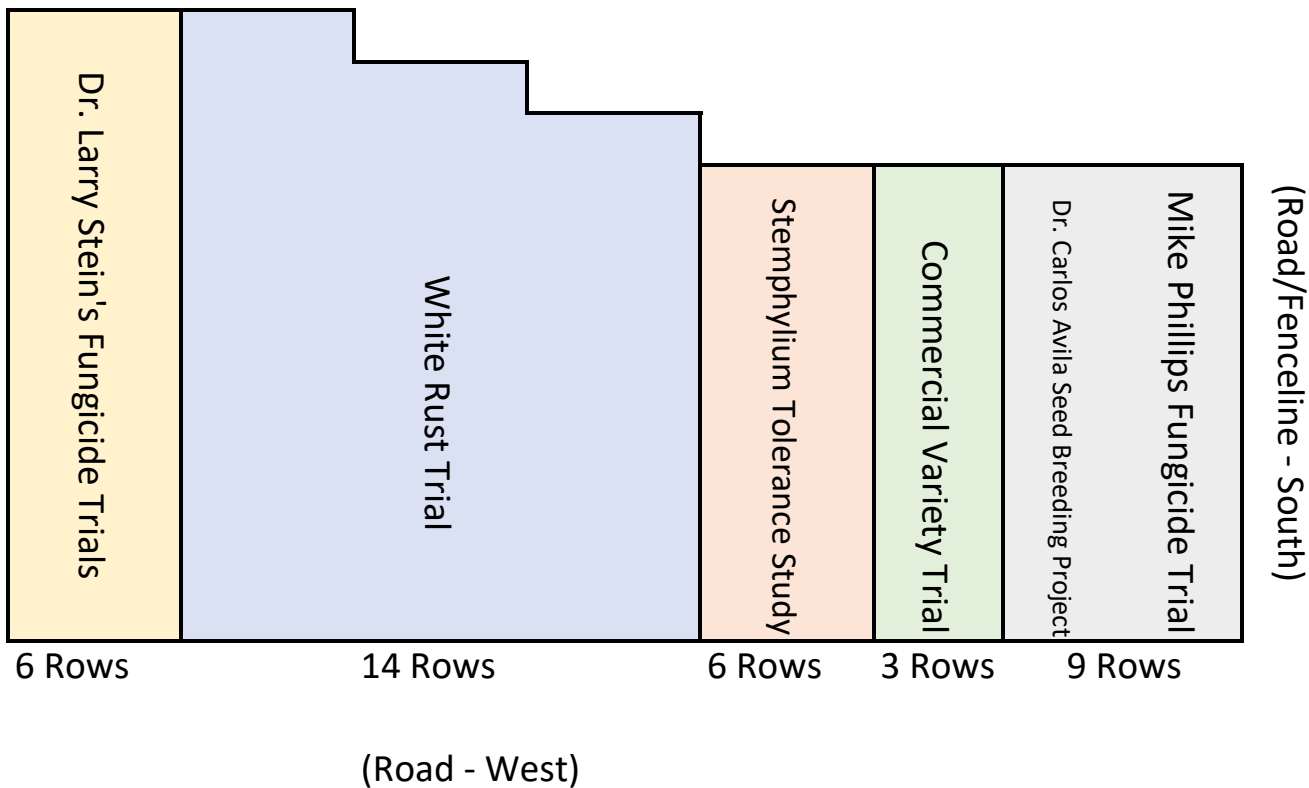


Research Plot Layout 2020-21



Stemphylium Tolerance Study On Spinach Varieties, 2020 – 2021

R E P 1	R E P 2	R E P 3	Variety	Seed Company
101	201	301	SV2994VC	Seminis
102	202	302	Alcor	BASF/Nunhems
103	203	303	Corvus	BASF/Nunhems
104	204	304	Nembus	BASF/Nunhems
105	205	305	Minkar	BASF/Nunhems
106	206	306	Regor	BASF/Nunhems
107	207	307	SV1846VC	Seminis
108	208	308	Kodiak	Rijk Zwaan
109	209	309	Renegade	Bejo
110	210	310	SV6203VB	Seminis
111	211	311	Space	Bejo
112	212	312	Responder	Bejo
113	213	313	Patton	Bejo
114	214	314	C2 - 606	Sakata
115	215	315	Eland	Rijk Zwaan
116	216	316	Cugoe	Rijk Zwaan
117	217	317	Palco	BASF/Nunhems
118	218	318	Spirico	BASF/Nunhems
119	219	319	Sunangel	Rijk Zwaan
120	220	320	Seaside	Sakata
121	221	321	Riverside	Sakata
122	222	322	51-se721	Rijk Zwaan
123	223	323	Parakeet	Rijk Zwaan
124	224	324	RSO6661470	Seminis
125	225	325	Bonobo	Rijk Zwaan
126	226	326	SV2146VB	Seminis
127	227	327	Midway	Seminis
128	228	328	Kona	Seminis
129	229	329	Carmel	Pop Vriend
130	230	330	Maya	Pop Vriend
131	231	331	Sioux	Pop Vriend
132	232	332	Banjo	Pop Vriend
133	233	333	SV2157VB	Seminis
134	234	334	Magnetic	Seminis
135	235	335	Silverwhale	Rijk Zwaan
136	236	336	Spiros	Bejo
137	237	337	Platypus	Rijk Zwaan
138	238	338	Baboon	Rijk Zwaan

Stemphylium Tolerance Study On Spinach Varieties, 2020 – 2021

R E P 1	R E P 2	R E P 3	Variety	Seed Company
139	239	339	Salamander	Rijk Zwaan
140	240	340	Tasman	Pop Vriend
141	241	341	Hamilton	Seminis
142	242	342	Fantail	Rijk Zwaan
143	243	343	Oceanside	Sakata
144	244	344	Lakeside	Sakata
145	245	345	Antigua	Seminis
146	246	346	Hammerhead	Rijk Zwaan
147	247	347	Cabezón	Rijk Zwaan
148	248	348	PV - 1516	Pop Vriend
149	249	349	Pawnee	Pop Vriend
150	250	350	PV - 1610	Pop Vriend
151	251	351	Virgo	BASF/Nunhems
152	252	352	Austin (PV - 1506)	Pop Vriend
153	253	353	Spoonbill	Rijk Zwaan
154	254	354	Vicuna	Rijk Zwaan
155	255	355	Laredo (PV - 1514)	Pop Vriend
156	256	356	Lizard	Rijk Zwaan
157	257	357	Hydrus	BASF/Nunhems
158	258	358	Scorpius	BASF/Nunhems
159	259	359	Houston (PV - 1515)	Pop Vriend
160	260	360	PV - 1569	Pop Vriend
161	261	361	Rapanui	Seminis
162	262	362	Cepheus	BASF/Nunhems
163	263	363	Canopus	BASF/Nunhems
164	264	364	Nevada	Pop Vriend
165	265	365	Kiowa	Pop Vriend
166	266	366	PV - 1611	Pop Vriend
167	267	367	Harmonica (PV - 1194)	Pop Vriend
168	268	368	Dallas	Pop Vriend
169	269	369	Fagot (PV - 1484)	Pop Vriend
170	270	370	PV - 1617	Pop Vriend
171	271	371	PV - 1526	Pop Vriend
172	272	372	Volans	BASF/Nunhems
173	273	373	Tabit	BASF/Nunhems
174	274	374	Colusa	Pop Vriend
175	275	375	Bandera	Pop Vriend
176	276	376	PV - 1599	Pop Vriend
177	277	377	Cocopah (PV - 1449)	Pop Vriend
178	278	378	PV - 1664	Pop Vriend
179	279	379	Melville	Seminis



Split on a bed

Stemphylium Tolerance Study On Spinach Varieties, 2020 – 2021

Layout

Plant Date: 12/17/2020

234	235	236
231	232	233
228	229	230
225	226	227
222	223	224
219	220	221
216	217	218
213	214	215
210	211	212
207	208	209
204	205	206
201	202	203
276	277	278-279
176	177	178-179
173	174	175
170	171	172
167	168	169
164	165	166
161	162	163
158	159	160
155	156	157
152	153	154
149	150	151
146	147	148
143	144	145
140	141	142
137	138	139
134	135	136
131	132	133
128	129	130
125	126	127
122	123	124
119	120	121
116	117	118
113	114	115
110	111	112
107	108	109
104	105	106
101	102	103

Section 1

239	238	237
242	241	240
245	244	243
248	247	246
251	250	249
254	253	252
257	256	255
260	259	258
263	262	261
266	265	264
269	268	267
272	271	270
275	274	273
379-378	377	376
303	302	301
306	305	304
309	308	307
312	311	310
315	314	313
318	317	316
321	320	319
324	323	322
327	326	325
330	329	328
333	332	331
336	335	334
339	338	337
342	341	340
345	344	343
348	347	346
351	350	349
354	353	352
357	356	355
360	359	358
363	362	361
366	365	364
369	368	367
372	371	370
375	374	373

Section 2

Crystal City Test Plot - Commercial Trial

Plant Date: 12/17/2020

Population: 2 mil

30 lines

Replicated 4 Times



22. 5872-Rangitoto	23. Dracus	24. Minkar
19. Imperial Valley	20. Countryside	21. Crosstrek
16. Crater	17. Imperial Beach	18. Baboon
13. Frontier-1059	14. Sportage-1038	15. Regor
10. 2146	11. Kona	12. Sunangel
7. Traverse-1062	8. Blobfish	9. 2157
4. Trailboss	5. Plymouth	6. 51-722
1. Magnetic	2. Nembus	3. 51-727



Commercial Trial 2020-21

	VARIETY	SEED CO
1	Magnetic	Seminis
2	Nembus	Nunhems
3	51-727	Rijk Zwaan
4	Trailboss	Enza
5	Plymouth	Sakata
6	51-722	Rijk Zwaan
7	Traverse-1062	Enza
8	Blobfish	Rijk Zwaan
9	2157	Seminis
10	2146	Seminis
11	Kona	Seminis
12	Sunangel	Rijk Zwaan
13	Frontier-1059	Enza
14	Sportage-1038	Enza
15	Regor	Nunhems
16	Crater	Nunhems
17	Imperial Beach	Sakata
18	Baboon	Rijk Zwaan
19	Imperial Valley	Sakata
20	Countryside	Sakata
21	Crosstrek	Enza
22	5872-Rangitoto	Seminis
23	Dracus	Nunhems
24	Minkar	Nunhems



Scale: 1 = clean 10 = 100% infected			Stemphylium Tolerance Study On Spinach Varieties, 2020 – 2021 Ratings		After Freeze WSU rating 2/20/21					Prior to Freeze Texas A&M rating 2/12/21				
rep 1	rep 2	rep 3	Variety	Company	rep 1	rep 2	rep 3	average	std err	rep 1	rep 2	rep 3	average	std err
101	201	301	SV2994VC	Seminis	2	2	1	1.7	0.3	4	4	4	4.0	0.0
102	202	302	Alcor	BASF/Nunhems	1	1	1	1.0	0.0	2	1	2	1.7	0.3
103	203	303	Corvus	BASF/Nunhems	2	1	1	1.3	0.3	1	2	1	1.3	0.3
104	204	304	Nimbus	BASF/Nunhems	1	1	1	1.0	0.0	1	1	2	1.3	0.3
105	205	305	Minkar	BASF/Nunhems	1	1	1	1.0	0.0	1	3	2	2.0	0.6
106	206	306	Regor	BASF/Nunhems	1	1	1	1.0	0.0	1	3	1	1.7	0.7
107	207	307	SV1846VC	Seminis	1	2	1	1.3	0.3	1	4	1	2.0	1.0
108	208	308	Kodiak	Rijk Zwaan	1	1	2	1.3	0.3	1	2	2	1.7	0.3
109	209	309	Renegade	Bejo	1	1	1	1.0	0.0	1	2	2	1.7	0.3
110	210	310	SV6203VB	Seminis	1	2	1	1.3	0.3	2	3	3	2.7	0.3
111	211	311	Space	Bejo	1	1	1	1.0	0.0	1	1	1	1.0	0.0
112	212	312	Responder	Bejo	6	5	5	5.3	0.3	5	5	5	5.0	0.0
113	213	313	Patton	Bejo	7	6	7	6.7	0.3	7	6	6	6.3	0.3
114	214	314	C2 - 606	Sakata	2	2	1	1.7	0.3	2	3	2	2.3	0.3
115	215	315	Eland	Rijk Zwaan	5	6	5	5.3	0.3	4	5	6	5.0	0.6
116	216	316	Cugoe	Rijk Zwaan	3	1	3	2.3	0.7	2	1	3	2.0	0.6
117	217	317	Palco	BASF/Nunhems	2	1	2	1.7	0.3	2	1	1	1.3	0.3
118	218	318	Spirico	BASF/Nunhems	3	1	3	2.3	0.7	1	1	3	1.7	0.7
119	219	319	Sunangel	Rijk Zwaan	1	2	1	1.3	0.3	2	1	1	1.3	0.3
120	220	320	Seaside	Sakata	6	7	6	6.3	0.3	7	7	7	7.0	0.0
121	221	321	Riverside	Sakata	7	6	7	6.7	0.3	7	6	8	7.0	0.6
122	222	322	51-se721	Rijk Zwaan	1	1	1	1.0	0.0	1	2	2	1.7	0.3
123	223	323	Parakeet	Rijk Zwaan	2	2	2	2.0	0.0	5	2	3	3.3	0.9
124	224	324	RSO6661470	Seminis	6	6	6	6.0	0.0	5	5	6	5.3	0.3
125	225	325	Bonobo	Rijk Zwaan	1	1	1	1.0	0.0	2	2	1	1.7	0.3
126	226	326	SV2146VB	Seminis	3	3	4	3.3	0.3	4	4	3	3.7	0.3
127	227	327	Midway	Seminis	6	6	7	6.3	0.3	5	6	8	6.3	0.9
128	228	328	Kona	Seminis	4	6	7	5.7	0.9	6	7	8	7.0	0.6
129	229	329	Carmel	Pop Vriend	5	6	7	6.0	0.6	4	6	7	5.7	0.9
130	230	330	Maya	Pop Vriend	5	6	7	6.0	0.6	4	5	5	4.7	0.3
131	231	331	Sioux	Pop Vriend	5	5	6	5.3	0.3	6	6	6	6.0	0.0
132	232	332	Banjo	Pop Vriend	4	5	6	5.0	0.6	4	4	5	4.3	0.3
133	233	333	SV2157VB	Seminis	3	3	3	3.0	0.0	3	4	3	3.3	0.3
134	234	334	Magnetic	Seminis	5	5	6	5.3	0.3	6	6	7	6.3	0.3
135	235	335	Silverwhale	Rijk Zwaan	3	3	4	3.3	0.3	3	3	4	3.3	0.3
136	236	336	Spiros	Bejo	2	1	1	1.3	0.3	2	2	1	1.7	0.3
137	237	337	Platypus	Rijk Zwaan	5	5	6	5.3	0.3	5	6	6	5.7	0.3
138	238	338	Baboon	Rijk Zwaan	2	1	1	1.3	0.3	2	3	2	2.3	0.3
139	239	339	Salamander	Rijk Zwaan	1	1	1	1.0	0.0	1	2	2	1.7	0.3
140	240	340	Tasman	Pop Vriend	5	5	6	5.3	0.3	6	6	6	6.0	0.0
141	241	341	Hamilton	Seminis	5	5	5	5.0	0.0	5	6	7	6.0	0.6
142	242	342	Fantail	Rijk Zwaan	2	1	1	1.3	0.3	2	3	2	2.3	0.3
143	243	343	Oceanside	Sakata	2	1	3	2.0	0.6	2	3	3	2.7	0.3
144	244	344	Lakeside	Sakata	6	8	7	7.0	0.6	7	8	8	7.7	0.3
145	245	345	Antigua	Seminis	1	1	1	1.0	0.0	2	2	2	2.0	0.0
146	246	346	Hammerhead	Rijk Zwaan	5	5	6	5.3	0.3	5	6	5	5.3	0.3
147	247	347	Cabezon	Rijk Zwaan	2	3	2	2.3	0.3	2	4	3	3.0	0.6
148	248	348	PV-1516	Pop Vriend	2	1	2	1.7	0.3	1	2	3	2.0	0.6
149	249	349	Pawnee	Pop Vriend	5	5	6	5.3	0.3	5	6	5	5.3	0.3
150	250	350	PV - 1610	Pop Vriend	1	2	1	1.3	0.3	1	1	1	1.0	0.0
151	251	351	Virgo	BASF/Nunhems	5	6	6	5.7	0.3	4	5	5	4.7	0.3
152	252	352	Austin (PV - 1506)	Pop Vriend	2	1	1	1.3	0.3	2	2	3	2.3	0.3
153	253	353	Spoonbill	Rijk Zwaan	3	1	1	1.7	0.7	3	2	1	2.0	0.6
154	254	354	Vicuna	Rijk Zwaan	2	2	2	2.0	0.0	2	1	1	1.3	0.3
155	255	355	Laredo (PV - 1514)	Pop Vriend	1	1	1	1.0	0.0	2	2	1	1.7	0.3
156	256	356	Lizard	Rijk Zwaan	5	6	5	5.3	0.3	6	7	7	6.7	0.3

Scale: 1 = clean 10 = 100% infected			Stemphylium Tolerance Study On Spinach Varieties, 2020 – 2021 Ratings		After Freeze WSU rating 2/20/21					Prior to Freeze Texas A&M rating 2/12/21				
rep 1	rep 2	rep 3	Variety	Company	rep 1	rep 2	rep 3	average	std err	rep 1	rep 2	rep 3	average	std err
157	257	357	Hydrus	BASF/Nunhems	1	2	1	1.3	0.3	3	2	2	2.3	0.3
158	258	358	Scorpius	BASF/Nunhems	1	2	1	1.3	0.3	2	2	1	1.7	0.3
159	259	359	Houston (PV - 1515)	Pop Vriend	1	1	2	1.3	0.3	2	1	1	1.3	0.3
160	260	360	PV - 1569	Pop Vriend	1	1	1	1.0	0.0	3	2	3	2.7	0.3
161	261	361	Rapanui	Seminis	6	7	7	6.7	0.3	5	6	6	5.7	0.3
162	262	362	Cepheus	BASF/Nunhems	4	6	6	5.3	0.7	5	4	5	4.7	0.3
163	263	363	Canopus	BASF/Nunhems	1	1	1	1.0	0.0	2	2	2	2.0	0.0
164	264	364	Nevada	Pop Vriend	3	2	2	2.3	0.3	3	3	2	2.7	0.3
165	265	365	Kiowa	Pop Vriend	1	3	1	1.7	0.7	1	2	2	1.7	0.3
166	266	366	PV - 1611	Pop Vriend	1	1	1	1.0	0.0	1	2	2	1.7	0.3
167	267	367	Harmonica (PV - 1194)	Pop Vriend	4	5	5	4.7	0.3	4	5	5	4.7	0.3
168	268	368	Dallas	Pop Vriend	1	1	1	1.0	0.0	2	2	2	2.0	0.0
169	269	369	Fagot (PV - 1484)	Pop Vriend	1	1	2	1.3	0.3	1	1	2	1.3	0.3
170	270	370	PV - 1617	Pop Vriend	2	2	3	2.3	0.3	3	2	4	3.0	0.6
171	271	371	PV - 1526	Pop Vriend	1	1	1	1.0	0.0	2	1	2	1.7	0.3
172	272	372	Volans	BASF/Nunhems	6	6	5	5.7	0.3	5	5	6	5.3	0.3
173	273	373	Tabit	BASF/Nunhems	1	1	1	1.0	0.0	1	1	1	1.0	0.0
174	274	374	Colusa	Pop Vriend	1	1	1	1.0	0.0	2	1	2	1.7	0.3
175	275	375	Bandera	Pop Vriend	2	2	3	2.3	0.3	2	3	2	2.3	0.3
176	276	376	PV - 1599	Pop Vriend	1	1	1	1.0	0.0	1	1	1	1.0	0.0
177	277	377	Cacopah (PV - 1449)	Pop Vriend	1	1	1	1.0	0.0	4	2	3	3.0	0.6
178	278	378	PV - 1664	Pop Vriend	1	1	1	1.0	0.0	5	3	2	3.3	0.9
179	279	379	Melville	Seminis	4	4	4	4.0	0.0	3	4	4	3.7	0.3

Rated: 2/12/2021 Scale: 1 = clean 10 = 100% infected			Stemphylium Tolerance Study On Spinach Varieties, 2020 – 2021 Ratings				Texas A&M White Rust Rating			
R E P 1	R E P 2	R E P 3	Variety	Seed Company	R E P 1	R E P 2	R E P 3	A V G		
101	201	301	SV2994VC	Seminis	7	8	9	8		
102	202	302	Alcor	BASF/Nunhems	4	4	3	3.67		
103	203	303	Corvus	BASF/Nunhems	2	2	3	2.33		
104	204	304	Nembus	BASF/Nunhems	4	5	4	4.33		
105	205	305	Minkar	BASF/Nunhems	3	4	3	3.33		
106	206	306	Regor	BASF/Nunhems	3	4	5	4		
107	207	307	SV1846VC	Seminis	9	9	8	8.67		
108	208	308	Kodiak	Rijk Zwaan	2	3	4	3		
109	209	309	Renegade	Bejo	2	3	4	3		
110	210	310	SV6203VB	Seminis	7	10	9	8.67		
111	211	311	Space	Bejo	4	3	4	3.67		
112	212	312	Responder	Bejo	3	5	5	4.33		
113	213	313	Patton	Bejo	7	6	6	6.33		
114	214	314	C2 - 606	Sakata	5	7	7	6.33		
115	215	315	Eland	Rijk Zwaan	1	1	2	1.33		
116	216	316	Cugoe	Rijk Zwaan	4	3	5	4		
117	217	317	Palco *(Downy on 217 - rated 5)	BASF/Nunhems	3	5	5	4.33		
118	218	318	Spirico	BASF/Nunhems	2	4	5	3.67		
119	219	319	Sunangel	Rijk Zwaan	3	2	1	2		
120	220	320	Seaside	Sakata	5	6	6	5.67		
121	221	321	Riverside	Sakata	3	4	5	4		
122	222	322	51-se721	Rijk Zwaan	3	3	2	2.67		
123	223	323	Parakeet	Rijk Zwaan	8	6	6	6.67		
124	224	324	RSO6661470	Seminis	4	9	8	7		
125	225	325	Bonobo	Rijk Zwaan	7	6	3	5.33		
126	226	326	SV2146VB	Seminis	7	8	6	7		
127	227	327	Midway	Seminis	5	6	8	6.33		
128	228	328	Kona	Seminis	9	8	8	8.33		
129	229	329	Carmel	Pop Vriend	2	2	2	2		
130	230	330	Maya	Pop Vriend	3	2	2	2.33		
131	231	331	Sioux	Pop Vriend	4	4	3	3.67		
132	232	332	Banjo	Pop Vriend	4	3	2	3		
133	233	333	SV2157VB	Seminis	3	9	6	6		
134	234	334	Magnetic	Seminis	8	8	6	7.33		
135	235	335	Silverwhale	Rijk Zwaan	7	7	5	6.33		
136	236	336	Spiros	Bejo	1	2	2	1.67		
137	237	337	Platypus	Rijk Zwaan	3	2	2	2.33		
138	238	338	Baboon	Rijk Zwaan	2	1	1	1.33		

Rated: 2/12/2021 Scale: 1 = clean 10 = 100% infected			Stemphylium Tolerance Study On Spinach Varieties, 2020 – 2021 Ratings		Texas A&M White Rust Rating			
R E P 1	R E P 2	R E P 3	Variety	Seed Company	R E P 1	R E P 2	R E P 3	A V G
139	239	339	Salamander	Rijk Zwaan	2	1	1	1.33
140	240	340	Tasman	Pop Vriend	1	1	1	1
141	241	341	Hamilton	Seminis	4	3	3	3.33
142	242	342	Fantail	Rijk Zwaan	1	1	1	1
143	243	343	Oceanside	Sakata	5	6	4	5
144	244	344	Lakeside	Sakata	6	7	6	6.33
145	245	345	Antigua	Seminis	4	6	5	5
146	246	346	Hammerhead	Rijk Zwaan	1	2	1	1.33
147	247	347	Cabazon	Rijk Zwaan	2	1	1	1.33
148	248	348	PV - 1516	Pop Vriend	5	5	5	5
149	249	349	Pawnie	Pop Vriend	7	4	3	4.67
150	250	350	PV - 1610	Pop Vriend	6	4	5	5
151	251	351	Virgo	BASF/Nunhems	3	3	4	3.33
152	252	352	Austin (PV - 1506)	Pop Vriend	8	3	4	5
153	253	353	Spoonbill	Rijk Zwaan	6	3	4	4.33
154	254	354	Vicuna	Rijk Zwaan	7	3	7	5.67
155	255	355	Laredo (PV - 1514)	Pop Vriend	3	2	2	2.33
156	256	356	Lizard	Rijk Zwaan	1	1	1	1
157	257	357	Hydrus	BASF/Nunhems	7	4	5	5.33
158	258	358	Scorpius	BASF/Nunhems	3	4	2	3
159	259	359	Houston (PV - 1515)	Pop Vriend	3	3	3	3
160	260	360	PV - 1569	Pop Vriend	2	2	1	1.67
161	261	361	Rapanui	Seminis	8	8	7	7.67
162	262	362	Cepheus	BASF/Nunhems	7	2	3	4
163	263	363	Canopus	BASF/Nunhems	7	4	4	5
164	264	364	Nevada	Pop Vriend	6	3	4	4.33
165	265	365	Kiowa	Pop Vriend	5	5	4	4.67
166	266	366	PV - 1611	Pop Vriend	6	5	6	5.67
167	267	367	Harmonica (PV - 1194)	Pop Vriend	2	2	1	1.67
168	268	368	Dallas	Pop Vriend	4	2	5	3.67
169	269	369	Fagot (PV - 1484)	Pop Vriend	4	3	4	3.67
170	270	370	PV - 1617	Pop Vriend	9	8	7	8
171	271	371	PV - 1526	Pop Vriend	3	2	3	2.67
172	272	372	Volans	BASF/Nunhems	2	4	4	3.33
173	273	373	Tabit	BASF/Nunhems	3	4	3	3.33
174	274	374	Colusa	Pop Vriend	2	2	2	2
175	275	375	Bandera	Pop Vriend	1	1	1	1
176	276	376	PV - 1599	Pop Vriend	3	3	3	3
177	277	377	Cocopah (PV - 1449)	Pop Vriend	4	4	3	3.67
178	278	378	PV - 1664	Pop Vriend	2	3	2	2.33
179	279	379	Melville	Seminis	1	1	1	1

Commercial Trial

Scale: 1 = clean 10 = 100% infection Plant Date: 12/17/2020 Date Rated: 2/12/2021

	VARIETY	SEED Co	White Rust Rating					Stemphylium Rating					Downy Mildew Rating				
			Rep 1	Rep 2	Rep 3	Rep 4	AVG	Rep 1	Rep 2	Rep 3	Rep 4	AVG	Rep 1	Rep 2	Rep 3	Rep 4	AVG
1	Magnetic	Seminis	5	8	6	5	6	3	1	1	1	1.5	1	1	1	1	1
2	Nembus	Nunhems	3	3	4	4	3.5	1	2	1	1	1.25	1	1	1	1	1
3	51-727	Rijk Zwaan	1	1	1	1	1	2	1	2	2	1.75	1	1	1	1	1
4	Trailboss	Enza	5	4	6	6	5.25	1	1	1	1	1	1	1	1	1	1
5	Plymouth	Sakata	4	4	1	1	2.5	1	1	3	1	1.5	1	1	8	10	5
6	51-722	Rijk Zwaan	1	1	1	1	1	2	1	2	1	1.5	1	1	1	1	1
7	Traverse-1062	Enza	5	6	8	6	6.25	1	3	1	1	1.5	1	1	1	1	1
8	Blobfish	Rijk Zwaan	2	2	3	2	2.25	1	1	1	1	1	1	1	1	1	1
9	2157	Seminis	5	4	7	1	4.25	2	1	1	1	1.25	1	1	1	10	3.25
10	2146	Seminis	4	3	6	1	3.5	1	2	3	6	3	1	1	1	9	3
11	Kona	Seminis	7	6	8	7	7	1	1	1	1	1	1	1	1	1	1
12	Sunangel	Rijk Zwaan	1	1	1	1	1	3	2	3	2	2.5	1	1	1	1	1
13	Frontier-1059	Enza	4	3	4	1	3	1	1	1	4	1.75	1	1	1	1	1
14	Sportage-1038	Enza	5	4	7	4	5	1	1	1	1	1	1	1	1	1	1
15	Regor	Nunhems	4	4	7	5	5	1	1	1	1	1	1	1	1	1	1
16	Crater	Nunhems	6	7	6	7	6.5	1	1	1	1	1	1	1	1	1	1
17	Imperial Beach	Sakata	4	7	1	1	3.25	1	1	4	1	1.75	1	1	9	10	5.25
18	Baboon	Rijk Zwaan	3	2	2	2	2.25	1	1	1	1	1	1	1	1	1	1
19	Imperial Valley	Sakata	6	8	1	1	4	1	1	1	1	1	1	1	9	10	5.25
20	Countryside	Sakata	2	1	1	1	1.25	2	5	1	1	2.25	1	1	7	10	4.75
21	Crosstrek	Enza	5	3	1	4	3.25	1	1	3	1	1.5	1	1	1	1	1
22	5872-Rangitoto	Seminis	4	4	6	1	3.75	1	1	1	1	1	1	1	8	9	4.75
23	Dracus	Nunhems	3	4	4	4	3.75	1	1	1	1	1	1	1	1	1	1
24	Minkar	Nunhems	4	4	4	5	4.25	1	1	1	2	1.25	1	1	1	1	1

White Rust Findings - January 20, 2021

The following varieties in the White Rust Trial showed the first signs of white rust, other than the spreader row:

A20
B13
B21
B27
B29
C1
C5
D221
D223
E7
F3
F4
F5

In addition, the following had symptoms of leaf spot in 2 reps:

F3

WHITE RUST RATING - 2/8/2021

	Rep 1	Rep 2	Rep 3	AVG
A1	4	1	7	4
A2	3	2	6	3.666666667
A3	4	3	3	3.333333333
A4	4	2	2	2.666666667
A5	3	3	3	3
A6	3	3	2	2.666666667
A7	3	1	1	1.666666667
A8	3	2	1	2
A9	4	2	3	3
A10	3	2	2	2.333333333
A11	4	4	3	3.666666667
A12	3	2	3	2.666666667
A13	3	4	3	3.333333333
A14	4	5	4	4.333333333
A15	2	2	4	2.666666667
A16	3	4	5	4
A17	5	5	5	5
A18	3	4	4	3.666666667
A19	3	5	5	4.333333333
A20	2	4	7	4.333333333

Scale: 1 = clean

10 = 100% infection

WHITE RUST RATING - 2/8/2021

	Rep 1	Rep 2	Rep 3	AVG
B1	3	2	4	3
B2	2	3	5	3.333333333
B3	3	2	5	3.333333333
B4	3	1	5	3
B5	3	2	5	3.333333333
B6	2	2	5	3
B7	3	1	5	3
B8	2	2	7	3.666666667
B9	3	3	8	4.666666667
B10	3	4	8	5
B11	2	4	5	3.666666667
B12	2	5	5	4
B13	2	4	10	5.333333333
B14	3	4	9	5.333333333
B15	2	5	4	3.666666667
B16	3	4	4	3.666666667
B17	2	3	6	3.666666667
B18	3	3	5	3.666666667
B19	4	3	7	4.666666667
B20	3	3	6	4
B21	3	3	8	4.666666667
B22	3	3	5	3.666666667
B23	4	3	5	4
B24	5	3	4	4
B25	4	3	5	4
B26	2	3	6	3.666666667
B27	5	4	5	4.666666667
B28	7	4	5	5.333333333
B29	7	4	3	4.666666667
B30	7	4	3	4.666666667

Scale: 1 = clean
10 = 100% infection

WHITE RUST RATING - 2/8/2021

	Rep 1	Rep 2	Rep 3	AVG
C1	1	2	4	2.333333333
C2	3	2	2	2.333333333
C3	2	4	3	3
C4	3	4	2	3
C5	2	5	8	5
C6	2	3	3	2.666666667
C7	2	2	2	2
C8	2	4	2	2.666666667
C9	2	4	1	2.333333333
C10	1	4	2	2.333333333
C11	2	3	2	2.333333333
C12	1	1	1	1
C13	1	2	1	1.333333333
C14	2	1	1	1.333333333
C15	1	1	1	1
C16	2	1	1	1.333333333
C17	1	2	1	1.333333333
C18	1	1	1	1
C19	1	1	1	1
C20	1	3	1	1.666666667
C21	1	3	2	2
C22	2	4	2	2.666666667
C23	2	3	1	2
C24	2	3	1	2
C25	2	1	1	1.333333333
C26	3	2	2	2.333333333
C27	3	2	1	2
C28	3	1	1	1.666666667
C29	2	1	3	2
C30	2	1	2	1.666666667
C31	2	2	3	2.333333333
C32	3	2	2	2.333333333
C33	2	2	2	2
C34	2	2	2	2
C35	1	3	2	2
C36	1	5	2	2.666666667
C37	1	3	3	2.333333333
C38	2	4	3	3
C39	2	1	2	1.666666667
C40	1	2	4	2.333333333

Scale: 1 = clean
10 = 100% infection

WHITE RUST RATING - 2/8/2021

	Rep 1	Rep 2	Rep 3	AVG
D1	5	3	4	4
D2	5	3	3	3.666666667
D3	5	4	3	4
D4	5	4	3	4
D5	4	3	3	3.333333333
D6	6	5	3	4.666666667
D7	7	2	3	4
D8	8	2	3	4.333333333
D9	5	3	5	4.333333333
D10	6	2	5	4.333333333
D11	5	3	6	4.666666667
D12	5	2	6	4.333333333
D13	3	3	7	4.333333333
D14	4	4	8	5.333333333
D15	3	6	5	4.666666667
D16	2	5	6	4.333333333
D17	3	6	4	4.333333333
D18	3	4	4	3.666666667
D19	3	2	7	4
D20	3	2	4	3
D21	3	3	6	4
D22	3	1	3	2.333333333
D23	3	2	5	3.333333333
D24	3	5	4	4
D25	5	2	3	3.333333333
D26	3	2	4	3
D27	3	2	3	2.666666667
D28	4	3	4	3.666666667
D29	2	1	2	1.666666667
D30	2	2	3	2.333333333

WHITE RUST RATING - 2/8/2021

	Rep 1	Rep 2	Rep 3	AVG
D31	3	2	3	2.666666667
D32	4	3	3	3.333333333
D33	3	2	4	3
D34	2	1	3	2
D35	4	2	5	3.666666667
D36	4	3	5	4
D37	5	5	3	4.333333333
D38	6	6	3	5
D39	3	4	2	3
D40	5	7	3	5
D41	3	2	2	2.333333333
D42	4	5	2	3.666666667
D43	4	3	2	3
D44	5	3	2	3.333333333
D45	3	4	2	3
D46	3	5	2	3.333333333
D47	4	5	4	4.333333333
D48	3	3	3	3
D49	4	5	5	4.666666667
D50	4	5	4	4.333333333

Scale: 1 = clean
10 = 100% infection

WHITE RUST RATING - 2/8/2021

	Rep 1	Rep 2	Rep 3	AVG
E1	7	4	4	5
E2	4	3	3	3.333333333
E3	3	4	3	3.333333333
E4	4	5	3	4
E5	4	5	4	4.333333333
E6	5	5	5	5
E7	5	9	3	5.666666667
E8	5	8	4	5.666666667

Scale: 1 = clean

10 = 100% infection

WHITE RUST RATING - 2/8/2021

	Rep 1	Rep 2	Rep 3	AVG
F1	3	5	2	3.333333
F2	2	4	2	2.666667
F3	8	5	3	5.333333
F4	8	6	2	5.333333
F5	3	6	2	3.666667
F6	5	7	3	5
F7	1	6	5	4
F8	2	5	4	3.666667
F9	2	5	5	4

Scale: 1 = clean

10 = 100% infection

WHITE RUST RATING - 2/8/2021

	Rep 1	Rep 2	Rep 3	AVG
G1	2	6	2	3.333333
G2	1	8	1	3.333333
G3	1	7	3	3.666667
G4	3	8	4	5

Scale: 1 = clean

10 = 100% infection

Stemphylium Leaf Spot of Spinach in Fresh Market, Processing, and Seed Crops

Kayla Spawton & Lindsey du Toit, February 2021

Washington State University Northwestern Washington Research & Extension Center

- **Background:** Historically, *Stemphylium* leaf spot of spinach was thought to be caused by the fungus *Stemphylium botryosum*. However, isolations completed in du Toit's lab at Washington State University (WSU) and Correll's lab at the University of Arkansas (UA) over the last 5 years from samples received from Arizona, California, Florida, and Texas revealed there are at least two species of *Stemphylium* that can cause leaf spots of spinach: 1) Lineage 1 isolates, which are most closely related to *S. vesicarium*; and 2) Lineage 2 isolates, most closely related to *S. beticola*. The isolates previously identified as *S. botryosum* have been re-named as *S. beticola*, a species first described in 2017 from sugar beet crops in the Netherlands. Almost all *Stemphylium* isolates obtained from leaf spots in spinach crops in Texas over the past 5 years have been from Lineage 1 (*S. vesicarium*). Isolates of the two lineages cause slightly different symptoms on spinach (**Figure 1**). In addition, All of the Lineage 1 isolates tested to date in du Toit's lab have caused leaf spots on the cv. Mandolin but not on Viroflay, whereas all Lineage 2 isolates caused leaf spots on both cultivars.
- **Resistance of Lineage 1 (*Stemphylium vesicarium*) isolates to strobilurin (FRAC 11) fungicides:** *Stemphylium* isolates of Lineage 1 and Lineage 2 were assessed in the lab for sensitivity to two fungicides commonly used in spinach crops, azoxystrobrin (e.g., Quadris) and pyraclostrobin (e.g., Cabrio). The majority of the Lineage 1 isolates tested were from spinach crops in Texas and Florida. All of these isolates were much less sensitive to both fungicides than isolates of lineage 2 (**Figure 2**). This explains the difficulty growers have had controlling *Stemphylium* leaf spot with FRAC 11 fungicides.
- **Differences in susceptibility of spinach cultivars to *Stemphylium* species:** Spinach cultivars provided by Rijk Zwaan (**Table 1**) and Texas growers (**Table 2**) were screened for susceptibility to *Stemphylium* isolates of Lineages 1 and 2. Most spinach cultivars are susceptible to isolates of Lineage 2 (*S. beticola*) but there are distinct differences in susceptibility among cultivars to isolates of Lineage 1, with some cultivars developing no symptoms at all. This corroborates the work of Mou et al. (2008) who demonstrated that all 22 spinach cultivars and 338 spinach Plant Introduction (PI) lines evaluated were susceptible to *S. botryosum* (re-named *S. beticola* = Lineage 2), with quantitative differences among cultivars and PI lines. In contrast, the qualitative differences in susceptibility of spinach cultivars to the isolate of Lineage 1 (*S. vesicarium*) indicates different genetic mechanisms of resistance to the two species of *Stemphylium*. Planting cultivars that are resistant to Lineage 1 (*S. vesicarium*) may be very effective for managing this disease.
- ***Stemphylium* species associated with spinach seed production:** Spinach seed can only be grown in about six regions of the world because of the climatic requirements to produce seed. Spinach seed lots grown in 2018 in each of Denmark, France, the Netherlands, New Zealand, and the U.S. were assessed for the incidence (%) of seed infected with *Stemphylium* (**Table 3**). Isolates of *Stemphylium* obtained from these seed were identified to species. Most isolates from seed produced in Europe and New Zealand (8 or the 10 lots) were from Lineage 1 (*S. vesicarium*), while most isolates from the 2 U.S. seed lots were from Lineage 2 (*S. beticola*). Only 3 of 15 isolates of Lineage 1, and 0 of the 4 isolates of Lineage 2 tested from these seed lots were pathogenic on spinach, i.e., not all *Stemphylium* isolates on spinach seed are pathogens of spinach.
- ***Stemphylium* species causing leaf spots in Washington spinach seed crops in 2020:** Eleven spinach seed crops were surveyed in Washington in 2020. Ten of the crops were infected with isolates of Lineage 2 (*S. beticola*), and 5 were infected with isolates of Lineage 1 (*S. vesicarium*) (**Table 4**). This is the first evidence of Lineage 1 isolates causing spinach leaf spot in Washington. However, some of the isolates of each species were not pathogenic when tested on spinach. A third species, *S.*

drummondii, was isolated from one seed crop and was pathogenic on spinach (**Figure 1**). This species has only previously been reported to cause a leaf spot of spinach in China.

- **Future work:** Two field trials were planted in the Texas Wintergarden area in late 2020 to evaluate the reactions of: 1) 326 Plant Introduction (PI) lines from the USDA spinach germplasm collection, and 2) 79 commercial spinach cultivars when inoculated with Texas isolates of Lineage 1 (*S. vesicarium*). We also will test isolates of both lineages for sensitivity to azoxystrobin and pyraclostrobin in a greenhouse to confirm the lab fungicide test results, and we will screen isolates of the two species for sensitivity to fungicides in other FRAC groups. Furthermore, we are exploring the genetic diversity of Lineage 1 isolates from spinach seed grown in different countries and from spinach crops in Texas.

Acknowledgements

We thank the Texas Wintergarden Spinach Producers' Board, Puget Sound Seed Growers' Association, Washington State Commission on Pesticide Registration, and ARCS Foundation for funding this project; seed company personnel, seed growers, crop consultants, and other agricultural companies for in-kind support of the project; and the Vegetable Seed Pathology team at Washington State University (Michael Derie, Sanjaya Gyawali, Paul Morgan, Eliza Mae Andrews, Alex Batson, Ryan Solemslie, and Marilen Nampijja) for technical support.

For more details, contact Kayla Spawton (kayla.spawton@wsu.edu) or Lindsey du Toit (dutoit@wsu.edu).

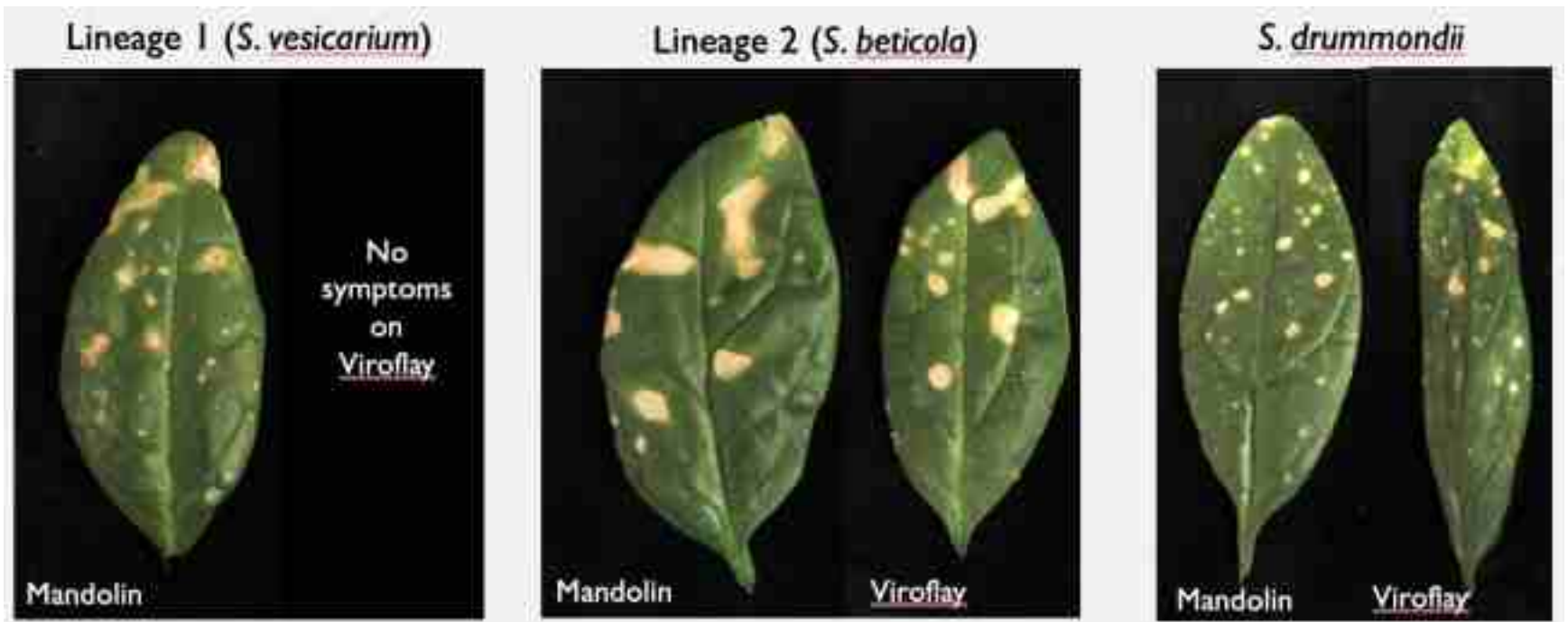


Figure 1: Three *Stemphylium* species detected thus far in the USA that are pathogenic on spinach, and the typical symptoms each causes on the spinach cultivars Mandolin and Viroflay.

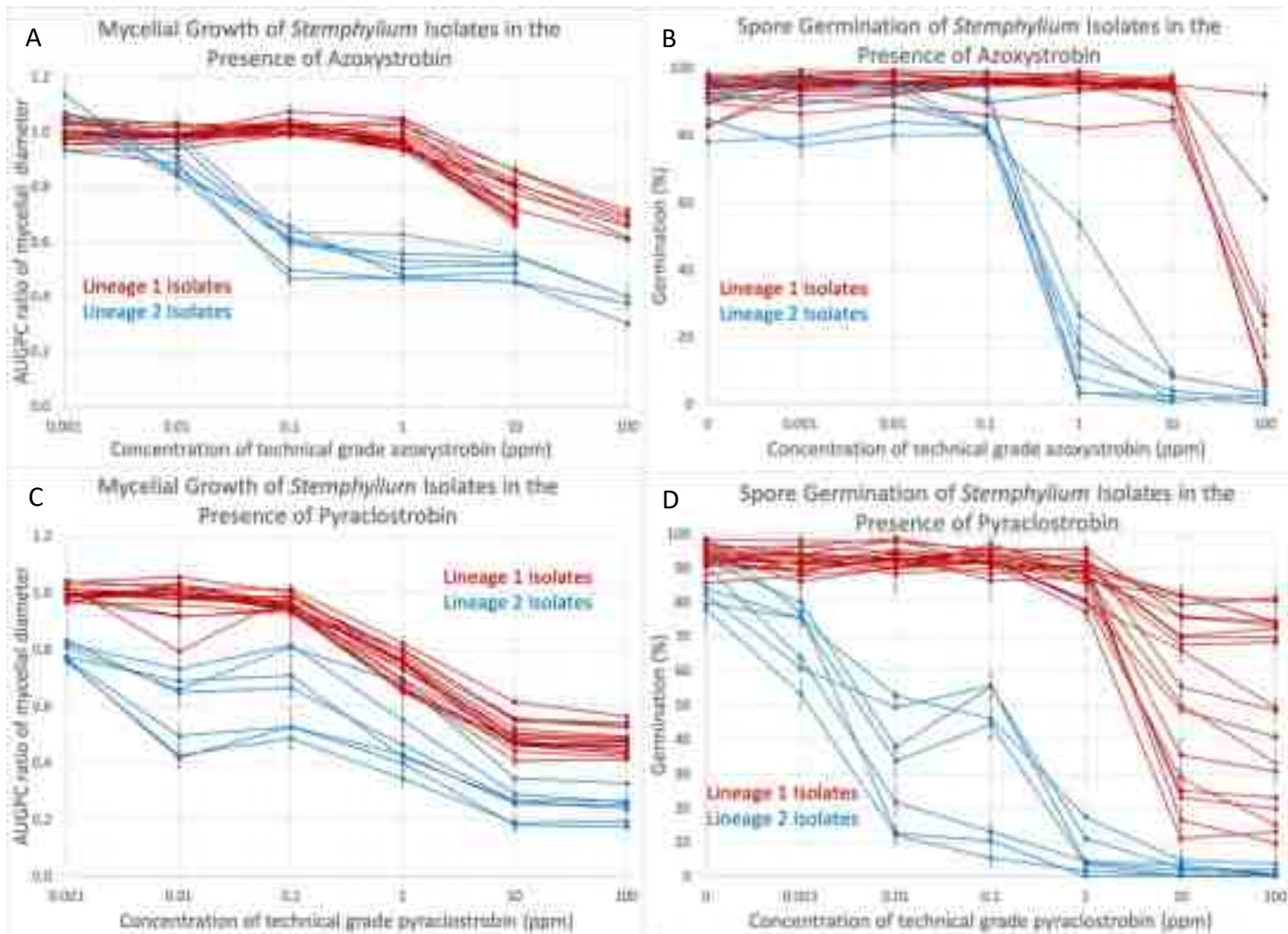


Figure 2: The area under the growth progress curve (AUGPC) of the diameter ratio of mycelial growth (A and C), and percentage of conidia germinated (B and D) of *Stemphylium* isolates of Lineage 1 (red lines = *S. vesicarium*) and Lineage 2 (blue lines = *S. beticola*) growing on agar medium amended with 0.001, 0.01, 0.1, 1, 10, and 100 ppm of azoxystrobin (A and B) or pyraclostrobin (C and D). AUGPC diameter ratio is the ratio of the AUGPC of the average mycelial diameter of an isolate measured after 3, 5, and 7 days of growth on agar medium amended with a given concentration of fungicide compared to the AUGPC of the same isolate growing on medium not amended with fungicide.

Table 1: Mean \pm standard error of the severity of *Stemphylium* leaf spot on spinach cultivars from the seed company Rijk Zwaan, 18 days after inoculation with *Stemphylium* isolates of Lineage 1 (isolate St523) and Lineage 2 (isolate St354).

Spinach cultivar	Inoculated leaf area (%) with spots	
	St523, Lineage 1 (<i>S. vesicarium</i>)	St354, Lineage 2 (<i>S. beticola</i>)
Mandolin	43 \pm 8	5 \pm 0
Viroflay (Sakata) ^a	0	4 \pm 1
Viroflay (Condor) ^a	0	5 \pm 0
Viroflay (PopVriend) ^a	0	5 \pm 0
Meerkat	23 \pm 5	5 \pm 0
Woodpecker	11 \pm 3	1 \pm 1
Parakeet	0	0
Perentie	0	5 \pm 0
Baboon	0	0
Galah	0	3 \pm 1
Bandicoot	0	0
Capybara	0	3 \pm 1

^a Three different seed sources of the open-pollinated cv. Viroflay were used to assess consistency in results among seed lots from different breeding programs.

Table 2: Mean \pm standard error of the severity of *Stemphylium* leaf spot on spinach cultivars used by Texas growers in 2019, 21 days after inoculation with *Stemphylium* isolates of lineage 1 (isolate St523) and lineage 2 (isolate St618).

Spinach cultivar ^a	Inoculated leaf area (%) with spots	
	St523, Lineage 1 (<i>S. vesicarium</i>)	St618, Lineage 2 (<i>S. beticola</i>)
Mandolin	55 \pm 3	15 \pm 6
Viroflay	0	10 \pm 4
A = Perentie (Rijk Zwaan)	0	5 \pm 0
B	0	5 \pm 0
C	40 \pm 14	6 \pm 1
D	0	9 \pm 4
E = Hammerhead (Rijk Zwaan)	65 \pm 3	6 \pm 1
F = Kookaburra (Rijk Zwaan)	50 \pm 6	7 \pm 2
G = Platypus (Rijk Zwaan)	43 \pm 9	5 \pm 0
H	0	6 \pm 1
I = Patton (Bejo)	45 \pm 3	5 \pm 0
J	0	14 \pm 4
K	0	10 \pm 4
L	0	7.5 \pm 2

^a Cultivars were received from Texas growers coded by letters, and the identifies of only some of the cultivar identities was then shared by the growers.

Table 3: Incidence of seed on which *Stemphylium* species were detected for 10 spinach seed lots grown in five countries in 2018. ^a

Lot	Country	Incidence of seed with <i>Stemphylium</i> species (%) ^b	Total # of isolates sequenced	Number of isolates identified to species by sequencing the calmodulin gene (<i>cmdA</i>)					
				Lineage 1, <i>S. vesicarium</i> (% of isolates)	Lineage 2, <i>S. beticola</i> (% of isolates)	<i>S. amaranthi</i>	<i>S. astragali</i>	<i>S. eturmiunum</i>	<i>Stemphylium</i> sp. (species not identified)
1	New Zealand	56	24	16 (67%)	8 (33%)	0	0	0	0
2	New Zealand	45	23	17 (74%)	2 (9%)	0	0	4	0
3	France	23	2	2 (100%)	0	0	0	0	0
4	France	60	37	37 (100%)	0	0	0	0	0
5	USA	34	30	3 (10%)	26 (87%)	0	0	0	1
6	USA	23	16	3 (19%)	13 (81%)	0	0	0	0
7	Denmark	6	5	4 (80%)	0	1	0	0	0
8	Denmark	11	8	7 (88%)	0	0	0	0	1
9	Netherlands	19	13	9 (69%)	0	2	1	0	1
10	Netherlands	5	3	3 (100%)	0	0	0	0	0
Total or average		28	161	101	49	3	1	4	3

^a For each seed lot, 100 seeds were incubated on a semi-selective agar medium and observed microscopically for conidia or pseudothecia typical of *Stemphylium*. *Stemphylium* isolates were identified to species based on the partial sequence of the *cmdA* locus. Numbers in parentheses are the percentage of isolates that were identified to be Lineage 1 or 2.

^b Preliminary data suggests that not all isolates of Lineages 1 and 2 from seed are pathogenic on spinach.

Table 4: Isolates of *Stemphylium* collected from spinach seed crops in northwestern Washington in 2020 that developed symptoms of *Stemphylium* leaf spot.

Crop #	County	Total # of isolates sequenced	Number of isolates identified to species by sequencing the calmodulin gene (<i>cmdA</i>)			
			Lineage 1, <i>S. vesicarium</i> (% of isolates from that field)	Lineage 2, <i>S. beticola</i> (% of isolates from that field)	<i>S. drummondii</i>	<i>Stemphylium</i> sp. (species not identified)
VSP 20-078	Skagit	2	0	2 (100%)	0	0
VSP 20-080	Skagit	23	23 (100%)	0	0	0
VSP 20-091	San Juan	6	0	6 (100%)	0	0
VSP 20-096	Skagit	6	0	6 (100%)	0	0
VSP 20-097	Skagit	10	1 (10%)	9 (90%)	0	0
VSP 20-098	Snohomish	6	1 (17%)	3 (50%)	1	1
VSP 20-101	Skagit	4	0	4 (100%)	0	0
VSP 20-102	Skagit	3	0	3 (100%)	0	0
VSP 20-103	Skagit	5	3 (60%)	2 (40%)	0	0
VSP 20-112	Skagit	6	0	6 (100%)	0	0
VSP 20-128	Skagit	3	2 (67%)	1 (33%)	0	0
Total		74	30 (43%)	42 (57%)	1	1

^a Numbers in parentheses indicate the percentage of isolates identified that belong to Lineages 1 or 2.

Cargile Consulting

Trial ID: Spinach 2021	Location:	Trial Year: 2021
Protocol ID:	Investigator (Creator): Mike Phillips	
Project ID:	Study Director:	
	Sponsor Contact:	

Reps: 3 Appl Code: Plots: 3.33 by 20 feet

Trt No.	Treatment Name	Form Type	Other Rate	Other Rate Unit	Amt Product to Measure	Rep 1	Rep 2	Rep 3
1	UNTREATED CHECK					101	207	310
2	MIRAVIS PRIME	SC	13.4 fl oz/a		3.141 mL/mx	102	209	311
3	INSPIRE	EC	7 fl oz/a		1.641 mL/mx	103	212	304
4	INSPIRE SUPER	SC	20 fl oz/a		4.687 mL/mx	104	211	303
5	LUNA SENSATION	SC	7 fl oz/a		1.641 mL/mx	105	201	306
6	REGALIA	SC	64 fl oz/a		15.0 mL/mx	106	205	312
7	MERIVON	SC	7 fl oz/a		1.641 mL/mx	107	202	305
8	REASON	SC	7 fl oz/a		1.641 mL/mx	108	206	307
9	BAS752 MIBELYA	SC	7 fl oz/a		1.641 mL/mx	109	203	308
10	BAS752 MIBELYA	SC	10 fl oz/a		2.344 mL/mx	110	204	302
11	BAS751 VELTYMA	SC	10 fl oz/a		2.344 mL/mx	111	208	301
12	BAS750 CEVYA	SC	5 fl oz/a		1.172 mL/mx	112	210	309

Sort Order: Application Code, Replicate 1

Product quantities required for listed treatments and applications of trials included in this table:

Amount*	Unit	Treatment Name	Form Conc	Form Unit	Form Type	Lot Code
3.141	mL	MIRAVIS PRIME			SC	
1.641	mL	INSPIRE			EC	
4.687	mL	INSPIRE SUPER			SC	
1.641	mL	LUNA SENSATION			SC	
15.000	mL	REGALIA			SC	
1.641	mL	MERIVON			SC	
1.641	mL	REASON			SC	
3.984	mL	BAS752 MIBELYA			SC	
2.344	mL	BAS751 VELTYMA			SC	
1.172	mL	BAS750 CEVYA			SC	

* 'Per area' calculations based on application amount= 20 GAL/AC, mix size= 0.6 L (mix size basis).

Preliminary results: Fungicides were applied in 20 gallons per acre on 7 (two to three leaf spinach), 18, and 29 January as well as on 8 February. Evaluation of fungicide efficacy was made 8 February on a 0 to 10 scale where 0 =no disease and 10 = all plants dead from disease. At that time, Reason at 7 ounces/a, Merivon at 7 ounces/a, Luna Sensation at 7 ounces/a, and apparently BAS 751 at 10 ounces/a gave nearly complete control of white rust. Stemphyllium had not yet developed when cold weather devastated the test system.

2020 – 2021 Spinach Fungicide Trial for White Rust control

Larry A. Stein, Texas A&M AgriLife Extension Service

1.	Untreated check
2.	Life Gard 2 oz alt. Merivon 7 oz alt. Miravis Prime 13.4
3.	Life Gard 2 oz alt. Presidio 3 oz alt. Merivon 7 oz
4.	Life Gard 2 oz alt. Merivon 7 oz alt. Reason 7 oz
5.	BAS 752 (Mibelya) 7 ounces/A
6.	BAS 751 (Veltyma) 10 ounces/A
7.	BAS 750 (Cevya) 5 oz/A
8.	Life Gard 2 oz alt. Prophyt 1.5 qts/A plus Presidio 3 oz alt. Oso 8.5 oz

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*A **HUGE** thank you to all who helped us get ready for this field day, especially the sponsors listed in your program. No doubt, without their help, this would not be possible!!*

2020 – 2021 Spinach Trial Tiro Tres Farms Crystal City, TX



2021 Spinach Research Trial

Photo provided by: Julia Paige Ritchie, Tiro Tres Farms