Appendix 1: Supplementary figures and tables

Table A1.1: Institutions coordinating area-wide management of ACP in Southern California.

County	Institution	History	Citrus acreage	Assessment rate (2018)	Coordinated treatments	Number of management units	Using PMAs?	Participation in AWM	Challenges	Other activities
Imperial	Imperial County Citrus Pest Control District	Formed in 1972 for California red scale (*Aonidiella aurantii*) control[†]. Expanded in 2013 to the whole county for ACP and HLB control[‡]	7,200	$15 / acre	Fall (Aug-Oct, Winter (Dec-Jan), Spring (Feb-Apr)	7 (6 after 2020)	No, PCD growing zones	High	ACP from across the Mexican border	Outreach, trap monitoring, coordination with Mexican authorities
Riverside	Citrus Pest Control District No. 2 (Coachella Valley)	Formed in 1946 for California red scale control[§]	8,000	$150 / acre	Fall (Sep-Oct), Winter (Dec-Jan)	4	No, four zones	High, reimbursing for treatments	Reinfestation from residential areas	Tree removal, biocontrol
	Citrus Pest Control	Formed in 2017 for ACP and	2,134	$100/acre	Fall (Sep), Winter (Dec-Jan)	2	No, two zones	Very high, three growers.	Reinfestation from	Funding some activities in

	District No. 3 (Hemet)	HLB control						Reimbursing for treatments	residential areas	residential areas
	Rest of the county	No entity directing the sprays	1,500	None	Fall, Winter			Low, not tracked	Absentee owners, small growers	UC Riverside promoting participation
San Bernardino	San Bernardino ACP/HLB Task Force	Formed in 2014[‖]	3,000	None	Fall (Oct-Nov), Winter (Nov-Dec), Spring (May-Jul)	19	Yes	Variable	Small growers, scarcity of PCOs, urban interface, water supply, bad actors	Grower liaison in contact with homeowners, reporting abandoned trees
San Diego	San Diego County Citrus Pest Control District	Formed in 2017 for ACP and HLB control[#]	4,500	$180 / acre	Fall (Aug-Sep), Winter (Jan), Spring (May-Jun)	3	No, three areas (Borrego Springs, San Pasqual, Pauma/Pala Valley)	Variable when it was voluntary. Now higher because of assessment reimbursements	Problems with organic treatments, small growers	County authorities monitor abandoned trees and try to remove them
Santa Barbara	Advisory committee	Formed in 2015 for ACP and HLB control[¶]	4,425	None	Fall (Sep), Winter (Jan)	12 (11 after 2019)	No, treating by cities	High	Weather, small properties	

Ventura	Ventura ACP/HLB Task Force	Formed in 2010 for ACP and HLB control[††]	25,000	None	Fall (Jul-Sep + Sep-Nov), Winter (Jan-Mar), Spring (Apr-Jun)	50	Yes	High	Spraying equipment shortage, continuous harvest, weather, movement of fruit	Outreach campaign in residential areas, reporting system for abandoned trees

[†] Margo Sanchez, pers. comm.

[‡] Mark McBroom, pers. comm.

[§] Baker, B. P. 1988. Pest Control in the Public Interest: Crop Protection in California. *UCLA Journal of Environmental Law and Policy* 8(1):31–71

[|] Bob Atkins, pers. comm.

[¶] Cressida Silvers, pers. comm.

[#] SDCCPCD. 2021. About Us. https://sdccpcd.specialdistrict.org/about-us.

[††] John Krist, pers. comm.

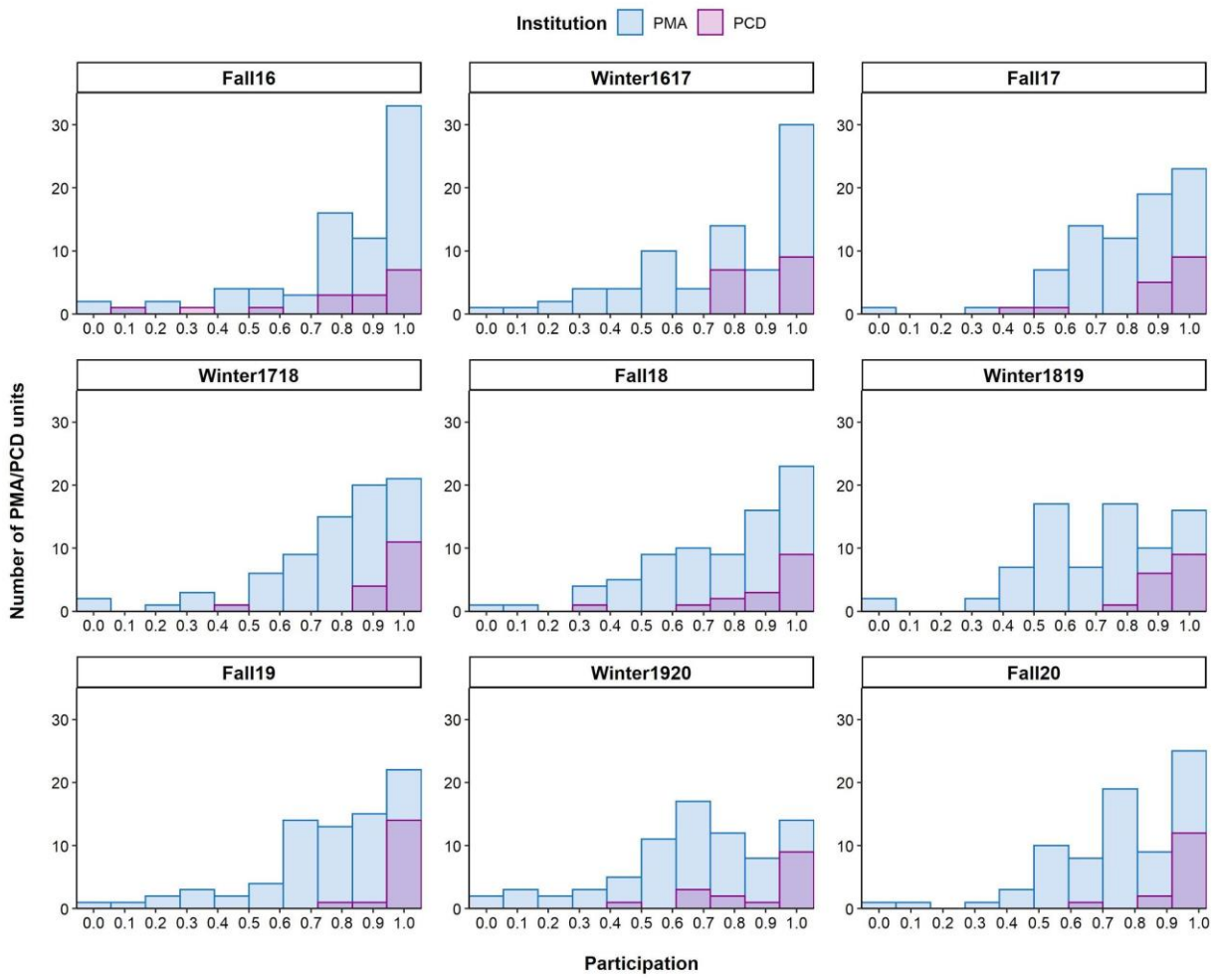

Fig. A1.1: Histogram of participation levels in area-wide management in Psyllid Management Areas (blue) and Pest Control Districts (purple) over nine seasons.

Table A1.2: Socio-economic characteristics of the survey respondents who indicated that they had citrus groves in Southern California (n =98).

Survey item	Responses
Role in citrus production	
Grove Owner	38
Ranch Manager	17
PCA	18
PCO	2
Other	18
NA	5
Farm size	
< 5 acres	23
5 – 25 acres	18
26 – 100 acres	11
101 – 500 acres	13
> 500 acres	28
NA	5
Age	
<35 years	12
35 - 50 years	14
51 – 65 years	37
> 65 years	35
Management system	
Conventional	59
Organic	13
Both	23
NA	3

Income from citrus	
< 25%	40
26 - 50%	13
51 - 75%	16
76 - 100%	23
NA	6

Note: Pest Control Adviser (PCA), Pest Control Operator (PCO), no answer (NA)

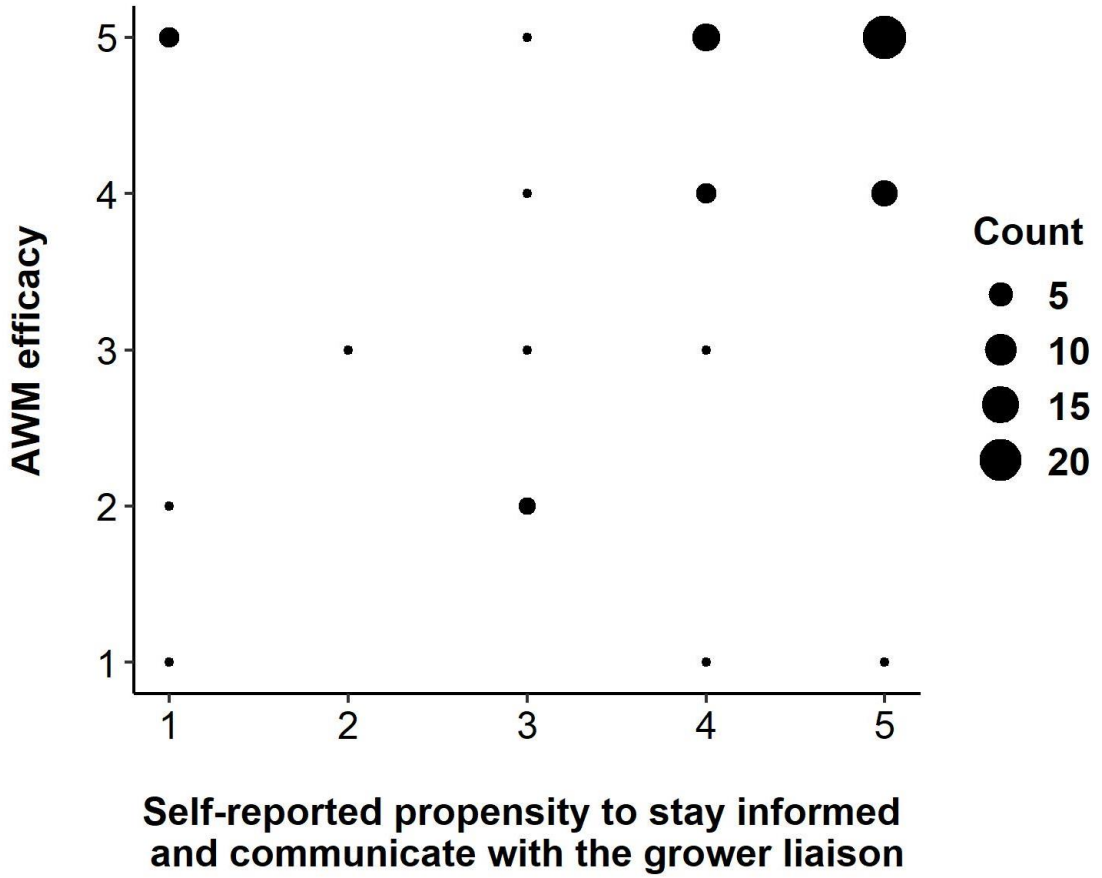

Fig. A1.2: Relationship between the self-reported propensity to stay informed and communicate with the grower liaison and the belief that coordinated insecticide treatments for ACP will slow down HLB spread more than uncoordinated treatments (AWM efficacy). Responses to the survey questions were transformed to numeric so that *very unlikely* = 1, *unlikely* = 2, *maybe* = 3, *likely* = 4, *very likely* = 5. The size of the points represents the number of participants who chose that combination of responses.

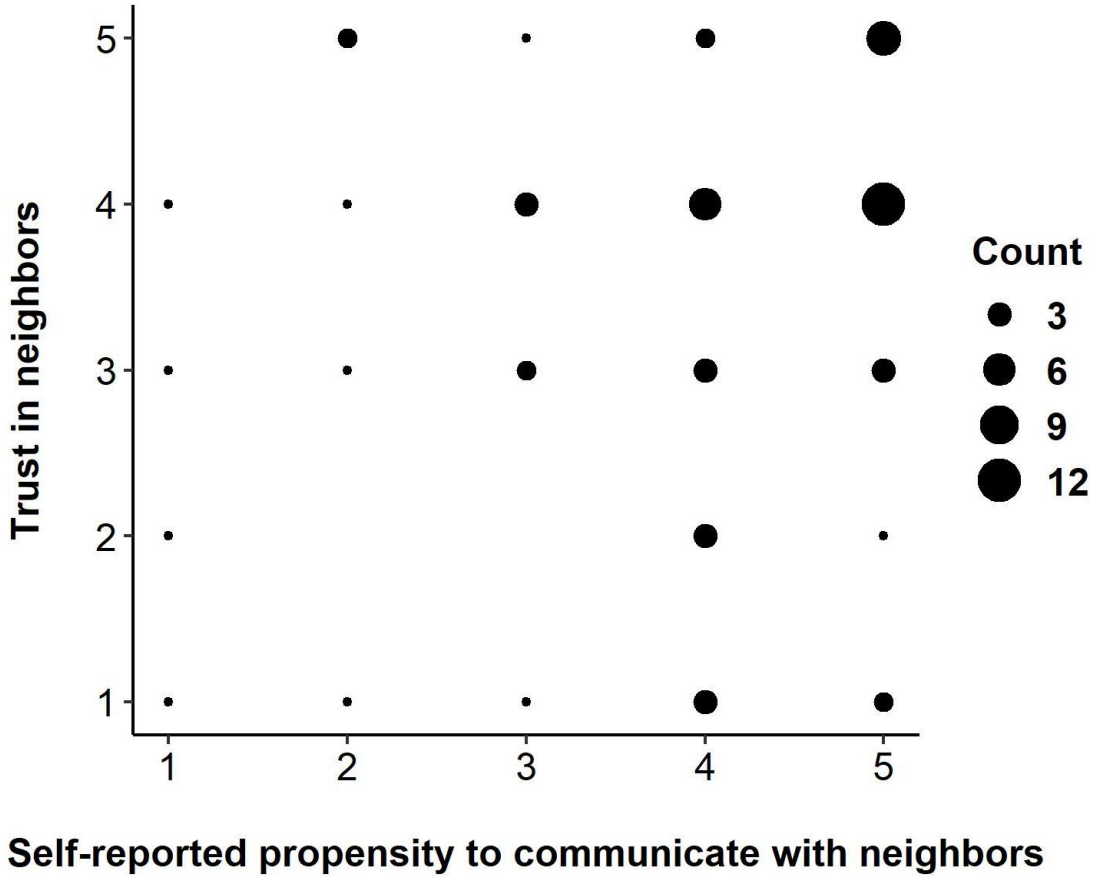

Fig. A1.3: Relationship between the self-reported propensity to communicate with neighbors and the belief that neighbors will apply insecticides for ACP within the recommended treatment window (trust in neighbors). Responses to the survey questions were transformed to numeric so that *very unlikely* = 1, *unlikely* = 2, *maybe* = 3, *likely* = 4, *very likely* = 5. The size of the points represents the number of participants who chose that combination of responses

Table A1.3: Posterior mean and 95% credible interval for the parameters in the zoib regression models evaluated that were more complex than the selected model (SD28).

		SD22	SD22	SD22	SD23	SD23	SD23	SD24	SD24	SD24	SD19	SD19	SD19	SD28	SD28	SD28
		mean	2.5%	97.5 %	mean	2.5%	97.5 %	mean	2.5%	97.5 %	mean	2.5%	97.5 %	mean	2.5%	97.5 %
logit (mean)	Institutional approach†	-1.08	-1.67	-0.52	-1.08	-1.61	-0.53	-1.06	-1.63	-0.50	-0.68	-1.21	-0.13	-1.09	-1.65	-0.57
	Group size	-0.01	-0.02	0.00	-0.01	-0.02	0.00	-0.01	-0.02	0.00	-0.01	-0.02	-0.01	-0.01	-0.02	0.00
	Size of resource system	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Grove size	0.10	0.06	0.14	0.10	0.07	0.14	0.10	0.06	0.15	0.08	0.04	0.12	0.10	0.06	0.14
	Heterogeneity	0.08	0.05	0.12	0.09	0.05	0.12	0.09	0.05	0.12	0.12	0.08	0.15	0.08	0.05	0.12
	Season‡	-0.18	-0.32	-0.04	-0.17	-0.30	-0.04	-0.17	-0.29	-0.03	-0.16	-0.29	-0.03	-0.17	-0.30	-0.05
	Age	-0.07	-0.10	-0.04	-0.07	-0.10	-0.05	-0.07	-0.10	-0.05	-0.07	-0.10	-0.05	-0.07	-0.10	-0.05
	Institution† x Age	0.17	0.10	0.25	0.17	0.09	0.25	0.17	0.09	0.25	0.18	0.09	0.26	0.17	0.10	0.25
	Grove size x Heterogeneity	-0.01	-0.01	0.00	-0.01	-0.01	0.00	-0.01	-0.01	0.00	-0.01	-0.01	0.00	-0.01	-0.01	0.00
	Intercept	0.43	0.06	0.78	0.40	0.07	0.73	0.42	0.07	0.77	0.46	0.12	0.81	0.43	0.11	0.79
log(dispersion)	Institutional approach†	-0.81	-1.32	-0.30	-0.81	-1.32	-0.33	-0.80	-1.30	-0.31				-0.81	-1.30	-0.38
	Group size	0.03	0.02	0.04	0.03	0.02	0.04	0.03	0.02	0.04	0.03	0.03	0.04	0.03	0.02	0.04
	Size of resource system	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				0.00	0.00	0.00
	Grove size	0.06	0.02	0.11	0.06	0.02	0.11	0.06	0.01	0.10				0.06	0.02	0.10
	Heterogeneity	-0.05	-0.09	-0.01	-0.05	-0.09	-0.02	-0.05	-0.09	-0.01				-0.05	-0.08	-0.02

	Season‡	-0.07	-0.27	0.13												
	Age	0.00	-0.03	0.04												
	Intercept	0.90	0.56	1.27	0.88	0.60	1.15	0.89	0.60	1.17	1.07	0.91	1.23	0.88	0.62	1.13
logit(P(1))	Institutional approach†	-92.64	-221.71	-6.68	-34.93	-85.72	-3.62	-46.39	-119.37	-3.70				-67.45	-188.90	-4.66
	Group size	-0.69	-1.21	-0.29	-0.61	-1.01	-0.31	-0.59	-1.07	-0.28	-0.49	-0.87	-0.22	-0.58	-0.93	-0.30
	Size of resource system	0.00	0.00	0.00												
	Grove size	-0.02	-0.15	0.10												
	Heterogeneity	0.04	-0.12	0.19							-0.01	-0.13	0.10			
	Season‡	0.51	-0.86	1.85												
	Age	-0.13	-0.40	0.13												
	Intercept	-1.06	-3.25	0.93	-1.37	-2.35	-0.43	-1.41	-2.45	-0.37	-2.13	-3.42	-0.96	-1.43	-2.38	-0.51
logit(P(0))	Institutional approach†	-0.22	-0.91	0.49												
	Group size	-0.31	-0.39	-0.24	-0.30	-0.37	-0.24	-0.32	-0.39	-0.26	-0.28	-0.34	-0.23	-0.32	-0.38	-0.27
	Size of resource system	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
	Grove size	0.08	0.04	0.13	0.08	0.04	0.13	0.05	0.02	0.08	0.07	0.05	0.10			
	Heterogeneity	-0.05	-0.11	0.00	-0.05	-0.10	0.00							0.03	0.00	0.06
	Season‡	-0.36	-0.82	0.08												
	Age	-0.08	-0.17	0.00												
	Intercept	0.50	-0.27	1.30	-0.13	-0.74	0.46	-0.20	-0.77	0.36	-0.34	-0.91	0.22	0.54	0.10	1.04
	DIC	1679813			1679811			1679814			1679852			1679849		

Multivariate psrf	1.39	1.05	1.20	1.01	1.10

Note: deviance information criterion (DIC), potential scale reduction factor (prsf)

† Institutional approach was modeled as a factor, considering PMA as the baseline

‡ Season of treatment was modeled as a factor, considering Fall as the baseline

Table A1.4: Posterior mean and 95% credible interval for the parameters in the zoib regression models evaluated that were less complex than the selected model (SD28).

		SD27	SD27		SD29	SD29		SD30	SD30		SD31	SD31		SD13	SD13		SD21	SD21		SD0	SD0	SD0
		mean	2.5%	97.5%	mean	2.5%	97.5%	mean	2.5%	97.5%	mean	2.5%	97.5%	mean	2.5%	97.5%	mean	2.5%	97.5%	mean	2.5%	97.5%
logit (mean)	Institutional approach†	-1.08	-1.64	-0.51	-1.34	-1.89	-0.83	-0.24	-0.68	0.20	-0.54	-0.97	-0.13	-0.67	-1.17	-0.13	-0.58	-1.13	-0.03			
	Group size	-0.01	-0.02	0.00	-0.02	-0.02	-0.01	-0.01	-0.02	0.00	-0.02	-0.02	-0.01	-0.01	-0.02	-0.01	-0.02	-0.03	-0.01			
	Size of resource system	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
	Grove size	0.10	0.07	0.14	0.03	0.00	0.06	0.10	0.06	0.14	0.03	0.00	0.05	0.08	0.04	0.12	0.09	0.05	0.12			
	Heterogeneity	0.08	0.04	0.12	0.02	-0.01	0.05	0.08	0.05	0.12	0.02	-0.01	0.05	0.12	0.08	0.15	0.13	0.09	0.16			
	Season‡	-0.17	-0.29	-0.04	-0.15	-0.28	-0.02	-0.17	-0.30	-0.04	-0.15	-0.28	-0.03	-0.16	-0.29	-0.03	-0.16	-0.30	-0.02			
	Age	-0.07	-0.10	-0.05	-0.07	-0.10	-0.05	-0.06	-0.08	-0.03	-0.06	-0.08	-0.03	-0.07	-0.10	-0.05	-0.07	-0.10	-0.04			
	Institution† x Age	0.17	0.09	0.25	0.16	0.08	0.24							0.18	0.09	0.26	0.17	0.08	0.26			
	Grove size x Heterogeneity	-0.01	-0.01	0.00				-0.01	-0.01	0.00				-0.01	-0.01	0.00	-0.01	-0.01	0.00			

	Intercept	0.41	0.07	0.76	1.05	0.79	1.30	0.34	-0.01	0.69	0.96	0.71	1.23	0.47	0.12	0.81	0.51	0.17	0.86	1.06	0.98	1.15
log (dispersion)	Institutional approach†	-0.82	-1.32	-0.33	-0.88	-1.38	-0.40	-0.89	-1.38	-0.41	-0.95	-1.44	-0.44									
	Group size	0.03	0.02	0.04	0.03	0.02	0.04	0.03	0.02	0.04	0.03	0.02	0.04	0.03	0.03	0.04						
	Size of resource system	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00									
	Grove size	0.06	0.02	0.11	0.06	0.02	0.10	0.07	0.03	0.11	0.07	0.03	0.11									
	Heterogeneity	-0.05	-0.09	-0.02	-0.06	-0.10	-0.02	-0.06	-0.09	-0.02	-0.06	-0.10	-0.03									
	Season‡																					
	Age																					
	Intercept	0.88	0.60	1.16	0.87	0.60	1.16	0.87	0.59	1.14	0.87	0.59	1.14	1.07	0.91	1.23	1.53	1.42	1.63	1.24	1.14	1.34
logit (P(1))	Institutional approach†																					
	Group size	-0.47	-0.83	-0.23	-0.48	-0.89	-0.23	-0.47	-0.84	-0.22	-0.51	-0.91	-0.24	-0.49	-0.85	-0.22						
	Size of resource system																					
	Grove size																					
	Heterogeneity																					
	Season‡																					
	Age																					
	Intercept	-2.22	-3.12	-1.36	-2.17	-3.10	-1.31	-2.21	-3.12	-1.35	-2.14	-3.06	-1.27	-2.17	-3.10	-1.30	-4.37	-5.00	-3.79	-4.37	-5.03	-3.79
logit (P(0))	Institutional approach†																					
	Group size	-0.32	-0.38	-0.27	-0.32	-0.38	-0.26	-0.32	-0.38	-0.26	-0.32	-0.38	-0.26	-0.31	-0.37	-0.26						
	Size of resource system																					

Grove size																			
Heterogeneity	0.03	0.00	0.07	0.03	0.00	0.07	0.03	0.00	0.07	0.03	0.00	0.07							
Season‡																			
Age																			
Intercept	0.53	0.06	1.01	0.53	0.05	1.00	0.53	0.05	1.02	0.53	0.05	1.03	0.89	0.55	1.25	-1.43	-1.61	-1.25	-1.43	-1.60	-1.26
DIC	1679860			1679885			1679877			1679900			1679883			1680225			1680402		
Multivariate psrf	1.04			1.02			1.05			1.05			1.02			1.05			1		

Note: deviance information criterion (DIC), potential scale reduction factor (prsf)

† Institutional approach was modeled as a factor, considering PMA as the baseline

‡ Season of treatment was modeled as a factor, considering Fall as the baseline

Table A1.5: Posterior mean and 95% credible interval for the parameters in the selected zoib regression model (SD28) with the size of the resource system, and the model without this independent variable (SD32).

		SD28 mean	SD28 2.5%	SD28 97.5%	SD32 mean	SD32 2.5%	SD32 97.5%
logit(mean)	Institutional approach†	-1.09	-1.65	-0.57	-0.65	-1.17	-0.13
	Group size	-0.01	-0.02	0.00	-0.01	-0.01	0.00
	Size of resource system	0.00	0.00	0.00			
	Grove size	0.10	0.06	0.14	0.13	0.09	0.16
	Heterogeneity	0.08	0.05	0.12	0.10	0.07	0.13
	Season‡	-0.17	-0.30	-0.05	-0.17	-0.31	-0.04
	Age	-0.07	-0.10	-0.05	-0.07	-0.10	-0.05
	Institution† x Age	0.17	0.10	0.25	0.17	0.09	0.26
	Grove size x Heterogeneity	-0.01	-0.01	0.00	-0.01	-0.01	-0.01
	Intercept	0.43	0.11	0.79	0.26	-0.06	0.58
log(dispersion)	Institutional approach†	-0.81	-1.30	-0.38	-0.42	-0.82	0.01
	Group size	0.03	0.02	0.04	0.04	0.03	0.05
	Size of resource system	0.00	0.00	0.00			
	Grove size	0.06	0.02	0.10	0.07	0.03	0.11
	Heterogeneity	-0.05	-0.08	-0.02	-0.05	-0.08	-0.02
	Season‡						
	Age						

	Intercept	0.88	0.62	1.13	0.88	0.62	1.15
logit(P(1))	Institutional approach[†]	-67.45	-188.90	-4.66	-53.65	-126.63	-3.99
	Group size	-0.58	-0.93	-0.30	-0.58	-0.94	-0.30
	Size of resource system						
	Grove size						
	Heterogeneity						
	Season[‡]						
	Age						
	Intercept	-1.43	-2.38	-0.51	-1.42	-2.39	-0.47
logit(P(0))	Institutional approach[†]						
	Group size	-0.32	-0.38	-0.27	-0.32	-0.37	-0.27
	Size of resource system						
	Grove size						
	Heterogeneity	0.03	0.00	0.06	0.03	0.00	0.07
	Season[‡]						
	Age						
	Intercept	0.54	0.10	1.04	0.54	0.06	1.04
	DIC	1679849			1679861		
	Multivariate psrf	1.10			1.33		

Note: deviance information criterion (DIC), potential scale reduction factor (prsf)

[†] Institutional approach was modeled as a factor, considering PMA as the baseline

[‡] Season of treatment was modeled as a factor, considering Fall as the baseline

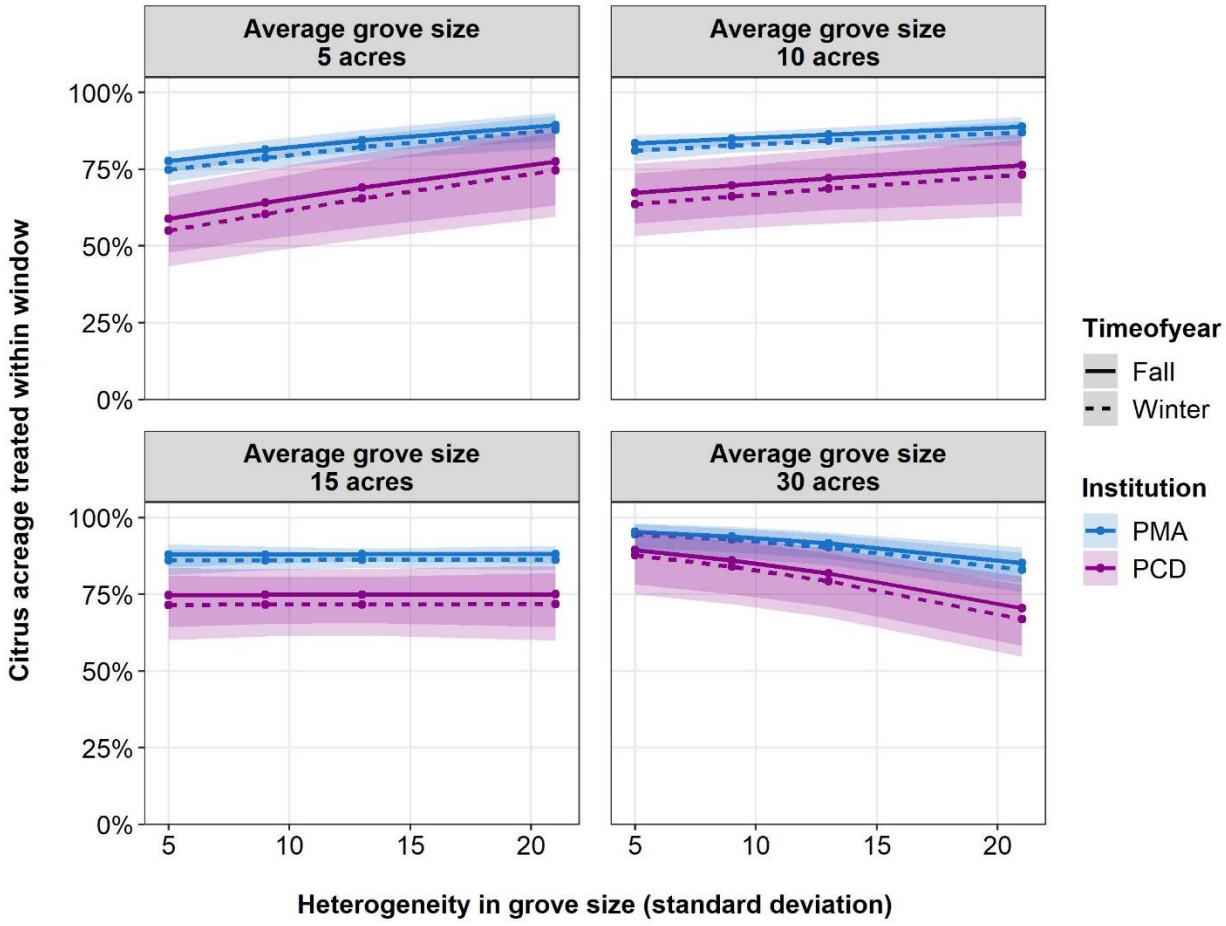

Fig. A1.4: Participation levels in AWM predicted by the zoib model depending on the average size of the citrus groves and their heterogeneity. The mean of the predicted values for season number 1 is shown in blue (PMAs) or in purple (PCDs). Predicted values for the fall treatments are linked by solid lines and predicted values for the winter treatments are linked by dashed lines. The panels show different average sizes of the citrus groves in an AWM unit.

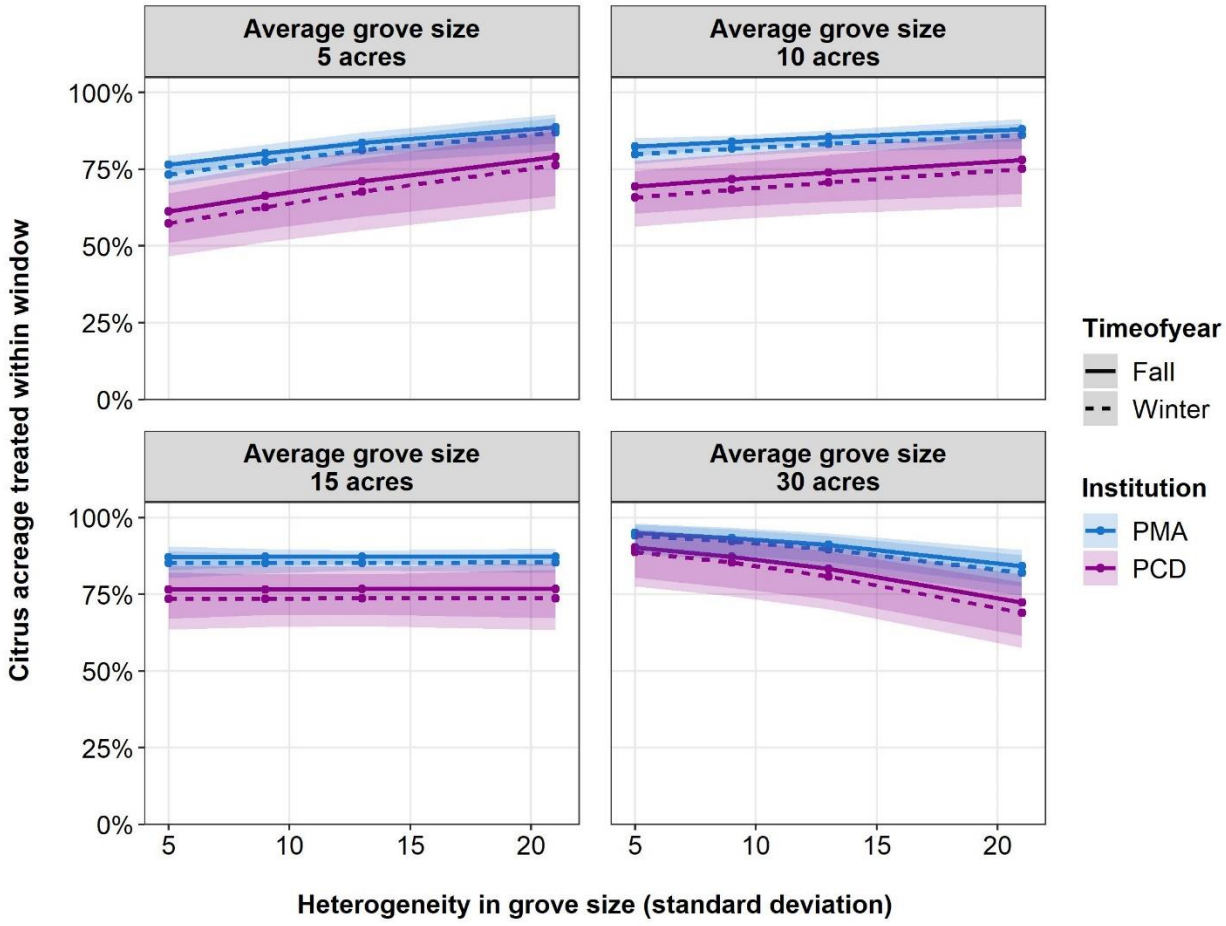

Fig. A1.5: Participation levels in AWM predicted by the zoib model depending on the average size of the citrus groves and their heterogeneity. The mean of the predicted values for season number 2 is shown in blue (PMAs) or in purple (PCDs). Predicted values for the fall treatments are linked by solid lines and predicted values for the winter treatments are linked by dashed lines. The panels show different average sizes of the citrus groves in an AWM unit.

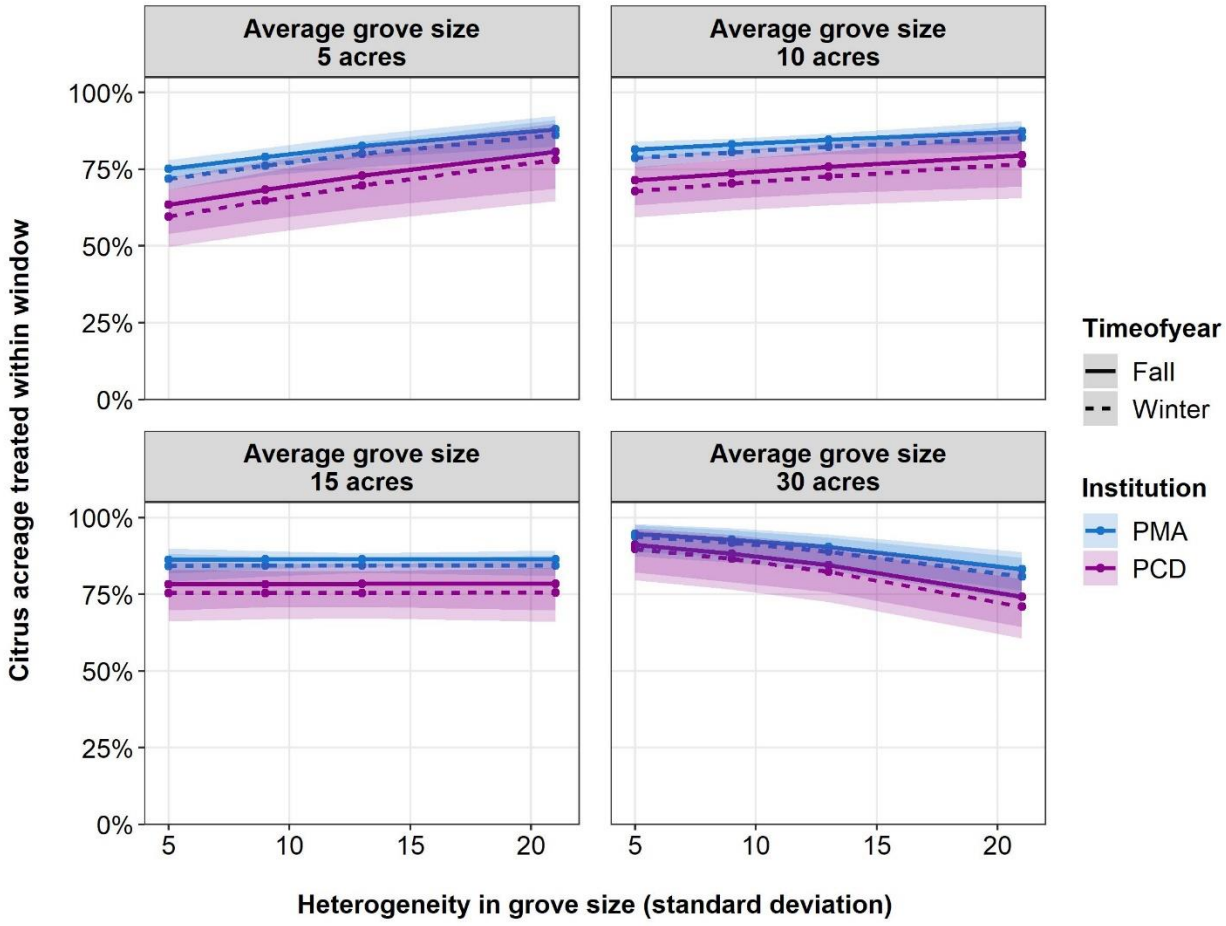

Fig. A1.6: Participation levels in AWM predicted by the zoib model depending on the average size of the citrus groves and their heterogeneity. The mean of the predicted values for season number 3 is shown in blue (PMAs) or in purple (PCDs). Predicted values for the fall treatments are linked by solid lines and predicted values for the winter treatments are linked by dashed lines. The panels show different average sizes of the citrus groves in an AWM unit.

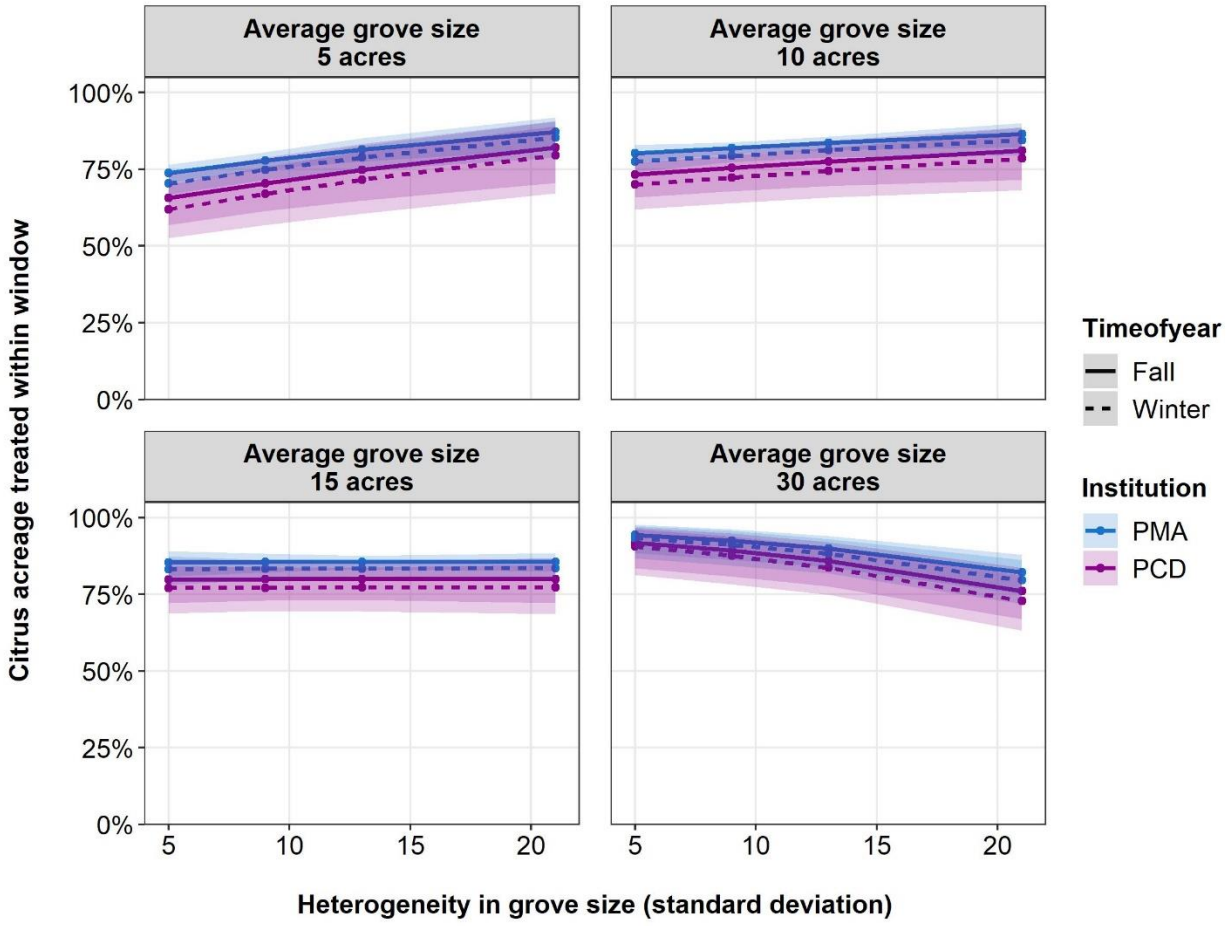

Fig. A1.7: Participation levels in AWM predicted by the zoib model depending on the average size of the citrus groves and their heterogeneity. The mean of the predicted values for season number 4 is shown in blue (PMAs) or in purple (PCDs). Predicted values for the fall treatments are linked by solid lines and predicted values for the winter treatments are linked by dashed lines. The panels show different average sizes of the citrus groves in an AWM unit.

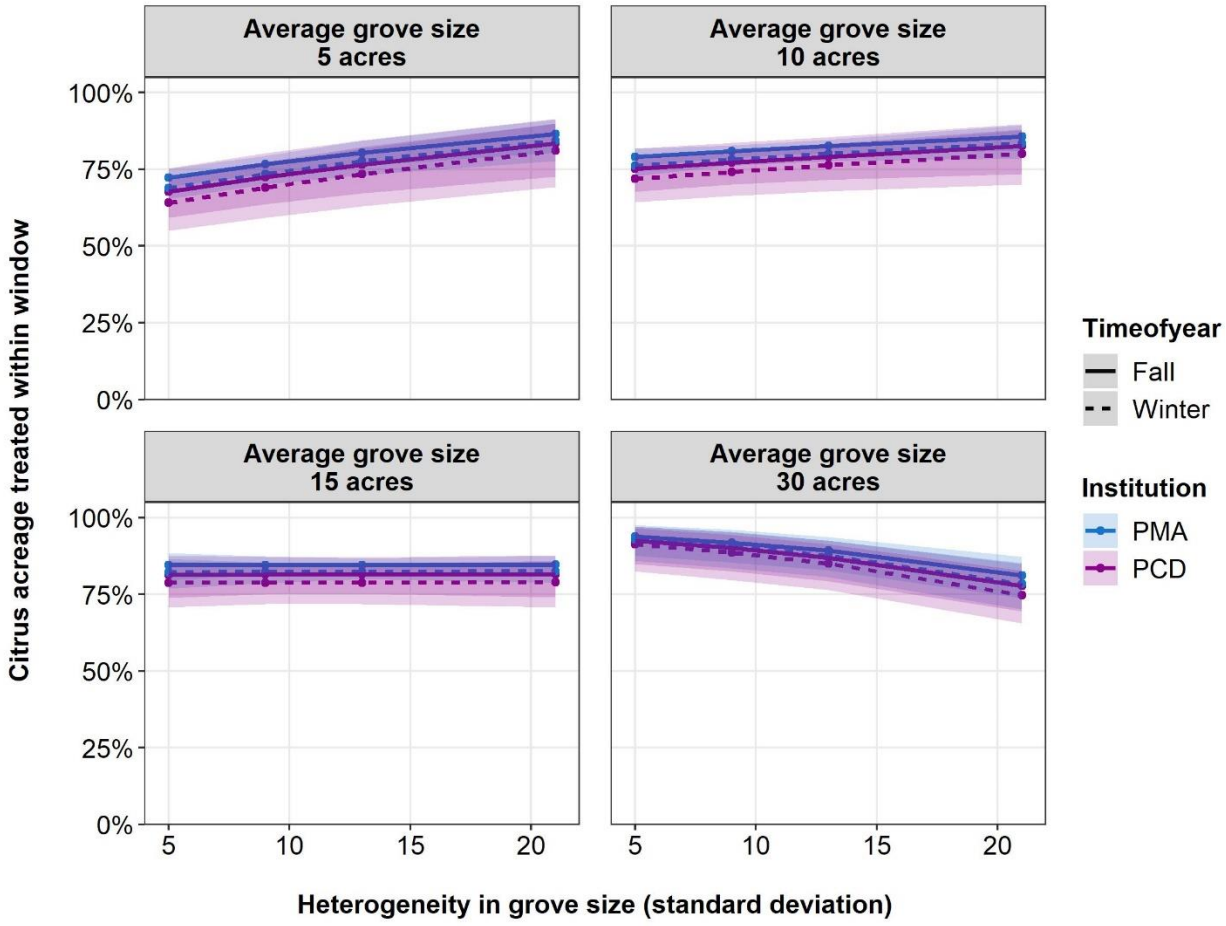

Fig. A1.8: Participation levels in AWM predicted by the zoib model depending on the average size of the citrus groves and their heterogeneity. The mean of the predicted values for season number 5 is shown in blue (PMAs) or in purple (PCDs). Predicted values for the fall treatments are linked by solid lines and predicted values for the winter treatments are linked by dashed lines. The panels show different average sizes of the citrus groves in an AWM unit.

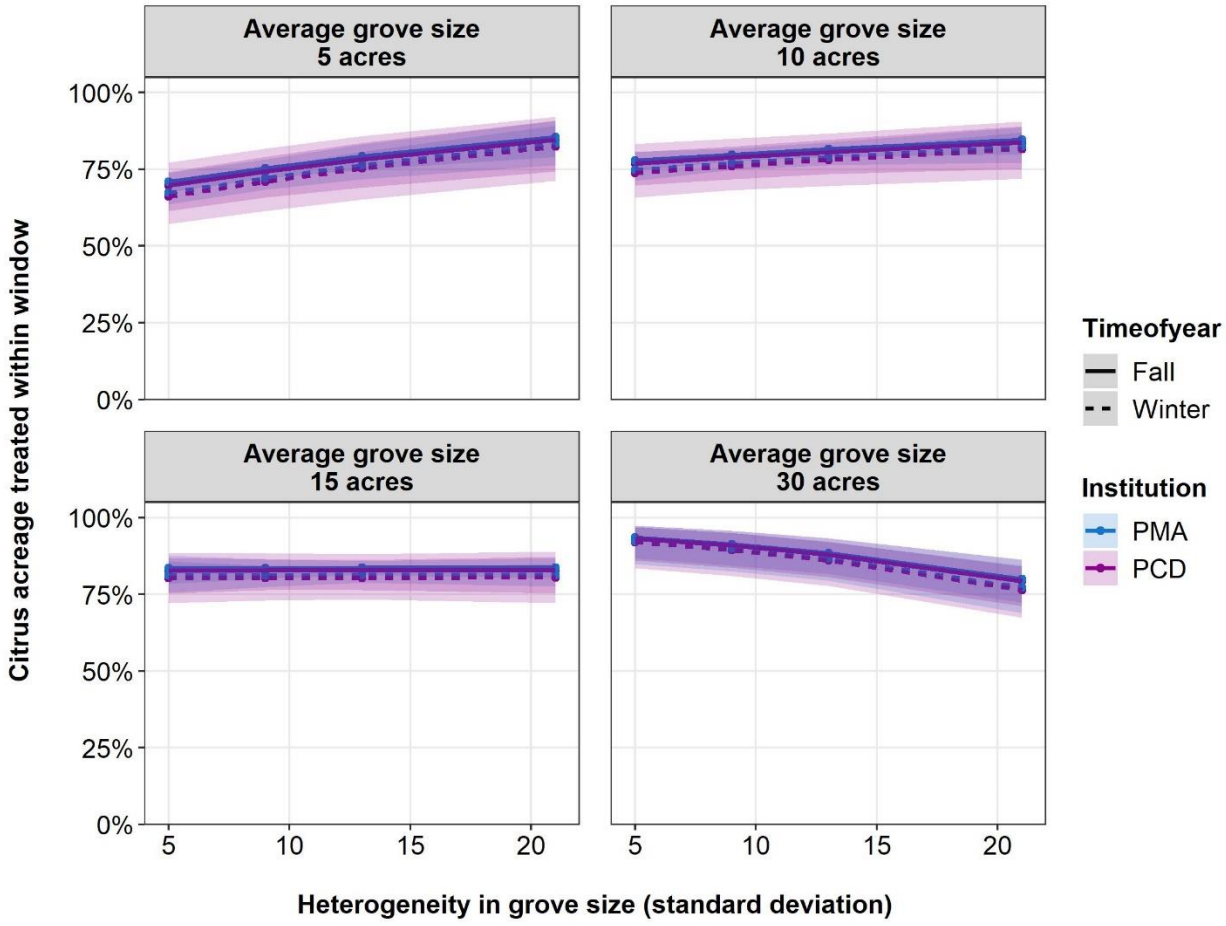

Fig. A1.9: Participation levels in AWM predicted by the zoib model depending on the average size of the citrus groves and their heterogeneity. The mean of the predicted values for season number 6 is shown in blue (PMAs) or in purple (PCDs). Predicted values for the fall treatments are linked by solid lines and predicted values for the winter treatments are linked by dashed lines. The panels show different average sizes of the citrus groves in an AWM unit.

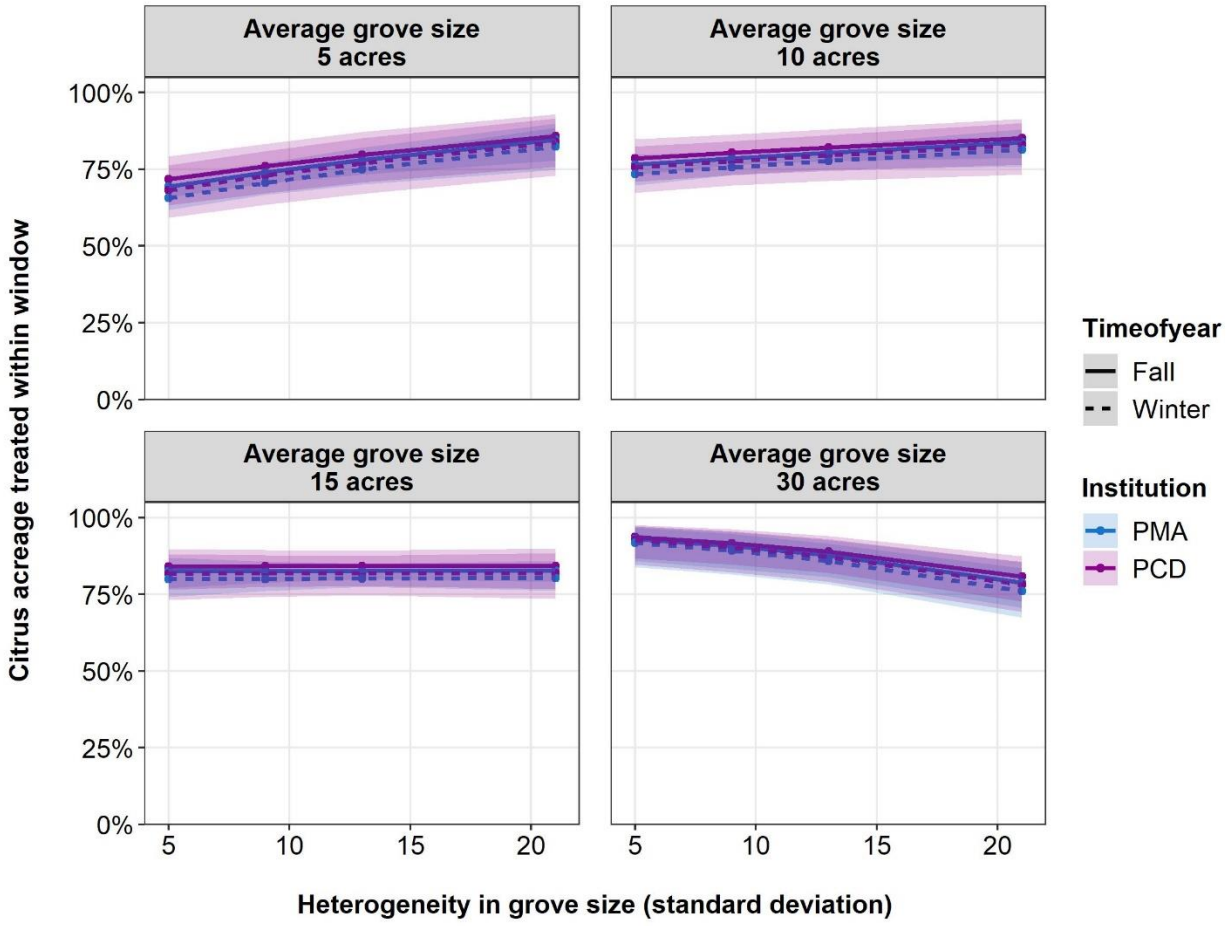

Fig. A1.10: Participation levels in AWM predicted by the zoib model depending on the average size of the citrus groves and their heterogeneity. The mean of the predicted values for season number 7 is shown in blue (PMAs) or in purple (PCDs). Predicted values for the fall treatments are linked by solid lines and predicted values for the winter treatments are linked by dashed lines. The panels show different average sizes of the citrus groves in an AWM unit.

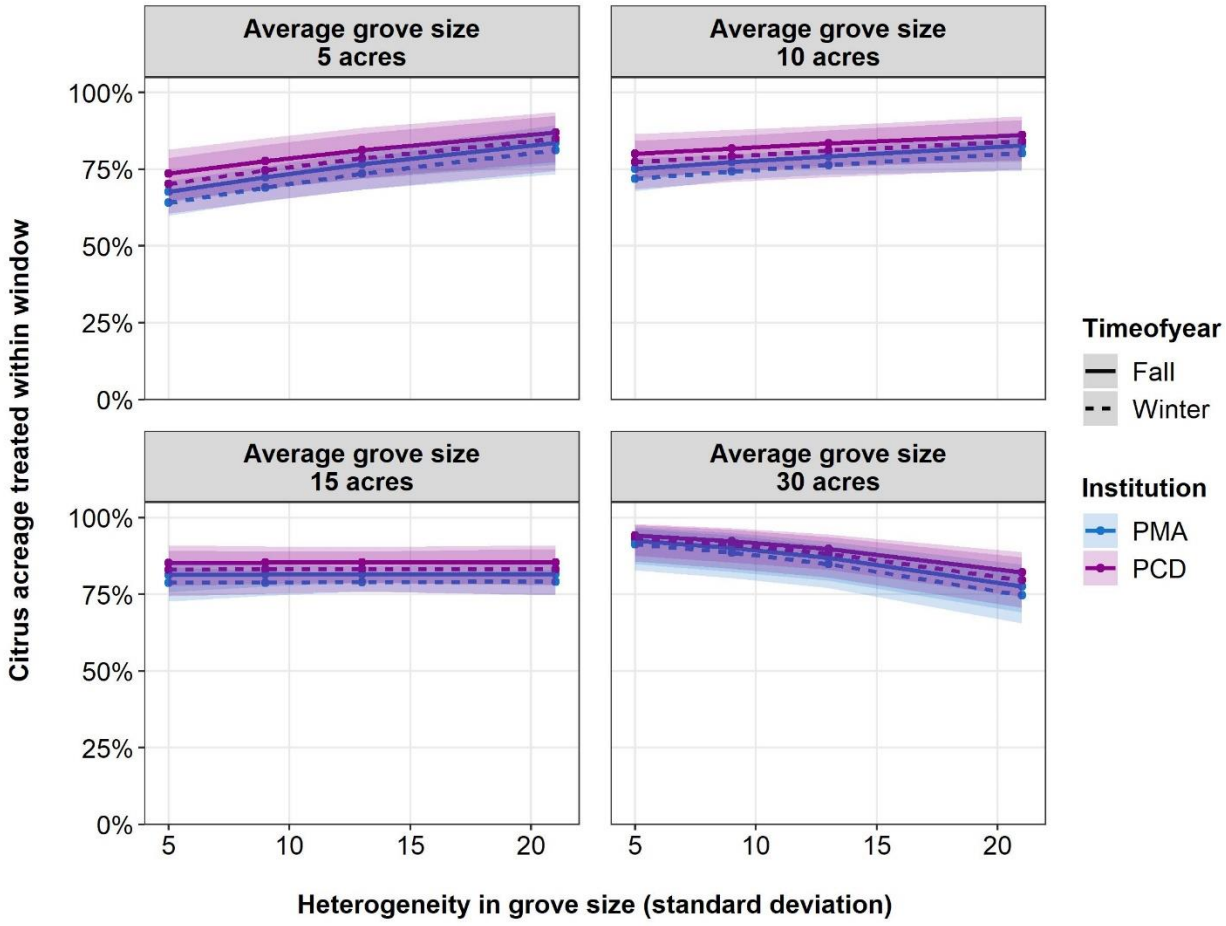

Fig. A1.11: Participation levels in AWM predicted by the zoib model depending on the average size of the citrus groves and their heterogeneity. The mean of the predicted values for season number 8 is shown in blue (PMAs) or in purple (PCDs). Predicted values for the fall treatments are linked by solid lines and predicted values for the winter treatments are linked by dashed lines. The panels show different average sizes of the citrus groves in an AWM unit.