

**Table S1** The occurrence records of orchardgrass in the world

Longitude	Latitude	Occurrence status	Longitude	Latitude	Occurrence status	Longitude	Latitude	Occurrence status
70.83	36.75	Afghanistan	12.874688	47.992058	Austria	-7.473089	54.123465	Ireland
69.04	35.32	Afghanistan	16.481231	47.841565	Austria	12.435955	45.63717	Italy
71	35.25	Afghanistan	11.407015	47.285949	Austria	11.155869	46.674636	Italy
69.03	34.55	Afghanistan	10.969013	47.057178	Austria	12.051161	44.211525	Italy
72	36.75	Afghanistan	12.44128	46.75403	Austria	7.253753	45.70202	Italy
44.650803	40.132141	Armenia	5.09258	51.26672	Belgium	13.016033	42.55688	Italy
44.715976	40.53174	Armenia	4.64581	50.83713	Belgium	11.222323	44.444273	Italy
46.53305	38.895317	Armenia	3.70723	50.95248	Belgium	12.302245	42.040055	Italy
45.407009	39.833915	Armenia	5.36162	50.78381	Belgium	12.0338	43.25765	Italy
45.95028	39.50083	Armenia	26.047518	41.612525	Bulgaria	10.402994	42.766333	Italy
44.76556	41.15722	Armenia	25.41629	43.020962	Bulgaria	9.6735	40.5411	Italy
45.44472	40.86583	Armenia	23.34857	42.673062	Bulgaria	8.296477	46.086835	Italy
43.99972	40.32417	Armenia	23.781453	42.902689	Bulgaria	8.59903	44.545095	Italy
44.20528	41.1375	Armenia	22.686111	43.611111	Bulgaria	12.327016	45.150819	Italy
45.12806	41.16306	Armenia	27.99167	41.98667	Bulgaria	8.959067	45.358273	Italy
46.575	39.69667	Azerbaijan	27.41833	42.04556	Bulgaria	13.922454	42.465532	Italy
46.70139	39.81417	Azerbaijan	27.70556	43.22806	Bulgaria	10.244617	44.893452	Italy
48.93	40.54	Azerbaijan	29.19285	53.142857	Belarus	10.658043	43.659274	Italy
46.9986	40.0017	Azerbaijan	26.724052	54.99511	Belarus	16.547214	40.145852	Italy
33.86	35.1	Cyprus	27.538972	52.774763	Belarus	12.976692	43.840475	Italy
32.92	34.76	Cyprus	23.859314	53.809039	Belarus	11.541495	45.472289	Italy
33.11	35.3	Cyprus	27.773418	53.95988	Belarus	7.191959	44.955931	Italy
1.158907	33.572022	Algeria	27.860929	51.717457	Belarus	12.847288	43.351403	Italy
6.903272	36.273543	Algeria	26.413732	54.135102	Belarus	140.309213	35.75324	Japan
4.39309	35.962452	Algeria	28.424882	55.265314	Belarus	126.275471	36.713168	Korea
5.916667	35.833333	Algeria	24.429269	53.41967	Belarus	128.840972	36.822427	Korea
8.32222	36.60667	Algeria	30.329512	55.66841	Belarus	126.784103	35.177536	Korea
5.509037965	36.51883387	Algeria	28.76059	55.486	Belarus	126.559417	33.438167	Korea
31.22	29.9	Egypt	30.362935	53.895688	Belarus	128.031888	37.839366	Korea
34.46667	31.5	Egypt	28.917423	54.298077	Belarus	128.053972	36.184417	Korea
42.55876	43.13523	Georgia	-82.255357	45.909776	Canada	128.161028	35.112639	Korea
43.092758	42.45934	Georgia	-71.928795	45.394172	Canada	24.404761	54.216707	Lithuania
40.630664	43.528194	Georgia	-113.933789	53.410554	Canada	24.513432	55.286793	Lithuania
46.5392	41.3486	Georgia	-61.950605	45.625305	Canada	23.788318	55.195674	Lithuania
41.468582	43.034016	Georgia	-137.79407	60.85381	Canada	25.72281	55.594702	Lithuania
45.887382	41.67517	Georgia	-119.265194	52.815306	Canada	23.517462	56.11787	Lithuania
44.45333	42.4925	Georgia	-119.893117	49.201	Canada	5.927286	49.552933	Luxembourg
41.02	43	Georgia	-114.893117	49.694444	Canada	6.08274	49.9405	Luxembourg
44.55	41.83	Georgia	-128.973306	55.292	Canada	6.08182	49.9398	Luxembourg

34.875275	32.305159	Israel	-132.11875	53.251167	Canada	25.13854	56.69089	Latvia
35.29	33.04	Israel	-79.097355	43.863682	Canada	22.721	57.288	Latvia
35.02	31.28	Israel	-80.731993	42.878767	Canada	24.485365	57.841719	Latvia
80.211113	30.063627	India	-83.034124	42.256814	Canada	24.36231	56.86902	Latvia
74.748906	34.206203	India	-73.875546	45.100088	Canada	5.812655	53.217264	Netherlands
78.96	20.59	India	-75.72261	45.390225	Canada	4.128604	51.926401	Netherlands
85.293333	25.039167	India	-123.498313	48.494575	Canada	5.220278	51.956389	Netherlands
76.844732	20.108176	India	8.766757	47.441309	Switzerland	6.75	53.2	Netherlands
76.334005	32.245765	India	9.499506	47.020097	Switzerland	4.55	51.9	Netherlands
77.03	32.58	India	9.284097	46.786364	Switzerland	3.95	51.3	Netherlands
76.7	11.42	India	7.911046	47.120295	Switzerland	6.6	52.2	Netherlands
78.62	29.8	India	7.357615	46.489573	Switzerland	6	52.5	Netherlands
75.6	32.5	India	10.265556	46.793346	Switzerland	5.337011	60.392592	Norway
76.73	11.4	India	9.010645	45.852797	Switzerland	8.553614	59.591063	Norway
76.98	9.57	India	17.878403	49.88009	Czech Republic	7.889283	62.580075	Norway
88.27	27.03	India	18.377766	49.889215	Czech Republic	10.107736	60.842801	Norway
75.42	34.26	India	15.317001	49.143451	Czech Republic	5.871308	61.948113	Norway
78.28	31.59	India	14.666878	48.887506	Czech Republic	9.715406	61.645744	Norway
78.285098	30.411189	India	12.642337	49.809362	Czech Republic	7.419393	58.010531	Norway
44.6	36.566667	Iraq	14.053314	50.64779	Czech Republic	7.711156	61.052622	Norway
43.94	36.61	Iraq	15.173361	50.701118	Czech Republic	10.259937	60.16978	Norway
46.19	35.38	Iraq	16.289535	48.769575	Czech Republic	5.259438	59.416051	Norway
45.05	36.67	Iraq	12.924712	49.382203	Czech Republic	10.29313	63.06555	Norway
42.85	37.27	Iraq	15.733543	50.217975	Czech Republic	11.347986	63.966889	Norway
45.43	35.55	Iraq	16.536616	49.225	Czech Republic	6.561304	58.272573	Norway
43	36.8833	Iraq	16.145135	50.24318	Czech Republic	11.441456	59.11177	Norway
50.288056	34.730278	Iran	14.029767	49.694315	Czech Republic	10.721339	60.946355	Norway
50.997422	35.804462	Iran	12.272859	50.150809	Czech Republic	18.369209	54.234722	Poland
45.019573	37.595242	Iran	13.629636	50.056012	Czech Republic	18.351446	54.244587	Poland
59.299902	36.40555	Iran	11.031689	50.097782	Germany	22.015314	50.257783	Poland
51.591939	33.585643	Iran	10.172145	54.303911	Germany	20.91072	52.339177	Poland
58.98194	36.46944	Iran	10.818841	51.051342	Germany	22.604034	53.29964	Poland
57.375627	37.936616	Iran	9.372888	48.61578	Germany	17.248486	52.838353	Poland
48.995028	37.286806	Iran	10.190489	47.647619	Germany	16.130227	53.101745	Poland
52.264861	35.934056	Iran	8.873786	52.488386	Germany	17.190616	51.071936	Poland
48.58	32.62	Iran	7.475921	51.695869	Germany	17.417573	51.687944	Poland
49.77	32.78	Iran	10.950945	54.327691	Germany	21.781855	53.621667	Poland
47.06	34.32	Iran	8.045452	51.087156	Germany	19.554586	51.861522	Poland
47.6	35.87	Iran	7.923739	47.983026	Germany	14.795424	51.575675	Poland
51.67	32.7	Iran	10.182551	48.873884	Germany	22.417959	50.051847	Poland
47.29	32.91	Iran	6.764755	50.612474	Germany	15.7587	50.915861	Poland

53.1	36.7	Iran	10.988536	52.475382	Germany	20.140013	49.719201	Poland
45.77	38.43	Iran	8.42282	48.955971	Germany	-8.740802	41.942845	Portugal
55.17	37.25	Iran	11.432443	48.163726	Germany	-8.552776	37.754101	Portugal
35.43333	30.33333	Jordan	6.956654	49.689332	Germany	-8.511667	39.430833	Portugal
35.8833	32.3	Jordan	12.328358	47.83732	Germany	-7.59	41.51	Portugal
35.9	31.4667	Jordan	11.39898	53.850688	Germany	-9.204616	38.926896	Portugal
74.495254	42.655837	Kyrgyzstan	12.208398	56.017961	Denmark	-17.003473	32.69247	Portugal
79.268417	42.624486	Kyrgyzstan	9.191913	56.574998	Denmark	23.574931	46.759916	Romania
71.958303	41.810315	Kyrgyzstan	8.508842	55.656606	Denmark	23.3825	45.185278	Romania
72.497778	41.534167	Kyrgyzstan	9.452439	54.960773	Denmark	24.685578	45.070941	Romania
72.0775	40.201944	Kyrgyzstan	9.104232	55.504191	Denmark	27.610464	47.161794	Romania
76.0209	42.8212	Kyrgyzstan	11.99684	55.109693	Denmark	26.054201	45.225704	Romania
74.77	41.2	Kyrgyzstan	9.276798	57.143645	Denmark	21.806574	46.112339	Romania
76.04583	41.15139	Kyrgyzstan	8.820446	56.991463	Denmark	23.593246	45.98317	Romania
78.24583	42.32528	Kyrgyzstan	26.26735	59.34881	Estonia	25.462681	45.604449	Romania
76.975143	43.082581	Kazakhstan	26.96401	58.38237	Estonia	24.047194	45.885188	Romania
78.735168	44.858639	Kazakhstan	22.95802	58.88085	Estonia	25.691944	46.074722	Romania
85.0383	49.521	Kazakhstan	25.416667	58.95	Estonia	23.561031	46.760644	Romania
81.059703	45.765786	Kazakhstan	24.0715	58.538083	Estonia	25.20155	45.165113	Romania
79.514236	43.293512	Kazakhstan	-7.729196	42.059591	Spain	21.241849	45.733956	Romania
70.703716	42.86722	Kazakhstan	-0.947364	41.706896	Spain	26.156764	44.262222	Romania
81.961441	45.303267	Kazakhstan	-6.373779	39.450569	Spain	26.496569	46.963326	Romania
70.285549	42.489156	Kazakhstan	2.160259	41.693066	Spain	27.033162	45.948538	Romania
35.569613	33.854513	Lebanon	-4.375827	39.749097	Spain	25.87388	47.929348	Romania
22.5	31.5	Libya	-3.52143	42.035998	Spain	20.402152	44.807743	Serbia
20.14	32.16	Libya	-3.113073	36.776828	Spain	22.326252	42.725221	Serbia
12.52	32.02	Libya	-1.187817	42.676792	Spain	19.822017	45.184681	Serbia
13.03333	32.33333	Libya	-3.292357	43.050806	Spain	19.284809	45.774464	Serbia
-6.99173	31.55532	Morocco	22.263193	61.28252	Finland	19.81535	43.547482	Serbia
-6.36	34.2	Morocco	22.212556	60.244446	Finland	21.035837	44.847154	Serbia
-3.98	35.23	Morocco	25.431153	64.574799	Finland	20.145578	45.805021	Serbia
-4.16	34.08	Morocco	24.205123	67.288358	Finland	20.416596	45.278666	Serbia
-7.86	31.2	Morocco	23.824297	60.835712	Finland	13.00597	58.50818	Swede
-5.2263	33.3012	Morocco	26.834299	63.963639	Finland	18.07945	59.51182	Swede
-5.3377	35.6223	Morocco	21.754953	61.483112	Finland	12.92513	55.84295	Swede
-2.02	34.9	Morocco	25.418852	64.808544	Finland	16.30638	60.55605	Swede
92.58	46.79	Mongolia	29.560137	61.56478	Finland	17.85566	60.18892	Swede
73.01	34.67	Pakistan	29.479318	65.21974	Finland	13.39947	55.5315	Swede
74.17	35.24	Pakistan	3.29044	43.50275	France	17.29341	62.38415	Swede
75.633333	35.3	Pakistan	3.93419	44.14761	France	13.65468	56.06315	Swede
73.665581	30.486404	Pakistan	4.36405	44.13754	France	15.45404	58.45514	Swede
73.399472	33.924497	Pakistan	0.831671	50.984993	UK	12.37545	57.50625	Swede

69.798113	24.731826	Pakistan	-3.927075	50.411553	UK	15.21751	60.66153	Swede
44.318005	58.824855	Russia	-0.983719	53.134824	UK	14.67596	56.99349	Swede
35.004169	57.866997	Russia	-2.139275	53.950926	UK	15.91445	57.24313	Swede
45.223842	51.836843	Russia	-3.422691	50.889429	UK	15.04016	59.45538	Swede
44.323445	58.823988	Russia	-1.723522	52.177871	UK	15.167584	45.847357	Slovenia
56.839691	61.820911	Russia	-1.722336	52.179007	UK	13.895819	46.288778	Slovenia
59.917053	55.170814	Russia	-3.599392	55.974858	UK	15.31364	45.460243	Slovenia
36.256743	54.097293	Russia	0.867925	52.579595	UK	14.91186	46.399664	Slovenia
44.322137	58.820022	Russia	-4.035429	51.619866	UK	13.412071	46.299615	Slovenia
37.158314	53.879494	Russia	-2.236441	51.407474	UK	19.547585	49.34034	Slovakia
38.002358	54.343614	Russia	-0.398441	52.789354	UK	19.291251	48.120274	Slovakia
41.450303	57.827527	Russia	1.580845	52.671285	UK	21.387843	49.040701	Slovakia
56.840538	61.819809	Russia	24.99	35.23	Greece	21.330286	48.650333	Slovakia
44.327875	58.816307	Russia	25.116667	39.9	Greece	18.672508	49.308322	Slovakia
41.448405	57.808625	Russia	26.016667	38.45	Greece	17.453878	48.236282	Slovakia
44.321747	58.820055	Russia	21.80111	39.55611	Greece	21.701656	48.886799	Slovakia
34.345475	61.782572	Russia	24.25944	41.37889	Greece	19.207422	48.737519	Slovakia
44.343655	58.827392	Russia	21.82556	38.90694	Greece	21.697001	48.883013	Slovakia
44.021915	56.199524	Russia	23.49167	37.46944	Greece	18.141667	47.8575	Slovakia
83.003937	55.110885	Russia	22.88194	40.49778	Greece	31.112218	49.406815	Ukraine
40.157126	50.088453	Russia	21.33278	40.0775	Greece	33.992619	44.75502	Ukraine
28.077716	58.455869	Russia	22.50806	39.46194	Greece	31.001048	50.91901	Ukraine
30.315188	60.038297	Russia	23.73389	41.27389	Greece	29.446686	50.743087	Ukraine
32.326502	59.913683	Russia	22.58	37.32889	Greece	37.788479	49.932277	Ukraine
38.181112	56.32457	Russia	22.57389	38.03361	Greece	34.414161	44.7446	Ukraine
36.803117	55.74987	Russia	15.174167	44.218613	Croatia	24.350966	50.949349	Ukraine
28.383318	59.008117	Russia	16.467222	46.343889	Croatia	24.421498	48.330363	Ukraine
34.756303	59.395825	Russia	18.725556	45.542222	Croatia	31.907733	49.228392	Ukraine
28.884065	59.465191	Russia	16.350368	45.503743	Croatia	33.989697	44.74972	Ukraine
36.743953	32.636893	Syria	16.642136	43.572669	Croatia	30.207975	50.560974	Ukraine
35.982117	35.654369	Syria	18.983251	45.353373	Croatia	31.877838	49.226963	Ukraine
68.85	38.85	Tajikstan	15.774783	43.761584	Croatia	31.332749	51.521313	Ukraine
70.5667	39.85	Tajikstan	17.014236	43.310661	Croatia	23.026727	49.144375	Ukraine
69.24139	38.3625	Tajikstan	15.76051	43.773326	Croatia	24.333557	50.957315	Ukraine
70.02889	37.89722	Tajikstan	13.80083	45.12111	Croatia	23.316478	49.718253	Ukraine
71.53583	37.6825	Tajikstan	17.125945	46.543685	Hungary	22.39713	48.22659	Ukraine
70.73778	38.67139	Tajikstan	18.375447	46.063868	Hungary	115.9287	29.57649722	China
56.28	38.43	Turkmenistan	19.227399	46.765868	Hungary	119.5340472	35.441125	China
57.87	40.93	Turkmenistan	21.295674	46.665115	Hungary	101.9566472	30.08232222	China
56.3836	38.4997	Turkmenistan	18.663964	46.717545	Hungary	110.6033083	30.11798611	China
56.7042	38.4881	Turkmenistan	16.528852	47.241901	Hungary	83.59324722	43.37993889	China

56.3375	38.8642	Turkmenistan	20.952559	47.713921	Hungary	103.9707	27.42979444	China
10.1167	33.4833	Tunisia	19.342558	47.700191	Hungary	110.1877778	32.85138889	China
9.28917	36.475	Tunisia	20.226952	46.412793	Hungary	102.7155556	25.08638889	China
9.59306	36.88389	Tunisia	18.251667	47.459722	Hungary	99.99553333	28.23646667	China
69.71472	41.67444	Uzbekistan	-6.878078	53.0901	Ireland	99.34722222	27.09266667	China
70.132712	41.146791	Uzbekistan	-7.860549	55.159382	Ireland	108.1577833	32.10901667	China
67.573471	38.417283	Uzbekistan	-9.493904	52.021548	Ireland	107.8263889	34.01277778	China
70.133	41.167	Uzbekistan	-6.182758	53.615081	Ireland	102.5452167	32.79832778	China
13.396472	47.312184	Austria	-6.419365	53.997449	Ireland	87.02838333	43.51566667	China
14.616757	48.199467	Austria	-9.238206	53.519598	Ireland	81.11644444	43.49108333	China
14.732067	47.652578	Austria	-8.587382	52.87358	Ireland	109.7750167	31.39576667	China

Table S2 Pearson correlation coefficient of environmental variables

	ESP	Gravel	OC	PH	Sand	BIO1	BIO2	BIO3	BIO4	BIO5	BIO6	BIO7	BIO8	BIO9	BIO10	BIO11	BIO12	BIO13	BIO14	BIO15	BIO16	BIO17	BIO18	BIO19	Elevation	AWC	Bulk	CECS	Clay	Drainage
ESP	1	-0.00759	-0.08516	0.330043	-0.02101	0.192129	0.178973	0.080663	-0.09276	0.240976	0.154862	-0.0639	0.104074	0.211789	0.234725	0.162366	-0.11034	-0.09108	-0.09742	0.072287	-0.09739	-0.09724	-0.13183	-0.06126	-0.00515	-0.02802	0.065025	-0.04535	0.066065	-0.01809
Gravel	-0.00759	1	-0.07441	0.209378	-0.05479	-0.09419	-0.03877	-0.09046	0.050293	-0.1061	-0.07462	0.03671	-0.16665	-0.05249	-0.10542	-0.07662	-0.14343	-0.11608	-0.08411	0.050008	-0.12335	-0.0926	-0.15884	-0.0601	0.141252	0.43643	0.01788	-0.09083	-0.10745	-0.0444
OC	-0.08516	-0.07441	1	-0.26121	-0.26239	-0.16136	-0.12819	-0.13244	0.139526	-0.14876	-0.15642	0.123165	-0.09489	-0.15732	-0.15232	-0.16157	0.019605	-0.02073	0.083565	-0.12954	-0.01388	0.078696	0.046079	0.022096	-0.08561	-0.13203	-0.86899	0.857749	0.108128	-0.38521
PH	0.330043	0.209378	-0.26121	1	-0.12525	0.134825	0.354729	-0.08161	0.03562	0.280717	0.058205	0.093761	0.055996	0.157485	0.240597	0.078741	-0.44193	-0.35699	-0.33078	0.190804	-0.38211	-0.34475	-0.39554	-0.3158	0.116802	0.140727	0.24252	-0.01619	0.062136	-0.0435
Sand	-0.02101	-0.05479	-0.26239	-0.12525	1	0.035282	0.148441	0.0409	-0.0191	0.055184	0.012268	0.017295	0.049818	0.018687	0.036672	0.028516	-0.07976	-0.05333	-0.08791	0.109964	-0.0556	-0.08883	-0.06569	-0.07322	0.027689	0.337435	0.40008	-0.51397	-0.65723	0.613061
BIO1	0.192129	-0.09419	-0.16136	0.134825	0.035282	1	0.577815	0.700191	-0.54485	0.966992	0.973516	-0.36915	0.944951	0.917657	0.976357	0.98027	0.539887	0.541428	0.315527	-0.38942	0.561952	0.332164	0.51831	0.317164	-0.69715	-0.16145	0.143456	-0.16915	0.315794	0.059062
BIO2	0.178973	-0.03877	-0.12819	0.354729	0.148441	0.577815	1	0.431284	-0.15139	0.648957	0.479306	0.125716	0.549039	0.515687	0.603111	0.527307	0.014369	0.097819	-0.10901	0.055724	0.098323	-0.11259	0.093985	-0.09131	-0.14133	-0.0028	0.151546	-0.08339	0.033937	0.120601
BIO3	0.080663	-0.09046	-0.13244	-0.08161	0.0409	0.700191	0.431284	1	-0.85186	0.550785	0.798914	-0.73476	0.5269	0.782052	0.562948	0.798119	0.636924	0.631831	0.352322	-0.05144	0.640617	0.379944	0.478063	0.47641	-0.2311	-0.16875	0.08997	-0.17077	0.300772	0.039858
BIO4	-0.09276	0.050293	0.139526	0.03562	-0.0191	-0.54485	-0.15139	-0.85186	1	-0.32209	-0.713	0.957172	-0.30258	-0.73147	-0.35158	-0.69857	-0.55739	-0.56105	-0.2875	0.025469	-0.56322	-0.31912	-0.35897	-0.43029	0.114866	0.126508	-0.08301	0.176909	-0.29014	-0.04519
BIO5	0.240976	-0.1061	-0.14876	0.280717	0.055184	0.966992	0.648957	0.550785	-0.32209	1	0.886675	-0.12409	0.969982	0.826216	0.997183	0.900629	0.430737	0.436909	0.253218	-0.40899	0.458651	0.262069	0.457074	0.223377	-0.73272	-0.1375	0.174135	-0.12087	0.253778	0.063267
BIO6	0.154862	-0.07462	-0.15642	0.058205	0.012268	0.973516	0.479306	0.798914	-0.713	0.886675	1	-0.56884	0.864661	0.955369	0.904398	0.997862	0.607685	0.601357	0.358746	-0.35094	0.619927	0.380984	0.528618	0.396986	-0.63133	-0.1557	0.119585	-0.1747	0.322635	0.04227
BIO7	-0.0639	0.03671	0.123165	0.093761	0.017295	-0.36915	0.125716	-0.73476	0.957172	-0.12409	-0.56884	1	-0.13024	-0.5806	-0.16713	-0.53944	-0.53792	-0.51336	-0.31946	0.025621	-0.51454	-0.35144	-0.3214	-0.4546	0.051521	0.129164	-0.05675	0.165601	-0.28686	-0.019
BIO8	0.104074	-0.16665	-0.09489	0.055996	0.049818	0.944951	0.549039	0.5269	-0.30258	0.969982	0.864661	-0.13024	1	0.754871	0.976019	0.875069	0.471628	0.468695	0.291514	-0.46601	0.492456	0.302499	0.529269	0.231886	-0.76321	-0.19914	0.12637	-0.11033	0.243334	0.038274
BIO9	0.211789	-0.05249	-0.15732	0.157485	0.018687	0.917657	0.515687	0.782052	-0.73147	0.826216	0.955369	-0.5806	0.754871	1	0.838211	0.955533	0.526536	0.527928	0.289934	-0.28819	0.54211	0.312674	0.405313	0.373598	-0.5499	-0.1188	0.130602	-0.15935	0.300434	0.034858
BIO10	0.234725	-0.10542	-0.15232	0.240597	0.036672	0.976357	0.603111	0.562948	-0.35158	0.997183	0.904398	-0.16713	0.976019	0.838211	1	0.915318	0.459848	0.460428	0.278871	-0.42865	0.482754	0.289227	0.4831	0.246157	-0.75148	-0.15791	0.168527	-0.13442	0.281795	0.053967
BIO11	0.162366	-0.07662	-0.16157	0.078741	0.028516	0.98027	0.527307	0.798119	-0.69857	0.900629	0.997862	-0.53944	0.875069	0.955533	0.915318	1	0.590077	0.592951	0.335327	-0.33356	0.610785	0.356553	0.522578	0.372084	-0.62253	-0.15065	0.129996	-0.179	0.315735	0.052566
BIO12	-0.11034	-0.14343	0.019605	-0.44193	-0.07976	0.539887	0.014369	0.636924	-0.55739	0.430737	0.607685	-0.53792	0.471628	0.526536	0.459848	0.590077	1	0.912607	0.748994	-0.32632	0.936825	0.78208	0.836354	0.763437	-0.36587	-0.20784	-0.07139	-0.05946	0.269022	-0.05905
BIO13	-0.09108	-0.11608	-0.02073	-0.35699	-0.05333	0.541428	0.097819	0.631831	-0.56105	0.436909	0.601357	-0.51336	0.468695	0.527928	0.460428	0.592951	0.912607	1	0.478451	-0.10615	0.992996	0.512464	0.783985	0.621608	-0.31838	-0.18728	-0.01564	-0.08273	0.267454	-0.05887
BIO14	-0.09742	-0.08411	0.083565	-0.33078	-0.08791	0.315527	-0.10901	0.352322	-0.2875	0.253218	0.358746	-0.31946	0.291514	0.289934	0.278871	0.335327	0.748994	0.478451	1	-0.47137	0.514605	0.992936	0.624786	0.677943	-0.28545	-0.1288	-0.12242	0.029805	0.118293	-0.04427
BIO15	0.072287	0.050008	-0.12954	0.190804	0.109964	-0.38942	0.055724	-0.05144	0.025469	-0.40899	-0.35094	0.025621	-0.46601	-0.28819	-0.42865	-0.33356	-0.32632	-0.10615	-0.47137	1	-0.1576	-0.48433	-0.30213	-0.29763	0.563656	0.031462	0.15338	-0.11407	0.013473	0.065173
BIO16	-0.09739	-0.12335	-0.01388	-0.38211	-0.0556	0.561952	0.098323	0.640617	-0.56322	0.458651	0.619927	-0.51454	0.492456	0.54211	0.482754	0.610785	0.936825	0.992996	0.514605	-0.1576	1	0.548696	0.805738	0.644761	-0.34354	-0.19276	-0.02518	-0.08214	0.270772	-0.0597
BIO17	-0.09724	-0.0926	0.078696	-0.34475	-0.08883	0.332164	-0.11259	0.379944	-0.31912	0.262069	0.380984	-0.35144	0.302499	0.312674	0.289227	0.356553	0.78208	0.512464	0.992936	-0.48433	0.548696	1	0.644319	0.706936	-0.29522	-0.1382	-0.12003	0.021978	0.133112	-0.04506
BIO18	-0.13183	-0.15884	0.046079	-0.39554	-0.06569	0.51831	0.093985	0.478063	-0.35897	0.457074	0.528618	-0.3214	0.529269	0.405313	0.4831	0.522578	0.836354	0.783985	0.624786	-0.30213	0.805738	0.644319	1	0.423368	-0.35743	-0.19186	-0.08662	-0.02707	0.187186	-0.0548
BIO19	-0.06126	-0.0601	0.022096	-0.3158	-0.07322	0.317164	-0.09131	0.47641	-0.43029	0.223377	0.396986	-0.4546	0.231886	0.373598	0.246157	0.372084	0.763437	0.621608	0.677943	-0.29763	0.644761	0.706936	0.423368	1	-0.23015	-0.11964	-0.06593	-0.03185	0.190734	-0.04548
Elevation	-0.00515	0.141252	-0.08561	0.116802	0.027689	-0.69715	-0.14133	-0.2311	0.114866	-0.73272	-0.63133	0.051521	-0.76321	-0.5499	-0.75148	-0.62253	-0.36587	-0.31838	-0.28545	0.563656	-0.34354	-0.29522	-0.35743	-0.23015	1	0.158384	0.016675	-0.06959	-0.04065	0.022987
AWC	-0.02802	0.43643	-0.13203	0.140727	0.337435	-0.16145	-0.0028	-0.16875	0.126508	-0.1375	-0.1557	0.129164	-0.19914	-0.1188	-0.15791	-0.15065	-0.20784	-0.18728	-0.1288	0.031462	-0.19276	-0.1382	-0.19186	-0.11964	0.158384	1	0.179471	-0.20984	-0.32828	0.219059
Bulk	0.065025	0.01788	-0.86899	0.24252	0.40008	0.143456	0.151546	0.08997	-0.08301	0.174135	0.119585	-0.05675	0.12637	0.130602	0.168527	0.129996	-0.07139	-0.01564	-0.12242	0.15338	-0.02518	-0.12003	-0.08662	-0.06593	0.016675	0.179471	1	-0.759	-0.23403	0.390275
CECS	-0.04535	-0.09083	0.857749	-0.01619	-0.51397	-0.16915	-0.08339	-0.17077	0.176909	-0.12087	-0.1747	0.165601	-0.11033	-0.15935	-0.13442	-0.179	-0.05946	-0.08273	0.029805	-0.11407	-0.08214	0.021978	-0.02707	-0.03185	-0.06959	-0.20984	-0.759	1	0.297928	-0.52337
Clay	0.066065	-0.10745	0.108128	0.062136	-0.65723	0.315794	0.033937	0.300772	-0.29014	0.253778	0.322635	-0.28686	0.243334	0.300434	0.281795	0.315735	0.269022	0.267454	0.118293	0.013473	0.270772	0.133112	0.187186	0.190734	-0.04065	-0.32828	-0.23403	0.297928	1	-0.37957
Drainage	-0.01809	-0.0444	-0.38521	-0.0435	0.613061	0.059062	0.120601	0.039858	-0.04519	0.063267	0.04227	-0.019	0.038274	0.034858	0.053967	0.052566	-0.05905	-0.05887	-0.04427	0.065173	-0.0597	-0.04506	-0.0548	-0.04548	0.022987	0.219059	0.390275	-0.52337	-0.37957	1

**Table S3** Projected potential suitable areas for orchardgrass under current and future climate scenarios

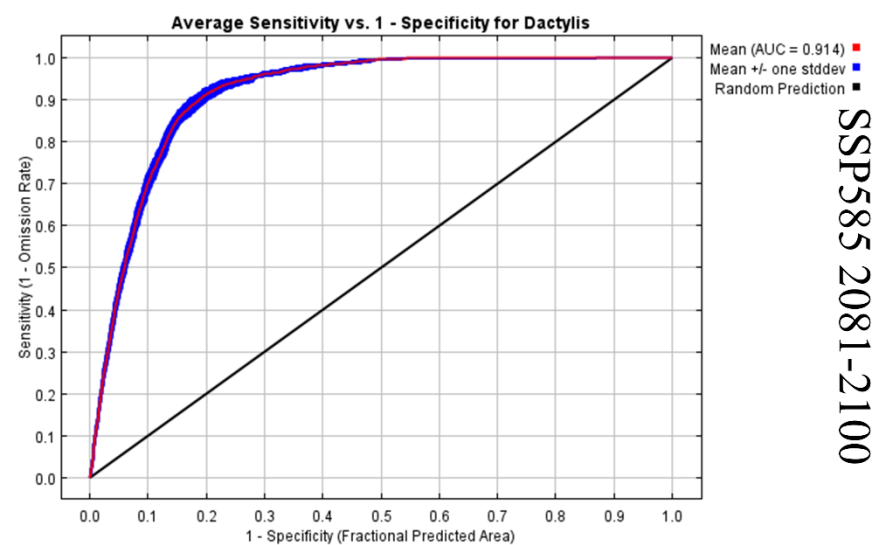
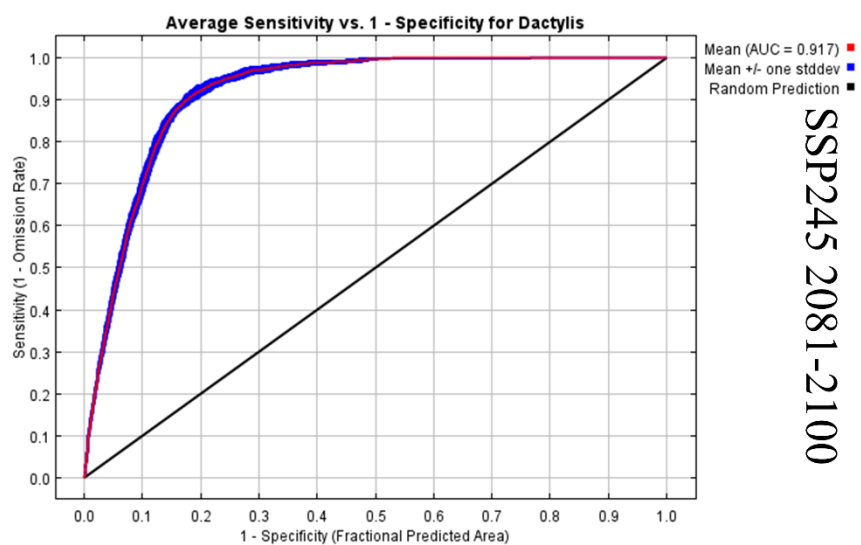
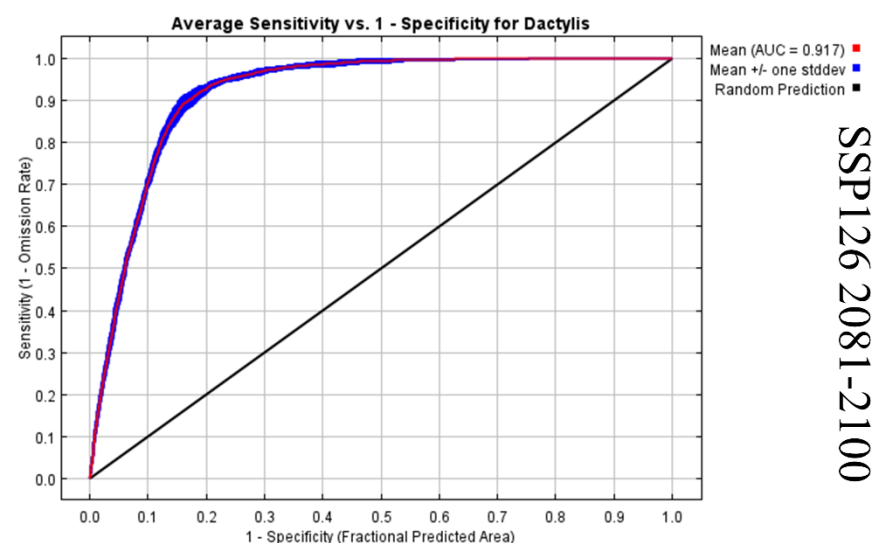
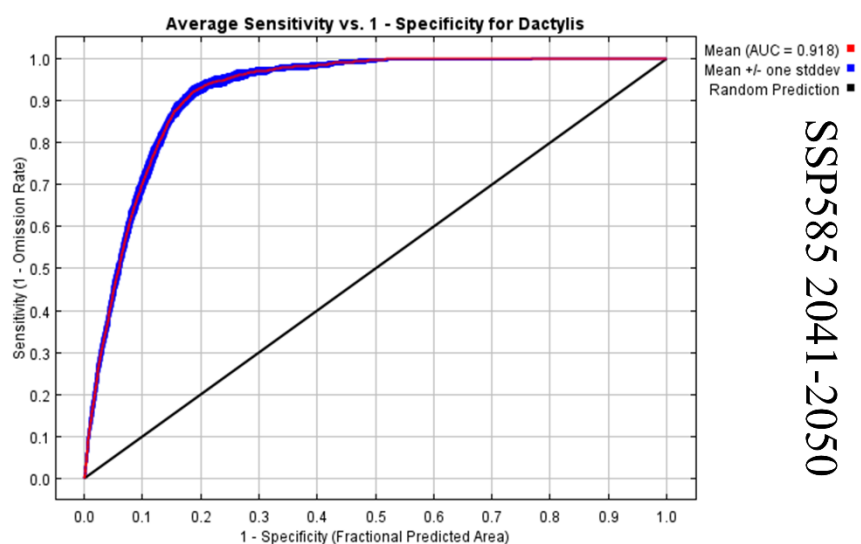
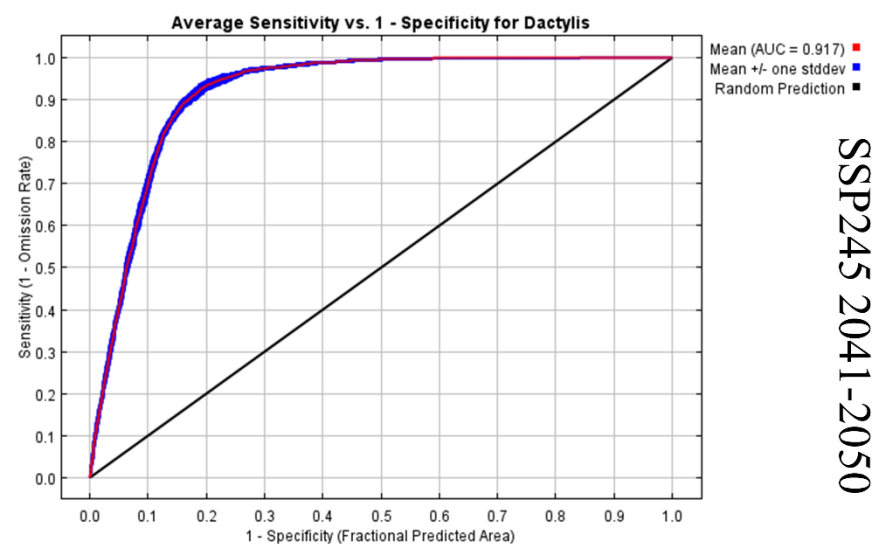
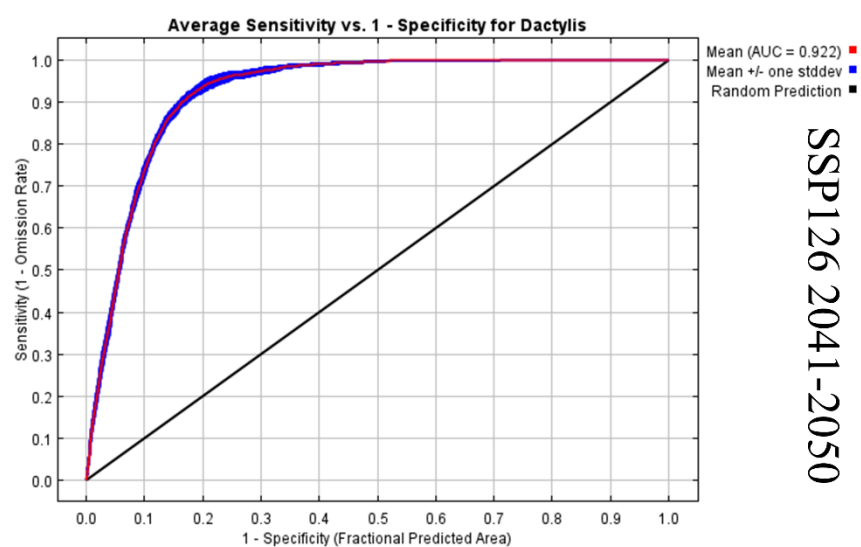
Parameters of potential suitable areas	ssp126		ssp245		ssp585	
	2041-2060	2081-2100	2041-2060	2081-2100	2041-2060	2081-2100
Centroid coordinates (current)	22°46'34.81"E 38°46'52.20"N					
Centroid coordinates (future)	21°58'10.92"E 40°44'27.20"N	19°40'54.65"E 40°53'48.28"N	21°15'8.25"E 41°26'21.34"N	20°10'53.52"E 41°53'46.02"N	17°52'7.31"E 42°1'28.59"N	10°42'6.34"E 43°38'50.65"N
Centroid shift distance	228.41 km	353.49 km	322.52 km	409.98 km	549.72 km	1143.49 km
Centroid shift direction	Northwest	Northwest	Northwest	Northwest	Northwest	Northwest
Range expansion	0.65%	0.65%	0.55%	0.76%	1.44%	2.38%
No occupancy(absence in both current and future climates)	84.41%	84.41%	84.51%	84.30%	83.62%	82.68%
No change (presence in both current and future climates)	13.60%	13.04%	13.19%	12.83%	13.23%	12.20%
Range contraction	1.34%	1.90%	1.75%	2.11%	1.71%	2.73%

**Table S4** The area change of suitable habitat of orchardgrass under different future climate scenarios on different continents.

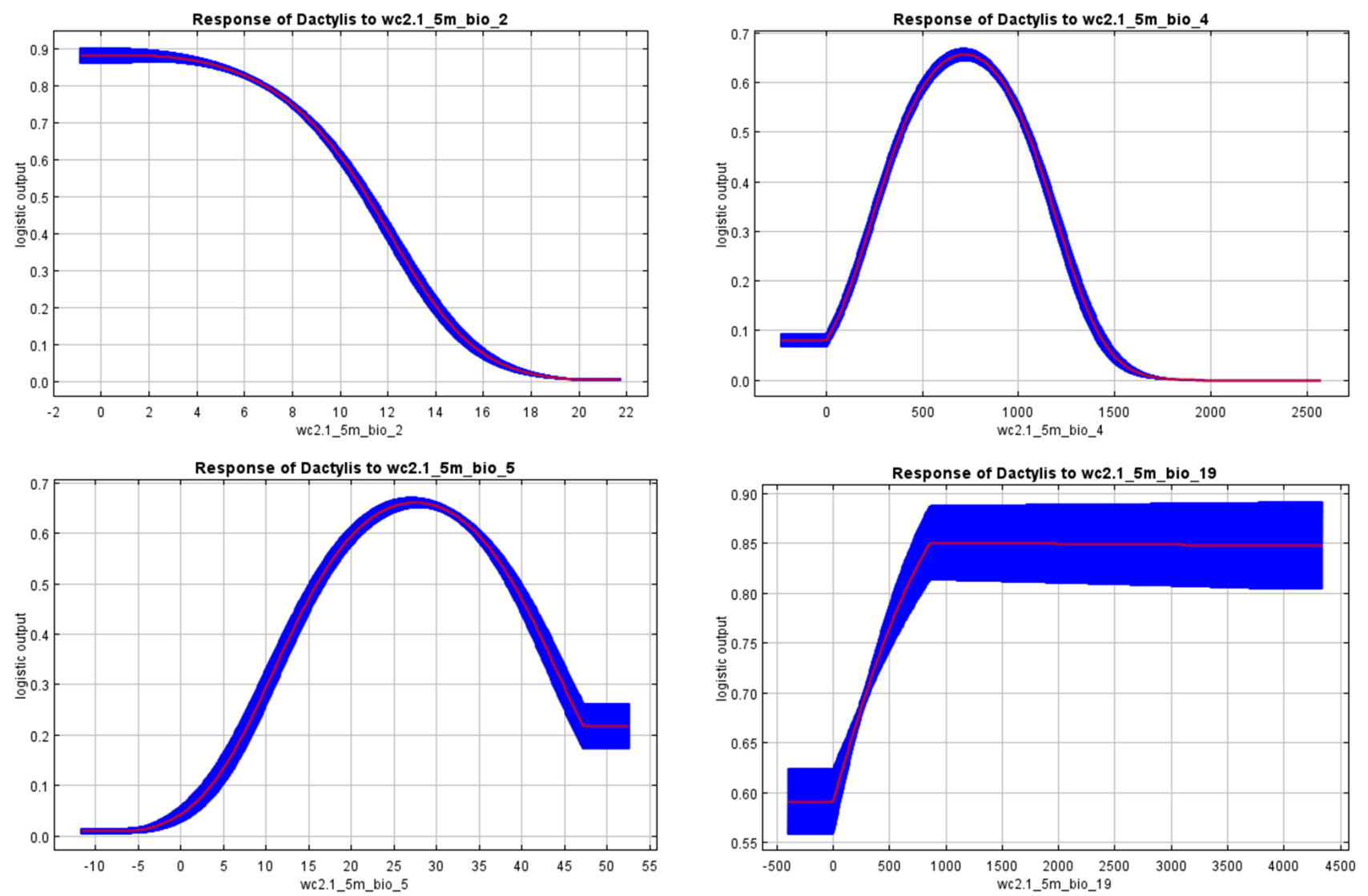
Continent		ssp126(10 <sup>4</sup> km <sup>2</sup> )		ssp245(10 <sup>4</sup> km <sup>2</sup> )		ssp585(10 <sup>4</sup> km <sup>2</sup> )	
		2041-2060	2081-2100	2041-2060	2081-2100	2041-2060	2081-2100
Asia	Expansion	21.37	20.49	23.78	27.28	38.13	34.77
	No occupancy	3640.98	3641.85	3638.57	3635.07	3624.21	3627.58
	No change	662.33	623.05	638.46	607.15	628.08	524.19
	Contraction	75.33	114.60	99.20	130.51	109.57	213.46
Europe	Expansion	18.55	6.88	6.24	17.53	22.28	61.94
	No occupancy	195.92	207.60	208.23	196.94	192.19	152.53
	No change	773.98	745.91	758.19	758.24	764.88	757.83
	Contraction	11.55	39.61	27.34	27.29	20.65	27.70
Africa	Expansion	4.37	5.23	10.19	12.06	33.22	72.78
	No occupancy	2898.67	2897.81	2892.85	2890.98	2869.82	2830.25
	No change	72.06	63.40	67.00	67.75	70.31	65.65
	Contraction	24.90	33.57	29.97	29.21	26.65	31.32
North America	Expansion	42.72	55.54	33.58	48.04	104.83	160.60
	No occupancy	2093.32	2080.49	2102.46	2088.00	2031.21	1975.44
	No change	231.05	246.11	235.73	234.34	251.76	248.37
	Contraction	32.91	17.85	28.23	29.62	12.20	15.59
South America	Expansion	0.40	0.70	0.53	0.61	0.81	2.53
	No occupancy	1335.66	1335.36	1335.54	1335.45	1335.25	1333.53
	No change	47.20	40.17	42.15	34.35	34.67	27.73
	Contraction	16.74	23.76	21.78	29.59	29.27	36.20
Oceania	Expansion	3.67	3.94	2.29	1.16	3.08	2.36
	No occupancy	837.47	837.19	838.85	839.98	838.06	838.77
	No change	44.16	41.89	36.43	30.65	37.90	31.01
	Contraction	14.70	16.97	22.43	28.22	20.96	27.86







**Figure S1** Receiver operating characteristic under future climate conditions



**Figure S2** Response curves of the main predictors of orchardgrass citri occurrence probability. Curves show the mean response over ten replicate Maxent runs (red) and the mean  $\pm 1$  SD (blue, two shades for categorical variables).