

## Supporting Information

**Table S1 Soil phosphorus activation coefficient in 40–45, 45–50, 50–55mm soil layer from fertilization layer.**

Phosphate fertilizer	40–45 mm (%)	45–50 mm (%)	50–55 mm (%)
CP	47.86 ± 3.71 a	7.65 ± 0.62 d	2.20 ± 0.25 d
HAP0.1	48.41 ± 8.11 a	7.73 ± 0.58 d	2.31 ± 0.11 d
HAP0.5	40.86 ± 0.41 a	35.70 ± 1.50 c	3.60 ± 0.37 c
HAP1	46.52 ± 2.99 a	38.54 ± 0.81 bc	6.44 ± 0.38 b
HAP5	45.28 ± 4.38 a	43.60 ± 7.48 b	7.39 ± 0.51 a
HAP10	48.41 ± 0.85 a	58.67 ± 5.66 a	6.36 ± 0.16 b

Means with no letter in common were significantly different at  $P < 0.05$ , as indicated by the LSD test.

**Table S2 Soil total PLFA, bacteria, gram-positive bacteria (Gm+), gram-negative bacteria (Gm-), fungi, and actinobacteria biomass, fungi:bacteria (F/B), and Gram-positive:Gram-negative (Gm+/Gm-) in the 0-40 mm soil layers around the P application site under NTC, CP, and HAP0.5 treatments.**

Treatment	Total PLFA (nmol g <sup>-1</sup> )	Bacteria (nmol g <sup>-1</sup> )	Gm+ (nmol g <sup>-1</sup> )	Gm- (nmol g <sup>-1</sup> )	Fungi (nmol g <sup>-1</sup> )	Actinobacteria (nmol g <sup>-1</sup> )	F:B	Gm+/Gm-
NTC	11.5 ± 1.1 a	2.9 ± 0.4 a	0.6 ± 0.1 a	0.3 ± 0.0 a	1.4 ± 0.2 a	0.6 ± 0.1 a	0.4 ± 0.1 a	2.1 ± 0.1 a
CP	7.9 ± 0.6 b	2.1 ± 0.1 b	0.4 ± 0.0 b	0.2 ± 0.0 a	0.7 ± 0.1 b	0.5 ± 0.0 a	0.3 ± 0.0 b	1.7 ± 0.5 a
HAP0.5	8.2 ± 1.5 b	2.3 ± 0.4 ab	0.4 ± 0.1 b	0.3 ± 0.0 a	0.8 ± 0.1 b	0.5 ± 0.1 a	0.2 ± 0.0 b	1.6 ± 0.2 a

Means with no letter in common were significantly different at  $P < 0.05$ , as indicated by the LSD test.

**Table S3 Correlation of soil total PLFA, bacteria, gram-positive bacteria (Gm+), gram-negative bacteria (Gm-), fungi, and actinobacteria biomass, fungi:bacteria (F/B), and Gram-positive:Gram-negative (Gm+/Gm-) in the 0–40 mm soil layers around the P application site with average TP and AP.**

Parameter	Total PLFA	Bacteria	Gm+	Gm-	Fungi	Actinobacteria	F:B	Gm+/Gm-
TP	-0.863 **	-0.758 *	-0.796 *	-0.300	-0.900 ***	-0.572	-0.875 **	-0.640
AP	-0.880 **	-0.784 *	-0.820 **	-0.319	-0.907 ***	-0.606	-0.864 **	-0.651

Values represented correlation coefficients, \*  $P < 0.05$ ; \*\*  $P < 0.01$ , \*\*\*  $P < 0.001$ .