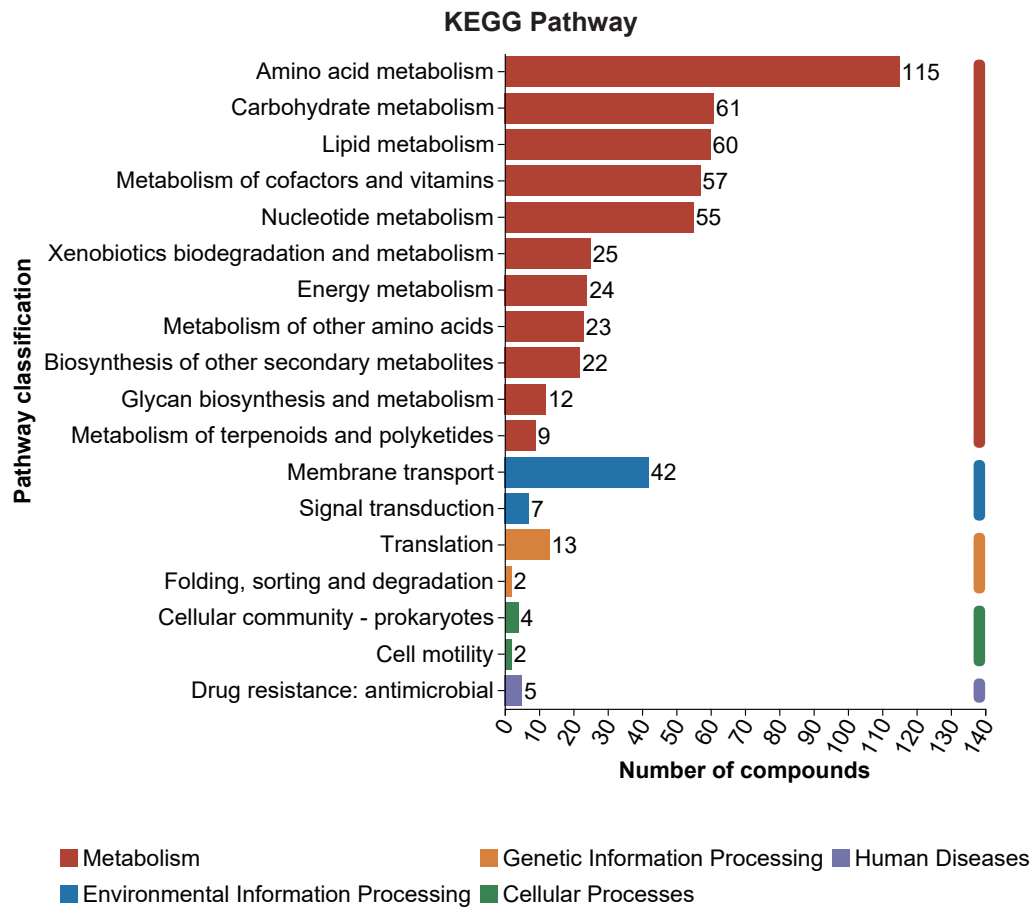
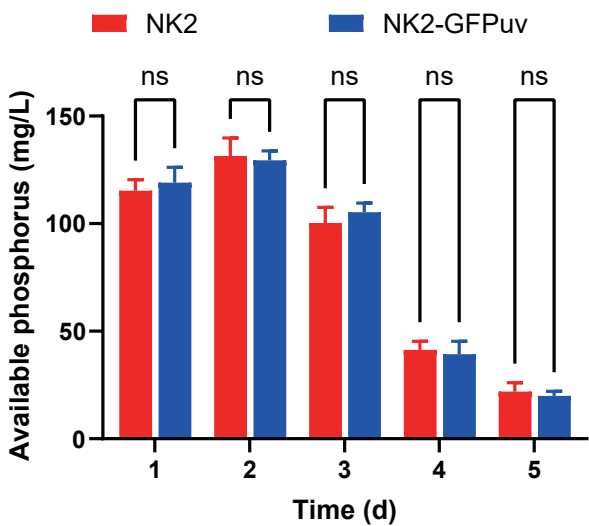
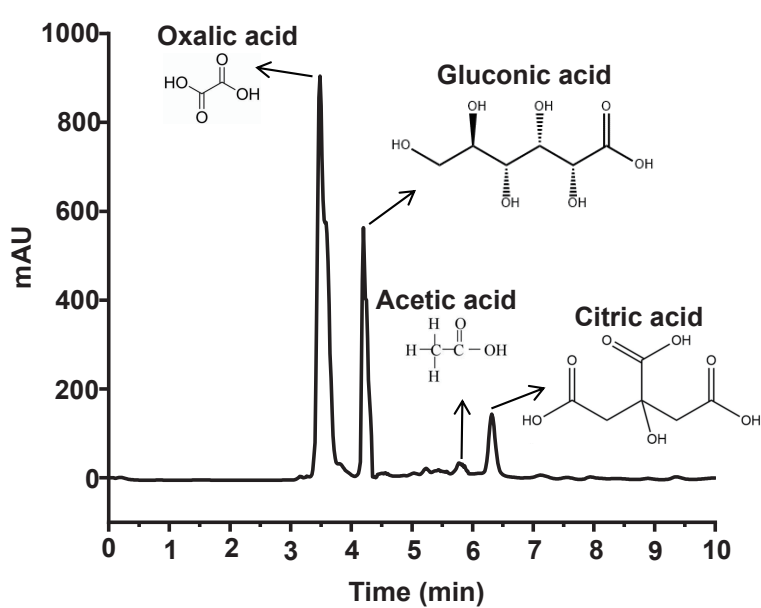


Figure S2

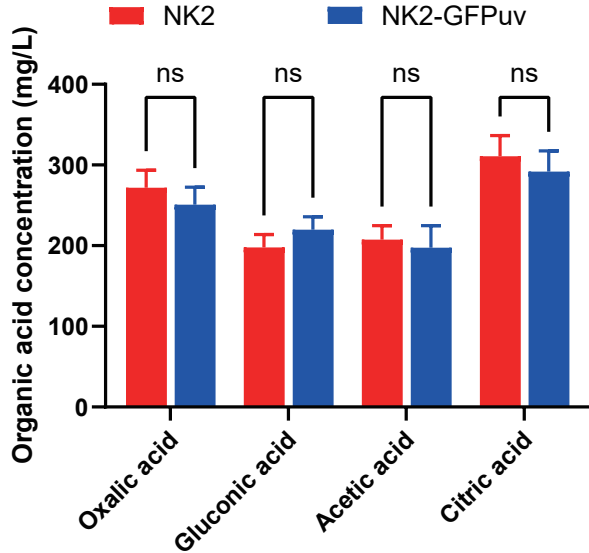
A



B



C

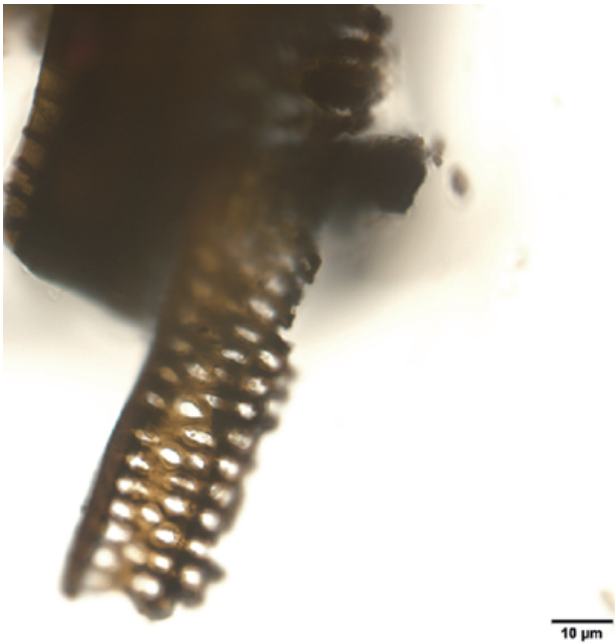


D

Organic acid	Treatment	Concentration (mg/mL)				
		1 d	2 d	3 d	4 d	5 d
Oxalic acid	NK2	178.74± 11.83b	271.84± 16.19b	299.47± 13.38a	131.54± 17.63a	32.48± 4.25b
	NK2-GFPuv	172.27± 10.64b	266.32± 13.96b	292.54± 17.39a	134.42± 20.11a	31.43± 5.18b
Gluconic acid	NK2	97.85± 17.84c	197.85± 17.84c	209.85± 37.84c	107.85± 7.84b	31.48± 4.28b
	NK2-GFPuv	93.23± 14.65c	195.39± 15.92c	205.85± 24.39c	101.11± 5.16b	33.20± 1.83b
Acetic acid	NK2	264.44± 29.12a	310.74± 29.65a	239.74± 19.65b	115.74± 13.65ab	45.78± 5.89a
	NK2-GFPuv	269.18± 19.69a	308.71± 21.28a	235.66± 23.07b	111.04± 21.04ab	42.51± 4.61a
Citric acid	NK2	-	208.35± 37.34c	237.35± 27.34b	117.35± 7.34ab	11.78± 1.79c
	NK2-GFPuv	-	211.43± 22.05c	243.14± 17.64b	119.12± 9.06ab	9.32± 2.06c

Figure S3

Bright field



GFP

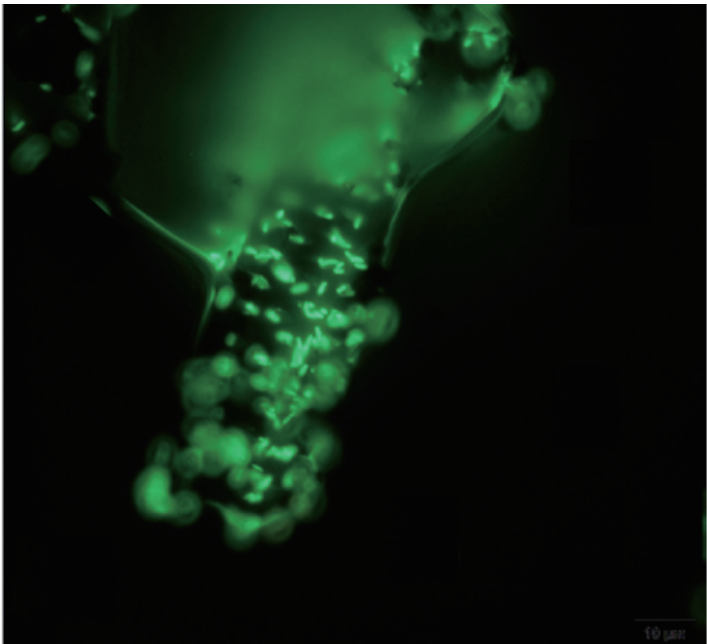


Figure S4

