Determination of the parameters for a day-degree method to predict the flight of host populations of *Hyalesthes obsoletus*

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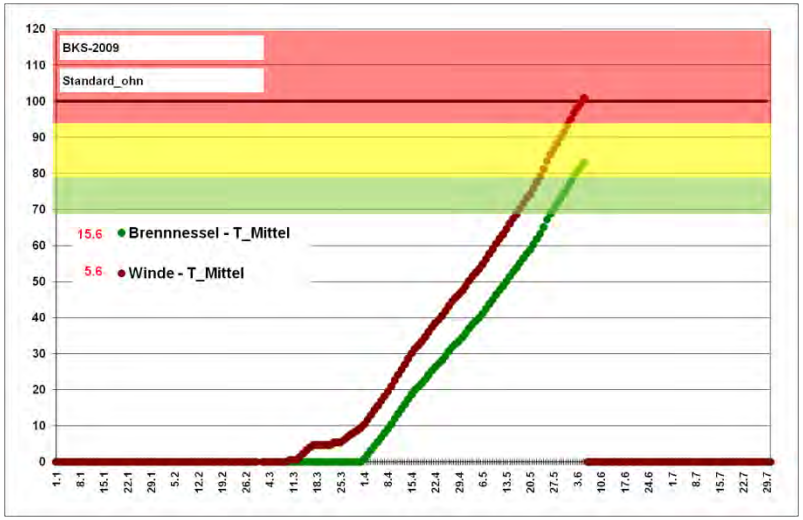

Life history of *Hyalesthes obsoletus*

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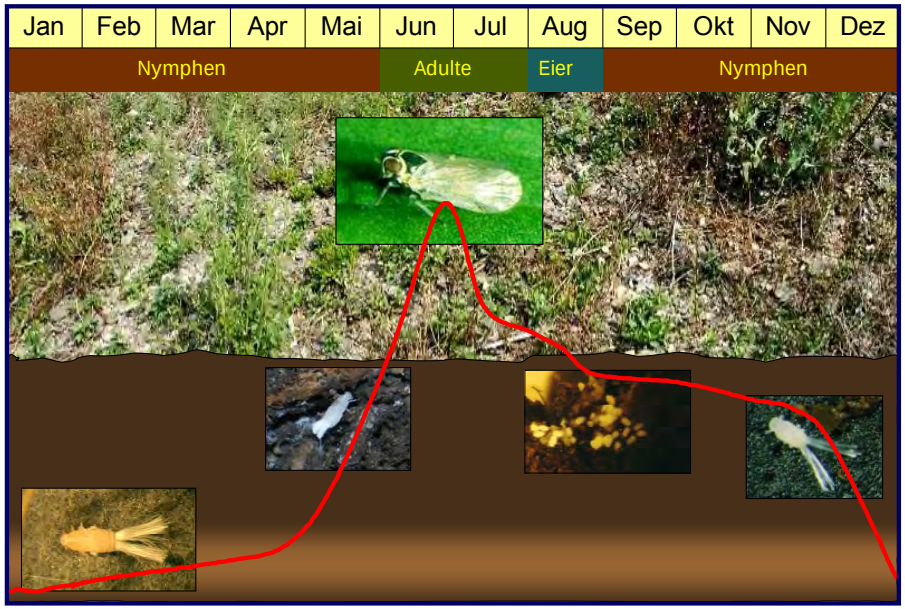
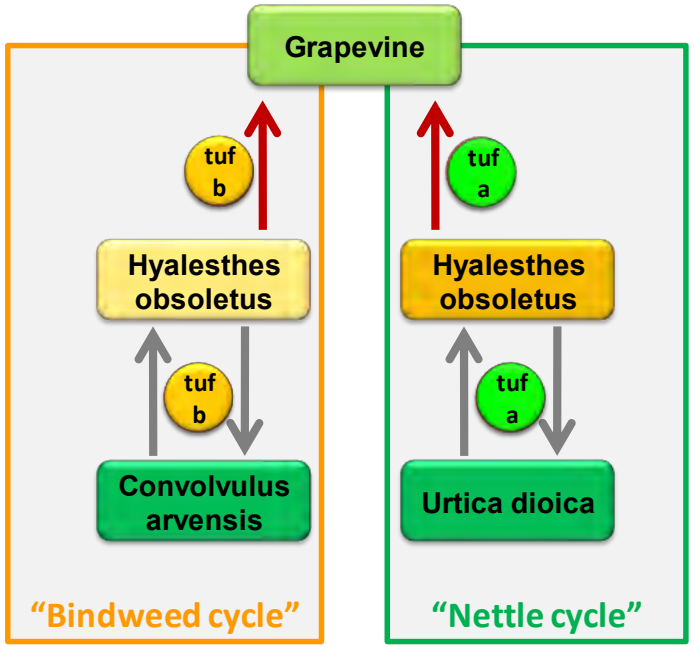
- Soil inhabiting Cixiid – only adult planthoppers occur above ground
- Specific host-populations are associated with bindweed and nettle





Temperature is a major abiotic determinant for the life history of arthropods

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- **Calculation of accumulated heat units allows prediction of life history parameters**
  - **Required parameters:**
    - Starting date (Biofix)
    - Temperature threshold (Basis)
    - Temperature sums required for the occurrence of a particular event
  - **Parameters are often unknown**
    - Use of “standard” values
    - “Trial and Error”
    - Use of empirical field data to estimate appropriate combinations of parameters (inverse modelling)

Flight activity data of *H. obsoletus*

including data of M. Breuer, U. Ipach and M. Stark-Urnau

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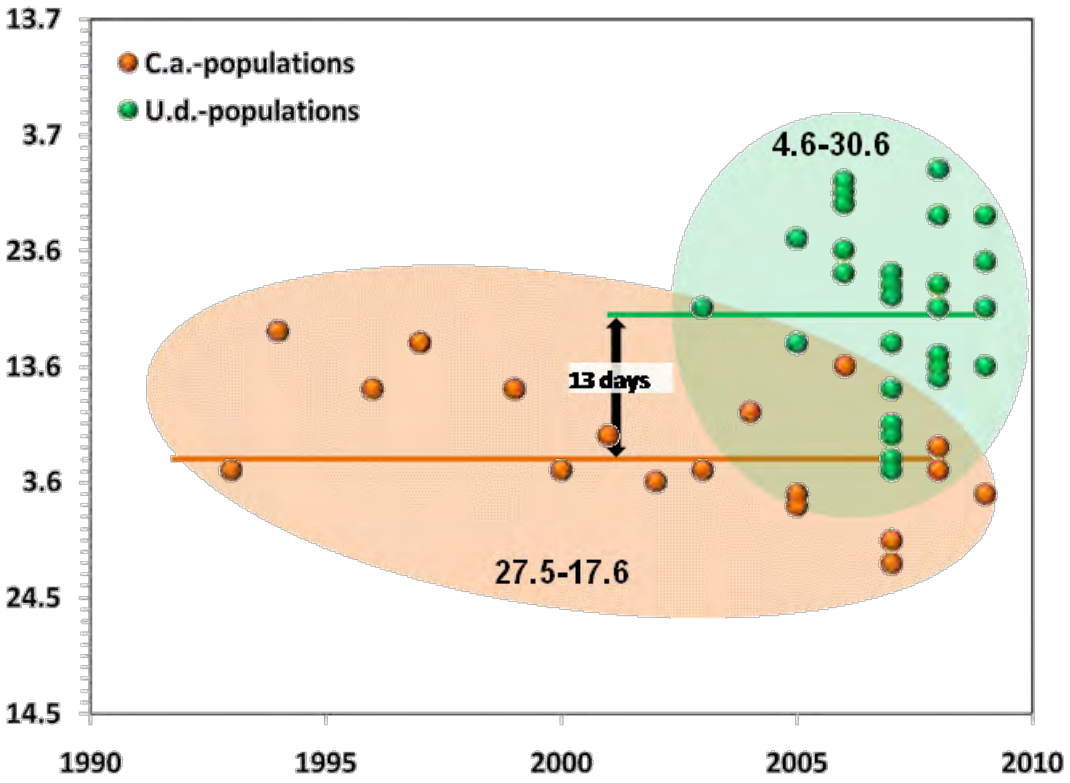
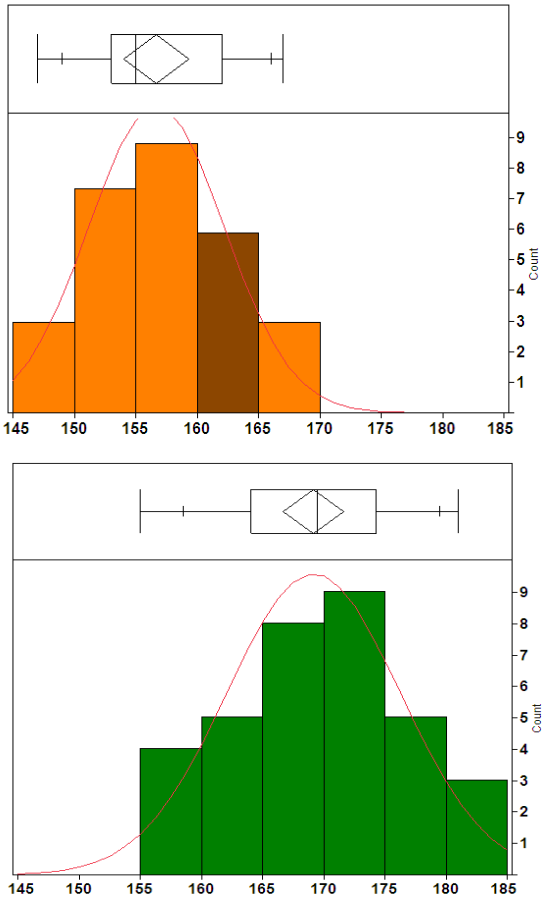
Start of flight activity of host populations of *Hyalesthes obsoletus*





Flugdaten von *H. obsoletus*

Mit Daten von M. Breuer, U. Ipach and M. Stark-Urnau

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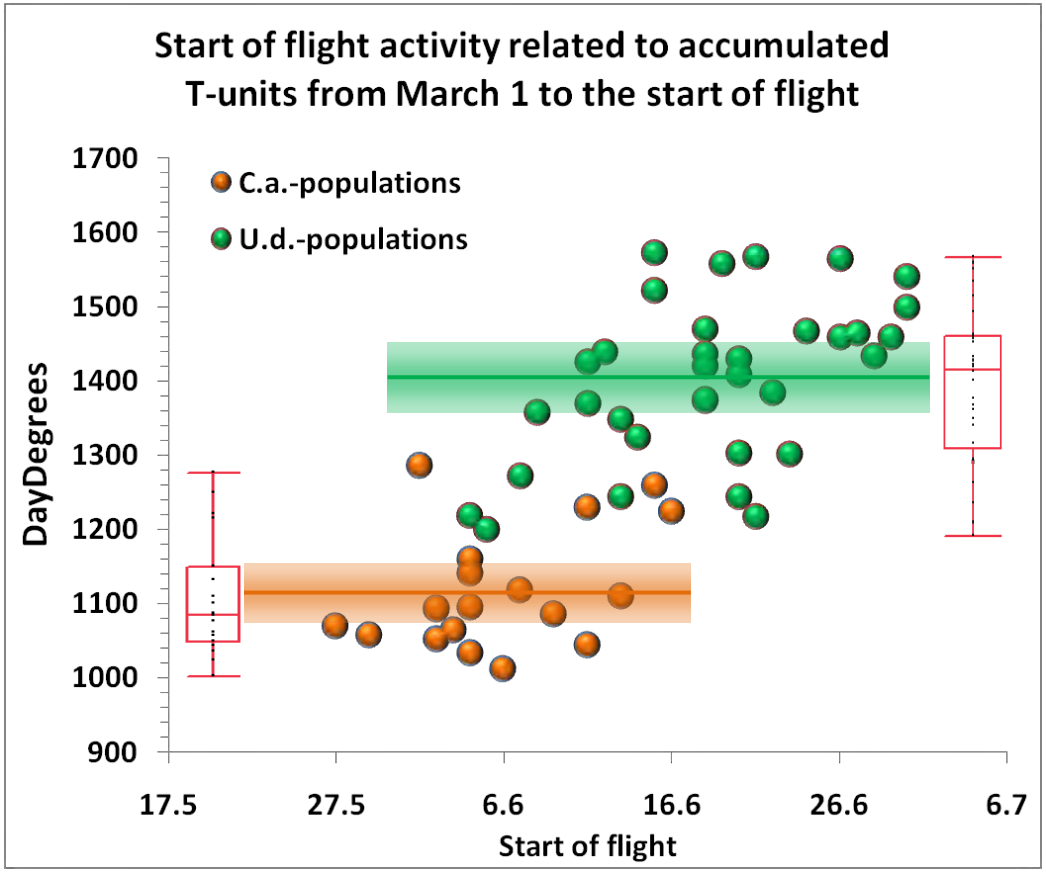
Temperature dependence of the flight of adult *H. obsoletus*



Calculation and optimization of the necessary parameters for a degree-day method

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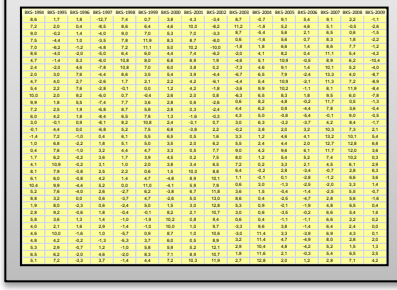
Field data on flight activity

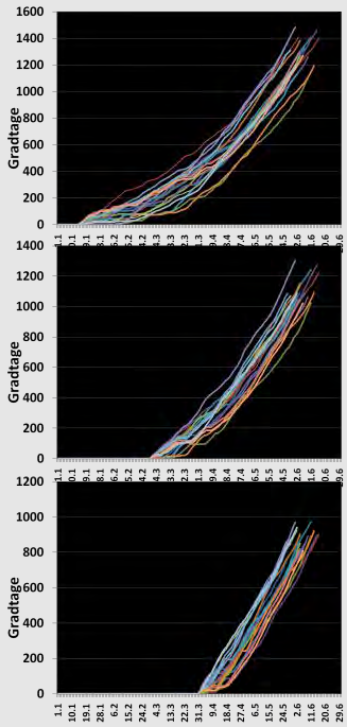
Weather-data



Starting date:
d_{min} ... d_{max}; $\Delta d=1$

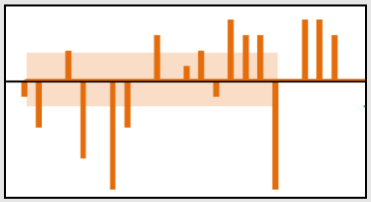
Threshold-Temp.:
T_{min} ... T_{max}; ΔT variabel

Temp-Sums

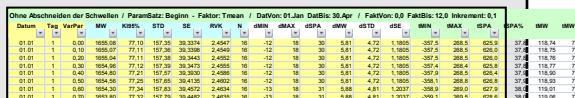


- Mean
- STD, SE, RCV

Comparison
Observed <> Calculated



- Days: - Range,
  - Mean, SE
- T-Sum: - Range
  - Mean, SE
  - abs. + rel.



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Calculation and optimization of the parameters for a degree-day method

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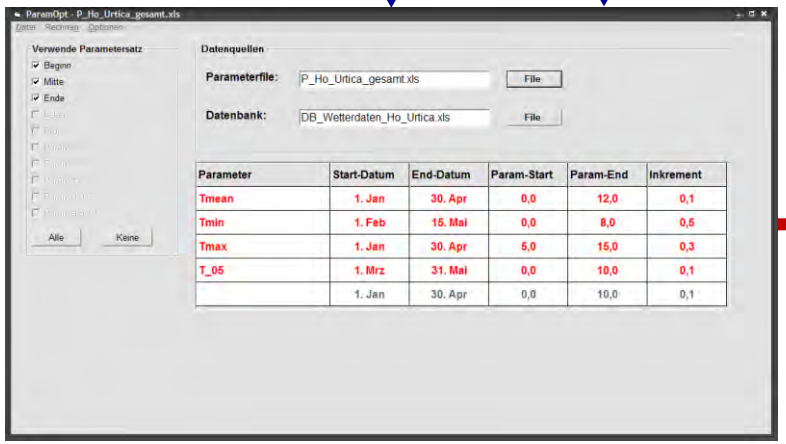
Bundesforschungsinstitut für Kulturpflanzen

Definition of parameter variation

	A	B	C	D	E	F	G
1		Parameter	Start-Datum	End-Datum	Start-Param	End-Param	Inkrement
2	WD_1	Tmean	1. Jan.	30. Apr.	0	12	0,10
3	WD_2	Tmin	1. Feb.	15. Mai.	0	8	0,50
4	WD_3	Tmax	1. Jan.	30. Apr.	5	15	0,25
5	WD_4	T_05	1. Mrz.	31. Mai.	0	10	0,10
6	WD_5						

Field observation and weather data

	A	B	C	D	E	F	
1	Satz	Bez	Verw	Beginn	Mitte	Ende	Leber
2				1	1	1	
3	1	Bac-2005	1	21.6	24.6	28.6	
4	2	Bac-2006	1	21.6	24.6	28.6	
5	3	Bac-2007	1	5.6	8.6	12.6	
6	4	Bac-2008	1	20.6	23.6	27.6	
7	5	BKS-2003	1	18.6	21.6	25.6	
8	6	BKS-2005	1	24.6	27.6	1.7	
9	7	BKS-2006	1	28.6	1.7	5.7	
10	8	BKS-2007	1	4.6	7.6	11.6	
11	9	BKS-2008	1	13.6	16.6	20.6	
12	10	BKS-2009	1	18.6	21.6	25.6	
13	11	a-2008	1	30.6	3.7	7.7	
14	12	b-2006	1	29.6	2.7	6.7	
15	13	c-2008	1	26.6	29.6	3.7	
16	14	d-2008	1	13.6	16.6	20.6	
17	15	e-2008	1	26.6	29.6	3.7	
18	16	f-2008	1	30.6	3.7	7.7	
19	17	g-2008	1	18.6	21.6	25.6	
20	18	h-2008	1	22.6	25.6	29.6	
21	19	d-2009	1	15.6	18.6	22.6	
22	20	e-2009	1	12.6	15.6	19.6	
23	21	f-2009	1	14.6	17.6	21.6	
24	22	g-2009	1	15.6	18.6	22.6	
25	23	i-2006	0	27.6	30.6	4.7	
26	24	j-2007	0	19.6	22.6	26.6	
27	25	k-2007	0	8.6	11.6	15.6	
28	26	k-2008	0	20.6	23.6	27.6	
29	27	l-2007	0	15.6	18.6	22.6	
30	28	l-2008	0	22.6	25.6	29.6	
31	29	m-2008	0	20.6	23.6	27.6	
32	30	n-2007	0	11.6	14.6	18.6	
33	31	o-2007	0	11.6	14.6	18.6	
34	32	p-2006	0	23.6	26.6	30.6	
35	33	p-2007	0	21.6	24.6	28.6	
36	34	q-2006	0	20.6	23.6	27.6	
37	35	q-2007	0	7.6	10.6	14.6	
38	36						



List of results

Ohne Abschneiden der Schwellen / ParamSatz: Beginn - Faktor: Tmean / DatVon: 01.Jan DatBis: 30.Apr / FaktVon: 0,0 FaktBis: 12,0 Inkrement: 0,1

Datum	Tag	VarPar	MW	KI95%	STD	SE	RVK	N	dMIN	dMAX	dSPA	dMW	dSTD	dSE	tMIN	tMAX	tSPA	tSPA%	tMW	tMW%
01.01	1	0,00	1655,08	77,10	157,35	39,3374	2,4547	16	-12	18	30	5,81	4,72	1,1805	-357,5	268,5	625,9	37,8	118,74	7,17
01.01	1	0,10	1655,07	77,11	157,36	39,3398	2,4549	16	-12	18	30	5,81	4,72	1,1805	-357,5	268,5	626,0	37,8	118,75	7,17
01.01	1	0,20	1655,04	77,11	157,38	39,3443	2,4552	16	-12	18	30	5,81	4,72	1,1805	-357,5	268,5	626,0	37,8	118,76	7,18
01.01	1	0,30	1654,96	77,12	157,39	39,3473	2,4555	16	-12	18	30	5,81	4,72	1,1805	-357,4	268,4	625,8	37,8	118,77	7,18
01.01	1	0,40	1654,80	77,21	157,57	39,3930	2,4586	16	-12	18	30	5,81	4,72	1,1805	-357,9	268,5	626,4	37,9	118,90	7,18
01.01	1	0,50	1654,56	77,25	157,65	39,4135	2,4602	16	-12	18	30	5,81	4,72	1,1805	-358,1	268,8	626,8	37,9	118,93	7,19
01.01	1	0,60	1654,30	77,34	157,83	39,4572	2,4634	16	-13	18	31	5,88	4,81	1,2037	-358,9	269,0	627,9	38,0	119,01	7,19
01.01	1	0,70	1653,80	77,32	157,79	39,4482	2,4635	16	-13	18	31	5,88	4,81	1,2037	-359,1	269,5	628,6	38,0	119,06	7,20
01.01	1	0,80	1653,40	77,28	157,71	39,4281	2,4629	16	-13	18	31	5,88	4,81	1,2037	-359,4	269,9	629,3	38,1	118,84	7,19
01.01	1	0,90	1652,74	77,45	158,07	39,5169	2,4694	16	-13	18	31	5,88	4,81	1,2037	-361,2	270,6	631,8	38,2	119,00	7,20
01.01	1	1,00	1652,28	77,40	157,96	39,4906	2,4684	16	-13	18	31	5,88	4,81	1,2037	-360,8	271,1	631,8	38,2	118,79	7,19
01.01	1	1,10	1651,59	77,54	158,25	39,5628	2,4740	16	-13	18	31	5,88	4,81	1,2037	-362,1	271,8	633,9	38,4	118,85	7,20
01.01	1	1,20	1650,89	77,51	158,19	39,5468	2,4741	16	-13	18	31	5,81	4,85	1,2118	-361,4	271,3	632,7	38,3	119,00	7,21
01.01	1	1,30	1650,59	77,46	158,08	39,5198	2,4728	16	-13	18	31	5,88	4,81	1,2037	-361,1	271,6	632,7	38,3	118,85	7,20
01.01	1	1,40	1649,76	77,69	158,56	39,6395	2,4815	16	-13	18	31	5,81	4,85	1,2118	-363,0	272,4	635,4	38,5	119,03	7,21
01.01	1	1,50	1648,78	77,84	158,85	39,7134	2,4876	16	-13	18	31	5,81	4,85	1,2118	-364,9	273,4	638,3	38,7	119,13	7,23
01.01	1	1,60	1647,73	78,19	159,57	39,8933	2,5005	16	-13	18	31	5,88	4,81	1,2037	-367,0	274,4	641,4	38,9	119,62	7,26
01.01	1	1,70	1646,62	78,19	159,57	39,8934	2,5022	16	-13	18	31	5,88	4,81	1,2037	-367,6	275,5	643,1	39,1	119,52	7,26
01.01	1	1,80	1645,34	78,19	159,56	39,8908	2,5040	16	-13	18	31	5,81	4,85	1,2118	-366,3	276,8	643,1	39,1	119,53	7,26
01.01	1	1,90	1643,30	78,25	159,70	39,9247	2,5092	16	-13	18	31	5,75	4,84	1,2093	-369,8	277,0	646,7	39,4	119,54	7,27
01.01	1	2,00	1641,63	78,00	159,19	39,7976	2,5038	16	-13	18	31	5,81	4,83	1,2084	-368,1	276,7	644,8	39,3	119,30	7,27
01.01	1	2,10	1639,23	78,03	159,25	39,8137	2,5085	16	-13	18	31	5,88	4,84	1,2106	-367,7	279,1	646,8	39,5	118,95	7,26
01.01	1	2,20	1638,31	77,98	159,14	39,7846	2,5080	16	-13	18	31	5,75	4,89	1,2230	-366,8	280,0	646,8	39,5	118,82	7,25
01.01	1	2,30	1636,64	78,17	159,52	39,8811	2,5167	16	-13	18	31	5,75	4,89	1,2230	-367,4	279,5	646,9	39,5	119,11	7,28
01.01	1	2,40	1634,76	78,00	159,19	39,7980	2,5143	16	-13	18	31	5,75	4,91	1,2264	-370,1	279,0	649,2	39,7	118,40	7,24
01.01	1	2,50	1632,50	77,37	157,90	39,4752	2,4974	16	-13	18	31	5,75	4,85	1,2128	-367,9	278,9	646,7	39,6	117,36	7,19
01.01	1	2,60	1630,93	77,51	158,18	39,5439	2,5041	16	-13	18	31	5,69	4,90	1,2238	-366,3	280,4	646,7	39,7	117,99	7,23
01.01	1	2,70	1629,47	77,01	157,17	39,2928	2,4905	16	-13	18	31	5,69	4,79	1,1962	-364,9	279,3	644,1	39,5	117,18	7,19
01.01	1	2,80	1627,43	76,97	157,08	39,2705	2,4922	16	-13	18	31	5,75	4,85	1,2128	-362,8	278,6	641,4	39,4	117,18	7,20
01.01	1	2,90	1625,50	76,84	156,82	39,2042	2,4909	16	-13	18	31	5,63	4,86	1,2141	-360,9	280,5	641,4	39,5	117,02	7,20
01.01	1	3,00	1622,95	76,80	156,74	39,1857	2,4937	16	-13	18	31	5,63	4,86	1,2141	-361,2	280,1	641,4	39,5	116,66	7,19
01.01	1	3,10	1621,26	76,72	156,57	39,1418	2,4935	16	-13	18	31	5,63	4,86	1,2141	-359,6	281,8	641,4	39,6	116,48	7,18

Calculation and optimization of the parameters for a degree-day method

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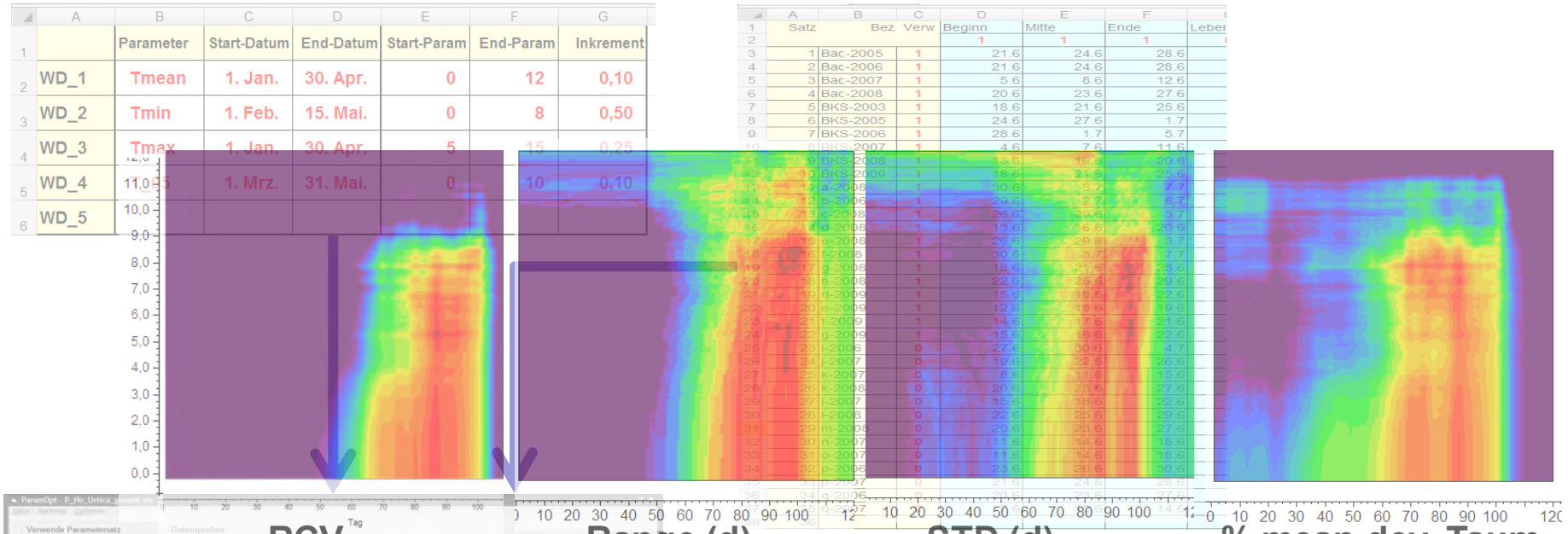
Bundesforschungsinstitut für Kulturpflanzen

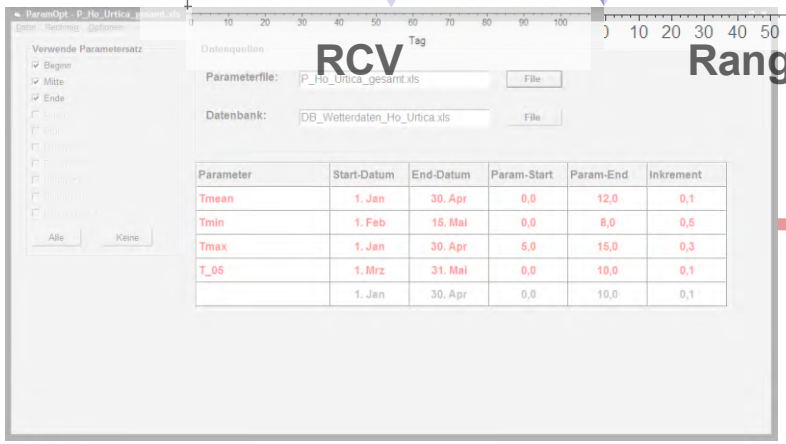
Definition of parameter variation

	Parameter	Start-Datum	End-Datum	Start-Param	End-Param	Inkrement
WD_1	Tmean	1. Jan.	30. Apr.	0	12	0,10
WD_2	Tmin	1. Feb.	15. Mai.	0	8	0,50
WD_3	Tmax	1. Jan.	30. Apr.	5	15	0,25
WD_4	T_05	1. Mrz.	31. Mai.	0	10	0,10
WD_5						

Field observation data

Satz	Bez	Verw	Beginn	Mitte	Ende
			1	1	1
1	Bac-2005	1	21.6	24.6	28.6
2	Bac-2006	1	21.6	24.6	28.6
3	Bac-2007	1	5.6	8.6	12.6
4	Bac-2008	1	20.6	23.6	27.6
5	BKS-2003	1	18.6	21.6	25.6
6	BKS-2005	1	24.6	27.6	1.7
7	BKS-2006	1	28.6	1.7	5.7
8	BKS-2007	1	4.6	7.6	11.6
9	BKS-2008	1	13.6	16.6	20.6
10	BKS-2009	1	18.6	21.6	25.6
11	a-2006	1	30.6	3.7	7.7
12	b-2006	1	29.6	2.7	6.7
13	c-2008	1	25.6	28.6	3.7
14	d-2008	1	13.6	16.6	20.6
15	e-2006	1	26.6	29.6	3.7
16	f-2008	1	30.6	3.7	7.7
17	g-2008	1	18.6	21.6	25.6
18	h-2008	1	22.6	25.6	29.6
19	d-2009	1	15.6	18.6	22.6
20	e-2009	1	12.6	15.6	19.6
21	i-2009	1	14.6	17.6	21.6
22	g-2009	1	15.6	18.6	22.6
23	l-2005	0	27.6	30.6	4.7
24	l-2007	0	19.6	22.6	26.6
25	k-2007	0	8.6	11.6	15.6
26	k-2008	0	20.6	23.6	27.6
27	l-2007	0	15.6	18.6	22.6
28	l-2008	0	22.6	25.6	29.6
29	m-2008	0	20.6	23.6	27.6
30	n-2007	0	11.6	14.6	18.6
31	o-2007	0	11.6	14.6	18.6
32	p-2006	0	23.6	26.6	30.6
33	p-2007	0	21.6	24.6	28.6
34	q-2006	0	24.6	27.6	1.7





Parameter	Start-Datum	End-Datum	Param-Start	Param-End	Inkrement
Tmean	1. Jan	30. Apr	0,0	12,0	0,1
Tmin	1. Feb	15. Mai	0,0	8,0	0,5
Tmax	1. Jan	30. Apr	5,0	15,0	0,3
T_05	1. Mrz	31. Mai	0,0	10,0	0,1
	1. Jan	30. Apr	0,0	10,0	0,1

List of results

Ohne Abschneiden der Schwellen / ParamSatz: Beginn - Faktor: Tmean / DatVon: 01.Jan DatBis: 30.Apr / FaktVon: 0,0 FaktBis: 12,0 Inkrement: 0,1

Datum	Tag	VarPar	MW	KI95%	STD	SE	RVK	N	dMIN	dMAX	dSPA	dMW	dSTD	dSE	tMIN	tMAX	tSPA	tSPA%	tMW	tMW%
01.01	1	0,00	1655,08	77,10	157,35	39,3374	2,4547	16	-12	18	30	5,81	4,72	1,1805	-357,5	268,5	625,9	37,8	118,74	7,17
01.01	1	0,10	1655,07	77,11	157,36	39,3398	2,4549	16	-12	18	30	5,81	4,72	1,1805	-357,5	268,5	626,0	37,8	118,75	7,17
01.01	1	0,20	1655,04	77,11	157,38	39,3443	2,4552	16	-12	18	30	5,81	4,72	1,1805	-357,5	268,5	626,0	37,8	118,76	7,18
01.01	1	0,30	1654,96	77,12	157,39	39,3473	2,4555	16	-12	18	30	5,81	4,72	1,1805	-357,4	268,4	625,8	37,8	118,77	7,18
01.01	1	0,40	1654,80	77,21	157,57	39,3930	2,4586	16	-12	18	30	5,81	4,72	1,1805	-357,9	268,5	626,4	37,9	118,90	7,18
01.01	1	0,50	1654,56	77,25	157,65	39,4135	2,4602	16	-12	18	30	5,81	4,72	1,1805	-358,1	268,8	626,8	37,9	118,93	7,19
01.01	1	0,60	1654,30	77,34	157,83	39,4572	2,4634	16	-13	18	31	5,88	4,81	1,2037	-358,9	269,0	627,9	38,0	119,01	7,19
01.01	1	0,70	1653,80	77,32	157,79	39,4482	2,4635	16	-13	18	31	5,88	4,81	1,2037	-359,1	269,5	628,6	38,0	119,06	7,20
01.01	1	0,80	1653,40	77,28	157,71	39,4281	2,4629	16	-13	18	31	5,88	4,81	1,2037	-359,4	269,9	629,3	38,1	118,84	7,19
01.01	1	0,90	1652,74	77,45	158,07	39,5169	2,4694	16	-13	18	31	5,88	4,81	1,2037	-361,2	270,6	631,8	38,2	119,00	7,20
01.01	1	1,00	1652,28	77,40	157,96	39,4906	2,4684	16	-13	18	31	5,88	4,81	1,2037	-360,8	271,1	631,8	38,2	118,79	7,19
01.01	1	1,10	1651,59	77,54	158,25	39,5628	2,4740	16	-13	18	31	5,88	4,81	1,2037	-362,1	271,8	633,9	38,4	118,85	7,20
01.01	1	1,20	1650,89	77,51	158,19	39,5468	2,4741	16	-13	18	31	5,81	4,85	1,2118	-361,4	271,3	632,7	38,3	119,00	7,21
01.01	1	1,30	1650,59	77,46	158,08	39,5198	2,4728	16	-13	18	31	5,88	4,81	1,2037	-361,1	271,6	632,7	38,3	118,85	7,20
01.01	1	1,40	1649,76	77,69	158,56	39,6395	2,4815	16	-13	18	31	5,81	4,85	1,2118	-363,0	272,4	635,4	38,5	119,03	7,21
01.01	1	1,50	1648,78	77,84	158,85	39,7134	2,4876	16	-13	18	31	5,81	4,85	1,2118	-364,9	273,4	638,3	38,7	119,13	7,23
01.01	1	1,60	1647,73	78,19	159,57	39,8933	2,5005	16	-13	18	31	5,88	4,81	1,2037	-367,0	274,4	641,4	38,9	119,62	7,26
01.01	1	1,70	1646,62	78,19	159,57	39,8934	2,5022	16	-13	18	31	5,88	4,81	1,2037	-367,6	275,5	643,1	39,1	119,52	7,26
01.01	1	1,80	1645,34	78,19	159,56	39,8908	2,5040	16	-13	18	31	5,81	4,85	1,2118	-366,3	276,8	643,1	39,1	119,53	7,26
01.01	1	1,90	1643,30	78,25	159,70	39,9247	2,5092	16	-13	18	31	5,75	4,84	1,2093	-369,8	277,0	646,7	39,4	119,54	7,27
01.01	1	2,00	1641,63	78,00	159,19	39,7976	2,5038	16	-13	18	31	5,81	4,83	1,2084	-368,1	276,7	644,8	39,3	119,30	7,27
01.01	1	2,10	1639,23	78,03	159,25	39,8137	2,5085	16	-13	18	31	5,88	4,84	1,2106	-367,7	279,1	646,8	39,5	118,95	7,26
01.01	1	2,20	1638,31	77,98	159,14	39,7846	2,5080	16	-13	18	31	5,75	4,89	1,2230	-366,8	280,0	646,8	39,5	118,82	7,25
01.01	1	2,30	1636,64	78,17	159,52	39,8811	2,5167	16	-13	18	31	5,75	4,89	1,2230	-367,4	279,5	646,9	39,5	119,11	7,28
01.01	1	2,40	1634,76	78,00	159,19	39,7980	2,5143	16	-13	18	31	5,75	4,91	1,2264	-370,1	279,0	649,2	39,7	118,40	7,24
01.01	1	2,50	1632,50	77,37	157,90	39,4752	2,4974	16	-13	18	31	5,75	4,85	1,2128	-367,9	278,9	646,7	39,6	117,36	7,19
01.01	1	2,60	1630,93	77,51	158,18	39,5439	2,5041	16	-13	18	31	5,69	4,90	1,2238	-366,3	280,4	646,7	39,7	117,99	7,23
01.01	1	2,70	1629,47	77,01	157,17	39,2928	2,4905	16	-13	18	31	5,69	4,79	1,1962	-364,9	279,3	644,1	39,5	117,18	7,19
01.01	1	2,80	1627,43	76,97	157,08	39,2705	2,4922	16	-13	18	31	5,75	4,85	1,2128	-362,8	278,6	641,4	39,4	117,18	7,20
01.01	1	2,90	1625,50	76,84	156,82	39,2042	2,4909	16	-13	18	31	5,63	4,86	1,2141	-360,9	280,5	641,4	39,5	117,02	7,20
01.01	1	3,00	1622,95	76,80	156,74	39,1857	2,4937	16	-13	18	31	5,63	4,86	1,2141	-361,2	280,1	641,4	39,5	116,66	7,19
01.01	1	3,10	1621,26	76,72	156,57	39,1418	2,4935	16	-13	18	31	5,63	4,86	1,2141	-359,6	281,8	641,4	39,6	116,48	7,18

Current parameters used to predict the flight of the host populations of *H. obsoletus*

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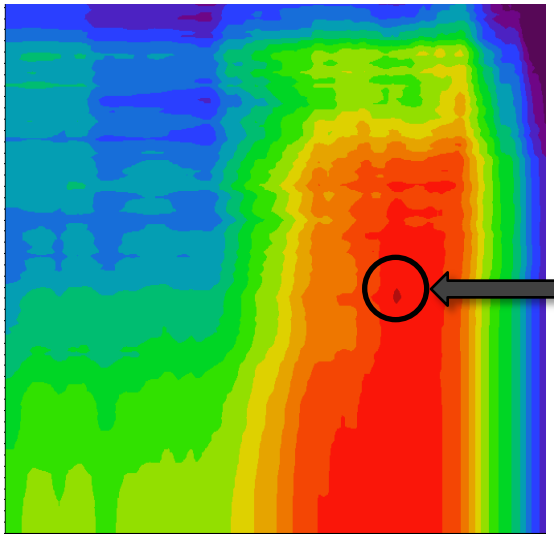
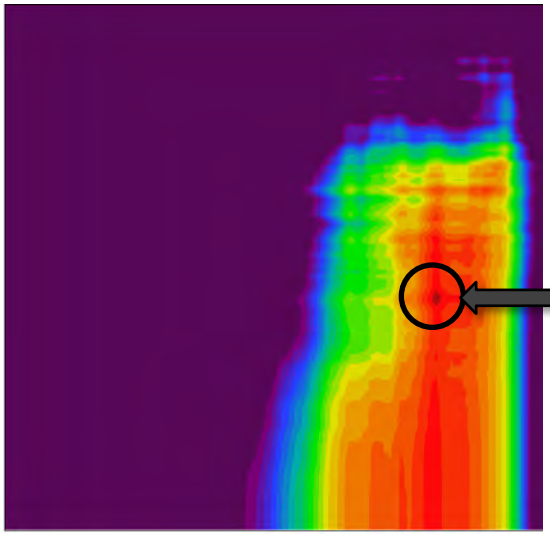
Bindweed populations



Nettle populations



C. arvensis populations:

Start of DD-summation: March 9

T-Threshold: 5.8 °C

Start of flight: 1053 DD

U. dioica populations:

Start of DD-summation: April 1

T-Threshold: 5 °C

Start of flight: 1160 DD

RVK
<= 1,400 <= 1,514 <= 1,629 <= 1,743 <= 1,857 <= 1,971
<= 2,086 <= 2,200 <= 2,314 <= 2,429 <= 2,543 <= 2,657
<= 2,771 <= 2,886 <= 3,000 > 3,000

Current parameters used to predict the flight of the host populations of *H. obsoletus*

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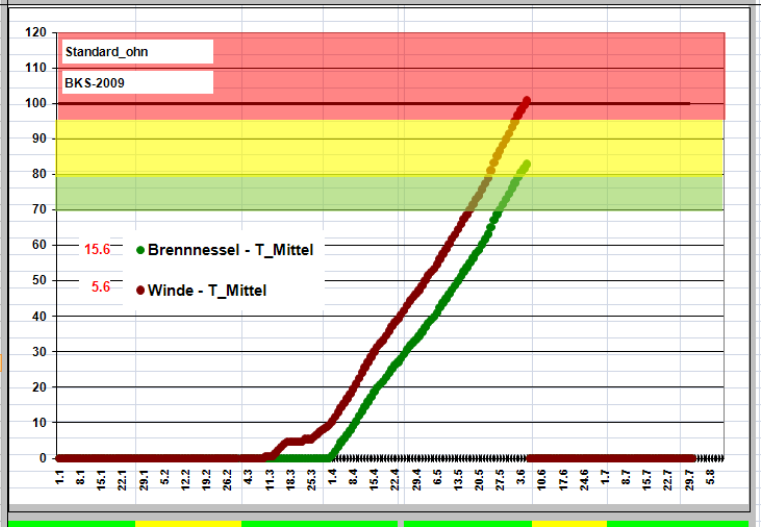
HyaProg.xls

T-Datensatz	BKS-2009		Parametersatz	Standard_ohn	
Winde			**Brennnessel**		
Grad-Tage	1062		Grad-Tage	962	
	101%			83%	
Flugbeg.	5.6		Flugbeg.	15.6	
Startdatum	9.3		Startdatum	1.4	
T-Thresh.	5,8		T-Thresh.	5,0	
T-Summe	1053		T-Summe	1160	
Schwelle	0		Schwelle	0	
Datentabelle	T_Mittel		Datentabelle	T_Mittel	



Comparison of calculated and observed flight data