

**Supplementary Table S1 Soil properties and environmental factors from the different sites studied**

Sites <sup>§</sup>	Physicochemical characteristics of Soils						Environmental factors				
	pH	EC (μS/cm)	OM(g/kg)	AN(mg/kg)	AP(mg/kg)	AK(mg/kg)	Latitude /longitude	Alt(m)	Ave. Tmin°C	Ave. Tmax°C	Ave. Precipitation (mm) per month
CXMD	5.47±0.02 l	117±2.65 e	28.93±0.75 g	126±7.8 efg	77.03±1.5 d	358.33±5.03 a	N101.9167 /E25.4833	2022	10.0	21.5	76.8
CXYA	7.74±0.03 a	245±38.43 c	25.17±0.4 i	146±21.66 bcdef	23.2±2.34 kl	132.67±1.53 g	N101.3833 /E26.0167	2569	6.7	18.3	85.2
CXDY	7.42±0.01 cd	819.33±33.5 a	30.23±0.32 f	151.93±8.01 bcde	26.37±0.6 j	97.57±0.95 j	N101.4667 /E26.0333	2234	8.6	20.4	81.4
CXLF	7.22±0.04 ef	142.67±8.5 de	32.57±0.55 e	167.33±14.55 bc	37.83±0.55 h	132.33±1.53 g	N102.5 /E25.3	1816	10.8	21.9	76.2
CXDH	5.77±0.04 k	74.37±12.36 f	24.8±0.35 i	103.17±3.34 g	22.93±0.4 kl	152.33±0.58 e	N101.4333 /E24.9333	1925	11.0	22.4	78.3
CXWD	7.24±0.03 ef	123.33±10.02 e	36.2±0.17 c	172.47±15.54 b	35.1±0.72 i	200±1.73 d	N101.0833 /E26.0833	2967	4.5	15.9	87.6
CXSB	6.37±0.01 i	80.73±10.71 f	30.73±0.45 f	136.03±4.97 cdef	12.57±0.23 m	108.67±2.08 i	N101.85 /E24.75	1583	13.2	24.5	72.5
CXNH	5.43±0.01 l	76.67±2.53 f	33.97±0.31 d	141.7±6.64 bcdef	21.73±0.42 kl	117.67±0.58 h	N101.5 /E25.1167	1861	11.3	22.8	75.5
DLXY	7.02±0.02 g	170.33±30.86 d	39.2±0.36 b	150.7±14.85 bcde	20.03±0.06 l	212±1.73 c	N100.607 /E25.4649	2013	10.1	21.4	81.6
DLWS	7.35±0.02 d	126±1 e	32.53±0.38 e	159.63±6.21 bcd	46.13±2.2 g	106±1 i	N100.2097 /E25.4025	1770	11.2	22.4	82.1
DLMD	6.93±0.01 h	69.13±6.56 f	29.1±0.26 g	133.47±24.5 defg	93.8±0.56 b	144.67±2.08 f	N100.8714 /E25.4786	1992	10.3	21.7	79.3
DLEY	7.38±0.1 cd	364±25.24 b	62.6±0.87 a	388.87±45.41 a	60.47±0.74 e	143.67±3.51 f	N99.9668 /E26.2324	2106	9.3	20.6	85.9
BSLY	7.16±0.03 f	138.33±9.5 de	19.43±0.31 j	124.5±5.86 efg	80.17±1.76 c	345±2 b	N98.8352 /E25.0591	1047	13.6	25.1	112.7
BSCN	7.52±0.02 b	162.67±15.7 d	17.2±0.52 k	118.1±5.86 fg	49.33±1.5 f	88.7±1 k	N99.447 /E24.8081	1033	14.1	25.8	95.4
BSSD	6.07±0.01 j	120±11.14 e	28±0.7 h	166.87±5.9 bc	138.93±2.25 a	214.67±4.04 c	N99.2394 /E24.571	1864	9.6	21.1	96.8

<sup>§</sup>. CXSB, Chuxiong Shuang bai, CXWD: Chuxiong Wu ding, CXYA: Chuxiong Yao an, CXMD: Chuxiong Mu ding, CXDH: Chuxiong Dong hua, CXDY: Chuxiong Dayao, CXLF: Chuxiong Lufeng, CXNH: Chuxiong Nanhua, DLEY: Dali Er yuan, DLXY: Dali Xiang yun, DLWS: Dali Wei shan, DLMD: Dali Mi du, BSLY: Baoshan Long yang, BSCN: Baoshan Chang ning, BSSD: Baoshan Shi dian.

**Supplementary Table S2 Geographic distribution of *P. vulgaris* nodulating rhizobia at the different sampling sites according to the 43 16S-23S rRNA gene IGS types (each associated with one or two representative strains, total of 46 representatives) and the bean variety used for trapping (H: variety 1 with black seeds/B: variety with white seeds, % of the total isolates (n=608)), and alpha-diversity indices calculated at the Cluster and the IGS levels according to sampling sites.**

Species (clade) Representative isolate (WYCCWR no.)	Isolat e no/ IGS type	Distribution [number of strains (H/B <sup>a</sup> )] of IGS types in the sampling site															Subtotal per clade
		CX MD	CXY A	CXD Y	CXLF	CXD H	CX WD	CXS B	CX NH	DL XY	DL WS	DLM D	DLE Y	BSL Y	BS CN	BS SD	
<i>Rhizobium sophorae</i> (Clade 1, C1)																	
CDYB-22 (WYCCWR13672)	9/20	0	0	9(1/8,1.5)	0	0	0	0	0	0	0	0	0	0	0	0	9(1/8,1.5)
<i>Rhizobium acidisoli</i> (Clade 2, C2)																	
CNHH-10 (WYCCWR13777)	9 /18	1(1/0 ,0.2)	0	0	0	0	1(0 /1,0.2)	0	7(7/ 0,1.2)	0	0	0	0	0	0	0	9(8/1,1.5)
<i>Rhizobium ecuadorensae</i> (Clade 3, C3)																	
DEYH-16 (WYCCWR14027)	11/13	0	0	0	0	0	0	3(3/0,0.5)	0	0	0	0	8(4/4,1.3)	0	0	0	11(7/4,1.80)
<i>Rhizobium</i> genosp. I (Clade 4, C4)																	
DMDH-21 (WYCCWR13936)	1 6/10	0	0	0	0	0	0	6(0/ 6,1)	0	0	1(1/ 0,0.2)	8(7/1, 1.3)	0	0	0	1(0/ 1,0.2)	21(10/11,3.5)
BSDB-6 (WYCCWR14133)	5 /30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5(2/ 3,0.8)	
<i>Rhizobium hidalgonense</i> (Clade 5, C5)																	
BSDH-6 (WYCCWR14114)	1 /43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1(1/ 0,0.2)	
DWSB-10 (WYCCWR13998)	6 /25	0	0	0	0	0	0	0	0	1(0/ 1,0.2)	4(2/ 2,0.7)	1(0/1, 0.2)	0	0	0	0	
DXYH-4 (WYCCWR13867)	1 /42	0	0	0	0	0	0	0	0	1(1/ 0,0.2)	0	0	0	0	0	0	
DWSH-6 (WYCCWR13972)	3 /37	0	0	0	0	0	0	0	1(1/ 0,0.2)	0	2(2/ 0,0.3)	0	0	0	0	0	32(20/12,5.3)
CMDH-27 (WYCCWR13551)	1 /41	1(1/0 ,0.2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
CMDH-4 (WYCCWR13528)	1 6/8	6(6/0 ,1)	0	0	0	0	0	3(0 /3,0.5)	0	0	2(2/ 0,0.3)	3(0/ 3,0.5)	0	2(2/0, 0.3)	0	0	0
CLFH-5 (WYCCWR13680)	4 /32	0	0	2(0/2,0.3)	2(2/0,0.3)	0	0	0	0	0	0	0	0	0	0	0	
<i>Rhizobium vallis</i> (Clade 6, C6)																	14(12/2,2.3)

CDHH-14 (WYCCWR13741)	2/39	0	0	0	0	2(2/0,0.3)	0	0	0	0	0	0	0	0	0	0
CDHH-1 (WYCCWR13728)	12/12	0	0	0	0	11(10/1,1.8)	0	0	1(0/1,0.2)	0	0	0	0	0	0	0
<i>Rhizobium sophoriradicis</i> (Clade 7, C7)																
CWDB-3 (WYCCWR13814)	5/28	0	0	0	0	0	5(0/5,0.8)	0	0	0	0	0	0	0	0	5(0/5,0.80)
<i>Rhizobium croatiense</i> (Clade 8, C8)																
CDYH-7 (WYCCWR13632)	8/23	0	4(1/3,0.7)	3(3/0,0.5)	1(1/0,0.2)	0	0	0	0	0	0	0	0	0	0	0
BCNB-10 (WYCCWR14106) 、CYAH-6 (WYCCWR13582)	44/3	0	9(2/7,1.5)	6(6/0,1)	1(1/0,0.2)	0	0	0	0	0	1(0/1,0.2)	0	0	10(4/6,1.6)	10(2/8,1.6)	7(6/1,1.2) 90(44/46,14.8)
CYAH-5 (WYCCWR13581)	10/15	0	10(3/7,1.6)	0	0	0	0	0	0	0	0	0	0	0	0	0
CYAH-25 (WYCCWR13601)	19/6	0	13(12/1,2.1)	0	0	0	0	0	1(1/0,0.2)	0	0	0	0	5(1/4,0.8)	0	0
CDYB-13 (WYCCWR13663)	9/21	0	0	3(0/3,0.5)	0	1(0/1,0.2)	0	3(0/3,0.5)	1(1/0,0.2)	1(0/1,0.2)	0	0	0	0	0	0
<i>Rhizobium anhuiense</i> (Clade 9, C9)																
CDYH-5 (WYCCWR13630) 、CDYH-21 (WYCCWR13646)	153/1	0	8(7/1,1.3)	24(15/9,3.9)	36(13/23,5.9)	1(1/0,0.2)	0	0	1(1/0,0.2)	6(3/3,1)	17(8/9,2.8)	32(14/18,5.3)	19(7/12,3.1)	2(1/1,0.3)	2(0/2,0.3)	5(4/1,0.8)
DWSB-11 (WYCCWR13999)	5/29	0	0	0	0	0	0	0	0	0	4(2/2,0.7)	0	1(1/0,0.2)	0	0	175(84/91,28.8)
CYAB-3 (WYCCWR13604)	13/11	0	3(0/3,0.5)	0	1(1/0,0.2)	0	0	1(1/0,0.2)	0	2(0/2,0.3)	3(3/0,0.5)	1(0/1,0.2)	0	0	1(0/1,0.2)	1(0/1,0.2)
CSBH-8 (WYCCWR13828)	4/34	0	0	0	0	0	0	1(1/0,0.2)	0	0	0	0	3(1/2,0.5)	0	0	0
<i>Rhizobium</i> genosp. II (Clade 10, C10)																
CMDH-25 (WYCCWR13549)	10/14	5(3/2,0.8)	1(0/1,0.2)	0	0	2(2/0,0.3)	0	0	1(1/0,0.2)	0	0	0	1(0/1,0.2)	0	0	10(6/4,1.6)
<i>Rhizobium phaseoli</i> (Clade 11, C11)																
CMDB-13 (WYCCWR13564)	63/2	19(8/11,3.1)	0	0	2(2/0,0.3)	9(3/6,1.5)	0	13(5/8,2.1)	4(2/2,0.7)	9(7/2,1.5)	0	0	0	4(2/2,0.7)	0	3(1/2,0.5) 170(77/93,28.0)

CNHB-19 (WYCCWR13810)	2/40	0	0	0	0	0	0	0	2(0/2,0.3)	0	0	0	0	0	0	0
CMDH-26 (WYCCWR13550) 、 DXYB-3 (WYCCWR13893)	38/4	12(2/10,2)	0	1(0/1,0.2)	1(1/0,0.2)	3(1/2,0.5)	0	5(2/3,0.8)	7(2/5,1.2)	9(3/6,1.5)	0	0	0	0	0	0
DXYH-20 (WYCCWR13883)	3/38	0	0	0	0	0	0	0	0	1(1/0,0.2)	0	1(0/1,0.2)	1(0/1,0.2)	0	0	0
BSDH-15 (WYCCWR14123)	9/22	0	0	0	0	0	0	1(0/1,0.2)	0	1(0/1,0.2)	0	2(1/1,0.3)	1(0/1,0.2)	0	0	4(4/0,0.7) )
DXYB-25 (WYCCWR13915)	3/36	0	0	0	0	0	0	0	1(1/0,0.2)	2(0/2,0.3)	0	0	0	0	0	0
DXYB-19 (WYCCWR13909)	17/7	0	0	0	1(0/1,0.2)	0	0	0	1(1/0,0.2)	7(4/3,1.2)	4(3/1,0.7)	4(2/2,0.7)	0	0	0	0
CSBH-19 (WYCCWR13839)	10/16	0	0	0	0	2(0/2,0.3)	0	6(3/3,1)	0	0	0	1(1/0,0.2)	0	1(0/1,0.2)	0	0
CSBH-3 (WYCCWR13823)	4/33	0	0	0	0	0	0	4(4/0,0.7)	0	0	0	0	0	0	0	0
CMDH-5 (WYCCWR13529)	5/26	4(4/0,0.7)	0	0	0	0	0	0	1(0/1,0.2)	0	0	0	0	0	0	0
CLFH-22 (WYCCWR13697)	16/9	0	0	0	2(1/1,0.3)	0	0	0	6(0/6,1)	4(3/1,0.7)	0	0	0	4(3/1,0.7)	0	0
<i>Rhizobium</i> genosp. III (Clade 12, C12)																
CDYB-4 (WYCCWR13654)	6/24	0	0	2(0/2,0.3)	1(0/1,0.2)	1(1/0,0.2)	0	0	2(2/0,0.3)	0	0	0	0	0	0	6(3/3,1)
<i>Rhizobium chutanense</i> (Clade 13, C13)																
DWSB-18 (WYCCWR14006)	5/27	0	0	0	1(1/0,0.2)	0	0	0	0	0	2(0/2,0.3)	0	2(2/0,0.3)	0	0	0
CNHB-17 (WYCCWR13808)	3/35	0	0	0	1(1/0,0.2)	0	0	0	2(0/2,0.3)	0	0	0	0	0	0	34(16/18,5.6)
CDHB-7 (WYCCWR13754)	26/5	0	0	0	2(2/0,0.3)	8(0/8,1.3)	0	0	5(4/1,0.8)	3(3/0,0.5)	3(0/3,0.5)	0	4(2/2,0.7)	0	0	1(1/0,0.2) )
<i>Rhizobium etli</i> (Clade 14, C14)																
CMDB-12 (WYCCWR13563)	4/31	3(1/2,0.5)	0	0	0	0	0	0	0	1(0/1,0.2)	0	0	0	0	0	4(1/3,0.7)
<i>Rhizobium</i> genosp. IV (Clade 15, C15)																9(6/3,1.5)

BLYB-15 (WYCCWR14090)	9/17	1(1/0,0.2)	0	0	0	0	0	0	0	0	1(1/0,0.2)	0	0	4(2/2,0.7)	3(2/1,0.5) )	0	
Rhizobium genosp. V (Clade 16, C16)																	
BLYH-17 (WYCCWR14071)	9/19	0	1(0/1,0.2)	0	0	0	0	0	0	0	0	0	0	8(8/0,1.3)	0	0	9(8/1,1.5)
Total number of isolates (%)	608/4 3	52(27/25, 8.6)	49(25/24 , 8.1)	50(25/25 , 8.2)	52(26/26, 8.6)	40(20/20 , 6.6)	9(0/9, 1.5)	43(19/24 , 7.1)	44(24/20 , 7.2)	50(27/23 , 8.2)	45(22/23 , 7.4)	50(25/25, 8.2)	42(19/23 , 7.0)	38(21/17 , 6.3)	16(4/12 , 2.6)	28(19/9 , 4.6)	/

<sup>a</sup>. (H/B): H is the black *Phaseolus vulgaris* of variety 1; B is the white *Phaseolus vulgaris* of variety 2.

<sup>b</sup>. DLEY: Dali Er yuan, DLXY: Dali Xiang yun, DLWS: Dali Wei shan, DLMD: Dali Mi du, CXSB, Chuxiong Shuang bai, CXWD: Chuxiong Wu ding, CXYA: Chuxiong Yao an, CXMD: Chuxiong Mu ding, CXDH: Chuxiong Dong hua, CXDY: Chuxiong Dayao, CXLf: Chuxiong Lufeng, CXNH: Chuxiong Nanhua, BSLY: Baoshan Long yang, BSCN: Baoshan Chang ning, BSSD: Baoshan Shi dian.

**Supplementary Table S3 Resistance to pH of representative strains**

Strains <sup>a</sup>	Acid and alkali resistance (pH)						
	pH=5	pH=6	pH=7	pH=8	pH=9	pH=10	PH=11
BSDH-15 BSDB-6							
DEYH-16 BCNB-10	-	-	+	+	-	-	-
CMDH-4 CMDH-25							
CMDH-26 CMDH-27							
CMDB-12 CMDB-13							
CYAH-25 CDHB-7	-	-	+	+	+	-	-
DWSH-6 DWSB-10							
BSDH-6 DWSB-11							
DWSB-18							
CDYH-5 CSBH-3							
CYAH-6 CDYB-4	-	+	+	+	+	-	-
DXYB-19 DMDH-21							
CMDH-5 CYAB-3							
CDYH-21 CDYB-22							
CLFH-22 CDHH-1	-	+	+	+	+	+	-
CSBH-8 DXYH-20							
DXYB-3 CSBH-19							
CNHB-19 CWDB-3							
CYAH-5 CDHH-14	-	-	+	+	+	+	+
CDYH-7 CDYB-13							
DXYH-4 DXYB-25	-	+	+	+	+	+	+
BLYH-17 BLYB-15							

Note: "+" indicates strain growth; "-" no strain growth (three replicates).

<sup>a</sup>: strains in bold are among the most pH-tolerant.

**Supplementary Table S4 Resistance to NaCl of representative strains**

Strains <sup>a</sup>	NaCl %				
	0.01%	1%	2%	3%	4%
CMDH-4 CMDH-25					
CMDH-27 DMDH-21					
CDYB-4 CDYB-22					
CLFH-5 CLFH-22					
CNHH-10 CNHB-17	+	+	-	-	-
CNHB-19 CWDB-3					
DXYH-4 BLYB-15					
<b>BSDH-6</b>					
CMDH-5 CMDH-26					
CMDB-12 CMDB-13					
CYAH-5 CYAH-6					
CYAB-3 CDYH-5					
CDYH-7 CDYH-21					
CDYB-13 CDHH-1					
CDHH-14 CDHB-7					
CSBH-3 CSBH-8	+	-	-	-	-
DXYH-20 DXYB-3					
DXYB-19 DXYB-25					
CSBH-19 DWSH-6					
DWSB-10 DWSB-11					
DWSB-18 DEYH-16					
BCNB-10 BSDH-15					
<b>BSDB-6</b>					
BLYH-17 CYAH-25	+	+	+	-	-

Note: "+" indicates strain growth, "-" no strain growth (three replicates).

<sup>a</sup>: strains in bold are among the most NaCl-tolerant.

**Supplementary Table S5 Resistance to different temperatures of representative strains**

Strains <sup>a</sup>	Temperature°C				
	4	10	28	37	45
CMDH-4 CMDH-5					
CMDH-26 CMDH-27					
CMDB-12 CMDB-13					
CYAH-5 CYAH-6					
CYAH-25 CYAB-3					
CDYH-5 CDYH-21					
CDYB-4 CDYB-22					
CLFH-5 CLFH-22					
CDHH-1 CDHH-14	-	-	+	-	-
CDHB-7 CNHH-10					
CNHB-17 CSBH-8					
DXYB-19 DXYB-25					
CSBH-19 DMDH-21					
DWSH-6 DWSB-10					
DWSB-18 DEYH-16					
BCNB-10 BSDH-6					
BSDH-15 BSDB-6					
CMDH-25 CDYB-13					
CNHB-19 CWDB-3					
CSBH-3 DXYH-4	-	-	+	+	-
DXYH-20 DXYB-3					
DWSB-11					
CDYH-7 BLYH-17	-	-	+	+	+
BLYB-15					

Note: "+" indicates strain growth, "-" no strain growth (three replicates).

<sup>a</sup>: strains in bold are among the most temperature-tolerant.



**Supplementary Table S6 Resistance to different polyethylene glycol concentrations of representative strains**

Strains <sup>a</sup>	PEG%				
	3%	5%	7%	10%	15%
CMDH-4 CMDH-5					
CMDH-26 CMDB-12					
CYAH-5 CDYH-7					
CLFH-22 CDHB-7					
CNHH-10 CNHB-17					
CNHB-19 CWDB-3	+	+	+	-	-
CSBH-3 CSBH-8					
DXYH-4 DXYH-20					
CSBH-19 DMDH-21					
DWSH-6 CDYH-21					
CMDH-25 CYAH-6					
CYAB-3 CDYB-4					
CDYB-13 CDYB-22	+	+	+	+	-
CDHH-1 CDHH-14					
DXYB-25 BLYH-17					
BLYB-15					
CMDH-27 CMDB-13					
CYAH-25 CDYH-5					
CLFH-5 DXYB-3					
DXYB-19 DWSB-10					
DWSB-11 DWSB-18	+	+	-	-	-
DEYH-16 BCNB-10					
BSDH-6 BSDH-15					
BSDB-6					

Note: "+" indicates strain growth, "-" no strain growth (three replicates).

<sup>a</sup>: strains in bold are among the most PEG-tolerant.

**Supplementary Table S7 Resistance to different glyphosate concentrations of representative strains**

Strains <sup>a</sup>	Glyphosate mL/L		
	0.6	1.2	1.8
CMDH-4 CMDH-26			
CMDB-12 CYAH-5			
CYAH-6 CYAH-25			
CYAB-3 CDYH-5			
CDYH-7 CDYH-21			
CDYB-4 CDYB-13			
CDYB-22 CLFH-5			
CDHH-1 CDHH-14	+	+	+
CDHB-7 CNHB-17			
CWDB-3 CSBH-8			
DXYH-4 DXYB-3			
CSBH-19 DMDH-21			
DWSB-11 BLYH-17			
BLYB-15			
CMDH-25 CMDH-27			
CMDB-13 CLFH-22			
CNHH-10 DXYB-19	+	+	-
DWSH-6 DWSB-10			
DWSB-18 BSDH-15			
BSDB-6			
CMDH-5 CNHB-19			
CSBH-3 DXYH-20	+	-	-
DXYB-25 DEYH-16			
BCNB-10 BSDH-6			

Note: "+" indicating strain growth; "-" indicates no grow (three replicates).

<sup>a</sup>: strains in bold are among the most glyphosate-tolerant.

**Supplementary Table S8 Representative strains with the highest abiotic stress tolerances**

Strains	Tolerance to <sup>a</sup> :					
	acidity	alkalinity	NaCl	temperature	PEG	glyphosate
CWDB-3 ( <i>R. sophoriradicis</i> , IGS28)	pH 6	pH 10	1%	37°C	7%	1.8 mL/L
DXYH-4 ( <i>R. hidalgonense</i> , IGS42)	pH 6	pH 11	1%	37°C	7%	1.8 mL/L
BLYH-17 ( <i>R. genosp. V</i> , IGS19)	pH 6	pH 11	2%	45°C	10%	1.8 mL/L
BLYB-15 ( <i>R. genosp. IV</i> , IGS17)	pH 6	pH 11	1%	45°C	10%	1.8 mL/L

<sup>a</sup> based-on data from Tables S3 to S7