

Supplementary Table S1 | Quantifying phosphate-solubilizing abilities of *Acinetobacter* sp. and *Aspergillus niger* in the Pikovskaya's liquid media modified by different insoluble phosphorus sources during a 5-day incubation.

Strains	Incubation day	concentration of available P (mg·L ⁻¹)					
		Ca ₃ (PO ₄) ₂	AlPO ₄	FePO ₄	fluorapatite	Lecithin	Phytate
<i>Acinetobacter</i> sp.	0	25.03±4.25 ¹ c ²	19.31±3.31 b	82.19±1.34 a	0.88±0.07 a	0.00±0.00 d	5.21±0.13 d
	1	362.92±3.11 b	18.38±3.43 b	77.50±1.82 a	0.81±0.02 a	3.17±0.72c	36.17±0.63 c
	2	366.95±8.20 ab	26.56±4.60 ab	84.15±0.61 a	0.72±0.01 a	21.17±0.21b	41.05±4.52 b
	3	402.27±11.02 a	23.89±4.16 ab	83.80±2.84 a	0.76±0.03 a	30.55±2.64a	50.77±0.92 a
	4	378.69±22.65 ab	24.35±4.07 ab	83.00±2.10 a	0.85±0.08 a	33.04±3.34a	51.79±0.55 a
	5	348.33±9.65 b	32.80±3.02 a	84.49±3.30 a	0.88±0.07 a	32.68±2.50a	54.21±0.73 a
<i>Aspergillus niger</i>	0	1.01±0.01 c	32.38±0.01 d	85.33±1.21 c	0.82±0.03 e	0.00±0.00 c	5.21±0.13 e
	1	459.59±27.86 b	32.38±1.40 d	85.34±6.20 c	2.81±0.21 d	0.03±0.03 c	2.65±5.84 de
	2	741.38±15.52 a	50.94±5.02 d	176.99±6.21 b	3.24±0.42 cd	23.05±0.86 b	38.64±1.11 d
	3	751.84±6.11 a	186.47±1.32 c	206.45±14.46 a	3.78±0.15 bc	23.13±3.32 b	85.32±7.34 c
	4	747.34±4.49 a	291.05±18.44 b	209.52±6.25 a	4.85±0.15 a	28.02±4.09 b	132.96±7.80 b
	5	770.51±21.66 a	431.26±33.88 a	208.33±10.06 a	4.24±0.15 ab	35.73±2.57 a	196.07±4.09 a

¹ data are shown as mean±standard error.

² Different letters (a – e) indicate significant differences among different incubation days at the same Pikovskaya's liquid media inoculating *Acinetobacter* sp. or *Aspergillus niger* (LSD test at $p < 0.05$).

Supplementary Table S2 | Survival dynamics (lg CFU g⁻¹ soil) of *Acinetobacter* sp. and *Aspergillus niger* on sterilized and non-sterilized fluvo-aquic soils during a 45-day incubation.

Strains	Soil treatments	Day of incubation					
		0	7	14	21	30	45
<i>Acinetobacter</i> sp.	Sterilized	9.39±0.03 ¹	9.47±0.16	6.10±0.10	8.56±0.04	8.16±0.18	8.56±0.03
		a ²	a	d	b	c	b
	Non sterilized	9.35±0.03	7.92±0.13	6.26±0.26	6.96±0.04	6.47±0.21	6.27±0.03
		a	b	d	c	d	d
<i>Aspergillus niger</i>	Sterilized	9.39±0.03	9.47±0.16	6.10±0.10	8.56±0.04	8.16±0.18	8.56±0.03
		a	a	d	b	c	b
	Non sterilized	9.35±0.03	7.92±0.13	6.26±0.26	6.96±0.04	6.47±0.21	6.27±0.03
		a	b	d	c	d	d

¹ data are shown as mean±standard error.

² Different letters (a – d) indicate significant differences among different incubation days at the same soil treatment (LSD test at $p < 0.05$).

Supplementary Table S3 | Multi-way ANOVA testing the effects of sampling time point, straw compost input and type of the inoculated PSMs, as well as their interactions on the average height and weight of ryegrass shoots.

Variables	Averaged shoot height		Shoot weight	
	<i>F</i> value	<i>P</i> value	<i>F</i> value	<i>P</i> value
Time	41.90	<0.001*** ¹	121.05	<0.001***
Compost	25.24	<0.001***	29.54	<0.001***
PSMs	30.86	<0.001***	9.26	<0.001***
Time×Compost	14.24	<0.001***	1.22	0.30
Time×PSMs	13.24	<0.001***	1.54	0.20
Compost×PSMs	10.19	0.003**	0.93	0.40
Time×Compost×PSMs	5.20	0.01*	5.36	0.001**

¹ * significant at 5 % level of significance; ** significant at 1 % level of significance; *** significant at 0.1 % level of significance.

Supplementary Table S4 | Multi-way ANOVA testing the effects of sampling time point, straw compost input and type of the inoculated PSMs, as well as their interactions on the total N, P and K concentrations in the ryegrass shoots.

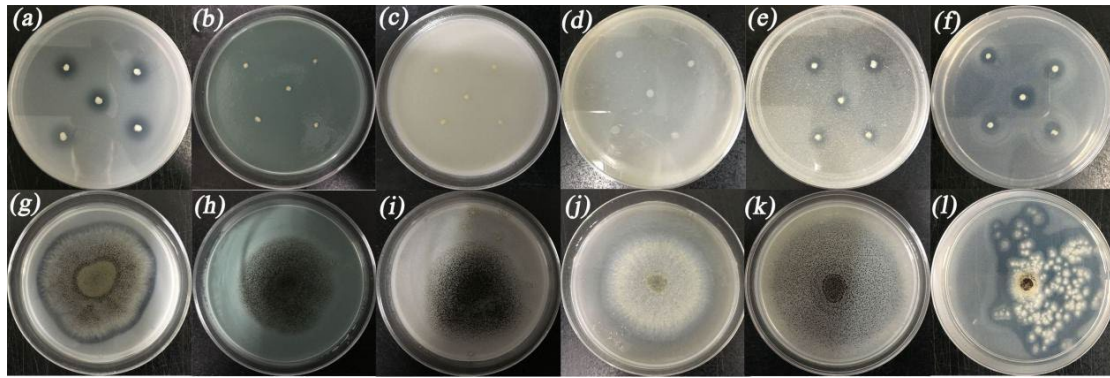
Variables	Total N concentration		Total P concentration		Total K concentration	
	<i>F</i> value	<i>P</i> value	<i>F</i> value	<i>P</i> value	<i>F</i> value	<i>P</i> value
Time	72.55	<0.001*** ¹	20.72	<0.001***	100.05	<0.001***
Compost	52.41	<0.001***	7.63	0.009**	27.77	<0.001***
PSMs	0.14	0.71	17.68	<0.001***	12.14	0.001**
Time×Compost	2.27	0.12	8.84	<0.001***	0.07	0.93
Time×PSMs	0.69	0.51	5.95	0.006**	25.13	<0.001***
Compost×PSMs	21.22	<0.001***	0.32	0.57	43.71	<0.001***
Time×Compost×PSMs	1.84	0.17	0.26	0.77	1.82	0.18

¹ * significant at 5 % level of significance; ** significant at 1 % level of significance; *** significant at 0.1 % level of significance.

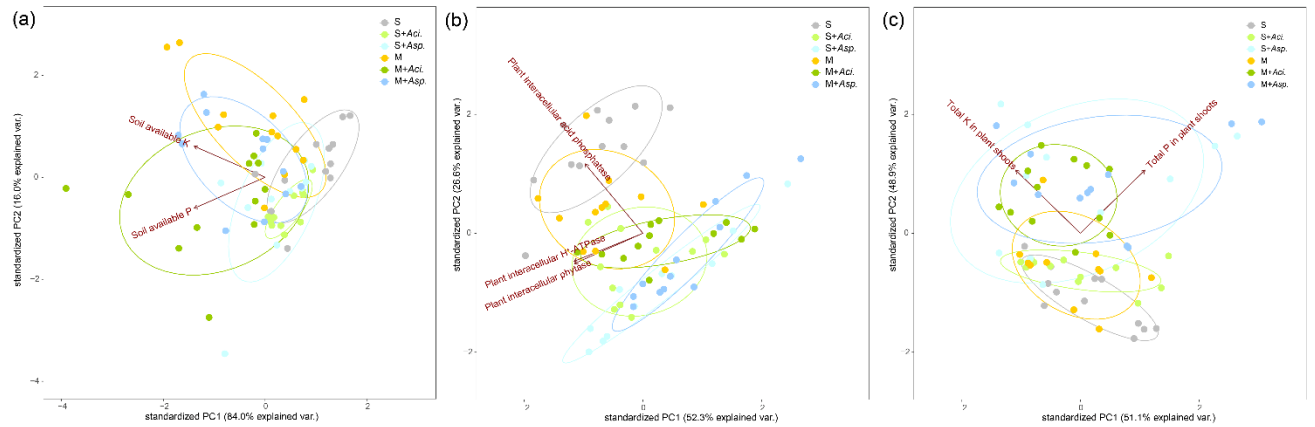
Supplementary Table S5 | Multi-way ANOVA testing the effects of sampling time point, straw compost input and type of the inoculated PSMs, as well as their interactions on the plant intracellular enzyme activities and total chlorophyll concentration in the ryegrass shoots.

Variables	Acid phosphatase activity		H ⁺ -ATPase activity		Phytase activity		Total chlorophyll concentration	
	<i>F</i> value	<i>P</i> value	<i>F</i> value	<i>P</i> value	<i>F</i> value	<i>P</i> value	<i>F</i> value	<i>P</i> value
Time	16.43	<0.001*** ¹	112.50	<0.001***	39.11	<0.001***	1.86	0.17
Compost	0.20	0.65	8.62	0.006**	14.15	<0.001***	2.51	0.12
PSMs	44.05	<0.001***	7.00	0.01*	20.73	<0.001***	2.80	0.10
Time×Compost	5.87	0.007**	7.96	0.001**	0.95	0.39	2.31	0.11
Time×PSMs	18.07	<0.001***	3.77	0.03*	1.27	0.29	0.80	0.46
Compost×PSMs	0.50	0.48	0.08	0.79	0.35	0.56	6.98	0.01*
Time×Compost×PSMs	8.55	<0.001***	0.35	0.71	3.15	0.05	0.64	0.54

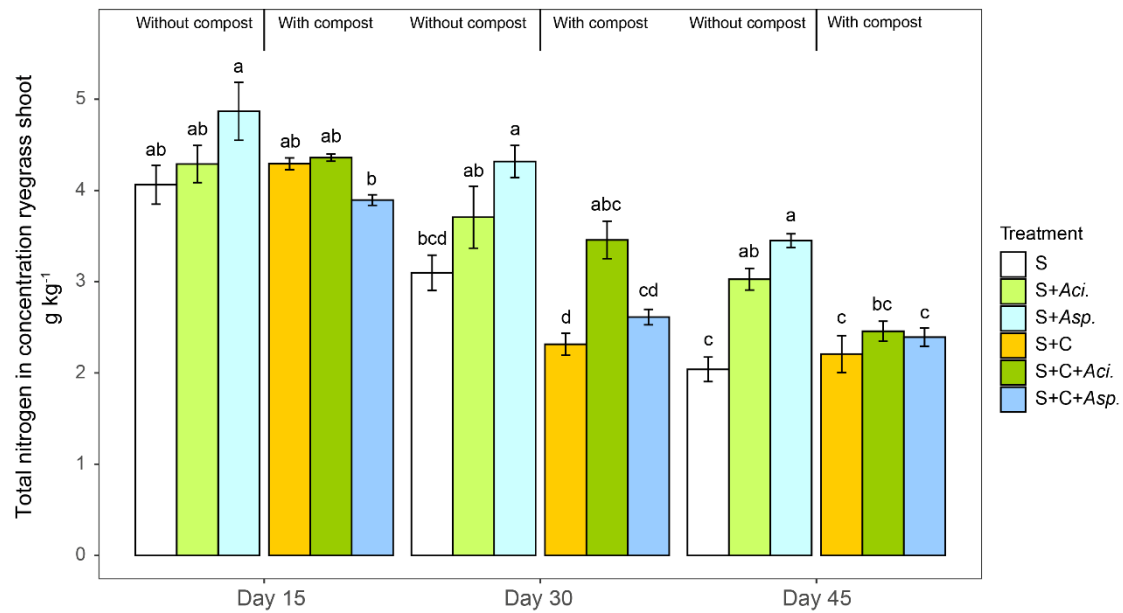
¹ * significant at 5 % level of significance; ** significant at 1 % level of significance; *** significant at 0.1 % level of significance.



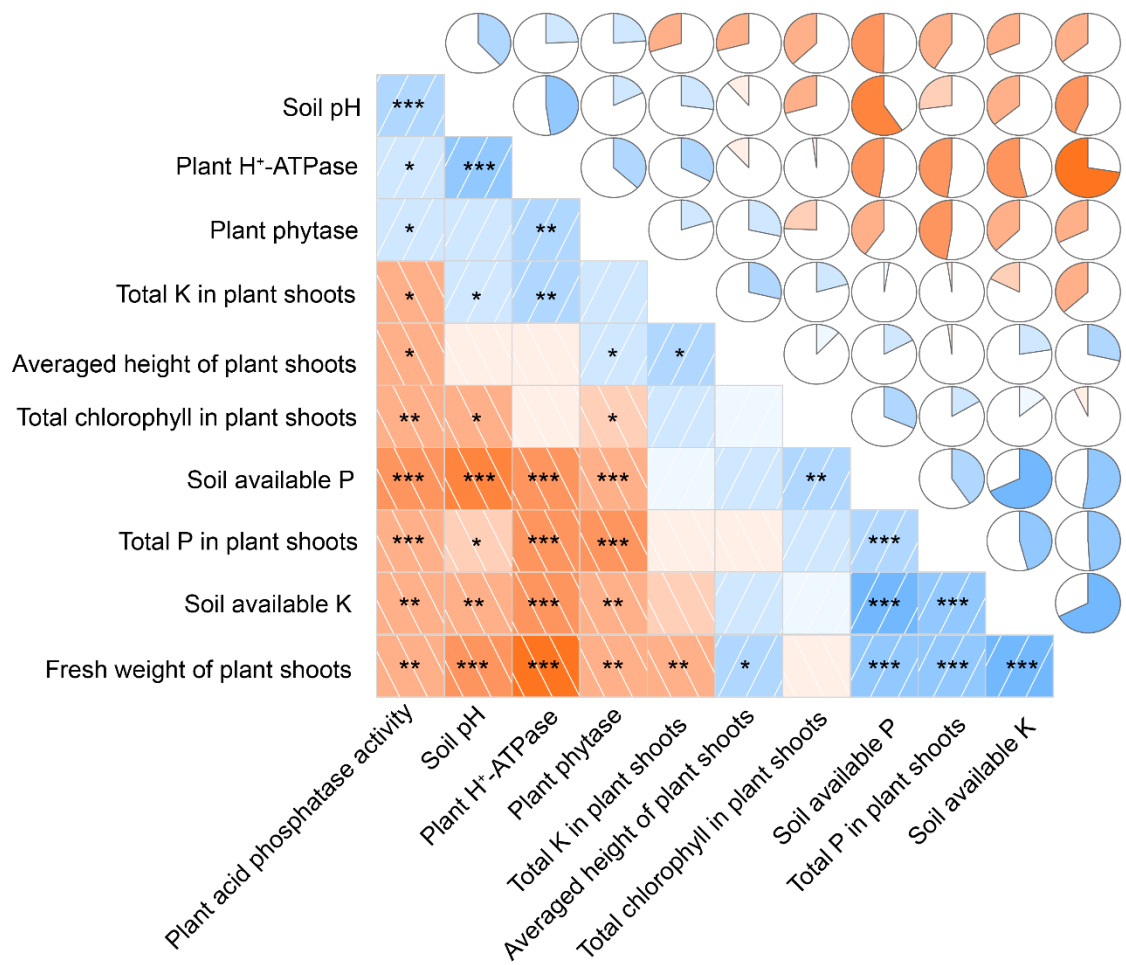
Supplementary Figure S1 | Growth of PSMs in the modified Pikovskaya's agar media. a and g were $\text{Ca}_3(\text{PO}_4)_2$ modified media inoculating *Acinetobacter* sp. and *Aspergillus niger*, respectively; b and h were FePO_4 modified media inoculating *Acinetobacter* sp. and *Aspergillus niger*, respectively; c and i were AlPO_4 modified media inoculating *Acinetobacter* sp. and *Aspergillus niger*, respectively; d and j were fluorapatite modified media inoculating *Acinetobacter* sp. and *Aspergillus niger*, respectively; e and k were lecithin modified media inoculating *Acinetobacter* sp. and *Aspergillus niger*, respectively; f and l were phytate modified media inoculating *Acinetobacter* sp. and *Aspergillus niger*, respectively. All of the media were incubated for four days at 30°C.



Supplemental Figure S2 | Contribution of the different variables to the principal component analysis. Soil nutrients were represented by the concentrations of available P and K in the soils (a); Plant intracellular enzyme activities were represented by the activities of acid phosphatase, phytase and H⁺-ATPase in the plant shoots (b); and Plant nutrients were represented by the concentrations of total P and K in the plant shoots (c).



Supplementary Figure S3 | The contents of total N in shoots of ryegrass at three time points across six treatments. S: soil without fertilization, S+Aci.: soil inoculated with *Acinetobacter* sp., S+Asp.: soil inoculated with *Aspergillus niger*, S+C: soil mixed with straw compost, S+C+Aci.: soil mixed with straw compost and *Acinetobacter* sp., and S+C+Asp.: soil mixed with straw compost and *Aspergillus niger*. Data are shown as mean \pm S.E. (n = 4). Different letters (a – c) indicate significant differences among different treatments at the same time point (Tukey’s HSD test at $P < 0.05$).



Supplementary Figure S4 | Pearson's correlation coefficients among soil physiochemical properties, ryegrass growth parameters and physiological properties of plant shoots. Red box represents negative correlation and blue box represents positive correlation. The proportions in the pie plots mean corresponding correlation coefficients (R). The inserted symbols mean significances, * means $P < 0.05$, ** means $P < 0.01$ and *** means $P < 0.001$.