Impact analysis for the purpose of the introduction of DROPLET version 1.3.2

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WOt-technical report 160

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Impact analysis for the purpose of the introduction of DROPLET version 1.3.2

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Abstract

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The user-friendly software tool DROPLET (acronym for **DR**inkwater uit **OP**pervlaktewater- **L**andbouwkundig gebruik **E**valuatie **T**ool) assists the Dutch Board for the Authorisation of Plant Protection Products and Biocides (Ctgb) in evaluating whether pesticides may exceed the 0.1 µg/L standard in one of the Dutch surface water abstraction points for drinking water production. Based upon Good Agricultural Practice DROPLET uses the peak concentration in the FOCUS D3 ditch (with spray drift deposition according to Dutch numbers) as starting point for the final, expected concentrations at the abstraction points situated in the larger waterbodies downstream. Results of this impact analysis showed, that for the plant protection products which have been authorized in the period 2014 – 2018, for which the current version of DROPLET (1.2) was used in the risk assessment, the use of the new DROPLET version (1.3.2.) has no effect on the conclusion for the drinking water criterion. The predicted concentration in surface water at drinking water abstraction points was below the threshold of 0.1 µg/L for all products for all abstraction points for both the old and the new model suite. Therefore, we recommend implementing the new DROPLET version in the national authorization procedure.

Keywords: surface water abstraction for drinking water production, pesticides, registration, DROPLET model suite

Referaat

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Het gebruikersvriendelijke instrument DROPLET (acroniem voor **DR**inkwater uit **OP**pervlaktewater-**L**andbouwkundig gebruik **E**valuatie **T**ool) ondersteunt het Nederlandse College voor de toelating van gewasbeschermingsmiddelen en biociden (Ctgb) bij het evalueren of gewasbeschermingsmiddelen de drinkwater norm van 0.1 µg/L overschrijden in één van de negen innamepunten van oppervlaktewater voor drinkwaterbereiding. Uitgaande van Goed Landbouwkundig Gebruik gebruikt DROPLET de piekconcentratie in de FOCUS D3 sloot (met spuitdriftdepositie volgens Nederlandse cijfers) als startpunt voor de berekening van de uiteindelijke concentratie bij de drinkwater innamepunten die benedenstrooms in grotere wateren zijn gesitueerd. Resultaten van de impactanalyse laten zien dat voor de gewasbeschermingsmiddelen die zijn toegelaten in de periode 2014 – 2018 en waarvoor de huidige versie van DROPLET (1.2) is gebruikt in de risicobeoordeling, het gebruik van de nieuwe DROPLET-versie (1.3.2) geen effect heeft op de conclusie ten aanzien van het drinkwatercriterium. De voorspelde concentratie in oppervlaktewater bij drinkwaterinnamepunten lag onder de norm van 0,1 µg/L, voor alle innamepunten voor zowel de oude als de nieuwe modellentrein. Daarom bevelen we aan om de nieuwe DROPLET versie in de nationale beoordelingsprocedure te implementeren.

Trefwoorden: extractie van oppervlaktewater voor productie van drinkwater, gewasbeschermingsmiddel, registratie, DROPLET modellentrein

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Preface

The present study has been commissioned by the WOt programme WOT-04-008-024 to the Ctgb, the Dutch Board for the Authorization of Plant Protection Products and Biocides. The set-up as well as its results and conclusions have been reviewed by dr. Erik van den Berg and ir. Paulien Adriaanse of the Environmental Risk Assessment team of Wageningen Environmental Research (ERA-WENR).

This study considers the impact of updating the DROPLET 1.2 model suite to the DROPLET 1.3.2 model suite on the current risk assessment with respect to the drinking water from surface water criterion. It does so by considering 24 substance-crop combinations, taken from a selection of plant protection products for which registration was requested in the period 2014-2018. So, instead of the hypothetical substances applied at 1 kg/ha considered in the Adriaanse & Beltman report (2017) the present study considers 'real' substances and application patterns, as submitted for authorization at Ctgb.

Contents

Summary

The user-friendly software tool DROPLET (acronym for **DR**inkwater uit **OP**pervlaktewater-**L**andbouwkundig gebruik **E**valuatie **T**ool) assists the Dutch Board for the Authorisation of Plant Protection Products and Biocides (Ctgb) in evaluating whether pesticides may exceed the 0.1 µg/L standard in one of the Dutch surface water abstraction points for drinking water production. Based upon Good Agricultural Practice DROPLET uses the peak concentration in the FOCUS D3 ditch (with spray drift deposition according to Dutch numbers) as starting point for the final, expected concentrations at the abstraction points situated in the larger waterbodies downstream.

The Dutch Ministry of Agriculture, Nature and Food Quality has commissioned a new version of DROPLET that makes use of the most recently released versions of the FOCUS models, i.e. the FOCUS-MACRO 5.5.3 model calculating pesticide losses via drainage plus the FOCUS-TOXSWA 4.4.3 model calculating next the resulting concentration in the FOCUS D3 ditch. The update resulted in increased concentrations at the abstraction points, up to a factor of 2.5, as reported in Wot-technical report 100 (Adriaanse & Beltman, 2017). It was shown that this was caused by an increase in the drainage flux calculated by FOCUS MACRO 5.5.3. So, the new release of DROPLET may have impact on decisions made in the registration procedure of the Netherlands when used in combination with FOCUS-MACRO 5.5.3. Therefore the ministry requested an impact analysis, enabling them to make an informed decision on implementation of DROPLET version 1.3.2 in the authorization procedure in the Netherlands.

To determine the potential impact of the new DROPLET version, we compared results of the old model suite (FOCUS-SWASH 3.1, FOCUS-MACRO 4.4.2, FOCUS-TOXSWA 3.3.1 and DROPLET 1.2) to those of the recently released model suite (FOCUS-SWASH 5.3, including the substance database SPIN 3.3, FOCUS-MACRO 5.5.3, FOCUS-TOXSWA 4.4.3 and DROPLET 1.3.2) for a selection of all the plant protection products authorized in the past five years (2014 – 2018), for which DROPLET was used in the risk assessment.

Results of the impact analysis showed, that for the plant protection products which have been authorized in the period 2014 – 2018, for which the current version of DROPLET (1.2) was used in the risk assessment, the use of the new DROPLET version (1.3.2.) has no effect on the conclusion for the drinking water criterion. The predicted concentration in surface water at drinking water abstraction points was below the threshold of 0.1 µg/L for all products, for all abstraction points for both the old and the new model suite.

The results of the impact study lead to other insights than the results of the Wot-technical report 100, where the new DROPLET 1.3.2 model suite often resulted in clearly higher concentrations at the drinking water abstraction points than the old DROPLET 1.2 suite ánd where the concentrations at the drinking water abstraction points of some hypothetical substances (D, G and H) were above the threshold of 0.1 µg/L. The reasons for these differences are:

i. the present impact study uses actual application rates, ranging between 0.01 to 0.1 kg/ha, while in the former WOt-technical report 100 the application rate was 1 kg/ha for all substances, i.e. a factor 10 to 100 larger (thus leading to concentrations of a factor 10 to 100 lower in the impact analysis);
ii. the 15 substances of the impact analysis are less sensitive to leaching via drains to surface water than substances D, G and even H and thus lead to lower concentrations in surface water. (N.B. Note that D and G are very sensitive to leaching to drains because of their low sorption coefficient K_{oc} of 10 L/kg and H as well due to its combination of relatively low K_{oc} of 100 L/kg coupled to a long half-life in soil of 300 d)
iii. due to their lower sensitivity for leaching to drains the peak concentration in the D3 ditch of the impact study is nearly always caused by spray drift deposition onto the D3 ditch. (N.B. the

D3 ditch is the starting point for calculation of concentration at the drinking water abstraction point.) In the impact analysis a drift deposition percentage of 0.5 was used, while in the WOt-technical report 100 a percentage of 1 was used, i.e. twice as large. So, for substances where spray drift deposition caused the peak concentration in the D3 ditch in both studies, the impact analysis led to lower concentrations than the WOt-technical report 100 study.

So, the overall conclusion is that the study of the WOt-technical report 100 led to too conservative concentrations in the drinking water abstraction points as demonstrated by the results of the more realistic calculations of the present impact analysis.

Based on the impact analysis, it can be concluded that implementation of the new DROPLET model version, to be used in collaboration with the newest release of the FOCUS models, is not expected to have a significant impact on the risk assessment of plant protection product regarding the drinking water criterion. Therefore, for pragmatic reasons, we recommend implementing the new DROPLET version in the national authorization procedure.

Samenvatting

Het gebruikersvriendelijke instrument DROPLET (acroniem voor **DR**inkwater uit **OP**pervlaktewater-**L**andbouwkundig gebruik **E**valuatie **T**ool) ondersteunt het Nederlandse College voor de toelating van gewasbeschermingsmiddelen en biociden (Ctgb) bij het evalueren of gewasbeschermingsmiddelen de drinkwater norm van 0.1 µg/L overschrijden in één van de negen innamepunten van oppervlaktewater voor drinkwaterbereiding.

Het ministerie van Landbouw, Natuur en Voedselkwaliteit (LNV) heeft opdracht gegeven om een nieuwe versie van DROPLET te maken, die gebruik maakt van de meest recent uitgebrachte versies van de FOCUS modellen, i.e. het FOCUS-MACRO 5.5.3 model dat de afvoer van bestrijdingsmiddel via drainage berekent plus het FOCUS-TOXSWA 4.4.3 model dat vervolgens de concentratie in de FOCUS D3 sloot berekent. Het bleek dat de update tot een factor 2,5 hogere concentraties bij de drinkwaterinnamepunten kon leiden, zoals beschreven in WOt-technical report 100 (Adriaanse & Beltman, 2017). In dit rapport werd aangetoond dat deze toename werd veroorzaakt door een toename in de drainageflux berekend door FOCUS-MACRO 5.5.3. Dus de nieuwe versie van DROPLET zou een impact kunnen hebben op de beslissingen die genomen worden in de beoordelingsprocedure door het Ctgb, wanneer deze nieuwe versie gebruikt wordt in combinatie met FOCUS-MACRO 5.5.3. Daarom heeft het ministerie opdracht gegeven voor een impactanalyse, zodat zij een geïnformeerde beslissing kunnen nemen ten aanzien van de implementatie van DROPLET versie 1.3.2 in de beoordelingsprocedure in Nederland.

Om de potentiele impact van de nieuwe DROPLET-versie te bepalen, zijn resultaten vergeleken die zijn berekend met de vorige modellentrein (FOCUS-SWASH 3.1, FOCUS-MACRO 4.4.2, FOCUS-TOXSWA 3.3.1 en DROPLET 1.2) met die van de meer recent uitgebrachte modellentrein (FOCUS-SWASH 5.3, inclusief de stoffendatabase SPIN 3.3, FOCUS-MACRO 5.5.3, FOCUS-TOXSWA 4.4.3 en DROPLET 1.3.2) voor een selectie van alle gewasbeschermingsmiddelen toegelaten in de laatste vijf jaar (2014 - 2018), waarvoor DROPLET is gebruikt in de risicobeoordeling.

Resultaten van de impactanalyse laten zien dat voor de gewasbeschermingsmiddelen die zijn toegelaten in de periode 2014 – 2018 en waarvoor DROPLET is gebruikt in de risicobeoordeling, het gebruik van de nieuwe DROPLET-versie (1.3.2) geen effect heeft op de conclusie ten aanzien van het drinkwatercriterium. De voorspelde concentratie in oppervlaktewater bij drinkwaterinnamepunten lag onder de norm van 0,1 µg/L voor alle innamepunten, voor zowel de oude als de nieuwe modellentrein. Daarom bevelen wij aan om de nieuwe DROPLET-versie te implementeren in de nationale toelatingsprocedure.

De resultaten van de impactstudie leiden tot andere inzichten dan de resultaten van het WOt-technical report 100, waarin de nieuwe DROPLET 1.3.2 modellentrein vaak tot duidelijk hogere concentraties bij de drinkwaterinnamepunten leidde dan de oude DROPLET 1.2 modellentrein, én waarin bovendien de concentraties bij de drinkwater innamepunten voor een paar hypothetische stoffen (D en G) boven de drinkwater norm van 0.1 µg/L lagen. Redenen voor deze verschillen zijn:

i. de onderhavige impact studie is gedaan met werkelijke doseringen van 0.01 tot 0.1 kg/ha, terwijl in het WOt-technical report 100 de dosering 1 kg/ha was, i.e. een factor 10 tot 100 hoger (resulterend in concentraties van een factor 10 tot 100 lager in de impact studie);
ii. de 15 middelen van de impact studie zijn minder gevoelig voor uitspoeling via drains naar het oppervlaktewater dan de stoffen D, G en H en dus leiden de 15 middelen van de impact studie tot lagere concentraties in het oppervlaktewater. (N.B. De stoffen D en G zijn zeer uitspoelingsgevoelig vanwege hun lage sorptiecoëfficiënt K_{oc} van 10 L/kg en dit geldt ook voor H met zijn relatief lage K_{oc} van 100 L/kg in combinatie met lange halfwaardetijd in de bodem van 300 d);

iii. door de lage gevoeligheid voor uitspoeling via drains naar het oppervlaktewater is de piekconcentratie in de D3 sloot bijna altijd het gevolg van spuitdriftdepositie op de D3 sloot. (N.B. De D3 sloot is het startpunt voor de berekening van de concentratie bij het drinkwaterinnamepunt.) Bij de impactstudie is een spuitdriftdepositie percentage van 0,5 gebruikt, terwijl in het WOt-technical report 100 een percentage van 1 was gebruikt, i.e. twee keer zo hoog. De impactstudie leidde dus tot lagere concentraties dan de studie uit het WOt-technical report 100 voor middelen waarbij spuitdriftdepositie de piek in de D3 sloot veroorzaakte.

De algehele conclusie is dus dat het WOt-technical report 100 tot te conservatieve concentraties in de drinkwaterinnamepunten leidde, zoals aangetoond in de onderhavige impactstudie met meer realistische berekeningen.

Gebaseerd op de impactanalyse, kan worden geconcludeerd dat de implementatie van de nieuwe DROPLET-versie, die gebruikt kan worden met de nieuwste versies van de FOCUS modellen, naar verwachting geen significante impact zal hebben op de risicobeoordeling van gewasbeschermingsmiddelen ten aanzien van het drinkwatercriterium. Uit pragmatisch oogpunt, bevelen we aan om de nieuwe DROPLET-versie te implementeren in de nationale beoordelingsprocedure.

1 Introduction

Ctgb uses the pre-registration software tool DROPLET to predict the concentrations of active substances in surface water at the nine surface water abstraction points for drinking water production. This tool is used in the registration procedure for products based on active substances which are not yet authorised for use in the Netherlands, or with their first authorization less than 3 years ago. DROPLET uses the peak concentration estimated by the European FOCUS Surface Water models in the FOCUS D3 ditch (with spray drift deposition according to Dutch numbers) as starting point for the final, expected concentrations at the abstraction points situated in the larger waterbodies downstream. On request of the Ctgb a new version of DROPLET 1.3.2 was developed, that communicates with the newer released versions of the FOCUS models, i.e. FOCUS-SWASH 5.3 (including the substance database SPIN), FOCUS-MACRO 5.5.3[1] and FOCUS-TOXSWA 4.4.3[1]. Figure 1 gives an overview of the sequence in which these tools and models are used to perform so-called Step 3 FOCUS Surface Water Scenarios simulations (Figure 1).

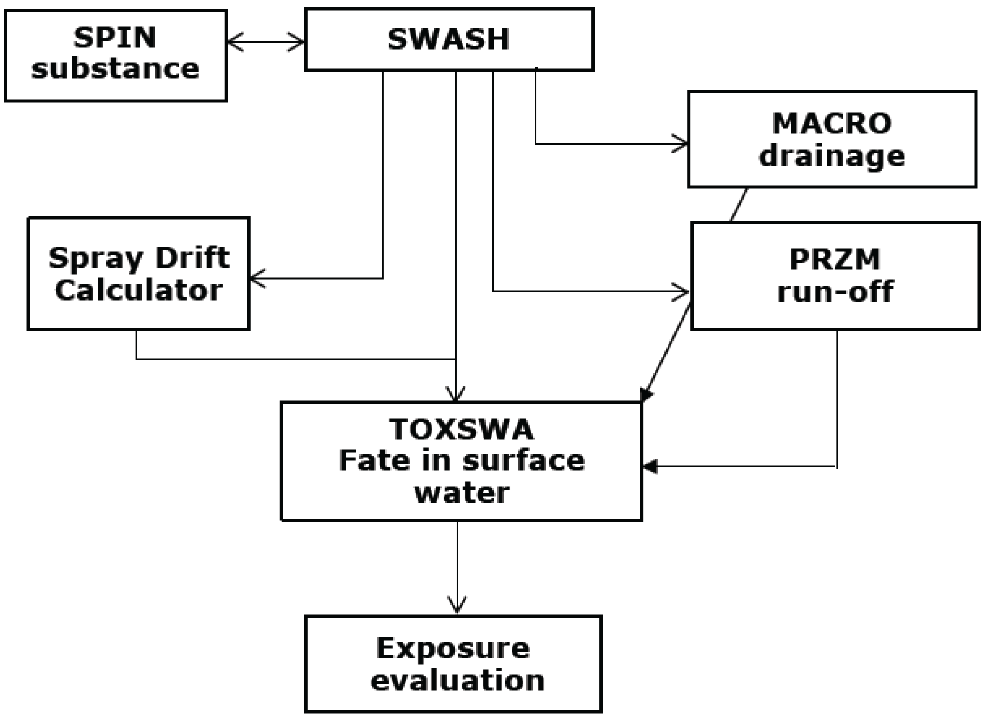


Figure 1 *Sequence of tools and models used to calculate pesticide exposure in the proposed Step 3 EU FOCUS Surface Water Scenarios*.

Some preliminary calculations performed with the updated version 1.3.2 of DROPLET (coupled to the newer released FOCUS models of SWASH, MACRO and TOXSWA) showed relatively large differences in the Predicted Environmental Concentration in surface water at the drinking water abstraction points (PEC_Tier1), compared to the PEC_Tier1 values calculated by DROPLET 1.2 (coupled to former releases of SWASH, MACRO and TOXSWA). A detailed analysis of the cause of these differences, is reported in Wot-technical report 100 (Adriaanse & Beltman, 2017). In this report it was demonstrated that the differences in PEC_Tier1 values were nearly entirely due to the increase in pesticide mass in the drainage fluxes of version 5.5.3 of the MACRO model with respect to those of the former version 4.4.2. The increase in calculated drainage flux by MACRO 5.5.3 is caused by important changes in the

[1] At the time of writing of this report the most recent version of FOCUS_MACRO and FOCUS_TOXSWA were version 5.5.4 and 5.5.3 respectively. However, these versions do not deliver significant different results compared to FOCUS_MACRO 5.5.3 and FOCUS_TOXSWA 4.4.3. Therefore, in order to be consistent with the calculations in WOt technical report 100, the same model versions were used in this report.

numerical solution of the flow and transport equations and some underlying mathematical functions of the MACRO model. When comparing PEC_Tier1 results calculated using both the old and the new model suite, it was shown that concentrations at drinking water intake points could be up to a factor 2.5 higher using the new model versions.

Therefore the Dutch Ministry of Agriculture, Nature and Food Quality decided that an impact analysis of the introduction of DROPLET version 1.3.2 was required, before a decision could be made on the implementation of the new version in the authorization procedure of plant protection products in the Netherlands. This report describes the method and results of an impact analysis, designed to determine the impact of the release of DROPLET 1.3.2 on the national risk assessment of plant protection products.

2 Method

The impact analysis was performed by means of calculations for plant protection products based on active substances new on the Dutch market, authorized in the period 2014-2018. In Table 2, an overview is presented of the products used in the impact analysis. Adriaanse & Beltman (2017) showed that the impact on the PEC_Tier1 value is largest for compounds that are relatively mobile (K_{oc} around 100 L/kg or smaller) and/or persistent in soil ($DegT_{50,soil}$ 30 d or greater). Products containing active substances with these properties are highlighted grey in Table 1. All four possible combinations of substance parameters are represented in the selected products (i.e. K_{oc} < 100 L/kg and $DegT_{50,soil}$ < 30 d, K_{oc} > 100 L/kg and $DegT_{50,soil}$ > 30 d, K_{oc} < 100 L/kg <u>and</u> $DegT_{50,soil}$ > 30 d, K_{oc} > 100 L/kg <u>and</u> $DegT_{50,soil}$ < 30 d).
For each of the nine surface water abstraction points for drinking water production, the associated acreage in the intake area of 24 different crops is represented in DROPLET. The 6 crops with the highest corresponding acreage for the 9 abstraction points are grass, potatoes, cereals, maize, fruit culture (tall) and sugar beets. In order to limit the total amount of test runs performed for the impact analysis, a selection was made based on the crops with the highest acreage; as a consequence, 4 active substances new on the Dutch market in the period 2014-2018 are discarded from the impact analysis, and for the remaining 15 active substances, not all products and/or applications authorised have been accounted for in model simulations. Please refer to Table 3 for the final list of active substances and corresponding crop scenarios included in the impact analysis.
Calculations were performed with the currently used DROPLET version 1.2 in combination with the former releases of the FOCUS-models (called old suite) and subsequently compared with calculations using the new DROPLET version 1.3.2 with the newer releases of the FOCUS models (called new suite):

Old suite	New suite
FOCUS-SWASH 3.1	FOCUS-SWASH 5.3
FOCUS-MACRO 4.4.2	SPIN 3.3*
FOCUS-TOXSWA 3.3.1	FOCUS-MACRO 5.5.3
DROPLET 1.2	FOCUS-TOXSWA 4.4.3
	DROPLET 1.3.2

*The new suite now includes a SPIN substance database, because all substance input has been taken out of FOCUS-SWASH and entered in a new database called SPIN (acronym for Substance Plug IN, Van Kraalingen et al., 2013)

Calculations were performed based on the critical use pattern of the product in combination with the drift values presented in Evaluation Manual 2.2 (Ctgb, 2018). The use pattern, drift values and substance parameters used in the calculations are reported in Appendix 1 for all products.

Related to the different model versions of the old and new model suite, some model parameter values are different between the two suites. Table 1 presents an overview of these parameters, which especially affect MACRO and TOXSWA. All other model parameters are the same in the calculations for both suites.

Table 1 *Parameter values that differ between the old and new model suite.*

	Old suite	New suite
TOXSWA and DROPLET Molar activation energy for the effect of temperature on transformation rate in water and in sediment	54 kJ/mol	65.4 kJ/mol
MACRO soil hydraulic functions	Brooks-Corey	Van Genuchten
MACRO Effect of temperature on transformation in soil	0.079	0.0948
MACRO and PRZM Exponent for the effect of moisture content on transformation rate in soil	0.7 (MACRO) 0.7 (PRZM)	0.49 (calibrated in MACRO) 0.7 (PRZM)

Table 2 Overview of products used in the impact analysis (products containing active substances with K_{oc} around 100 L/kg or smaller and/or $DegT_{50,soil}$ of 30 d or greater are highlighted grey).

Active substance	Year authorised	Product	Use(s)	FOCUS D3 crop	$DegT_{50,soil}$ [d]	K_{oc} [L/kg]
valifenalate	2018	Valis M	Potatoes, Vines	Potatoes, Pome/stone fruit late	0.15	859
Mandestrobin*	2018	SISAM	Oilseed rape	Spring oilseed rape	231.2	448
cyantraniliprole	2018	Benevia	Bulb vegetables, onions, shallots, garlic, leek, Cauliflower, broccoli, head cabbage, Brussels sprout, strawberries, Carrot, other root and tuber vegetables, Potatoes	Vegetables – bulb, Vegetables – leafy, Vegetables – root, Potatoes	32.4	193
flupyradifurone	2018	Sivanto Prime	Apple, Pear, Grapevine, Lettuce, Hop, Bulb flowers, Ornamentals, Tree nursery	Pome/stone fruits early + late, Vegetables – leafy, Spring cereals, Vegetables – bulb	94.8	98.4
Benzovindiflupyr	2017	Elatus Era, Elatus Plus	Cereals	Winter cereals, spring cereals	184	3696
Pyriofenone	2017	PROPERTY 180SC	Cereals	Winter cereals, spring cereals	117	705
Sedaxane	2017	Vibrance	Maize		100	534
Isoxaben	2017	AZ 500	Pome fruit (Apple, Pear), Winter cereals, Rhubarb, Onion, shallot, garlic, Witloof (large-rooted chicory, witloof chicory (roots), Asparagus, Leek, Ornamentals,	Pome/stone fruit early Cereals, winter Field beans	94.3	354

			Grass seed crops (Bluegrass, Fescue), fodder grassland, clover (fodder crops), managed amenity turf	Vegetables – bulb, Vegetables – leafy, Grass, alfalfa		
Halauxifen-methyl	2016	ARYLEX TECHNICAL	Cereals	Winter cereals	20	995
thiencarbazone-methyl	2016	Conviso One, Monsoon Active, Cossack Star, Atlantis Star, Capreno	Maize, Beets, Cereals	Maize	11.6	100
acibenzolar-S-methyl*	2015	Inssimo	Chrysanthemum	Vegetables – leafy	0.131	1284
Penflufen	2015	Emesto Prime DS, Emesto Prime Vloeibaar, Emesto Silver, Emesto Silver – rood	Potatoes	Potatoes	113	483
penthiopyrad	2015	DuPont CIELEX, DuPont FONTELIS DuPont TREORIS DuPont VERTISAN	Cereals, Apple, Pear	Spring cereals, Pome fruit	116.2	761
flupyrsulfuron-methyl	2015	DuPont LEXUS SX	Cereals	Winter cereals	16.1	29.5
Benfluralin	2014	BONALAN	Beans, Peas	Field beans, Vegetables – leafy, Vegetables - root	38.7	10052
clethodim	2014	Centurion Plus, WOPRO-Clethodim120 gr/lt	Beets, Potatoes	Sugarbeet, Potatoes	0.66	4.0
Fenpyrazamine*	2014	Prolectus	Strawberries	Vegetables - fruiting	20.5	310
imazamox	2014	Corum	Beans, Peas	Legumes	45.6	67
napropamide*	2014	DEVRINOL 45SC	Heading cabbages, Brussels sprouts, cauliflower and broccoli	Vegetables - leafy	19	648
thifensulfuron-methyl	2014	Harmony SX, Omnera	Maize, Grass	Maize, Grass/alfalfa	3.4	28

*active substance not included in the simulations because no authorized use in one of the six crops with the highest acreage in the intake area of the surface water abstraction points for drinking water

3 Results & discussion

In Table 3, the maximum concentration in the FOCUS D3 ditch (PEC_{max}) with Dutch drift deposition for the old and the new suite have been reported. The PEC_{max} value is the starting point for the calculation of the concentration in the drinking water abstraction points (PEC_Tier1), that are located more downstream in larger water bodies. In Table 4, corresponding PEC_Tier1 values are reported. In Appendix 1, the use pattern, drift values and substance input parameters used for the model runs are reported.

Table 3 *Maximum concentration (PEC_{max}) and cause of peaks in FOCUS D3 ditch for all model runs of the old and new suite.*

Substance	Use	D3 ditch PECmax [µg/L] old suite	Cause of peak	D3 ditch PECmax [µg/L] new suite	Cause of peak*
Valifenalate	Potatoes	0.247	spray drift	0.2469	spray drift
Cyantraniliprole	Potatoes	0.0212	spray drift	0.02127	spray drift + background**
Flupyradifurone	Pome/stone fruit, early	9.978	spray drift	9.983	spray drift
	Pome/stone fruit, late	5.125	spray drift	5.129	spray drift + background**
Benzovindiflupyr	Cereals, winter	0.122	spray drift	0.1223	spray drift
Pyriofenone	Cereals, winter	0.147	spray drift	0.1474	spray drift
	Cereals, spring	0.148	spray drift	0.1476	spray drift
Sedaxane	Maize (seed treatment)	0.000	drainage	$<1^{E}$-6	drainage
Isoxaben	Pome/ stone fruit, early	0.821	spray drift	0.8218	spray drift
	Cereals, winter	0.164	spray drift	0.1639	spray drift
	Grass/ alfalfa	0.123	spray drift	0.1228	spray drift
Halauxifen-methyl	Cereals, winter	0.128	spray drift	0.1280	spray drift
	Cereals, spring	0.128	spray drift	0.1280	spray drift
Thiencarbazon-methyl	Maize	0.164	spray drift	0.1643	spray drift
	Sugar beet	0.0247	spray drift	0.02467	spray drift
	Cereals, winter	0.0123	spray drift	0.01214	spray drift
Penflufen	Potatoes (incorporation)	0.000	drainage	$<1^{E}$-6	drainage
Penthiopyrad	Cereals, winter	0.393	spray drift	0.3934	spray drift
Flupyrsulfuron-methyl	Cereals, winter	0.0171	spray drift	0.01692	spray drift + background**
Clethodim	Sugar beet	0.493	spray drift	0.4930	spray drift
	Potatoes	0.493	spray drift	0.4935	spray drift
Imazamox	Sugar beet	0.0382	spray drift	0.05173	spray drift + background**
Thifensulfuron-methyl	Maize	0.0123	spray drift	0.01216	spray drift
	Grass	0.0369	spray drift	0.03670	spray drift

* Please refer to Annex 2 for illustrative graphs of the concentrations of a.s. in the water layer
** peak concentration due to spray drift occurs on top of a background concentration already present in the water layer

The results of the calculations performed with current and new FOCUS-SWASH versions show that the resulting FOCUS_NL D3 PEC_{max} concentrations are only slightly different. Only application of imazamox in sugar beet results in a 1.5 times higher FOCUS_NL D3 PEC_{max} concentration (0.0382 µg/L vs 0.05173 µg/L for old and new suite, respectively). This increase is caused by an increase in the contribution of the existing background concentration in the water phase to the maximum concentration. For both suites, the maximum simulated concentration coincides with the time of application. According to the current Guidance (Van Leerdam et al., 2010), this suggests that the maximum concentration is caused by spray drift. However, for imazamox there is a significant contribution from the background concentration in the water phase to the maximum concentration. In Figure 2, the simulated concentration in the water phase is presented for both the old and new model suite. For the old model suite, about one third of the maximum concentration is caused by the existing background concentration; but for the new model suite about one half of the maximum concentration is caused by the existing background concentration. This increase in the simulated background concentration in the new model suite can be explained by the higher drainage flux that is calculated by the new FOCUS-MACRO version 5.5.3.

PEC_Tier1 results following calculations at the nine drinking water abstraction points, performed with DROPLET 1.2 and 1.3.2 are identical, despite the small differences in PEC_{max} values calculated by FOCUS-TOXSWA. The PEC_Tier1 is < 0.1 µg/L for all products for all abstraction points for the old and the new model suite.

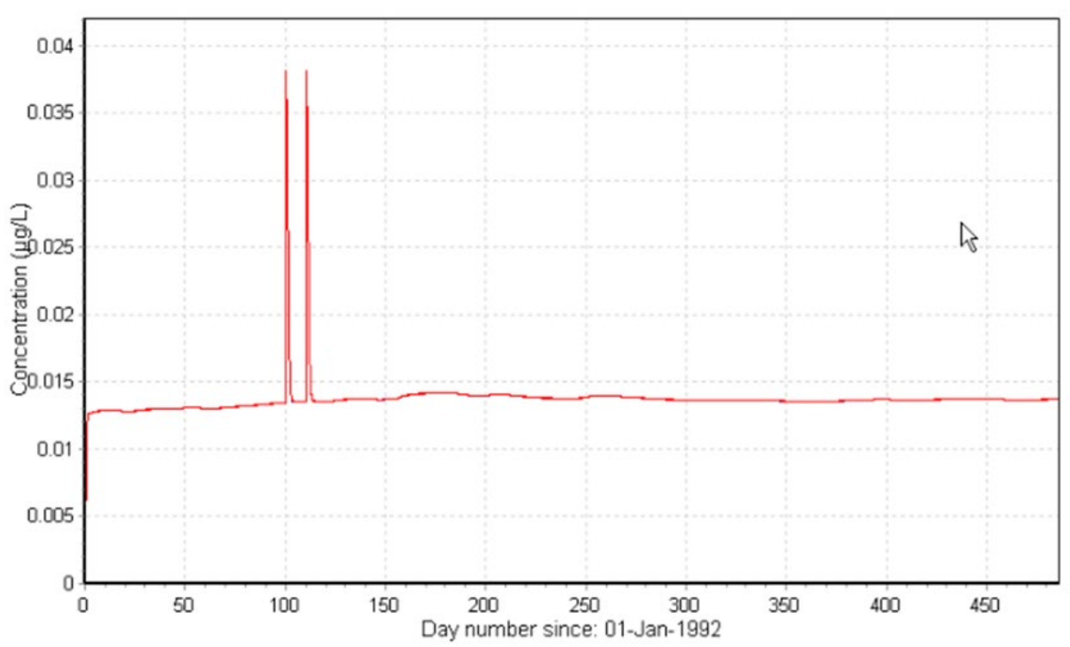
Comparing our results to those of the WOt-technical report 100 we observe the following differences:

i. in this impact analysis the differences between the PEC_{max} values in the D3 ditch of the old and the new model suite are clearly smaller than in the WOt-technical report 100 study, and;
ii. in this impact analysis the PEC_Tier1 values in the nine drinking water abstraction points are well below the threshold value of 0.1 µg/L for all 24 substance-crop combinations, while in the WOt-technical report 100 study the PEC_Tier1 values in the nine drinking water abstraction points are clearly above the threshold value of 0.1 µg/L for a number of substances (i.e. D, G and H).

The reasons for these differences are:

i. the present impact analysis uses actual application rates, ranging between 0.01 to 0.1 kg/ha, while in the former WOt-technical report 100 the application rate was 1 kg/ha for all substances, i.e. a factor 10 to 100 larger (thus leading to concentrations PEC_{max} and PEC_Tier1 of a factor 10 to 100 smaller in the impact analysis);
ii. the 15 substances of the impact analysis are less sensitive to leaching via drains to surface water than substances D, G and even H and thus lead to lower concentrations in surface water, PEC_{max} as well as next, PEC_Tier1. (N.B. Note that substances D, G and H are very sensitive to leaching to drains because of a low sorption coefficient K_{oc} of 10 L/kg (D and G) or due to a combination of relatively low K_{oc} of 100 L/kg coupled to a long half-life in soil of 300 d (H));
iii. due to their lower sensitivity for leaching to drains the peak concentration in the D3 ditch of the impact analysis is nearly always caused by spray drift deposition onto the D3 ditch. In this impact analysis a drift deposition percentage of 0.5 is used, while in the WOt-technical report 100 a percentage of 1 was used, i.e. twice as large. So, for substances where spray drift deposition caused the peak concentration in the D3 ditch in both studies, the impact analysis led to lower concentrations than the WOt-technical report 100 study.

Old model suite



New model suite

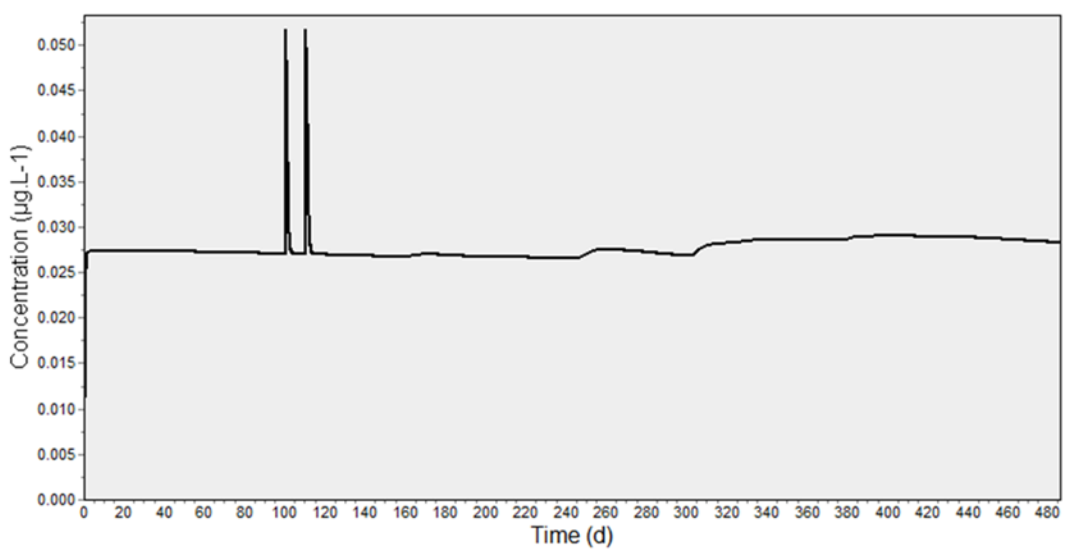


Figure 2 *Total concentration in the water layer for the simulation of substance imazamox for both the old model suite (top) and the new model suite (bottom)*.

__Table 4__ DROPLET values for various active substances.

Drinking water inlet point	Valifenalate		Cyantraniliprole		Flupyradifurone				Benzovindiflupyr		Pyriofenone			
	Potatoes		Potatoes		Pome/stone fruit, early		Pome/stone fruit, late		Cereals, winter		Cereals, winter		Cereals, spring	
	$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L		$PEC_{TIER\ 1}$ [µg/L]	
	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2
De Punt	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001
Andijk	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nieuwegein	0.000	0.000	0.000	0.000	0.031	0.031	0.016	0.016	0.000	0.000	0.001	0.001	0.001	0.001
Heel	0.000	0.000	0.000	0.000	0.013	0.013	0.007	0.007	0.001	0.001	0.001	0.001	0.001	0.001
Amsterdam-Rijnkanaal	0.000	0.000	0.000	0.000	0.024	0.024	0.012	0.012	0.000	0.000	0.000	0.000	0.000	0.000
Brakel	0.000	0.000	0.000	0.000	0.005	0.005	0.002	0.002	0.000	0.000	0.000	0.000	0.001	0.001
Petrusplaat	0.000	0.000	0.000	0.000	0.004	0.004	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000
Twentekanaal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Scheelhoek	0.000	0.000	0.000	0.000	0.010	0.010	0.005	0.005	0.001	0.001	0.001	0.001	0.001	0.001
Bommelerwaard	0.000	0.000	0.000	0.000	0.027	0.027	0.014	0.014	0.000	0.000	0.000	0.000	0.000	0.000

Drinking water inlet point	Sedaxane		Isoxaben						Halauxifen-methyl				Thiencarbazon-methyl	
	Maize (seed treatment)		Pome/stone fruit, early		Cereals, winter		Grass/ alfalfa		Cereals, winter		Cereals, spring		Maize	
	$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L		$PEC_{TIER\ 1}$ [µg/L]	
	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2
De Punt	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.003	0.000	0.000	0.000	0.000	0.001	0.001
Andijk	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Nieuwegein	0.000	0.000	0.003	0.003	0.001	0.001	0.004	0.004	0.000	0.000	0.000	0.000	0.001	0.001
Heel	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.002	0.000	0.000	0.000	0.000	0.001	0.001
Amsterdam-Rijnkanaal	0.000	0.000	0.002	0.002	0.001	0.001	0.004	0.004	0.000	0.000	0.000	0.000	0.001	0.001
Brakel	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.000	0.000	0.000	0.000	0.002	0.002
Petrusplaat	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.002	0.000	0.000	0.000	0.000	0.002	0.002
Twentekanaal	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.000	0.000	0.000	0.000	0.001	0.001
Scheelhoek	0.000	0.000	0.001	0.001	0.001	0.001	0.003	0.003	0.000	0.000	0.000	0.000	0.002	0.002
Bommelerwaard	0.000	0.000	0.002	0.002	0.000	0.000	0.005	0.005	0.000	0.000	0.000	0.000	0.001	0.001

Table 4 *(continued).*

Drinking water inlet point	Thiencarbazon-methyl				Penflufen		Penthiopyrad		Flupyrsulfuron-methyl		Clethodim			
	Sugar beet		Cereals, winter		Potatoes (incorporation)		Cereals, winter		Cereals, winter		Sugar beet		Potatoes	
	$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L]	
	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2
De Punt	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.001	0.001	0.004	0.004
Andijk	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nieuwegein	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Heel	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.000	0.000	0.002	0.002	0.001	0.001
Amsterdam-Rijnkanaal	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Brakel	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.001	0.001	0.001
Petrusplaat	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.001	0.001	0.001
Twentekanaal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Scheelhoek	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.001	0.001	0.001	0.001
Bommelerwaard	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000

Drinking water inlet point	Imazamox		Thifensulfuron-methyl			
	Sugar beet		Maize		Grass	
	$PEC_{TIER\ 1}$ [µg/L]		$PEC_{TIER\ 1}$ [µg/L		$PEC_{TIER\ 1}$ [µg/L	
	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2	DROPLET 1.2	DROPLET 1.3.2
De Punt	0.000	0.000	0.000	0.000	0.000	0.000
Andijk	0.000	0.000	0.000	0.000	0.000	0.000
Nieuwegein	0.000	0.000	0.000	0.000	0.000	0.000
Heel	0.001	0.001	0.000	0.000	0.000	0.000
Amsterdam-Rijnkanaal	0.000	0.000	0.000	0.000	0.000	0.000
Brakel	0.000	0.000	0.000	0.000	0.000	0.000
Petrusplaat	0.000	0.000	0.000	0.000	0.000	0.000
Twentekanaal	0.000	0.000	0.000	0.000	0.000	0.000
Scheelhoek	0.000	0.000	0.000	0.000	0.000	0.000
Bommelerwaard	0.000	0.000	0.000	0.000	0.001	0.001

4 Conclusions and recommendations

The impact analysis has demonstrated that for the plant protection products which have been authorized in the period 2014 – 2018, for which the current version of DROPLET (1.2) was used in the risk assessment, the use of the new DROPLET version (1.3.2.) has no effect on the conclusion for the drinking water criterion. The PEC_Tier1 is < 0.1 µg/L for all products for all abstraction points for both the old and the new model suite.

In WOt-technical report 100 (Adriaanse & Beltman, 2017) calculations were made with hypothetical substances and hypothetical application rates. In this impact analyses calculations were based on existing plant protection products, with a factor 10 to 100 lower application rates (0.01 to 0.1 kg/ha vs 1 kg/ha) and substances which are less sensitive to leaching via drainage. Apparently, the application rate of 1 kg/ha and the specific substance properties of the hypothetical substances used in Adriaanse & Beltman (2017), are not likely to occur in 'real' plant protection products. The only product that contained an active substance with these properties (i.e. imazamox), is not used in the high dose rate (1 kg/ha) that was used in the calculations by Adriaanse & Beltman (2017). Therefore, in this impact study the PEC_Tier1 values in the nine drinking water abstraction points are well below the threshold value of 0.1 µg/L for all 24 substance-crop combinations, while in the WOt-technical report 100 study, the PEC_Tier1 values in the nine drinking water abstraction points are clearly above the threshold value of 0.1 µg/L for a number of substances (i.e. D, G and H).
So, the overall conclusion is that the study of the WOt-technical report 100 led to overly conservative concentrations in the drinking water abstraction points, as demonstrated by the results of the more realistic calculations of the present impact study.

Based on the impact analysis, it can be concluded that implementation of new DROPLET model version, to be used in collaboration with the newer release of the FOCUS models, is not expected to have a significant impact on the risk assessment of 'real' plant protection products regarding the drinking water criterion.

Adriaanse & Beltman (2017) showed that the latest version of the FOCUS model MACRO (version 5.5.3), calculates higher drainage fluxes for the FOCUS D3 scenario compared to the old MACRO (version 4.4.2). At present it is unclear which version of MACRO results in drainage fluxes reflecting best reality for the D3 scenario. Therefore, Adriaanse & Beltman (2017) concluded that it is not possible to make any recommendation on the preferred model suite for use in the exposure assessment procedure at EU level and in The Netherlands. However, the presented impact analysis has shown that it is not expected that the use of the new DROPLET version in combination with MACRO 5.5.3 will have a significant impact on the risk assessment.

In addition, applicants are required to use the newest version of the FOCUS surface water models in the zonal submission of an application for authorization of a plant protection product. The use of MACRO version 4.4.2 is no longer allowed in a zonal surface water assessment at EU level. The new DROPLET version facilitates the national risk assessment for the drinking water criterion, because it can be used in combination with the new FOCUS models. Therefore, applicants will no longer need to revert to older versions of the FOCUS models to be able to perform the national risk assessment for the drinking water criterion, when applying for authorization of a product in the Netherlands.

So, both based upon the fact that the impact study revealed that there is no influence on the concentrations at the drinking water abstraction points by updating from the DROPLET 1.2 to DROPLET 1.3.2 model suite and the fact that use of MACRO 4.4.2 of the old DROPLET suite is no longer allowed in a zonal surface water assessment, we recommend implementing the new DROPLET version in the national authorization procedure.

References

Adriaanse, P.I. and W.H.J. Beltman (2017). Comparison of pesticide concentrations at drinking water abstraction points in The Netherlands simulated by DROPLET version 1.2 and 1.3.2 model suites. Wageningen, the Statutory Research Tasks Unit for Nature & the Environment (WOT Natuur & Milieu). WOt-technical report 100. 52 p.; 6 Figs; 12 Tabs; 5 Refs; 5 Annexes.

Ctgb (2018). Evaluation Manual for the Authorisation of Plant protection products and Biocides according to Regulation (EC) No 1107/2009 NL part Plant protection products Chapter 6 Fate and behaviour in the environment; behaviour in surface water and sediment.

Van Kraalingen, D., E.L. Wipfler, F. van den Berg, W.H.J. Beltman, M.S. ter Horst, G. Fait, J.A. te Roller (2013). SPIN Manual 1.1. User's Guide version 1, for use with FOCUS_SWASH 4.2. WOt-werkdocument 354. WOT Natuur & Milieu, Wageningen UR, Wageningen, The Netherlands.

Van Leerdam, R.C., P.I. Adriaanse and J.A. te Roller (2010). DROPLET to calculate concentrations at drinking water abstraction points. Alterra report 2020.

List of used abbreviations

Variable	Description
PEC_{max}	Maximum Predicted Environmental Concentration in water of the FOCUS D3 ditch receiving spray drift deposition according to Dutch deposition numbers
PEC_Tier1	Predicted Environmental Concentration at the surface water abstraction points for drinking water production

Justification

This study was carried out by ir. A. de Jong and drs. A. Poot, (*Ctgb, Dutch Board for the Authorisation of Plant Protection Products and Biocides*), and supervised by dr. Erik van den Berg and ir. Paulien Adriaanse *(Wageningen Environmental Research, Wageningen University and Research).* Critical questions and remarks by drs. Miranda Meijster (*Ministry of Agriculture, Nature and Food Quality*) to an early version of this report, have contributed to a more accessible final report.

Annex 1 Substance input parameters and model input parameters

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Valifenalate	Valis M	Potatoes	Potatoes	4 / 7	0.150	116-180	0.5
Substance input parameters							
Molecular mass			398.89				
Saturated vapour pressure			9.6E-8				
Solubility in water			45.5				
Arithmetic mean Kom			498.3				
Arithmetic mean 1/n			1.038				
Factor plant uptake			0.0 (conservative default)				
Geometric mean DT_{50} water (DT_{50} system)			4.6				
Geometric mean field/lab DT_{50} soil			0.15				
DT_{50} sediment			1000 (default)				
DT_{50} crop (d)			10 (default)				

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Cyantraniliprole	Benevia	Potatoes	Potatoes	2 / 7	0.0125	116-160	0.5
Substance input parameters							
Molecular mass (g/mol)			473.7				
Saturated vapour pressure (Pa) (20ºC)			5.1E-15				
Solubility in water (mg/L)			14.2				
Arithmetic mean Kom (mL/g)			112				
Arithmetic mean 1/n			0.93				
Factor plant uptake			0.0 (conservative default)				
Geometric mean DT_{50} water (DT_{50} system) (d)			25.1				
Geometric mean field/lab DT_{50} soil (d)			87.0				
DT_{50} sediment (d)			1000 (default)				
DT_{50} crop (d)			10 (default)				

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Flupyradifurone	Sivanto Prime	Pome/stone fruit, early	Tall fruit culture	1 / -	0.18	91-121	16.8
		Pome/stone fruit, late					8.6

Substance input parameters	
Molecular mass (g/mol)	288.68
Saturated vapour pressure (Pa) (20ºC)	9.1E-7
Solubility in water (mg/L)	3200
Arithmetic mean Kom (mL/g)	57.08
Arithmetic mean 1/n	0.87
Factor plant uptake	0.0 (conservative default)
Geometric mean DT_{50} water (DT_{50} system) (d)	228
Geometric mean field/lab DT_{50} soil (d)	94.8
DT_{50} sediment (d)	1000 (default)
DT_{50} crop (d)	10 (default)

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Benzovindiflupyr	Elatus Era	Cereals, winter	Cereals	1 / -	0.075	311-341	0.5

Substance input parameters	
Molecular mass (g/mol)	398.24
Saturated vapour pressure (Pa) (25ºC)	3.2E-9
Solubility in water (mg/L) (25ºC)	0.98
Arithmetic mean Kom (mL/g)	2144
Arithmetic mean 1/n	0.92
Factor plant uptake	0.0 (conservative default)
Geometric mean DT_{50} water (DT_{50} system) (d)	1000 (default)
Geometric mean field/lab DT_{50} soil (d)	184
DT_{50} sediment (d)	559
DT_{50} crop (d)	10 (default)

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Pyriofenone	Property 180SC	Cereals, winter	Cereals	2 / 14	0.09	311-360	0.5
		Cereals, spring				77-125	

Substance input parameters	
Molecular mass (g/mol)	365.8
Saturated vapour pressure (Pa) (25ºC)	1.9E-6
Solubility in water (mg/L) (20ºC)	1.56
Arithmetic mean Kom (mL/g)	409
Arithmetic mean 1/n	0.88
Factor plant uptake	0.0 (conservative default)
Geometric mean DT_{50} water (DT_{50} system) (d)	1000 (default)
Geometric mean field/lab DT_{50} soil (d)	117
DT_{50} sediment (d)	8.4
DT_{50} crop (d)	10 (default)

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Sedaxane	Vibrance	Maize?? Seed treatment! → incorporation	Maize	1 / -	0.035	111-141	0

Substance input parameters	
Molecular mass (g/mol)	331
Saturated vapour pressure (Pa) (25ºC)	1.7E-7
Solubility in water (mg/L) (20ºC)	14
Arithmetic mean Kom (mL/g)	309.7
Arithmetic mean 1/n	0.865
Factor plant uptake	0.0 (conservative default)
Geometric mean DT_{50} water (DT_{50} system) (d)	1000 (default)
Geometric mean field/lab DT_{50} soil (d)	100
DT_{50} sediment (d)	866
DT_{50} crop (d)	10 (default)

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Isoxaben	AZ 500	Pome/stone fruit, early (herbicide treatment)	Tall fruit culture	1 / -	0.5	91-121	0.5
		Cereals, winter	Cereals		0.1	311-341	
		Grass/ alfalfa	Grass		0.075	1-31	

Substance input parameters	
Molecular mass (g/mol)	332.4
Saturated vapour pressure (Pa) (20ºC)	5.5E-7
Solubility in water (mg/L) (20ºC)	1.04
Arithmetic mean Kom (mL/g)	205.3
Arithmetic mean 1/n	0.905
Factor plant uptake	0.0 (conservative default)
Geometric mean DT_{50} water (DT_{50} system) (d)	1000 (default)
Geometric mean field/lab DT_{50} soil (d)	94.3
DT_{50} sediment (d)	16.8
DT_{50} crop (d)	10 (default)

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
halauxifen-methyl	Arylex Technical	Cereals, winter	Cereals	1 / -	0.0782	311-341	0.5
		Cereals, spring				77-107	

Substance input parameters	
Molecular mass (g/mol)	345
Saturated vapour pressure (Pa) (20ºC)	5.9E-9
Solubility in water (mg/L)	1.7
Arithmetic mean Kom (mL/g)	577
Arithmetic mean 1/n	0.87
Factor plant uptake	0.0 (conservative default)
Geometric mean DT_{50} water (DT_{50} system) (d)	1.8
Geometric mean field/lab DT_{50} soil (d)	20
DT_{50} sediment (d)	1000 (default)
DT_{50} crop (d)	10 (default)

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
thiencarbazon-methyl	Capreno	Maize	Maize	1 / -	0.1	111-141	0.5
	Conviso One	Sugar beet	Sugar beets	2 / 10	0.015	101-150	
		Cereals, winter	Cereals	1 / -	0.0075	311-341	
Substance input parameters							
Molecular mass (g/mol)			390.4				
Saturated vapour pressure (Pa) (20ºC)			8.8E-14				
Solubility in water (mg/L)			436				
Arithmetic mean Kom (mL/g)			58				
Arithmetic mean 1/n			0.91				
Factor plant uptake			0.5				
Geometric mean DT_{50} water (DT_{50} system) (d)			26.1				
Geometric mean field/lab DT_{50} soil (d)			11.6				
DT_{50} sediment (d)			1000 (default)				
DT_{50} crop (d)			10 (default)				

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Penflufen	Emesto Silver	Potatoes → incorporation 10 cm	Potatoes	1 / -	0.1	116-146	-
Substance input parameters							
Molecular mass (g/mol)			317.41				
Saturated vapour pressure (Pa) (20ºC)			4.1E-7				
Solubility in water (mg/L)			12.4				
Arithmetic mean Kom (mL/g)			279.9				
Arithmetic mean 1/n			0.9198				
Factor plant uptake			0.0 (conservative default)				
Geometric mean DT_{50} water (DT_{50} system) (d)			221				
Geometric mean field/lab DT_{50} soil (d)			113				
DT_{50} sediment (d)			1000 (default)				
DT_{50} crop (d)			10 (default)				

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Penthiopyrad	DuPont Cielex	Cereals, winter	Cereals	1 / -	0.24	311-341	0.5

Substance input parameters	
Molecular mass (g/mol)	359.42
Saturated vapour pressure (Pa) (20ºC)	6.4E-6
Solubility in water (mg/L) (20ºC)	7.53E-3
Arithmetic mean Kom (mL/g)	441
Arithmetic mean 1/n	0.96
Factor plant uptake	0.0 (conservative default)
Geometric mean DT_{50} water (DT_{50} system) (d)	268
Geometric mean field/lab DT_{50} soil (d)	116.2
DT_{50} sediment (d)	1000 (default)
DT_{50} crop (d)	10 (default)

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Flupyrsulfuron-methyl	DuPont Lexus SX	Cereals, winter	Cereals	1 / -	0.01	311-341	0.5

Substance input parameters	
Molecular mass (g/mol)	487.4
Saturated vapour pressure (Pa) (20ºC)	1E-9
Solubility in water (mg/L)	0.61
Arithmetic mean Kom (mL/g)	17.1
Arithmetic mean 1/n	0.9
Factor plant uptake	0.5
Geometric mean DT_{50} water (DT_{50} system) (d)	4.24
Geometric mean field/lab DT_{50} soil (d)	16.1
DT_{50} sediment (d)	1000 (default)
DT_{50} crop (d)	10 (default)

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Clethodim	Centurion Plus	Sugar beets	Sugar beets	1 / -	0.3	101-131	0.5
		Potatoes	Potatoes			116-146	
Substance input parameters							
Molecular mass (g/mol)			359.9				
Saturated vapour pressure (Pa) (20ºC)			2.08E-6				
Solubility in water (mg/L)			5450				
Arithmetic mean Kom (mL/g)			2.32				
Arithmetic mean 1/n			0.975				
Factor plant uptake			0.5				
Geometric mean DT_{50} water (DT_{50} system) (d)			11.34				
Geometric mean field/lab DT_{50} soil (d)			0.66				
DT_{50} sediment (d)			1000 (default)				
DT_{50} crop (d)			10 (default)				

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Imazamox	Corum	Sugar beets		2 / 7	0.015	101-150	0.5
Substance input parameters							
Molecular mass (g/mol)			305.3				
Saturated vapour pressure (Pa) (25ºC)			1.33E-5				
Solubility in water (mg/L) (25ºC)			626000				
Arithmetic mean Kom (mL/g)			38.9				
Arithmetic mean 1/n			0.96				
Factor plant uptake			0.5				
Geometric mean DT_{50} water (DT_{50} system) (d)			141				
Geometric mean field/lab DT_{50} soil (d)			45.6				
DT_{50} sediment (d)			1000 (default)				
DT_{50} crop (d)			10 (default)				

Substance	Product	D3 Use	Droplet Crop	Freq./ interval	Dose rate [kg/ha]	MACRO Julian days	TOXSWA drift (%)
Thifensulfuron-methyl	Harmony SX	Maize	Maize	1 / -	0.0075	111-141	0.5
		Grass	Grass	1 / -	0.0225	1-31	

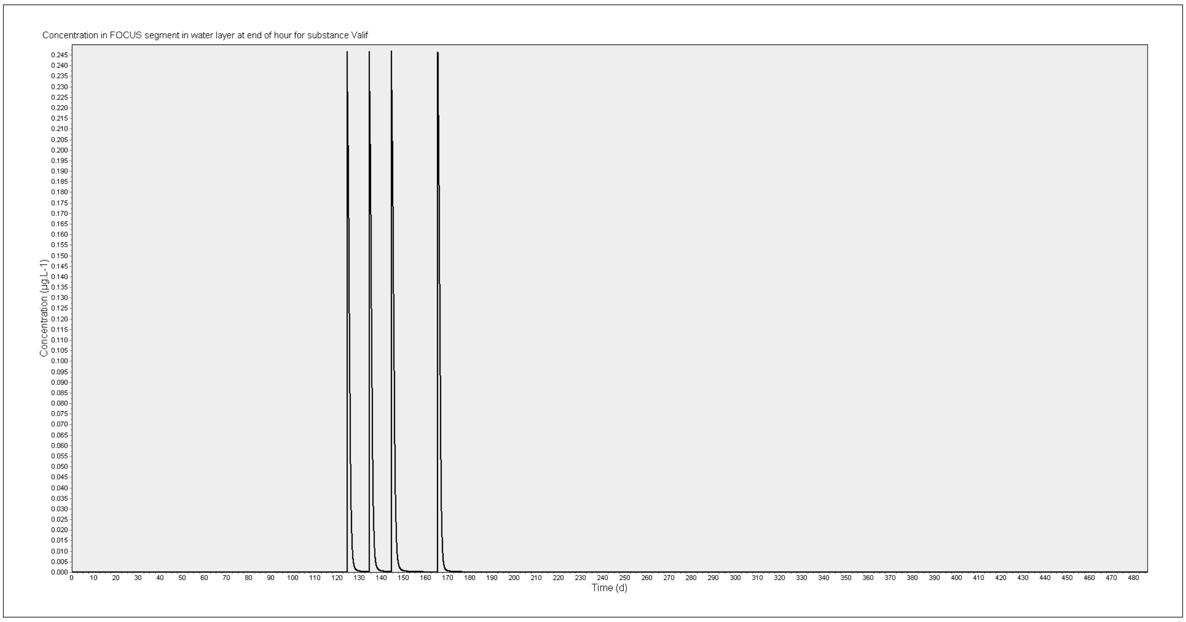
Substance input parameters	
Molecular mass (g/mol)	387.4
Saturated vapour pressure (Pa) (20ºC)	7.5E-6
Solubility in water (mg/L) (25ºC)	2.24E-3
Arithmetic mean Kom (mL/g)	16.4
Arithmetic mean 1/n	0.9
Factor plant uptake	0.0 (conservative default)
Geometric mean DT_{50} water (DT_{50} system) (d)	23.5
Geometric mean field/lab DT_{50} soil (d)	3.4
DT_{50} sediment (d)	1000 (default)
DT_{50} crop (d)	10 (default)

Annex 2 Graphical representation of concentration in water layer

Results from simulations based on the recently released model versions (i.e. new model suite)

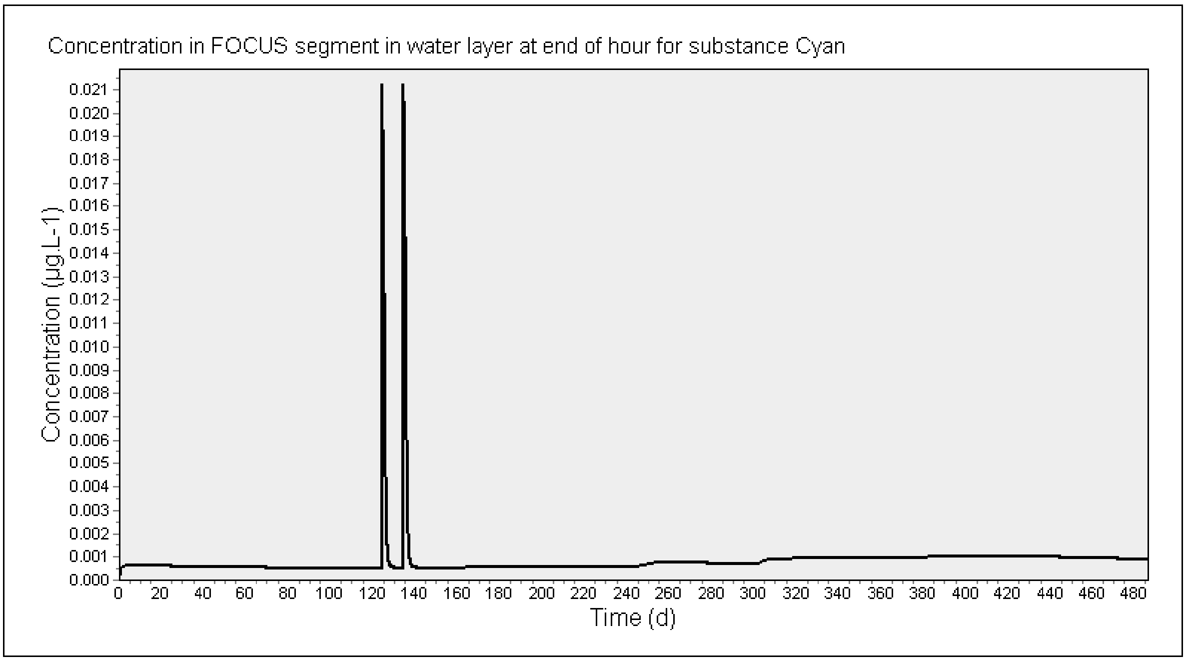
A.s. valifenalate

Potatoes



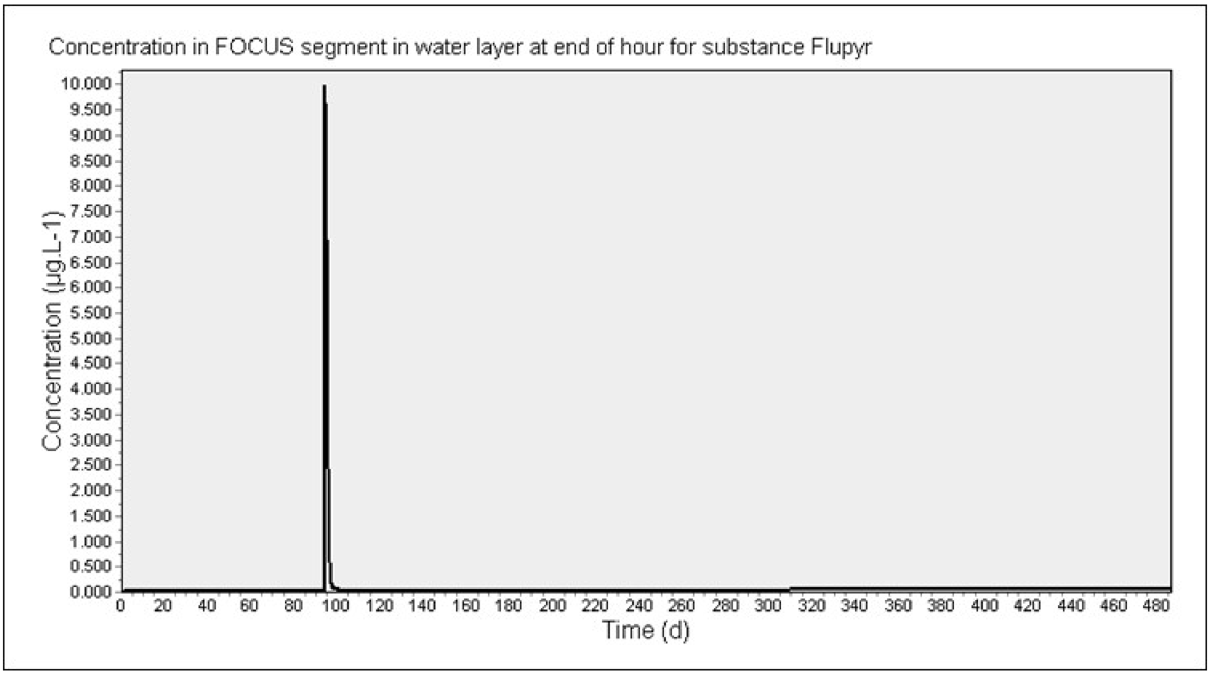
A.s. cyantraniliprole

Potatoes

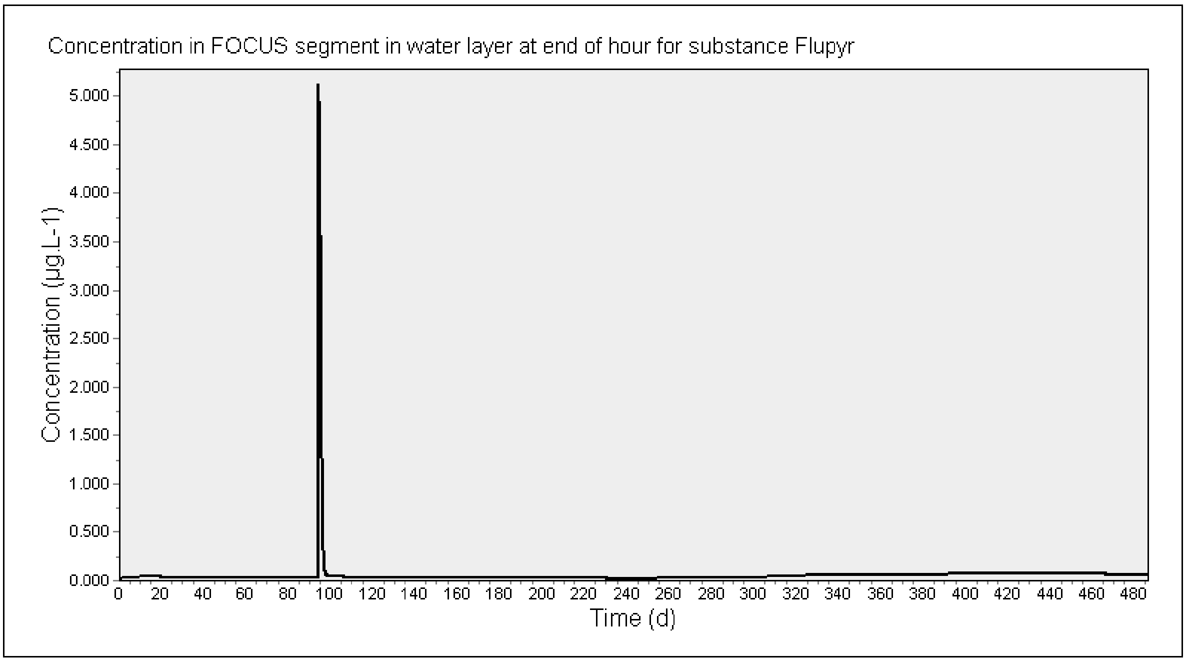


A.s. flupyradifurone

Pome/stone fruit, early

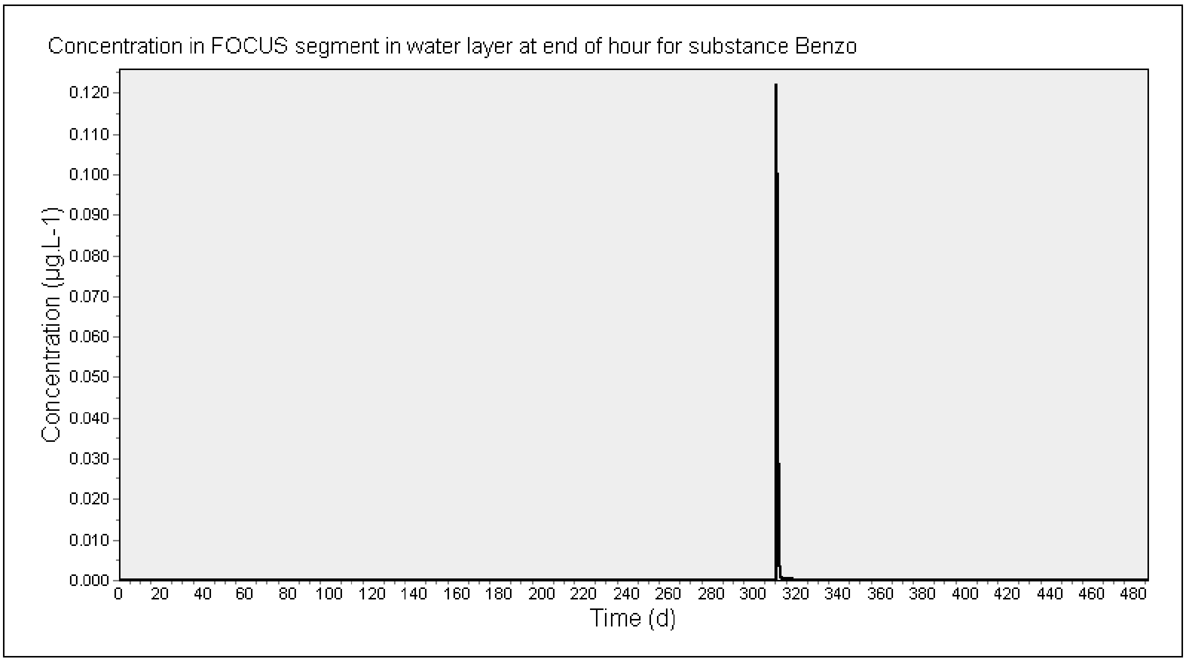


Pome/stone fruit, late



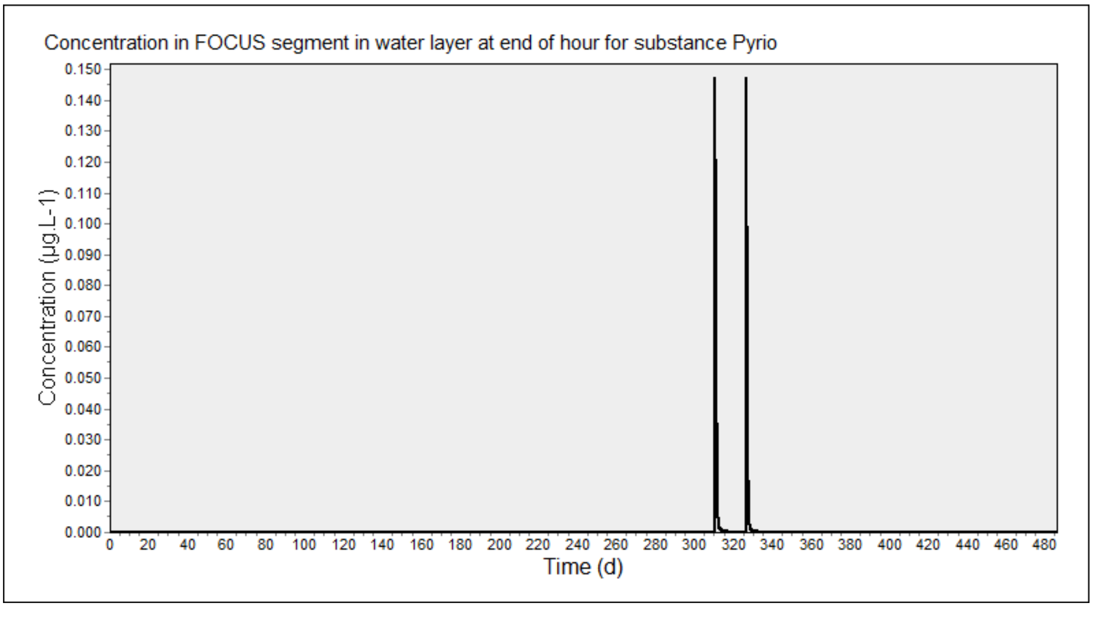
A.s. benzovindiflupyr

Cereals, winter

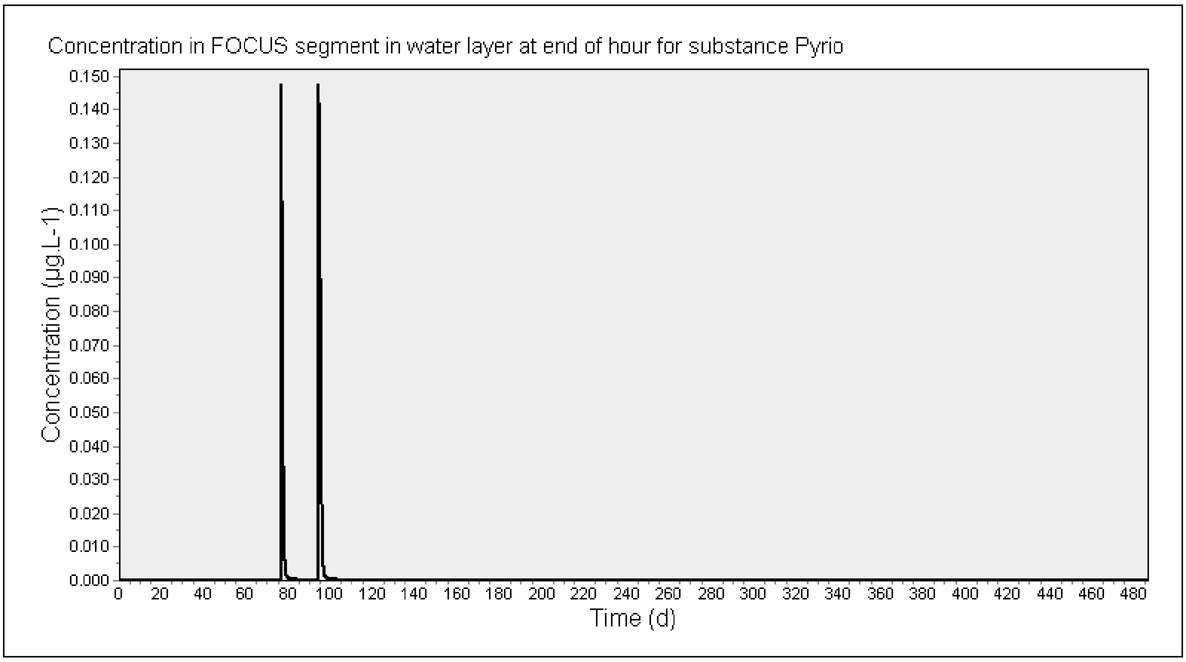


A.s. pyriofenone

Cereals, winter

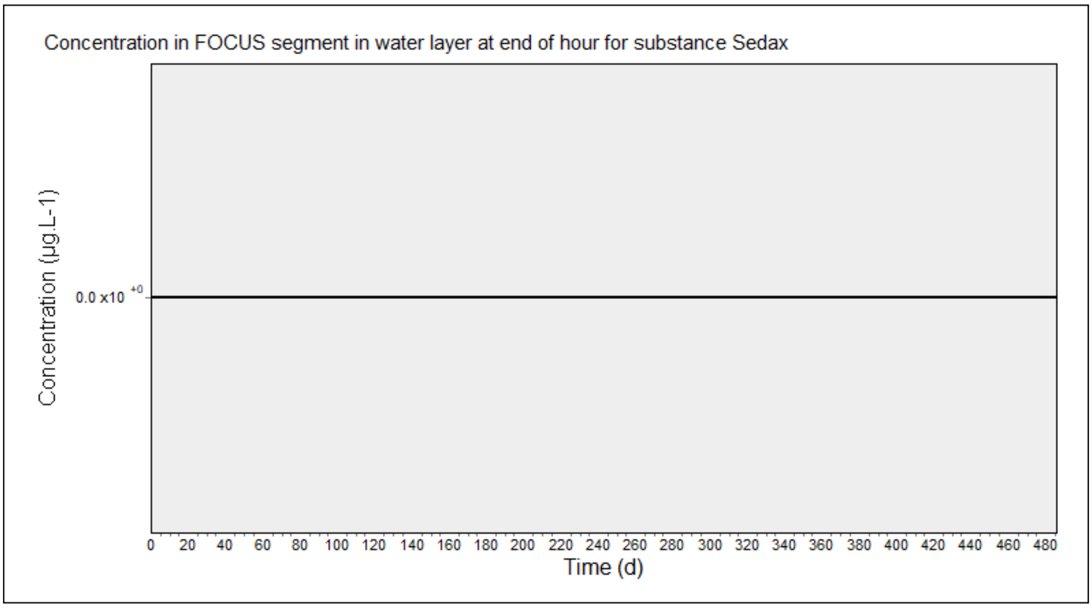


Cereals, spring



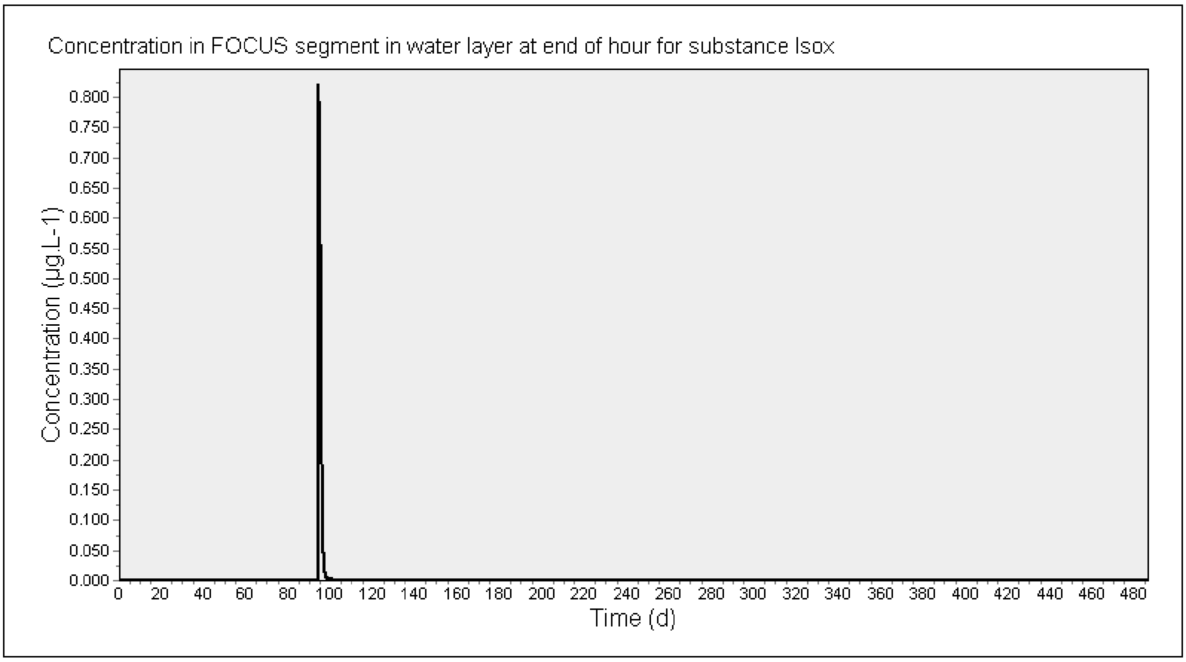
A.s. sedaxane

Maize

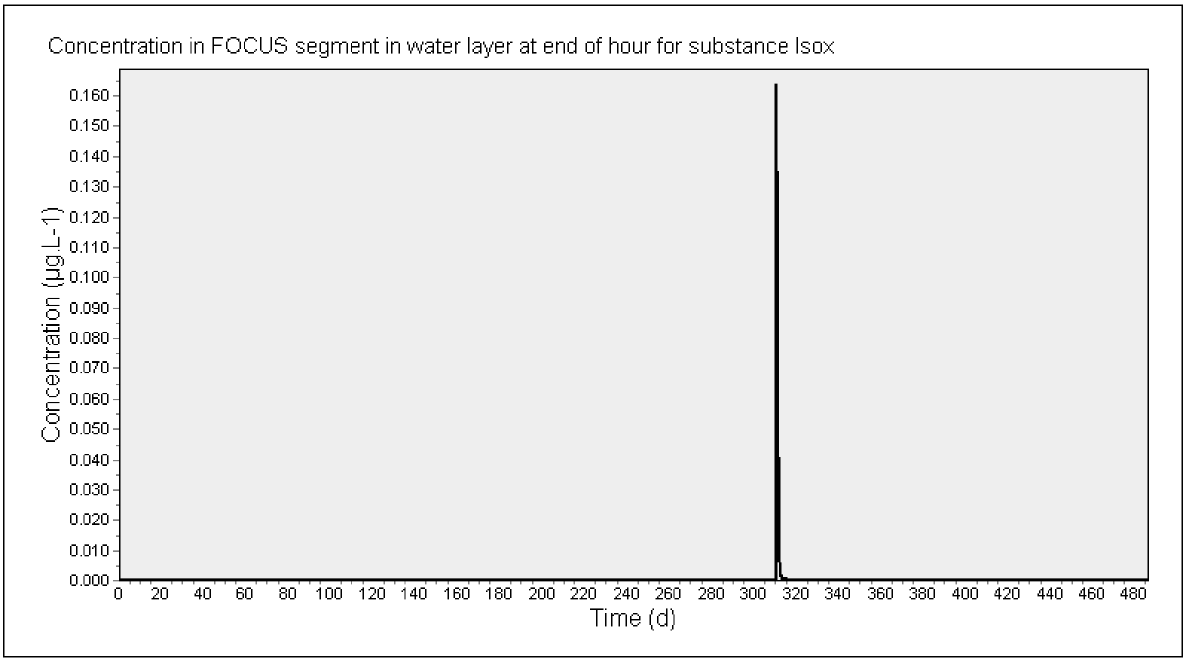


A.s. isoxaben

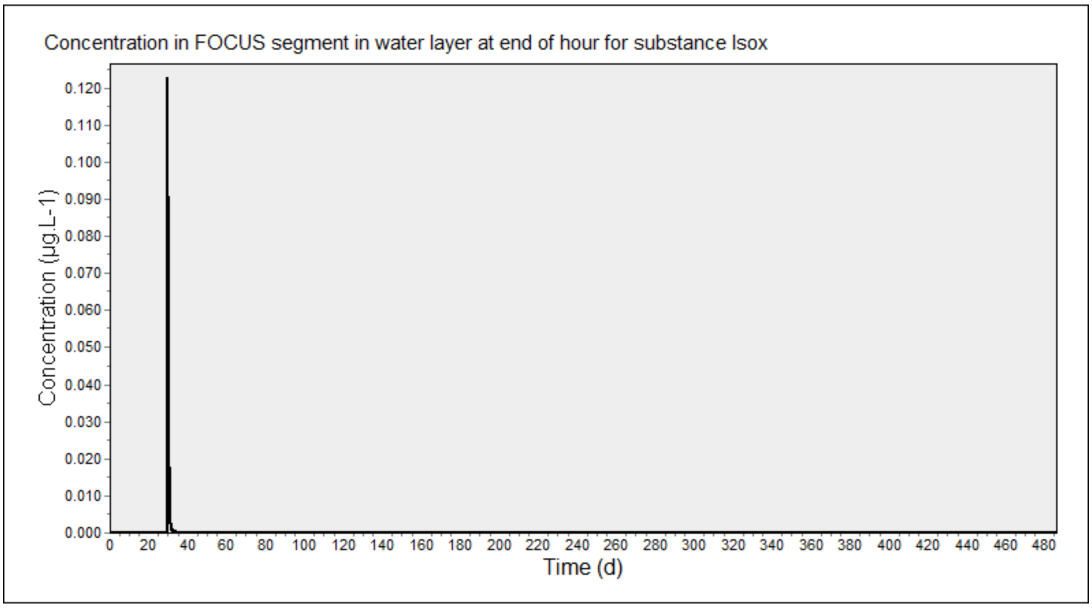
Pome/stone fruit, early



Cereals, winter

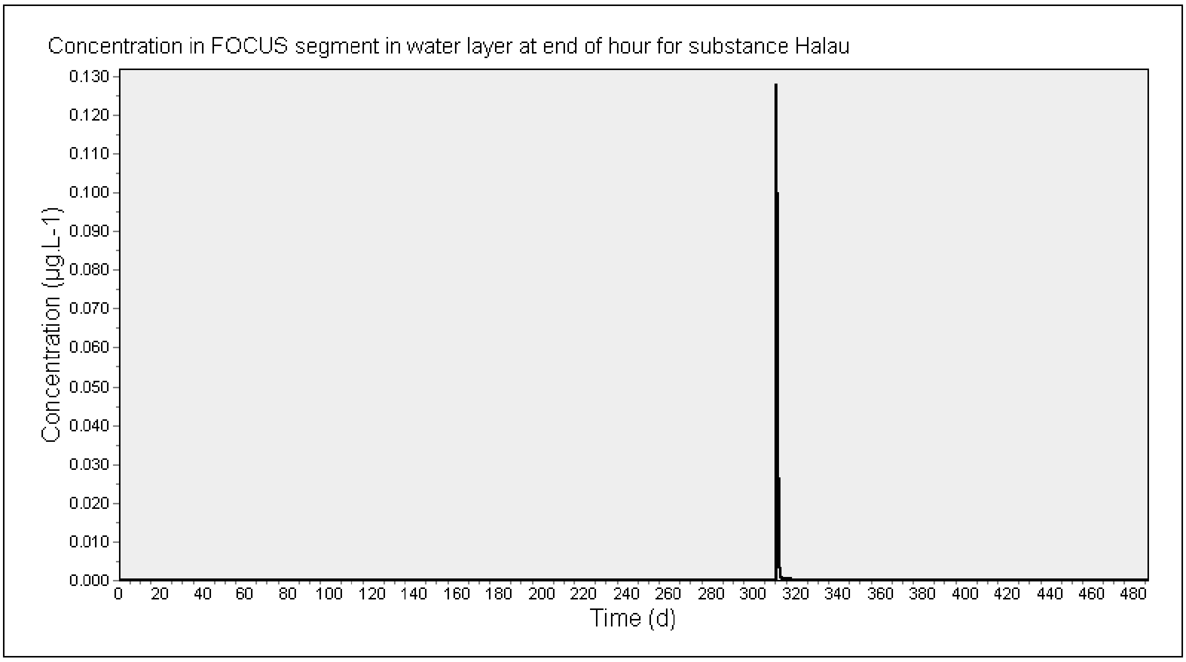


Grass/alfalfa



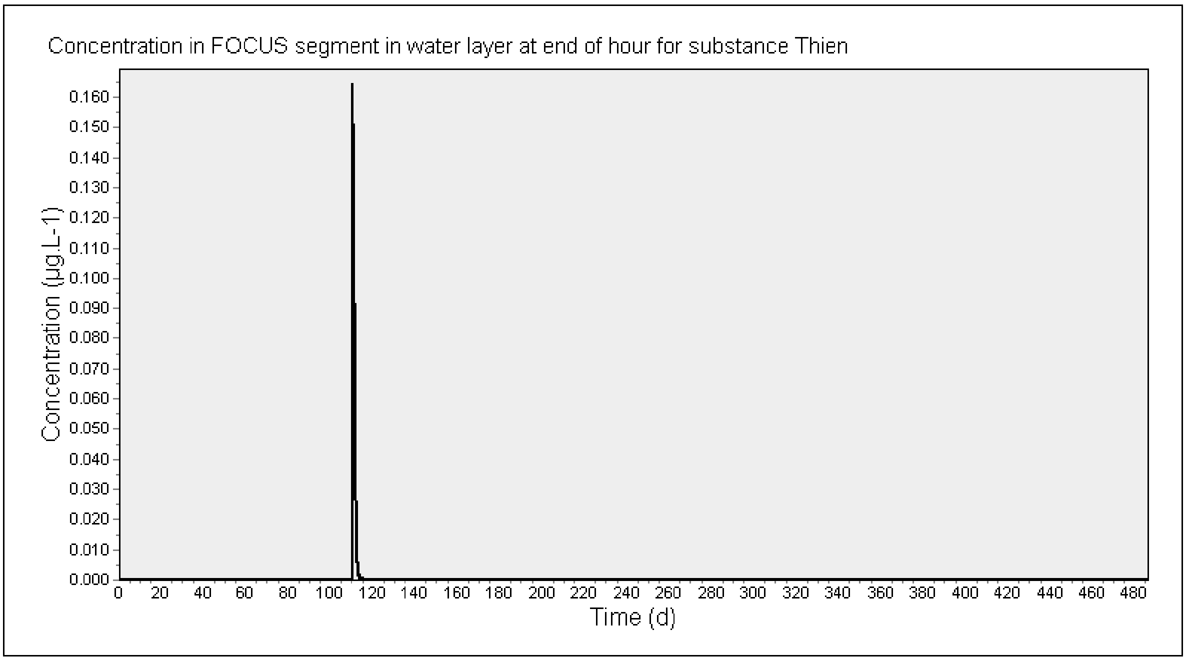
A.s. halauxifen-methyl

Cereals, winter

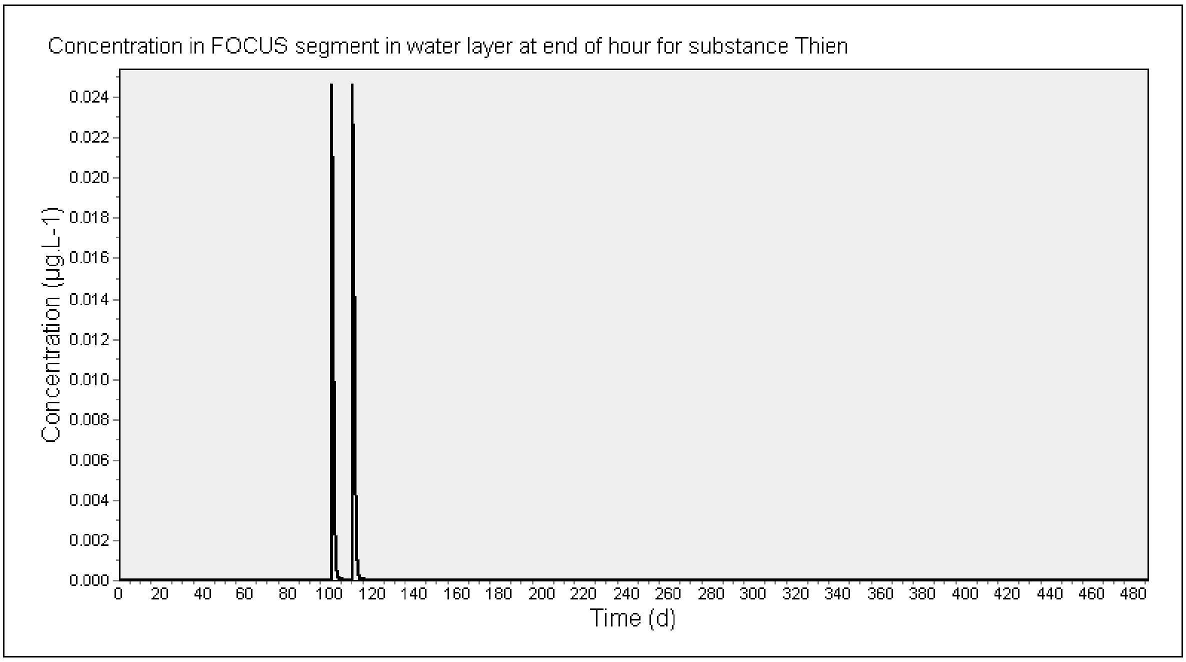


Thiencarbazon-methyl

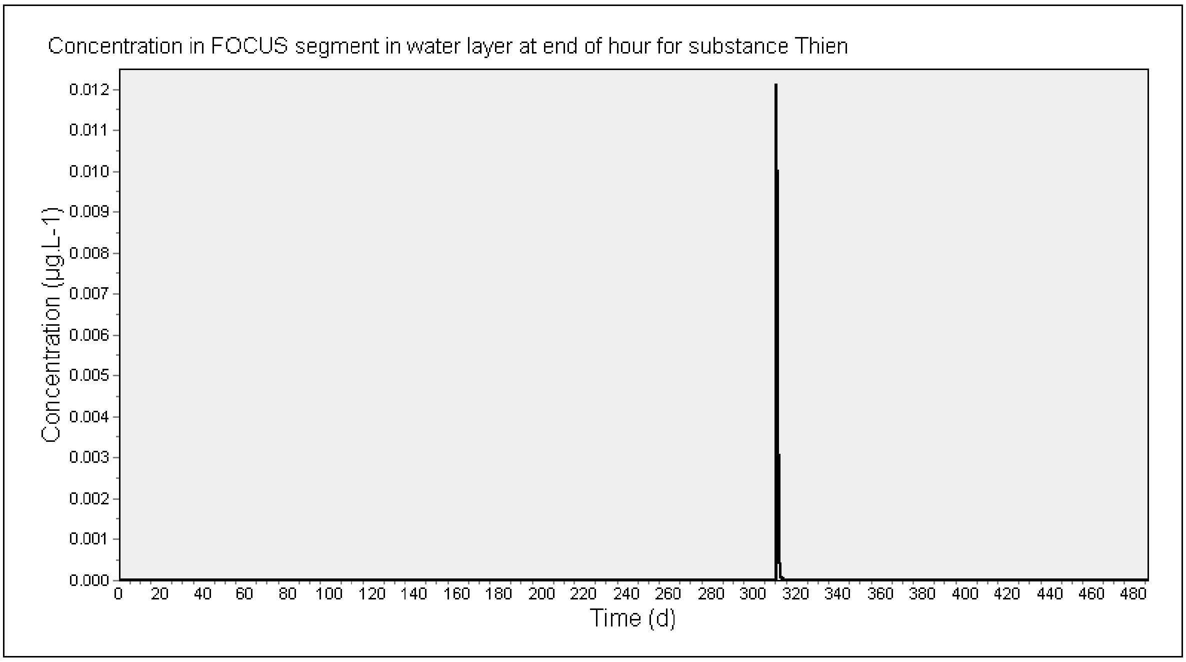
Maize



Sugar beet

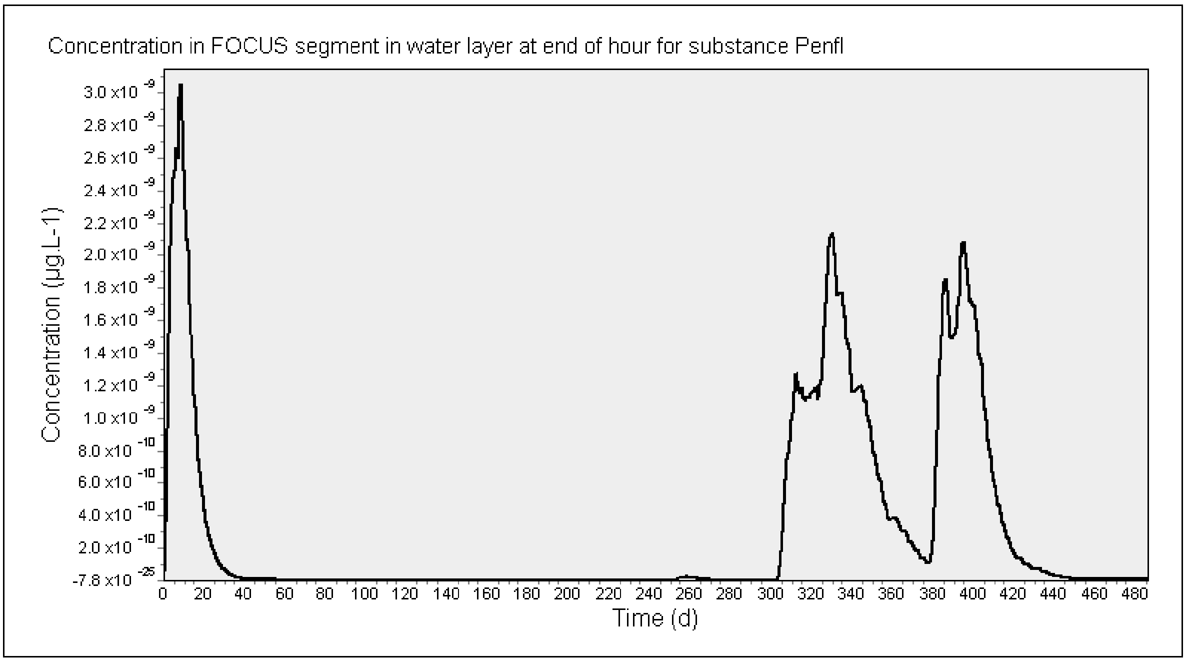


Cereals, winter



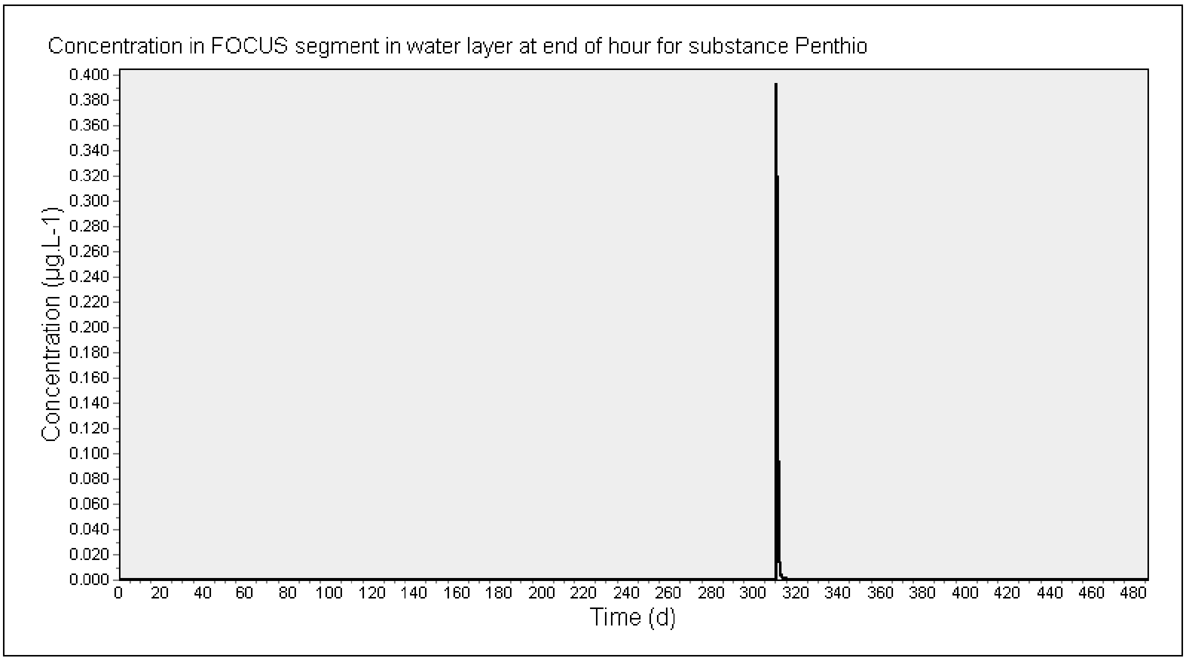
A.s penflufen

Potatoes



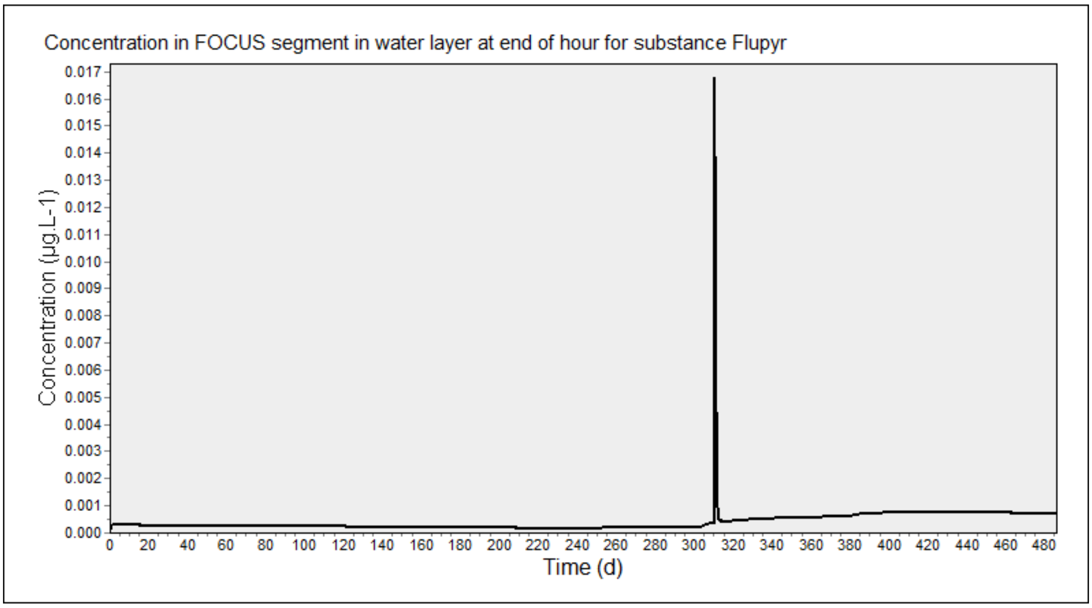
A.s. Penthiopyrad

Cereals, winter



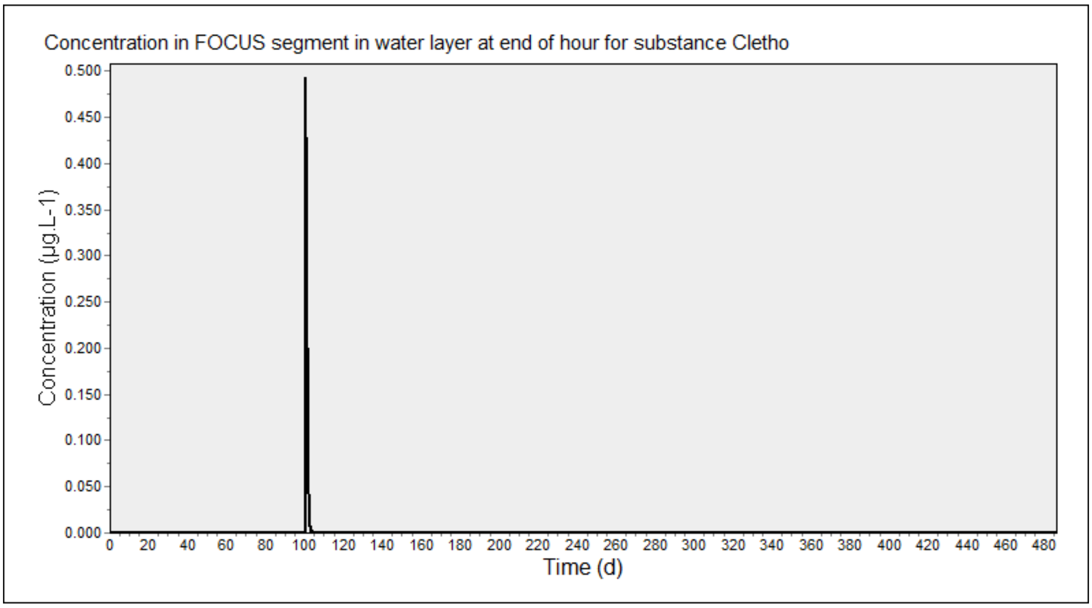
A.s. flupyrsulfuron-methyl

Cereals, winter

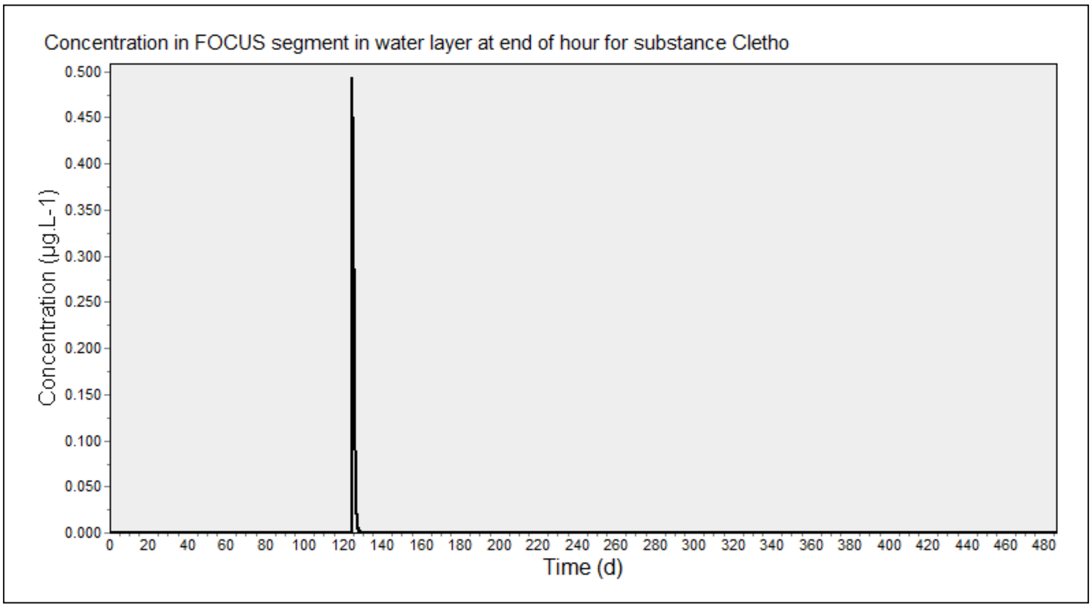


A.s. clethodim

Sugar beets

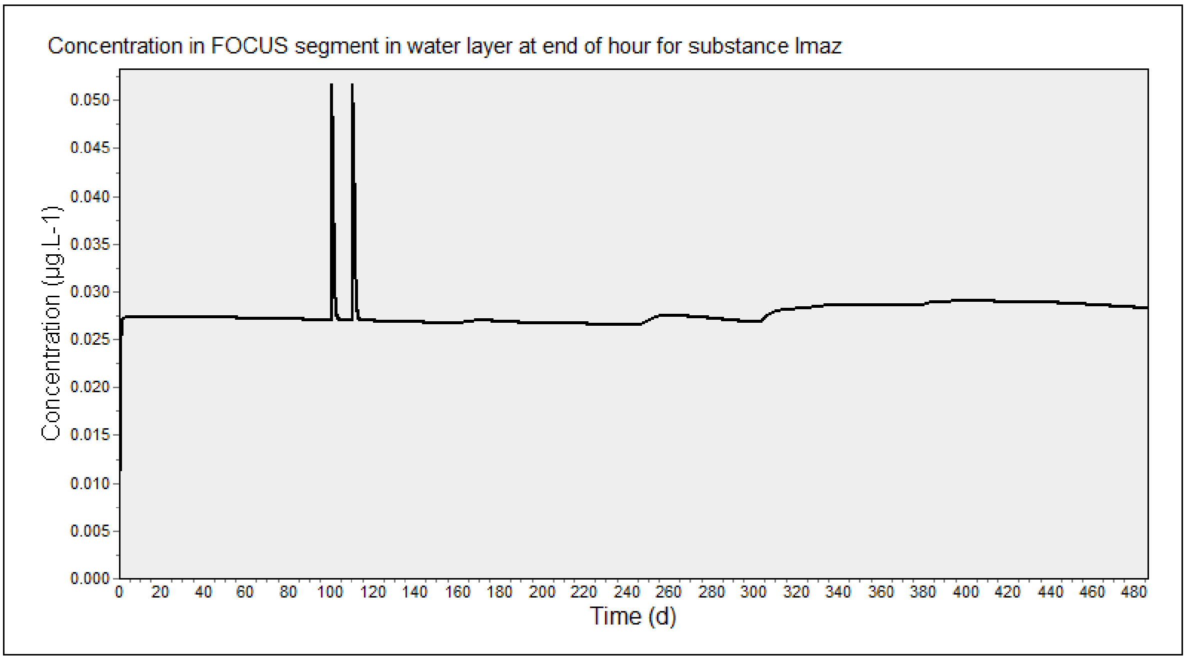


Potatoes



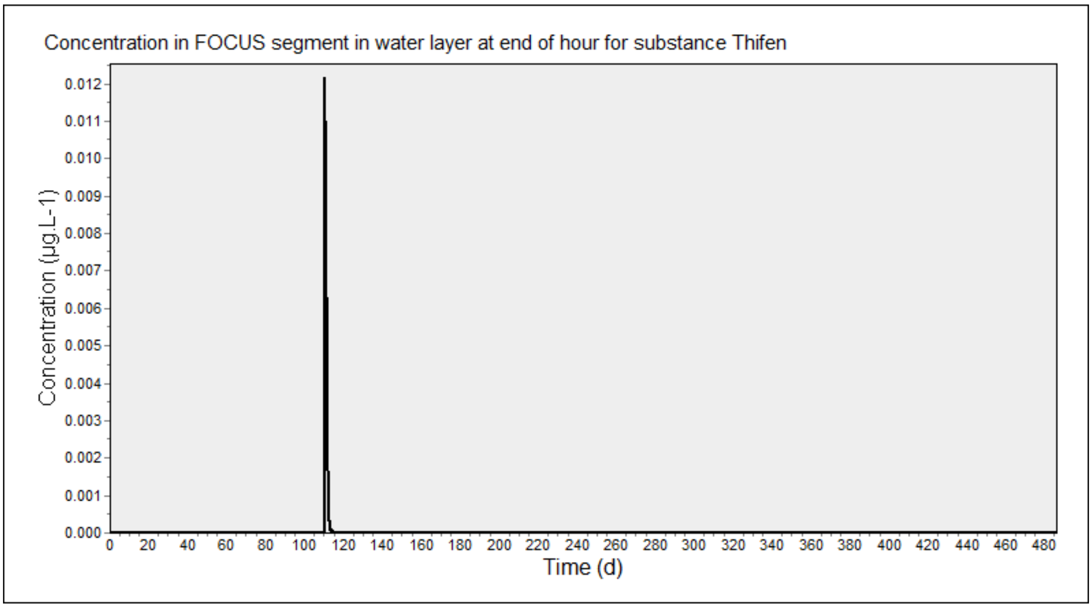
A.s. imazamox

Sugar beets

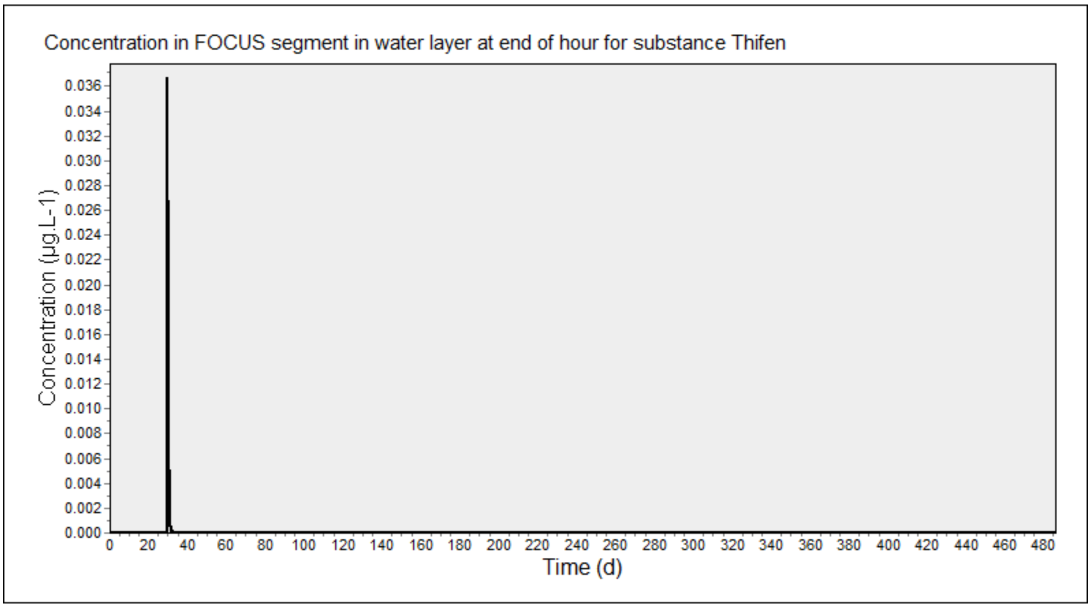


A.s. thifensulfuron-methyl

Maize



Grass



Concentration in FOCUS segment in water layer at end of hour for substance Thifen
Concentration (µg.L-1)
0.036
0.034
0.032
0.030
0.028
0.026
0.024
0.022
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480
Time (d)

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