Supplementary Material

Table S1 Details of the tested mulch films

The processing number	Manufacturer	Mulch film type	Thickness (mm)	Color	Width (m)	Origin
PP-JL	Xifeng Company, Hunjiang, China	PBAT+PLA	0.01	Black	1.2	Jilin
PP-SD	Qing Tian Company, Linyi, China	PBAT+PLA	0.01	Black	1.2	Shandong
PP-SH	Hongtui Company, Shanghai, China	PBAT+PLA	0.01	Black	1.2	Shanghai
PPC-BK	Garden-Bee Horticulture Company, Hangzhou, China	PPC	0.01	Black	1.2	Hangzhou
PPC-BR			0.01	Brown	1.2	
PE	Jinye Company, Guangzhou, China	PE	0.01	Black	1.2	Canton
PCK	-	Not covered	-	-	-	-
NCK	-	Mulching	-	-	-	-

Biodegradable mulch films: PP-JL, PP-SD, PP-SH, PPC-BK, and PPC-BR. Polyethylene mulch: PE. Straw mulching: NCK. Uncovered control: PCK.

Table S2 Degradation strength of BMF and PE films

Dispose	Number of days after lamination											
	5d	13d	21d	40d	50d	55d	64d	79d	88d	100d	120d	129d
PP-JL	0	0	0	1	1	1	1	1	1	2	3	3
PP-SH	0	0	0	0	0	0	1	1	1	3	4	4
PP-SD	0	0	0	0	0	1	1	1	4	4	5	5
PPC-BK	0	0	0	0	1	1	3	4	4	5	7	7
PPC-BR	0	0	1	2	2	4	5	6	6	7	8	8
PE	0	0	0	0	0	0	0	0	0	1	1	1

Biodegradable mulch films: PP-JL, PP-SD, PP-SH, PPC-BK, and PPC-BR. Polyethylene mulch: PE. Straw mulching: NCK. Uncovered control: PCK.

Table S3 Agronomic characters and yield of pepper treated with plastic films

Dispose	Plant height (cm)	Stem diameter (mm)	Equivalent to yield per hectare (kg/hm^2)
PP-JL	27.98±1.12a	6.01±0.08a	5890±1633.309a
PP-SH	28.35±3.23a	6.67±1.40a	4760±1455.885a
PP-SD	27.35±2.80a	6.77±0.59a	4546.667±1774.608a
PPC-BK	28.56±3.38a	6.93±0.50a	4823.333±1393.999a
PPC-BR	27.65±1.40a	6.82±1.24a	4833.333±686.319a

PE	27.97±2.69a	6.50±1.13a	5140±2391.004a
PCK	25.30±4.31a	5.44±0.55a	3290±1774.852a
NCK	28.91±3.80a	6.66±0.82a	3820±530a

Note: Mean ±SD. Different lowercase letters mean significant differences between different mulching treatments at $P<0.05$, one-way ANOVA. Biodegradable mulch films: PP-JL, PP-SD, PP-SH, PPC-BK, and PPC-BR. Polyethylene mulch: PE. Straw mulching: NCK. Uncovered control: PCK.

Table S4 MRPP analysis of bacterial community in different treatments

	MRPP	PP-JL	PP-SH	PP-SD	PPC-BK	PPC-BR	PE	PCK
	PP-JL	0	0.125	0.1	**0.026**	**0.013**	0.084	0.004
	PP-SH	0.4566	0	0.062	**0.036**	0.077	0.087	0.006
	PP-SD	0.4146	0.4393	0	**0.003**	**0.006**	0.266	0.001
T1	PPC-BK	0.4207	0.446	0.4049	0	0.087	**0.026**	0.024
	PPC-BR	0.4346	0.4637	0.4173	0.424	0	**0.016**	0.098
	PE	0.4441	0.4715	0.4283	0.4344	0.4494	0	0.005
	PCK	0.4358	0.4625	0.42	0.4261	0.4404	0.4495	0
	PP-JL	0	0.318	0.32	0.177	**0.045**	0.217	0.08
	PP-SH	0.3955	0	0.118	0.318	0.056	0.223	0.028
	PP-SD	0.3835	0.3662	0	**0.036**	**0.003**	0.144	0.006
T2	PPC-BK	0.4106	0.3958	0.3838	0	**0.023**	0.197	0.008
	PPC-BR	0.4212	0.4073	0.3943	0.4215	0	0.025	0.18
	PE	0.3883	0.3715	0.3615	0.3886	0.3992	0	0.002
	PCK	0.4148	0.4004	0.388	0.4151	0.4257	0.3928	0
	PP-JL	0	0.232	0.177	**0.024**	**0.004**	**0.016**	0.004
	PP-SH	0.3808	0	0.016	**0.035**	**0.005**	**0.002**	0.002
	PP-SD	0.4055	0.3798	0	**0.04**	**0.006**	0.054	0.078
T3	PPC-BK	0.4246	0.3989	0.4236	0	0.499	0.082	0.427
	PPC-BR	0.416	0.3902	0.4149	0.4341	0	0.076	0.555
	PE	0.3842	0.3585	0.3832	0.4023	0.3936	0	0.046
	PCK	0.4081	0.3824	0.4071	0.4262	0.4176	0.3858	0

Note: Blacked-out font indicates a significant difference. The significant ($p < 0.05$, one-way ANOVA) differences are indicated in bold. T1: May 10th. T2: June 10th. T3: July 10th. Biodegradable mulch films: PP-JL, PP-SD, PP-SH, PPC-BK, and PPC-BR. Polyethylene mulch: PE. Straw mulching: NCK. Uncovered control: PCK.

Table S5 Alpha diversity of bacterial community in different mulches

	Treatment	Shannon	Simpson	Chao1
T1	PP-JL	6.69±0.11b	0.050±0.02c	6186±392ab
	PP-SH	6.61±0.17b	0.0467±0.02c	5883±328b
	PP-SD	6.72±0.16ab	0.055±0.02bc	5934±316b
	PPC-BK	6.92±0.07a	0.075±0.01ab	6205±300ab
	PPC-BR	6.93±0.04a	0.086±0.01a	6149±208ab
	PE	6.75±0.35ab	0.061±0.03bc	6431±381a
	PCK	6.92±0.12a	0.067±0.02abc	6195±316ab
	NCK	6.78±0.23ab	0.058±0.03bc	5908±398b
T2	PP-JL	6.22±0.30d	0.031±0.02b	5393±309c
	PP-SH	6.45±0.18cd	0.034±0.01b	5718±273bc
	PP-SD	6.31±0.27d	0.030±0.01b	5476±457c
	PPC-BK	6.35±0.15d	0.034±0.01b	5291±359c
	PPC-BR	6.78±0.14a	0.057±0.02a	6194±499ab
	PE	6.47±0.19bcd	0.036±0.01b	6084±399ab
	PCK	6.66±0.32abc	0.042±0.02ab	6002±498b
	NCK	6.72±0.12ab	0.036±0.01b	6514±272a
T3	PP-JL	6.56±0.17c	0.049±0.02b	5705±306bc
	PP-SH	6.74±0.14ab	0.056±0.01ab	6022±495abc
	PP-SD	6.63±0.24bc	0.057±0.02ab	5631±302c
	PPC-BK	6.76±0.10ab	0.060±0.01ab	5644±206c
	PPC-BR	6.88±0.12a	0.074±0.02a	6396±325a
	PE	6.82±0.08a	0.068±0.02ab	6147±492ab
	PCK	6.84±0.09a	0.062±0.02ab	6311±544a
	NCK	6.82±0.08a	0.056±0.02ab	6131±325ab

Note: Different lowercase letters mean significant differences between different mulching treatments at $P<0.05$, one-way ANOVA.T1: May 10th. T2: June 10th. T3: July 10th. Biodegradable mulch films：PP-JL, PP-SD, PP-SH, PPC-BK, and PPC-BR. Polyethylene mulch: PE. Straw mulching: NCK. Uncovered control: PCK.

Table S6 Number of nodes and connections in the building network

Treatment	T1		T2		T3	
	Number of nodes	Number of connections	Number of nodes	Number of connections	Number of nodes	Number of connections
PP-JL	766	1633	694	1739	772	1529
PP-SH	865	2164	947	5626	927	1898
PP-SD	788	1064	875	6963	863	1465
PPC-BK	910	1346	592	1137	776	1340
PPC-BR	1135	7885	980	5229	926	2419
PE	881	1458	761	1237	977	1907
PCK	888	1619	856	1686	877	1728
NCK	774	1369	968	1736	1030	2036

T1: May 10th. T2: June 10th. T3: July 10th. Biodegradable mulch films：PP-JL, PP-SD, PP-SH, PPC-BK, and PPC-BR. Polyethylene mulch: PE. Straw mulching: NCK. Uncovered control: PCK.

Table S7 Molecular ecological network index of soil bacterial communities covered by different mulches

	Network Indexes	R square of power-law	Average degree (avgK)	Average clustering coefficient (avgCC)	Average path distance (GD)
T1	PP-JL	0.883	4.264	0.308	9.065
	PP-SH	0.736	5.003	0.479	10.959
	PP-SD	0.846	2.701	0.278	14.424
	PPC-BK	0.792	2.958	0.286	12.859
	PPC-BR	0.173	13.894	0.499	5.828
	PE	0.763	3.31	0.312	11.693
	PCK	0.792	3.646	0.378	9.845
	NCK	0.808	3.537	0.29	9.739
T2	PP-JL	0.877	5.012	0.318	6.424
	PP-SH	0.255	11.882	0.517	6.256
	PP-SD	0.769	3.273	0.319	12.117
	PPC-BK	0.809	3.841	0.286	7.509
	PPC-BR	0.047	10.671	0.505	6.202
	PE	0.848	3.251	0.308	10.289
	PCK	0.882	3.939	0.335	9.524
	NCK	0.818	3.587	0.308	12.019
T3	PP-JL	0.805	3.961	0.345	8.996
	PP-SH	0.801	4.095	0.353	10.342
	PP-SD	0.794	3.395	0.31	11.595
	PPC-BK	0.823	3.454	0.301	9.509
	PPC-BR	0.758	5.225	0.351	7.777
	PE	0.876	3.904	0.32	9.864
	PCK	0.81	3.941	0.314	10.138
	NCK	0.746	3.953	0.332	9.877

T1: May 10th. T2: June 10th. T3: July 10th. Biodegradable mulch films：PP-JL, PP-SD, PP-SH, PPC-BK, and PPC-BR. Polyethylene mulch: PE. Straw mulching: NCK. Uncovered control: PCK.

Table S8 Number of critical nodes present in each network

Treatment	T1		T2		T3	
	Connector	Modular hubs	Connector	Modular hubs	Connector	Modular hubs
PP-JL	12	3	18	2	4	6
PP-SH	5	5	7	13	11	7
PP-SD	1	2	8	4	4	5
PPC-BK	6	9	4	2	5	2
PPC-BR	17	2	19	6	7	8
PE	7	5	7	3	13	6
PCK	4	3	3	8	7	4
NCK	9	8	6	11	8	9

T1: May 10th. T2: June 10th. T3: July 10th. Biodegradable mulch films: PP-JL, PP-SD, PP-SH, PPC-BK, and PPC-BR. Polyethylene mulch: PE. Straw mulching: NCK. Uncovered control: PCK.

Table S9 Soil chemical properties in different mulches

Period	Treatment	pH	Organic matter	Available phosphorus	Total nitrogen
T1	PP-JL	6.9	15.7	34.4	11.12
	PP-SH	7.2	14.4	27.1	10.43
	PP-SD	7.3	16.3	38.1	10.69
	PPC-BK	6.6	15.3	38.9	10.23
	PPC-BR	6.8	15.6	30.5	10.64
	PE	7	14.9	30.5	10.68
	PCK	7.6	16.5	28.6	12.02
	NCK	7.1	16.7	34.8	13.09
T2	PP-JL	7.3	16	48.3	12.43
	PP-SH	7.7	14.3	21.6	10.31
	PP-SD	7.4	10.9	24.3	9.53
	PPC-BK	7.7	14.9	26.8	12.83
	PPC-BR	7.9	15.3	34.1	11.99
	PE	7.4	15.7	28.7	12.83
	PCK	7.6	17.2	35.4	12.71
	NCK	7.9	16.6	25.6	11.82
T3	PP-JL	7.2	16.6	33.5	14.4
	PP-SH	7.4	13.8	28.7	13.1
	PP-SD	7.1	13	14.7	11.66
	PPC-BK	7.6	13.5	13.5	11.73
	PPC-BR	7.8	12.8	10.7	10.37
	PE	7.4	14	11	11.71
	PCK	7.5	14.4	17.6	8.69
	NCK	7.8	16.9	13.3	10.86

Table S10 Mantel test analysis between soil environmental factors and bacterial community

Envs	r.BC	p.BC	r.JC	p.JC
pH	0.2265	**0.001**	0.2972	**0.001**
AC_PH	0.0336	0.273	0.0512	0.181
URE	0.3389	**0.001**	0.1812	**0.002**
Sucrase	0.1527	**0.002**	0.095	**0.022**
Glucuronidase	0.0812	0.063	0.1004	**0.031**
SOM	-0.045	0.793	-0.042	0.754
AP	0.0701	0.104	0.0396	0.247
TN	-0.007	0.563	-0.01	0.572

Note: The significant differences ($p < 0.05$) are indicated in bold.

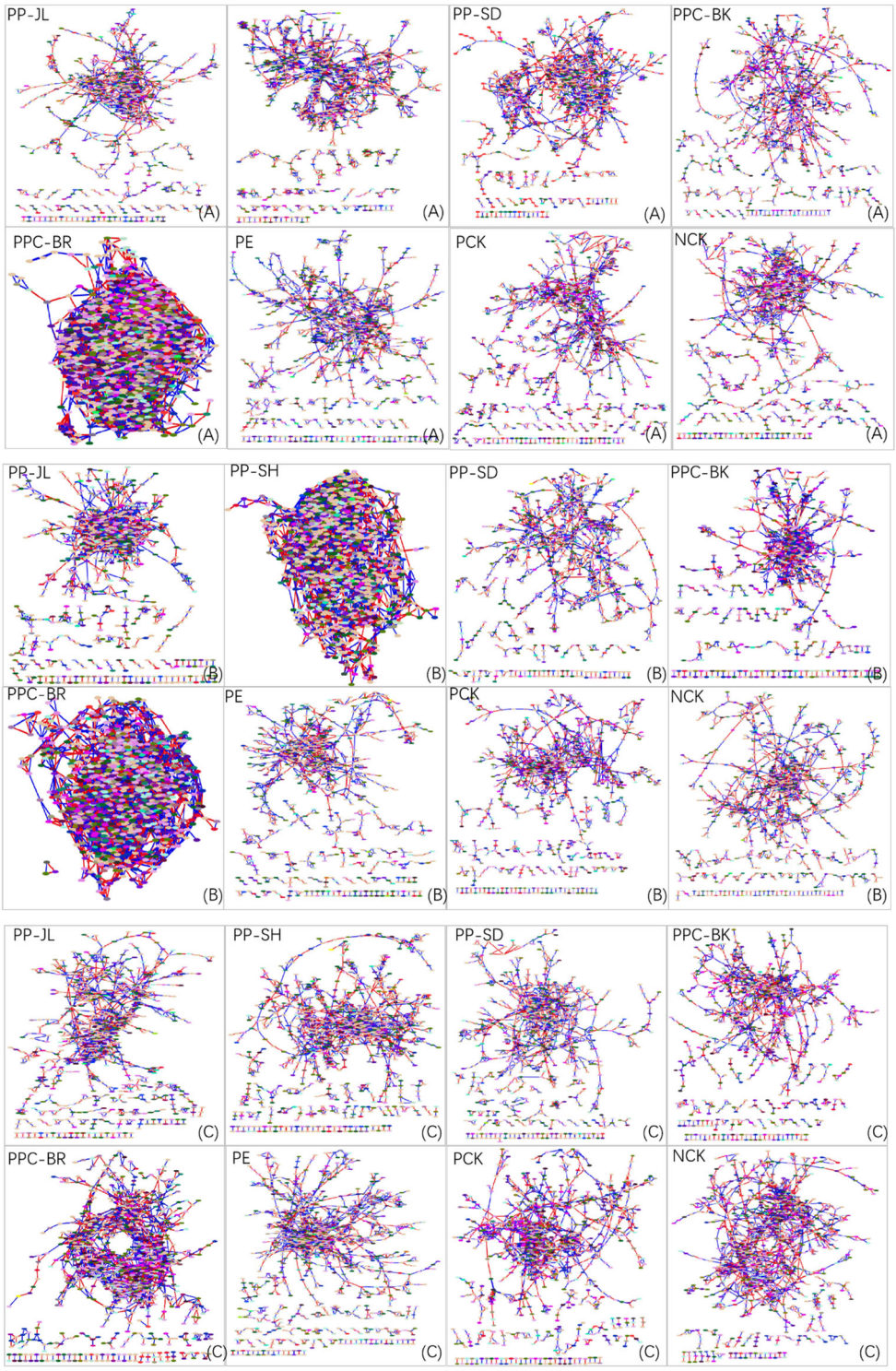

Figure S1. Molecular ecological network of bacterial communities in different mulches.

A: T1, B: T2, C: T3. A node represents an OTU, a node of the same color represents a node of the same gate classification, the red color of the connection line represents the positive interaction, and the gray color represents the negative interaction. T1: May 10th. T2: June 10th. T3: July 10th. Biodegradable mulch films: PP-JL, PP-SD, PP-SH, PPC-BK, and PPC-BR. Polyethylene mulch: PE. Straw mulching: NCK. Uncovered control: PCK.