The Effect of Biopreparations and Biostimulants on the Chemical Composition and Microorganisms Associated with Verticillium Wilt of Horseradish Roots (*Armoracia rusticana* Gaertn.)

Katarzyna Gleń-Karolczyk, Elżbieta Boligłowa, Agnieszka Filipiak-Florkiewicz, Adam Florkiewicz and Lidia Luty

3. Results and Discussions

3.2. Microorganisms Related to Verticillium Wiltof Horseradish Roots

3.2.1. Quantitative Analysis of Microorganisms Colonizing Horseradish Roots Affected by Verticillium Wilt

In the analysed years, the smallest number (i.e., lowest richness) of species, namely 26, was recorded in the warmest season with the highest water deficit—i.e., in 2015 (Supplementary Table S1). On the other hand, in the years 2016–2017, along with the increase in recorded precipitation, the species richness increased to 37 (Table 5, Supplementary Table S2).

Table S1. Frequency of species in microbial communities isolated from horseradish roots in the years 2015-2017.

Species of fungi	Year		
	2015	2016	2017
A. strictum		0.14	0.37
A. niger		0.55	0.25
A. terreus	0.18	0.41	0.37
A. brassicae	10.65	4.84	1.86
A. alternata	3.79	1.38	1.49
B. cinerea	1.08	2.35	1.73
C. globosum	0.72	1.24	0.62
C. rosea		0.14	0.37
C. lunata	0.90	1.52	2.23
C. acutatum	2.53	2.49	1.24
E. nigrum	4.87	4.43	8.18
F. acuminatum	9.75	3.60	2.60
F. avenaceum	1.62	4.01	1.73
F. culmorum	1.62	0.69	0.50
F. equiseti	2.53	3.32	3.97
F. proliferatum	4.33	4.84	3.35
F. solani	2.71	4.01	2.60
F. incarnatum	3.43	1.94	0.87
F. sambucinum	0.90	0.97	1.98
F. oxysporum	0.54	1.38	1.12
I. destructans	4.15	7.05	10.16
P. expansum		3.60	2.11
P. verrucosum		0.28	0.87
Penicillium spp.		0.97	1.36
P. herbarum		0.69	0.37
D. glomerata		0.55	1.12
J. eupyrena	1.81	0.69	0.37

U. consortiale	0.18	1.11	0.87
S. sclerotiorum		2.07	3.47
T. viride		2.35	2.85
V. albo-atrum	2.89	0.28	1.24
V. dahliae	28.16	19.23	13.75
R. solani	1.81	5.95	10.90
Rh. stolonifer	1.26	0.41	1.49
Rhizomucor spp.		0.28	0.74
Mucor spp.	0.36	0.55	0.62
Total fungi	92.78	90.32	89.71
G. irregulare	4.87	7.88	8.80
Unknown microorganisms	2.35	1.80	1.49
S	26	37	37
Explanations		– Eudominants (>10%)	
		– Dominants (5.1–10%)	
		– Subdominants (2.1–5)	
		– Recedents (1.1–2%)	
		– Subrecedents (<1%)	

Table S2. Frequency of species in microbial communities isolated from horseradish roots in depending of treatments protection.

Species of fungi	**Protection treatments**					
	ChP	**RChP**	**BPPo**	**BPBs**	**BPEm**	**Control**
A. strictum			0.14	0.40	0.38	
A. niger		0.38	0.55	0.81	0.38	
A. terreus			0.27	0.81	0.38	0.32
A. brassicae		4.41	6.55	2.43	3.66	6.15
A. alternata	2.14	4.61	1.77	0.81	0.76	4.37
B. cinerea		0.77	1.09	0.40	3.03	1.94
C. globosum		1.54	1.36	0.40	1.39	
C. rosea			0.41	1.21	0.25	
C. lunata	2,14	0,77	1.91	1.62	2.14	1.29
C. acutatum		2,88	1.77	1.21	1.89	3.07
E. nigrum	3.57	0.96	8.73	12.55	8.07	1.94
F. acuminatum	5.71	7.87	4.37	0.81	5.67	9.87
F. avenaceum	3.57	4.41	0.95		0.63	5.50
F. culmorum	1.43	1.34	0.95		0.88	1.29
F. equiseti	3.57	3.26	3.14	3.64	2.65	4.21
F. proliferatum	2.86	3.45	3.55	4.45	4.41	3.24
F. solani	1.43	1.92	2.59	1.62	4.29	3.40
F. incarnatum		0.19	1.36	1.21	3.03	2.75
F. sambucinum	3.57	1.34	1.91	1.21	0.76	1.46
F. oxysporum			0.95	0.81	2.14	0.49
I. destructans	10.01	8.64	6.55	9.31	8.95	3.56
P. expansum	4.29	4.03	2.86	1.62	2.52	0.49
P. verrucosum	2.14	0.58	0.41	0.81	0.38	
Penicillium spp.			1.09	2.02	1.77	
P. herbarum		0.19	0.41		0.25	
D. glomerata			0.82	0.81	0.25	0.81
J. eupyrena	0.71	0.58	0.68		1.39	
U. consortiale	1.43	0.58	0.68	0.40	1.01	

S. sclerotiorum		2.69	3.82	4.86	2.40	0.81
T. viride			0.95	2.02	5.17	0.65
V. albo-atrum	2.14	1.73	1.50	0.40	1.64	1.29
V. dahliae	13.57	19.96	20.70	19.03	11.22	25.57
R. solani	20.00	8.25	5.46	8.50	4.79	5.83
Rh. stolonifer		0.58	1.50	2.02	1.51	
Rhizomucor spp.			0.95	2.43	0.13	
Mucor spp.		0.19	0.14		0.88	
Total fungi	84.28	88.10	92.90	90.69	91.05	90.29
G. irregulare	12.86	9,21	6.28	8.91	6.18	7.93
Unknown microorganisms	2.86	2.69	0.82	0.40	2.77	1.78
S	19	29	37	32	37	25
Explanations		– Eudominants (>10%)				
		– Dominants (5.1–10%)				
		– Subdominants (2.1–5)				
		– Recedents (1.1–2%)				
		– Subrecedents (<1%)				