AppDate 3.01

Estimation of consistent application dates dependent on BBCH crop development stages for FOCUS models

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1. Introduction

AppDate is software which calculates consistent application dates which can be used in further FOCUS modelling. Currently, a couple of FOCUS models (*e.g.,* PEARL, PELMO, MACRO, PRZM, and TOXSWA) are used in European pesticide registration to assess predicted environmental concentrations (PEC) in ground and surface water. Apart from the internal settings FOCUS scenarios, main drivers of the simulations are the application pattern (rate and date of application) and the physical-chemical properties of the compounds.

Unfortunately, FOCUS did not provide the link between crop development stages (BBCH codes) and actual dates when these stages are reached. However, for all FOCUS models the distinct definition of application dates is essential.

The original version of AppDate (version 1.0) was developed in 2006 and included only recommendations for the groundwater location “Hamburg” (Klein 2006). In 2012 version 2.0 of AppDate was released with now all FOCUS groundwater scenarios included (Klein 2012). AppDate 2.0 SE (special edition) released in 2015 made recommendations also for FOCUS surface water scenarios. The most recent version is AppDate version 3.0 which is described in this manual. Version 3.0 was completely revised and includes, *e.g.*, also recommendations for potato tuber.

The BBCH codes describe the development of supported crops by in total 9 principal stages as summarised in Table 1. They have been developed by three organisations (**B**iologische Bundesanstalt, **B**undessortenamt, **CH**emische Industrie, IVA) already in 1992 and were updated in 2001 (BBCH 2001).

Table 1: BBCH - principal growth stages to describe crop development

BBCH macro code	Description
00	Germination / sprouting / bud development
10	Leaf development (main shoot)
20	Formation of side shoots / tillering
30	Stem elongation or rosette growth / shoot development (main shoot)
40	Development of harvestable vegetative plant parts or vegetatively propagated organs / booting (main shoot)
50	Inflorescence emergence (main shoot) / heading
60	Flowering (main shoot)
70	Development of fruit
80	Ripening or maturity of fruit and seed
90	Senescence, beginning of dormancy
99	Harvest

The principal growth stages presented in Table 1 alone are not sufficient to exactly define application or evaluation dates, since they always describe time spans in the course of the development of a plant. Therefore additional secondary stages have been defined to precisely identify the optimum time of applications for farmers.

2. Linking BBCH codes to dates

2.1. Methodology

General remarks

AppDate uses a database where suitable application dates for major development stages (*e.g.*, BBCH 10, 20, 30) are collected. Between these BBCH stages, the dates are always linearly interpolated. The dates for the major development stages are based on various sources and also dependent on whether they refer to groundwater or surface water scenarios. According to the BBCH-monograph not all BBCH stages are defined for most of crops. This was followed in AppDate.

For lawn, pasture, and evergreens the FOCUS models are using the fully developed crop for the whole period of the simulation. Therefore, no BBCH codes could be linked to these cultivations.

A general problem when defining these dates are the significant variances of crop development between different agricultural locations within the area which is representative for a certain FOCUS location (*e.g.*, Jokioinen, Hamburg). Nevertheless, only a single date is given per location and BBCH stage. This was done because the main objective was the development of a standardised parameter set that is supposed to provide a consistent guidance to the modeller.

For surface water AppDate does not recommend application dates but gives recommendation for the appropriate application window. The beginning of the window is set to the current BBCH stage. The duration of the application window is linked to the requirements of FOCUS SWASH shell, *i.e.*, the minimum window for a single application is 30 days. For multiple applications the end of the window is calculated based on the number of applications and the minimum interval between applications.

Linear interpolation procedure

As already mentioned AppDate uses a linear interpolation routine for BBCH stages which are not explicitly listed in the data base. However, linear interpolation cannot be simply done by calculating the mathematical differences between BBCH stages (*e.g.*, BBCH 80 - BBCH 35 = 45) as for most of the crops complete BBCH macro stages are missing (*e.g.,* tillering for maize). In addition there is also no crop where all micro stages are present (*e.g.*, for cereals where all macro stages are present, BBCH 70, 72 or 74 do not exist though macro stage 7 is defined).

AppDate uses following principles with regard to the problem of missing BBCH stages:

- If BBCH macro stages are missing (*e.g.*, tillering in maize) they are not considered for the interpolation at all.
- If only single BBCH micro stages are missing but the macro stage is defined, these micro stages are considered in the interpolation routine.

The procedure is further explained in the following example. The date for BBCH stage 59 in pome fruit at Hamburg should be calculated. In the database, BBCH 10 and BBCH 70 are given with dates on 16/04 and 15/05, respectively. This whole period includes 29 days.

Following total number of micro stages between BBCH 10 and BBCH 70 is used by AppDate:

10 micro stages (complete macro stage 10 "leaf development")
10 micro stages (complete macro stage 30 "shoot development")
10 micro stages (complete macro stage 50 "inflorence emergence")
10 micro stages (complete macro stage 60 "begin flowering"
40 micro stages

Following total number of micro stages between BBCH 10 and BBCH 59 is used by AppDate:

10 micro stages (complete macro stage 10 "leaf development")
10 micro stages (complete macro stage 30 "shoot development")
9 micro stages (relevant part of macro stage 50 "inflorence emergence")
29 micro stages

Based on these results the date for BBCH stage 59 is calculated as follows:

$$16/4 + \frac{29\ stages}{40\ stages}\ 29\ days = 16/4 + 21\ days = 7/5$$

There is, however one exception for winter crops in their hibernation phase set between BBCH 21 and BBCH 30 in AppDate. In this period the standard interpolation routine is not used. Instead, BBCH 21 is fixed to 9 days before BBCH 30. For the time reaching the following BBCH stages (up to BBCH 30) always one day is assumed.

Differentiation of senescence and harvest

The maximum BBCH stage in all previous versions was set to 90. However, BBCH 90 means beginning of senescence rather than harvesting of the crop. In the new version additional BBCH codes above 90 up to 99 were added to better match the late BBCH stages.

Potato tubers

Potatoes can be considered an exceptional case because the aboveground part of the plants and the subsurface tubers develop independently. For the tubers, BBCH codes between 40 and 50 are defined. The development starts at BBCH 40 when the plant reaches BBCH 51 and it reaches BBCH 50 at the end of senescence of the crop (BBCH 99). In the new version of AppDate the special behaviour of potatoes was considered by implementing two different BBCH curves for crop and tubers.

Biennial crops that are harvested at BBCH 50

Some biennial crops are usually harvested in the first year at BBCH 50. For these crops BBCH 40 was used to define the date of the maximum LAI and BBCH 50 to define the harvest date. Both dates are always given by FOCUS (surface water and groundwater).

This refers to following crops:

- groundwater: cabbage, carrots, onions, sugar beet
- surface water: vegetables (bulb), vegetables (leafy), vegetables (root), sugar beet

Hibernation of winter crops

The simple strategy of linear interpolation between defined BBCH stages does not hold for crops with a dormancy period in winter. This process was to some extent considered already in previous versions of AppDate, but without a clear methodology. The new version of AppDate uses a following simple algorithm and the spring point for the time between crop emergence and the end of the hibernation:

- Date BBCH code 20 = 15 days after crop emergence
- Date BBCH code 21= 9 days before spring point
- Date BBCH code 30 = spring point

Spring points are given by FOCUS (2009/2014) for the 6 locations Châteaudun, Hamburg, Jokioinen, Kremsmünster, Okehampton, and Piacenza. They can be found as footnotes under the crop development tables in Annex A20. For FOCUS surface water scenarios spring points were defined by FOCUS for drainage scenarios (D1 to D6) whereas for R-scenarios no spring points were defined. They can be found in the appendix C of the FOCUS SW report (parameter “Intermediate crop development”). For the relevant scenarios R1 and

R3 the respective spring points from the groundwater locations Hamburg (R1) and Piacenza (R3) were used also for these surface water scenarios.

Following this algorithm, the dates summarised in Table 2 and Table 3 are calculated by AppDate for winter cereals at all locations. The columns without hibernation refer to linear interpolation between BBCH 10 and BBCH 60 (maximum LAI).

Table 2: Estimated dates for major BBCH stages with and without hibernation for winter cereals (locations Châteaudun, Hamburg ,Jokioinen)

	Châteaudun		Hamburg		Jokioinen	
BBCH	linear interp.	incl. hibernation	linear interp.	incl. hibernation	linear interp.	incl. hibernation
0	20.10.01	20.10.01	12.10.01	12.10.01	10.09.01	10.09.01
9	26.10.01	26.10.01	01.11.01	01.11.01	20.09.01	20.09.01
10	27.10.01	27.10.01	02.11.01	02.11.01	21.09.01	21.09.01
20	11.12.01	10.11.01	16.12.01	16.11.01	18.11.01	05.10.01
30	25.01.02	15.04.02	04.05.02	04.05.02	14.01.02	14.05.02
41	02.05.02	02.05.02	14.05.02	14.05.02	29.05.02	29.05.02
51	17.05.02	17.05.02	24.05.02	24.05.02	12.06.02	12.06.02
61	01.06.02	01.06.02	03.06.02	03.06.02	26.06.02	26.06.02
71	07.06.02	07.06.02	18.06.02	18.06.02	05.07.02	05.07.02
83	15.06.02	15.06.02	06.07.02	06.07.02	15.07.02	15.07.02
92	26.06.02	26.06.02	22.07.02	22.07.02	27.07.02	27.07.02
99	15.07.02	15.07.02	10.08.02	10.08.02	15.08.02	15.08.02

Table 3: Estimated dates for major BBCH stages with and without hibernation for winter cereals (locations: Kremsmünster, Okehampton, Piacenza)

	Kremsmünster		Okehampton		Piacenza	
BBCH	linear interp.	incl. hibernation	linear interp.	incl. hibernation	linear interp.	incl. hibernation
0	25.10.01	25.10.01	07.10.01	07.10.01	25.11.01	25.11.01
9	05.11.01	05.11.01	17.10.01	17.10.01	01.12.01	01.12.01
10	06.11.01	06.11.01	18.10.01	18.10.01	02.12.01	02.12.01
20	17.12.01	20.11.01	01.12.01	01.11.01	04.01.02	16.12.01
30	31.01.02	24.04.02	13.01.02	21.04.02	06.02.02	19.03.02
41	09.05.02	09.05.02	30.04.02	30.04.02	07.04.02	07.04.02
51	23.05.02	23.05.02	08.05.02	08.05.02	24.04.02	24.04.02
61	06.06.02	06.06.02	17.05.02	17.05.02	11.05.02	11.05.02
71	20.06.02	20.06.02	03.06.02	03.06.02	18.05.02	18.05.02
83	06.07.02	06.07.02	25.06.02	25.06.02	27.05.02	27.05.02
92	22.07.02	22.07.02	13.07.02	13.07.02	08.06.02	08.06.02
99	10.08.02	10.08.02	01.08.02	01.08.02	01.07.02	01.07.02

The respective results for winter oil seed rape are summarised in Table 4 and Table 5.

Table 4: Estimated dates for major BBCH stages with and without hibernation for winter oil seed rape (locations Châteaudun, Hamburg)

	Châteaudun		Hamburg	
BBCH	linear interp.	incl. hibernation	linear interp.	incl. hibernation
0	30.08.01	30.08.01	25.08.01	25.08.01
9	07.09.01	07.09.01	2.09.01	2.09.01
10	08.09.01	08.09.01	3.09.01	3.09.01
20	13.11.01	22.09.01	03.11.01	17.09.01
30	19.01.02	11.03.02	03.01.02	18.04.02
50	21.04.02	21.04.02	27.04.02	27.04.02
60	31.05.02	31.05.02	05.05.02	05.05.02
71	04.06.02	04.06.02	25.05.02	25.05.02
80	07.06.02	07.06.02	10.06.02	10.06.02
97	03.07.02	03.07.02	21.07.02	21.07.02
99	10.07.02	10.07.02	28.07.02	28.07.02

Table 5: Estimated dates for m\ajor BBCH stages with and without hibernation for winter oil seed rape (locations: Kremsmünster, Okehampton, Piacenza)

	Kremsmünster		Okehampton		Piacenza	
BBCH	linear interp.	incl. hibernation	linear interp.	incl. hibernation	linear interp.	incl. hibernation
0	25.08.01	25.08.01	07.08.01	07.08.01	30.09.01	30.09.01
9	2.09.01	2.09.01	14.08.01	14.08.01	05.10.01	05.10.01
10	3.09.01	3.09.01	15.08.01	15.08.01	06.10.01	06.10.01
20	03.11.01	17.09.01	19.10.01	29.08.01	23.11.01	20.10.01
30	03.01.02	15.04.02	22.12.01	09.04.02	10.01.02	07.03.02
50	25.04.02	25.04.02	20.04.02	20.04.02	27.03.02	27.03.02
60	05.05.02	05.05.02	30.04.02	30.04.02	15.04.02	15.04.02
71	25.05.02	25.05.02	19.05.02	19.05.02	28.04.02	28.04.02
80	10.06.02	10.06.02	04.06.02	04.06.02	09.05.02	09.05.02
97	21.07.02	21.07.02	14.07.02	14.07.02	13.06.02	13.06.02
99	28.07.02	28.07.02	21.07.02	21.07.02	20.06.02	20.06.02

In the previous versions of AppDate, the handling of hibernation for surface water scenarios was considered using BBCH 10 as spring point. In order to harmonise results for both types of water bodies the surface water scenarios were adopted to also use BBCH 30 for this purpose.

The results for winter cereals are presented in Table 6, Table 7, and Table 8 for drainage and run-off scenarios and AppDate 2.0 and AppDate 3.0, respectively. Please note that even the results based on the previous methodology are using BBCH 99 for harvest stage of the crop.

Table 6: Estimated dates for major BBCH stages with and without hibernation for winter cereals (locations D1, D2, D3)

	D1		D2		D3	
BBCH	linear interp.	incl. hibernation	linear interp.	incl. hibernation	linear interp.	incl. hibernation
0	15.09.01	15.09.01	15.10.01	15.10.01	11.11.01	11.11.01
9	25.09.01	25.09.01	25.10.01	25.10.01	21.11.01	21.11.01
10	26.09.01	26.09.01	26.10.01	26.10.01	22.11.01	22.11.01
20	13.04.02	10.10.01	22.04.02	09.11.01	07.05.02	06.12.01
30	02.05.02	25.03.02	10.05.02	04.04.02	27.05.02	16.04.02
41	27.04.02	27.04.02	06.05.02	06.05.02	22.05.02	22.05.02
51	27.05.02	27.05.02	04.06.02	04.06.02	24.06.02	24.06.02
61	25.06.02	25.06.02	01.07.02	01.07.02	25.07.02	25.07.02
71	11.07.02	11.07.02	11.07.02	11.07.02	30.07.02	30.07.02
83	31.07.02	31.07.02	22.07.02	22.07.02	06.08.02	06.08.02
92	15.08.02	15.08.02	31.07.02	31.07.02	11.08.02	11.08.02
99	26.08.02	26.08.02	07.08.02	07.08.02	15.08.02	15.08.02

Table 7: Estimated dates for major BBCH stages with and without hibernation for winter cereals (locations: D4, D5, D6)

	D4		D5		D6	
BBCH	linear interp.	incl. hibernation	linear interp.	incl. hibernation	linear interp.	incl. hibernation
0	08.09.01	12.09.01	25.10.01	31.10.01	15.11.01	20.11.01
9	22.09.01	22.09.01	10.11.01	10.11.01	30.11.01	30.11.01
10	18.03.02	23.09.01	15.03.02	11.11.01	16.02.02	01.12.01
20	07.04.02	07.10.01	28.03.02	25.11.01	25.02.02	15.12.01
30	27.04.02	18.03.02	09.04.02	15.03.02	06.03.02	16.02.02
41	22.04.02	22.04.02	06.04.02	06.04.02	03.03.02	03.03.02
51	24.05.02	24.05.02	27.04.02	27.04.02	17.03.02	17.03.02
61	23.06.02	23.06.02	17.05.02	17.05.02	01.04.02	01.04.02
71	08.07.02	08.07.02	01.06.02	01.06.02	25.04.02	25.04.02
83	27.07.02	27.07.02	20.06.02	20.06.02	23.05.02	23.05.02
92	10.08.02	10.08.02	04.07.02	04.07.02	13.06.02	13.06.02
99	21.08.02	21.08.02	15.07.02	15.07.02	30.06.02	30.06.02

Table 8: Estimated dates for major BBCH stages with and without hibernation for winter cereals (locations: R1, R3)

	R1		R3	
BBCH	linear interp.	incl. hibernation	linear interp.	incl. hibernation
0	31.10.01	02.11.01	20.11.01	21.11.01
9	12.11.01	12.11.01	01.12.01	01.12.01
10	13.11.01	13.11.01	02.12.01	02.12.01
20	10.02.02	27.11.01	05.02.02	16.12.01
30	10.05.02	04.05.02	10.04.02	19.03.02
41	18.05.02	18.05.02	07.04.02	07.04.02
51	30.05.02	30.05.02	24.04.02	24.04.02
61	11.06.02	11.06.02	11.05.02	11.05.02
71	24.06.02	24.06.02	25.05.02	25.05.02
83	10.07.02	10.07.02	10.06.02	10.06.02
92	22.07.02	22.07.02	22.06.02	22.06.02
99	31.07.02	31.07.02	01.07.02	01.07.02

The respective results for winter oil seed rape are summarised in Table 9 and Table 10.

Table 9: Estimated dates for major BBCH stages with and without hibernation for winter oil seed rape (locations D2, D3, D4)

	D2		D3		D4	
BBCH	linear interp.	incl. hibernation	linear interp.	incl. hibernation	linear interp.	incl. hibernation
0	05.09.01	05.09.01	23.08.01	23.08.01	24.08.01	24.08.01
9	15.09.01	15.09.01	02.09.01	02.09.01	03.09.01	03.09.01
10	10.03.02	16.09.01	21.02.02	03.09.01	21.02.02	04.09.01
20	03.04.02	30.09.01	16.03.02	17.09.01	16.03.02	18.09.01
30	28.04.02	10.03.02	09.04.02	21.02.02	09.04.02	01.03.02
50	18.04.02	18.04.02	09.04.02	09.04.02	18.04.02	18.04.02
60	15.06.02	15.06.02	25.05.02	25.05.02	05.06.02	05.06.02
71	23.06.02	23.06.02	10.06.02	10.06.02	23.06.02	23.06.02
80	30.06.02	30.06.02	23.06.02	23.06.02	08.07.02	08.07.02
97	13.07.02	13.07.02	17.07.02	17.07.02	06.08.02	06.08.02
99	15.07.02	15.07.02	20.07.02	20.07.02	09.08.02	09.08.02

Table 10: Estimated calculated dates for major BBCH stages with and without hibernation for winter oil seed rape (locations: D5, R1, R3)

	D5		R1		R3	
BBCH	linear interp.	incl. hibernation	linear interp.	incl. hibernation	linear interp.	incl. hibernation
0	10.09.01	10.09.01	25.08.01	25.08.01	25.09.01	25.09.01
9	20.09.01	20.09.01	04.09.01	04.09.01	05.10.01	05.10.01
10	21.09.01	21.09.01	05.09.01	05.09.01	06.10.01	06.10.01
20	19.03.02	05.10.01	30.12.01	19.09.01	28.12.01	20.11.01
30	05.04.02	01.03.02	25.04.02	18.04.02	20.03.02	07.03.02
50	05.04.02	05.04.02	07.05.02	07.05.02	05.04.02	29.03.02
60	10.05.02	10.05.02	25.05.02	25.05.02	20.04.02	20.04.02
71	26.05.02	26.05.02	07.06.02	07.06.02	02.05.02	03.05.02
80	08.06.02	08.06.02	18.06.02	18.06.02	13.05.02	14.05.02
97	02.07.02	02.07.02	08.07.02	08.07.02	25.05.02	03.06.02
99	05.07.02	05.07.02	10.07.02	10.07.02	05.06.02	05.06.02

Corresponding dates for field beans are given in Table 11.

Table 11: Estimated calculated dates for major BBCH stages with and without hibernation for field beans (location: D2)

	D2	
BBCH	linear interp.	incl. hibernation
0	02.11.01	02.11.01
9	12.11.01	12.11.01
10	13.11.01	13.11.01
20	15.01.02	01.04.02
51	09.05.02	18.04.02
60	29.06.02	29.06.02
71	21.07.02	21.07.02
81	10.08.02	10.08.02
93	03.09.02	03.09.02
99	15.09.02	15.09.02

2.2. Groundwater scenarios

Most of the crops refer to the FOCUS groundwater report (FOCUS 2000, FOCUS 2009).

These crops were already defined by the FOCUS groundwater working group in 2000 and 2009. Consequently, most of the information in the data base was directly taken from FOCUS (2009/2014) as shown in Table 12.

Table 12: Crop development stages in AppDate adopted from FOCUS (2009/2014)

Stage according to FOCUS (2009/2014)	BBCH stage in AppDate	Remarks
Planting date	BBCH 0	as given by FOCUS, if not applicable (*e.g*, permanent crop) it was not used
Emergence date	BBCH 9	always given by FOCUS
1 day after emergence	BBCH 10	all crops
15 days after emergence	BBCH 20	only winter crops* (to consider hibernation)
9 days before BBCH 30	BBCH 21+	only winter crops* (to consider hibernation)
Spring point	BBCH 30	only winter crops* (to consider hibernation)
Maximum LAI	BBCH 40	biennial plants that are harvested in the first year (*e.g.*, cabbage)
Harvest	BBCH 50	biennial plants that are harvested in the first year (*e.g.*, cabbage)
Maximum LAI	BBCH 60	all annual crops
Maximum LAI	BBCH 70	Pome, stone fruits and vines
Senescence	BBCH 90	all crops except biennial plants that are harvested in the first year
Harvest	BBCH 99	all crops except biennial plants that are harvested in the first year

* winter crops are winter cereals and winter oil seed rape at Châteaudun, Hamburg, Jokioinen, Kremsmünster, Okehampton, and Piacenza

\+ BBCH 21 is set outside the standard interpolation routine and therefore also not mentioned in the following tables

In general the FOCUS date for maximum leaf area index (LAI) or “maturation date” in PELMO was used to define BBCH stage 60 (begin flowering). However, for those crops which are harvested already at BBCH stage 50 (*e.g.*, sugar beet, cabbage, onions, carrots) maximum LAI was used to define BBCH stage 40 (booting).

Unfortunately, the planting date is not always provided by FOCUS (2009/2014). Missing dates were set to 10 days before crop emergence. The crop development dates in AppDate are summarised in the following for all FOCUS locations.

Table 13: AppDate 3.0 crop development dates for Châteaudun as defined by FOCUS (2009/2014)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
cabbage 1		20.04.01	21.04.01			31.05.01	15.07.01					15.07.01
cabbage 2		31.07.01	01.08.01			05.09.01	15.10.01					15.10.01
carrots 1	28.02.01	10.03.01	11.03.01			20.04.01	31.05.01					31.05.01
carrots 2	30.06.01	10.07.01	11.07.01			10.08.01	20.09.01					20.09.01
cereals spring	20.02.01	10.03.01	11.03.01					10.06.01			30.06.01	20.07.01
cereals winter	20.10.01	26.10.01	27.10.01	10.11.01	15.04.02			31.05.02			20.06.02	15.07.02
maize	20.04.01	01.05.01	02.05.01					15.08.01			01.09.01	01.10.01
oil seed rape, winter	30.08.01	07.09.01	08.09.01	22.09.01	11.03.02			20.04.02			10.06.02	10.07.02
onions	15.04.01	25.04.01	26.04.01			30.06.01	01.09.01					01.09.01
peas	25.03.01	05.04.01	06.04.01					07.06.01			31.07.01	15.08.01
pome fruit		01.04.01	02.04.01						31.05.01		01.09.01	01.10.01
potatoes	15.04.01	30.04.01	01.05.01				28.05.01	15.06.01			02.08.01	01.09.01
potato tuber						28.05.01	01.09.01					01.09.01
stone fruit		01.04.01	02.04.01						31.05.01		01.09.01	01.10.01
sugar beet	25.03.01	16.04.01	17.04.01			15.07.01	15.10.01					15.10.01
tomatoes		10.05.01	11.05.01					30.06.01			26.07.01	25.08.01
vines		01.04.01	02.04.01						31.07.01		13.08.01	01.11.01

Table 14: AppDate 3.0 crop development dates for Hamburg as defined by FOCUS (2009/2014)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
beans	25.03.01	10.04.01	11.04.01					10.07.01			05.08.01	25.08.01
cabbage 1		20.04.01	21.04.01			31.05.01	15.07.01					15.07.01
cabbage 2		31.07.01	01.08.01			05.09.01	15.10.01					15.10.01
carrots 1	28.02.01	10.03.01	11.03.01			20.04.01	31.05.01					31.05.01
carrots 2	30.06.01	10.07.01	11.07.01			10.08.01	20.09.01					20.09.01
cereals spring	10.03.01	01.04.01	02.04.01					05.06.01			31.07.01	20.08.01
cereals winter	12.10.01	01.11.01	02.11.01	16.11.01	04.05.02			01.06.02			16.07.02	10.08.02
maize	20.04.01	05.05.01	06.05.01					30.07.01			21.08.01	20.09.01
oil seed rape, winter	25.08.01	2.09.01	3.09.01	17.09.01	18.04.02			5.05.02			28.06.02	28.07.02
onions	15.04.01	25.04.01	26.04.01			30.06.01	01.09.01					01.09.01
peas	25.03.01	10.04.01	11.04.01					10.07.01			10.08.01	25.08.01
pome fruit		15.04.01	16.04.01						01.07.01		30.09.10	30.10.01
potatoes	1.05.01	10.05.01	11.05.01					20.07.01			16.08.01	15.09.01
potato tuber						22.06.01	15.09.01					15.09.01
stone fruit		15.04.01	16.04.01				1.05.01		01.07.01		30.09.01	30.10.01
strawberries		15.03.01	16.03.01					30.04.01			01.08.01	31.08.01
sugar beet	1.04.01	15.04.01	16.04.01			30.08.01	08.10.01					08.10.01
vines		01.05.01	02.05.01						15.07.01		11.08.01	30.10.01

Table 15: AppDate 3.0 crop development dates for Jokioinen as defined by FOCUS (2009/2014)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
cabbage 1		20.05.01	21.05.01			05.09.01	20.09.01					20.09.01
carrots 1	15.05.01	01.06.01	02.06.01			05.09.01	05.10.01					05.10.01
cereals spring	07.05.01	18.05.01	19.05.01					30.06.01			05.08.01	25.08.01
cereals winter	10.09.01	20.09.01	21.09.01	05.10.01	14.05.02			25.06.02			21.07.02	15.08.02
oil seed rape, summer	10.05.01	20.05.01	21.05.01					05.07.01			31.07.01	30.08.01
onions	10.05.01	20.05.01	21.05.01			25.06.01	15.08.01					15.08.01
peas	10.05.01	25.05.01	26.05.01					30.06.01			10.08.01	25.08.01
pome fruit		10.05.01	11.05.01						25.05.01		15.09.01	15.10.01
potatoes	15.05.01	05.06.01	06.06.01					30.08.01			05.09.01	25.09.01
potato tuber						26.07.01	25.09.01					25.09.01
soft fruits		10.05.01	11.05.01					25.05.01			06.08.01	25.10.01
stone fruit		10.05.01	11.05.01						25.05.01		15.09.01	15.10.01
strawberries		15.05.01	16.05.01					25.06.01			16.08.01	15.09.01
sugar beet	10.05.01	25.05.01	26.05.01			10.08.01	15.10.01					15.10.01

Table 16: AppDate 3.0 crop development dates for Kremsmünster as defined by FOCUS (2009/2014)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
beans	25.03.01	10.04.01	11.04.01					10.07.01			05.08.01	25.08.01
cabbage 1		20.04.01	21.04.01			31.05.01	15.07.01					15.07.01
cabbage 2		31.07.01	01.08.01			05.09.01	15.10.01					15.10.01
carrots 1	28.02.01	10.03.01	11.03.01			20.04.01	31.05.01					31.05.01
carrots 2	30.06.01	10.07.01	11.07.01			10.08.01	20.09.01					20.09.01
cereals spring	10.03.01	01.04.01	02.04.01					05.06.01			31.07.01	20.08.01
cereals winter	25.10.01	05.11.01	06.11.01	20.11.01	24.04.02			05.06.02			16.07.02	10.08.02
maize	20.04.01	05.05.01	06.05.01					30.07.01			21.08.01	20.09.01
oil seed rape, winter	25.08.01	2.09.01	3.09.01	17.09.01	15.04.02			5.05.02			28.06.02	28.07.02
onions	15.04.01	25.04.01	26.04.01			30.06.01	01.09.01					01.09.01
peas	25.03.01	10.04.01	11.04.01					10.07.01			10.08.01	25.08.01
pome fruit		15.04.01	16.04.01						01.07.01		30.09.01	30.10.01
potatoes	1.05.01	10.05.01	11.05.01					20.07.01			16.08.01	15.09.01
potato tuber						22.06.01	15.09.01					15.09.01
stone fruit		15.04.01	16.04.01						01.07.01		30.09.01	30.10.01
strawberries		15.03.01	16.03.01					30.04.01			01.08.01	31.08.01
sugar beet	1.04.01	15.04.01	16.04.01			30.08.01	10.10.01					10.10.01
vines		01.05.01	02.05.01						15.07.01		11.08.01	30.10.01

Table 17: AppDate 3.0 crop development dates for Okehampton as defined by FOCUS (2009/2014)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
beans	01.03.01	15.03.01	16.03.01					07.06.01			26.08.01	15.09.01
cereals spring	25.03.01	01.04.01	02.04.01					22.05.01			31.07.01	20.08.01
cereals winter	07.10.01	17.10.01	18.10.01	01.11.01	21.04.02			15.05.02			07.07.02	01.08.02
linseed	25.03.01	30.03.01	31.03.01					25.06.01			18.08.01	25.09.01
maize	07.05.01	25.05.01	26.05.01					15.07.01			18.08.01	07.10.01
oil seed rape, summer	25.03.01	30.03.01	31.03.01					15.05.01			21.07.01	20.08.01
oil seed rape, winter	07.08.01	14.08.01	15.08.01	29.08.01	09.04.02			30.04.02			21.06.02	21.07.02
peas	25.03.01	05.04.01	06.04.01					07.06.01			31.07.01	15.08.01
pome fruit		25.03.01	26.03.01						15.06.01		16.08.01	15.09.01
potatoes	15.04.01	30.04.01	01.05.01					15.07.01			02.08.01	01.09.01
potato tuber						15.06.01	01.09.01					01.09.01
stone fruit		25.03.01	26.03.01						15.06.01		16.08.01	15.09.01
sugar beet	10.04.01	25.04.01	26.04.01			30.08.01	25.10.01					25.10.01

Table 18: AppDate 3.0 crop development dates for Piacenza as defined by FOCUS (2009/2014)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
cereals winter	25.11.01	01.12.01	02.12.01	16.12.01	19.03.02			10.05.02			01.06.02	01.07.02
maize	30.04.01	15.05.01	16.05.01					31.07.01			30.09.01	30.10.01
oil seed rape, winter	30.09.01	05.10.01	06.10.01	20.10.01	07.03.02			15.04.02			21.05.02	20.06.02
pome fruit		01.04.01	02.04.01						31.05.01		02.09.01	01.11.01
potatoes	01.04.01	20.04.01	21.04.01					01.06.01			11.08.01	10.09.01
potato tuber						15.05.01	10.09.01					10.09.01
soybean	25.04.01	10.05.01	11.05.01					31.07.01			10.09.01	05.10.01
stone fruit		01.04.01	02.04.01						31.05.01		02.09.01	01.11.01
sugar beet	01.03.01	20.03.01	21.03.01				15.09.01					15.09.01
sun flower	01.04.01	20.04.01	21.04.01					20.06.01			26.08.01	20.09.01
tobacco	10.05.01	20.05.01	21.05.01					20.07.01			25.09.01	05.10.01
tomatoes		10.05.01	11.05.01					30.06.01			26.07.01	25.08.01
vines		01.04.01	02.04.01						31.07.01		13.08.01	01.11.01

Table 19: AppDate 3.0 crop development dates for Porto as defined by FOCUS (2009/2014)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
beans	28.02.01	10.03.01	11.03.01					15.05.01			11.08.01	31.08.01
cabbage 1		28.02.01	01.03.01			15.05.01	01.07.01					01.07.01
cabbage 2		31.07.01	01.08.01			31.08.01	15.11.01					15.11.01
carrots 1	15.02.01	28.02.01	01.03.01			01.05.01	31.05.01					31.05.01
carrots 2	15.07.01	22.07.01	23.07.01			15.09.01	15.10.01					15.10.01
cereals spring	20.02.01	10.03.01	11.03.01					10.06.01			30.06.01	20.07.01
cereals winter	15.11.01	30.11.01	01.12.01					30.04.02			31.05.02	30.06.02
maize	20.04.01	01.05.01	02.05.01					15.08.01			01.09.01	01.10.01
oil seed rape, summer	15.03.01	22.03.01	23.03.01					31.05.01			26.07.01	25.08.01
oil seed rape, winter	30.08.01	07.09.01	08.09.01					20.04.02			10.06.01	10.07.02
onions	15.02.01	28.02.01	01.03.01			15.05.01	31.05.01					31.05.01
pome fruit		15.03.01	16.03.01						30.06.01		01.09.01	31.10.01
potatoes	28.02.01	15.03.01	16.03.01					30.05.01			08.06.01	15.06.01
potato tuber						30.04.01	15.06.01					15.06.01
stone fruit		15.03.01	16.03.01						30.06.01		01.09.01	31.10.01
sugar beet	28.02.01	15.03.01	16.03.01			30.04.01	01.08.01					01.08.01
tomatoes		15.03.01	16.03.01					15.06.01			01.08.01	31.08.01
vines		15.03.01	16.03.01						31.07.01		31.07.01	30.09.01

Table 20: AppDate 3.0 crop development dates for Sevilla as defined by FOCUS (2009/2014)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
cabbage 1		01.03.01	02.03.01			01.05.01	01.06.01					01.06.01
cabbage 2		15.06.01	16.06.01			15.08.01	15.09.01					15.09.01
cereals winter	15.11.01	30.11.01	01.12.01					28.02.02			01.05.02	31.05.02
cotton	25.03.01	05.04.01	06.04.01					30.04.01			06.06.01	31.07.01
maize	28.02.01	07.03.01	08.03.01					15.06.01			01.07.01	31.07.01
pome fruit		15.03.01	16.03.01						31.05.01		16.08.01	15.10.01
potatoes	15.01.01	31.01.01	01.02.01					31.03.01			01.05.01	31.05.01
potato tuber						08.03.01	31.05.01					31.05.01
stone fruit		15.03.01	16.03.01						31.05.01		16.08.01	15.10.01
strawberries		30.11.01	01.12.01					30.04.02			01.08.02	31.08.02
sugar beet	31.10.01	10.11.01	11.11.01			15.04.02	01.07.02					01.07.02
sun flower	01.03.01	10.03.01	11.03.01					15.06.01			20.06.01	15.07.01
tomatoes		15.04.01	16.04.01					30.05.01			01.06.01	01.07.01
vines		31.03.01	01.04.01						15.06.01		11.09.01	30.11.01

Table 21: AppDate 3.0 crop development dates for Thiva as defined by FOCUS (2009/2014)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
beans 1	25.03.01	01.04.01	02.04.01					01.05.01			26.05.01	15.06.01
beans 2	01.07.01	08.07.01	09.07.01					08.08.01			10.09.01	30.09.01
cabbage 1		15.08.01	16.08.01			30.09.01	30.11.01					30.11.01
carrots 1	01.03.01	15.03.01	16.03.01			15.04.01	22.05.01					22.05.01
carrots 2	01.06.01	15.06.01	16.06.01			15.07.01	10.09.01					10.09.01
cereals winter	15.11.01	30.11.01	01.12.01					30.03.02			31.05.02	30.06.02
cotton	01.05.01	15.05.01	16.05.01					15.07.01			15.07.01	30.08.01
maize	01.04.01	20.04.01	21.04.01					15.06.01			16.08.01	15.09.01
onions	15.02.01	10.04.01	11.04.01			15.06.01	30.06.01					30.06.01
oil seed rape, winter	30.08.01	07.09.01	08.09.01					20.04.02			10.06.02	10.07.02
pome fruit		15.03.01	16.03.01						30.06.01		21.08.01	20.10.01
potatoes	15.02.01	01.03.01	02.03.01					30.04.01			30.06.01	30.07.01
potato tuber						06.04.01	30.07.01					30.07.01
stone fruit		15.03.01	16.03.01						30.06.01		21.08.01	20.10.01
sugar beet	15.04.01	01.05.01	02.05.01			30.06.01	30.09.01					30.09.01
tobacco		01.05.01	02.05.01					15.08.01			20.09.01	30.09.01
tomatoes		10.04.01	11.04.01					30.05.01			11.08.01	10.09.01
vines		15.03.01	16.03.01						30.06.01		01.08.01	20.10.01

Some additional crops were defined in previous versions of AppDate and were taken over for the current implementation. The crops are summarised in Table 22. This table lists only crops which are not defined by FOCUS. In contrast to the other FOCUS locations, a specific approach is taken here for Kremsmünster scenario: According to FOCUS (2009/2014) the BBCH dates for this location are practically identical to Hamburg. Therefore, the same crop and the same development stages were used for Kremsmünster as for Hamburg.

Table 22: Development dates for existing crops in AppDate 1.0 and PELMO 3.0 (considered for location Hamburg and Kremsmünster in AppDate 3.0)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
asparagus	1.04.01	1.05.01	2.05.01	15.05.01			1.06.01	15.06.01	15.07.01	1.09.01		1.10.01
hops	1.04.01	15.04.01	16.04.01	20.04.01	1.05.01		15.06.01	1.07.01	1.08.01	1.09.01		1.09.01
oats	2.04.01	7.04.01	8.04.01	11.04.01	30.04.01		30.05.01	5.06.01	28.06.01	3.08.01		10.08.01
rye	4.10.01	10.10.01	11.10.01	15.10.01	5.04.02		5.05.02	14.05.02	4.06.02	21.07.02		20.07.02
spring barley	2.04.01	7.04.01	8.04.01	11.04.01	30.04.01		30.05.01	5.06.01	28.06.01	3.08.01		10.08.01
spring wheat	22.03.01	1.04.01	2.04.01	10.04.01	15.05.01		13.06.01	18.06.01	2.07.01	11.08.01		20.08.01
sun flower	10.04.01	1.05.01	2.05.01		1.06.01		25.06.01	1.07.01	20.07.01	20.08.01		31.08.01
soft fruits	1.04.01	25.04.01	26.04.01		1.05.01		10.05.01	15.05.01	10.06.01	10.07.01		31.07.01
tomatoes	15.03.01	1.04.01	2.04.01	10.04.01			5.06.01	20.06.01	15.07.01	20.08.01		25.08.01
winter barley	30.09.01	5.10.01	6.10.01	9.10.01	17.04.02		18.05.02	24.05.02	5.06.02	9.07.02		10.07.02
winter wheat	21.10.01	5.11.01	6.11.01	20.11.01	19.04.02		6.06.02	12.06.02	23.06.02	12.08.02		10.08.02

2.3. Surface water scenarios

All crops refer to the FOCUS surface water report (FOCUS 2001). Consequently, most of the information in the data base was directly taken from FOCUS as shown in the following table.

Table 23: Crop development stages in AppDate adopted from FOCUS (2001)

Stage according to FOCUS (2001)	BBCH stage in AppDate	Remarks
Planting date	BBCH 0	Set to 10 days before emergence. If not applicable (*e.g*, permanent crop) it was not used
Emergence date	BBCH 9	always given by FOCUS
1 day after emergence	BBCH 10	all crops
15 days after emergence	BBCH 20	only winter crops* (begin of hibernation)
9 days before the next macro stage (e.g., BBCH 30)	BBCH 21+	only winter crops* (end of hibernation)
Spring point**	BBCH 30	only winter crops* (to consider hibernation)
Maximum LAI	BBCH 40	biennial plants that are harvested in the first year (*e.g.*, cabbage)
Harvest	BBCH 50	biennial plants that are harvested in the first year (*e.g.*, cabbage)
Maximum LAI	BBCH 60	all annual crops
Maximum LAI	BBCH 70	Hop, vine, pome and stone fruits
Senescence	BBCH 90	all crops except biennial plants that are harvested in the first year (earliest harvest date)
Harvest	BBCH 99	all crops except biennial plants that are harvested in the first year (last harvest date)

* winter crops are winter cereals, winter oil seed rape at D1 to D5, R1 and R3 and field beans (D2)
** no spring points were defined for the R-scenarios by FOCUS (2001). Therefore for R1 and R3 the spring points for Hamburg and Piacenza were considered, respectively
\+ BBCH 21 is set outside the standard interpolation routine and therefore also not mentioned in the following tables

In general the FOCUS date for maximum leaf area index (LAI) or “maturation date” in PRZM was used to define BBCH stage 60 (begin flowering). However, for those crops which are harvested already at BBCH stage 50 (*e.g.*, sugar beet, cabbage, onions, carrots) maximum LAI was used to define BBCH stage 40 (“booting“).

Unfortunately, the planting date was not always given by FOCUS (2001). Missing dates set to 10 days before crop emergence. The crop development dates in AppDate are summarised in the following for all FOCUS locations.

Table 24: AppDate 3.0 crop development dates for D1 according to FOCUS (2001)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
Cereals, Spring	25.04.01	05.05.01	06.05.01					28.06.01				04.09.01
Cereals, Winter	15.09.01	25.09.01	26.09.01	10.10.01	25.03.02			23.06.02				26.08.02
Oilseed rape, spring	09.05.01	19.05.01	20.05.01					04.07.01				08.09.01

Table 25: AppDate 3.0 crop development dates for D2 according to FOCUS (2001)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
Cereals, Winter	15.10.01	25.10.01	26.10.01	09.11.01	04.04.02			30.06.02				07.08.02
Field beans 1st	02.11.01	12.11.01	13.11.01	27.11.01			10.04.02	29.06.02				15.09.02
Oilseed rape, winter	05.09.01	15.09.01	16.09.01	30.09.01	10.03.02			15.06.02				15.07.02

Table 26: AppDate 3.0 crop development dates for D3 according to FOCUS (2001)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
Cereals, Spring	22.03.01	01.04.01	02.04.01					05.06.01				20.08.01
Cereals, Winter	11.11.01	21.11.01	22.11.01	06.12.01	16.04.02			24.07.02				15.08.02
Field beans 1st	20.04.01	30.04.01	01.05.01					15.07.01				10.09.01
Legumes	05.04.01	15.04.01	16.04.01					15.06.01				10.08.01
Maize	25.04.01	05.05.01	06.05.01					10.08.01				20.09.01
Oilseed rape, spring	31.03.01	10.04.01	11.04.01					15.06.01				25.08.01
Oilseed rape, winter	23.08.01	02.09.01	03.09.01	17.09.01	21.02.02			25.05.02				20.07.02
Pome fruit		15.04.01	16.04.01						01.07.01			30.10.01
Potatoes 1st	30.04.01	10.05.01	11.05.01					20.07.01				15.09.01
Potato tuber 1st						22.06.01	15.09.01					15.09.01
Stone fruit		15.04.01	16.04.01						01.07.01			30.10.01
Sugar beets	15.04.01	25.04.01	26.04.01			25.07.01	18.10.01					18.10.01
Vegetables, bulb 1st	15.04.01	25.04.01	26.04.01			30.06.01	01.09.01					01.09.01
Vegetables, leafy 1st		25.04.01	26.04.01			05.06.01	20.07.01					20.07.01
Vegetables, leafy 2nd		05.08.01	06.08.01			10.09.01	20.10.01					20.10.01
Vegetables, root 1st	15.04.01	25.04.01	26.04.01			30.06.01	15.08.01					15.08.01

Table 27: AppDate 3.0 crop development dates for D4 according to FOCUS (2001)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
Cereals, Spring	16.04.01	26.04.01	27.04.01					19.06.01				26.08.01
Cereals, Winter	12.09.01	22.09.01	23.09.01	07.10.01	18.03.02			21.06.02				21.08.02
Field beans 1st	05.04.01	15.04.01	16.04.01					10.07.01				25.08.01
Legumes	13.04.01	23.04.01	24.04.01					20.06.01				10.08.01
Maize	30.04.01	10.05.01	11.05.01					18.08.01				12.09.01
Oilseed rape, spring	21.04.01	01.05.01	02.05.01					17.06.01				31.08.01
Oilseed rape, winter	24.08.01	03.09.01	04.09.01	18.09.01	01.03.02			05.06.02				09.08.02
Pome fruit		20.04.01	21.04.01						05.07.01			30.10.01
Potatoes 1st	12.05.01	22.05.01	23.05.01					21.08.01				23.09.01
Potato tuber 1st						16.07.01	23.09.01					23.09.01
Stone fruit		20.04.01	21.04.01						05.07.01			30.10.01
Sugar beets	24.04.01	04.05.01	05.05.01			28.07.01	25.10.01					25.10.01
Vegetables, bulb 1st	13.04.01	23.04.01	24.04.01			10.07.01	13.09.01					13.09.01
Vegetables, leafy 1st		10.05.01	11.05.01			20.07.01	26.09.01					26.09.01

Table 28: AppDate 3.0 crop development dates for D5 according to FOCUS (2001)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
Cereals, Spring	05.03.01	15.03.01	16.03.01					15.05.01				20.07.01
Cereals, Winter	31.10.01	10.11.01	11.11.01	25.11.01	15.03.02			15.05.02				15.07.02
Legumes	05.03.01	15.03.01	16.03.01					30.05.01				15.07.01
Maize	30.04.01	10.05.01	11.05.01					15.07.01				15.09.01
Oilseed rape, spring	05.03.01	15.03.01	16.03.01					25.05.01				30.07.01
Oilseed rape, winter	10.09.01	20.09.01	21.09.01	05.10.01	01.03.02			10.05.02				05.07.02
Pome fruit		01.04.01	02.04.01						31.05.01			10.10.01
Stone fruit		01.04.01	02.04.01						31.05.01			10.10.01
Sunflower	21.04.01	01.05.01	02.05.01					10.07.01				31.08.01

Table 29: AppDate 3.0 crop development dates for D6 according to FOCUS (2001)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
Cereals, Winter	20.11.01	30.11.01	01.12.01	15.12.01	16.02.02			30.03.02				30.06.02
Cotton	10.04.01	20.04.01	21.04.01					10.06.01				15.09.01
Field beans 1st	22.03.01	01.04.01	02.04.01					01.05.01				15.06.01
Field beans 2nd	28.06.01	08.07.01	09.07.01					08.08.01				30.09.01
Legumes	10.04.01	20.04.01	21.04.01					20.05.01				25.06.01
Maize	10.04.01	20.04.01	21.04.01					15.06.01				15.09.01
Potatoes 1st	31.03.01	10.04.01	11.04.01					30.05.01				15.07.01
Potato tuber 1st						10.05.01	15.07.01					15.07.01
Potatoes 2nd	26.07.01	05.08.01	06.08.01					30.09.01				25.11.01
Potato tuber 2nd						10.09.01	25.11.01					25.11.01
Vegetables, bulb 1st	30.04.01	10.05.01	11.05.01			30.06.01	31.07.01					31.07.01
Vegetables, bulb 2nd	10.10.01	20.10.01	21.10.01			10.03.02	10.04.02					10.04.02
Vegetables, fruiting		10.04.01	11.04.01					30.05.01				10.08.01
Vegetables, leafy 1st		15.08.01	16.08.01			30.09.01	30.11.01					30.11.01
Vegetables, root 1st	15.02.01	25.02.01	26.02.01			15.04.01	13.05.01					13.05.01
Vines		01.02.01	02.02.01						01.05.01			10.11.01

Table 30: AppDate 3.0 crop development dates for R1 according to FOCUS (2001)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
Cereals, Winter	02.11.01	12.11.01	13.11.01	27.11.01	04.05.02			10.06.02				31.07.02
Field beans 1st	31.03.01	10.04.01	11.04.01					10.07.01				25.08.01
Hops	05.04.01	15.04.01	16.04.01						27.08.01			01.09.01
Legumes	05.04.01	15.04.01	16.04.01					12.06.01				15.08.01
Maize	23.04.01	03.05.01	04.05.01					07.08.01				25.09.01
Oilseed rape, spring	31.03.01	10.04.01	11.04.01					07.06.01				15.08.01
Oilseed rape, winter	25.08.01	04.09.01	05.09.01	19.09.01	18.04.02			25.05.02				10.07.02
Pome fruit		15.04.01	16.04.01						01.07.01			30.10.01
Potatoes 1st	25.04.01	05.05.01	06.05.01					25.06.01				08.09.01
Potato tuber 1st						05.06.01	08.09.01					08.09.01
Stone fruit		15.04.01	16.04.01						01.07.01			30.10.01
Sugar beets	06.04.01	16.04.01	17.04.01			15.07.01	10.10.01					10.10.01
Sunflower	21.04.01	01.05.01	02.05.01					05.07.01				31.08.01
Vegetables, bulb 1st	10.04.01	20.04.01	21.04.01			25.06.01	25.08.01					25.08.01
Vegetables, leafy 1st		20.04.01	21.04.01			31.05.01	15.07.01					15.07.01
Vegetables, leafy 2nd		31.07.01	01.08.01			05.09.01	15.10.01					15.10.01
Vegetables, root 1st	10.04.01	20.04.01	21.04.01			25.06.01	10.08.01					10.08.01
Vines		15.04.01	16.04.01						01.07.01			30.10.01

Table 31: AppDate 3.0 crop development dates for R2 according to FOCUS (2001)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
Field beans 1st	28.02.01	10.03.01	11.03.01					15.05.01				31.08.01
Legumes	10.04.01	20.04.01	21.04.01					20.05.01				25.06.01
Maize	21.04.01	01.05.01	02.05.01					15.08.01				01.10.01
Pome fruit		15.03.01	16.03.01						31.07.01			30.09.01
Potatoes 1st	05.03.01	15.03.01	16.03.01					30.05.01				15.06.01
Potato tuber 1st						30.04.01	15.06.01					15.06.01
Stone fruit		15.03.01	16.03.01						31.07.01			30.09.01
Vegetables, bulb 1st	18.02.01	28.02.01	01.03.01			15.05.01	31.05.01					31.05.01
Vegetables, fruiting		15.03.01	16.03.01					15.06.01				31.08.01
Vegetables, leafy 1st		28.02.01	01.03.01			15.05.01	01.07.01					01.07.01
Vegetables, leafy 2nd		31.07.01	01.08.01			31.08.01	15.11.01					15.11.01
Vegetables, root 1st	18.02.01	28.02.01	01.03.01			01.05.01	31.05.01					31.05.01
Vegetables, root 2nd	12.07.01	22.07.01	23.07.01			15.09.01	15.10.01					15.10.01
Vines		15.03.01	16.03.01						31.07.01			30.09.01

Table 32: AppDate 3.0 crop development dates for R3 according to FOCUS (2001)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
Cereals, Winter	21.11.01	01.12.01	02.12.01	16.12.01	19.03.02			10.05.02				01.07.02
Field beans 1st	23.03.01	02.04.01	03.04.01					01.05.01				15.06.01
Legumes	11.04.01	21.04.01	22.04.01					20.05.01				25.06.01
Maize	21.04.01	01.05.01	02.05.01					25.07.01				01.10.01
Oilseed rape, winter	25.09.01	05.10.01	06.10.01	20.10.01	07.03.02			20.04.02				05.06.02
Pome fruit		01.04.01	02.04.01						31.05.01			15.10.01
Potatoes 1st	31.03.01	10.04.01	11.04.01					30.05.01				01.09.01
Potato tuber 1st						10.05.01	01.09.01					01.09.01
Soybean	30.04.01	10.05.01	11.05.01					31.07.01				05.10.01
Stone fruit		01.04.01	02.04.01						31.05.01			15.10.01
Sugar beets	10.03.01	20.03.01	21.03.01			25.06.01	03.09.01					03.09.01
Sunflower	05.04.01	15.04.01	16.04.01					25.06.01				20.09.01
Tobacco	10.05.01	20.05.01	21.05.01					20.07.01				05.10.01
Vegetables, bulb 1st	19.02.01	01.03.01	02.03.01			15.05.01	31.05.01					31.05.01
Vegetables, fruiting		10.05.01	11.05.01					30.06.01				25.08.01
Vegetables, leafy 1st		01.03.01	02.03.01			01.05.01	01.06.01					01.06.01
Vegetables, leafy 2nd		15.06.01	16.06.01			15.08.01	15.09.01					15.09.01
Vegetables, root 1st	16.02.01	26.02.01	27.02.01			15.04.01	13.05.01					13.05.01
Vines		01.04.01	02.04.01						31.07.01			01.11.01

Table 33: AppDate 3.0 crop development dates for R4 according to FOCUS (2001)

Crop	Seeding	Emergence	Begin leaf develop.	Tillering	Shoot develop.	Booting	Inflorence emergence (main shoot)	Begin flowering	Fruit develop.	Maturation	Senescence	Harvest
BBCH	00	09	10	20	30	40	50	60	70	80	90	99
Cereals, Spring	05.03.01	15.03.01	16.03.01					15.05.01				20.07.01
Cereals, Winter	31.10.01	10.11.01	11.11.01					15.05.02				15.07.02
Field beans 1st	23.03.01	02.04.01	03.04.01					01.05.01				15.06.01
Legumes	11.04.01	21.04.01	22.04.01					20.05.01				25.06.01
Maize	31.03.01	10.04.01	11.04.01					15.06.01				31.08.01
Pome fruit		15.03.01	16.03.01						31.05.01			15.10.01
Soybean	28.02.01	10.03.01	11.03.01					20.07.01				20.09.01
Stone fruit		15.03.01	16.03.01						31.05.01			15.10.01
Sunflower	20.03.01	30.03.01	31.03.01					20.06.01				20.08.01
Vegetables, bulb 1st	19.02.01	01.03.01	02.03.01			15.05.01	31.05.01					31.05.01
Vegetables, fruiting		20.04.01	21.04.01					10.06.01				15.07.01
Vegetables, leafy 1st		01.03.01	02.03.01			01.05.01	01.06.01					01.06.01
Vegetables, leafy 2nd		15.06.01	16.06.01			15.08.01	15.09.01					15.09.01
Vegetables, root 1st	16.02.01	26.02.01	27.02.01			15.04.01	13.05.01					13.05.01
Vines		10.03.01	11.03.01						20.07.01			20.09.01

3. Offline mode AppDate

Normally AppDate performs an online check at the start whether a new version is available and offers different update options. However, if the computer has no free access to the internet the check may delay the start process. The online check can be omitted using following command:

AppDate.exe /offline

4. Batch mode of AppDate

In the new version a batch mode for AppDate was implemented. It can be called using the following command.

AppDate.exe /B <input/output folder>

AppDate will read in data from a file called “BBCH.in” which should be located in the folder specified after the command /B. .

BBCH must be a text file. In each line of the file the necessary information about location, crops, and BBCH stages must be given. All fields must be separated by TABs. Results are written in a text file called “BBCH.out” in the same folder as the input file.

More information about the structure of the input file is given in the next chapter. An example file is part of the installation package.

5. Data format of AppDate

AppDate uses three different types of input data files:

- BBCH development tables:
  Filename: BBCH_<*FOCUS compartment*>_<*FOCUS location*>*.tab*
- Crop interception tables:
  Filename: BBCH_<*FOCUS compartment*>_<*source*>.tab
- Picture assignment table:
  Picture_<*FOCUS compartment*>.tab

<*FOCUS compartment*> can be either "SW" or "GW" for surface water and groundwater, respectively. The spelling of the <FOCUS locations> has to be as described in Table 34.

Table 34: Keywords used by AppDate to define the FOCUS locations

Groundwater	Surface Water
Chateaudun	D1
Hamburg	D2
Jokioinen	D3
Kremsmunster	D4
Okehampton	D5
Piacenza	D6
Porto	R1
Sevilla	R2
Thiva	R3
	R4

All files are in ASCII format so that it is straightforward to define additional crops and use individual crop interception values. The format of the individual files is described in the following sections.

5.1. BBCH development tables

Within a line all fields are separated by TABs (ASCII code 9). All development tables should use the same sequence of crops.

Line	Contents	
1st line	1st field:	"Crop" (comment)
	2nd to 13th field:	names of the BBCH stages
	14th field:	“Dormancy flag” (comment)
2nd line	1st field:	"BBCH" (comment)
	2nd to 13th field:	Codes of the BBCH stages
3rd line	1st field:	Number of crops in the file
	2nd field:	Version date
Following lines (number of lines = number of crops)	1st field:	name of the crop
	2nd to 13th field:	date of the respective BBCH-stage (format: DD.MM.YY)
	14th field:	hibernation flag (0: no hibernation, 1: hibernation)

5.2. Crop interception tables

Within a line all fields are separated by TABs (ASCII code 9). The user has to take care that the same sequence of crops is used in the crop interception table and in the BBCH development table. The crop tables are in line with current EFSA guidance (EFSA 2014).

Line	Contents	
1st line	1st field:	Number of crops in the file
	2nd field:	Version date
2nd line	1st field:	"BBCH code" (comment)
	2nd to 100th field:	Codes of the BBCH stages
	101st field:	"e" (code for the end of the line)
Following lines (number of lines = number of crops)*	1st field:	name of the crop
	2nd to 100th field:	crop interception for the respective BBCH stage (%)
	101st field:	"e" (code for the end of the line)
Next line*	1st field:	"BBCH code" (comment)
	2nd to 100th field:	Codes of the BBCH stages
	101st field:	"e" (code for the end of the line)
Following lines (number of lines = number of crops)	1st field:	name of the crop
	2nd to 100th field:	occurrence of the respective BBCH stage (0=no, 1=yes)
	101st field:	"e" (code for the end of the line)

* only for groundwater locations, lines are not present for surface water scenarios

5.3. Picture assignment tables

Within a line all fields are separated by TABs (ASCII code 9).

Line	Contents	
1st line	1st field:	"BBCH code" (comment)
	Following fields:	crop names (comments)*
2nd to 100th line	1st field:	BBCH code (comment)**
	Following fields:	pointer to the respective figure (no number=no figure)
	36th field:	"e" (code for the end of the line)

* These crop names are not further used in the model. The user has to take care that the sequence is the same as in the BBCH development table.

** These BBCH codes are not further used in the model. The user has to take care that the codes are in numerical order.

5.4. Batch input file BBCH.in

Within a line all fields are separated by TABs (ASCII code 9).

Line	Contents	
1st line	Comment line: information about the structure of the following lines	
Following lines	1st field:	Compartment (1 = ground water, 2 = surface water)
	2nd field:	Location (order in the respective AppDate listbox)
	3rd field:	Crop (order in the respective AppDate listbox)
	4th field:	Requested BBCH code
	5th field:	Nominal application rate (kg/ha)*
	6th field:	Number of applications**
	7th field:	Time between two applications (d)**

* Required only for groundwater scenarios, type blank for surface water scenarios
** Required only for surface water scenarios, type blank for groundwater scenarios

6. References

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