Supplementary Material

Dynamic effects of key soil factors and endophytic bacteria driven by seasons on the growth of *Codonopsis pilosula*(tangshen)

Table S1. PCR amplification system (50 μL system)

Amplification system	Volume
10× KOD Buffer	5 μL
dNTPs (2.5 mM)	5 μL
Primer (5μM)	1.5 μL
Taq DNA polymerase (KOD polymerase)	1 μL
Template DNA	100 ng

Table S2. PCR amplification conditions

Amplification condition	Temperature	Time
Predenaturation	95℃	2min
Denature	98℃	10s
Anneal	62℃	30s
Extend	68℃	30s
Final extension	68℃	10min
Cycles	27 rounds	

Table S3. Changes of non-rhizosphere soil physical and chemical factors in different seasons

Environmental Factors	Non-rhizosphere soil			
	RHCS	RHCX	RHCA	RHCW
WC (%)	11.12±0.92d	22.09±1.48a	16.36±0.70b	14.3±0.63c
EC (μS/cm)	128.5±3.48a	109.9±11.81b	25.6±0.25c	31.6±0.58c
pH	7.76±0.02b	8.39±0.01a	7.73±0.11b	7.78±0.03b
TN (g/kg)	73.78±18.66d	330.45±45.96c	597.45±11.36a	469±86.26b
AN (mg/kg)	13.99±3.11b	13.99±2.48b	238.5±35.23a	273±56.58a
TP (mg/kg)	0.56±0.03a	0.45±0.01b	0.06±0.013c	0.07±0.01c
AP (mg/kg)	4.97±0.56c	2.21±0.32c	176.56±3.39a	126.32±20.65b
TK (mg/kg)	22.71±1.06a	1.89±0.51d	9.06±1.24c	12.22±1.24b
AK (mg/kg)	306.41±6.08a	172.52±9.93c	190.6±10.62b	306.5±6.08a
OM (%)	8.85±0.45c	8.84±0.68c	43.49±0.81a	21.95±6.29b
CAT (mL/g/d)	0.19±0.00c	0.21±0.00b	1.072±0.01a	1.08±0.00a
URE (mg/g/d)	622.5±14.13a	553.11±22.4b	284.63±11.87c	157.77±19.95d
SUC (mg/g/d)	2.64±0.034c	5.15±0.12c	2356.6±307.7b	4270.49±177.5a
PRO (μg/g/d)	87.26±31.75c	182.11±43.12c	402.52±86.11a	238.11±29.20b

Table S4. α-diversity index of rhizosphere bacteria

Indexes	SHCS	SHCX	SHCA	SHCW
Shannon	6.70±0.04c	6.83±0.06bc	6.93±0.02ab	6.99±0.12a
Simpson	0.996±0.00ab	0.996±0.00b	0.10±0.00ab	0.10±0.00a
Chao	4108.52±173.37b	4391.38±80.00ab	4659.92±195.94a	4662.01±291.48a
Ace	4064.20±188.27b	4331.88±90.55ab	4672.75±241.654a	4618.14±254.55a

Note: The same letter means the difference is not significant ($p > 0.05$), different letters mean the difference is significant ($p < 0.05$), the same below.

Table S5. α-diversity index of endophytic bacteria in root

Indexes	RHCS	RHCX	RHCA	RHCW
Shannon	0.98±0.11c	0.79±0.059d	1.57±0.08a	1.40±0.035b
Simpson	0.51±0.02c	0.43±0.044d	0.74±0.029a	0.66±0.016b
Chao	166.86±58.71a	107.88±27.72a	222.63±29.39a	257.75±154.89a
Ace	134.28±24.83ab	106.19±33.73b	233.73±23.37ab	249.06±112.74a

Table S6. Resilience indicators of plants in all seasons

Resilience indexes	Plants			
	HCS	HCX	HCA	HCW
SS	3.64±1.05bc	2.67±0.10c	5.22±0.89a	5.07±0.37ab
SPS	8.65±10.90a	4.21±1.56a	14.82±8.39a	17.29±12.31a
SOD	97.15±35.53a	86.93±26.50a	84.59±20.83a	67.12±8.56a
RCAT	9.93±17.15a	0.07±0.04a	9.93±17.15a	0.05±0.04a
POD	0.91±0.22a	0.95±0.47a	1.02±1.00a	0.60±0.49a
APX	0.71±0.25a	1.43±0.66a	1.43±0.66a	1.71±0.43a
MDA	4.76±1.08b	15.14±1.49a	4.43±0.93b	5.24±0.87b
Pro	417.02±109.80bc	636.64±85.23b	1217.67±399.34a	198.16±56.17c

Note: SS, SPS, SOD, RCAT, POD, APX, MDA and Pro are sucrose synthase, sucrose phosphate synthase, superoxide dismutase, catalase, peroxidase, ascorbate peroxidase, malondialdehyde and proline, respectively. The different letters in a, b, c, and d indicate significant differences ($p<0.05$), and same letters indicate no significant differences ($p>0.05$).the same below.

Table S7. Phenotypic indicators of plants in all seasons

Phenotypes	Plants			
	HCS	HCX	HCA	HCW
RL	10.27±0.35b	14.44±0.78a	15.49±1.58a	15.82±1.98a
RD	3.50±0.31c	5.09±0.48b	5.41±0.64b	8.24±0.40a

Note: RL and RD refer to root length and root diameter.

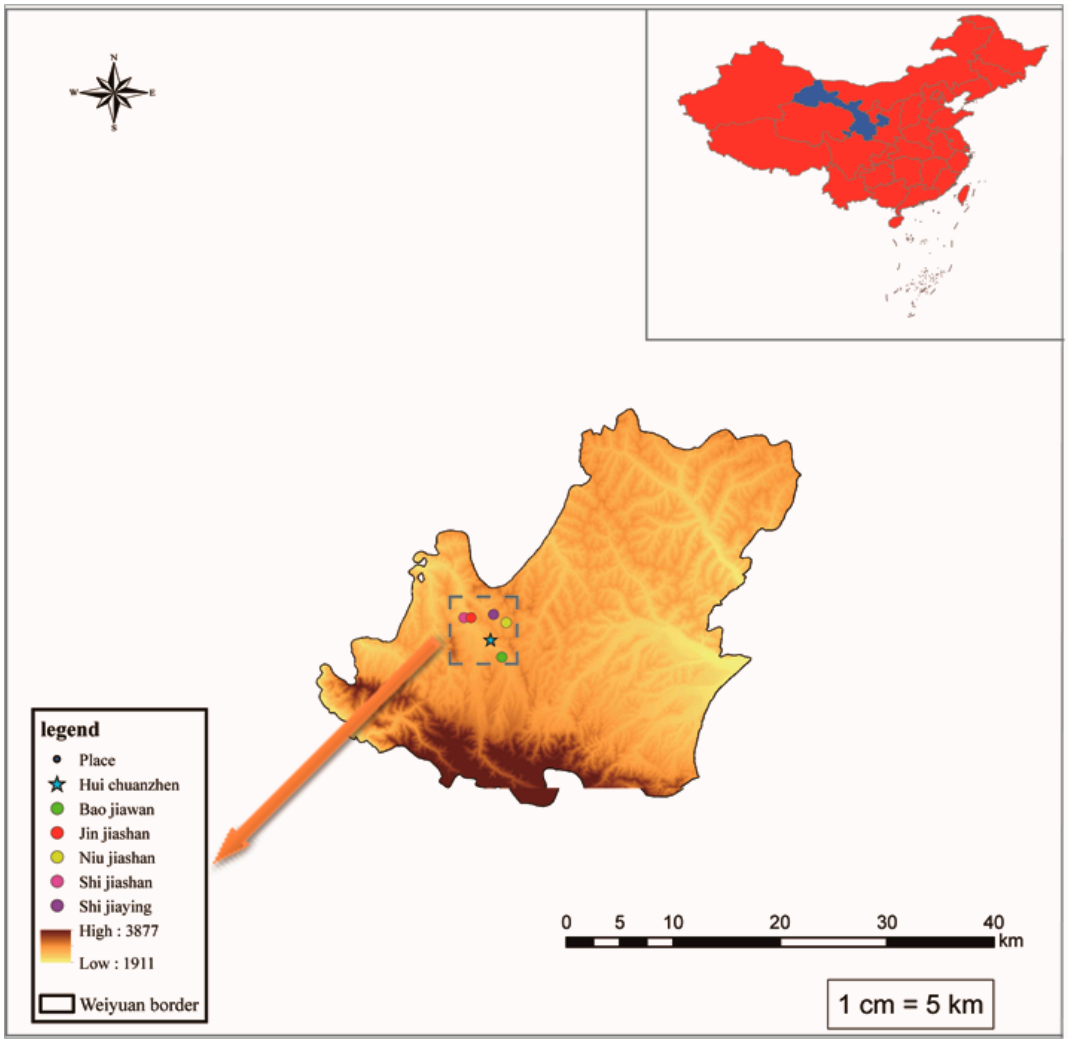

Fig. S1 The location information of the sampling sites

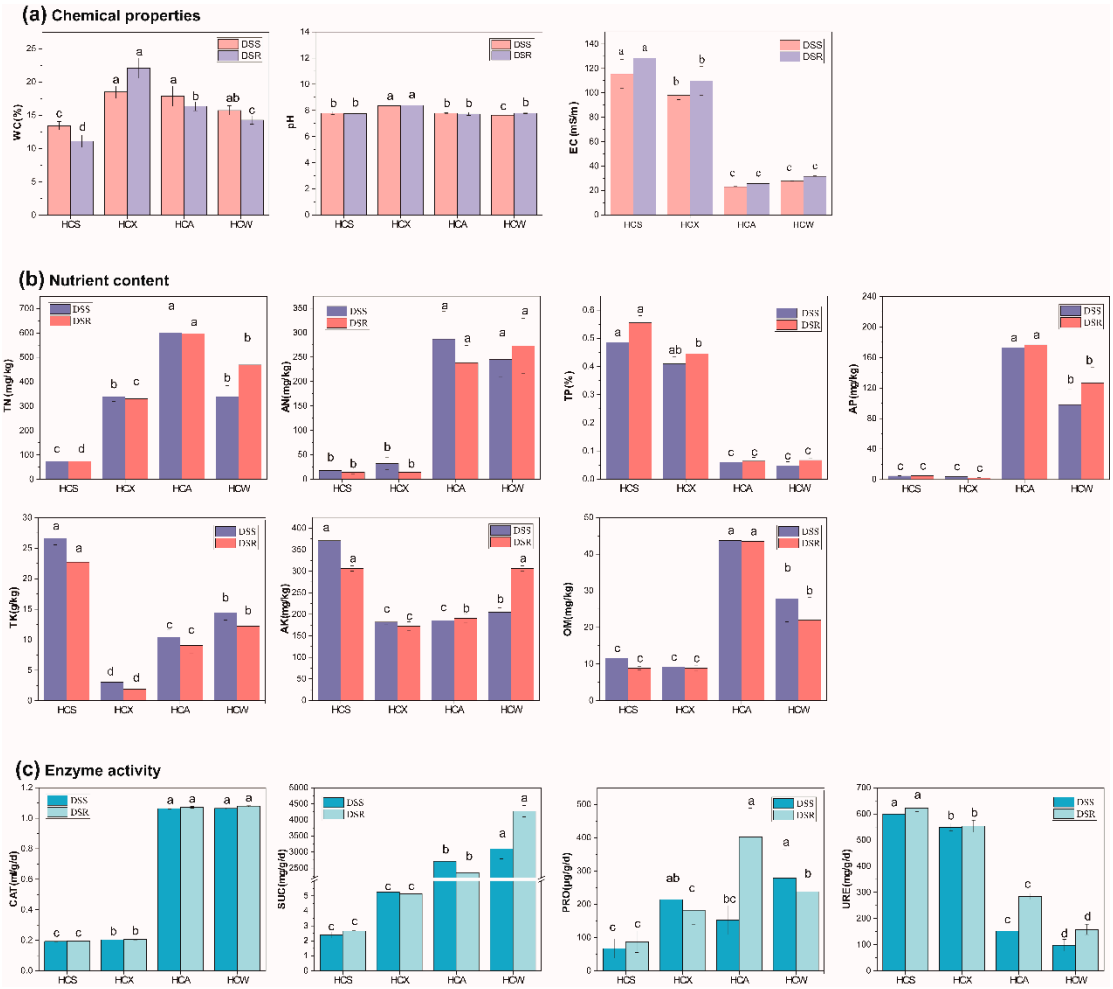

Fig. S2 Seasonal changes in rhizosphere soil and non-rhizosphere soil physicochemical factors.

Note: The combitation of first and second letters represents sampling sites, and the last letters S, X, A, W represent respectively Spring, Summer, Autumn and Winter. DSS and DSR denotes the rhizosphere soil of Dangshen and Non-rhizosphere soil of Dangshen. The same below.The same letter indicates that the difference is not significant ($p>0.05$), and different letters represent a significant difference ($p<0.05$), the same below.

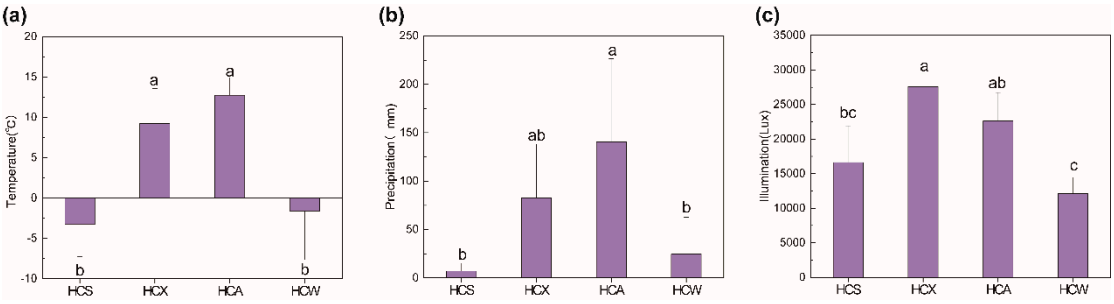

Fig. S3 The meteorological conditions of the sample site vary throughout the four seasons

Note: Soil moisture refers to 100cm from the surface to the ground.The same letter indicates that the difference is not significant ($p>0.05$), and different letters represent a significant difference ($p<0.05$), the same below.

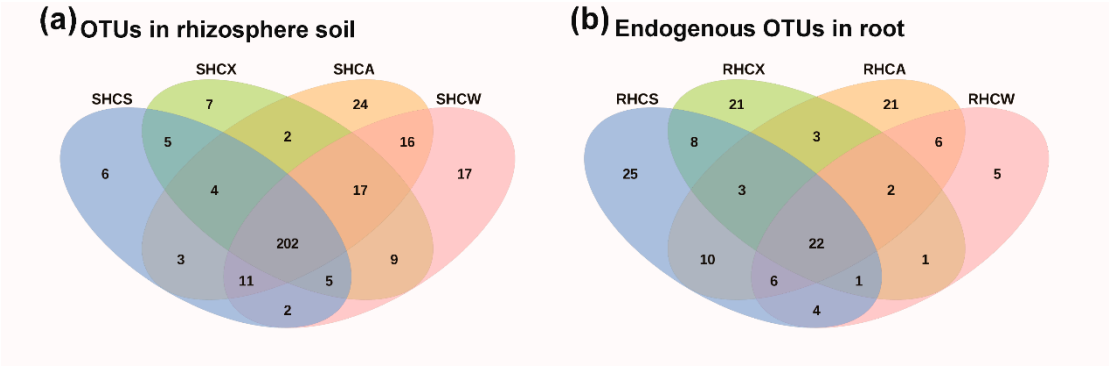

Fig. S4 OTUs cluster analysis of *C. pilosula* at the genus level

Note: The initial letter S in the sample name in Fig. a indicates the sample type (rhizosphere soil); the initial letter R in the sample name in Fig. b indicates the sample type (endogenous root); H indicates the sampling location Huichuan; C indicates *C. pilosula*; S , X, A, W represent the sampling season (spring, summer, autumn, winter) respectively.

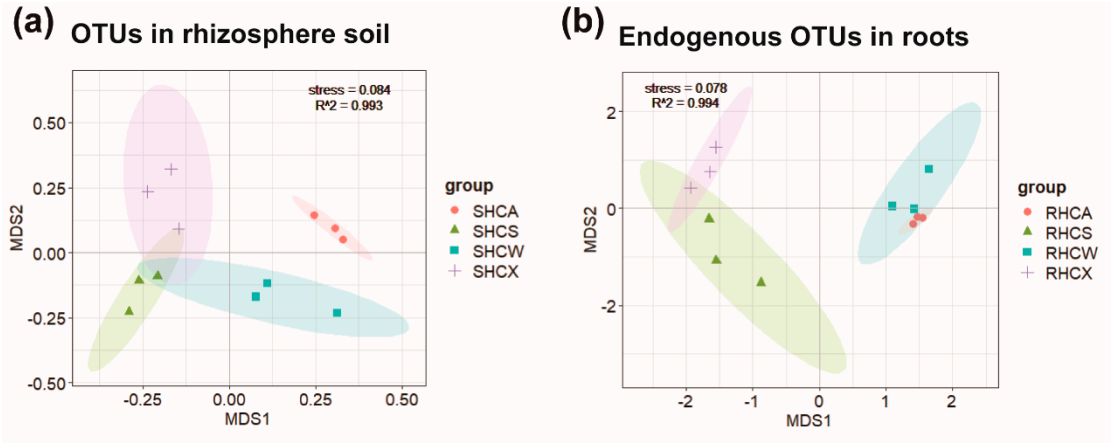

Fig. S5 The changing of NMDS diversity at the genus level in rhizosphere soil and root endophytic samples. *Note*: Fig. a and b are non-metric NMDS analysis of rhizosphere soil and endogenous OTUs based on the Bray-Curtis measure. MDS1 and MDS2 represent the two dimensions that explain the degree of change in the sample. In the figure, MDS1 explains the change trend in the time dimension, and MDS2 explains the variation of differences within the species itself.

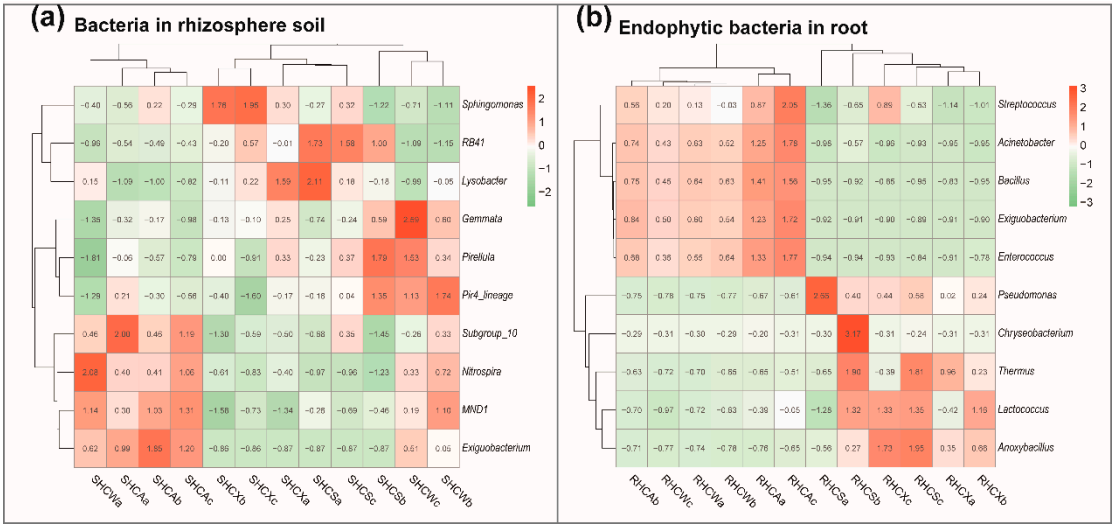

Fig. S6 Genus level TOP10 bacteria heat map

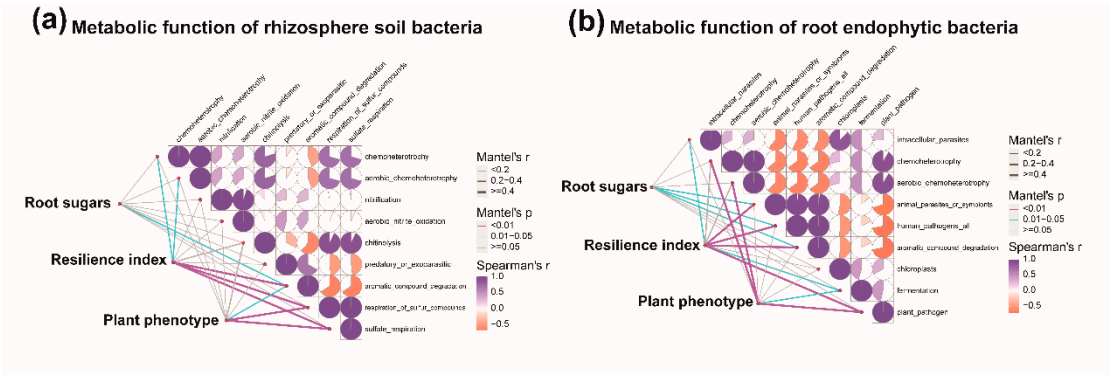

Fig. S7 Mantel correlation between bacterial function and growth index of *C. pilosula*

Note: The upper right part of the figure is the Spearman correlation analysis between bacteria function. Different colors represent positive and negative correlations, and the shaded part of the sector represents the significance level. The lower left part is the Spearman correlation between the growth index of *C. pilosula* and bacteria function, and the width and color of the connecting line represent the statistics of r and the significance p value, respectively.