

Table S1 Effects of nitrogen (N) addition on soil pH, SOC, TN.

Indicators	Subgroups	n	lnR	95% CIs	p	Effect size
pH	All	16	-0.335	-0.758—0.088	p = 0.008	-0.28
	Fertilizer types	N	9	-0.53		-0.41
		NPK	7	0.626		0.87
		0-50	10	-0.7		-0.50
	N addition rate	50-200	3	0.275		0.32
		200+	3	0.986		1.68
	N addition duration	0-10	10	-0.377		-0.31
		10-20	3	-0.642		-0.47
		20+	3	2.149		7.58
	Climate conditions	Tem	8	-0.242		-0.21
		Sub	8	0.444		0.56
	Water	Dry	4	-0.008		-0.01
		Wet	12	-0.477		-0.38
	Nitrogen content	Limit	13	-0.634		-0.47
		Unlimited	3	1.161		2.19
	Saline-alkali conditions	Fresh	13	-0.309		-0.27
		Salt	3	-0.421		-0.34
SOC	All	23	0.294	-0.100—0.688	p = 0.002	0.34
	Fertilizer types	N	11	0.802		0.22
		NPK	12	-0.424		0.59
		0-50	5	0.994		1.70
	N addition rate	50-200	13	0.08		0.08
		200+	5	-0.084		-0.08
	N addition duration	0-10	10	0.576		0.78
		10-20	8	0.598		0.82
		20+	5	-1.185		-0.69
	Climate conditions	Tem	11	0.92		1.51
		Sub	12	-0.398		-0.33
	Water	Dry	3	-0.129		-0.12
		Wet	20	0.312		0.37
	Nitrogen content	Limit	19	0.578		0.78
		Unlimited	4	-1.106		-0.67
	Saline-alkali conditions	Fresh	19	0.379		0.46
		Salt	4	-0.017		0.02
TN	All	18	0.281	-0.283—0.844	p = 0.009	0.32
	Fertilizer types	N	8	0.196		0.22
		NPK	10	0.466		0.59
		0-50	5	-0.107		-0.10
	N addition rate	50-200	9	0.445		0.56
		200+	4	1.11		2.03
	N addition duration	0-10	6	-0.147		-0.14
		10-20	10	1.035		1.82

	20+	2	-0.151	-1.736—1.434	-0.14
Climate	Tem	10	0.671	-0.058—1.401	0.96
conditions	Sub	8	-0.298	-1.185—0.590	-0.26
	Dry	4	0.168	-1.115—1.450	0.18
Water	Wet	14	0.308	-0.320—0.935	0.36
	Limit	14	0.545	-0.056—1.146	0.72
Nitrogen content	Unlimited	4	-1.632	-3.250—-0.015	-0.80
Saline-alkali	Fresh	16	0.684	0.050—1.319	0.98
conditions	Salt	2	-1.227	-2.454—-0.000	-0.71

Table S2 Effects of nitrogen (N) addition on microbial Shannon index, microbial Chao 1 index, microbial Simpson index, microbial ACE index.

Indicators	Subgroups	n	lnR	95% CIs	p	Effect size	
Shannon	All	18	-0.086	-0.475—0.303		-0.08	
	Fertilizer	N	10	0.1	-0.351—0.550		0.11
	types	NPK	8	-0.629	-1.400—0.142		-0.47
		0-50	5	0.421	-0.250—1.091		0.52
	N addition rate	50-200	7	-0.494	-1.050—0.062		-0.39
		200+	6	0.083	-0.851—1.016		0.09
		0-10	10	0.1	-0.351—0.550		0.11
	N addition duration	10-20	1	-1.872	-3.931—0.188		-0.85
		20+	7	-0.426	-1.258—0.405		-0.35
	Climate	Tem	4	-0.046	-1.134—1.041		-0.04
	conditions	Sub	14	-0.092	-0.509—0.325		-0.09
	Nitrogen	Limit	14	-0.501	-0.92—0.077		-0.39
	content	Unlimited	4	2.083	1.113—3.054	p= 0.000	7.03
	Saline-alkali	Fresh	13	-0.438	-0.87—0.004		-0.35
	conditions	Salt	5	1.381	0.496—2.266	p= 0.002	2.98
Chao 1	All	13	-0.757	-1.25—0.256		-0.53	
	Fertilizer	N	6	-0.712	-1.27—0.152	p= 0.013	-0.51
	types	NPK	7	-0.94	-2.068—0.187		-0.61
		0-50	1	-0.276	-1.205—0.653		-0.24
	N addition rate	50-200	8	-0.755	-1.37—0.140		-0.53
		200+	4	-3.982	-6.37—-1.590	p= 0.001	-0.98
		0-10	6	-0.712	-1.272-0.152		-0.51
	N addition duration	10-20	1	-0.038	-1.638—1.563		-0.04
		20+	6	-1.829	-3.418-0.240		-0.84
	Climate	Tem	1	-0.038	-1.63—1.563		-0.04
	conditions	Sub	11	-0.836	-1.36—0.308	p= 0.002	-0.57
	Saline-alkali conditions	Fresh	10	-0.758	-1.26—0.257	p= 0.000	-0.53
Simpson	All	9	-0.672	-1.14—0.200		-0.49	
	Fertilizer	N	5	-0.968	-1.51—0.425	p= 0.000	-0.62
	types	NPK	4	0.232	-0.718—1.181		0.26
		0-50	2	-0.695	-1.629—0.239		-0.50
	N addition rate	50-200	6	-0.559	-1.11—0.001		-0.43
		200+	1	-3.266	-6.03—0.494		-0.96
		0-10	5	-0.968	-1.51—0.425	p= 0.000	-0.62
	N addition duration	10-20	1	0.657	-1.01—2.32		0.93
		20+	3	0.03	-1.13—1.18		0.03
	Climate	Tem	6	0.039	-0.772—0.850		0.04
	conditions	Sub	3	-1.035	-1.61—0.455	p= 0.000	-0.64
ACE	All	4	-0.28	-1.89—1.33		-0.24	

Table S3 Effects of nitrogen (N) addition on the abundance of nitrogen cycling and carbon cycling genes.

Indicators	Subgroups	n	lnR	95% CIs	p	Effect size	
nifH	All	8	1.603	0.725—2.481		3.97	
	N	5	2.115	0.748—3.481		7.29	
	Fertilizer	NPK	3	1.244	0.098—2.389		2.47
	types	50-200	4	1.705	0.361—3.050		4.50
		200+	3	1.527	0.368—2.686	p= 0.010	3.60
	N addition	0-10	5	2.115	0.748—3.481	p= 0.002	7.29
	duration	20+	2	1.527	0.367—2.686	p= 0.010	3.60
	Climate conditions	Sub	7	1.773	0.889—2.657	p= 0.000	4.89
	Nitrogen content	Limit	6	1.603	0.725—2.481	p= 0.000	3.97
	Saline-alkali conditions	Fresh	3	1.244	0.098—2.389		2.47
	Salt	5	2.115	0.748—3.481	p= 0.002	7.29	
nirK	All	4	0.193	-0.750—1.135		0.21	
	Fertilizer	N	3	0.193	-0.750—1.135		0.21
	types						
	N addition rate	0-50	2	0.989	-0.342—2.320		1.69
		200+	2	-0.609	-1.944—0.726		-0.46
	Climate conditions	Sub	3	0.193	-0.750—1.135		0.21
	Nitrogen content	Limit	2	0.989	-0.342—2.320		1.69
		Unlimited	2	-0.609	-1.944—0.726		-0.46
Saline-alkali conditions	Salt	3	0.193	-0.750—1.135		0.21	
nirS	All	5	0.044	-0.811—0.898		0.04	
	Fertilizer	N	2	-0.343	-1.354—0.669		-0.29
	types	NPK	3	1.004	-0.591—2.600		1.73
	N addition rate	0-50	2	-0.343	-1.354—0.669		-0.29
		200+	1	0.451	-1.180—2.081		0.57
	N addition	0-10	3	0.337	-0.887—1.561		0.40
	duration	10-20	2	-0.235	-1.429—0.958		-0.21
	Climate conditions	Tem	2	-1.027	-2.778—0.725		-0.64
		Sub	3	0.378	-0.601—1.357		0.46
	Water	Dry	2	-0.32	-2.028—1.388		-0.27
		Wet	3	0.165	-0.822—1.152		0.18
	Nitrogen content	Limit	4	-0.122	-0.982—0.738		-0.11
	Saline-alkali conditions	Fresh	3	1.004	-0.591—2.600		1.73
		Salt	2	-0.343	-1.354—0.669		-0.29
nosZ	All	7	0.523	-0.367—1.414		0.69	
	Fertilizer	N	4	0.78	-0.286—1.845		1.18

	types	NPK	3	-0.071	-1.693—1.551		-0.07
	N addition rate	0-50	4	0.781	-0.285—1.846		1.18
		50-200	2	-0.071	-1.693—1.551		-0.07
	N addition	0-10	5	-0.786	-2.323—0.751		-0.54
	duration	10-20	1	0.817	-0.881—2.514		1.26
		20+	1	1.446	0.018—2.874		3.25
	Climate	Tem	2	-0.054	-1.654—1.547		-0.05
	conditions	Sub	5	0.782	-0.290—1.854		1.19
	Water	Wet	5	0.79	-0.112—1.693		1.20
	Nitrogen	Limit	4	0.791	-0.111—1.694		1.21
	content						
	Saline-alkali	Fresh	3	-0.071	-1.693—1.551		-0.07
	conditions	Salt	4	0.78	-0.286—1.845		1.18
AOA	All		3	2.468	0.893—4.043		10.80
AOB	All		7	-0.531	-1.530—0.469		-0.41
	Fertilizer	N	4	0.593	-0.680—1.866		0.81
	types	NPK	3	-2.335	-3.949—-0.722		-0.90
		0-50	2	0.217	-1.030—1.464		0.24
	N addition rate	50-200	2	-8.91	-14.138—-3.682		-1.00
		200+	3	-1.074	-2.839—0.690		-0.66
	N addition	0-10	6	-0.275	-1.487—0.938		-0.24
	duration	10-20	1	-1.073	-2.838—0.692		-0.66
	Climate	Tem	2	-8.569	-14.719—-2.419	p= 0.006	-1.00
	conditions	Sub	5	-0.313	-1.326—0.700		-0.27
	Water	Dry	1	-8.91	-14.13—-3.682		-1.00
		Wet	6	-0.213	-1.231—0.805		-0.19
	Nitrogen	Limit	4	-0.212	-1.231—0.806		-0.19
	content	Unlimited	3	-8.92	-14.148—-3.692		-1.00
	Saline-alkali	Fresh	4	-2.335	-3.949 —-0.722		-0.90
	conditions	Salt	3	0.593	-0.680—1.866	p= 0.001	0.81
PDR	All		6	1.62	0.738—2.501		4.05
	Fertilizer	N	5	1.383	0.48—2.28	p= 0.003	2.99
	types						
	N addition rate	0-50	2	1.943	0.373—3.513		5.98
		50-200	4	1.471	0.405—2.536		3.35
	N addition	0-10	3	2.505	1.045—3.965	p= 0.001	11.24
	duration	10-20	3	1.111	0.005—2.217		2.04
	Climate	Tem	2	1.912	0.369—3.454		5.77
	conditions	Sub	4	1.478	0.404—2.553		3.38
	Water	Wet	5	1.383	0.484—2.282	p= 0.003	2.99
	Nitrogen	Limit	3	1.111	0.005—2.217		2.04
	content	Unlimited	3	2.505	1.045—3.965	p= 0.001	11.24
PNR	All		4	-1.03	-2.084—0.025	p= 0.019	-0.64
	Fertilizer	N	3	-1.273	-2.335—-0.211		-0.72

		types					
	N addition rate	0-50	1	-1.598	-3.545—0.348		-0.80
		50-200	3	-0.793	-2.048—0.461		-0.55
		10-20	3	-1.273	-2.335—-0.211		-0.72
	Climate conditions	Tem	3	-1.273	-2.335—-0.211		-0.72
	Water	Wet	3	-1.273	-2.335—-0.211		-0.72
	Nitrogen content	Limit	3	-1.273	-2.335—-0.211		-0.72
mcrA	All		4	0.47	-0.43—1.37		0.60
	Fertilizer types	N	3	0.28	-0.633—1.185		0.32
	N addition rate	0-50	2	0.74	-0.33—1.81		1.10
		50-200	2	-0.189	-1.863—1.484		-0.17
	Climate conditions	Tem	2	-0.53	-1.7—0.65		-0.41
		Sub	2	1.9	0.49—3.31		5.69
	Water	Wet	3	0.276	-0.633—1.185		0.32
	Nitrogen content	Limit	1	1.478	0.042—2.913		3.38
		Unlimited	3	-0.192	-1.350—0.967		-0.17
	Saline-alkali conditions	Fresh	3	-0.192	-1.350—0.967		-0.17
	Salt	1	1.478	0.042—2.913		3.38	
pmoA	All		4	-2.581	-4.094—-1.067		-0.92
	Fertilizer types	N	3	-2.003	-3.584—-0.422	p= 0.013	-0.87
	N addition rate	0-50	2	-2.003	-3.584—-0.422	p= 0.013	-0.87
	Water	Wet	3	-2.003	-3.584—-0.422	p= 0.013	-0.87
	Nitrogen content	limit	1	-2.003	-3.584—-0.422		-0.87
		Unlimited	3	-8.933	-14.173—-3.693	p= 0.001	-1.00
	Saline-alkali conditions	Salt	3	-2.003	-3.584—-0.422		-0.87

Table S4 Effects of nitrogen (N) addition on greenhouse gas emissions.(GHG)

Indicators	Subgroups	n	lnR	95% CIs	p	Effect size	
CH ₄	All	4	0.253	-0.559—1.065		0.29	
	Fertilizer types	N	3	0.189	-0.624—1.002		0.21
	N addition rate	0-50	1	-0.108	-1.495—1.279		-0.10
		200+	2	0.344	-0.659—1.347		0.41
	Water	Wet	3	0.189	-0.624—1.002		0.21
	Saline-alkali conditions	Salt	3	0.189	-0.624—1.002		0.21
CO ₂	All	3	0.617	-0.469—1.704		0.85	
	Fertilizer types	N	1	-0.099	-1.701—1.503		-0.09
		NPK	2	1.227	-0.252—2.706		2.41
	N addition duration	0-10	2	0.198	-0.948—1.343		0.22
		10-20	1	4.383	0.950—7.816		79.08
	Climate conditions	Tem	2	0.198	-0.948—1.343		0.22
		Sub	1	4.383	0.950—7.816		79.08
	Nitrogen content	Limit	2	1.227	-0.252—2.706		2.41
		Unlimited	1	-0.099	-1.701—1.503		-0.09