

Grapevine phenology in four Portuguese wine regions: modelling and predictions

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Supplementary Material

Table S1: List of calibrations with the Sigmoid model for each variety, region and phenological stage, as well as the performance parameters of the model (RMSE, EF). "N" indicates the number of years with phenological and meteorological data and the "n" is the number of observations.

Phenophase	Region	Variety	N	n	Sigmoid model		Model performance	
					d	e	RMSE	EF
Budburst	Douro	Touriga Nacional	5	23	-0.57	10.28	6.80	0.43
		Alfrocheiro	4	12	-0.70	11.27	4.88	0.69
		Baga	4	12	-0.33	6.32	3.88	0.16
	Dão	Bical	4	12	-0.67	11.12	5.09	0.61
		Jaen	5	13	-0.63	11.56	7.03	0.20
		Touriga Nacional	5	13	-0.60	10.15	5.36	0.55
		Average value					5.25	0.44
		Alfrocheiro	24	24	-0.48	8.00	6.71	0.54
		Alvarinho	24	24	-0.53	7.64	6.06	0.46
		Antão Vaz	24	24	-0.57	7.92	6.65	0.50
		Aragonez	24	24	-0.51	7.91	6.69	0.46
		Arinto	24	24	-0.54	7.50	7.06	0.32
		Avesso	11	11	-0.59	9.75	3.99	0.65
	Lisboa	Azal Branco	11	11	-0.53	8.37	4.59	0.71
		Baga	23	23	-0.49	7.47	6.52	0.29
		Bastardo	11	11	-0.57	10.09	4.52	0.58
		Cabernet Sauvignon	11	11	-0.60	8.78	5.97	0.37
		Castelão	29	29	-0.35	8.88	5.44	0.59
		Chardonnay	11	11	-0.69	9.12	4.52	0.59
		Dona Maria	11	11	-0.59	8.58	4.38	0.71
		Encruzado	11	11	-0.50	7.23	4.16	0.61
		Espadeiro	14	14	-0.73	6.32	4.96	0.29
		Fernão Pires	29	29	-0.47	8.89	5.17	0.61
		Gouveio	20	20	-0.53	7.17	5.72	0.40
		Jaen	24	24	-0.49	8.49	5.51	0.61
		Loureiro	24	24	-0.61	8.75	6.60	0.50

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		Malvasia Fina	24	24	-0.46	8.78	6.92	0.50
		Merlot	12	12	-0.52	8.53	5.23	0.56
		Moscatel de Setúbal	11	11	-0.44	9.28	4.72	0.51
		Moscatel Galego	11	11	-0.61	8.16	3.60	0.81
		Pinot	11	11	-0.48	11.53	4.55	0.57
		Riesling	11	11	-0.55	7.93	5.24	0.34
		Sauvignon	11	11	-0.62	8.11	5.76	0.32
		Siria	24	24	-0.54	8.37	7.40	0.47
		Syrah	11	11	-0.54	8.30	3.73	0.80
		Tinta Barroca	11	11	-0.54	8.71	3.87	0.74
		Tinta Francisca	11	11	-0.59	8.50	4.33	0.74
		Tinto Cão	23	23	-0.43	7.84	5.84	0.51
		Touriga Franca	24	24	-0.53	7.49	6.00	0.51
		Touriga Nacional	24	24	-0.64	7.54	6.70	0.20
		Trajadura	24	24	-0.55	8.18	6.07	0.54
		Vinhão	24	24	-0.52	7.96	6.52	0.50
		Viosinho	11	11	-0.58	7.03	4.11	0.66
		Average value				5.44	0.53	
Flowering	Douro	Touriga Nacional	5	23	-0.55	15.00	4.93	0.79
		Touriga Franca	17	42	-0.29	14.79	6.30	0.41
		Aragonez	11	11	-1.00	20.00	8.98	0.33
		Moscatel Galego	4	4	-0.50	16.00	1.56	0.97
		Average value				5.44	0.63	
	Dão	Alfrocheiro	4	12	-0.48	11.49	4.78	0.83
		Baga	4	12	-1.00	15.00	4.71	0.81
		Bical	4	12	-1.00	13.00	3.29	0.88
		Jaen	5	13	-0.80	12.00	5.56	0.68
		Touriga Nacional	5	13	-1.00	12.50	6.09	0.49
		Average value				4.89	0.74	

Table S1: List of calibrations with the Sigmoid model for each variety, region and phenological stage, as well as the performance parameters of the model (RMSE, EF). "N" indicates the number of years with phenological and meteorological data and the "n" is the number of observations.

Flowering	Vinhos Verdes	Alvarinho	11	11	-0.50	11.00	6.79	0.37
		Arinto	11	11	-0.50	12.00	6.53	0.58
		Azal Branco	11	11	-0.50	12.30	7.47	0.43
		Espadeiro	11	11	-0.45	10.00	6.45	0.57
		Vinhão	22	22	-0.59	11.89	6.34	0.42
		Loureiro	22	22	-0.39	11.53	6.66	0.37
		Average value					6.71	0.46
	Lisboa	Alfrocheiro	24	24	-0.41	14.59	5.87	0.61
		Alvarinho	24	24	-0.44	13.51	4.94	0.66
		Antão Vaz	24	24	-0.45	13.55	4.68	0.72
		Aragonez	24	24	-0.44	15.07	4.55	0.72
		Arinto	24	24	-0.59	13.76	3.80	0.84
		Avesso	11	11	-0.49	13.21	4.68	0.82
		Azal Branco	11	11	-0.60	14.84	4.19	0.82
		Baga	23	23	-0.44	13.87	3.88	0.82
		Bastardo	11	11	-0.49	13.00	4.72	0.79
		Cabernet Sauvignon	11	11	-0.62	13.61	4.33	0.84
		Castelão	29	29	-0.49	13.37	5.07	0.66
		Chardonnay	11	11	-0.52	12.74	4.70	0.81
		Dona Maria	11	11	-0.73	15.63	3.25	0.89
		Encruzado	11	11	-0.56	14.60	3.07	0.88
		Espadeiro	14	14	0.66	12.81	2.34	0.90
		Fernão Pires	29	29	-0.53	12.82	5.03	0.67
		Gouveio	20	20	-0.61	13.67	4.81	0.47
		Jaen	24	24	-0.51	14.88	6.00	0.53
		Loureiro	24	24	-0.48	13.23	5.70	0.60
		Malvasia Fina	24	24	-0.55	10.50	6.12	0.54
		Merlot	12	12	-0.65	14.44	5.14	0.71

Table S1: List of calibrations with the Sigmoid model for each variety, region and phenological stage, as well as the performance parameters of the model (RMSE, EF). "N" indicates the number of years with phenological and meteorological data and the "n" is the number of observations.

Veraison		Moscatel de Setúbal	11	11	-0.65	14.59	4.57	0.80
		Moscatel Galego	11	11	-0.67	14.20	3.22	0.88
		Pinot	11	11	-0.51	12.82	4.63	0.82
		Riesling	11	11	-0.65	14.34	3.23	0.92
		Sauvignon	11	11	-0.53	13.74	4.01	0.86
		Siria	24	24	-0.48	15.22	5.42	0.60
		Syrah	11	11	-0.66	15.27	3.63	0.83
		Tinta Barroca	11	11	-0.63	15.61	3.87	0.84
		Tinta Francisca	11	11	-0.77	15.29	3.66	0.85
		Tinto Cão	23	23	-0.55	13.93	4.90	0.69
		Touriga Franca	24	24	-0.60	13.29	5.63	0.55
		Touriga Nacional	24	24	-0.46	12.35	4.16	0.81
		Trajadura	24	24	-0.60	13.66	4.48	0.75
		Vinhão	24	24	-0.51	14.04	5.03	0.67
		Viosinho	11	11	-0.72	14.74	4.18	0.78
		Average value					4.49	0.75
	Douro	Touriga Nacional	5	23	-0.28	7.45	6.68	0.75
		Touriga Franca	17	42	-0.23	12.34	5.12	0.68
		Aragonez	11	11	-0.55	18.00	6.99	0.55
		Moscatel Galego	4	4	-0.50	21.00	3.66	0.87
		Average value					5.61	0.71
	Dão	Alfrocheiro	4	12	-0.42	13.38	3.40	0.91
		Baga	4	12	-0.50	16.00	3.63	0.86
		Bical	4	12	-0.38	12.02	2.93	0.93
		Jaen	5	13	-0.60	17.00	6.41	0.61
		Touriga Nacional	5	13	-0.80	15.00	5.58	0.81
		Average value					4.39	0.82
		Alvarinho	11	11	-0.34	12.25	5.42	0.57
		Arinto	11	11	-0.55	14.00	4.35	0.78

Table S1: List of calibrations with the Sigmoid model for each variety, region and phenological stage, as well as the performance parameters of the model (RMSE, EF). "N" indicates the number of years with phenological and meteorological data and the "n" is the number of observations.

Veraison	Vinhos Verdes	Azal Branco	11	11	-0.29	9.50	3.76	0.83
		Espadeiro	11	11	-0.25	13.00	4.24	0.77
		Vinhão	22	22	-0.70	15.50	5.55	0.56
		Loureiro	22	22	-0.50	14.50	5.22	0.63
		Average value					4.76	0.69
	Lisboa	Alfrocheiro	24	24	-0.29	13.16	2.79	0.86
		Alvarinho	24	24	-0.39	12.64	5.92	0.64
		Antão Vaz	24	24	-0.26	9.67	7.44	0.54
		Aragonez	24	24	-0.28	10.73	5.42	0.59
		Arinto	24	24	-0.50	13.60	5.02	0.72
		Avesso	11	11	-0.26	8.35	5.12	0.70
		Azal Branco	11	11	-0.27	9.65	5.35	0.66
		Baga	23	23	-0.34	12.81	5.84	0.65
		Bastardo	11	11	-0.47	14.66	4.06	0.74
		Cabernet Sauvignon	11	11	-0.35	8.99	5.44	0.81
		Castelão	29	29	-0.37	13.19	4.78	0.66
		Chardonnay	11	11	-0.50	14.00	4.44	0.83
		Dona Maria	11	11	-0.50	13.50	8.73	0.47
		Encruzado	11	11	-0.50	14.70	6.42	0.56
		Espadeiro	14	14	-0.55	14.00	2.91	0.87
		Fernão Pires	29	29	-0.36	10.59	7.10	0.51
		Gouveio	20	20	-0.55	13.90	11.02	0.09
		Jaen	24	24	-0.43	13.45	4.02	0.75
		Loureiro	24	24	-0.31	11.08	7.11	0.46
		Malvasia Fina	24	24	-0.53	11.91	7.99	0.33
		Merlot	12	12	-0.60	15.50	4.67	0.77
		Moscatel de Setúbal	11	11	-0.48	14.50	8.07	0.42
		Moscatel Galego	11	11	-0.41	11.72	3.10	0.88

Table S1: List of calibrations with the Sigmoid model for each variety, region and phenological stage, as well as the performance parameters of the model (RMSE, EF). "N" indicates the number of years with phenological and meteorological data and the "n" is the number of observations.

Lisboa	Pinot	11	11	-0.55	14.80	3.74	0.82
	Riesling	11	11	-0.49	12.39	3.39	0.88
	Sauvignon	11	11	-0.50	15.00	4.47	0.82
	Siria	24	24	-0.34	9.32	10.08	0.19
	Syrah	11	11	-0.60	17.50	3.75	0.38
	Tinta Barroca	11	11	-0.50	15.50	3.45	0.76
	Tinta Francisca	11	11	-0.48	12.87	2.12	0.92
	Tinto Cão	23	23	-0.46	13.11	3.78	0.75
	Touriga Franca	24	24	-0.43	11.75	3.55	0.83
	Touriga Nacional	24	24	-0.55	15.30	5.41	0.70
	Trajadura	24	24	-0.50	14.00	8.21	0.45
	Vinhão	24	24	-0.40	12.63	3.26	0.85
	Viosinho	11	11	-0.50	12.50	5.79	0.72
	Average value					5.38	0.66

Table S2: The same as in Table S1, but with the generalized parameters and their validation (RMSEP and EF*) for each phenological stage, variety and region. The F-forcing parameter (thermal accumulation) is also represented.

Phenophase	Region	Variety	N	n	Sigmoid Model		Model performance		F	Validation model	
					d	e	RMSE	EF		RMSEP	EF*
Budburst	Douro	Touriga Nacional	5	23	-0.55	8.57	7.26	0.35	45.91	7.32	0.34
	Dão	Alfrocheiro	4	12	-0.55	8.57	7.72	0.23	47.27	8.05	0.22
		Baga	4	12	-0.55	8.57	3.93	0.14	52.80	3.92	0.16
		Bical	4	12	-0.55	8.57	7.49	0.15	43.61	7.82	0.12
		Jaen	5	13	-0.55	8.57	7.58	0.07	51.64	7.76	0.08
		Touriga Nacional	5	13	-0.55	8.57	6.51	0.34	52.68	6.72	0.24
	Lisboa	Alfrocheiro	24	24	-0.55	8.57	6.68	0.54	56.17	6.82	0.52
		Alvarinho	24	24	-0.55	8.57	6.05	0.46	59.76	6.18	0.46
		Antão Vaz	24	24	-0.55	8.57	6.67	0.49	60.82	6.81	0.49
		Aragonez	24	24	-0.55	8.57	6.72	0.46	62.55	6.62	0.47
		Arinto	24	24	-0.55	8.57	7.05	0.32	64.24	7.21	0.31
		Avesso	11	11	-0.55	8.57	4.03	0.64	50.57	4.22	0.65
		Azal Branco	11	11	-0.55	8.57	4.61	0.71	56.35	4.83	0.68
		Baga	23	23	-0.55	8.57	6.61	0.27	63.01	6.76	0.26
		Bastardo	11	11	-0.55	8.57	4.51	0.59	55.82	4.72	0.58
		Cabernet Sauvignon	11	11	-0.55	8.57	5.89	0.38	66.94	6.04	0.38
		Castelão	29	29	-0.55	8.57	5.52	0.58	53.78	5.61	0.58
		Chardonnay	11	11	-0.55	8.57	4.34	0.62	54.50	4.40	0.63
		Dona Maria	11	11	-0.55	8.57	4.23	0.73	66.70	4.41	0.73
		Encruzado	11	11	-0.55	8.57	4.76	0.49	61.29	4.79	0.52
		Fernão Pires	29	29	-0.55	8.57	5.26	0.60	57.06	5.34	0.60
		Gouveio	20	20	-0.55	8.57	6.25	0.28	61.26	6.40	0.25
		Jaen	24	24	-0.55	8.57	5.61	0.60	61.35	5.52	0.61

Table S2: The same as in Table S1, but with the generalized parameters and their validation (RMSEP and EF*) for each phenological stage, variety and region. The F-forcing parameter (thermal accumulation) is also represented.

		Loureiro	24	24	-0.55	8.57	6.48	0.52	59.00	6.61	0.52
		Malvasia Fina	24	24	-0.55	8.57	7.03	0.49	61.41	7.17	0.49
		Merlot	12	12	-0.55	8.57	5.30	0.55	58.38	5.53	0.55
		Moscatel de Setúbal	11	11	-0.55	8.57	5.12	0.42	68.04	5.18	0.37
		Moscatel Galego	11	11	-0.55	8.57	3.44	0.82	51.85	3.60	0.81
		Pinot	11	11	-0.55	8.57	4.93	0.50	56.03	5.17	0.50
		Riesling	11	11	-0.55	8.57	5.27	0.33	60.15	5.50	0.34
		Sauvignon	11	11	-0.55	8.57	5.54	0.37	62.93	5.80	0.37
		Siria	24	24	-0.55	8.57	7.41	0.47	63.15	7.57	0.47
		Syrah	11	11	-0.55	8.57	3.70	0.80	61.25	3.88	0.80
		Tinta Barroca	11	11	-0.55	8.57	3.86	0.74	57.16	3.96	0.76
		Tinta Francisca	11	11	-0.55	8.57	4.24	0.75	61.68	4.45	0.72
		Tinto Cão	23	23	-0.55	8.57	6.04	0.47	59.38	6.17	0.48
		Touriga Franca	24	24	-0.55	8.57	6.07	0.50	56.70	6.06	0.50
		Touriga Nacional	24	24	-0.55	8.57	6.83	0.16	56.83	6.90	0.18
		Trajadura	24	24	-0.55	8.57	6.11	0.53	66.66	6.21	0.54
		Vinhão	24	24	-0.55	8.57	6.59	0.49	67.88	6.72	0.49
		Viosinho	11	11	-0.55	8.57	4.21	0.65	59.66	4.41	0.64
Flowering	Douro	Touriga Nacional	5	23	-0.59	13.72	5.72	0.72	35.68	5.73	0.73
		Touriga Franca	17	42	-0.59	13.72	6.49	0.37	39.12	6.54	0.38
		Moscatel Galego	4	4	-0.59	13.72	1.98	0.95	32.94	2.29	0.94
	Dão	Alfrocheiro	4	12	-0.59	13.72	4.78	0.84	32.81	4.66	0.86

Table S2: The same as in Table S1, but with the generalized parameters and their validation (RMSEP and EF*) for each phenological stage, variety and region. The F-forcing parameter (thermal accumulation) is also represented.

Flowering	Vinhos Verdes	Baga	4	12	-0.59	13.72	4.32	0.84	32.94	4.50	0.84
		Bical	4	12	-0.59	13.72	3.63	0.85	34.63	3.65	0.86
		Jaen	5	13	-0.59	13.72	5.84	0.64	32.53	6.07	0.65
		Touriga Nacional	5	13	-0.59	13.72	7.13	0.30	32.59	7.35	0.31
		Arinto	11	11	-0.59	13.72	7.83	0.39	30.86	8.17	0.40
		Azal Branco	11	11	-0.59	13.72	8.70	0.11	33.45	9.11	0.11
		Espadeiro	11	11	-0.59	13.72	9.42	0.09	29.78	9.71	0.12
		Vinhão	22	22	-0.59	13.72	6.75	0.35	31.54	6.86	0.35
		Loureiro	22	22	-0.59	13.72	7.40	0.23	31.52	7.54	0.23
		Alfrocheiro	24	24	-0.59	13.72	6.29	0.55	44.68	6.07	0.60
	Lisboa	Alvarinho	24	24	-0.59	13.72	5.20	0.62	43.77	5.30	0.62
		Antão Vaz	24	24	-0.59	13.72	4.85	0.70	45.35	4.96	0.70
		Aragonez	24	24	-0.59	13.72	4.97	0.67	43.34	5.00	0.68
		Arinto	24	24	-0.59	13.72	3.77	0.84	42.36	3.84	0.84
		Avesso	11	11	-0.59	13.72	4.85	0.80	46.06	5.07	0.81
		Azal Branco	11	11	-0.59	13.72	4.76	0.76	48.78	4.98	0.76
		Baga	23	23	-0.59	13.72	4.15	0.80	41.75	4.15	0.80
		Bastardo	11	11	-0.59	13.72	4.87	0.78	43.95	4.85	0.80
		Cabernet Sauvignon	11	11	-0.59	13.72	4.24	0.85	41.61	4.40	0.85
		Castelão	29	29	-0.59	13.72	5.41	0.61	43.24	5.47	0.62
		Chardonnay	11	11	-0.59	13.72	4.62	0.82	43.65	4.82	0.82
		Dona Maria	11	11	-0.59	13.72	4.66	0.76	47.34	4.61	0.79
		Encruzado	11	11	-0.59	13.72	3.47	0.85	45.26	3.32	0.87
		Espadeiro	14	14	-0.59	13.72	2.72	0.86	38.84	2.75	0.87
		Fernão Pires	29	29	-0.59	13.72	5.04	0.67	43.39	5.13	0.67
		Gouveio	20	20	-0.59	13.72	4.71	0.50	42.67	4.81	0.50
		Jaen	24	24	-0.59	13.72	6.25	0.49	43.40	6.38	0.49
		Loureiro	24	24	-0.59	13.72	5.81	0.59	44.67	5.40	0.66

Table S2: The same as in Table S1, but with the generalized parameters and their validation (RMSEP and EF*) for each phenological stage, variety and region. The F-forcing parameter (thermal accumulation) is also represented.

Flowering	Lisboa	Malvasia Fina	24	24	-0.59	13.72	4.37	0.76	46.12	4.46	0.76
		Merlot	12	12	-0.59	13.72	5.48	0.67	46.14	5.72	0.67
		Moscatel de Setúbal	11	11	-0.59	13.72	4.67	0.79	47.82	4.59	0.82
		Moscatel Galego	11	11	-0.59	13.72	3.81	0.84	47.97	3.95	0.84
		Pinot	11	11	-0.59	13.72	4.82	0.80	43.11	4.97	0.81
		Riesling	11	11	-0.59	13.72	3.05	0.93	42.31	3.08	0.94
		Sauvignon	11	11	-0.59	13.72	4.10	0.85	45.10	4.08	0.87
		Siria	24	24	-0.59	13.72	5.64	0.57	43.89	5.71	0.58
		Syrah	11	11	-0.59	13.72	4.53	0.73	48.11	4.67	0.74
		Tinta Barroca	11	11	-0.59	13.72	4.67	0.76	46.53	4.65	0.78
		Tinta Francisca	11	11	-0.59	13.72	4.56	0.77	48.08	4.73	0.77
		Tinto Cão	23	23	-0.59	13.72	4.99	0.68	43.18	5.09	0.68
		Touriga Franca	24	24	-0.59	13.72	5.65	0.55	42.17	5.77	0.55
		Touriga Nacional	24	24	-0.59	13.72	4.47	0.78	41.11	4.55	0.78
		Trajadura	24	24	-0.59	13.72	4.38	0.76	43.77	3.85	0.82
		Vinhão	24	24	-0.59	13.72	5.12	0.66	43.52	5.22	0.66
		Viosinho	11	11	-0.59	13.72	4.53	0.74	44.07	4.74	0.74
Veraison	Douro	Touriga Nacional	5	23	-0.45	13.22	6.84	0.73	65.21	6.79	0.75
		Touriga Franca	17	42	-0.45	13.22	5.18	0.67	58.50	5.09	0.69
		Aragonez	11	11	-0.45	13.22	7.87	0.43	55.04	8.24	0.43
		Moscatel Galego	4	4	-0.45	13.22	6.63	0.59	57.29	6.31	0.72
	Dão	Alfrocheiro	4	12	-0.45	13.22	3.26	0.92	54.35	3.16	0.93

Table S2: The same as in Table S1, but with the generalized parameters and their validation (RMSEP and EF*) for each phenological stage, variety and region. The F-forcing parameter (thermal accumulation) is also represented.

Veraison	Vinhos Verdes	Baga	4	12	-0.45	13.22	3.38	0.88	50.58	3.35	0.89
		Bical	4	12	-0.45	13.22	2.94	0.93	56.87	2.80	0.94
		Jaen	5	13	-0.45	13.22	4.22	0.83	51.97	4.30	0.84
		Touriga Nacional	5	13	-0.45	13.22	5.94	0.78	61.14	6.05	0.79
		Alvarinho	11	11	-0.45	13.22	5.61	0.54	61.13	4.36	0.74
		Arinto	11	11	-0.45	13.22	3.82	0.83	63.85	3.97	0.83
		Azal Branco	11	11	-0.45	13.22	4.65	0.74	67.06	3.88	0.83
		Espadeiro	11	11	-0.45	13.22	4.11	0.78	69.51	3.73	0.84
		Vinhão	22	22	-0.45	13.22	3.11	0.86	63.60	3.17	0.86
		Loureiro	22	22	-0.45	13.22	3.62	0.82	63.55	3.71	0.82
	Lisboa	Alfrocheiro	24	24	-0.45	13.22	3.02	0.84	66.12	3.05	0.85
		Alvarinho	24	24	-0.45	13.22	5.92	0.64	72.44	5.86	0.67
		Antão Vaz	24	24	-0.45	13.22	7.52	0.53	72.91	7.64	0.53
		Aragonez	24	24	-0.45	13.22	5.40	0.59	62.30	5.48	0.60
		Arinto	24	24	-0.45	13.22	5.04	0.72	76.97	4.98	0.74
		Avesso	11	11	-0.45	13.22	5.39	0.66	84.23	5.49	0.68
		Azal Branco	11	11	-0.45	13.22	5.51	0.64	83.81	4.91	0.74
		Baga	23	23	-0.45	13.22	5.85	0.65	66.22	5.82	0.66
		Bastardo	11	11	-0.45	13.22	4.27	0.71	70.61	4.47	0.71
		Cabernet Sauvignon	11	11	-0.45	13.22	5.69	0.80	72.45	5.91	0.80
		Castelão	29	29	-0.45	13.22	4.82	0.66	71.25	4.90	0.66
		Chardonnay	11	11	-0.45	13.22	4.09	0.85	72.47	2.28	0.85
		Dona Maria	11	11	-0.45	13.22	8.70	0.47	76.74	8.39	0.55
		Encruzado	11	11	-0.45	13.22	5.68	0.65	77.91	5.93	0.65
		Espadeiro	14	14	-0.45	13.22	2.99	0.86	76.03	3.07	0.86
		Fernão Pires	29	29	-0.45	13.22	7.14	0.50	66.11	7.19	0.51
		Gouveio	20	20	-0.45	13.22	10.97	0.09	64.08	10.89	0.15
		Jaen	24	24	-0.45	13.22	4.01	0.75	61.51	3.81	0.78

Table S2: The same as in Table S1, but with the generalized parameters and their validation (RMSEP and EF*) for each phenological stage, variety and region. The F-forcing parameter (thermal accumulation) is also represented.

Loureiro	24	24	-0.45	13.22	7.17	0.45	77.23	6.68	0.54
Malvasia Fina	24	24	-0.45	13.22	8.06	0.32	66.70	7.75	0.39
Merlot	12	12	-0.45	13.22	3.69	0.86	70.25	3.77	0.86
Moscatel de Setúbal	11	11	-0.45	13.22	7.72	0.47	70.87	8.09	0.47
Moscatel Galego	11	11	-0.45	13.22	3.22	0.87	73.19	3.27	0.88
Pinot	11	11	-0.45	13.22	3.24	0.86	68.72	3.33	0.87
Riesling	11	11	-0.45	13.22	3.53	0.87	71.21	3.44	0.89
Sauvignon	11	11	-0.45	13.22	3.60	0.88	68.17	3.74	0.89
Siria	24	24	-0.45	13.22	10.14	0.18	69.25	10.12	0.22
Tinta Barroca	11	11	-0.45	13.22	3.03	0.82	63.37	3.17	0.82
Tinta Francisca	11	11	-0.45	13.22	2.08	0.92	65.33	2.19	0.92
Tinto Cão	23	23	-0.45	13.22	3.77	0.75	73.69	2.93	0.86
Touriga Franca	24	24	-0.45	13.22	3.68	0.81	60.27	3.65	0.82
Touriga Nacional	24	24	-0.45	13.22	5.47	0.70	71.63	5.53	0.70
Trajadura	24	24	-0.45	13.22	8.14	0.45	69.64	8.32	0.45
Vinhão	24	24	-0.45	13.22	3.27	0.85	67.50	2.68	0.90
Viosinho	11	11	-0.45	13.22	6.24	0.67	74.56	5.81	0.73