The Danish Pesticide Leaching Assessment Programme

MONITORING RESULTS
MAY 1999 - JUNE 2023

Geological Survey of Denmark and Greenland
Department of Geochemistry

Aarhus University
Department og Agroecology
Department of Ecoscience

PLAP

The Danish Pesticide Leaching Assessment Programme

Monitoring results May 1999–June 2023

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Editor: Nora Badawi
Front page photo by Eugene J.G.G. Driessen: Wheat crop at Faardrup
Layout and graphic production: Authors
Printed for a hard copy version*: May 2024*

ISSN (print): 2446-4228
ISSN (online): 2446-4236
ISBN (print): 978-87-7871-599-9
ISBN (online): 978-87-7871-598-2

Available from:
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Table of contents

Preface

In 1998, the Danish Parliament initiated the Danish Pesticide Leaching Assessment Programme (PLAP), which is an intensive monitoring programme aimed at evaluating the leaching risk of pesticides under field conditions. The Danish Government funded the first phase of the programme from 1998 to 2001. The programme has now been prolonged several times, initially with funding from the Ministry of the Environment and the Ministry of Food, Agriculture and Fisheries for the period 2002 to 2009, and then from the Danish Environmental Protection Agency (EPA) in the period 2010 to 2018. Additionally, funding for establishing a new test field, designated to be included in the monitoring programme for 2016-2018, was provided in the Danish Finance Act for the fiscal year of 2015. The establishment of the new test field was, however, delayed and not initiated until the autumn of 2016. In April 2017, PLAP received funding until 2021 via the Pesticide Strategy 2017-2021 set by the Danish Government, and this funding was recently prolonged via the Pesticide Strategy 2022-2026.

The work was conducted by the Geological Survey of Denmark and Greenland (GEUS), the Department of Agroecology (AGRO) at Aarhus University, and the Department of Ecoscience (ECOS) at Aarhus University, under the direction of a project management group comprising Nora Badawi (GEUS), Kirsten Kørup (AGRO), Sachin Karan (GEUS), Eline B. Haarder (GEUS), Steen Marcher (Danish EPA) and Signe Bonde Rasmussen (Danish EPA).

Maria Sommer Holtze (Danish EPA) chairs the steering group, including the members René Gislum (AGRO), Claus Kjøller (GEUS), and the project leader Nora Badawi (GEUS). Kirsten Kørup (AGRO) and Steen Marcher (Danish EPA) are substitutes, and Sachin Karan is the secretary.

This report presents the results for the period May 1999–June 2023 with a focus on the leaching risk of pesticides applied during the monitoring period July 2021-June 2023. During this period, several pesticides were monitored, although they were applied in the preceding years. In these cases, the comprehensive monitoring period, starting from the background sampling before application, is also included in the evaluations presented in Chapter 5. This present report covers two years monitoring overlapping one year with the previous report (Badawi et al. 2023b).

Starting from October 1, 2022, all pesticide monitoring at the new field in Lund was temporarily put on standby due to uncertainties regarding the water balance and potential hydraulic connectivity issues in the monitoring wells. The bromide tracer experiment, initially done in 2017 when the field was established, appears to have been erroneous. Consequently, a new bromide tracer experiment was initiated in January 2023 and will be assessed in the upcoming years.

All reports covering results from previous years and links to associated peer-reviewed articles are available at www.plap.dk.

The report was prepared jointly by Nora Badawi (GEUS), Sachin Karan (GEUS), Eline B. Haarder (GEUS), and Kirsten Kørup (AGRO) with contributions from Lasse Gudmundsson (GEUS), Lars A. Olsen (GEUS), Carl H. Hansen (GEUS), Finn Plauborg (AGRO), and Carsten B. Nielsen (ECOS).

Dansk sammendrag: Der er udarbejdet et dansk sammendrag med fokus på perioden Juli 2021 til og med juni 2023 med ISBN (print) 978-87-7871-601-9 og ISBN (online) 978-87-7871-600-2.

Nora Badawi

May 2024

Summary

In 1998, the Danish Parliament initiated the Pesticide Leaching Assessment Programme (PLAP), an intensive monitoring programme aimed at evaluating the leaching risk of pesticides and/or their degradation products under field conditions. The objective of PLAP is to improve the scientific foundation for decision-making in the Danish regulation of pesticides by enabling field studies to be included in the risk assessment of selected pesticides. The specific aim is to evaluate whether approved pesticides applied in accordance with current regulations and maximum permitted dosages according to crop and BBCH stages, under actual, Danish field conditions can result in leaching of the pesticides and/or their degradation products to the groundwater in concentrations exceeding the limit value of 0.1 µg/L for groundwater and drinking water.

This report focuses on results from the period July 2021 – June 2023. During this period, 17 different products containing a total of 14 different active ingredients were applied to the PLAP fields as part of the agricultural management. Only selected active ingredients from these products were chosen for testing, and therefore some of the active ingredients applied are not included in the monitoring or evaluated in this report.

The current report presents the results of tests carried out on four different agriculture fields, of which one is sandy (Jyndevad) and the other three consist mainly of clay till (Silstrup, Estrup, Faardrup). It is noted that several active ingredients were applied to the fields before July 1, 2021, for which either the active ingredient, degradation product/s, or both were included in the monitoring. In the evaluation of the individual test of specific compounds, we have therefore included the results of chemical analyses carried out before July 2021 in cases where this was needed. A summary of the results is given in Table 0.1 for all samples included in the monitoring and evaluations in the present reporting period (July 2021 to June 2023). The report represents either preliminary or final results of the testing of 16 active ingredients (for simplicity hereafter referred to as pesticides), of which two pesticides and a total of 17 degradation products were included in the monitoring. The pesticides were applied to the PLAP fields by spraying 14 different commercial products. In some cases, the commercial products contained one or more pesticides, and in other cases, the same pesticide was applied to the fields using different commercial products.

Please refer to Table 7.1 and Table 7.2 for a historical perspective of the entire monitoring in PLAP from 1999–2023, which has so far included tests of 70 pesticides (active ingredients), from which analyses of either the pesticide itself or one or more of its degradation products have been included in the monitoring. In total, 53 pesticides and 105 degradation products (158 in total) have been included in the monitoring. Detailed information and results of previous tests can be found in previous PLAP reports (e.g. Badawi et al. 2023b and other reports available at www.plap.dk).

Starting from October 1, 2022, all pesticide monitoring at Lund was put on standby due to uncertainty of the hydraulic connectivity in the monitoring wells and the percolating water from the field. Pesticide tests that were active at Lund at that time, will not undergo evaluation and previous evaluated tests should not be used in pesticide assessments, as the uncertainty in hydraulic connectivity can affect the outcome of the tests (the lack of detections can be a consequence of lacking hydraulic connectivity). The bromide tracer experiment, initially done in 2017 when the field was established, appears to have been erroneous. Consequently, a new bromide tracer experiment was initiated in January 2023 and will be assessed in the upcoming years.

Table 0.1. Summary for compounds included in the current report. Two pesticides and 17 degradation products (19 analytes) were either in test or have been included in the monitoring during July 2021 to June 2023. Refer to Badawi et al (2023b) for compounds, where the test was finalized in the period July 2021-June 2022. 16 compounds not previously evaluated in PLAP are marked in red. VZ is variably saturated zone (drains and suction cups), SZ is saturated zone (vertical and horizontal groundwater screens), and irrigation is number of analysed irrigation water samples. Concentrations in irrigation water are presented in brackets in units of µg/L. Det. is detections > 0.01 µg/L and Max conc. is maximum concentration. Background samples collected before application of the pesticides are not included in the counting.

Pesticide	**Analyte**	**Number of samples**			**Results of analysis**					
					Variably saturated zone			**Saturated zone (groundwater)**		
		VZ	**SZ**	**Irrigation**	**Det.**	**> 0.1 µg/L.**	**Max conc.** µg/L	**Det.**	**> 0.1 µg/L.**	**Max conc.** µg/L
Acetamiprid **	IM-1-4	54	207	6 (-)	0	-	-	0	-	-
	IM-1-5	54	207	6 (-)	0	-	-	0	-	-
Azoxystrobin **	CyPM	65	227		52	9	0.21	51	3	0.23
Cyazofamid **	CCIM	62	262	-	0	-	-	0	-	-
	CTCA	62	262	-	0	-	-	0	-	-
	N,N,-DMS	72	311	9 (0.027)	46	13	0.39	178	81	0.44
	DMSA	72	311	1 (0.02)	11	6	2.1	133	71	1.17
Fluopyram	Fluopyram	129	488	3 (-)	50	9	0.34	36	8	0.28
	Fluopyram-7-hydroxy	86	385	3 (-)	18	1	0.27	15	2	0.12
Lamdba-cyhalothrin*	Compound 1a									
Oxathiapiprolin*	IN-E8S72									
Pendimethalin*	M455H001									
Propyzamide	Propyzamide	36	113		5	2	7	1	0	0.067
Tebuconazole **	1,2,4-triazole **	736	2265	18 (-)	636	271	0.47	1130	89	0.26
Prothioconazole **										
Difenoconazole (SD) **/***										
Epoxiconazole **										
Propiconazole **										
Metconazole **										
Thifensulfuron-methyl ****	IN-B5528 ****	63	180		1	0	0.078	0	-	-
	IN-JZ789	63	180		0	-	-	0	-	-
	IN-L9223	63	180		0	-	-	0	-	-
Tribenuron-methyl ****	IN-B5528 ****	90	406	5 (-)	1	0	0.081	0	-	-
	IN-R9805	90	406	5 (-)	0	-	-	0	-	-
	M2	90	406	5 (-)	0	-	-	0	-	-

** Only background samples available in the current reporting period. Evaluation of test included in next PLAP report. ** Final test results presented in current report *** SD: Seed dressing. Difenoconazole was only applied as seed dressing. **** IN-B5528 is a common degradation product from thifensulfuron-methyl and tribenuron-methyl.*

Highlights for compounds included in the monitoring period July 2021–June 2023

The following sections summarize the results of the pesticide tests presented in Chapter 5.

Acetamiprid

Acetamiprid was tested in a potato crop at Jyndevad in 2020. None of the two degradation products, IM-1-4 and IM-1-5, were detected in water from the suction cups, groundwater, or irrigation water, neither before the acetamiprid application (from April to June 2020) nor in the monitoring period from June 2020 to September 2022, when the monitoring ended. In conclusion, IM-1-4 and IM-1-5 do not give rise to groundwater detections above > 0.1 µg/L during the two-year monitoring period at the sandy field Jyndevad.

Azoxystrobin

Azoxystrobin was tested in Silstrup in winter wheat in May/June 2020 and its degradation product CyPM was included in the monitoring. The occurrence of the overall maximum CyPM concentration in the groundwater monitoring wells was in October 2020, corresponding to 5 months after the first azoxystrobin application. Exceedance of 0.1 µg/L in three wells was also observed in October 2020 after which no detections of CyPM in concentrations > 0.1 µg/L occurred in the groundwater. A similar pattern was observed in the maximum drainage concentration coinciding with the occurrence of maximum concentrations observed in the groundwater wells. Hence, the overall leaching pattern of CyPM was similar in drainage and groundwater samples, with relatively high concentrations found 5 months after azoxystrobin application and following the first major drainage event. The subsequent slow decrease in concentration seen in drainage samples, however, did not correspond to the pattern seen in groundwater samples, as the concentrations here declined rapidly and continue to be far below 0.1 µg/L for the rest of the monitoring period. This indicated that CyPM, although detectable in the drainage throughout the monitoring period, did not leach into the groundwater to a great extent, perhaps due to further degradation. A total of 292 samples were collected in drainage and groundwater during the azoxystrobin test at Silstrup from May 2020 to February 2023 when the test ended. CyPM was detected in 103 of these and in 12 samples in concentrations > 0.1 µg/L. The CyPM detections > 0.1 µg/L were found in nine drainage samples out of 65 drainage samples and in three out of 227 groundwater samples.

Azoles

In line with previously published PLAP monitoring reports (e.g., Badawi et al. 2023b), 1,2,4-triazole continued to be detected at all monitored PLAP fields. Likewise, the current and final evaluation confirmed that the concentration in which 1,2,4-triazole was detected in groundwater varied considerably among the monitored fields. For instance, groundwater concentrations continuously exceeding 0.1 µg/L were observed at Estrup for relatively long periods at a time (around six months); in Silstrup merely on two occasions; and in Faardrup, no detections above 0.1 µg/L were made. Still, there were some generally consistent patterns of the 1,2,4-triazole leaching across the clay till fields: High concentrations in the variably saturated zone (drainage) were followed by relatively high detections in the groundwater monitoring wells and vice versa. This contrasted with the sandy field, where detected concentration levels decreased over time in the variably saturated zone. The EFSA conclusion on tebuconazole (EFSA, 2014), states that azoles are known to accumulate in the plough layer, and with recent knowledge of azoles also being used in seed dressing (Albers et al., 2022), it is acknowledged that the 1,2,4-triazole detections cannot be directly linked to a specific azole application. Because azoles have been used in the PLAP fields several times since 1999, the presence of accumulated azoles in the PLAP fields is highly likely and may cause the continuous degradation of azoles into 1,2,4-triazole, leading to long-term leaching. 1,2,4-triazole is a common degradation product of azoles, and the specific source of 1,2,4-triazole cannot be determined, especially, when several azoles have been used and possibly accumulated, as is the case in the PLAP fields. This means that the leaching of 1,2,4-triazole from all PLAP fields cannot be coupled to current sprayings and application of azole-dressed sowing seeds or directly related to past applications of azoles. However, the leaching of 1,2,4-triazole can be linked to the historical application of azoles in the fields, as 1,2,4-triazole is detected in water from the variably saturated zone (water from suction cups and drainage).

Cyazofamid

Cyazofamid was applied on Jyndevad in a potato crop from June to September 2020 and four of its degradation products, CCIM, CTCA, DMS, and DMSA, were included in the monitoring. DMS and DMSA were generally detected in concentrations > 0.1 µg/L and over long periods (approximately 6-12 months) in groundwater wells. In these periods, the DMS- and DMSA concentrations exceeded the limit value by a factor of 2-4, while individual measurements exceeded the limit value by up to a factor of 10. Further, there was a consistent pattern of DMSA being detected earlier in groundwater below the field than DMS, and the first breakthroughs of the two degradation products in concentrations > 0.1 µg/L generally occurred approximately one year after the first cyazofamid application. The results showed that the duration (pulse) of detections is longer for DMS than for DMSA, although the maximum detected concentrations of DMSA are higher than for DMS. Results from suction cups at 1 mbgs, representing flow from the field down to the groundwater, supported the results from the groundwater wells. Thus, analyses from 1 mbgs showed that DMS and DMSA leach in concentrations > 0.1 µg/L, that DMS and DMSA were found 2-3 months after the first cyazofamid application, and that the duration of DMSA detections was shorter than for DMS. Both DMS and DMSA are still monitored. The degradation products CCIM and CTCA were not detected in any of the samples collected and these are no longer monitored.

Fluopyram

Fluopyram was tested in three different crops, rapeseed at Faardrup, spring barley at Jyndevad and Silstrup, and winter wheat at Silstrup and Faardrup during the monitoring period May/June 2021 - June 2023. At Silstrup, fluopyram was first detected in a concentration > 0.1 µg/L (0.21 µg/L) in a drainage sample approximately one month after the 2021 application, and the maximum fluopyram concentration (0.34 µg/L) was detected in September 2022, approximately two months after the 2022 application in winter wheat. Fluopyram-7-hydroxy was first detected in a concentration > 0.1 µg/L in a drainage sample (0.27 µg/L) in September 2022, coinciding with the maximum detected concentration of fluopyram. The Silstrup field is recognized for its short transport time from the surface of the field to the drainage, as demonstrated in previous tracer experiments using bromide. These experiments revealed bromide breakthrough in the first drainage event following its application (Badawi et al., 2022). Although fluopyram and fluopyram-7-hydroxy were both frequently detected in drainage at Silstrup, the majority of the detections were in concentrations below < 0.1 µg/L.

Fluopyram and fluopyram-7-hydroxy were both detected in the groundwater at the Silstrup field and both in concentrations exceeding 0.1 µg/L. The maximum concentration of fluopyram (0.28 µg/L) was detected in January 2023, approximately six months after the split application of fluopyram in winter wheat in May/June 2022. The maximum detected fluopyram-7-hydroxy concentration (0.12 µg/L) in groundwater was detected in October 2022. Except for one detection of fluopyram in a concentration < 0.1 µg/L in May 2023, no fluopyram or fluopyram-7-hydroxy were detected in May and June 2023 when the reporting period ended. Neither fluopyram nor fluopyram-7-hydroxy were detected in samples collected upstream of the field.

Fluopyram and fluopyram-7-hydroxy were neither detected in groundwater samples from Jyndevad and Faardrup, nor in water from the variably saturated zone (suction cups) at Jyndevad. At Faardrup, fluopyram and fluopyram-7-hydroxy were detected in the drainage, and only fluopyram once in a concentration > 0.1 µg/L (0.14 µg/L). This detection was the first time fluopyram was detected in drainage at Faardrup and it was in January 2023.

Monitoring of fluopyram and fluopyram-7-hydroxy is ongoing at all three fields.

Lambda-cyhalothrin

Lambda cyhalothrin was tested in potatoes at Jyndevad and applied on July 28 and August 25, 2023. The degradation product, compound Ia, from lambda cyhalothrin was selected for monitoring at Jyndevad starting in February 2023. Compound Ia was not detected in any background samples or irrigation water samples collected before the application. As the lambda cyhalothrin application dates are not within the present reporting period July 2021 to June 2023, no compound Ia monitoring results are available but will be included in the coming report covering the period July 2022 to June 2024.

Oxathiapiprolin

Oxathiapiprolin was tested in potatoes at Jyndevad and applied on July 8 and 18, 2023. The degradation product, IN-E8S72, from oxathiapiprolin, was selected for monitoring at Jyndevad starting in February 2023. IN-E8S72 was not detected in any background samples or irrigation water samples collected before the application. As the oxathiapiprolin application dates are not within the present reporting period July 2021 to June 2023, no IN-E8S72 monitoring results are available but will be included in the coming report covering the period July 2022 to June 2024.

Pendimethalin

Pendimethalin was tested in PLAP in connection with sowing of winter rapeseed at Silstrup and Estrup and it was applied on August 17, 2023 at both Silstrup and Estrup. The degradation product, M455H001, from pendimethalin, was selected for monitoring at both fields starting in May 2023. M455H001 was not detected in any background samples collected before the application dates. As the pendimethalin application dates are not within the present reporting period July 2021 to June 2023, no M455H001 monitoring results are available but will be included in the coming report covering the period July 2022 to June 2024.

Propyzamide

Propyzamide was tested in winter rapeseed at Faardrup and the test was initiated in October 2020. Propyzamide was twice detected in drainage in concentrations > 0.1 µg/L and the first detection occurred during the first drainage event after the propyzamide application. This was three months after application and propyzamide was detected in a concentration of 7.0 µg/L.

Propyzamide was detected once in groundwater from Faardrup in a concentration < 0.1 µg/L. The leaching of propyzamide to groundwater was generally observed to occur at the first drainage event after application at the clay till fields. This was evident from e.g., detections of propyzamide in groundwater coinciding with detections in drainage both at Faardrup and Silstrup (Badawi et al., 2023b). From previous bromide tracer tests, travel times from the surface to the groundwater seem to be somewhat longer at Faardrup compared to Silstrup (Badawi et al., 2022). Nevertheless, since no further detections of propyzamide in groundwater occurred after the one detection coinciding with the first drainage event after the propyzamide application, the monitoring ended in November 2022.

Thifensulfuron-methyl

During 2021-2023, thifensulfuron-methyl was tested in two different crops, spring barley, and perennial ryegrass at Estrup. Three thifensulfuron-methyl degradation products not previously tested in PLAP, IN-B5528, IN-JZ789, and IN-L9223 were included in the monitoring. None of the degradation products are detected in groundwater, neither in the period before the thifensulfuron-methyl application (April-June 2021) nor in the monitoring period from June 1, 2021 to June 30, 2023. IN-B5528 was detected once in a drainage sample in a concentration < 0.1 µg/L after the thifensulfuron-methyl application, whereas IN-JZ789, and IN-L9223 were not detected. In conclusion, IN-B5528, IN-JZ789, and IN-L9223 do not give rise to groundwater detections above the limit value during the present monitoring period. However, the monitoring is ongoing, and a final evaluation will be presented when the monitoring is finalized minimum two years after the 2022 application. It is noted that IN-B5528 is also a degradation product from tribenuron-methyl.

Tribenuron-methyl

In 2022, Tribenuron-methyl was tested in two different crops, spring barley at Jyndevad, and winter wheat at Silstrup and Faardrup. Three tribenuron-methyl degradation products not previously tested in PLAP, IN-B5528, IN-R9805, and M2 were included in the monitoring. Except for one detection of IN-B5528 in a concentration < 0.1 µg/L in a drainage sample from Faardrup in April 2023, none of the three degradation products were detected in water from the suction cups, drainage, groundwater, or irrigation water, neither in the period before the tribenuron-methyl application (April 2022) nor in the monitoring period from April 2022 to June 30, 2023. In conclusion, IN-B5528, IN-R9805, and M2 do not give rise to groundwater detections above the limit value during the present monitoring period. However, the monitoring is ongoing at the three fields Jyndevad, Silstrup, and Faardrup, and a final evaluation will be presented when the monitoring is finalized, minimum two years after the last application. It is noted that IN-B5528 is also a degradation product from thifensulfuron-methyl.

1. Introduction

In Denmark, the majority of drinking water is based on groundwater that undergoes a simple treatment, where the water is aerated and passed through a filter of sand. As Denmark is intensively cultivated, there is public concern about pesticides and their degradation products being increasingly detected in groundwater during the past decades. Since 1989, this concern was the basis for initiating monitoring programmes reporting on the quality of the Danish groundwater (the Danish National Groundwater Monitoring Programme; GRUMO; Thorling et al., 2023) and the effect of agricultural practices (the Pesticide Leaching Assessment Programme, PLAP). The reported results have been and are still continuously addressed in the regulation of pesticides.

The detection of pesticides in groundwater since the 1980s has demonstrated the need for further enhancement of the scientific foundation for the existing approval procedure for pesticides and to improve the present leaching risk assessment tools. The main issue in this respect is that the EU groundwater risk assessment, and hence also the Danish assessment of the risk of pesticides and/or their degradation products leaching to groundwater, is largely based on modelling studies and, if available, lysimeter studies (Gimsing et al., 2019). However, those types of data may not adequately describe the leaching which may occur under actual field conditions. Although models are widely used within the registration process, their validation requires further work (Gassmann, 2021). The FOCUS models (FOrum for Co-ordination of pesticide fate models and their Use) applied in the EU process are one-dimensional and at the lowest tier, use climate standards from 1960-1990, apply constant groundwater table at 2 m depth, and have limited inclusion of preferential solute transport added with issues regarding parameter and input estimation caused by the lack of field data (Boesten, 2000; Rosenbom et al., 2015). Moreover, laboratory and lysimeter studies only to a minor degree include the spatial variability of the soil parameters (hydraulic, chemical, physical, and microbiological soil properties) affecting the pesticide transformation and coherent assessed leaching of the degradation products (Gassmann, 2021). This is of particular importance for silty and clay till soils, where preferential transport may have a major impact on pesticide leaching (Jacobsen and Kjær, 2007; Rosenbom et al., 2015). Various field studies suggest that considerable preferential transport of several pesticides occurs to a depth of 1 m under conditions comparable to those present in Denmark (Kördel, 1997; Jarvis, 2020).

The inclusion of field studies, i.e., test plots exceeding one hectare, in risk assessment of pesticide leaching to groundwater is considered an important improvement to the assessment procedures. For example, the US Environmental Protection Agency (US EPA) has since 1987 included field-scale studies in its risk assessments (US EPA, 1998). Therefore, pesticides that may potentially leach into the groundwater are required to be included in field studies as part of the registration procedure, and the US EPA conducted field studies with more than 50 pesticides in the period 1987-1998. A similar concept was hereafter adopted by the European Union (EU), where Directive 91/414/EEC, Annex VI (Council Directive 97/57/EC of 22 September 1997) came into force enabling field leaching study results to be included in the risk assessments. This was enforced in 2011 by supplementing Regulation (EC) 1107/2009 with the uniform principles in Regulation 546/2011 (Annex C 2.5.1.2) (European Commission, 2011) allowing simulated groundwater concentrations above the guideline to be discarded if ‘‘it is scientifically demonstrated that under relevant field conditions the lower concentration is not exceeded’’ (Gimsing et al., 2019).

1.1. Objective

In 1998, the Danish Government initiated the Pesticide Leaching Assessment Programme (PLAP), which is an intensive monitoring programme to evaluate the leaching risk of pesticides under field conditions. The PLAP is intended to serve as an early warning system providing decision-makers with advance warning if otherwise approved pesticides or their selected degradation products leach in unacceptable concentrations. The programme, which currently includes four active agricultural fields and two fields on stand-by, focuses on pesticides used in arable farming and monitors leaching through the agricultural fields (Figure 1.1). All six fields are selected to represent typical Danish geological settings and climatic conditions. Except for one (Lund), all the fields were included in the monitoring since 1999. To increase the representability, the field at Lund (clay till overlaying chalk), was included in May 2017 based on a one-time special grant from the Danish EPA. Subsequently, at the end of 2018, monitoring at Lund was continued. Presently Lund is in technical stand-by as the bromide tracer test from 2017 seemed to have been erroneous and had to be repeated to elucidate the water balance in the field. A new bromide test was started in January 2023 and no pesticide monitoring will be done while this test is running and evaluated. The sandy field (Tylstrup) was put on stand-by, because of the termination of the special grant.

The objective of PLAP is to improve the scientific foundation for decision-making in the Danish registration and approval procedures for pesticides by enabling field studies to be included in the risk assessment of selected pesticides. The specific aim is to evaluate whether approved pesticides applied in accordance with current regulations and maximum permitted dosages according to crop and BBCH stages, under actual, Danish field conditions can result in leaching of the pesticides and/or their degradation products to the groundwater in concentrations exceeding the limit value of 0.1 µg/L for groundwater and drinking water.

1.2. Structure of PLAP

The pesticides included in PLAP are selected based on expert judgement by the Danish EPA. At present, 53 pesticides and 105 degradation products have been included in PLAP. All compounds (pesticides and degradation products) analysed since 1999 are listed in Appendix 1.

Soil type and climatic conditions are considered some of the most important parameters controlling pesticide leaching (e.g., Flury, 1996). Today, PLAP encompasses six fields that represent dominant soil types and climatic conditions in Denmark (Figure 1.1). The sandy field Tylstrup was set on stand-by at the end of 2018, and consequently, no water samples are collected for analysis from this field. The clay till field Lund was set on technical standby (no pesticide monitoring, but water balance monitoring is ongoing) on October 1, 2022 as there was uncertainty about the hydraulic connectivity in the monitoring wells. To elucidate this a new bromide tracer test was started in January 2023.

The groundwater table at the PLAP fields is relatively shallow (generally fluctuating between 1 and 5 meters below ground surface (mbgs)), enabling rapid detection of pesticide leaching to groundwater. Cultivation of the PLAP fields is done in accordance with the conventional agricultural practice in the local area. The pesticides are applied at maximum permitted dosages as specified in the regulations. Thus, any pesticides or degradation products appearing in the groundwater downstream of the fields can, with a few exceptions (e.g., the azoles) be related to the current approval conditions and use of the given pesticide.

Results and data in the present report comprise the five fields: Tylstrup (data only in Chapter 8 and Appendix 3), Jyndevad, Silstrup, Estrup, and Faardrup. Due to the uncertainty about the water balance at Lund, results of the pesticide monitoring at this field cannot be evaluated before the ongoing bromide tracer test is assessed, and thus, they are not included in the report. The location of the fields is shown in Figure 1.2.1 with more detailed characteristics given in Table 1.2.1.

Field characterization and monitoring design are described in detail by Lindhardt et al. (2001) for the five fields Tylstrup, Jyndevad, Silstrup, Estrup, and Faardrup, and in Haarder et al. (2021) for Lund. The focus of the current report is on the leaching risk of pesticides and/or degradation products included in the July 2021-June 2023 monitoring. Chapter 7 gives an overview of results from the entire monitoring period May 1999-June 2023 at all five fields. Detailed descriptions of the earlier monitoring periods from May 1999 to June 2021 are published in previous reports, available at www.plap.dk. Within PLAP, the leaching risk of pesticides and degradation products is based on approximately two years of monitoring data.

For pesticides applied in April-June 2023, the present reporting must be considered preliminary, as these compounds have only been monitored for a short period. This year, three pesticides (lambda cyhalothrin, oxathiapiprolin and pendimethalin) were used in July and August 2023 but the monitoring prior to the applications (background samples) started during the present monitoring period. The tests for these pesticides are therefore included in Chapter 5 but no monitoring results are presented. Thus, monitoring results for these compounds will be further evaluated in the coming reports.

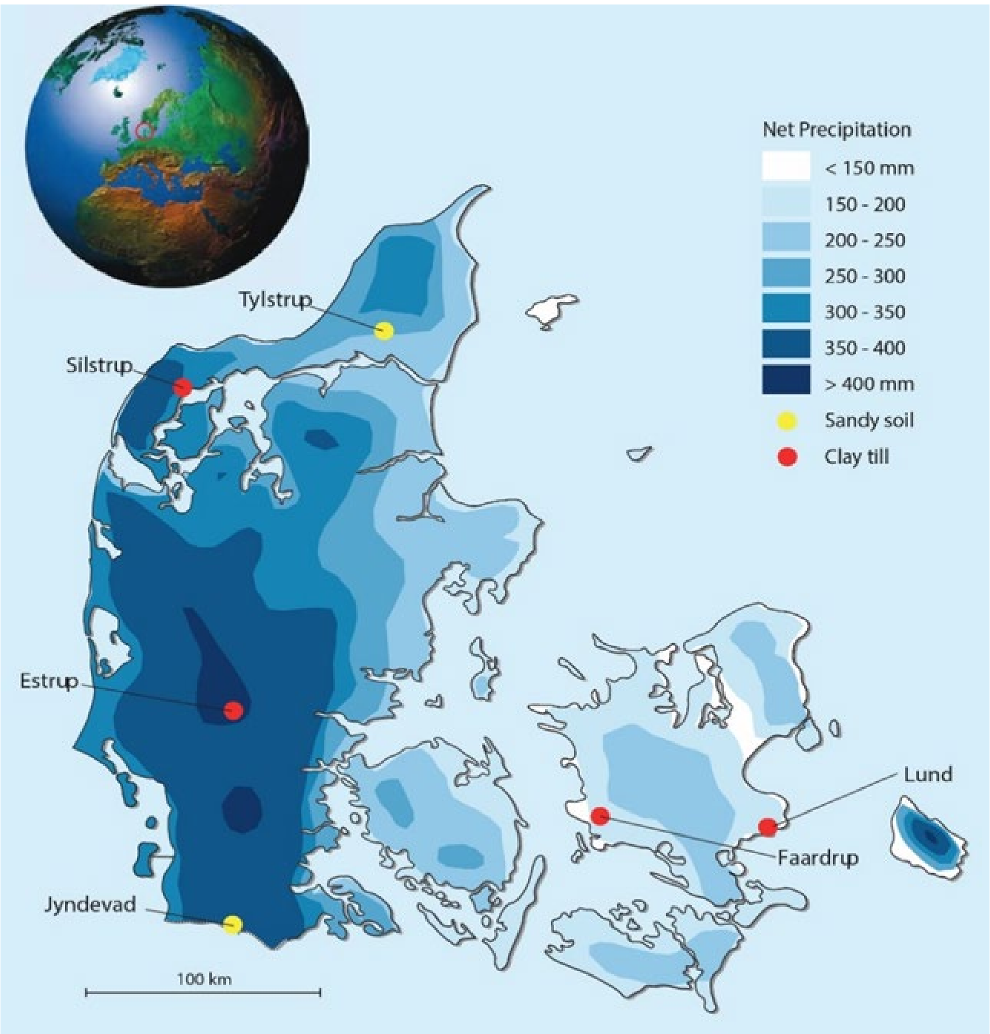

Figure 1.2.1. Annual net precipitation across Denmark (Danish EPA, 1992) and location of the six PLAP fields: Tylstrup (sandy, on standby), Jyndevad (sandy), Silstrup (clay till), Estrup (clay till), Faardrup (clay till), and Lund (clay till, on technical stand-by).

To support the pesticide analysis results, hydrological modelling of the variably saturated zone was conducted with MACRO (version 5.2, Larsbo et al., 2005) to describe and evaluate the soil water dynamics of the six PLAP fields. Models for the five fields Tylstrup, Jyndevad, Silstrup, Estrup, and Faardrup were calibrated for the monitoring period May 1999–June 2004 and applied for the monitoring period May 1999–June 2023.

Table 1.2.1. Characteristics of the six PLAP fields included in the PLAP-monitoring for the period 1999-2023 (modified from Lindhardt et al., 2001). Tylstrup was set on standby by the end of December 2018 and Lund was set on technical standby October 1, 2022.

	Tylstrup *on stand-by*	**Jyndevad**	**Silstrup**	**Estrup**	**Faardrup**	**Lund**
Location	Brønderslev	Tinglev	Thisted	Askov	Slagelse	Rødvig
Precipitation1) (mm/y)	752	995	976	968	626	577[4]
Pot. evapotransp.1) (mm/y)	553	554	564	543	586	568[4]
Width (m) x Length (m)	70 x 166	135 x 180	91 x 185	105 x 120	150 x 160	100 x 300
Area (ha)	1.2	2.4	1.7	1.3	2.3	2.8
Tile drain	No	No	Yes	Yes	Yes	Yes
Depths to tile drain (m)			1.1	1.1	1.2	1.1
Monitoring initiated	May 1999	Sep 1999	Apr 2000	Apr 2000	Sep 1999	July 2017
Geological characteristics						
– Deposited by	Saltwater	Meltwater	Glacier	Glacier /meltwater	Glacier	Glacier
– Sediment type	Fine sand	Coarse sand	Clayey till	Clayey till	Clayey till	Clayey till
– DGU symbol	YS	TS	ML	ML	ML	ML
– Depth to the calcareous matrix (m)	6	5–9	1.3	1–42)	1.5	1.5
– Depth to the reduced matrix (m)	>12	10–12	5	>52)	4.2	3.8
– Max. fracture depth3) (m)	–	–	4	>6.5	8	>6
– Fracture intensity 3–4 m depth (fractures m^{-1})	–	–	<1	11	4	<1
– Saturated hydraulic conductivity (Ks) in C horizon (m/s)	$2.0\cdot10^{-5}$	$1.3\cdot10^{-4}$	$3.4\cdot10^{-6}$	$8.0\cdot10^{-8}$	$7.2\cdot10^{-6}$	$5.8\cdot10^{-6}$
Characteristics of the plough layer						
– DK classification	JB2	JB1	JB7	JB5/6	JB5/6	JB5/6
– Classification	Loamy Sand	Sand	Sandy clay loam / sandy loam	Sandy loam	Sandy loam	Sandy loam
– Clay content (%)	6	5	18–26	10–20	14–15	10-25
– Silt content (%)	13	4	27	20–27	25	30-35
– Sand content (%)	78	88	8	50–65	57	30-50
– pH	4–4.5	5.6–6.2	6.7–7	6.5–7.8	6.4–6.6	7.4-9.1
– Total organic carbon (TOC, %)	2.0	1.8	2.2	1.7–7.3	1.4	0-1.3

1) Normal values based on time series for 1961–1990. Precipitation values are corrected to the soil surface (Olesen, 1991). 2) Large variation within the field. 3) Maximum fracture depth refers to the maximum fracture depth found in excavations and wells. 4) Normal values based on time series for 1961–1990. Precipitation values are corrected to the soil surface (Scharling, 2000).

All six fields are fertilized in accordance with agricultural practices and water samples from 1 mbgs collected within the monitoring period are additionally analysed for nitrate. All fields, except Lund, were subjected to at least three bromide applications, and bromide analyses were included in the inorganic analyses. The bromide measurements are used to obtain knowledge about flow and transport pathways in the subsurface beneath the fields and support the hydrological modelling. As mentioned earlier, a second bromide application in Lund was started in January 2023 and is ongoing.

Scientifically valid analytical methods are essential to ensure the integrity of PLAP, and thus all chemical analyses of pesticides and degradation products are conducted by an accredited commercial laboratory. The field monitoring work is additionally supported by quality assurance entailing continuous evaluation of the analytical methods employed. Here, it is noted that several compounds that should have been introduced in the analytical programme in May 2018, April 2019, and April 2020 were not introduced as planned. This was due to a delay in internal procedures regarding the selection of compounds for the monitoring programme in these periods, and thus delays in both the procurement of the analytical standards and consequently analytical method development. This problem is now solved, and all analytical methods used for the monitoring related to the tests included in this present report were ready when the monitoring started with background sampling before the pesticide applications. The quality assurance methodology and results are presented in Chapter 6 and Appendix 6.

In the previous report (Badawi et al., 2022), data from all bromide applications in the fields were revisited and analysed for the first time in conjunction. The analyses aimed to gain further knowledge of transport times and improve the fundamental understanding of hydrogeology in the fields. In the present report, the bromide evaluations from the previous report are included for convenience in Appendix 7.

2. Monitoring design, sampling programme and field descriptions

Monitoring design

The six PLAP fields (four active and two on technical stand-by) have an overall similar design (Figure 2.1.1. 2.2.1, 2.3.1, and 2.4.1), which is described in more detail in the establishing report for the PLAP system (Lindhardt et al., 2001). Each field consists of a cultivated area surrounded by an uncultivated buffer zone with grass cover. Groundwater samples are collected from vertical and horizontal monitoring wells, whereas water samples from the variably saturated zone 1 mbgs are collected through suction cups installed at the edge of the cultivated area. At the tile-drained clayey fields, water samples are collected from the drainage system, which is placed at a depth of approximately 1 mbgs, thus, also representing the variably saturated zone. The drainage system underneath the PLAP field has been disconnected from the drainage pipes of the surrounding fields, such that only drainage water stemming from the PLAP field itself is collected at the drainage outlet. The piezometer wells (marked "P") are generally placed along the outer border of the field in the buffer zone and are used for assessing the general flow direction underneath the field through measurements (both manually and automated) of the level of the groundwater table. Online access to the current as well as historical groundwater levels for each PLAP field is possible through the web interface at www.grundvandsstanden.dk.

Monitoring wells (marked "M"), from which water samples are obtained, are placed in accordance with the general groundwater flow direction such that several monitoring wells are placed in the buffer zone downstream of the field. Similarly, at least one well is located upstream of the field, i.e., upstream of the general groundwater flow direction. Hence, the upstream well is assumed to not represent water from the monitoring field and thus not be influenced by compound application on the PLAP field. Naming of screens in the monitoring wells follows these principles: The upper-most screen "Mx.1" is commonly placed at a depth of around 2 mbgs, and the following screens "Mx.2", "Mx.3" and "Mx.4" are commonly placed at depth of around 3 m, 4 m, and 5 m, respectively. Horizontal monitoring wells are installed on the four active PLAP fields. These wells consist of three horizontal screens from which water can be sampled. The horizontal wells installed in 2008 at the clay till fields (H1 and H2 at Silstrup and Faardrup, and H1 at Estrup) are placed at a depth of 3.5 mbgs, whereas the newer horizontal wells installed in 2011 are located at 2.5 mbgs (H1 at Jyndevad) and 2 mbgs (H3 at Silstrup and Faardrup, and H2 at Estrup). In the tile-drained fields, it was attempted to position the horizontal wells such that one of the three well screen segments was placed directly underneath a portion of the tile-drain. The installation of horizontal wells is detailed in e.g. Appendix 8 of the previous report, which can be found on www.plap.dk.

Each PLAP field is further equipped with sensors for measuring soil moisture content and soil temperature to a depth of 2.1 m. Precipitation is measured by precipitation gauges installed at the fields, while other climate data such as air temperature, barometric pressure, global radiation, and wind speed for each PLAP field are collected locally, but not directly at the field.

Sampling programme

Since the initiation of PLAP in 1999, different wells and screens were sampled during different periods. In the early years, many water samples were taken at each sampling campaign, but due to later budget reductions, it was decided to sample only the two uppermost well screens below the groundwater table in the vertical monitoring wells with the notion to sample the shallow groundwater. Additionally, only approximately three3 monitoring wells at each field were sampled monthly, with another 2-3 wells sampled half-yearly. Samples from the horizontal wells and suction cups at 1 mbgs were collected monthly. At the beginning of 2023, a new sampling procedure was put in effect for all active PLAP fields. In the new sampling programme, focus is on achieving coherent data series with results from the same screens. However, due to budget constraints this means that it is not possible to sample as many wells as previously, and therefore only three monitoring wells at each field is sampled every month. One of these monitoring wells is the upstream well, from which we collect a shallow sample, preferably from screen Mx.2, and a deep sample from screen Mx.4. From the two downstream monitoring wells, samples are collected from all screens (Mx.1-4), when possible.

At the end of September 2022, it was decided to sample additional monitoring wells at the PLAP fields, to decide which wells should remain part of the monitoring and which should not be sampled when starting the new sampling programme January 2023.

It should be noted that it is not always possible to collect all planned samples. This occurs, when the groundwater table is below the depth of e.g. the horizontal screens, and drainage samples can also only be obtained, when there is active flow in the drainage system. Appendix 2 describes the current and previous sampling procedures in more detail.

2.1. Jyndevad

Jyndevad is located in southern Jutland (Figure 1.2.1). The field covers a cultivated area of 2.4 ha (135 x 180 m) and is practically flat. A windbreak borders the eastern side of the field, which is otherwise surrounded by conventionally cultivated agricultural fields. The area has a shallow groundwater table ranging from 1 to 3 mbgs (Figure 4.1.1B). The overall direction of groundwater flow is towards the northwest (Figure 2.1.1). The soil is classified as Arenic Eutrudept and Humic Psammentic Dystrudept (Soil Survey Staff, 1999) with coarse sand as the dominant texture class and topsoil containing 5% clay and 1.8% total organic carbon (Table 1.2.1). The geological description points to Jyndevad being located on a sandy meltwater plain, with local occurrences of thin clay and silt beds.

The water sampling plan has been altered several times since the beginning of PLAP. During the current monitoring period and until January 1, 2023, water sampling for pesticide analysis at Jyndevad was done monthly from suction cups at 1 m depth at S1 and S2 and wells M1, M4, M7, and H1. Additional samples from wells M2 were collected four times per year, and additional samples from M5 were collected two times per year. In this sampling programme only the two upper-most water filled screens in vertical monitoring wells were sampled. Thus, a total of nine samples were collected eight times per year, 11 samples collected two times per year and 13 samples collected two times per year. For several months during the summer and fall it was not possible to obtain water samples from the horizontal well H1 as the groundwater table was below screen depth.

During the sampling in October, November and December 2023 samples were also collected from M3 and M6, as well as additional samples from M1, M2, M4, M5, and M7 covering sampling from all water filled screens.

From January 1, 2023, monthly samples were collected from 1 m depth at S1 and S2, all water filled screens in M2 and M4 (potentially four samples from each well), and from two screens of M7. In total 12 samples every month.

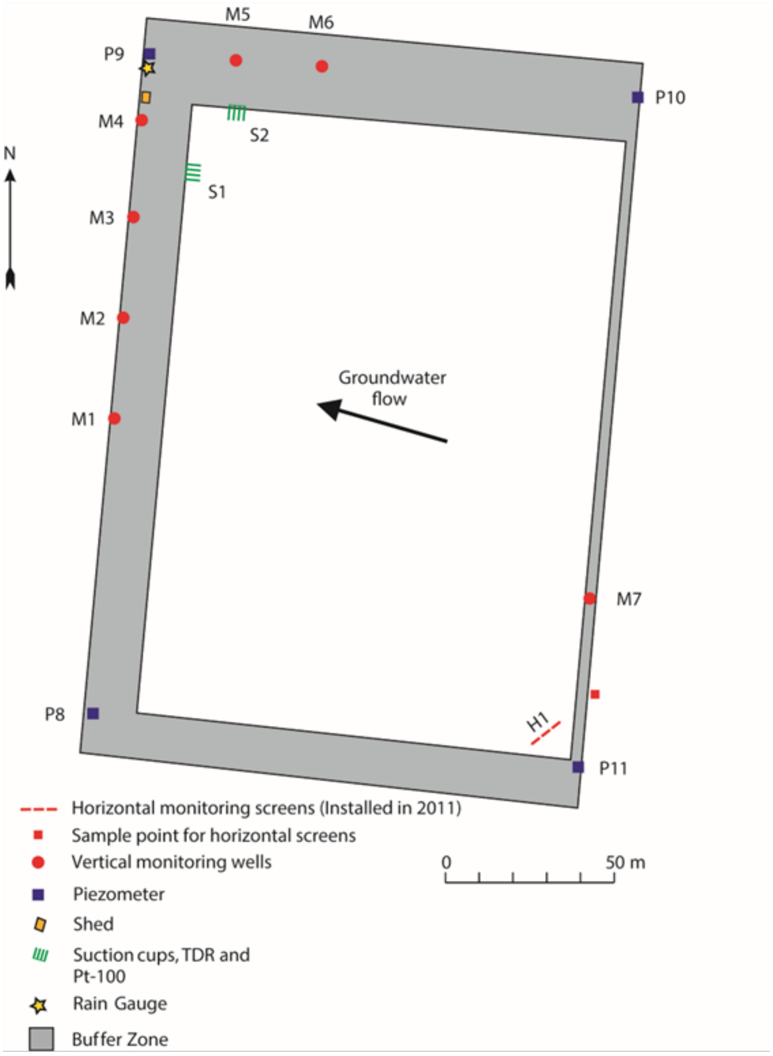

Figure 2.1.1. Overview of the Jyndevad field. The innermost white area indicates the cultivated area surrounded by the buffer zone (in grey). At S1 and S2, water content (via TDR) and soil temperature (via Pt100) is measured at four different depths. Additionally, suction cups are installed to collect pore water from the variably saturated matrix for analysis of pH-independent compounds. Water samples for pesticide monitoring can be collected from screens at the suction cups at S1 and S2, vertical monitoring wells (M1-M7) and from the horizontal monitoring well H1. See text and Appendix 2 for details on the specific sampling programme.

2.2. Silstrup

The test field at Silstrup is located south of the city Thisted in northwestern Jutland (Figure 1.2.1). The cultivated area is 1.7 ha (91 x 185 m) and slopes gently 1–2° to the north (Figure 2.2.1). Based on two profiles excavated in the buffer zone bordering the field, the soil was classified as Alfic Argiudoll and Typic Hapludoll (Soil Survey Staff, 1999). The clay content in the topsoil was 18% and 26%, and the organic carbon content was 3.4% and 2.8%, respectively (Table 1.2.1). The geological description showed a rather homogeneous clay till rich in chalk and chert, containing 20–35% clay, 20–40% silt, and 20–40% sand. In some intervals the till was sandier, containing only 12–14% clay. Moreover, thin lenses of silt and sand were detected in some of the wells. The gravel content was approximately 5% but could be as high as 20%.

The water sampling plan has been revised several times since the beginning of PLAP. During the current monitoring period and until January 1, 2023, water sampling at Silstrup was done monthly from wells M5, M9, H1.2, and H3; with additional samples collected two times per year from wells M10 and M12 (the upstream well). In this sampling programme only the two upper-most water filled screens in the vertical monitoring wells were generally sampled. At M9, however, only one sample was collected. Thus, a total of five samples were collected ten times per year, and 10 samples were collected two times per year.

During the last three sampling events in 2022 (September, October, November) samples were also collected from M11 and M6, as well as additional samples from M5, M9, M10 and M12 covering sampling from all water filled screens.

From January 2023, monthly samples were collected from all water-filled screens at M5, M9 (potentially four samples from each well), in two screens in M12, and from H1, in total 11 samples per month. Additionally, water from the drainage system at Silstrup is collected every week when active drainage takes place.

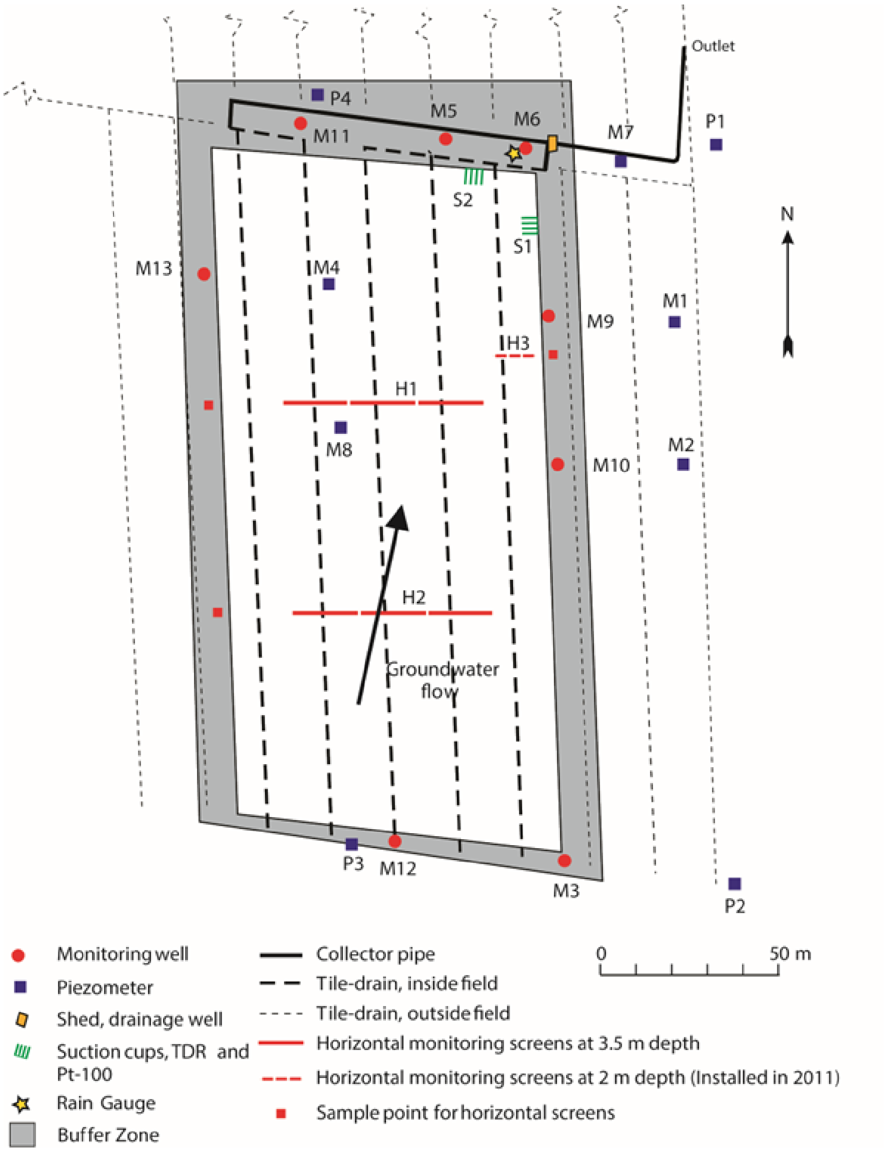

Figure 2.2.1. Overview of the Silstrup field. The innermost white area indicates the cultivated area surrounded by the buffer zone (grey). Samples are collected weekly from the tile drain system via a drainage well (during periods of continuous drainage), and monthly from selected vertical (M5-12) and horizontal monitoring screens (H1-H3). See text and Appendix 2 for details on the specific sampling programme. At S1 and S2, water content (via TDR) and soil temperature (via Pt100) is measured at four different depths. Additionally, suction cups are installed to collect pore water from the variably saturated matrix for analysis of inorganic analytes.

2.3. Estrup

Estrup is located in central Jutland (Figure 1.2.1) west of the Main Stationary Line on a hill-island, i.e. a glacial till preserved from the Saalian Glaciation. Estrup has thus been exposed to weathering, erosion, leaching, and other geomorphological processes for a much longer period than the other fields (approximately 140,000 years). The test field covers a cultivated area of 1.3 ha (105 x 120 m) and is nearly flat (Figure 2.3.1). The field is highly heterogeneous with considerable variation in both topsoil and aquifer characteristics (Lindhardt et al., 2001), which is quite common for this geological formation. Based on three profiles excavated in the buffer zone bordering the field the soil was classified as Abrupt Argiudoll, Aqua Argiudoll, and Fragiaquic Glossudalf (Soil Survey Staff, 1999). The topsoil is characterised as sandy loam with a clay content of 10–20% and organic carbon content of 1.7–7.3%. A C-horizon of low permeability also characterises the field. The saturated hydraulic conductivity in the C-horizon is 10-8 m/s, which is about two orders of magnitude lower than at the other clay till fields (Table 1.2.1). The geological structure is complex comprising a clay till core with deposits of different ages and compositions including freshwater peat in the southwestern part of the field (Lindhardt et al., 2001).

In November 2022 a new upstream well, M8, was installed as replacement for the original upstream well M7. The reason for the replacement was that M7 was drilled in an area in the field which contained very localized peat, which was not representative of the subsurface sediments at the Estrup field in general. The new upstream well was installed in the southeastern corner of the field and consists of four individual wells with screens at 1.5-2.5 m, 2.5-3.5 m, 3.5-4.5 m, and 4.5-5.5 m depth, respectively. The geology of M8 consists almost entirely of clayey materials seen as both clay till and meltwater clay. Water level measurements, both manual and automatic, were collected from right after the installation, and samples for pesticide monitoring started January 2023, where all water-filled screens were sampled at each sampling event.

The water sampling plan was revised several times since the beginning of PLAP. During the current monitoring period and until 1 January 2023, water sampling at Estrup was done monthly from wells M4, H1.2, and H2, with additional samples collected three to four times per year from wells M1, M5, and M6. No sampling is done from wells M2, M3, and M7. In this sampling programme only the two upper-most water filled screens in vertical monitoring wells were generally sampled. Thus, a total of four samples were collected ten times per year, and ten samples were collected two times per year.

During the last three sampling events in 2022 (September, October, November) samples were also collected from M3, as well as additional samples from M1, M4, M5, and M6.

From January 2023 monthly samples were collected from all water-filles screens at M3, M4, M8 (potentially four samples from each well) and one sample was collected from H1, in total 13 samples per month. Additionally, water from the drainage system at Estrup is collected every week when active drain flow takes place.

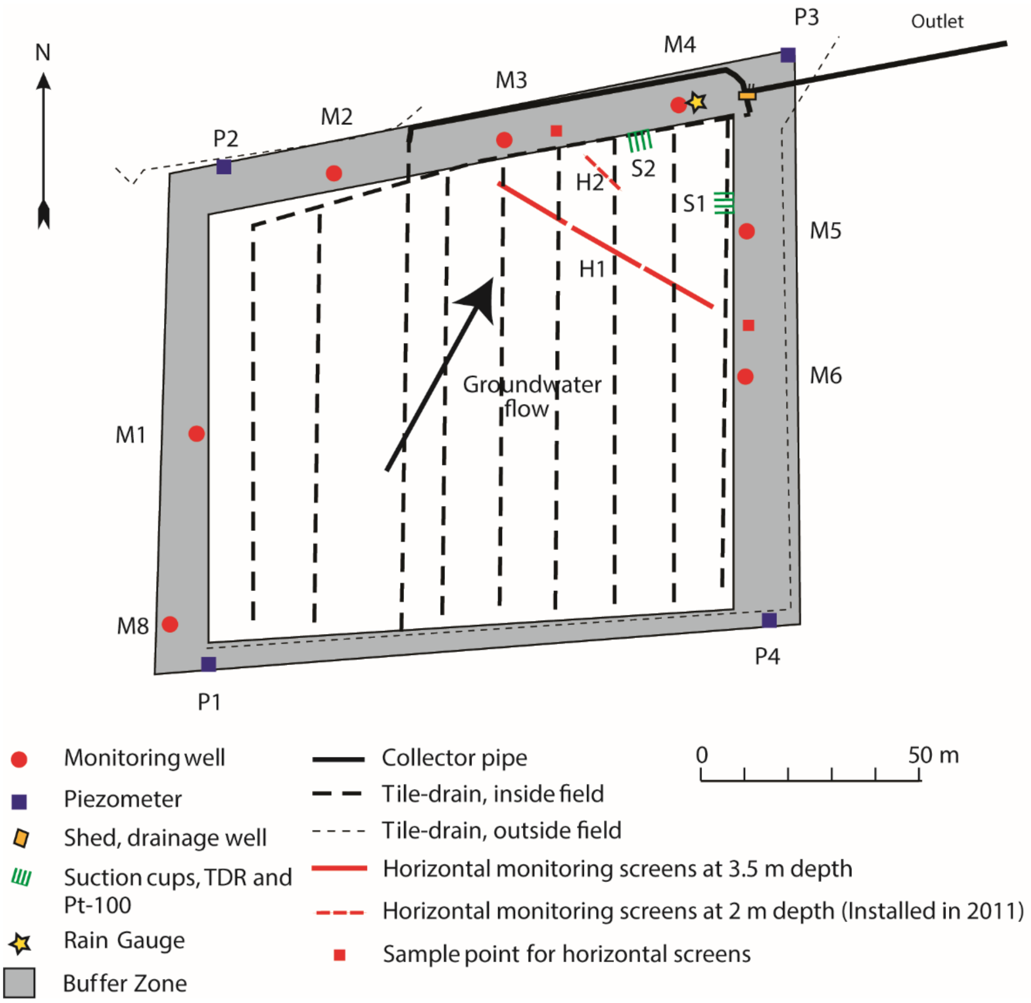

Figure 2.3.1. Overview of the Estrup field. The innermost white area indicates the cultivated area surrounded by the buffer zone (grey). Samples are collected weekly from the tile drain system via a drainage well (during periods of continuous drainage), and monthly from selected vertical (M1-M8) and horizontal (H1-2) monitoring wells. See text and Appendix 2 for details on the specific sampling programme. At S1, water content (via TDR) and soil temperature (via Pt100) are measured at four different depths. Additionally, suction cups are installed at both S1 and S2 to collect pore water from the variably saturated matrix for analysis of inorganic analytes.

2.4. Faardrup

Faardrup is located in southern Zealand (Figure 1.2.1) and the test field covers a cultivated area of 2.3 ha (150 x 160 m, Figure 2.4.1). The terrain slopes gently (1–3° to the west). Based on three soil profiles excavated in the buffer zone bordering the field, the soil was classified as Haplic Vermudoll, Oxyaquic Hapludoll, and Oxyaquic Argiudoll (Soil Survey Staff, 1999). The topsoil is characterised as sandy loam with 14–15 % clay and 1.4 % organic carbon (Table 1.2.1). Within the upper 1.5 m, numerous desiccation cracks coated with clay are present. The test field contains glacial deposits dominated by sandy till to a depth of about 1.5 m overlying a clay till. The geological description shows that small channels or basins filled with meltwater clay and sand occur both interbedded in the till and as a large structure crossing the test field (Lindhardt et al., 2001). The calcareous matrix and the reduced matrix begin at 1.5 m and 4.2 mbgs, respectively.

The dominant direction of groundwater flow is towards the west in the upper part of the aquifer (Figure 2.4.1) and the groundwater table is located 1-3 mbgs. During fieldwork within a 5 m deep test pit dug nearby the field, it was observed that most of the water entering the pit came from an intensely horizontally-fractured zone in the till at a depth of 1.8–2.5 m. The intensely fractured zone could very well be hydraulically connected to the sand fill in the deep channel, which might facilitate parts of the percolation.

The water sampling plan was revised several times since the beginning of PLAP. During the current monitoring period and until January 2023, water sampling at Faardrup was done monthly from wells M4, M5, H2, and H3, and additional samples are collected two times per year from wells M6 and M2. No sampling was done from wells M1, M3, M7, and H1. In this sampling programme only the two upper-most water-filled screens in vertical monitoring wells were generally sampled. Thus, a total of six samples were collected ten times per year, and ten samples were collected two times per year.

During the last three sampling events in 2022 (September, October, November) additional samples were collected from M2, M5 and M6.

From January 2023 monthly samples were collected from all water-filled screens at M4, M5 (potentially four samples from each well), two samples were collected from the upstream well M2, and one sample was collected from the horizontal well H2. Thus, a total of 11 samples could be collected per month. Additionally, water from the drainage system at Faardrup is collected every week when active drain flow takes place.

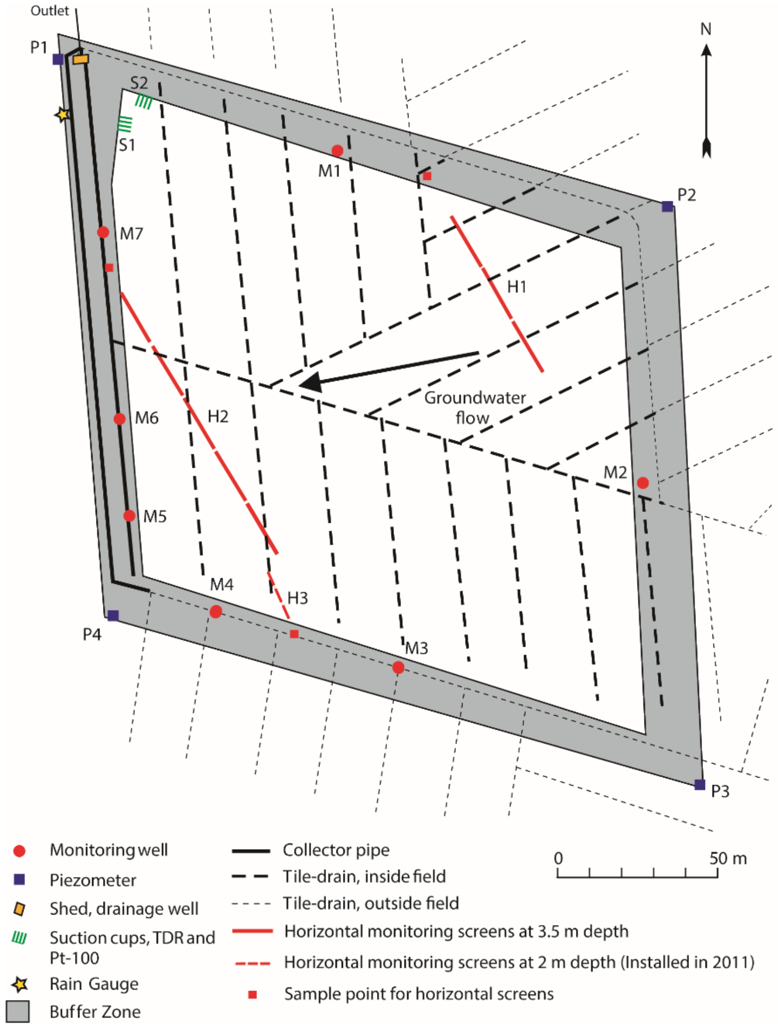

Figure 2.4.1. Overview of the Faardrup field. The innermost white area indicates the cultivated area, while the grey area indicates the surrounding buffer zone. The positions of the various installations are indicated, as is the direction of groundwater flow (arrow). Samples are collected weekly from the tile drain system via a drainage well (during periods of continuous drainage), and monthly from selected vertical and horizontal monitoring wells as described in section 2.4 and Appendix 2. At S1 and S2, water content (via TDR) and soil temperature (via Pt100) is measured at four different depths as at the other PLAP fields. Additionally, suction cups are installed to collect pore water from the variably saturated matrix for analysis of inorganic analytes.

3. Agricultural management

Agricultural management of the four PLAP fields in Jyndevad, Silstrup, Estrup, and Faardrup is described below. The description covers the growing seasons 2020 to 2023 in all fields and in addition the 2019 growing season in Estrup. In this period the monitoring and evaluation of pesticides is covered in the present report. Detailed information concerning pesticide monitoring on these four fields is found in Chapter 5.

The PLAP fields in Tylstrup and Lund were put on standby by the end of 2018 and 2022, respectively. The fields are still cultivated, although not included in the pesticide monitoring, but Tylstrup can be resumed if needed. Lund is in technical standby, while studying the water balance in the field (Chapter 1). Information about the agricultural management of these fields from 2018 until 2023 is found in Appendix 3, Table A3.1 (Tylstrup) and Table A3.6 (Lund).

Additional information about agricultural management and pesticide monitoring before 2020 for all fields can be found in previous reports available at www.plap.dk. The information in the most recent report is always updated and valid.

3.1. Agricultural management at Jyndevad

Agricultural management practice at Jyndevad from June 2020 until November 2023 is briefly summarised below and detailed in Appendix 3 (Table A3.2). Detailed information on pesticide monitoring is described in Chapter 5.

Potatoes – harvest 2020

On February 3, 2020, the field was ploughed, and on April 25 planted with potatoes (cv. Kuras, not coated). Fertiliser was placed at planting: 28.0, 6.0, and 30.0 kg/ha of N, P, and K. Furthermore, 168.0 kg/ha N and 135.0 kg/ha K were added with a pneumatic fertiliser spreader. On May 20, the potatoes were at BBCH 08, and weeds in the field were sprayed with a mixture of glyphosate and clomazone. Neither of these pesticides was monitored. The potatoes emerged on May 24 (BBCH 09). They were irrigated with 20 mm on June 13 and 21, and with 30 mm on August 2, 8, and 15. Spraying against fungi was done six times with cyazofamid on June 14 and 23, July 17, August 12, and September 1 and 10, 2020. The BBCH stage of the potatoes at the times of treatment was 28, 41, 68, 77, 89, and 91, respectively (Figure 3.1.1). Three of cyazofamid's known degradation products (DMSA, CTCA, and CCIM) and one potential degradation product (DMS) were monitored (Table 3.1.1). Two additional fungicides were used but not monitored: One containing propamocarb and cymoxanil was used twice (August 6 and 19), and another containing mancozeb was used six times (July 3, 9, and 27, August 3 and 27, and September 16). Pests were sprayed with azadirachtin on both August 12 and September 1 with the intention of monitoring for the degradation product azadirachtin H*. However, as azadirachtin H* was unstable in aqueous solution, it could not be analysed, and the compound will not be further discussed. Acetamiprid, another compound for pest control, was applied on June 23 and July 17 at BBCH stages 41 and 68, and two of its degradation products, IM-1-4 and IM-1-5, were included in the monitoring (Table 3.1.1). Harvest of potatoes was done on October 21, 2020, yielding 142.8 hkg/ha (100% dry matter).

Figure 3.1.1. Potatoes on the Jyndevad field in 2020: June 14 (top left) and 23 (top right), July 17 (bottom left), August 15 (bottom middle) and 27 (bottom right) (Photos: Henning Carlo Thomsen).

Winter rye – harvest 2021

After rotor cultivation of the field, winter rye (cv. Serafino, coated with prothioconazole and tebuconazole) was sown on October 21, 2020, and it emerged on November 5. The crop was fertilised with 54.6, 10.4, and 26.0 kg/ha of N, P, and K, respectively, on March 8, 2021, and with 79.8, 15.4, and 38.0 kg/ha of N, P, and K, respectively on April 7. The winter rye was irrigated three times on April 27, June 8 and 16 with 30, 27, and 35 mm, respectively. Only one spraying with MCPA against weeds was performed on April 20, and this was not monitored. The winter rye was harvested on August 20 with a grain yield of 59.6 hkg/ha (85% dry matter) and a straw yield of 42.3 hkg/ha (100% dry matter). On August 30, liming was done with 3.6 t/ha magnesium limestone.

Spring barley – harvest 2022

The field was ploughed on February 1, 2022, and disc harrowed on February 2, where after spring barley (cv. Flair, coated with prothioconazole and tebuconazole) was sown on March 5. Fertilisation of the crop was split in three: on March 28, April 27, and May 5. Each time with 46.2, 8.8, and 21.0 kg/ha of N, P, and K. It was irrigated six times: On April 28, May 7, June 22, and July 13 with 20 mm and on May 19, and June 5 with 25 mm. The weeds in the field were treated with tribenuron-methyl on April 23, when the spring barley was at BBCH stage 22 (Figure 3.1.2). The applied amount of tribenuron-methyl was 10.0 g/ha, which is higher than the maximum allowed dose of 5.0 g/ha at this growth stage of spring sown crops. Three degradation products, IN-B5528, IN-R9805, and M2, were monitored (Table 3.1.1). Spraying against fungi was done with prothioconazole and fluopyram on May 22, at barley BBCH stage 49 (Figure 3.1.2). Fluopyram and the degradation product fluopyram-7-hydroxy were included in the monitoring programme (Table 3.1.1). The degradation product 1,2,4-triazole was continuously monitored (since 2014). Additional herbicide treatments were carried out with MCPA on May 18 and glyphosate on July 20. Neither of these was monitored.

Figure 3.1.2. Spring barley field in Jyndevad on April 23 (left) and May 22 (right), 2022 (Photos: Henning Carlo Thomsen).

During the growing season, the aboveground vegetation density of the spring barley was at the same level as on other spring barley fields within a radius of 10 km from the PLAP-field in Jyndevad according to the Normalised Difference Vegetation Index (NDVI) measurements (Figure 3.1.3; CropManager). This indicates that the development of the aboveground biomass of the spring barley in the Jyndevad field is similar to other fields in the area. The spring barley was harvested on August 1 with a grain yield of 75.7 hkg/ha (85% dry matter) and straw yield of 38.6 hkg/ha (100% dry matter). The straw was shredded and left in the field after harvest.

Potatoes – harvest 2023

The field was cultivated with a disc harrow, where after a catch crop comprising oat (cv. Dominik) and a mixture of rye varieties was sown on August 17, 2022. The field was disc harrowed twice on February 2 and March 20 in 2023, before planting the seed potatoes (cv. Ydon, coated with fludioxonile and a mixture of micronutrients: S, Cu, Fe and Mn) on April 12. A total of 140.0, 30.0, and 150.0 kg/ha of N, P, and K was placed at planting. Additionally, 60.0 kg/ha of N was supplied on August 2, 2023. The weeds were treated with the herbicide glyphosate (not monitored) on May 10, before the potato plants emerged on May 12. Lack of precipitation, especially during May and June, necessitated irrigation of the field on June 1, 8, 13, and 22 with 20, 20, 25, and 30 mm, respectively, as well as on August 18 and September 6, each day with 25 mm.

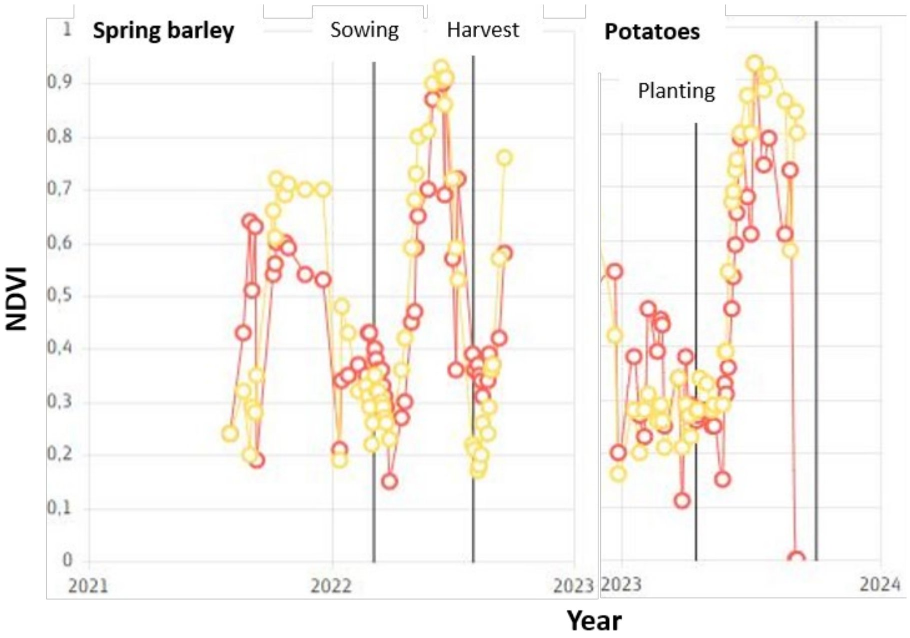

Figure 3.1.3. Aboveground vegetation density estimated as Normalised Difference Vegetation Index (NDVI) of spring barley 2022 and potaoes 2023 in the Jyndevad field –o-- *compared to the the average NDVI of the respective crops grown on fields within a 10 km radius* --o-- *from the PLAP-field (CropManager). Times of sowing and harvest of the spring barley in the Jyndevad field are indicated, likewise is planting time of the potatoes.*

The fungicide oxathiapiprolin was applied on July 8 and 18 at potato growth stage BBCH 63 and 65, respectively (Figure 3.1.4), and the degradation product IN-E8S72 was monitored (Table 3.1.1 and Chapter 5.7). Several other fungicides were used, but not included in the monitoring programme: Mandipropamid on June 28, July 28 and August 11, fluazinam on June 28, July 8 and 18, August 4, 18 and 25, September 1 and 8, difenoconazole on July 18 and August 11, cymoxanil on August 11 and 25 and September 1 and 8, and finally propamocarb in combination with cymoxanil on July 28, August 4 and 18. Pests were treated with lambda-cyhalothrin on July 28 at BBCH 66 and August 25 at BBCH 71 (Figure 3.1.4), and compound Ia was monitored (Table 3.1.1 and Chapter 5.6). Another insecticide, i.e. acetamiprid, was used on June 28, but not monitored.

The development of the aboveground vegetation density of the potato plants was above or similar to other potato fields in the area around the Jyndevad-field as indicated by the NDVI measurements (Figure 3.1.3; CropManager). The potatoes were harvested on November 14 with a tuber yield of 149.1 hkg/ha (100% dry matter).

Figure 3.1.4. Potatoes on the field in Jyndevad in 2023: June 28 (left), July 18 (middle) and August 18 (right) (Photos: Henning Carlo Thomsen).

*Table 3.1.1. Pesticides analysed at **Jyndevad** from 2018 until 2023. For each compound it is indicated whether it is a pesticide (P) or degradation product (M). The application date and end of monitoring period is listed*

Crop – Year of harvest	Applied product	Analysed pesticide (P)/ degradation product (M)	Application date	End of monitoring
Winter wheat 2018	Lexus 50WG			
SD: Redigo Pro 170 FS	Flupyrsulfuron-methyl (P)	IN-KF311 (M)	Oct-17	Mar-19
(Prothioconazole +		IN-JE127 (M)*	Oct-17	Mar-19
tebuconazole)	Hussar Plus OD			
	Mesosulfuron-methyl (P)	AE F099095 (M)	Apr-18	Mar-20
		AE F160459 (M)	Apr-18	Mar-20
		AE F147447 (M)	Apr-18	Mar-20
	Topsin WG			
	Thiophanat-methyl (P)	Carbendazim (M)	Jun-18	Oct-20
Winter rye 2019	Talius			
SD: Celeste Formula M	Proquinazid (P)	IN-MM671 (M)	Apr-19	Mar-21
(Fludioxonil)		IN-MM991 (M)	Apr-19	Mar-21
Potatoes 2020	Ranman Top			
	Cyazofamid (P)	CCIM (M)	Jun-20	Jan-23
		CTCA (M)	Jun-20	Jan-23
		DMSA (M)	Jun-20	Ongoing
		N,N-DMS (M)	Jun-20	Ongoing
	Mospilan SG			
	Acetamiprid (P)	IM-1-4 (M)	Jun-20	Sep-22
		IM-1-5 (M)	Jun-20	Sep-22
Winter rye 2021 SD: Redigo Pro 170 FS (Prothioconazole + tebuconazole)				
Spring barley 2022	Nuance Max 75 WG			
SD: Redigo Pro 170 FS	Tribenuron-methyl (P)	IN-B5528 (M)	Apr-22	Ongoing
(Prothioconazole +		IN-R9805 (M)	Apr-22	Ongoing
tebuconazole)		M2 (M)	Apr-22	Ongoing
	Propulse SE 250			
	Prothioconazole (P)	1,2,4-triazole (M)	May-22	Jan-23
	Fluopyram (P)	Fluopyram (P)	May-22	Ongoing
		Fluopyram-7-hydroxy (M)	May-22	Ongoing
Potatoes 2023	Zorvec Enicade			
SD: Maxim 100 FS	Oxathiapiprolin (P)	IN-E8S72 (M)	Jul-23	Background-sampling
(fludioxonil)	Lamdex			
	Lambda-cyhalothrin (P)	Compound Ia (M)	Jul-23	Background-sampling

*Systematic chemical nomenclature for the analysed pesticides is given in Appendix 1. SD = Seed dressing. *The degradation product IN-JE127 was discontinued due to instability in aqueous solution.*

3.2. Agricultural management at Silstrup

Agricultural management practice at Silstrup from September 2019 until August 2023 is briefly summarised below and detailed in Appendix 3 (Table A3.3). Further information on pesticide monitoring is described in Chapter 5.

Winter wheat – harvest 2020

On September 19, 2019, the field was ploughed, and on September 21, winter wheat (cv. Benchmark, coated with fludioxonile) was sown. The crop emerged on October 7, 2019. On March 25, 2020, it was fertilised with the following amounts of N, P, and K: 177.2, 25.3, and 84.4 kg/ha. Spraying of weeds was done on April 7, 2020, in winter wheat at BBCH stage 30, using pyroxsulam and florasulam in a mixture. From pyroxsulam, five degradation products were included in the monitoring: PSA, 6-Cl-7-OH-pyroxsulam, 5-OH-pyroxsulam, 7-OH-pyroxulam, and pyridine sulfonamide (Table 3.2.1). From florasulam, four degradation products were monitored: TSA, 5OH-florasulam, DFP-ASTCA, and DFP-TSA. Fungicides were sprayed twice, using prothioconazole together with azoxystrobin on May 28 and June 16, 2020, at winter wheat BBCH stage 42 and 68, respectively. From azoxystrobin, the degradation product CyPM was included in the monitoring, and 1,2,4-triazole from prothioconazole was continuously monitored (Table 3.2.1, Chapter 5.3 and 5.2, respectively). On August 13, 2020, 97.0 hkg/ha of grain (85% dry matter) was harvested. The amount of straw shredded and left in the field at harvest was not determined.

Spring barley – harvest 2021

The field was ploughed on September 28, 2020, and winter wheat (cv. Skyscraper, coated with difenoconazole) was sown on September 30. Due to a poor seedbed and late sowing of the winter wheat, the germination was deficient, and the crop emerged unevenly. Therefore, it was decided to wither away the plants with glyphosate on March 31, 2021. This pesticide was not monitored. On April 15, a mixture of varieties of spring barley (not coated) was sown and fertilised with N, P, and K: 136.9, 19.6, and 65.2 kg/ha. Foliar fertilisation with 0.11 kg/ha N and 0.24 kg/ha Mn was done contemporary with spraying against weeds with MCPA (not monitored) on June 10. On June 30, the barley was at BBCH stage 61, and it was treated with the fungicides prothioconazole and fluopyram. Fluopyram was included in the monitoring (Chapter 5.5), whereas 1,2,4-triazole was continuously monitored (Table 3.2.1 and Chapter 5.2). The spring barley was harvested on August 23 with a grain yield of 53.7 hkg/ha (85% dry matter). The straw yield was not determined, but it was shredded and left in the field.

Winter wheat – harvest 2022

The field was ploughed on September 19, 2021, and on September 21, winter wheat (cv. Herup, coated with fludioxonile and tebuconazole) was sown. The crop emerged shortly before October 13, 2021, when it was at BBCH stage 11. It was fertilised with 197.4, 28.2, and 94.0 kg/ha of N, P, and K on April 5, 2022. Spraying against weeds was performed with tribenuron-methyl and metsulfuron-methyl on April 29 at BBCH stage 31 of winter wheat. The degradation products IN-B5528, IN-R9805, and M2 from tribenuron-methyl were included in the monitoring (Table 3.2.1 and Chapter 5.11). On May 4 and June 10, 2022 (Figure 3.2.1), the crop was at BBCH stage 32 and 60, respectively, and it was treated with the fungicides prothioconazole and fluopyram. Fluopyram and 1,2,4-triazole monitoring continued and the degradation product fluopyram-7-hydroxy from fluopyram was included (Table 3.2.1 and Chapter 5.5).


Figure 3.2.1. Winter wheat at the Silstrup field, May 4 (left) and June 10 (right), 2022 (Photos: Helle Baadsgaard and Kaj Madsen).

According to NDVI measurements, the aboveground vegetation density on the Silstrup-field during the growing season was at a similar level as other winter wheat fields in a 10 km radius from the PLAP-field in Silstrup (Figure 3.2.2; CropManager), indicating that the winter wheat developed like in other fields with the same crop in the area. The winter wheat was harvested on August 16 with a grain yield of 94.0 hkg/ha (85% dry matter). The straw yield was 86.8 hkg/ha (100% dry matter). It was shredded and left in the field after harvest.

Winter wheat – harvest 2023

The field was ploughed on August 22, 2022. On September 1, the seedbed was prepared and winter wheat (cv. Heerup, coated with prothioconazole) was sown. The wheat emerged on September 10 and on September 16 the weeds were treated with the herbicide diflufenican (not monitored). It was fertilised on April 18, 2023, with the following amounts of N, P, and K: 180.0, 26.0 and 86.0 kg/ha, respectively. Another treatment against weeds was performed with tribenuron-methyl and metsulfuron-methyl on May 11, 2023, at winter wheat growth stage BBCH 37 (Figure 3.2.3.). Monitoring of the degradation products IN-B5528, IN-R9805, and M2 from tribenuron-methyl continued (Table 3.2.1 and Chapter 5.11). A split application of the fungicides prothioconazole and fluopyram was done on May 15 and June 7, 2023, at growth stage BBCH 38 and 57 of winter wheat (Figure 3.2.3). Monitoring of fluopyram and the degradation product fluopyram-7-hydroxy from fluopyram continued (Table 3.2.1 and Chapter 5.5).

The NDVI of winter wheat in the PLAP-field from September 2022 until March 2023 (except in early January) was higher than the average of other winter fields in the same area (Figure 3.2.2; CropManager), most likely reflecting the early sowing of winter wheat in the Silstrup field. However, no difference in NDVI was found during the rest of the growing season. The winter wheat was harvested on August 14 with a grain yield of 29.4 hkg/ha (85% dry matter). The straw was shredded and left in the field without yield determination

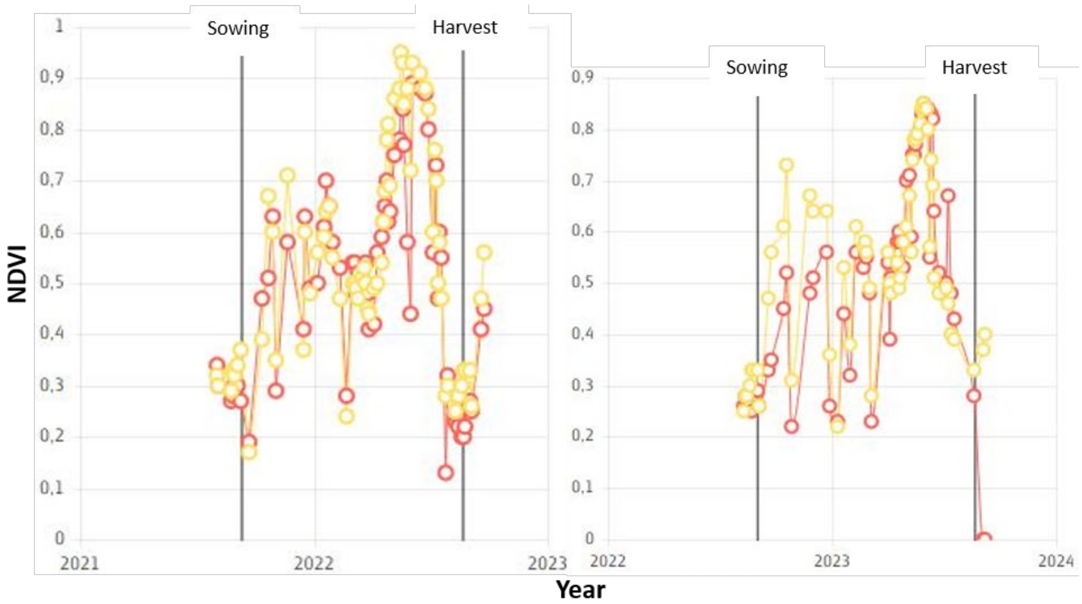

Figure 3.2.2. Aboveground vegetation density estimated as NDVI of winter wheat in 2022 and 2023 in Silstrup –o-- compared to the the average NDVI of winter wheat fields within a 10 km radius **--o--** *from the PLAP-field (CropManager). Times of sowing and harvest of the PLAP-field are indicated.*

Figure 3.2.3. The winter wheat field in Silstrup on May 11 (top) and 16 (bottom left) and June 7 (bottom right), 2023 (Photos: Helle Baadsgaard and Kaj Madsen).

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Winter rapeseed – harvest 2024

On August 14, 2023, the field was ploughed and three days later winter rapeseed (cv. Haugustina, coated with *Bacillus amyloliquefaciens* MBI 600) was sown. On the day of sowing, August 17, 2023, the field was fertilised with 40.0, 5.7 and 19.0 kg/ha of N, P and K, and the weeds were treated with the herbicide pendimethalin (Figure 3.2.4). The degradation product, M455H001, was included in the monitoring (Table 3.2.1 and Chapter 5.8).

Figure 3.2.4. Winter rapeseed was sown in the field at Silstrup on August 17, 2023, and it was sprayed with pendimethalin on the same day (Photo: Kaj Madsen).

*Table 3.2.1. Pesticides analysed at **Silstrup** from 2020 until 2023. For each compound it is indicated whether it is a pesticide (P) or degradation product (M). The application date and end of monitoring period is listed.*

Crop – Year of harvest	Applied product	Analysed pesticide (P)/ degradation product (M)	Application date	End of monitoring
Winter wheat 2020	*Broadway*			
SD: Celest Formula M	Pyroxsulam (P)	PSA (M)	Apr-20	Mar-22
(Fludioxonile)		6-Cl-7-OH-XDE-742 (M)	Apr-20	Mar-22
		5-OH-XDE-742 (M)	Apr-20	Mar-22
		7-OH-XDE-742 (M)	Apr-20	Mar-22
		Pyridine sulfonamide (M)	Apr-20	Mar-22
	Florasulam (P)	TSA(M)	Apr-20	Mar-22
		5OH-florasulam (M)	Apr-20	Mar-22
		DFP-ASTCA (M)	Apr-20	Mar-22
		DFP-TSA (M)	Apr-20	Mar-22
	Proline 250 EC			
	Prothioconazole (P)	1,2,4-triazole (M)	May-20	Jan-23
	Amistar	Azoxystrobin (P)	May-20	
		CyPM (M)	May-20	Feb-23
Winter wheat 2021	Propulse SE 250			
SD: Difend	Prothioconazole (P)	1,2,4-triazole (M)	Jun-21	Jan-23
(Difenoconazole)	Fluopyram (P)	Fluopyram (P)	Jun-21	ongoing
Spring barley 2021				
Winter wheat 2022	*Express Gold 33 SX*			
SD: Seedron	Tribenuron-methyl (P)	IN-B5528 (M)	Apr-22	ongoing
(Fludioxonile +		IN-R9805 (M)	Apr-22	ongoing
tebuconazole)		M2 (M)	Apr-22	ongoing
	Propulse SE 250			
	Prothioconazole (P)	1,2,4-triazole (M)	May-22	Jan-23
	Fluopyram (P)	Fluopyram (P)	May-22	ongoing
		Fluopyram-7-hydroxy (M)	May-22	ongoing
Winter wheat 2023	*Express Gold 33 SX*			
SD: Redigo FS 100	Tribenuron-methyl (P)	IN-B5528 (M)	May-23	ongoing
(prothioconazole)		IN-R9805 (M)	May-23	ongoing
		M2 (M)	May-23	ongoing
	Propulse SE 250			
	Fluopyram (P)	Fluopyram (P)	May-23	ongoing
		Fluopyram-7-hydroxy (M)	May-23	ongoing
Winter rapeseed 2024	*Stomp CS*			
SD: Integral Pro	Pendimethalin (P)	M455H001 (M)	Aug-23	Background-sampling
(*Bacillus amyloliquefaciens*				
MBI 600)				

Systematic chemical nomenclature for the analysed pesticides is given in Appendix 1. SD = Seed dressing.

3.3. Agricultural management at Estrup

Agricultural management practice at Estrup from April 2019 until August 2023 is briefly summarised below and detailed in Appendix 3 (Table A3.4). Further information on pesticide monitoring is provided in Chapter 5.

Spring barley – harvest 2019

On April 8, 2019, a spring barley (cv. Flair, coated with prothioconazole and tebuconazole) was sown and fertilised with 137.0, 26.0, and 65.0 kg/ha of N, P, and K. On April 17, 2019, the barley emerged. The herbicides fluroxypyr and halauxifen-methyl were sprayed on May 22, 2019, when spring barley was at BBCH stage 31. Only X-729 (halauxifen or X11393729), a degradation product from halauxifen-methyl, was included in the monitoring programme (Table 3.3.1). A split application of metconazole against fungi was done on May 22 and June 13, at BBCH stages 31 and 50, respectively. 1,2,4-triazole was continuously monitored and metconazole was included in the monitoring (Table 3.3.1 and Chapter 5.2). Harvest of the spring barley took place on August 11, 2019, yielding 70.4 hkg/ha of grain (85% dry matter), whereas 23.3 hkg/ha of straw (100 % dry matter) was shredded and left in the field.

Winter wheat – harvest 2020

Ploughing of the field, as well as the sowing of winter wheat (cv. Sheriff, coated with prothioconazole and tebuconazole), was done on September 16, 2019. The winter wheat emerged on September 26, 2019 and was sprayed with the herbicide pendimethalin on October 7, 2019 (not monitored). The winter wheat was fertilised with N, P, and K twice: On April 7 and 15, 2020. At first, 136.5, 26.0, and 65.0 kg/ha of N, P, and K were applied, whereas at the second application, the respective amounts of N, P, and K were 73.5, 14.0, and 35.0 kg/ha. Further spraying of weeds was done on May 3, when winter wheat was at BBCH stage 31 (Figure 3.3.1), using a mixture of pyroxsulam and florasulam. From pyroxsulam five degradation products were included in the monitoring: PSA, 6-Cl-7-OH-pyroxsulam, 5-OH-pyroxsulam, 7-OH-pyroxsulam, and pyridine sulfonamide (Table 3.3.1). From florasulam four degradation products were included in the monitoring: TSA, 5-OH-florasulam, DFP-ASTCA, and DFP-TSA (Table 3.3.1). Harvest of the winter wheat on August 11, 2020, yielded 71.4 hkg/ha of grain (85% dry matter) and 38.4 hkg/ha of straw (fresh weight). The straw was shredded at harvest and left in the field.

Spring barley – harvest 2021

On February 2, 2021, a total of 3.5 t/ha of magnesium limestone was added to the field. Spring barley (cv. Flair, coated with prothioconazole and tebuconazole) was sown on April 19. Two days later, it was fertilised with 120.0, 22.8, and 57.0 kg/ha of N, P, and K, and it emerged before April 27, where it was recorded to have reached BBCH stage 11. On June 1, 2021, at BBCH stage 27 (Figure 3.3.1), it was sprayed with the herbicide thifensulfuron-methyl. The applied amount of thifensulfuron-methyl was 9 g/ha, which is higher than the maximum allowed dose of 7.5 g/ha in spring cereals. The degradation products IN-JZ789, IN-B5528, and IN-L9223 were included in the monitoring programme (Table 3.3.1 and Chapter 5.10). The spring barley was harvested on August 15 with a grain yield of 44.6 hkg/ha (85% dry matter) and a straw yield of 29.0 hkg/ha (100% dry matter). The straw was shredded and left in the field.

Figure 3.3.1. Crops at the Estrup field. Winter wheat on May 3, 2020 (left) and spring barley on June 2, 2021 (right) (Photos: Henning Carlo Thomsen).

Perennial ryegrass – harvest 2022

On August 23, 2021, a mixture of perennial ryegrass varieties (Foragemax33) was sown, and it emerged on September 1. The ryegrass was fertilised with N, P, and K three times, each time with 63.0, 12.0, and 30.0 kg/ha. The first fertilisation was on April 1, 2022, whereas the second and third were on June 2 and July 6 after the first and the second cut, respectively. Spraying against weeds with thifensulfuron-methyl was performed on July 19, at ryegrass BBCH stage 30 (Figure 3.3.2), and monitoring of the degradation products IN-JZ789, IN-B5528 and IN-L9223 continued (Table 3.3.1 and Chapter 5.10). In total, three cuts of grass were done in 2022: On May 31, July 4 and August 8, yielding 26.7, 24.1 and 25.0 hkg/ha (100% dry matter), respectively.

Figure 3.3.2. The perennial ryegrass in the Estrup field on July 19, 2022 (Photo: Henning Carlo Thomsen).

Perennial ryegrass, second season – harvest 2023

The second-year perennial ryegrass was fertilised on April 4 and June 6, 2023, each time with 63.0, 9.0, and 30.0 kg/ha of N, P, and K. The grass was cut on May 30 and July 24, 2023, with yields of 21.5 and 21.0 hkg/ha (100% dry matter). On August 2, the field was sprayed with glyphosate (not monitored) to terminate the growth of the grass.

Winter rapeseed – harvest 2024

Winter rapeseed (cv. DK Exsteel, coated with *Bacillus amyloliquefaciens* MBI 600) was sown on August 16, 2023 (Figure 3.3.3). The following day the field was sprayed with the herbicide pendimethalin and the degradation product, M455H001, was included in the monitoring (Table 3.3.1 and Chapter 5.8).

Figure 3.3.3. Sowing winter rapeseed in Estrup on August 16, 2023 (Photo: Henning Carlo Thomsen).

Table 3.3.1. Pesticides analysed at ***Estrup*** *from 2018 until 2023. For each compound it is indicated whether it is a pesticide (P) or degradation product (M). The application date and end of monitoring period is listed.*

Crop – Year of harvest	Applied product	Analysed pesticide (P)/ degradation product (M)	Application date	End of monitoring
Winter wheat 2018	Hussar Plus OD			
SD: Redigo Pro 170 FS	Mesosulfuron-methyl (P)	AE-F099095 (M)	Apr-18	Mar-20
(Prothioconazole +		AE-F160459 (M)	Apr-18	Mar-19
tebuconazole)		AE-F147447 (M)	Apr-18	Mar-19
	Topsin WG			
	Thiophanat-methyl (P)	Carbendazim (M)	Jun-18	Oct-20
Spring barley 2019	Pixxaro EC			
SD: Redigo Pro 170 FS	Halauxifen-methyl (P)	X-729 (M)	May-19	Mar-21
(Prothioconazole +	Fluroxypyr (P)			
tebuconazole)	Juventus 90			
	Metconazole (P)	Metconazole (P)	May-19	Mar-21
		1,2,4-triazole (M)	May-19	Jan-23
Winter wheat 2020	Broadway			
SD: Redigo Pro 170 FS	Pyroxsulam (P)	Amitrol (M)	May-20	Mar-22
(Prothioconazole +		PSA (M)	May-20	Mar-22
tebuconazole)		6-Cl-7-OH-XDE-742 (M)	May-20	Mar-22
		5-OH-XDE-742 (M)	May-20	Mar-22
		7-OH-XDE-742 (M)	May-20	Mar-22
		Pyridine sulfonamide (M)	May-20	Mar-22
	Florasulam (P)	TSA (M)	May-20	Mar-22
		5OH-florasulam (M)	May-20	Mar-22
		DFP-ASTCA (M)	May-20	Mar-22
		DFP-TSA (M)	May-20	Mar-22
Spring barley 2021	Harmony 50 SX			
SD: Redrigo Pro 170 FS	Thifensulfuron-methyl (P)	IN-B5528 (M)	Jun-21	Ongoing
(Prothioconazole +		IN-JZ789 (M)	Jun-21	Ongoing
tebuconazole)		IN-L9223 (M)	Jun-21	Ongoing
Perennial ryegrass 2022	Harmony 50 SX			
	Thifensulfuron-methyl (P)	IN-B5528 (M)	Jul-22	Ongoing
		IN-JZ789 (M)	Jul-22	Ongoing
		IN-L9223 (M)	Jul-22	Ongoing
Perennial ryegrass 2023, second year				
Winter rapeseed 2024	Stomp CS			
SD: Integral Pro	Pendimethalin (P)	M455H001 (M)	Aug-23	Background-sampling
(*Bacillus amyloliquefaciens* MBI 600)				

Systematic chemical nomenclature for the analysed pesticides is given in Appendix 1. SD = Seed dressing.

3.4. Agricultural management at Faardrup

Management practice at Faardrup from March 2020 until August 2023 is briefly summarised below and detailed in Appendix 3 (Table A3.5). Detailed information on pesticide monitoring is found in Chapter 5.

Spring wheat – harvest 2020

Spring wheat (cv. Cornette, coated with fludioxonile, not monitored) was sown on March 26, 2020, fertilised with 134.0, 26.0, and 65.0 kg/ha of N, P, and K on April 2, and it emerged on April 6. On May 20, the weeds were treated with bromoxynil (not monitored). At harvest on August 14, 2020, yields of grain were 56.5 hkg/ha (85% dry matter), and 43.1 hkg/ha (100% dry matter) of straw was shredded and left in the field.

Winter rapeseed – harvest 2021

Immediately after harvest on August 14, 2020, the field was ploughed and winter rapeseed (cv. V3160L, coated with *Bacillus amyloliquefaciens* MBI 600) was sown. Before crop emergence, the field was sprayed with the herbicide clomazone on September 1, 2020 (not monitored). The crop emerged on September 9, 2020. On November 25, 2020, at winter rapeseed BBCH stage 15, another herbicide treatment was carried out with propyzamide. Propyzamide was included in the monitoring (Table 3.4.1). The crop was fertilised twice with N, P, and K with the amounts 123.6, 21.6, and 60.0 kg/ha on March 9, 2021, and 97.9, 3.5, and 47.5 kg/ha on April 13. A treatment against fungi was made with prothioconazole and fluopyram at crop BBCH stage 69 on May 26, 2021. Fluopyram was included in the monitoring and 1,2,4-triazole was continuously monitored (Table 3.4.1, Chapter 5.5 and 5.2, respectively). The winter rapeseed was harvested on August 11 with a seed yield of 29.6 hkg/ha. The stubble was shredded at harvest.

Winter wheat – harvest 2022

On September 28, 2021, the field was sprayed with the herbicide glyphosate (not monitored). It was ploughed on October 7, and winter wheat (cv. Rembrandt, coated with prothioconazole and tebuconazole) was sown the following day. The crop emerged on October 22, 2021, and it was fertilised with N, P, and K twice in 2022 with the amounts: 98.7, 18.8, and 47.0 kg/ha on March 9, and 57.8, 11.0, and 27.5 kg/ha on April 27. The herbicides tribenuron-methyl and metsulfuron-methyl were applied on April 21, 2022, at wheat BBCH stage 28 (Figure 3.4.1). The degradation products IN-B5528, IN-R9805 and M2 from tribenuron-methyl were included in the monitoring (Table 3.4.1 and Chapter 5.11). The fungicides prothioconazole and fluopyram were applied twice in 2022: On May 4 and 30 at BBCH stages 31 and 51, respectively (Figure 3.4.1). Monitoring of fluopyram and 1,2,4-triazole continued, and the degradation product fluopyram-7-hydroxy from fluopyram was included in the monitoring (Table 3.4.1, Chapter 5.5 and 5.2).

The NDVI measurements indicates that from sowing in October 2021 until March 2022 the development of the aboveground vegetation density of the spring barley was at a slightly lower level compared to other fields with the same crop in a radius of 10 km from the PLAP-field in Faardrup (Figure 3.4.2; CropManager). However, thereafter the development was similar for both the Faardrup field and surrounding fields. The winter wheat was harvested on August 11, 2022, with a grain yield of 108.6 hkg/ha (fresh weight) and a straw yield of 70.2 hkg/ha (fresh weight). The straw was shredded and left in the field after harvest.

Figure 3.4.1. Winter wheat on the Faardrup field on April 19 (top left), May 4 (top right) and June 7 (bottom), 2022 (Photos: Eugène J.G.G. Driessen).

Winter wheat – harvest 2023

On September 5, 2022, the field was ploughed and harrowed before sowing winter wheat (cv. Heerup, coated with prothioconazole). The wheat emerged on September 19 and on the same day the herbicide diflufenican was applied (not monitored). On October 27, 2022, insects on the field were treated with tau-fluvalinat (not monitored). The winter wheat was fertilised on March 28, 2023 with 73.5, 10.5, and 35.0 kg/ha of N, P, and K. Another fertilisation was done on April 19 with 115.5, 16.5, and 55.0 kg/ha of N, P, and K. The weeds were treated with tribenuron-methyl and metsulfuron-methyl on April 18, 2023, when the winter wheat was at growth stage BBCH 30 (Figure 3.4.3). Monitoring of the degradation products IN-B5528, IN-R9805 and M2 from tribenuron-methyl continued (Table 3.4.1 and Chapter 5.11). A split application of the fungicides prothioconazole and fluopyram was done on May 4 and 30, at BBCH 33 and 53, respectively (Figure 3.4.3). Monitoring of fluopyram and the degradation product fluopyram-7-hydroxy from fluopyram continued (Table 3.4.1 and Chapter 5.5).

Contrary to the previous year, the NDVI indicates that the aboveground vegetation density on the Faardrup-field was higher than on other winter wheat fields in the area, from sowing in September throughout November, 2022, and again from February through May, 2023 (Figure 3.4.2; CropManager). Like the winter wheat sown in September 2022 in Silstrup, this probably reflects that the crop was sown early. According to the NDVI measurements, the level of aboveground vegetation density was similar to that observed in the surrounding fields during the rest of the growing season. The winter wheat was harvested on August 14 with a grain yield of 103.6 hkg/ha (85% dry matter) and a straw yield of 81.1 hkg/ha (100% dry matter). The straw was shredded and left in the field after harvest.

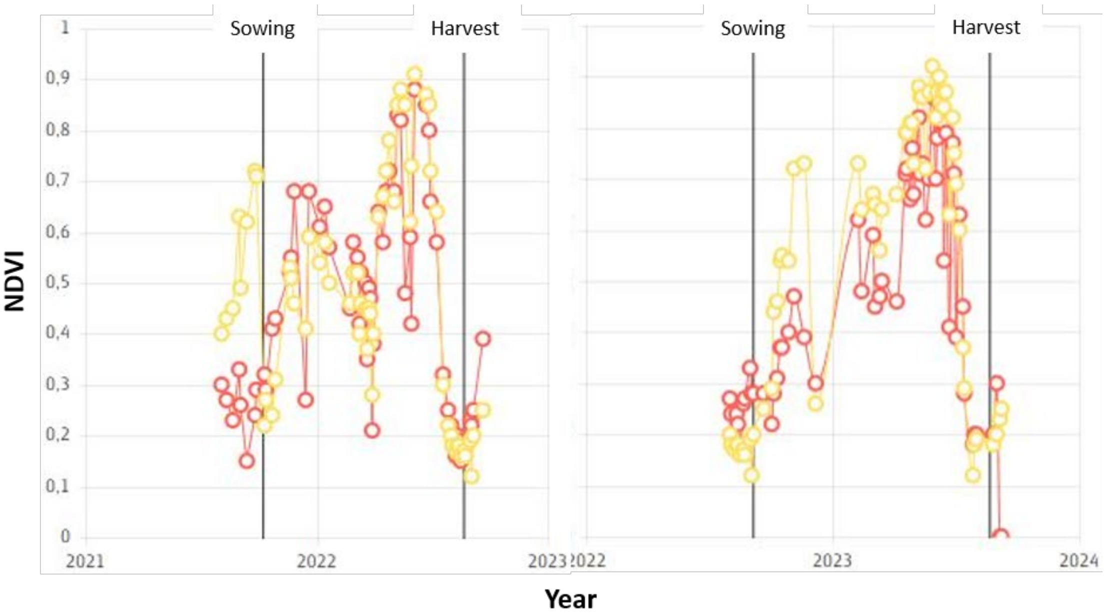

Figure 3.4.2. Aboveground vegetation density estimated as NDVI of winter wheat in 2022 (left) and 2023 (right) in Faardrup ***–o--*** *compared to the the average NDVI of winter wheat fields within a 10 km radius* ***--o--*** *from the PLAP-field (CropManager). Times of sowing and harvest of the PLAP-field are indicated.*

Figure 3.4.3. Winter wheat in Faardrup in 2023 on April 18 (left), May 3 (middle) and 30 (right) (Photos: Eugène J.G.G. Driessen).

Table 3.4.1. Pesticides analysed at ***Faardrup*** *from 2018 until 2023. For each compound it is indicated whether it is a pesticide (P) or degradation product (M). The application date and end of monitoring period is listed*

Crop – Year of harvest	Applied product	Analysed pesticide (P)/ degradation product (M)	Application date	End of monitoring
Sugar Beet 2018	Conviso One			
SD: Gaucho WS70	Thiencarbazone-methyl(P)	AE1394083 (M)	May-18	Mar-20
(Imidacloprid) +	Foramsulfuron (P)			
Tachigaren WP	Goltix SC 700	Metamitron (P)	May-18	Mar-20
(Hymexazol)		Desamino-metamitron (M)	May-18	Mar-20
		MTM-126-ATM (M)	May-18	Mar-20
Spring barley 2019	Talius			
SD: Redigo Pro 170 FS	Proquinazid (P)	IN-MM671 (M)	Jun-19	Mar-21
(prothioconazole +		IN-MM991 (M)	Jun-19	Mar-21
tebuconazole)				
Spring wheat 2020				
SD: Celest Formula M				
(Fludioxonil)				
Winter rapeseed 2021	Kerb 400 SC	Propyzamide (P)	Nov-20	Nov-22
SD: Integral Pro	Propulse SE 250			
(*Bacillus amyloliquefaciens*	Prothioconazole (P)	1,2,4-triazole (M)	May-21	Jan-23
MBI 600)		Fluopyram (P)	May-21	Ongoing
Winter wheat 2022	Express Gold 33 SX			
SD: Redigo Pro 170 FS	Tribenuron-methyl (P)	IN-B5528 (M)	Apr-22	Ongoing
(Prothioconazole +		IN-R9805 (M)	Apr-22	Ongoing
tebuconazole)		M2 (M)	Apr-22	Ongoing
	Propulse SE 250			
	Prothioconazole (P)	1,2,4-triazole (M)	May-22	Jan-23
		Fluopyram (P)	May-22	Ongoing
		FLuopyram-7-hydroxy (M)	May-22	Ongoing
Winter wheat 2023	Express Gold 33 SX			
SD: Redigo FS 100	Tribenuron-methyl (P)	IN-B5528 (M)	Apr-23	Ongoing
(Prothioconazole)		IN-R9805 (M)	Apr-23	Ongoing
		M2 (M)	Apr-23	Ongoing
	Propulse SE 250	Fluopyram (P)	May-23	Ongoing
		Fluopyram-7-hydroxy (M)	May-23	Ongoing

Systematic chemical nomenclature for the analysed pesticides is given in Appendix 1. SD = Seed dressing.

4. Model set-up and soil water dynamics

The water balance at all fields is assessed through monitoring of hydrological variables and numerical modelling. The numerical modelling is conducted using MACRO 5.2 (Larsbo et al., 2005). The monitoring of the hydrological variables from each of the fields is used in a combination of model driving data and observations. All PLAP fields have a similar design in terms of monitoring (Chapter 2) and, thus, locally measured climate data are used as driving data, while current observation data in the model comprises groundwater levels, soil water content in various depths, and drain flow.

The treated area of each PLAP field is represented by a one-dimensional model which covers the upper five meters of the soil profile ensuring that the observed groundwater table is represented in the model. Soil characteristics for each field were based on the pedological profiles that were described for each PLAP field at the time of establishment (Lindhardt et al., 2001; Haarder et al., 2021). One model for each field was set up and used to simulate water dynamics in the variably saturated zone during the full monitoring period and to establish an annual water balance and estimate the percolation 1 mbgs. In each reporting period the most recent climate and crop data is added to the current MACRO setup. For the fields Jyndevad, Silstrup, Estrup, and Faardrup the model was calibrated for the monitoring period from May 1999 to June 2004 and subsequently used to compare simulated water balance with monitoring results from July 2004 to June 2023. As the Lund field was established in 2017 and data collection at the field was initiated in 2017/2018, the model for Lund is not included but is expected to be updated as more data is collected. Currently, a new bromide test has been initiated at Lund and the tracer is being monitored. For the models representing the remaining sites, the following types of measured data were used in the calibration process: Daily time series of the groundwater table measured in piezometers located in the buffer zone; soil water content based on TDR-measurements at three different depths (0.25, 0.6, and 1.1 mbgs) from the two profiles S1 and S2; and bromide concentrations measured in suction cups located at 1 and 2 mbgs. Data acquisition, model setup, and results related to the modelling are described in Barlebo et al. (2007).

Currently, the models are being updated and re-calibrated using state-of-the-art inverse calibration routines and utilizing the relatively long time series that have been collected since PLAP's initiation. As the models become updated, these will be detailed in upcoming PLAP reports. In the current report, the latest model results are shown together with measured observations as done in previous reports. However, only the results from the past three years (July 2020-June 2023) are detailed. The aim is to make it clearer how the model performs quantitatively compared to observed data within the current reporting period. Hence, in the coming reports, the statistics of the model performance compared to observed data will be detailed, e.g., to better assess how the models perform. Further, the shorter period aids to infer whether a monitoring device is performing as expected. That is, with a shorter reporting interval, the qualitative performance (e.g., related to drifting issues) of a measuring device and data collection gaps are easily displayed.

It is noted that some simulation results may deviate slightly from previously published results. The reason is that various model parameter values were corrected, for instances, where typos occurred in the data input files. Similarly, the water balance contributions reported in the tables within the current chapter may deviate from the formerly reported periods.

4.1. Jyndevad

The monthly measured groundwater levels from all the well screens showed that the levels varied on average from around 2 to 3 mbgs (Figure 4.1.1B). The two automatic loggers from P9.2 and P11.2 show that the measured groundwater dynamics vary similarly and are offset by approximately 0.2 m (Figure 4.1.1B). As both wells are located at a terrain elevation of around 15 meters above sea level (masl), the offset is consistent with the general groundwater flow from the upstream well P11 towards the downstream well P9 (Figure 2.1.1, Chap 2, Jyndevad). Overall, the simulated groundwater level fluctuation temporally follows the observations in terms of measured maximum and minimum levels, although the simulated groundwater level amplitude is less than what is measured. Further, the simulated groundwater levels are higher than the averaged observed groundwater levels.

The soil water saturation deduced from TDR-measured soil water content at S1 and S2 showed that differences between measurements were largest at 1.1 mbgs (Figure 4.1.1C-E). Generally, the soil water saturation dynamics were similar in S1 and S2 in depths of 0.25 and 0.6 mbgs. Also, the simulated soil water saturation at these depths followed the measured dynamics although showing an offset of around 10% in 0.25 mbgs. In 1.1 mbgs, a relatively large offset of around 30% was present between S1 and S2 (Figure 4.1.1E). This was due to errors in the software of the new data logger installed in Jyndevad in May 2019, and no S2 soil water content measurements at 1.1 mbgs were obtained after May 2021. It is noted that the simulated soil water saturation in 1.1 mbgs, although offset around 20%, followed the measured soil water saturation in S1.

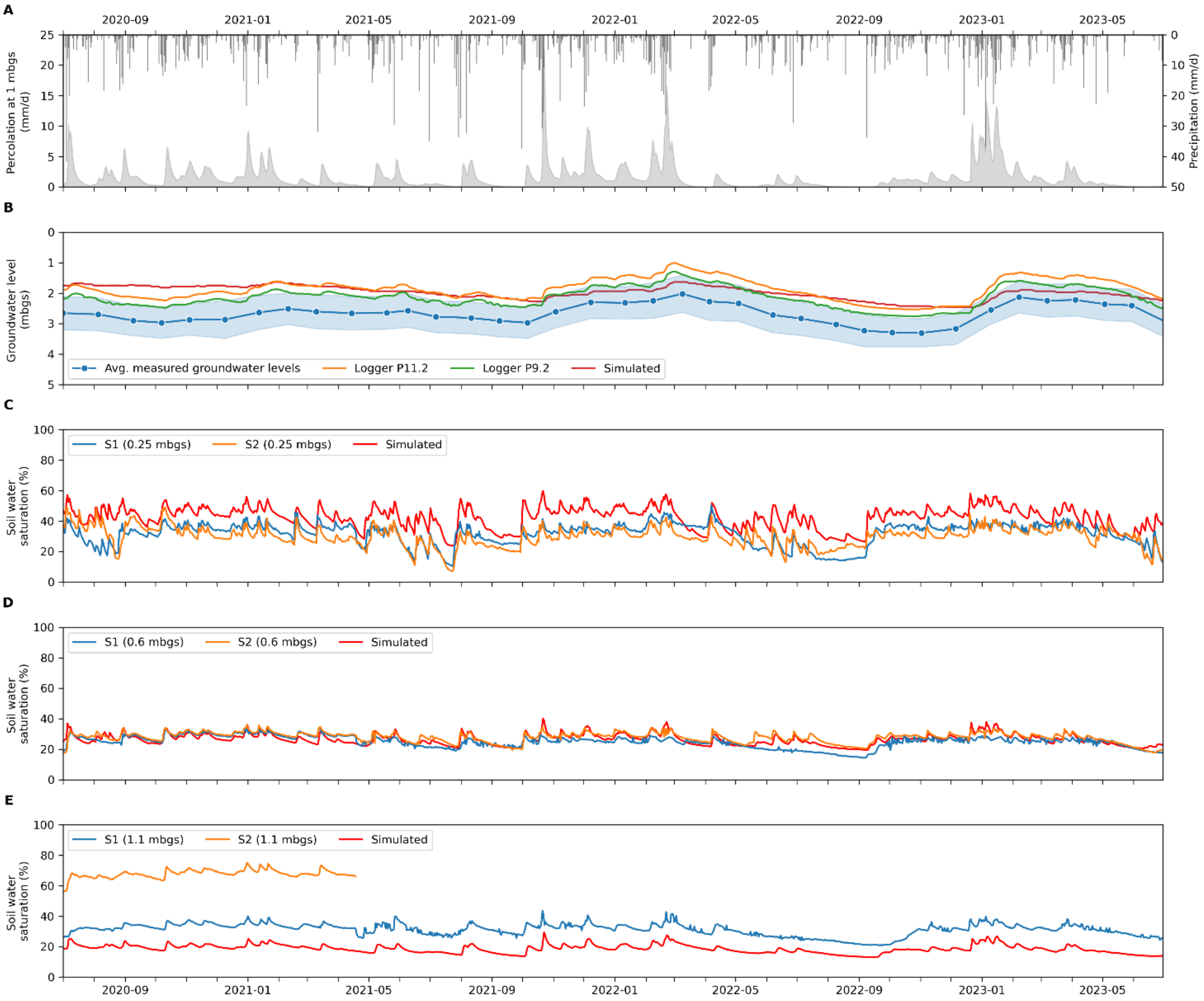

Figure 4.1.1. Hydrological components at Jyndevad. (A) Measured precipitation and simulated percolation 1 mbgs. (B) Depth to measured- and simulated groundwater table. The blue-shaded area represents the standard deviation of the averaged groundwater levels from the monitoring wells. (C-E) Soil water saturation from TDR probes at S1 and S2 together with simulated data. The measured data in B comprises piezometers located in the buffer zone. The measured data in C, D, and E from TDR probes installed at S1 and S2 (Figure 2.1.1).

The estimated yearly water balance for Jyndevad is shown in Table 4.1.1. The measured precipitation in 2023 was 19% lower compared to the average. The simulated actual evaporation was also lower than the average by 13% for 2023, while irrigation was 2% above the average. The estimated recharge for 2023 decreased by 21% compared to the average.

Table 4.1.1. Annual water balance for Jyndevad (mm/yr).

	Normal precipitation[1)]	Precipitation[2)]	Irrigation	Actual evapotranspiration[3)]	Groundwater recharge[4)]
01.07.99–30.06.00	995	1073	29	500	602
01.07.00–30.06.01	995	810	0	461	349
01.07.01–30.06.02	995	1204	81	545	740
01.07.02–30.06.03	995	991	51	415	627
01.07.03–30.06.04	995	937	27	432	531
01.07.04–30.06.05	995	1218	87	578	727
01.07.05–30.06.06	995	857	117	490	484
01.07.06–30.06.07	995	1304	114	571	847
01.07.07–30.06.08	995	1023	196	613	605
01.07.08–30.06.09	995	1078	84	551	610
01.07.09–30.06.10	995	1059	80	530	610
01.07.10–30.06.11	995	1070	92	554	607
01.07.11–30.06.12	995	1159	30	490	699
01.07.12–30.06.13	995	991	60	478	572
01.07.13–30.06.14	995	1104	75	485	693
01.07.14–30.06.15	995	1267	102	569	800
01.07.15–30.06.16	995	1365	105	581	888
01.07.16–30.06.17	995	1031	60	531	559
01.07.17–30.06.18	995	1230	210	570	870
01.07.18–30.06.19	995	805	240	569	477
01.07.19–30.06.20	995	1188	70	494	877
01.07.20–30.06.21	995	991	182	560	613
01.07.21–30.06.22	995	1073	110	538	645
01.07.22–30.06.23	995	880	115	468	527
Average	995	1082	113	536	666

1) Normal values based on time series for 1961-1990. 2) Precipitation is corrected to the soil surface according to the method of Allerup and Madsen (1979). 3) Actual evapotranspiration is estimated by the MACRO model applying climate data including potential evapotranspiration. 4) Groundwater recharge is calculated as precipitation + irrigation - actual evapotranspiration.

4.2. Silstrup

The monthly measured groundwater levels from all the well screens showed that the average groundwater levels fluctuated from around 1 to 3 mbgs (Figures 4.2.1B). During periods with drain flow, the groundwater levels fluctuated around approximately 1.4 mbgs (Figures 4.2.1B and C). The loggers from P3.2 and M7.4 both seemed to fluctuate around 1 mbgs during drain flow, while they were offset by approximately 1 m in periods without drain flow. The measured levels in M7.4 were more surface-near relative to P3.2 and were likely related to the terrain sloping downwards from P3 at around 45 masl towards M7 at around 41 masl. Hence, the measured groundwater levels were consistent with the general groundwater flow from the upstream well, P3 to the downstream well, M7 (Figure 2.2.1, Chapter 2, Silstrup). The elevated groundwater levels fluctuating around 1 mbgs in periods with drain flow were likely related to the drain depth. When the monitoring fields characterised as clay till were established, it was numerically assessed that the drain depths were approximately between 1-1.3 mbgs (e.g., Kjær et al, 2004). Therefore, the fluctuating groundwater levels around 1 mbgs indicate, that the drainpipes collect sufficient water to maintain the groundwater level around 1 mbgs. The simulated groundwater level generally captured the measured dynamics of the groundwater levels, especially during drain flow. Hence, similar to the observed groundwater levels during drain flow, where the groundwater levels fluctuated around 1 mbgs, the simulated levels also fluctuated around 1 mbgs (Figure 4.2.1B). Overall, the simulated drain flow was temporally comparable to measured drain flow meaning that drain flow was simulated when drain flow also was measured. Still, there is a pattern of simulated drain flow being overestimated (Figure 4.2.1C and Table 4.2.1).

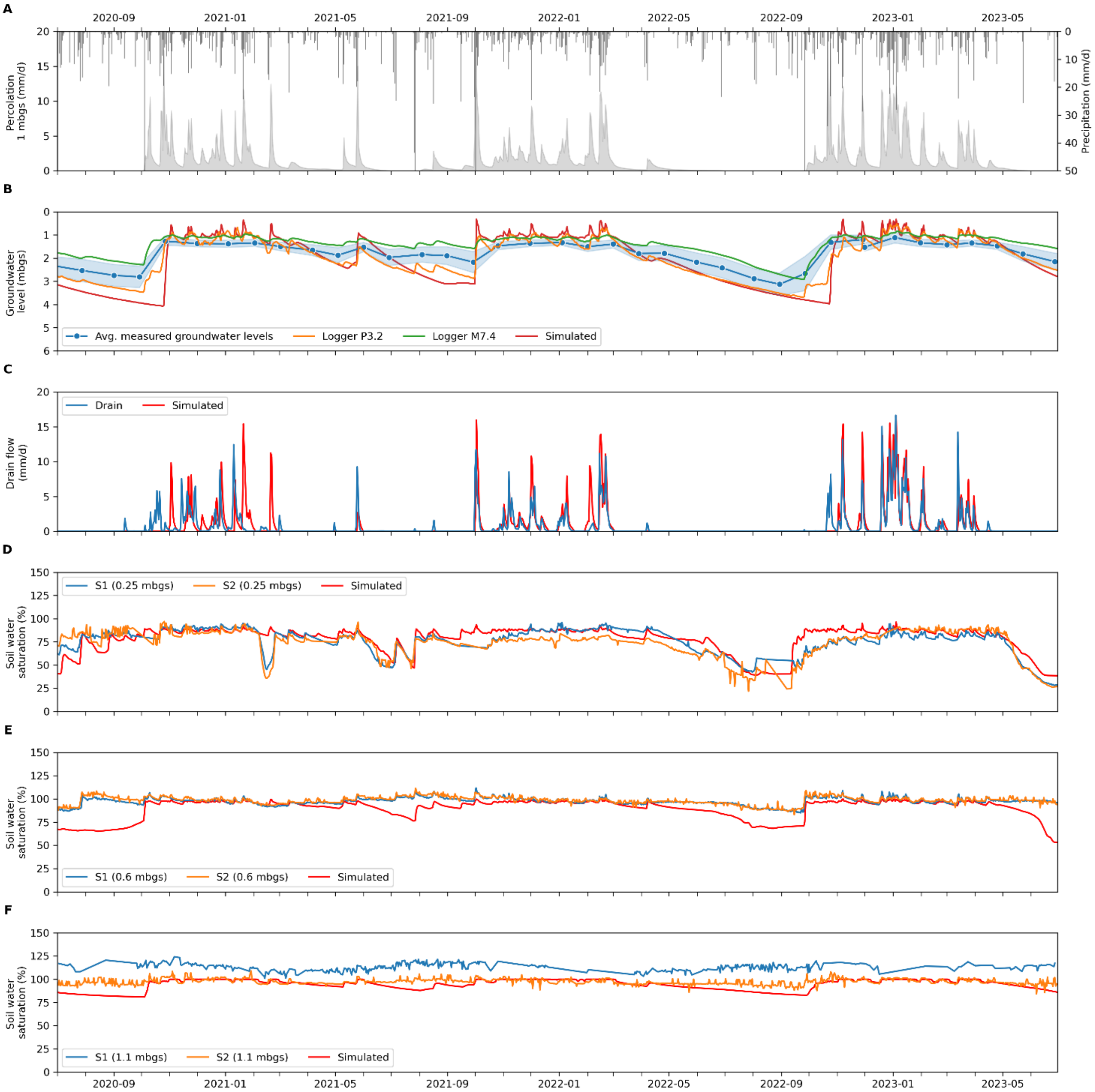

Figure 4.2.1. Soil water dynamics at Silstrup. (A) Measured precipitation and simulated percolation 1 mbgs. (B) Depth to measured- and simulated groundwater table. The blue-shaded area represents the standard deviation of the averaged groundwater levels from the monitoring wells. (C) Measured and simulated drain flow. (D-F) Soil water saturation from TDR probes at S1 and S2 together with simulated data. The measured data in B comprises piezometers located in the buffer zone. The measured data in D, E, and F from TDR probes installed at S1 and S2 (Figure 2.2.1).

At 0.25 mbgs, the measured soil water saturation at S1 and S2 were generally similar (Figure 4.2.1D). The measured periods with high/low soil water saturation in S1 and S2 were coincident, though their absolute values were offset. The simulated soil water saturation captured the overall dynamics from the measurements at 0.25 mbgs. At 0.6 mbgs, the measured soil water saturation at S1 and S2 were similar, whereas the simulated soil water saturation showed larger fluctuations that were derived from the simulated soil water saturation at 0.25 mbgs (Figure 4.2.1E). At 1.1 mbgs, the measurements between S1 and S2 deviated from one another, both in terms of periods with high/low soil water saturation and absolute values (Figure 4.2.1F). Also, periods with high/low soil water saturation were not coincident between S1 and S2 in 1.1 mbgs. Further, data from the measured time series of S1 were removed after being assessed as erroneous, and therefore, the time series is smoothed in some periods compared to S2 (Figure 4.2.1F). Overall, some of the calculated soil water saturation exceeded 100% and this is merely an artefact from the applied saturated volumetric water content in the saturation calculation, which was similar to what was used in the model for the given depths of measured soil water content.

Generally, the simulated soil water saturation dynamics from June 2020 to July 2023 were similar to the measured in 0.25 mbgs. The simulated soil water saturation dynamics in 0.6 and 1.1 mbgs were not consistent with the measurements, especially during periods with low groundwater table (e.g., Figures 4.2.1B and E-F). During these periods, the simulated soil water saturation was lower compared to what was measured. It is noted that the simulated groundwater level was also lower than what was observed and consequently, the simulated soil water content was lower compared to the measured. However, all groundwater measurements showed groundwater deeper than 1 mbgs during periods with the deeper levels to the groundwater, why soil water saturation should likely have decreased. This could indicate that locally around S1 and S2, the soil water saturation was higher than what was inferred from the groundwater measurements or simply that the measurements from the TDRs were erroneous.

Table 4.2.1. Annual water balance for Silstrup (mm/yr).

	Normal precipitation[2]	Precipitation[3)]	Actual evapotransp.[4]	Measured drain flow	Simulated drain flow	Groundwater recharge1[5]	Groundwater recharge2[6]
01.07.99–30.06.00[1)]	976	1175	457	-	443	275	-
01.07.00–30.06.01	976	909	443	217	232	249	234
01.07.01–30.06.02	976	1034	474	227	279	334	281
01.07.02–30.06.03	976	879	537	81	74	261	268
01.07.03–30.06.04	976	760	517	148	97	94	145
01.07.04–30.06.05	976	913	506	155	158	252	249
01.07.05–30.06.06	976	808	504	101	95	203	208
01.07.06–30.06.07	976	1153	543	361	307	248	302
01.07.07–30.06.08	976	882	438	200	184	243	260
01.07.08–30.06.09	976	985	537	161	260	286	187
01.07.09–30.06.10	976	835	395	203	225	237	214
01.07.10–30.06.11	976	1063	402	172	569	489	92
01.07.11–30.06.12	976	1103	432	230	321	441	349
01.07.12–30.06.13	976	1020	455	249	333	316	232
01.07.13–30.06.14	976	1067	556	275	335	236	175
01.07.14–30.06.15	976	1314	462	329	412	523	440
01.07.15–30.06.16	976	1200	352	293	517	555	332
01.07.16–30.06.17	976	871	402	95	228	374	240
01.07.17–30.06.18	976	984	539	233	520	212	-75
01.07.18–30.06.19	976	1103	435	226	316	442	351
01.07.19–30.06.20	976	1334	523	440	600	371	212
01.07.20-30.06.21	976	988	442	207	225	339	321
01.07.21–30.06.22	976	988	411	217	298	359	278
01.07.22–30.06.23	976	1114	517	379	421	217	175
Average	976	1020	470	226	310	315	238

1) *The monitoring started in April 2000. 2) Normal values based on time series for 1961–1990 corrected to soil surface (Olesen, 1991). 3)Precipitation is corrected to the soil surface according to the method of Allerup and Madsen (1979). 4) Actual evapotranspiration is estimated by the MACRO-model applying climate data including potential evapotranspiration 5) Groundwater recharge calculated as precipitation-simulated actual evapotranspiration-measured drain flow. 6) Groundwater recharge calculated as precipitation-simulated actual evapotranspiration-simulated drain flow.*

The estimated yearly water balance for Silstrup is shown in Table 4.2.1. The measured precipitation in 2023 was 9% above the average and the simulated actual evaporation 10% above the average. The measured drain flow was 68% above the average for 2023 and likewise, the simulated drain flow was 38% above to the average. It is noted that the groundwater recharge estimates were modified to include two different methods rather than one (as seen in PLAP reports prior to 2023). The recharge estimate method used hitherto was the following:

Groundwater recharge1 = precipitation – simulated actual evapotranspiration – measured drain flow,

and the currently added is:

Groundwater recharge2 = precipitation – simulated actual evapotranspiration – simulated drain flow.

The added recharge estimate represents the simulated groundwater recharge while the previous method yields a groundwater recharge estimate based on a mix of simulated and measured data. The estimated groundwater recharge with the recharge1 method for 2023 decreased 31% compared to the average. With the recharge2 method, the estimated groundwater recharge for 2023 decreased by 26% compared to the average. In terms of absolute values, it is evident that the two recharge estimation methodologies yield different values as the difference in yearly average is 77 mm/yr. Hence, the recharge estimated from the simulated results (recharge2 method) was 25% lower than groundwater recharge estimated from the recharge1 method (Table 4.2.1).

4.3. Estrup

The monthly measured groundwater levels from all the well screens showed that the groundwater levels fluctuated from around 2 to 7 mbgs. The levels were generally at their maximum during periods of drain flow (Figures 4.3.1B and C). The loggers from P1 and P3 showed similar dynamics, although the observations were offset around 1 m. The measured levels in P3.1 were more surface-near relative to the measured levels in P1.1 and were likely related to the terrain sloping downwards from P1 at around 58 masl to P3 at around 56 masl. This was consistent with the general groundwater flowing from the upstream well, P1 towards the downstream well, P3 (Figure 2.3.1 Chapter 2, Estrup). It is noted that the maximum elevation measured at the two wells was offset, which deviates from the observations at the other clay till field Silstrup, where upstream and downstream wells had comparable groundwater levels during drain flow (Figure 4.2.1B). This could indicate either that the drain levels are not located at similar depths below the terrain or that the drains, situated in the downstream area of the field, cannot prevent groundwater build-up from exceeding the drain depth. This is also backed by the averaged groundwater levels from all the wells showing relatively large standard deviations (Figure 4.3.1B) indicating that the differences in depth to the groundwater is pronounced at Estrup. The simulated groundwater levels were consistent with the measured groundwater levels at P3. Though the simulated drain flow events were consistent with measured drain flow, there were some instances, where the model did not capture the measured drain flows. e.g., in October 2021, a large event > 20 mm/d was not captured by the model (Figure 4.3.1C). Still, there was a pattern of simulated drain flow being overestimated (Figure 4.3.1C and Table 4.3.1).

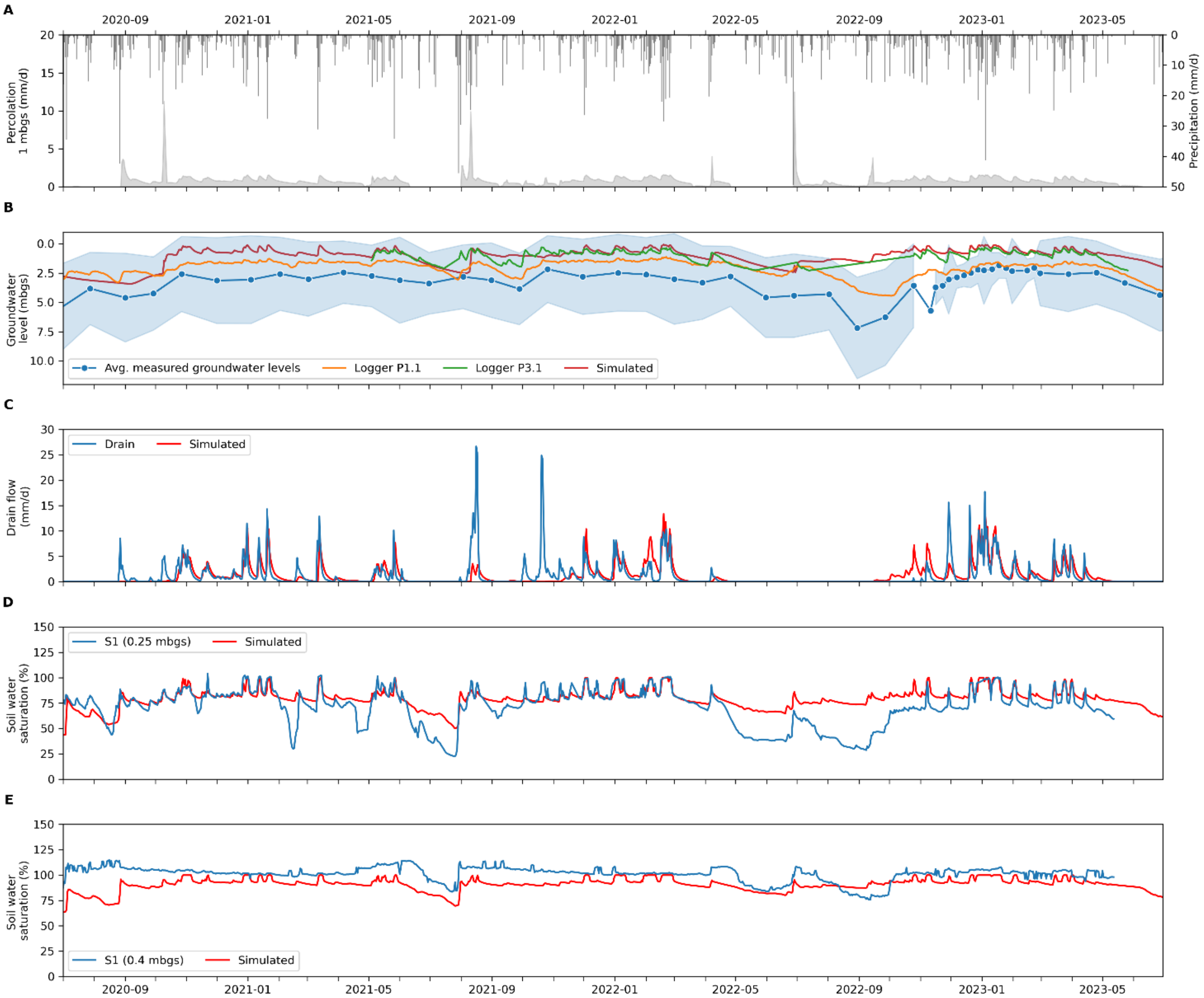

Figure 4.3.1. Soil water dynamics at Estrup. (A) Measured precipitation and simulated percolation 1 mbgs. (B) Depth to measured- and simulated groundwater table. The blue-shaded area represents the standard deviation of the averaged groundwater levels from the monitoring wells. (C) Measured and simulated drain flow. (D-E) Soil water saturation from TDR probes at S1 and S2 together with simulated data. The measured data in B comprises piezometers located in the buffer zone. The measured data in D and E are from TDR probes installed at S1 and S2 (Figure 2.3.1)

At Estrup, only TDRs in S1 were functional during this reporting period. The deduced soil water saturation in 0.25 mbgs seemed to coincide with the drain flow, so the maximum soil water saturation was measured during periods of drain flow (Figures 4.3.1C and D). At 0.4 mbgs, the coincidence between maximum soil water saturation and drain flow was also observed (Figures 4.3.1C and E), though not as clear as in 0.25 mbgs. Deduced soil water saturation exceeding 100% in 0.4 mbgs was related to the applied porosity in the saturation calculation, which was similar to what was used in the model for the given depths of measured soil water content. Nevertheless, the soil water saturation of around 100% was consistent with measurements at P3.1 showing groundwater levels fluctuating around 0.5 mbgs during drain flow. Generally, the simulated soil water saturation, captured the dynamics of the measurements, although simulated values were offset from measured values.

Table 4.3.1. Annual water balance for Estrup (mm/yr).

	Normal Precipitation[2]	Precipitation3)	Actual evapo-transpiration[4]	Measured drain flow	Simulated drain flow	Groundwater recharge1[5]	Groundwater recharge2[6]
01.07.99–30.06.00 1)	968	1173	466	-	539	168	168
01.07.00–30.06.01	968	887	420	356	336	111	131
01.07.01–30.06.02	968	1290	516	505	556	270	219
01.07.02–30.06.03	968	939	466	329	346	144	126
01.07.03–30.06.04	968	928	502	298	312	128	115
01.07.04–30.06.05	968	1087	476	525	466	86	146
01.07.05–30.06.06	968	897	460	258	339	179	98
01.07.06–30.06.07	968	1370	510	547	616	312	244
01.07.07–30.06.08	968	1047	536	521	564	-9	-53
01.07.08–30.06.09	968	1065	476	523	323	66	266
01.07.09–30.06.10	968	1190	528	499	510	163	151
01.07.10–30.06.11	968	1158	546	210	342	402	270
01.07.11–30.06.12	968	1222	469	479	504	274	249
01.07.12–30.06.13	968	1093	452	503	482	138	159
01.07.13–30.06.14	968	1015	571	404	434	39	9
01.07.14–30.06.15	968	1190	439	379	490	373	262
01.07.15–30.06.16	968	1230	446	491	564	293	220
01.07.16–30.06.17	968	847	511	274	264	63	72
01.07.17–30.06.18	968	1098	544	546	544	8	10
01.07.18–30.06.19	968	918	404	284	300	230	214
01.07.19–30.06.20	968	1396	509	620	713	267	174
01.07.20–30.06.21	968	1064	465	399	401	200	197
01.07.21–30.06.22	968	1044	417	522	406	105	221
01.07.22–30.06.23	968	995	339	409	421	277	235
Average	968	1089	478	430	449	177	163

1) The monitoring regarding water sampling started in April 2000. 2) Normal values based on time series for 1961–1990 corrected to the soil surface (Olesen, 1991). 3) Precipitation is corrected to the soil surface according to the method of Allerup and Madsen (1979). 4) Actual evapotranspiration is estimated by the MACRO-model applying climate data including potential evapotranspiration. 5) Groundwater recharge calculated as precipitation-simulated actual evapotranspiration-measured drain flow. 6) Groundwater recharge calculated as precipitation-simulated actual evapotranspiration-simulated drain flow.

The estimated yearly water balance for Estrup is shown in Table 4.3.1. The measured precipitation in 2023 was 9% lower compared to the average. The simulated actual evapotranspiration was 29% lower than the average for 2023. The measured drain flow was 5% lower than the average in 2023 and the simulated drain flow was 6% lower. It is noted that the groundwater recharge estimates are modified to include two different methods rather than one. The recharge estimate method used hitherto was the following:

Groundwater recharge1 = precipitation – simulated actual evapotranspiration – measured drain flow,

and the currently added is:

Groundwater recharge2 = precipitation – simulated actual evapotranspiration – simulated drain flow.

The added recharge estimate represents the simulated groundwater recharge while the previous method yields a groundwater recharge estimate based on a mix of simulated and measured data. The estimated groundwater recharge with the recharge1 method for 2023 increased by 29% compared to the average and with the recharge2 method, the estimated groundwater recharge increased by 45%. In terms of absolute values, the difference in estimated recharge using the two estimation methodologies yielded a difference in a yearly average of 8 mm/yr. Hence, the recharge estimated from the simulated results (recharge2 method) was 3% higher than the groundwater recharge estimated from the recharge1 method (Table 4.3.1).

4.4. Faardrup

The measured averaged groundwater levels from all screens showed that the groundwater levels fluctuated from around 2 to 8 mbgs (Figures 4.4.1B). The measured groundwater levels were at their maximum during periods of drain flow (Figures 4.4.1B and C) but not as distinctly as observed in Silstrup and Estrup. At Faardrup, the logger measurements from P2.2 and M6.4 were offset up to 2 m during periods of declining groundwater levels. The measured levels in M6.4 were generally more surface-near relative to P2.2 and likely related to the terrain sloping downwards from P2 at around 32 masl towards M6 at around 30 masl. Hence, the measured groundwater levels were consistent with the general groundwater flow from the upstream well, P2 to the downstream well, M6 (Figure 2.4.1, Chapter 2, Faardrup). However, the measurements showed that there was a temporal lag between P2.2 and M6.4 such that the highs/lows in groundwater levels were not coincident. For instance, from around January-March 2021 and December 2021-March 2022, groundwater highs/lows in M6.4 were reached later compared to P2.2 (Figure 4.4.1B). This indicates that the hydraulic properties surrounding the two wells are different and, thus also their response to groundwater level fluctuations. The simulated groundwater captured the overall observed dynamics, although offset compared to both the logger measurements.

At both Silstrup and Estrup, it was observed that elevated groundwater levels remained relatively constant during drain flow. At Faardrup, where groundwater levels were also elevated during drain flow, it is noted that groundwater levels seemed less responsive to drain flow (Figure 4.4.1B and C). That is, after a low in groundwater level, the increase following a drain event was relatively gentle compared to both Silstrup and Estrup, where increases in groundwater level following drain flow was essentially instantaneous and more pronounced. The reason for the slower response to drain flow is likely related to the greater depth to the groundwater at Faardrup compared to Silstrup and Estrup. At Faardrup, the average depth to the groundwater was around 4.3 m, while it was around 1.7 and 3.1 m at Silstrup and Estrup. Consequently, groundwater levels at Faardrup must increase more to reach the drain depth. This effect is also seen in the average drain flow, which at Faardrup is substantially lower (84 mm/yr) compared to Silstrup (226 mm/yr) and Estrup (430 mm/yr). Lastly, it also noted the average precipitation of 687 mm/yr at Faardrup is substantially lower compared to Silstrup (1020 mm/yr) and Estrup (1089 mm/yr).

The TDRs were not functioning during the entire first half of the period shown in Figure 4.4.1D-F. In 0.6 mbgs, the TDR measurements were offset and the S2 logger seemed to be erroneous from June to November 2022. Still, the simulated soil water saturation captured the overall dynamics inferred from the measurements.

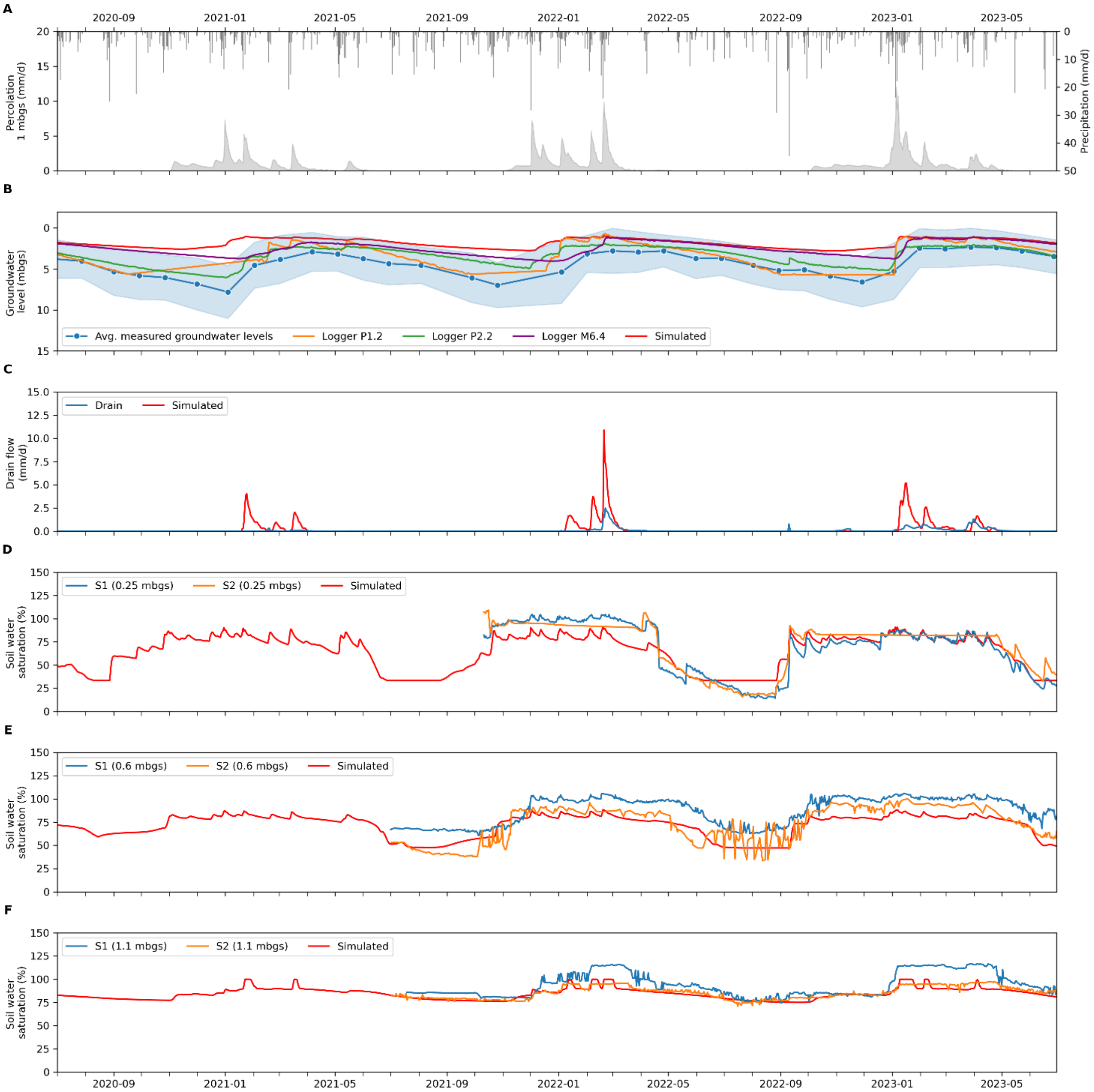

Figure 4.4.1. Soil water dynamics at Faardrup. (A) Measured precipitation and simulated percolation 1 mbgs. (B) Depth to measured- and simulated groundwater table. The blue-shaded area represents the standard deviation of the averaged groundwater levels from the monitoring wells. (C) Measured and simulated drain flow. (D-E) Soil water saturation from TDR probes at S1 and S2 together with simulated data. The measured data in B comprises piezometers located in the buffer zone. The measured data in D and E are from TDR probes installed at S1 and S2 (Figure 2.4.1)

The estimated yearly water balance for Faardrup is shown in Table 4.4.1. The measured precipitation in 2023 was 2% above the average, while the simulated actual evaporation was similar to the average in 2022. The measured drain flow in 2023 was 42% below average and the simulated drain flow 2% lower than the average. It is noted that the groundwater recharge estimates are modified to include two different methods rather than one. The recharge estimate method used hitherto was the following:

Groundwater recharge1 = precipitation – simulated actual evapotranspiration – measured drain flow,

and the currently added is:

Groundwater recharge2 = precipitation – simulated actual evapotranspiration – simulated drain flow.

The added recharge estimate represents the simulated groundwater recharge while the previous method yields a groundwater recharge estimate based on a mix of simulated and measured data. The estimated groundwater recharge with the recharge1 method for 2023 increased by 29% compared to the average, whereas the recharge2 method increased 10% compared to the average. In terms of absolute values, the difference in estimated recharge using the two estimation methodologies yielded a difference in a yearly average of 26 mm/yr. Hence, the recharge estimated from the simulated results (recharge2 method) was 42% lower compared to the groundwater recharge estimated from the recharge1 method (Table 4.4.1).

Table 4.4.1. Annual water balance for Faardrup (mm/yr).

	Normal Precipitation[1]	Precipitation[2]	Actual Evapotranspiration[3]	Measured drain flow	Simulated drain flow	Groundwater recharge1[4]	Groundwater recharge2[5]
01.07.99–30.06.00	626	715	572	192	151	-50	-9
01.07.00–30.06.01	626	639	383	50	35	206	221
01.07.01–30.06.02	626	810	469	197	201	145	141
01.07.02–30.06.03	626	636	470	49	108	118	59
01.07.03–30.06.04	626	685	513	36	24	136	148
01.07.04–30.06.05	626	671	469	131	55	72	147
01.07.05–30.06.06	626	557	386	28	18	144	154
01.07.06–30.06.07	626	796	511	202	191	83	94
01.07.07–30.06.08	626	645	522	111	76	12	47
01.07.08–30.06.09	626	713	472	46	19	195	221
01.07.09–30.06.10	626	624	438	54	35	132	152
01.07.10–30.06.11	626	703	472	133	144	97	86
01.07.11–30.06.12	626	746	430	98	112	218	203
01.07.12–30.06.13	626	569	450	62	69	57	50
01.07.13–30.06.14	626	595	438	44	92	112	64
01.07.14–30.06.15	626	819	493	123	167	202	159
01.07.15–30.06.16	626	800	429	124	167	247	204
01.07.16–30.06.17	626	628	410	0	34	218	184
01.07.17–30.06.18	626	754	426	169	265	160	63
01.07.18–30.06.19	626	668	426	5	104	237	137
01.07.19–30.06.20	626	745	385	33	242	327	118
01.07.20–30.06.21	626	621	491	4	58	126	72
01.07.21–30.06.22	626	641	430	32	110	179	101
01.07.22–30-06.23	626	697	456	48	105	192	135
Average	626	687	456	82	108	149	123

1) Normal values based on time series for 1961–1990 corrected to the soil surface (Olesen, 1991).2) For July 1999-June 2002, July 2003-June 2004, in January and February of both 2005 and 2006, and July 2006-June 2007, measured at the DIAS Flakkebjerg meteorological station located 3 km from the field (see detailed text above). Precipitation is corrected to the soil surface according to the method of Allerup and Madsen (1979). 3) Actual evapotranspiration is estimated by the MACRO-model applying climate data including potential evapotranspiration. 4) Groundwater recharge calculated as precipitation-simulated actual evapotranspiration-measured drain flow. 5)Groundwater recharge calculated as precipitation-simulated actual evapotranspiration-simulated drain flow.

5. Evaluation of pesticide tests

In this chapter, each pesticide is evaluated separately. This means that in the present report, pesticide test results are reported as a whole, covering its application in all fields included in the specific test. Further, it is noted that the present reporting period covers the monitoring period ending June 30, 2023 so testing of compounds initiated in 2023 is mentioned but not evaluated. However, these compounds will be evaluated in the forthcoming report.

In the previous report, the reporting period was covering two years 2020-2022 with no overlap. However, this was only done to make up for delay in the publication of the report. This present report covers data from the period July 1, 2021 to June 30, 2023 overlapping the previous report (Badawi et al. 2023b) from July 1, 2021 to June 30, 2022. During this period, several pesticides were monitored, although they were applied in the preceding years. In these cases, the comprehensive monitoring period, starting from the background sampling before application till the end of the test or the reporting period, will also be included in the evaluation presented in the following sections. Therefore, the monitoring periods are specified individually for each of the pesticide tests as they might be exceeding the reporting period from July 1, 2021 to June 30, 2023. A short overview of the pesticide applied in each field is given in the next section and followed by the evaluation of each individual pesticide test in specific sections.

For information on the agricultural management and related use of pesticides in the fields (eg. seed dressings), please refer to Chapter 3 and Appendix 3. For previous agricultural management please refer to earlier reports (e.g. Badawi et al. 2023b, available at www.plap.dk).

Pesticides applied at Jyndevad

The fungicide cyazofamid and the insecticide acetamiprid were applied in potatoes in 2020. In total, cyazofamid was applied six times from June to September, whereas acetamiprid was applied twice (in June and July). Four degradation products from cyazofamid, DMS, DMSA, CCIM, and CTCA (monitoring of CTCA and CCIM ended in January 2023), and two degradation products from acetamiprid, IM-1-4, and IM-1-5 were included in the monitoring in May 2020. No pesticide test was initiated in 2021. The herbicide tribenuron-methyl was applied in spring barley (seed coated with tebuconazole and prothioconazole) in April 2022, and the fungicides prothioconazole and fluopyram were applied in May 2022. Three degradation products from tribenuron-methyl: IN-B5528, IN-R9805, and M2, and fluopyram and its degradation product, fluopyram-7-hydroxy, were included in the monitoring in February 2022. The common degradation product from azoles, 1,2,4-triazole, was continuously monitored (monitoring ended in December 2022).

The herbicide glyphosate was applied twice, once in July 2022 and again in May 2023. Glyphosate was not included in the monitoring, but glyphosate tests are reported in previous reports available at www.plap.dk.

The fungicide oxathiapiprolin and the insecticide lambda cyhalothrin were applied in potatoes (coated with fludioxonil) in July 2023, and lambda cyhalothrin was applied a second time in August 2023. The degradation product IN-E8S72 from oxathiapiprolin and Compound Ia (lambda cyhalothrin acid) from lambda cyhalothrin were included in the monitoring in February 2023. During the period June-September 2023, the potato crop was additionally applied the fungicides mandipropamid, fluazinam, difenoconazole, propamocarb and cymoxanil and the insecticide acetamiprid, but none of the compounds or their degradation products were included in the monitoring.

Figure 5.0.1 shows all applications of pesticides at Jyndevad from April 2020 to September 2023. For each pesticide, it is indicated whether it was included in the monitoring or not. Since Jyndevad is irrigated during the dry months, this is also indicated in the figures. For more details about agricultural management at the field, please refer to Chapter 3.1.

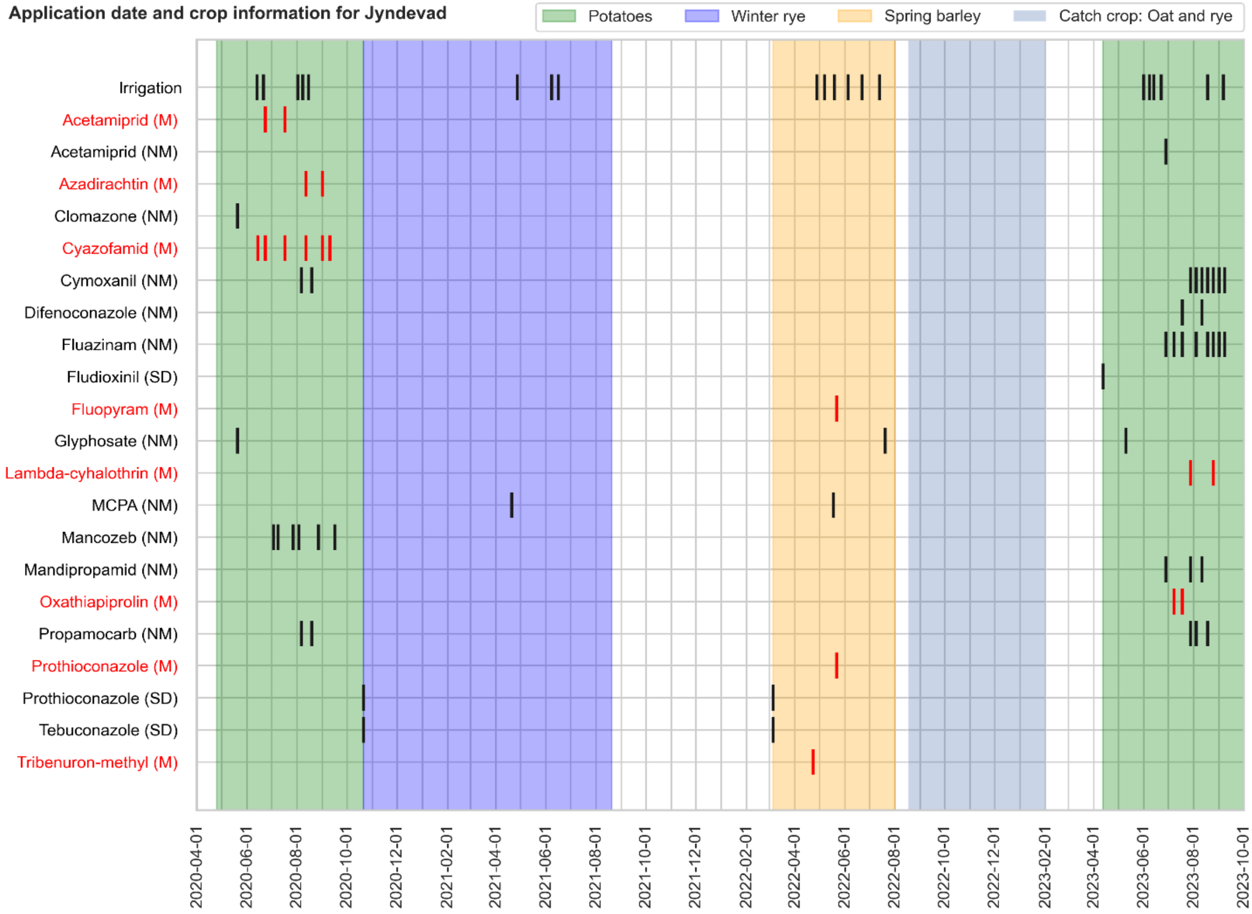

Figure 5.0.1. Application of pesticides at Jyndevad. Substances included in the monitoring are marked (M), substances that were not included in the monitoring are marked (NM). Pesticides applied as seed dressings are marked (SD).

Pesticides applied at Silstrup

Two herbicides, pyroxsulam, and florasulam were used in winter wheat (seed coated with fludioxonil) in April 2020. Five degradation products from pyroxsulam, PSA, 6-Cl-7-OH-pyroxsulam, 5-OH-pyroxsulam, 7-OH-pyroxsulam, and pyridine sulfonamide, and four degradation products from florasulam, TSA, 5OH-florasulam, DFP-ASTCA, and DFP-TSA were included in the monitoring in March 2020 (monitoring ended in March 2022 and final evaluation was reported in Badawi et al. 2023b). In May and June 2020, the winter wheat was additionally applied two fungicides, prothioconazole, and azoxystrobin. The azoxystrobin degradation product, CyPM was included in the monitoring in May 2020.

The fungicides, prothioconazole, and fluopyram were applied in the spring barley in June 2021. Fluopyram was included in the monitoring in April 2021 and 1,2,4-triazole was continuously monitored.

The herbicide tribenuron-methyl was applied in winter wheat (seed coated with tebuconazole and fludioxonil) in April 2022, and the fungicides prothioconazole and fluopyram were applied in May and June 2022. Three degradation products from tribenuron-methyl, IN-B5528, IN-R9805 and M2, and fluopyram and its degradation product, fluopyram-7-hydroxy, were included in the monitoring in February 2022. The common degradation product from azoles, 1,2,4-triazole, was continuously monitored (monitoring ended in December 2022). In September 2022, the herbicide diflufenican was applied in a new crop of winter wheat but not monitored.

The herbicides tribenuron-methyl and metsulfuron-methyl were applied in the winter wheat (seed coated with prothioconazole) in May 2023 and the fungicides prothioconazole and fluopyram were applied in May and June 2023. The three degradation products from tribenuron-methyl, IN-B5528, IN-R9805 and M2, and fluopyram and its degradation product, fluopyram-7-hydroxy were continuously monitored.

The herbicide pendimethalin was applied in winter rapeseed in August 2023, and the degradation product M455H001 was included in the monitoring in May 2023.

Figure 5.0.2 shows all applications of pesticides at Silstrup from September 2019 to August 2023. For each pesticide, it is indicated whether it was included in the monitoring or not. For more details about agricultural management at the field, please refer to Chapter 3.2.

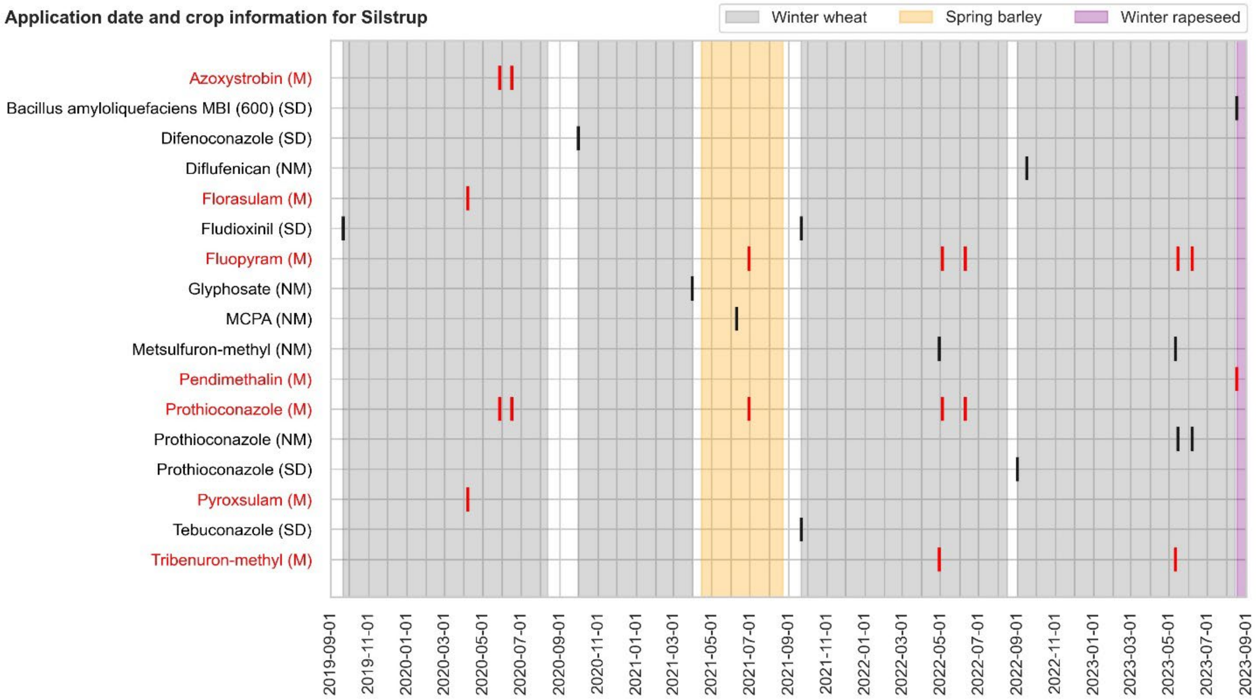

Figure 5.0.2. Application of pesticides at Silstrup. Substances included in the monitoring are marked (M), substances that were not included in the monitoring are marked (NM). Pesticides applied as seed dressings are marked (SD).

Pesticides applied at Estrup

Two pesticides, pyroxsulam, and florasulam were applied in winter wheat (seed coated with tebuconazole and prothioconazole) in May 2020. Five degradation products from pyroxsulam, PSA, 6-Cl-7-OH-pyroxsulam, 5-OH-pyroxsulam, 7-OH-pyroxsulam, and pyridine sulfonamide, and four degradation products from florasulam, TSA, 5OH-florasulam, DFP-ASTCA, and DFP-TSA, were included in the monitoring in April 2020 (monitoring ended in March 2022 and final evaluation was reported in Badawi et al. 2023b). One pesticide, thifensulfuron-methyl was applied in spring barley (seed coated with tebuconazole and prothioconazole) in June 2021 and the three thifensulfuron-methyl degradation products, IN-JZ789, IN-B5528, and IN-L9223 were included in the monitoring in April 2021. The monitoring of the three degradation products continued in 2023 as thifensulfuron-methyl was reapplied in July 2022 in a mixture of perennial ryegrass varieties. The common degradation product from azoles, 1,2,4-triazole, was continuously monitored (monitoring ended in December 2022). The herbicide pendimethalin was applied in winter rapeseed in August 2023, and the degradation product M455H001 was included in the monitoring in May 2023.

Figure 5.0.3 shows all applications of pesticides at Estrup from September 2019 to August 2023. For each pesticide, it is indicated whether it was included in the monitoring or not. For more details about agricultural management at the field, please refer to Chapter 3.3.

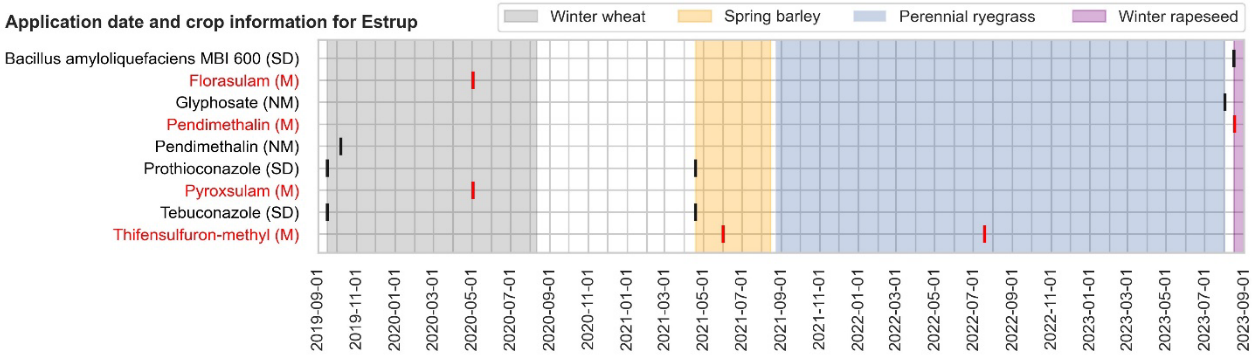

Figure 5.0.3. Application of pesticides at Estrup. Substances included in the monitoring are marked (M), substances that were not included in the monitoring are marked (NM). Pesticides applied as seed dressings are marked (SD).

Pesticides applied at Faardrup

The herbicide propyzamide was applied in winter rapeseed in November 2020 and the compound was included in the monitoring in October 2020 (monitoring ended in November 2022). The fungicides, prothioconazole, and fluopyram were applied in the winter rapeseed (coated with Bacillus amyloliquefaciens MBI 600) in May 2021. Fluopyram was included in the monitoring in April 2021. Prothioconazole and fluopyram were reapplied in winter wheat (seed coated with tebuconazole and prothioconazole) twice in May 2022. The herbicide tribenuron-methyl was applied in winter wheat in April 2022. Three tribenuron-methyl degradation products, IN-B5528, IN-R9805, and M2, and one additional fluopyram degradation product, fluopyram-7-hydroxy were included in the monitoring in February 2022.

The herbicide diflufenican (not monitored) and insecticide tau-fluvalinate (not monitored) were applied in winter wheat (coated with prothioconazole) in September and October 2022, respectively. The herbicide tribenuron-methyl and metsulfuron-methyl was applied in the winter wheat in April 2023, and the fungicides fluopyram and prothioconazole were applied twice in May 2023. The three tribenuron-methyl degradation products, IN-B5528, IN-R9805, and M2, fluopyram, and the fluopyram degradation product, fluopyram-7-hydroxy were continuously monitored.

The common degradation product from azoles, 1,2,4-triazole, was continuously monitored (monitoring ended in December 2022).

Figure 5.0.4 shows all applications of pesticides at Faardrup from July 2020 to June 2023. For each pesticide, it is indicated whether it was included in the monitoring or not. For more details about agricultural management at the field, please refer to Chapter 3.4.

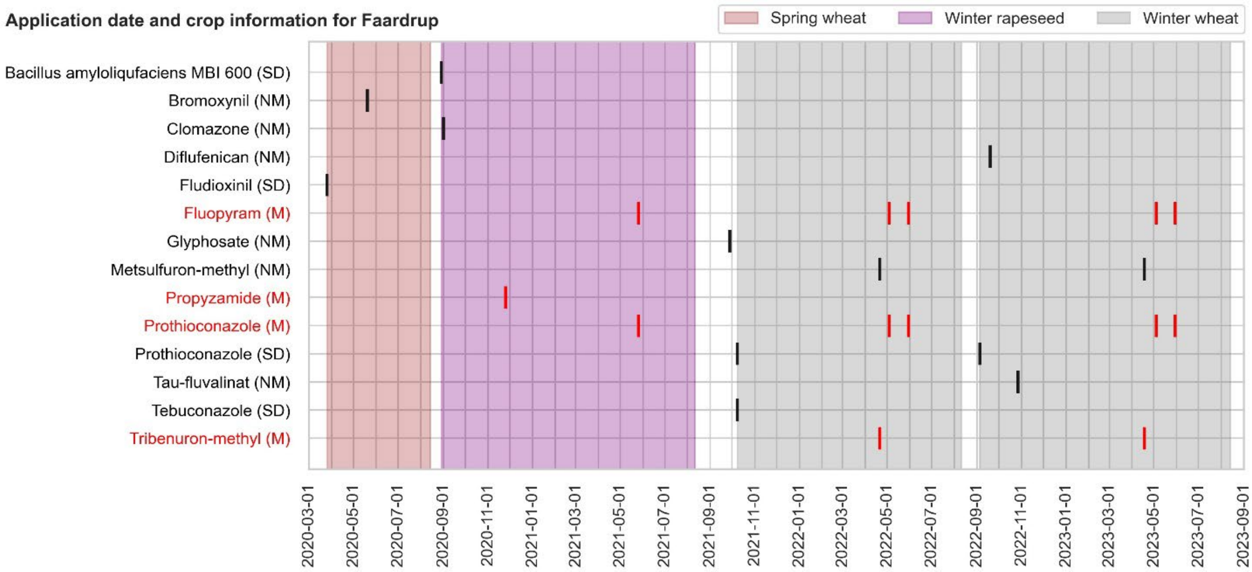

Figure 5.0.4. Application of pesticides at Faardrup. Substances included in the monitoring are marked (M), substances that were not included in the monitoring are marked (NM). Pesticides applied as seed dressings are marked (SD).

Pesticides applied at Lund

Starting from October 1, 2022, all pesticide monitoring at Lund was put on standby due to uncertainty of the hydraulic connectivity in the monitoring wells and the percolating water from the field. Pesticide tests that were active at Lund at that time, will not undergo evaluation and previous evaluated tests should not be used in pesticide assessments as the uncertainty in hydraulic connectivity can affect the outcome of the tests (the lack of detections can be a consequence of lacking hydraulic connectivity). The bromide tracer experiment, initially done in 2017 when the field was established, appears to have been erroneous. Consequently, a new bromide tracer experiment was initiated in January 2023 and will be assessed in the upcoming years.

Evaluation of pesticide tests from July 2021 to June 2023

This report presents the results for the period May 1999–June 2023 with a focus on the leaching risk of pesticides applied during the monitoring period July 2021-June 2023. During this period, several pesticides were monitored, although they were applied in the preceding years. In these cases, the entire monitoring period, starting from the background sampling before application, will also be included in the evaluation presented in the following sections. The reporting periods are specified individually for each of the pesticide tests.

5.1. Acetamiprid

Two degradation products, IM-1-4 and IM-1-5 from acetamiprid, were monitored in the current reporting period, July 2021-June 2023, following acetamiprid application on the sandy field Jyndevad. Detailed information on the field site is available in Chapter 2.

5.1.1. Application of acetamiprid at Jyndevad

Acetamiprid was tested in PLAP in connection with cropping of potatoes at Jyndevad in 2020. Acetamiprid was applied at Jyndevad on June 23, and July 17, 2020. Detailed information on agricultural management is available in Chapter 3 and Appendix 3. Acetamiprid was additionally applied in potatoes in June 2023, but this application was not part of a test and neither acetamiprid nor any of its degradation products were included in the monitoring.

Acetamiprid was previously applied in a potato crop at Jyndevad in 2014, but neither acetamiprid nor any of its degradation products were included in the monitoring at the time. Information on the agricultural management relating to the 2014 application is reported in previous PLAP reports available at www.plap.dk.

5.1.2. Compounds included in the monitoring

Two degradation products, IM-1-4 and IM-1-5, from acetamiprid were selected for monitoring at Jyndevad starting in April 2020 and monitoring continued until September 2022, when the test ended.

Monitoring of the degradation products started in April 2020, but the analytical methods for analyses of IM-1-4 and IM-1-5 were not ready. Consequently, the water samples collected from April to October 2020 were stored at -20°C (refer to Chapter 7 in Badawi et al. 2023b) after which the analytical methods were ready. The effect of storing the samples is currently unknown but relatively unstable compounds may degrade during storage leading to underestimation of concentration magnitudes (e.g., Lyytikäinen et al. 2003). In total 67 of 299 samples were stored before analysis.

5.1.3. Results of the IM-1-4 and IM-1-5 monitoring

IM-1-4 and IM-1-5 were introduced in the monitoring in April 2020, meaning that background samples were collected before the first acetamiprid application on June 23, 2020. In total, 31 background samples were collected in suction cups and monitoring wells, before the acetamiprid application and none of these contained IM-1-4 and IM-1-5.

Water used for irrigation of the field was additionally analysed for both IM-1-4 and IM-1-5. One irrigation water sample was collected in June 2020 before the acetamiprid application, and six were collected and analysed from June 23, 2020 to September 2022. IM-1-4 and IM-1-5 were not detected in any of the irrigation water samples.

An overview of the entire monitoring is given in Table 5.1.1 and shows the number of detections in water from suction cups and monitoring wells during the monitoring period from June 23, 2020 to September 2022, when the monitoring ended.

Table 5.1.1. Number of samples and detections of IM-1-4 and IM-1-5 at Jyndevad in water from suction cups (S), vertical monitoring wells (M), and horizontal wells (H). The counting comprises all samples collected from June 23, 2020 to September 2022. Background samples collected before the application of acetamiprid and irrigation water samples are not included in the counting.

	Total			S			M			H			Total Groundwater (M+H)		
	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L
Jyndevad															
IM-1-4	261	0	0	54	0	0	193	0	0	14	0	0	207	0	0
IM-1-5	261	0	0	54	0	0	193	0	0	14	0	0	207	0	0

Suction cups and groundwater monitoring wells

A total of 54 and 207 samples were collected from suction cups and groundwater monitoring wells, respectively, at Jyndevad in connection with the acetamiprid test from June 2020 to September 2022. IM-1-4 and IM-1-5 were neither detected in samples collected from the suction cups nor the groundwater wells (Table 5.1.1).

5.1.4. Discussion and conclusion of the IM-1-4 and IM-1-5 monitoring

Acetamiprid was tested in a potato crop at Jyndevad in 2020. None of the two degradation products, IM-1-4 and IM-1-5, were detected in water from the suction cups, groundwater, or irrigation water, neither before the acetamiprid application (from April to June 2020) nor in the monitoring period from June 2020 to September 2022, when the monitoring ended. In conclusion, IM-1-4 and IM-1-5 did not give rise to groundwater detections above 0.1 µg/L during the two-year monitoring period at the sandy field Jyndevad.

5.2. Azole fungicides

The degradation product, 1,2,4-triazole was monitored in the current reporting period, July 2021 to June 2023, but 1,2,4-triazole has continuously been part of the monitoring since 2014 at Jyndevad, Estrup and Faardrup and since 2016 at Silstrup. Monitoring of 1,2,4-triazole at all fields ended in December 2022. The monitoring results from 2014 to July 2022 were discussed in detail in Badawi et al. (2022) and Badawi et al. (2023b). As the current report contains the final evaluation of the 1,2,4-triazole monitoring we have included results already described in previous reports where this was relevant.

During the nine (seven at Silstrup) years of monitoring, several azole fungicides were used in different crops both as spray application and as seed dressing. Azole-coated seeds (tebuconazole, prothioconazole, and difenoconazole) were frequently used in the fields and their registration started in 2017. In the present reporting period the most recent applications of azole fungicides was propiconazole and prothioconazole at the sandy field Jyndevad and clay till field Faardrup, and prothioconazole and metconazole at the clay till fields Silstrup and Estrup, respectively. Detailed information on the field sites included in the tests is available in Chapter 2.

1,2,4-triazole was also monitored at Lund since 2018, but all pesticide monitoring at Lund was set on standby in October 2022, due to uncertainty of the hydraulic connectivity in the monitoring wells and the percolating water from the field. The azole tests done at Lund will therefore not be further evaluated as the uncertainty in hydraulic connectivity may have had an effect on the outcome of the tests. A new bromide tracer test to elucidate the connectivity was started at Lund in January 2023, as the bromide test in 2017, seemed to have been erroneous.

5.2.1. Application of azoles at Jyndevad, Silstrup, Estrup, and Faardrup

The azole pesticides were tested in the four fields with cropping of winter wheat, spring barley, winter rapeseed, and a catch crop of grass and clover during 2016-2023.

Metconazole was applied at Estrup in spring barley (coated with prothioconazole and tebuconazole) in June 2019.

Propiconazole was applied in a crop of spring barley and a catch crop of grass and clover at Jyndevad in June 2016, and in spring barley (coated with imazalil) in Faardrup in June and July 2017.

Prothioconazole was applied at Silstrup, in winter wheat (coated with fludioxonil) in May and June 2020, in spring barley (not coated) in June 2021, and in winter wheat (coated with fludioxonil and tebuconazole) in May and June 2022. At Faardrup, prothioconazole was applied to winter rapeseed in May 2021, and to winter wheat (coated with prothioconazole and tebuconazole) in May 2022. At Jyndevad, prothioconazole was applied to spring barley (coated with prothioconazole and tebuconazole) in May 2022.

Apart from the sprayings and related use of azole-coated seeds mentioned above, tebuconazole and prothioconazole were previously used as seed dressing several times in all fields (Figures 5.0.1-4, Chapter 3 and Appendix 3).

The azole fungicides, tebuconazole, prothioconazole, epoxiconazole, propiconazole, and difenoconazole have previously been applied at the PLAP fields. Detailed information on previous azole applications and agricultural management is available in Chapter 3 and Appendix 3, and previous PLAP reports (available at www.plap.dk).

5.2.2. Compounds included in the monitoring

1,2,4-triazole was included in the monitoring in 2014 at the three PLAP fields, Jyndevad, Estrup and Faardrup, and in 2016 at Silstrup, and was continuously monitored until January 1, 2023, when it was ended at all four fields. No other degradation products from the azole fungicides are tested in PLAP.

5.2.3. Results of the 1,2,4-triazole monitoring

As the azoles were applied several times between 1999 and 2014 before the 1,2,4-triazole monitoring was initiated in 2014 at four fields (Jyndevad, Silstrup, Estrup, and Faardrup), it is not possible to determine the background content of 1,2,4-triazole.

The complete 1,2,4-triazole monitoring is plotted for each of the four fields in the figures below and individual plots for each well screen are presented in Appendix 8.

Table 5.2.1. Number of samples and detections of 1,2,4-triazole at Jyndevad, Silstrup, Estrup, and Faardrup, in suction cups (S; Jyndevad only) and drainage (D), vertical monitoring wells (M) and horizontal wells (H). As the azoles were used several times during the last couple of years the counting comprises all samples collected since monitoring started in 2014 at Jyndevad, Estrup, and Faardrup, and in 2016 at Silstrup, and ends January 1, 2023 at all fields. Irrigation water samples (Jyndevad) are not included in the counting.

	Total			S/D			M			H			Total Groundwater (M+H)		
	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L
Jyndevad															
1,2,4-triazole	1052	612	15	185*	94*	9*	796	479	6	71	39	0	867	518	6
Silstrup															
1,2,4-triazole	548	305	10	141	137	6	291	96	2	116	72	2	407	168	4
Estrup															
1,2,4-triazole	721	674	329	268	267	250	275	232	66	178	175	13	453	407	79
Faardrup															
1,2,4-triazole	680	175	6	142	138	6	418	19	0	120	18	0	538	37	0

**data from suction cups at Jyndevad*

The monitoring of 1,2,4-triazole ended January 1, 2023, at all fields, and the present evaluation is therefore the final evaluation of the 1,2,4-triazole monitoring at the fields.

Jyndevad

At Jyndevad, 1,2,4-triazole was included in the monitoring in November 2014. The most recent application of an azole product in Jyndevad was a prothioconazole spraying in May 2022. The results of the full monitoring period from November 2014 to December 2022 are shown in Figure 5.2.1 as well as Table 5.2.1.

Variably saturated zone - suction cups

From the suction cups 1 mbgs in the variably saturated zone, 1,2,4-triazole was detected in 94 out of 185 samples and in nine of these in concentrations > 0.1 µg/L during the entire monitoring period (Table 5.2.1). All 1,2,4-triazole detections in concentrations > 0.1 µg/L occurred from August 2015 to July 2017, with a maximum concentration of 0.27 µg/L detected in S2 (Figure 5.2.1B). Hereafter, no detections > 0.1 µg/L were made, and interchanging periods with detections and non-detections occurred. From October 2017 to December 2019, 1,2,4-triazole was generally detected continuously in samples 1 mbgs from S2, while detections in samples from S1 were sporadic after July 2018. From July 2018 until the end of the monitoring on January 1, 2023, detections from S1 were limited to four samples. In S2, 1,2,4-triazole detections, still < 0.1 µg/L, were generally observed during three six-month periods starting from August 2020, May 2021 and June 2022 (Figure 5.2.1B). It seems that the concentration of 1,2,4-triazole in water from the suction cups decreased from June 2017 and leveled out at a concentration of approximately 0.02 µg/L in the last two years of monitoring.

Groundwater monitoring wells

It is important to note that before October 2022, the monitoring strategy was to sample only the two uppermost water-filled screens in all selected monitoring wells at each specific sampling date. Consequently, fluctuations in groundwater levels resulted in data discontinuity, particularly in the deepest screens. Starting from October 2022, all water-filled screens have been sampled from selected wells (refer Chapter 2).

During the entire monitoring period, detections of 1,2,4-triazole occurred continuously in the downstream groundwater wells, M1 and M2, and generally in concentrations < 0.1 µg/L. In M1, all detections were < 0.1 µg/L (Figure 5.2.1C). Contrary to M1, detections with concentrations exceeding 0.1 µg/L occurred in M2. Here, 1,2,4-triazole concentrations exceeded 0.1 µg/L in November 2014 and again from April 2019 to November 2019 with a maximum concentration of 0.18 µg/L in September 2019. After November 2019, 1,2,4-triazole concentrations < 0.1 µg/L occurred for the remainder of the monitoring period. Still, in monitoring well M2, the M2.3 screen (2.9-3.9 mbgs) showed two six-month periods of increasing concentrations starting from August 2020 and May 2021, respectively (Figure 5.4.1D). Further, at the end of the monitoring period, when all possible waterfilled screens were sampled, analyses showed that 1,2,4-triazole detections were made in all three screens from M2 (no water was present in the uppermost screen, M2.1), though in concentrations < 0.1 µg/L.

Sampling from the downstream wells M4 and M5, and the horizontal well H1 showed no detections of 1,2,4-triazole exceeding 0.1 µg/L (Figure 5.2.1E and F). Hence, 17 samples out of 198 samples from M4, 0 of 44 samples from M5, and 39 of 71 samples from H1 had 1,2,4-triazole detections, and all in concentrations < 0.1 µg/L with a maximum concentration reaching 0.07 µg/L (Figure 5.2.1G).

In the upstream groundwater monitoring well M7, continuous 1,2,4-triazole detections (in 205 of 253 samples) from November 2014 to January 2023 were observed, though generally, the detections were in concentrations < 0.1 µg/L (Figure 5.2.1). One 1,2,4-triazole detection was in a concentration > 0.1 µg/L and occurred in September 2019 (0.12 mg/L). Hereafter, similar to the downstream wells, the M7.2 and M7.3 screens showed three six-month periods of increasing concentrations, though < 0.1 µg/L, from August 2020, and July 2021 and July 2022 (Figure 5.2.1H). At the end of the monitoring period in December 2022, the maximum concentration was 0.058 µg/L in M7.3 and no 1,2,4-triazole was detected in the deepest screen, M7.4.

Irrigation water

During the dry seasons between November 2014 and December 2022, 18 irrigation water samples were collected from the irrigation wells at Jyndevad and analysed for the content of 1,2,4-triazole. 1,2,4-triazole was not detected in any of the samples.

Figure 5.2.1. 1,2,4-triazole monitoring at Jyndevad. Precipitation and measured groundwater levels, with standard deviations (A); measured 1,2,4-triazole in the variably saturated zone (B); measured 1,2,4-triazole in the downstream vertical groundwater monitoring well (C-F); measured 1,2,4-triazole in the horizontal groundwater wells (G); measured 1,2,4-triazole in the upstream vertical groundwater monitoring well M7 (H); The vertical coloured lines indicate the date of azole applications. Azoles applied as seed dressing (vertical green dashed lines). The horizontal red dashed line depicts the limit value of 0.1 µg/L. Note that the results cover the full monitoring period from November 2014 to December 2022. Monitoring of 1,2,4-triazole ended December 2022.

Silstrup

At Silstrup, 1,2,4-triazole was included in the monitoring in December 2016. The most recent applications of azole products at Silstrup, were split applications of prothioconazole initiated in May 2020, June 2021 and May 2022 (Figure 5.2.2). The results of the full monitoring period from 2016 to December 2022 are shown in Figure 5.2.2 and Table 5.2.1).

Variably saturated zone monitoring

During the entire monitoring period, 1,2,4-triazole was detected in almost all drainage samples (137 out of 141 samples, Table 5.2.1). Concentrations of 1,2,4-triazole exceeded 0.1 µg/L in the fall of 2017 and on a single occasion in September 2018. After September 2018, 1,2,4-triazole was detected almost continuously in concentrations < 0.1 µg/L when drain flow occurred (Figure 5.2.2B). During the last two years of monitoring, 1,2,4-triazole concentrations in drainage fluctuated from 0.01 to 0.077 µg/L.

Groundwater monitoring wells

In the period from 2016 to 2020, 1,2,4-triazole concentrations exceeded 0.1 µg/L in M5 and H3 in October 2017 with maximum concentrations of 0.14 µg/L and 0.12 µg/L, respectively. From May 2020 to December 2022, groundwater sampling from the downstream wells M5, M9, and M10, and horizontal wells H1 and H2 showed 1,2,4-triazole detections fluctuating in concentrations < 0.1 µg/L. For instance, in the horizontal wells, detections of 1,2,4-triazole primarily occurred concomitantly with periods of percolation and drain flow (Figure 5.2.2F), while the first and maximum occurrence of 1,2,4-triazole (0.051 µg/L; M5.2) in the vertical monitoring wells coincided with the onset of drain flow in October 2020 (Figure 5.2.2B and C). Aside from the first detections, both the horizontal and vertical monitoring wells generally showed detections in October 2020-March 2021, June 2021-March 2022, and September 2022 till the end of the monitoring period in December 2022 (Figure 5.2.2C-F).

In the upstream groundwater monitoring well M12, no 1,2,4-triazole detections were made during the entire monitoring period (Figure 5.2.2G).

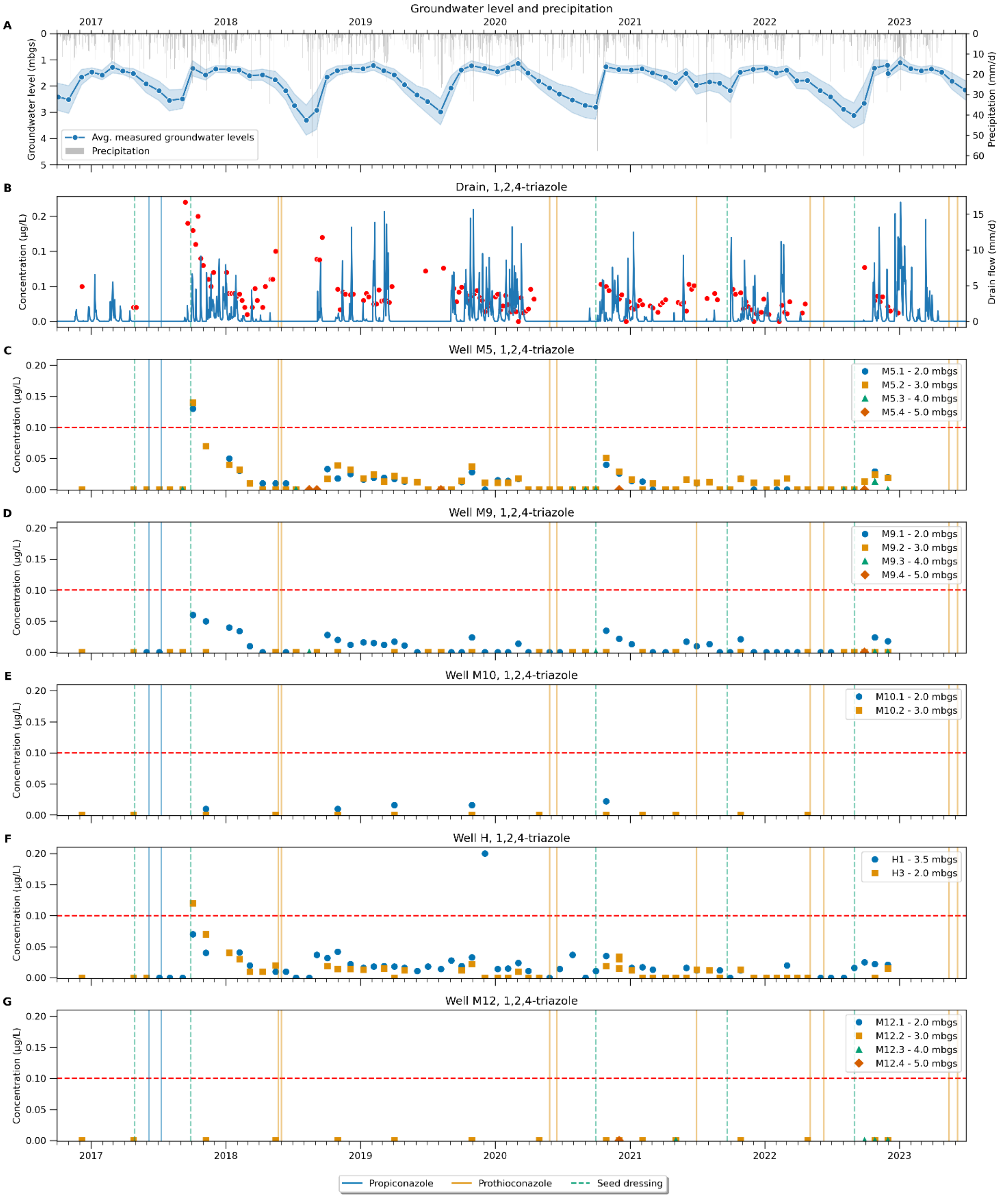

Figure 5.2.2. 1,2,4-triazole monitoring at Silstrup. Precipitation and measured groundwater levels, with standard deviations (A); measured 1,2,4-triazole in the variably saturated zone (B); measured 1,2,4-triazole in the downstream vertical groundwater monitoring wells (C-E); measured 1,2,4-triazole in the horizontal groundwater wells (F); measured 1,2,4-triazole in the upstream vertical groundwater monitoring well (G); The secondary y-axis (plot B) represents the drain flow. The vertical coloured lines indicate the date of azole applications. Azoles applied as seed dressing (vertical green dashed lines). The horizontal red dashed line depicts the limit value of 0.1 µg/L. Note that the results cover December 2016-December 2022. Monitoring of 1,2,4-triazole ended in December 2022.

Estrup

At Estrup, 1,2,4-triazole was included in the monitoring in 2014. The most recent application of an azole product in Estrup was the split application of metconazole in May/June 2019. The results of the full monitoring period from May 2014 to December 2022 are shown in Figure 5.2.3 and Table 5.2.1).

Variably saturated zone monitoring

In the drainage, 1,2,4-triazole detections were observed in almost all samples and primarily in concentrations > 0.1 µg/L throughout the entire monitoring period ending in December 2022 (Figure 5.2.3B and Table 5.2.1). The maximum drainage concentration of 0.47 µg/L was observed in July 2020 and 1,2,4-triazole was detected in 267 drainage samples out of a total of 268 and 250 of these in a concentration > 0.1 µg/L.

Groundwater monitoring wells

Sampling from the downstream wells M1, M4, M5 and M6, and horizontal wells H1 and H2 showed 1,2,4-triazole detections throughout the entire monitoring period. In M4.1, the uppermost screen, 1,2,4-triazole concentrations > 0.1 µg/L were detected almost continuously from May 2014 to February 2021 (Figure 5.2.3D). In the period from February 2021 to the end of the monitoring in December 2022, the 1,2,4-triazole concentrations primarily fluctuated between 0.05 to 0.1 µg/L in M4. In wells M1, M5, M6, and H1, 1,2,4-triazole was detected throughout the monitoring period, though in concentration < 0.1 µg/L. In the horizontal well H2, there were several detections > 0.1 µg/L during the entire monitoring period and the concentration peaked in January 2015 (0.26 µg/L) and in October 2017 (0.23 µg/L). During the last two years of monitoring all detections in H2 were < 0.1 µg/L (Figure 5.2.3G). Also, although few 1,2,4-triazole detections were exceeding 0.1 µg/L between spring 2021 and December 2022, almost all prior 1,2,4-triazole detections in M4 were exceeding 0.1 µg/L (Figure 5.2.3D).

Figure 5.2.3. 1,2,4-triazole monitoring at Estrup. Precipitation and measured groundwater levels, with standard deviations (A); measured 1,2,4-triazole in the variably saturated zone (B); measured 1,2,4-triazole in the downstream vertical groundwater monitoring wells (C-F); measured 1,2,4-triazole in the horizontal groundwater wells (G); It is noted, that sampling of an upstream well at Estrup did not take place during the monitoring period. The secondary y-axis (plot B) represents the drain flow. The vertical coloured lines indicate the date of azole applications. Azoles applied as seed dressing (vertical green dashed lines). The horizontal red dashed line depicts the limit value of 0.1 µg/L. Note that the results cover May 2014-December 2022. Monitoring of 1,2,4-triazole ended in December 2022.

Faardrup

At Faardrup, 1,2,4-triazole was included in the monitoring in May 2014. The most recent applications of an azole product in Faardrup were prothioconazole in May 2021, and a split application of prothioconazole in May 2022 (Figure 5.2.4). The results of the full monitoring period from May 2014 to December 2022 are shown in Figure 5.2.4 and Table 5.2.1.

Variably saturated zone monitoring

1,2,4-triazole was detected in almost all drainage samples (138 out of 142 samples, Table 5.2.1) during the entire monitoring period, with six samples exceeding 0.1 µg/L. During the last two years of monitoring (from July 2020 to December 2022), 1,2,4-triazole was only detected in concentrations > 0.1 µg/L during January-February 2022 (0.19 µg/L). No drainage was available from June 2022 until the monitoring ended in December 2022. Detections of 1,2,4-triazole in concentration > 0.1 µg/L were previously observed in drainage in October 2017 (0.2 µg/L) and March-April 2019 (0.12 µg/L) and except for four samples with no detections, 1,2,4-triazole was detected in concentrations < 0.1 µg/L in the remaining 138 samples collected during the entire monitoring period from May 2014 to December 2022 (Figure 5.2.4B and Table 5.2.1).

Groundwater monitoring wells

Throughout the entire monitoring period from May 2014 to December 2022, the 1,2,4-triazole monitoring at Faardrup revealed sporadic detections, and all detected concentrations were below 0.1 µg/L. The majority of the samples collected during this period; 126 of 142 samples in M4, 141 of 144 samples in M5, 72 of 84 samples in H2, and 29 of 35 samples in H3, showed no 1,2,4-triazole detections (Figure 5.2.4). 1,2,4-triazole was not detected in either of the 133 samples collected in downstream well M6. In the upstream groundwater monitoring well M2, no 1,2,4-triazole detections were made in the 19 samples collected (Figure 5.2.4G).

Figure 5.2.4. 1,2,4-triazole monitoring at Faardrup. Precipitation and measured groundwater levels, with standard deviations (A); measured 1,2,4-triazole in the variably saturated zone (B); measured 1,2,4-triazole in the downstream vertical groundwater monitoring wells (C-E); measured 1,2,4-triazole in the horizontal groundwater wells (F); measured 1,2,4-triazole in the upstream vertical groundwater monitoring well M2 (G); The secondary y-axis (plot B) represents the drain flow. The vertical coloured lines indicate the date of azole applications. Azoles applied as seed dressing (vertical green dashed lines). The horizontal red dashed line depicts the limit value of 0.1 µg/L. Note that the results cover May 2014-December 2022. Monitoring of 1,2,4-triazole ended in December 2022.

5.2.4. Discussion and conclusion of the 1,2,4-triazole monitoring

As reported in the previous report (Badawi et al., 2023b), azoles were applied in the PLAP fields multiple times since 1999, and in addition to these azole applications, azole-coated seeds were also frequently used. Both types of applications will contribute to the azole soil content and potentially 1,2,4-triazole leaching (Albers et al., 2022). Although azoles were used since 1999, 1,2,4-triazole was not included in the monitoring until 2014, when awareness of the degradation product rose, and the analytical method had become available. Therefore, it was not possible to determine the background content of 1,2,4-triazole in any of the fields before 1,2,4-triazole monitoring was started. Also, the use of azole-coated seeds was registered from 2017 and onwards, but they were most likely used before this time. As mentioned, e.g., in the EFSA conclusion on tebuconazole (EFSA, 2014), azoles are known to accumulate in the plough layer. Therefore, the presence of accumulated azoles in the PLAP fields is highly likely and may cause continuous degradation of azoles into 1,2,4-triazole leading to long-term leaching to the groundwater. 1,2,4-triazole is a common degradation product of azoles, and the specific origin of 1,2,4-triazole leaching cannot be determined, especially, when several azoles have been used and possibly accumulated, as is the case in the PLAP fields. This implies that the leaching of 1,2,4-triazole from all PLAP fields cannot be coupled to current sprayings and application of azole-dressed sowing seeds or directly related to past applications of azoles. However, the leaching of 1,2,4-triazole can be linked to the application of azoles in the fields, as 1,2,4-triazole is detected in water from the variably saturated zone (water from suction cups and drainage), where the water flow mainly occurs vertically. To discern between the different azole applications and leaching of 1,2,4-triazole, detailed fate studies of azoles in soil are needed. All azole applications including the known use of azole-coated seeds are reported in Appendix 3 and previous PLAP reports (available at www.plap.dk).

Variably saturated zone

Leaching of 1,2,4-triazole to the variably saturated zone is assessed from the monitoring in the suction cups and drainage from sand and clay-till fields, respectively. At the sandy field Jyndevad, the relatively high number of detections at 1 mbgs in S2, especially in the period from February 2015 to September 2019, indicate that 1,2,4-triazole is continuously formed in the topsoil. However, it is noted that these consistent detections were not seen at 1 mbgs at S1, where no detections > 0.1 µg/L were found. Nevertheless, the detections in the suction cups in 1 mbgs are likely representative of leaching from the field itself as the depth to the groundwater table is rarely less than 1 m (Figure 5.2.1). Detections of 1,2,4-triazole were continuous although decreasing throughout the monitoring period, thus, supporting that 1,2,4-triazole is consistently present in the variably saturated zone and leached when percolating water is present. This corroborates with the findings of Albers et al. (2022) and the EFSA conclusion on tebuconazole stating possible azole accumulation in the plough layer (EFSA, 2014).

At all the clay till fields (viz. Silstrup, Estrup, and Faardrup), 1,2,4-triazole was detected in drainage throughout the monitoring period, though the concentrations varied considerably between the fields. In Silstrup and Faardrup, some detections exceeded 0.1 µg/L (Table 5.2.1; Figure 5.2.2B and Figure 5.2.4B), and in Estrup, except a few samples, all detections were in concentrations > 0.1 µg/L (Figure 5.2.3B). Hence, some fields seem more prone to leaching of 1,2,4-triazole in higher concentrations, which is also observed in the measured concentrations from the groundwater monitoring wells as described below. As such, high drainage concentrations were followed by relatively high detections in the groundwater monitoring wells. For instance, in Estrup, where the highest 1,2,4-triazole concentrations (of around 0.4 µg/L) were detected in drainage (Figure 5.2.3B), correspondingly high concentrations (up to around 0.2 µg/L) were detected in the groundwater (Figure 5.2.3C-G). In contrast, at Silstrup where the highest 1,2,4-triazole concentrations (up to around 0.2 µg/L) occurred only twice in drainage (Figure 5.2.2B), correspondingly low concentrations (commonly < 0.05 µg/L) were detected in groundwater (Figure 5.2.2C-G). Therefore, based on these measurements it seems plausible that the 1,2,4-triazole drainage concentration levels serve as a proxy for 1,2,4-triazole concentration levels in groundwater, although at lower concentration levels.

Groundwater monitoring

Leaching of 1,2,4-triazole at Jyndevad to the groundwater was confirmed and showed consistent detections in the downstream wells M1 and M2. During approximately one year (November 2018 - November 2019) with quarterly sampling, increasing detections > 0.1 µg/L were made in the downstream well M2 (Figure 5.2.1D), while none of the remaining downstream wells showed detections exceeding 0.1 µg/L. Subsequently, two periods with increasing concentrations in M2 (< 0.1 µg/L) started in August 2020 and May 2021, while such patterns were not observed in the remaining downstream wells. However, it is noted that in the upstream well, M7, the time of maximum concentrations coincided with the detection of the maximum concentration in M2 (Figure 5.2.1D and H). Similarly, the upstream well also showed periods of increasing concentration coinciding with the detected increase in 1,2,4-triazole in M2. It is unlikely that these detections in M7 stem from the 1,2,4-triazole application on the Jyndevad field, as the M7 well location is upstream meaning that groundwater flowing towards M7 originates east of the field (see Figure 2.1.1, Jyndevad in Chapter 2). Therefore, an explanation for the similarities in the leaching patterns between the upstream and downstream wells is likely related to azoles similarly being bound in the variably saturated zone for relatively long periods in the neighboring field. If azole products were used in sprayings or seed coatings at upstream fields, 1,2,4-triazole is likely formed from degradation of the azole fungicides in the topsoil as observed at the Jyndevad field.

At the clay till fields, the leaching pattern from each of the fields differed in terms of detected concentration levels in the groundwater monitoring wells. As discussed above concerning the detections in the drainage, high drainage concentrations were followed by relatively high detections in the groundwater monitoring wells and vice versa. Nevertheless, in contrast to the sandy field, where detected concentration levels decreased over time in the variably saturated zone, 1,2,4-triazole concentration levels in drainage of the clay till fields persisted (e.g., Figure 5.2.2C). The reason for consistent leaching to drainage and groundwater is likely related to 1,2,4-triazole being formed in the topsoil from accumulated azoles.

Generally, in periods with drain flow and drainage detections, 1,2,4-triazole was also observed in groundwater. As such, 1,2,4-triazole concentration levels exceeding 0.1 µg/L at Estrup in downstream groundwater samples were measured throughout the monitoring in the periods with drainage. Similarly, at Silstrup, 1,2,4-triazole detections in the groundwater, although below 0.1 µg/L, coincide with drainage detections.

In conclusion, throughout the entire monitoring period from 2014 to January 1, 2023 a persistent and relatively unchanged trend in 1,2,4-triazole detections was observed across all fields. The challenge of attributing the detected 1,2,4-triazole to specific applications, presumably stemming from a combination of long-term leaching from accumulated azole fungicides and the formation of newly produced 1,2,4-triazole from recent applications, led to the decision to end the monitoring of 1,2,4-triazole in PLAP by January 1, 2023.

5.3. Azoxystrobin test

CyPM was monitored in the current reporting period, July 2021-June 2023, following azoxystrobin application at the clay till field, Silstrup. Detailed information on the Silstrup field is available in Chapter 2.

5.3.1. Application of azoxystrobin at Silstrup

Azoxystrobin was tested in PLAP in connection with cropping of winter wheat in Silstrup in 2020 (sown in 2019), and azoxystrobin was applied twice, on May 28 and June 16, 2020. Detailed information on agricultural management is available in Chapter 3 and Appendix 3.

Azoxystrobin was previously applied five times on the Silstrup field (2004, 2005, 2009, 2013, 2014), twice in Tylstrup (2008, 2009), three times at Jyndevad (2005, 2008, 2010), six times at Estrup (2004, 2006, 2008, 2009, 2012, 2014), three times at Faardrup (2004, 2010, 2014), and once at Lund (2017). The results from the previous azoxystrobin applications are described in previous PLAP reports available at www.plap.dk.

All pesticide monitoring at Lund was set on standby in October 2022, due to uncertainty of the hydraulic connectivity in the monitoring wells and the percolating water from the field. Therefore, the azoxystrobin test done at Lund in 2017 is currently regarded as uncertain due to possible lack of hydraulic connectivity affecting the outcome of the test. A new bromide tracer test to elucidate the connectivity was started at Lund in January 2023, as the previous bromide test in 2017, seemed to have been erroneous.

5.3.2. Compounds included in the monitoring

The azoxystrobin degradation product CypM was selected for monitoring and included in the monitoring in May 2020 at Silstrup. For additional information on CypM refer to Appendix 1. Monitoring of CyPM ended February 8, 2023, hence the evaluation of the azoxystrobin test in this present report therefore covers the entire monitoring period from May 2020 to February 2023.

Azoxystrobin was not included in the monitoring in this present test at Silstrup, but it was included in the monitoring in the previous tests at Silstrup, Tylstrup, Jyndevad, Estrup, and Faardrup.

5.3.3. Results of the CyPM monitoring at Silstrup

The day before the first azoxystrobin application on May 28, 2020, background samples were collected in the horizontal well and the monitoring wells. In total, four samples were collected and none of these contained CyPM.

An overview of the entire monitoring is given in Table 5.3.1 and shows the number of detections for each monitoring screen after the first azoxystrobin application on May 28, 2020, and to February 8, 2023, when the test ended. Figure 5.3.1 shows the CyPM monitoring in drainage and selected monitoring wells, but plots for all monitored wells are available in Appendix 8.

Table 5.3.1. Number of samples and detections of CyPM at Silstrup in drainage (D), vertical monitoring wells (M), and horizontal wells (H). The counting comprises all samples collected from May 28, 2020, to February 8, 2023, when the test ended. Background samples collected before the application of azoxystrobin are not included in the counting.

	Total			D			M			H			Total Groundwater (M+H)		
	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L
Silstrup															
CyPM	292	103	12	65	52	9	173	32	2	54	19	1	227	51	3

Variably saturated zone monitoring

Analyses from the drainage show that CyPM was detected for the first time in October 2020, corresponding to 5 months after the first azoxystrobin application in May 2020 (Figure 5.3.1B). This also coincided with the first drainage event after the azoxystrobin application. The drainage detections were relatively consistent (52 out of 65 samples) throughout the monitoring period. The maximum CyPM concentration of 0.21 µg/L was detected in October 2020, and concentrations > 0.1 µg/L were generally observed from October 2020 to April 2021, corresponding to six months. From May 2021 to the latest sampling in February 2023, the detections were consistently < 0.1 µg/L, and CyPM was detected in drainage throughout the monitoring period when drainage was present.

Groundwater monitoring wells

It is noted that not all groundwater monitoring wells were actively monitored due to budget limitations, and neither is each of the screens in the wells selected for monitoring. For the current report, the vertical monitoring wells M5, M9, M10, and M12 were sampled in the two uppermost water-filled screens until January 1, 2023 when the sampling strategy was changed (Chapter 2.2). Thereafter, all water-filled screens were sampled in the downstream wells selected for monitoring (M5 and M9) and in two screens in upstream well M12. Both horizontal wells H1 and H3 were monitored until January 2023, when monitoring in H3 was stopped.

Well H1 and H3

Monthly groundwater samples from the horizontal wells, H1 and H3, showed CyPM detections in October 2020 which corresponded to the maximum observed concentrations of 0.11 and 0.073 µg/L, respectively (Figure 5.3.1F). Subsequently, there were no detections with concentrations > 0.1 µg/L and from June 2021 to August 2022, none of the groundwater samples from the horizontal wells contained CyPM. From September 2022 to the end of the monitoring period in February 2023, CyPM was detected in H1 in concentrations ranging from 0.016 µg/L to 0.031 µg/L. At the last sampling event in February 2023 before finalizing the test, no CyPM was detected in the groundwater from H1.

Well M5

The first two detections of CyPM in M5 were observed in October 2020, two weeks after the first detection of CyPM in drainage which also occurred in October 2020 and corresponded to 5 months after application of azoxystrobin. Further, these two first detections were > 0.1 µg/L with concentrations of 0.19 and 0.23 µg/L, being the highest observed concentrations among all the results from groundwater monitoring wells (Figure 5.3.1C). From December 2020 until August 2022, all measured concentrations were < 0.1 µg/L. There were no detections from April 2021 to August 2022, except on two occasions in June 2021 and March 2022, where concentrations did not exceed 0.016 µg/L (Figure 5.3.1E). From September 2022 to the end of the monitoring period in February 2023, CyPM was detected in the uppermost screens of M5 (M5.1 and M5.2, Figure 5.3.1C) in concentrations ranging from 0.015 µg/L to 0.032 µg/L. At the last sampling event in February 2023 before finalizing the test, no CyPM was detected in the groundwater samples from M5.

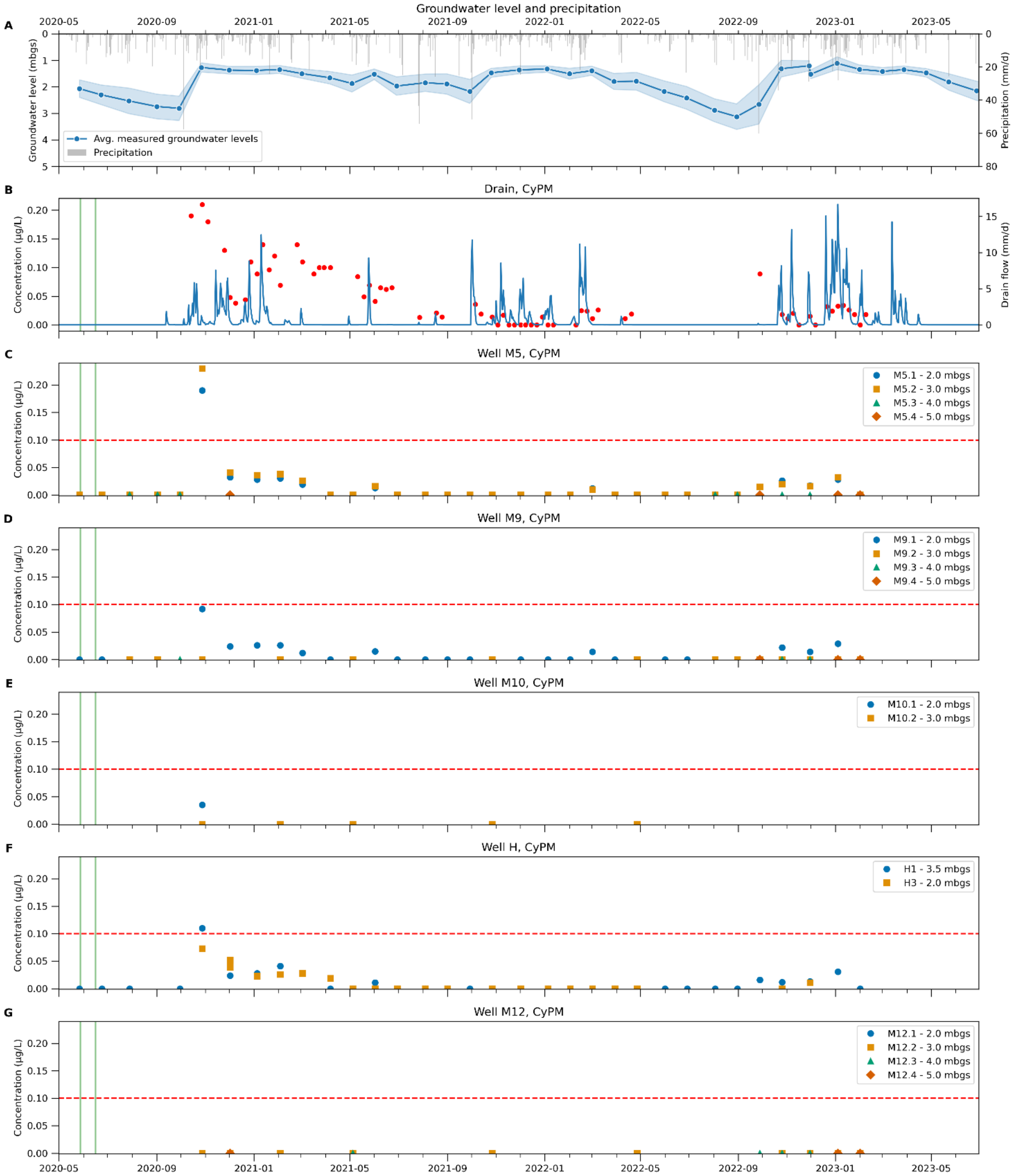

Figure 5.3.1. CyPM monitoring at Silstrup. Precipitation and measured groundwater levels, with standard deviations (A); measured CyPM in the variably saturated zone (B); measured CyPM in the downstream vertical groundwater monitoring wells (C-E); measured CyPM in the horizontal groundwater wells (F); measured CyPM in the downstream vertical groundwater monitoring well M12 (G); The secondary y-axis (B) represents the drain flow. The vertical green lines indicate the date of azoxystrobin applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. CyPM was included in the monitoring in May 2020 as part of the 2020 azoxystrobin test initiated in May 2020. Monitoring of CyPM at Silstrup ended in February 2023.

Well M9

Groundwater samples from well M9 showed CyPM concentrations close to 0.1 µg/L in one sample five months (October 2020) after the first azoxystrobin application in May 2020 (Figure 6.3.1E). This detection, which was the first of CyPM in groundwater, corresponded to the maximum concentration (0.092 µg/L) observed in well M9 during the monitoring period. From December 2020 until the last sampling in February 2023, the detections in well M9 were similar to what was observed in well M5. That is, all measured concentrations were < 0.1 µg/L while there were only a few detections of CyPM in samples from April 2021 and onwards, specifically in June 2021, March, October and November 2022, and January 2023. On these five occasions, CyPM was detected in concentrations ranging from 0.014 to 0.029 µg/L and only detected in the uppermost screen in M9.1 (Figure 5.3.1D).

Well M10

In well M10, groundwater sampling differs from wells M5 and M9 as the sampling frequency was lower. Well M10 was sampled in varying intervals ranging from quarterly to half-yearly and the last sample was collected from M10 in April 2022. During the entire monitoring period, CyPM was detected once (October 2020) five months after the first azoxystrobin application in May 2020 (Figure 5.3.1E) in a concentration < 0.1 µg/L.

Well M12

In upstream well M12, the groundwater represents water from the field located upstream of the PLAP field. The sampling strategy in M12 also differs from wells M5 and M9 in that the sampling frequency was low until September 2022 when monthly sampling was started (Chapter 2.2). Until September 2022, well M12 is sampled in varying intervals ranging from quarterly to half-yearly. No detections of CyPM were observed in M12 during the entire monitoring period (Figure 5.3.1G).

5.3.4. Discussion and conclusion on the CyPM monitoring at Silstrup

The occurrence of the overall maximum CyPM concentration in the groundwater monitoring wells was in October 2020 corresponding to 5 months after the first azoxystrobin application. The exceedance of 0.1 µg/L observed in wells M5 and H1 was also observed in October 2020 after which no detections of CyPM in concentrations > 0.1 µg/L occurred in the groundwater. A similar pattern was observed in the maximum drainage concentration coinciding with the occurrence of maximum concentrations observed in the groundwater wells (Figure 5.3.1C-G). Hence, the overall leaching pattern of CyPM was similar in drainage and groundwater samples, with relatively high concentrations found 5 months after azoxystrobin application and following the first major drainage event. The subsequent slow decrease in concentration seen in drainage samples, however, does not correspond to the pattern seen in groundwater samples, as the concentrations here declined rapidly and continue to be far below 0.1 µg/L for the rest of the monitoring period. This indicated that CyPM, although detectable in the drainage throughout the monitoring period, did not leach into the groundwater to a great extent, perhaps due to further degradation. A total of 292 samples were collected in drainage and groundwater during the azoxystrobin test at Silstrup from May 2020 to February 2023 when the test ended. CyPM was detected in 103 of these and in 12 samples in concentrations > 0.1 µg/L. The CyPM detections > 0.1 µg/L were found in nine drainage samples out of 65 drainage samples and in three out of 227 groundwater samples.

5.4. Cyazofamid test

The four degradation products, CTCA, CCIM, DMS, and DMSA were monitored during the current reporting period, July 2021-June 2023, following cyazofamid application in PLAP at the sandy field, Jyndevad. Detailed information on the field site is available in Chapter 2.

5.4.1. Application of cyazofamid at Jyndevad

Cyazofamid has been tested in PLAP in connection with potato cultivation three times on the Jyndevad field site, viz., in 2010, 2014, and 2020. The results from the 2010 and 2014 cyazofamid applications are described in previous PLAP reports available at www.plap.dk. In 2020, cyazofamid was applied six times from June 14 to September 10, with 0.5 L/ha. It is noted that in the previous PLAP report from 2022 (Badawi et al., 2022), cyazofamid was erroneously specified as being applied seven times. Cyazofamid was applied six times following the regulation (Chapter 3).

The spray solutions applied in the fields were, as common practice in PLAP, analysed for the content of the active ingredient included in the test. The six spray solutions used at Jyndevad in 2020 contained cyazofamid in the range of 220-330 mg/L (% CV from the nominal concentration was ± 17-24 %) (Badawi et al. 2023b). Previously, no degradation products were analysed in the spray solutions, but as the monitoring results from the suction cups suggested DMSA as being produced already in the spray solution even before application, degradation products were introduced in the analyses. Therefore, an additional spray solution prepared similar to the six used in the field, was prepared on June 22, 2022, and analysed for the content of cyazofamid and the four degradation products, DMS, DMSA, CCIM, and CTCA. The results from the analysis showed that in addition to cyazofamid, both CCIM and DMSA were present in the solution before application (Table 5.4.1). The concentration of cyazofamid in this spray solution was 290 mg/L, which was similar to the content of cyazofamid in the previous six spray solutions applied in the field. The additional spray solution is therefore considered representative of the spray solutions used in the cyazofamid test.

Table 5.4.1. Content of the active ingredient, cyazofamid, and the degradation products, DMS, DMSA, CCIM, and CTCA in the spray solution from June 22, 2022. The spray solution was only prepared with the purpose of analysing the content of the five compounds and was not applied in the field. The concentration is converted to millimolar (mM) and the content of CCIM and DMSA as a percentage of cyazofamid content is calculated (%mM). The original content of cyazofamid is calculated as the sum of cyazofamid and CCIM and is used for calculating the percentage of DMSA and CCIM.

Compound	µg/L	g/L	g/mole	mol/L	mM	% µg/L	% mM
Cyazofamid	290,000	0.29	324.8	0.00089	0.89	-	-
CCIM	43,500	0.0435	215.7	0.00020	0.20	13.0	18.4
DMSA	4,340	0.00434	125.2	0.00003	0.03	1.3	3.2
CTCA	< 100*	< 0.1	236.7	-	-	-	-
DMS	< 100*	< 0.1	124.2	-	-	-	-

** Detection limit (DL) is noted as < 100 µg/L in the non-diluted spray solution, which is equal to a DL of 0.01 µg/L in the diluted sample used for analysis (dilution factor 10.000).*

5.4.2. Compounds included in the monitoring

The EFSA conclusion on cyazofamid defines the degradation products CTCA and CCIM as major metabolites (EFSA, 2020) and these were included in the monitoring. In addition, DMS and DMSA were included in the monitoring. DMS is not mentioned as a metabolite of cyazofamid in the EFSA conclusion (EFSA, 2020) but in 2019 an ongoing research project, *Fungisource* (funded by Bekæmpelsesmiddelpuljen, DEPA), detected relatively low concentrations of DMS in groundwater from the Jyndevad field. Therefore, DMS was also selected for monitoring. DMSA is mentioned in the EFSA conclusion on cyazofamid in connection with acute oral toxicity- and an in vitro bacterial mutation test, where its toxicity was tested (EFSA, 2020). I.e., DMSA is not mentioned as a metabolite of cyazofamid but, as it is suspected to be a hydrolysis product from cyazofamid to CCIM (Figure 5.4.1), DMSA was included in the monitoring. Hence, the four degradation products; CTCA, CCIM, DMS, and DMSA were included in the monitoring and analysed for in suction cups and groundwater samples at the Jyndevad field. Cyazofamid was not part of the monitoring. Monitoring of DMS and DMSA is still ongoing but monitoring of CTCA and CCIM was ended in January 2023. The monitoring period evaluated in this report is thus from April 2020 to January 2023 for CTCA and CCIM, and from April 2020 to June 2023 for DMS and DMSA.

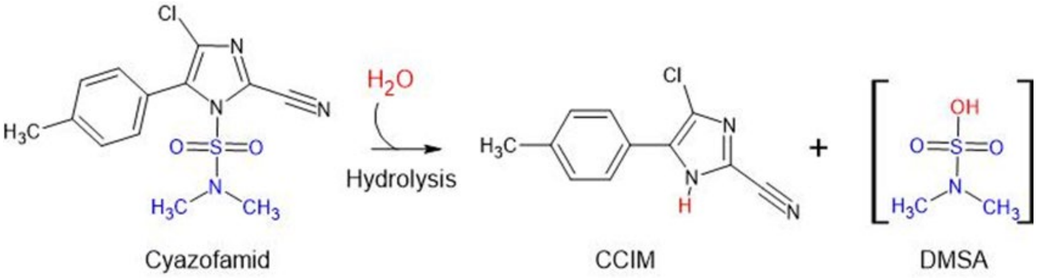

Figure 5.4.1 Proposed hydrolytic reaction scheme of cyazofamid and formation of hydrolysis products, CCIM, and DMSA. Only CCIM is noted as a hydrolysis product from cyazofamid in the EFSA conclusion on cyazofamid (EFSA 2020). Both compounds were present in the aqueous cyazofamid spray solution before application in the field (table 1).

It is noted that monitoring of the four degradation products was planned to start in April 2020, but the analytical methods for analyses of CTCA, CCIM, DMS, and DMSA were not available at that time. Therefore, the water samples collected in the period from April to October 2020 were stored at -20°C before analytical methods for CCIM, CTCA, and DMSA were ready. The analytical method for analysis of DMS was ready after 14 days of storage at -20°C (refer to Chapter 7). The effect of storing the samples is currently unknown but, relatively unstable compounds may degrade during storage leading to underestimation of concentration magnitudes (e.g., Lyytikäinen et al. 2003). In the following, it is clearly stated which samples were stored, and overall, merely 65 of 265 samples were stored before analyses of DMSA, CCIM, and CTCA, and nine of 265 samples were stored before analysis of DMS.

5.4.3. Results of DMS, DMSA, CTCA and CCIM monitoring at Jyndevad.

CTCA and CCIM monitoring

CTCA and CCIM were not detected in any of the collected samples. An overview of the entire monitoring is given in Table 5.4.2. The table shows the number of samples and detections for each monitored degradation product in water from suction cups and groundwater during the monitoring period from June 2020 when cyazofamid was first applied to June 2023 when the reporting period ended.

Table 5.4.2. Number of samples and detections of DMS, DMSA, CCIM, and CTCA at Jyndevad in water from suction cups (S), vertical monitoring wells (M), and horizontal wells (H). The counting comprises all samples collected from June 14, 2020, to June 30, 2023. Background samples collected before the application of cyazofamid are not included in the counting.

	Total			S			M			H			Total Groundwater (M+H)		
	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L
Jyndevad															
DMS	383	224	94	72	46	13	297	166	74	14	12	7	311	178	81
DMSA	383	144	77	72	11	6	297	129	68	14	4	3	311	133	71
CCIM	324	0	0	62	0	0	248	0	0	14	0	0	262	0	0
CTCA	324	0	0	62	0	0	248	0	0	14	0	0	262	0	0

DMS monitoring at Jyndevad

Before the first cyazofamid application on June 14, 2020, 31 background samples were collected in suction cups and groundwater. Three of the 31 background samples contained DMS, all with a concentration < 0.1 µg/L.

Variably saturated zone monitoring

Analyses from the suction cups in 1 mbgs show that DMS was detected in August and September 2020, corresponding to 2-3 months after the first cyazofamid application in June 2020. Subsequently, increasing DMS concentrations were generally measured until December 2020, after which the concentrations decreased (Figure 5.4.2B). Relatively high concentrations (> 0.1 µg/L) are measured, with maximum concentrations up to 0.39 µg/L from August 2020 to April 2021. After April 2021, concentrations decreased to levels < 0.1 µg/L and continued to decrease towards the last sampling event in June 2023.

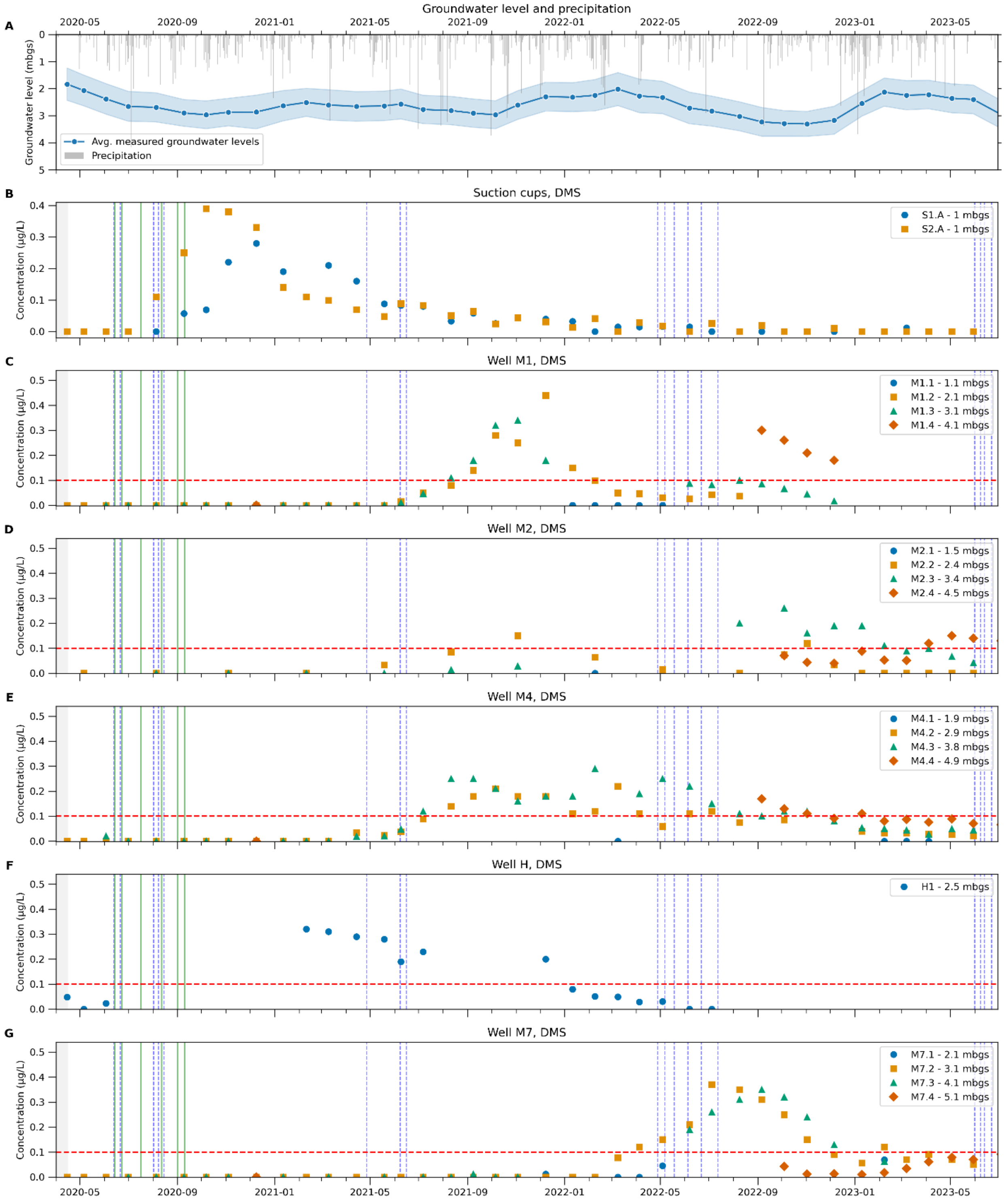

Figure 5.4.2. DMS monitoring at Jyndevad. Precipitation and measured groundwater levels, with standard deviations (A); measured DMS in the variably saturated zone (B); measured DMS in the downstream monitoring wells (C-E); measured DMS in the horizontal well (F); measured DMS in the downstream monitoring well M7 (G); Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. Monitoring of DMS is ongoing.

Groundwater monitoring wells
It is noted that not all monitoring wells and screens were sampled due to budget limitations. The sampling procedure until September 2022 was to sample the two uppermost screens from which sampling could be conducted. From September 2022 to December 2022, additional samples were collected in many monitoring wells, and from January 2023 all screens from selected monitoring wells were sampled as part of the new, and ongoing, sampling programme. See Chapter 2 for more details.

Well M1

Groundwater samples from well M1 show that DMS is detected in relatively high concentrations (> 0.1 µg/L) with a maximum concentration of 0.44 µg/L (Figure 5.4.2C). From June 2021, approximately one year after the first cyazofamid application, DMS is detected for the first time, after which a pulse of DMS with a duration of one year to June 2022 is observed (Figure 5.4.2C). The breakthrough of DMS in concentrations exceeding the limit value of 0.1 µg/L occurred 15 months (in August 2021) after the first cyazofamid application in June 2020. From August 2021, the measured DMS concentrations increased towards the overall maximum around mid-October 2021, whereafter concentrations were decreasing. However, for six months from August 2021 to January 2022, there were constant detections of DMS in concentrations > 0.1 µg/L, both in screens M1.2 and M1.3 (Figure 5.4.2C). Screen M1.1 at 1 mbgs, was sampled from January 2022 to June 2022 and showed no DMS detections. The detections from 2-meter depth (screen M1.2) are < 0.1 µg/L in the same period. From June to September 2022, screen M1.2 and M1.3 were sampled and showed concentrations < 0.1 µg/L. However, from September 2022 and until the last sampling in December 2022 in well M1, where screen M1.3 and M1.4 were sampled, DMS concentrations measured from screen M1.4 were relatively high, exceeding the limit value of 0.1 µg/L. The first measurement from September 2022 in screen M1.4 had a concentration of 0.3 µg/L, which decreased to around 0.2 µg/L in December 2022. Measurements from screen M1.3 also showed decreasing concentrations from September 2022 and until December 2022 and did not exceed the limit value.

Well M2

The sampling frequency from the monitoring well M2 was quarterly until October 2022 and changed to monthly sampling from hereon. The first detection of DMS occurred in May 2021, approximately one year after the first cyazofamid application, which is also observed in well M1. A groundwater sample from well M2 containing DMS in a concentration above the limit value (0.15 µg/L) was detected 16 months (November 2021) after the first cyazofamid application in June 2020 (Figure 5.4.2D). However, based on the quarterly sampling, a pulse of DMS is observed from May 2021 to May 2022 (Figure 5.4.2D) and it seems that the duration of this pulse, in well M2 corresponding to one year's duration, is comparable to the observed DMS pulse in well M1 (Figure 5.4.2C). From August 2022 to June 2023, DMS concentrations exceeding 0.1 µg/L were consistently detected in M2, except from the sampling in March 2023. The onset for exceedance of the limit value is comparable to what was measured in well M1, where a second pulse of DMS in concentrations exceeding the limit value occurred in September 2022 (Figure 5.4.2C and D).

Well M4

Groundwater samples from well M4 showed that DMS was detected in relatively high concentrations (> 0.1 µg/L) with a maximum concentration of 0.29 µg/L (Figure 5.4.2E). From April 2021 until the latest sampling event in June 2023, DMS is constantly detected (Figure 5.4.2E). The breakthrough of DMS in concentrations exceeding the limit value of 0.1 µg/L occurred 14 months (July 2021) after the first cyazofamid application in June 2020. From July 2021 to November 2022, corresponding to 1.5 year, generally all groundwater samples (22 out of 24) contained DMS in concentrations exceeding the limit value. The maximum DMS concentration was detected in February 2022 (Figure 5.4.2E). In contrast to well M1, where a relatively well-defined first pulse of DMS lasting around 0.5 year was observed (Figure 5.4.2C), there were no clear signs of decreasing concentrations in M4 until July 2022, which corresponded to around one year of leaching (Figure 5.4.2E). From July 2022 to June 2023, the number of samples with concentrations exceeding 0.1 µg/L seems to be declining. After December 2022, no further detections exceeding the limit value were made, though DMS is detected at all sampling events.

Well H1

Groundwater samples from well H1 were collected at varying intervals, as there was not always water in the well during the monthly sampling. When comparing the measured groundwater level in various observation wells (Figure 5.4.2A) and the collection of water samples for analysis (Figure 5.4.2F), it appears that groundwater samples cannot be collected, when the groundwater is generally more than 2.5 meters below ground. Not until February 2021, after the first cyazofamid application in June 2020, was it possible to collect the first groundwater sample from H1. Here, the maximum DMS concentration of 0.32 µg/L was measured (Figure 5.4.2F). This corresponds to DMS being detected eight months after application in well H1, while DMS is generally detected after one year in the other groundwater wells (see e.g., Figure 5.4.2C). From February 2021 to December 2021, corresponding to 10 months, there are constant detections of DMS above the limit value in all groundwater samples from well H1. Overall, a decreasing content of DMS was detected after February 2021, and from January 2022 to July 2022 the measured concentrations were below 0.1 µg/L. No samples were collected from H1 from July 2022 and onwards to the end of the monitoring period in June 2023. This was due to the groundwater being lower than the screen level and a change in sampling strategy leading to stop in sampling from H1.

Well M5

In well M5, the sampling varies between quarterly and half-yearly. DMS was detected three times in concentrations < 0.1 µg/L (Appendix 8, Figure A8.35). Thus, the observations from well M5 are markedly different compared to observations in wells M1, M2, M4, and H1, all of which had substantially more detections of DMS. The minor detections in M5 is related to the well not being within the general groundwater flow field from the field (Badawi et al., 2022a)

Well M7

In upstream groundwater well M7, DMS was also detected in concentrations > 0.1 µg/L with a maximum concentration of 0.37 µg/L in July 2022 (Figure 5.4.2G). From screen M7.2, which represents a depth of approximately 3 mbgs groundwater, samples were collected monthly throughout the monitoring period. From samples taken in screen M7.2, it appears that DMS was detected 21 months (in March 2022) after the first cyazofamid application in June 2020. The DMS detections in well M7 occurred substantially later than what was observed in the downstream groundwater wells, where DMS was detected approximately one year after the first cyazofamid application. After the first detections in M7, the DMS concentrations increased further and from April 2022 to December 2022 concentrations > 0.1 µg/L were consistently detected in well M7. After December 2022 until the end of monitoring in June 2023, DMS was detected once in a concentration > 0.1 µg/L, though consistently detected.

DMSA monitoring at Jyndevad

Variably saturated zone monitoring

Analysis of water from the suction cups showed the first detections of DMSA in August 2020? and October 2020, corresponding to 2–4 months after the first cyazofamid application in June 2020 (Figure 5.4.3B). In contrast to the detections of DMS, there is no clear increase in the concentration of DMSA over several months, and no pulse-like pattern. However, the maximum detected DMSA concentrations are substantially higher than what was detected for DMS. The maximum DMSA concentration of 2.1 µg/L in S2 is approximately a factor of 5 higher than the maximum measured DMS concentration in water from the suction cups. After June 2021, DMSA is detected one time in in February 2022 in a concentrations < 0.1 µg/L. Hereafter, no further detections of DMSA were observed in water from the suction cups (Figure 5.4.3B).

Groundwater monitoring wells

Well M1

Groundwater samples from well M1 also showed detections of DMSA. The breakthrough of DMSA in concentrations > 0.1 µg/L occurred approximately one year (June 2021) after the first cyazofamid application in June 2020 (Figure 5.4.3C). Thus, DMSA in concentrations above the limit value were detected approximately 3 months earlier compared to when DMS was detected in concentrations > 0.1 g/L. From June 2021, the measured DMSA concentrations increased towards a maximum (of 0.38 µg/L) in September 2021, after which the concentrations were generally decreasing. Thus, for six months from June to November 2021, there were constant detections of DMSA with concentrations > 0.1 µg/L (Figure 5.4.3C). From December 2021 to August 2022, DMSA was only once detected in a concentration exceeding the limit value. However, from September to December 2022, DMSA was again detected and consistently exceeding the limit value in the deepest screen at approximately 5 mbgs. Within this period of nine months, the overall maximum DMSA concentration of 0.61 µg/L was detected in September 2022.

Well M2

The sampling frequency of the monitoring well M2 was quarterly until October 2022 and changed to monthly sampling from hereon. Similar to detections of DMSA in well M1, detections of DMSA exceeding the limit value occurs in two distinct periods in M2. The first period, with detections of DMSA in concentrations > 0.1 µg/L, occurred in May 2021 (0.34 µg/L, Figure 5.4.3D). This corresponded to approximately one year after the first cyazofamid application, which was similar to what was observed in well M1. No further detections of DMSA exceeding the limit value were observed until August 2022. From August 2022 to the end of monitoring in June 2023, DMSA was consistently detected in concentrations > 0.1 µg/L (Figure 5.4.3D). The overall maximum detected concentration of DMSA (0.35 µg/L) was measured in October 2022.

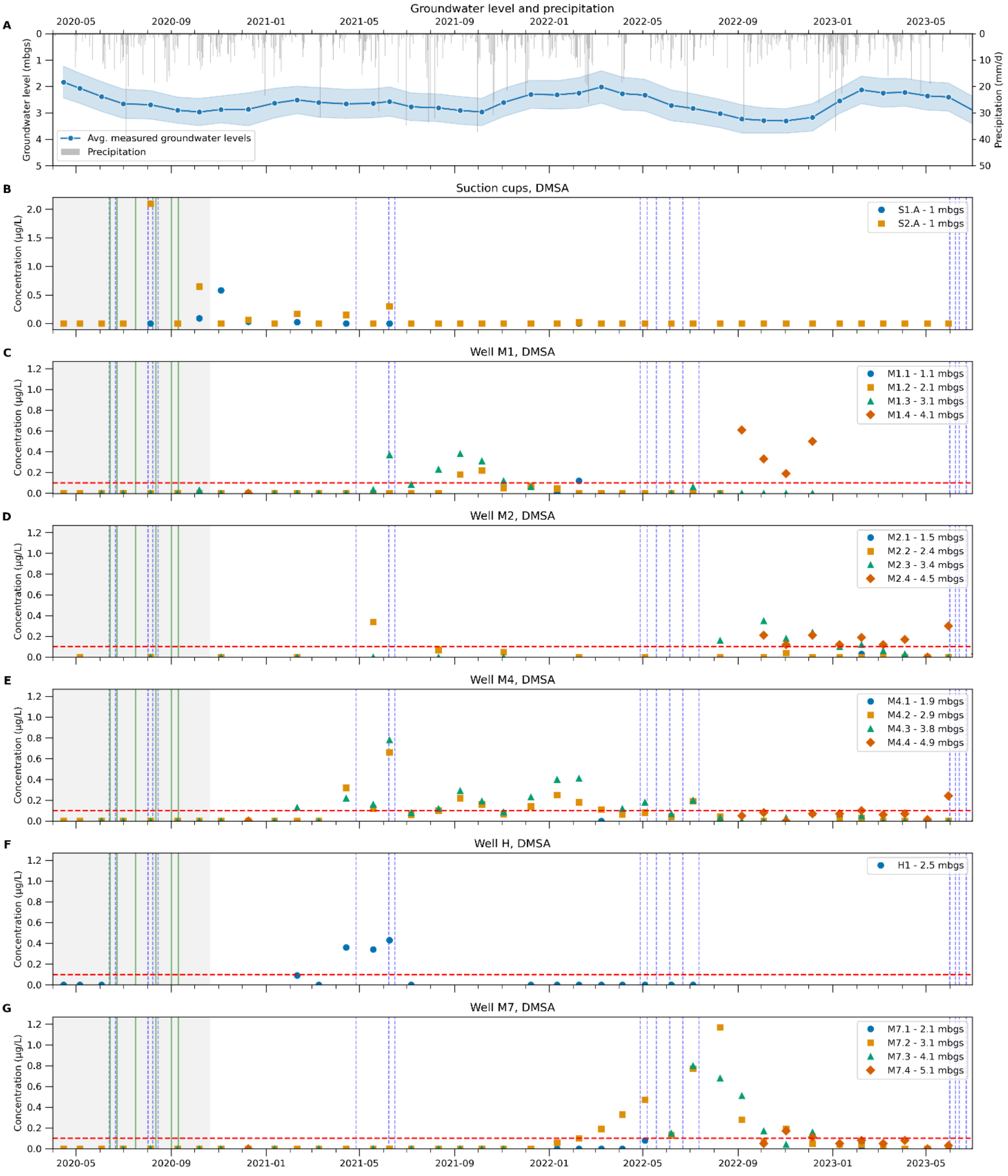

Figure 5.4.3. DMSA monitoring at Jyndevad. Precipitation and measured groundwater levels, with standard deviations (A); measured DMSA in the variably saturated zone (B); measured DMSA in the downstream monitoring wells (C-E); measured DMSA in the horizontal well (F); measured DMSA in the downstream monitoring well M7 (G). Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. Monitoring of DMSA is ongoing.

Well M4

Groundwater samples from well M4 showed that DMSA is detected in concentrations > 0.1 µg/L with a maximum detected concentration of 0.78 µg/L (Figure 5.4.3E). DMSA was detected in groundwater samples from well M4 in February 2021 after the first cyazofamid application in June 2020. Subsequently, DMSA was generally detected consistently until the end of the monitoring period in June 2023. From April 2021, when DMSA was first detected in a concentration > 0.1 µg/L and until July 2022, 0.1 µg/L was exceeded in 14 out of 32 samples. Detections of DMSA exceeding the limit value was, thus, generally consistent for a period of around one and a half year (Figure 5.4.3E). The pattern of a relatively long period with detections in concentrations exceeding the limit value was also observed for the leaching of DMS in well M4 (Figure 5.4.2E). The maximum DMSA concentrations in M4 were measured in June 2021. These detections were substantially higher relative to the remaining measurements, though two consecutive months with DMSA concentrations of around 0.4 µg/L were observed in January and February 2022. After July 2022, DMSA was consistently detected, but only one exceedance of the limit value, which was detected at the latest sampling event in May 2023.

Well H1

In well H1, DMSA was detected in February 2021 at the first possible sampling event after the cyazofamid applications. After this, DMSA was constantly detected in groundwater samples from April to June 2021, where the limit value was exceeded in all samples. The maximum DMSA concentration of 0.43 µg/L was detected in June 2021 (Figure 5.4.3F). Subsequently, from June 2021 and until the last sampling event in well H1 conducted in July 2022, there were no more detections of DMSA in the groundwater samples.

Well M5

In well M5, the sampling varies between quarterly and half-yearly. DMSA was detected three times with one detection > 0.1 µg/L (Appendix 8, Figure A8.41). Thus, the observations from well M5 are markedly different compared to observations in wells M1, M2, M4, and H1, all of which had substantially more detections of DMSA. The few detections in M5 is related to the well not being within the general flow groundwater flow field from the field (Badawi et al., 2023b)

Well M7

Groundwater samples from M7, which is an upstream well, also showed detections of DMSA with a maximum concentration of 1.17 µg/L (Figure 5.4.3G). The screen M7.2, which represents a depth of approximately 3 meters below ground, was sampled monthly throughout the monitoring period. Samples collected in M7.2 showed that DMSA was detected 19 months (in January 2022) after the first cyazofamid application in June 2020. After the first detection of DMSA, the measured concentrations increased consistently until August 2022, where the maximum concentration was detected. From September 2022 to the last sampling event in May 2023, the DMSA concentrations decreased. However, it is noted that the exceedance of the limit values persisted from March 2022 to December 2022 (Figure 5.4.3G). Similar to the detections of DMS in well M7, the DMSA detections occurred substantially later than what was observed in the downstream groundwater wells, in which DMSA was detected. In these downstream groundwater wells, DMSA was detected approximately one year after the first cyazofamid application compared to 19 months in M7.

Irrigation water

The irrigation water used at the Jyndevad field is obtained from four wells east and northeast of the field. The nearest well is located 2-300 m east (i.e., upstream of the field), and screened from 15.5 to 21.5 mbgs. The remaining irrigation wells are located at distances of 500-1000 m from the field (Table 5.4.3, Figure 5.4.4). Commonly, it is not possible to determine which wells supply the irrigation water as all pumps in the four wells are connected in series. However, the water sample from May 19, 2022, was specifically taken from the nearest irrigation well (Figure 5.4.4, DGU no. 167.1089).

Table 5.4.3. Irrigation wells in proximity of the Jyndevad field. Irrigation water is commonly mixed from all four wells.

DGU well no.	Depth (m)	Screen depth (mbgs)	Geology	Location relative to PLAP field
167.513	7.5	na.	na.	1000 m NNE
167.973	20	10-20	Meltwater sand	800 m NNE
167.892	7.5	na.	na.	500 m NE
167.1089	22	15.5-21.5	Meltwater sand	2-300 m E

The irrigation water used in the field is sampled on nine occasions during the monitoring period 2020-2023 (Table 5.4.4). DMS is detected in 7 out of 9 samples, DMSA in 1 out of 9 samples, while CCIM and CTCA were not detected. The DMS concentration was between 0.011 µg/L and 0.027 µg/L, while the DMSA concentration was 0.02 µg/L (note that the DMSA detection limit is 0.02 µg/L).

Table 5.4.4. Results from the irrigation water analyses at Jyndevad in 2020-2023. For locations of the irrigation wells, see Figure 5.4.4. Note the different detection limits for DMS and DMSA. DMS DL = 0.01 µg/L and DMSA DL = 0.02 µg/L.

Date	DMS, concentration (µg/L)	DMSA, concentration (µg/L)
07-06-2020	0.011	< 0.02
03-08-2020	0.011	< 0.02
27-04-2021	< 0.01	< 0.02
16-06-2021	0.027	< 0.02
28-04-2022	0.021	0.02
19-05-2022*	0.014*	< 0.02*

**Water sample from DGU well 167.1089 closest to the field.*

Figure 5.4.4. The location of the PLAP field, Jyndevad delineated by the green box. The yellow stars represent the irrigation wells, and the blue arrow shows the general groundwater flow direction.

5.4.4. Discussion on the CTCA, CCIM, DMS, and DMSA monitoring

CTCA and CCIM were not detected in the monitoring, indicating that these metabolites from cyazofamid are not prone to leaching.

In all groundwater wells with DMS detections, there were correspondingly consistent detections of DMSA and vice versa. Both DMS and DMSA were detected in concentrations exceeding the limit value of 0.1 µg/L. Also, the detected concentrations were relatively high, in some cases up to a factor of 5 higher than the limit value. In all groundwater wells with DMS- and DMSA detections, there were generally consistent patterns of DMSA in concentrations above the limit value being detected earlier than DMS is detected in concentrations > 0.1 µg/L. For instance, DMSA was detected above the limit value approximately three months before DMS is detected in concentrations > 0.1 µg/L in well M1 (Figure 5.4.2C and Figure 5.4.3C) and approximately five months before DMS is detected above the limit value in well M4 (Figure 5.4.2E and Figure 5.4.3E). The period in which measured DMS- and DMSA concentrations exceeded 0.1 µg/L varied between the different wells. However, there was a tendency for a longer period with continued leaching of DMS than there was for DMSA. For instance, in well M1, DMS is detected in concentrations > 0.1 µg/L during approximately one year (Figure 5.4.2C) while DMSA is detected in concentrations > 0.1 µg/L for approximately half a year (figure 5.4.3C).

In the horizontal groundwater well H1 located below the field, DMS was detected earlier in concentrations > 0.1 µg/L compared to the other groundwater wells. In well H1, DMS is detected approximately 8 months after the first cyazofamid application (Figure 5.4.2F), while DMS detections > 0.1 µg/L are generally observed approximately after one year in the other groundwater wells (e.g. Figure 5.4.2C). The reason DMS was observed earlier in well H1 is likely that H1 is located directly below the field, meaning that the transport time is relatively short compared to the vertical wells M1, M2, and M4, which are located in the buffer zone approximately 15-20 meters downstream of the cultivated area of the field (Figure 2.1.1, Chapter 2). Therefore, DMS could be present in the groundwater below the field before the observed findings downstream of the field. This cannot be verified, as the groundwater table was deeper than the screen depth of well H1 in the period up to the first detection of DMS in H1, hence no samples from underneath the field could be collected in that period. However, previous tracer experiments with bromide show that maximum bromide concentrations in well H1 were found approximately 5 months after tracer application, while it took approximately 14 months before bromide was observed in the downstream wells (Badawi et al., 2022).

In well M5, DMS- and DMSA are not detected (Appendix 8, Figure A8.35 and A8.41). This is because the well does not represent the water flowing from the field to the groundwater at the same degree as the wells M1, M2, M4, and H1. This is supported by previous bromide tracer experiments, where the detections differ substantially from the other downstream wells (Badawi et al., 2022).

Though the monitoring from well M1 and M2 had differences in the number of detections > 0.1 µg/L and the concentration magnitude of DMS and DMSA, these wells exhibited similarities in their observed leaching patterns. That is, a pulse of DMS and DMSA appeared to occur during two times within the monitoring period from May 2021 to June 2023. This is perhaps most evident for the leaching pattern of DMS (Figure 5.4.2), where well M2 and M4 showed concentrations of DMS peaking around November 2021 and again around October 2022. In the upstream well M7, both DMS and DMSA were detected, though in principle, no DMS or DMSA should be detected in well M7, as it is considered an upstream well. This means that the well represents water and groundwater flowing towards the field and, thus, not affected by water from the field itself. To explain the DMS and DMSA detections in M7, it was investigated which crops were grown on the adjacent fields and which pesticide products were reported to the Danish Environmental Protection Agency's IT system SJI. It was found that a crop of potatoes was sown in 2021 on the field immediately east of the Jyndevad field, located upstream (Figure 5.4.4), and that cyazofamid was applied in the summer of 2021. This can explain the DMS- and DMSA detections in early 2022 in the upstream well M7, since the groundwater flow direction is generally from east to west. This corroborated with the two different periods in which a pulse of DMS and DMSA was observed in the downstream wells M1 and M2. From the detections in the suction cups, it was evident that the maximum concentrations of DMS and DMSA leached through the variably saturated zone in October 2020 and September 2020, respectively, after which the concentrations decreased consistently, and the compounds eventually ceased to be detected. As such, the leaching pattern through the variably saturated zone cannot explain the pattern of a second leaching pulse observed in the downstream monitoring wells. Therefore, the first pulse of DMS and DMSA observed leaching and detected in both M1 and M2 is deemed to be related to the cyazofamid application on the PLAP field itself. In contrast, the second pulse of DMS and DMSA observed leaching was related to the cyazofamid application on the adjacent upstream field.

It is noted that DMS is present in some of the groundwater wells before the first cyazofamid application in June 2020. Before this application, DMS is detected in well M4 with concentrations of 0.021 µg/L in a single background sample (Figure 5.4.2E), and twice in H2 in concentrations of 0.023 and 0.048 µg/L (Figure 5.4.2F). The DMS detections in background samples from H1 are likely because cyazofamid is previously used in the field, most recently in 2014. This was also found in the research project TRIAFUNG while developing the analytical method for DMS and 1,2,4-triazole used for research purposes in the GEUS laboratory. Here, in September 2019, they detected relatively low DMS concentrations (< 0.04 µg/L) in water from the Jyndevad field. Further, DMS is detected in all but one of the irrigation samples, suggesting that DMS is present in the groundwater in low concentrations in the area (Table 5.4.4).

5.4.5. Conclusion on the cyazofamid test at Jyndevad

After cyazofamid application on the Jyndevad field, the monitoring shows that the degradation products CCIM and CTCA are not detected in any of the samples collected. In contrast, DMS and DMSA are generally detected in concentrations > 0.1 µg/L and over long periods (approximately 6-12 months) in groundwater wells. During these periods, the DMS- and DMSA concentrations exceeded the limit value by a factor of 2-4, while individual measurements exceeded the limit value by up to a factor of around 8 and 10, respectively. Further, there is a consistent pattern of DMSA being detected earlier in groundwater below the field than DMS, and the first breakthroughs of the two degradation products in concentrations > 0.1 µg/L generally occurred approximately one year after the first cyazofamid application. The results show that the duration (pulse) of detections is longer for DMS than for DMSA, although the maximum detected concentrations of DMSA are higher than for DMS. The detections from water samples in the suction cells at 1 mbgs, representing flow from the field down to the groundwater, support the results from the groundwater wells. Thus, analyses from 1 mbgs show that DMS and DMSA leach in concentrations > 0.1 µg/L, that DMS and DMSA are found 2-3 months after the first cyazofamid application, and that the duration of DMSA detections is shorter than for DMS.

DMS- and DMSA detections in upstream well M7 are not considered to originate from the cyazofamid application on the Jyndevad field. This is because (i) the groundwater flow direction from the field is west and well M7 is located east of the field, (ii) the time of the detections is later than what was observed in the other groundwater wells downstream of the field, and (iii) that the neighboring field was cultivated with potatoes in 2021, and cyazofamid was used in the potato crop. Thus, the detections observed later in well M7 are likely related to the cyazofamid application on the neighboring field, where potatoes are grown a year later than on the Jyndevad field.

From the analysis of the spray solution, it is clear that cyazofamid to some extend is hydrolyzed to CCIM and DMSA before the solution is sprayed on the field. The contribution of DMSA from the spray solution to the field is not considered to be the primary source of leaching of DMSA, as the content of DMSA in the solution only contributed with approximately 3% of the added cyazofamid. This result is supported by a column experiment (Badawi et al. 2023a), where the leaching of DMSA from the columns is more than 6 times higher than that supplied to the columns via the aqueous cyazofamid spike solution.

In the study by Badawi et al. (2023a), both batch degradation and soil column experiments support the results from the monitoring at the PLAP field at Jyndevad. Cyazofamid has been shown to break down relatively quickly in soil. Degradation of cyazofamid produces both DMS and DMSA, whereas the formation of DMSA from DMS degradation is not observed. Furthermore, the column leaching experiment shows that DMS and DMSA leach in concentrations > 0.1 µg/L after addition of cyazofamid in a concentration corresponding to one field application (80 g cyazofamid/L per hectare). Leaching of CCIM or CTCA (CTCA detected once in one column leachate) was not detected in the column experiment, which is consistent with the PLAP results.

5.5. Fluopyram

Fluopyram and one degradation product, fluopyram-7-hydroxy were monitored in the current reporting period, July 2021-June 2023, following fluopyram applications at the sandy field Jyndevad, and the three clay till fields Silstrup, Faardrup and Lund. Detailed information on the field sites included in the test is available in Chapter 2.

All pesticide monitoring at Lund was set on standby in October 2022, due to uncertainty of the hydraulic connectivity in the monitoring wells and the percolating water from the field. The fluopyram tests done at Lund in 2021 and 2022 and presented in the previous report (Badawi et al. 2023b) will therefore not be further evaluated as the uncertainty may affect the outcome of the tests. A new bromide tracer test to elucidate the hydraulic connectivity was started at Lund in January 2023, as the bromide test in 2017, seemed to have been erroneous.

5.5.1. Application of fluopyram at Jyndevad, Silstrup, and Faardrup

Fluopyram was tested in PLAP with cropping of winter wheat, spring barley, and winter rapeseed during the reporting period July 2021 to June 2023 (Figure 5.5.0).

Fluopyram was applied at Jyndevad in spring barley on May 22, 2022.

At Silstrup, fluopyram was applied in spring barley on June 30, 2021, and in winter wheat on May 4, and June 10, 2022 and in a second crop of winter wheat on May 15 and June 7, 2023.

At Faardrup, fluopyram was applied in winter rapeseed on May 26, 2021 and on winter wheat on May 4 and 30, 2022 and again in a second crop of winter wheat on May 4 and 30, 2023. Detailed information on agricultural management is available in Chapter 3 and Appendix 3, and previous PLAP reports.

Fluopyram was not applied in PLAP prior to the tests initiated in 2021.

5.5.2. Compounds included in the monitoring

In the 2021 fluopyram test at Silstrup and Faardrup only fluopyram was included in the monitoring, but the degradation product, fluopyram-7-hydroxy, was added in connection with the 2022 fluopyram tests at Jyndevad, Silstrup, and Faardrup, and the 2023 fluopyram tests at Silstrup and Faardrup (Figure 5.5.0).

Monitoring of fluopyram was initiated in April 2021 at Silstrup and Faardrup, and at Jyndevad in February 2022. The degradation product, fluopyram-7-hydroxy was included in the monitoring in February 2022 at all three fields, and the monitoring of fluopyram and fluopyram-7-hydroxy is ongoing.

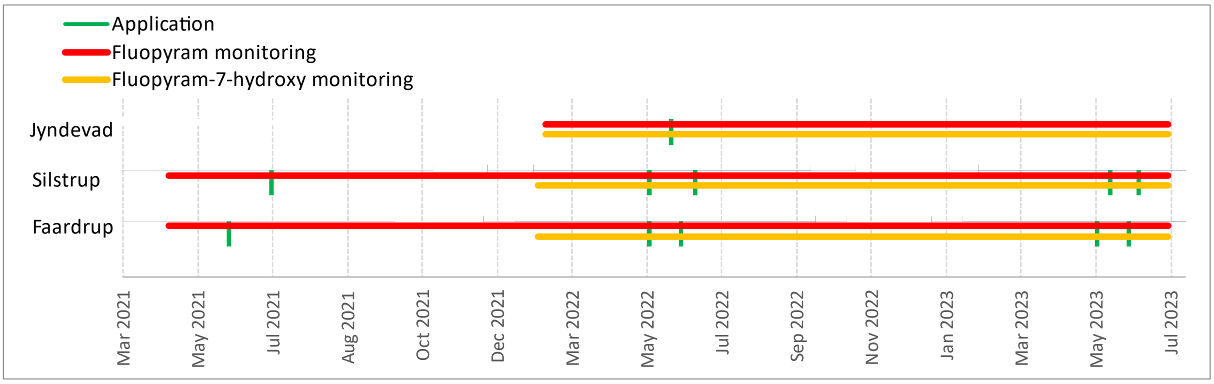

Figure 5.5.0. Overview of the fluopyram and fluopyram-7-hydroxy monitoring at Jyndevad, Silstrup and Faardrup.

5.5.3. Results of the fluopyram and fluopyram-7-hydroxy monitoring

Before the fluopyram test in May/June 2021 on the clay till fields Silstrup and Faardrup, results from the background sampling (started in April 2021) showed that fluopyram was not detected in any drainage- or groundwater samples from the two fields. In total, 28 and 15 samples were collected from Silstrup and Faardrup, respectively.

Fluopyram and fluopyram-7-hydroxy were included in the monitoring in February 2022 at Jyndevad and fluopyram was applied on May 22, 2022. In total, 42 background samples were collected in suction cups and monitoring wells before the fluopyram application, and none of these contained fluopyram or fluopyram-7-hydroxy. The Jyndevad field was irrigated three times before the fluopyram application, and two of the three irrigation samples were analysed for fluopyram or fluopyram-7-hydroxy. None of the irrigation water samples contained fluopyram or fluopyram-7-hydroxy.

Fluopyram-7-hydroxy was added to the ongoing monitoring of fluopyram at Silstrup and Faardrup in February 2022, when fluopyram for the second consecutive year was applied in May and June at Silstrup, and twice in May at Faardrup. Before these applications, a total of 32 and 36 background samples were collected for analysis of fluopyram-7-hydroxy in drainage and groundwater monitoring wells at Silstrup and Faardrup. Fluopyram-7-hydroxy was detected in two of the 7 background samples collected from drainage before the May 2022 application in Silstrup. Both detections from February 2022 were < 0.1 µg/L. As fluopyram was applied to the fields for the second year in a row, the detection of fluopyram-7-hydroxy was not unexpected. It is noted that fluopyram-7-hydroxy was not detected in drainage or groundwater samples before the application in May 2022 at Faardrup.

An overview of the entire monitoring results is given in Table 5.5.1 and shows the number of detections in drainage and monitoring wells during the monitoring period from May 2022 to June 2023 at Jyndevad, and May/June 2021 to June 2023 at Silstrup and Faardrup.

Table 5.5.1. Number of samples and detections of fluopyram and fluopyram-7-hydroxy at Jyndevad, Silstrup, and Faardrup in suction cups (S, Jyndevad only) and drainage (D), vertical monitoring wells (M) and horizontal wells (H). The fluopyram counting comprises all samples collected from May 22, 2022 to June 2023 at Jyndevad, from June 30, 2021 to July 2023 at Silstrup, and from May 26, 2021 to June 2023 at Faardrup. The fluopyram-7-hydroxy counting comprises all samples collected from May 4, 2022 at Silstrup and Faardrup to June 2023, and from May 22, 2022 to June 2023 at Jyndevad. Background samples collected before the fluopyram applications and analyses of irrigation water (Jyndevad) are not included in the counting.

	Total			S/D			M			H			Total Groundwater (M+H)		
	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L
Jyndevad															
Fluopyram	158	0	0	26*	0	0	130	0	0	2	0	0	132	0	0
Fluopyram-7-hydroxy**	158	0	0	26*	0	0	130	0	0	2	0	0	132	0	0
Silstrup															
Fluopyram	250	81	16	52	45	8	163	28	7	35	8	1	198	36	8
Fluopyram-7-hydroxy**	167	31	3	28	16	1	123	11	2	16	4	0	139	15	2
Faardrup															
Fluopyram	209	5	1	51	5	1	133	0	0	25	0	0	158	0	0
Fluopyram-7-hydroxy**	146	2	0	32	2	0	100	0	0	14	0	0	114	0	0

**Data from suction cups at Jyndevad. ** fluopyram-7-hydroxy included from May 2022 after fluopyram application.*

Variably saturated zone monitoring

During the monitoring from May/June 2021 to July 2023, a total of 52 and 51 drainage samples were collected and analysed for fluopyram from Silstrup and Faardrup, respectively. From these, a total of 28 and 32 were analysed for fluopyram-7-hydroxy during the period May 2022 to July 2023, respectively.

Jyndevad

At Jyndevad, 26 samples were collected from suction cups in the period from May 2022 to July 2023. No fluopyram or fluopyram-7-hydroxy were detected in suction cups at Jyndevad during this period.

Silstrup

At Silstrup, fluopyram was detected in 45 drainage samples out of 52 (Figure 5.5.1B, Table 5.5.1), with eight detections in concentration > 0.1 µg/L. Fluopyram was first detected in a concentration > 0.1 µg/L in July 2021 (0.21 µg/L), approximately one month after the first fluopyram spring barley application in June 2021. Thereafter, fluopyram was detected in concentrations < 0.1 µg/l (0.025 µg/L) until April 2022, where the drainage stops. From August 2021 to April 2022 when the drainage was active, the concentration of fluopyram fluctuated below 0.1 µg/L and peaked twice in October 2021 and February 2022 with maximum concentrations of 0.086 µg/L and 0.054 µg/L, respectively (Figure 5.5.1B). In September 2022, the drainage was again active and the maximum concentration of fluopyram (0.34 µg/L) was detected in the first collected drainage sample. Thereafter, fluopyram was detected in all drainage samples until June 2023, and the concentration fluctuated between 0.013 to 0.18 µg/L with six detections in concentration > 0.1 µg/L.

Fluopyram-7-hydroxy is detected in 16 drainage samples out of 28 samples, one in a concentration > 0.1 µg/L (0.27 µg/L) in September 2022 coinciding with the maximum detected concentration of fluopyram following the May/June 2022 fluopyram applications (Figure 5.5.1B and 5.5.2B). Fluopyram-7-hydroxy was included in the monitoring in February 2022, approximately half a year after the first application of fluopyram at Silstrup. From February 2022 till the second fluopyram application in May 2022, fluopyram-7-hydroxy was detected twice, both in concentrations < 0.1 µ/L. No further detections of fluopyram-7-hydroxy were made until the drainage stopped in April 2022. The drainage started flowing again in September 2022, and in the first drainage event fluopyram-7-hydroxy was present in the previously mentioned maximum concentration detected. From October 2022 to July 2023, fluopyram-7-hydroxy was detected in 15 out of 27 drainage samples, all in concentrations < 0.1 µg/L (0.012-0.073 µg/L).

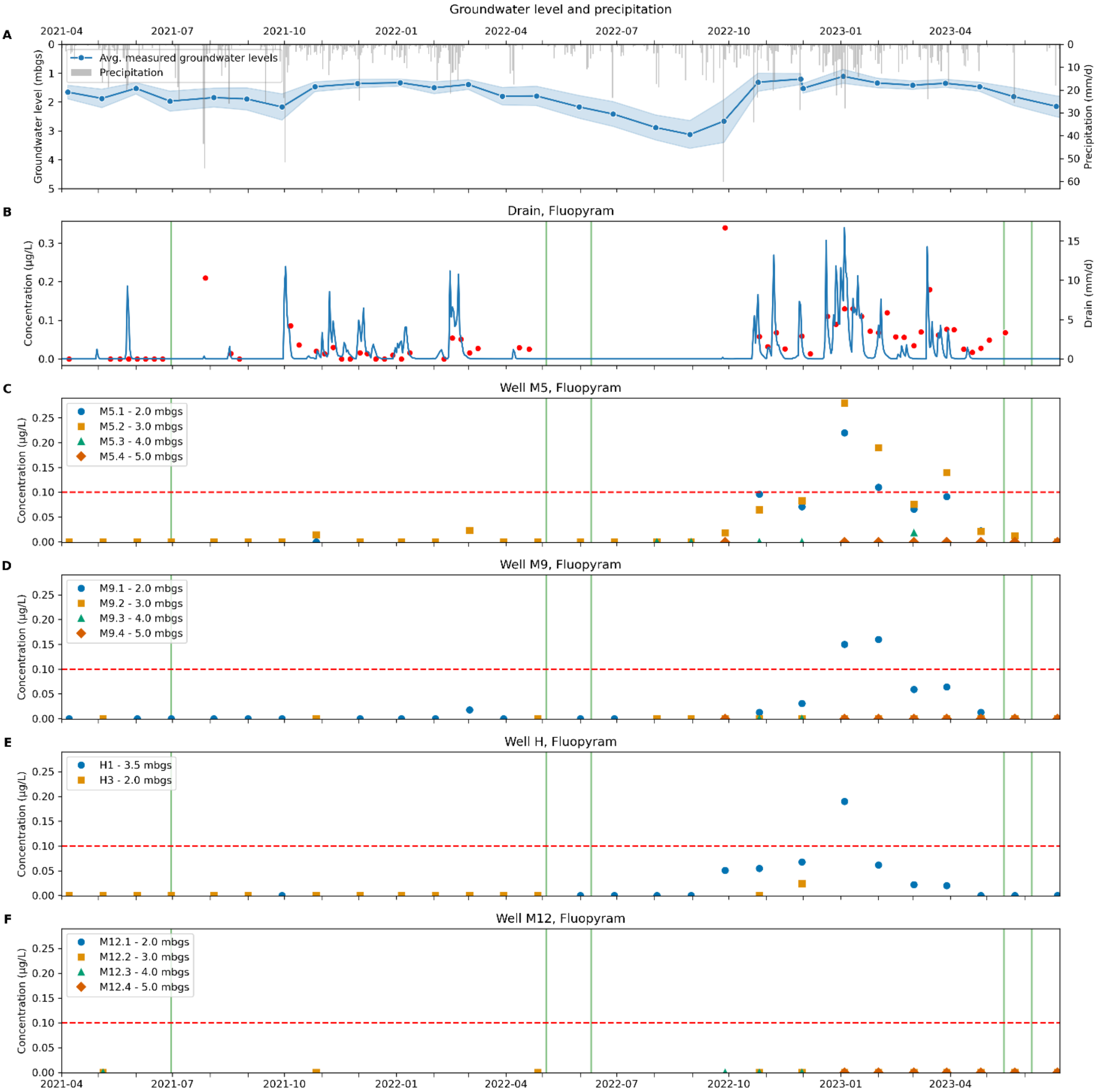

Figure 5.5.1. Fluopyram monitoring at Silstrup. Precipitation and measured groundwater levels, with standard deviations (A); measured fluopyram in the variably saturated zone (B); measured fluopyram in the downstream vertical groundwater monitoring wells (C-D); measured fluopyram in the horizontal groundwater wells (E); measured fluopyram in the downstream vertical groundwater monitoring well M12 (F); The secondary y-axis (B) represents the drain flow. The vertical green lines indicate the date of fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. Fluopyram was included in the monitoring in April 2021 and monitoring of Fluopyram at Silstrup is ongoing.

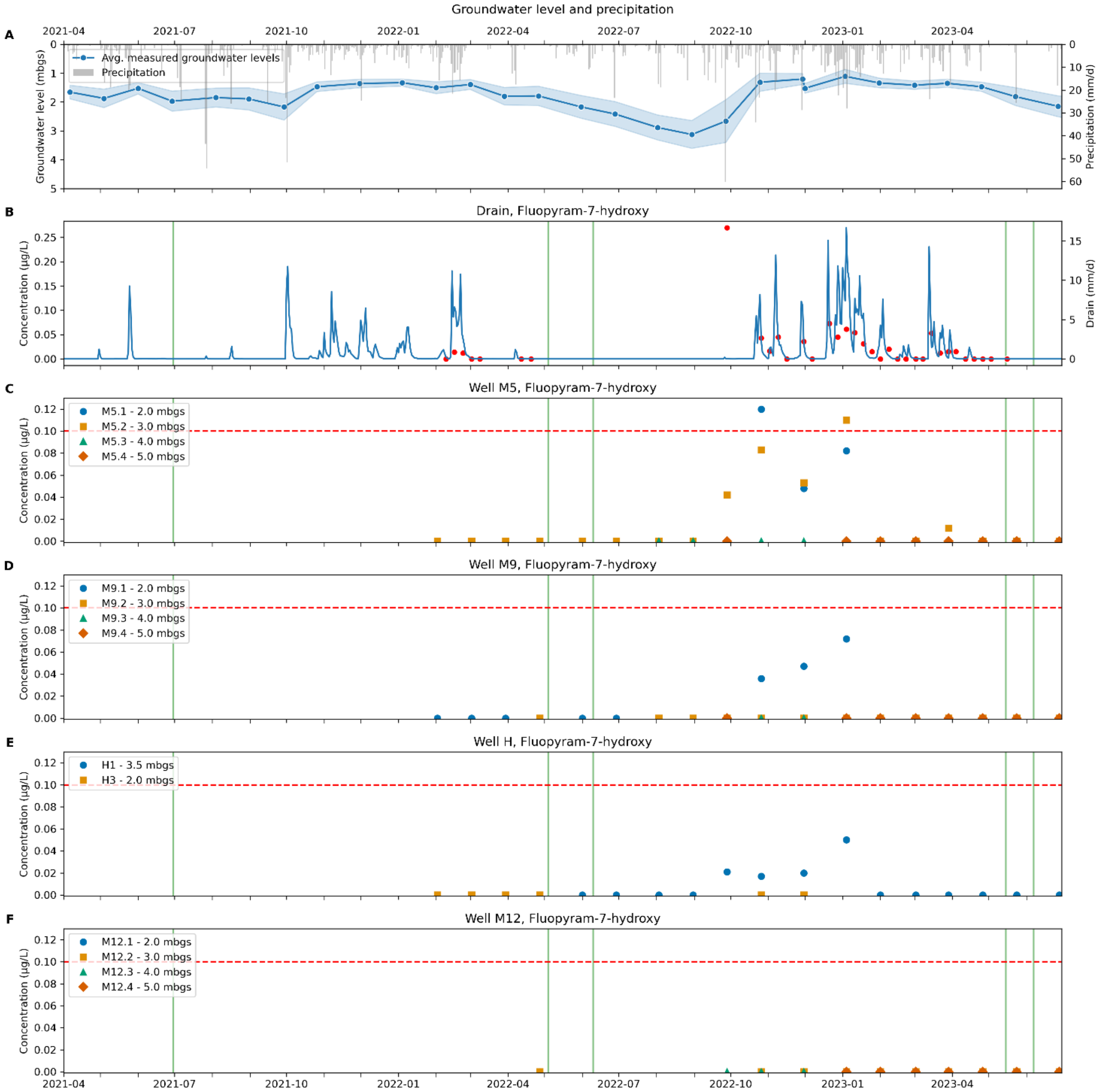

Figure 5.5.2. Fluopyram-7-hydroxy monitoring at Silstrup. Precipitation and measured groundwater levels, with standard deviations (A); measured fluopyram-7-hydroxy in the variably saturated zone (B); measured fluopyram-7-hydroxy in the downstream vertical groundwater monitoring wells (C-D); measured fluopyram-7-hydroxy in the horizontal groundwater wells (E); measured fluopyram-7-hydroxy in the upstream vertical groundwater monitoring well M12 (F); The secondary y-axis (B) represents the drain flow. The vertical green lines indicate the date of fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. Fluopyram-7-hydroxy was included in the monitoring in February 2022. Monitoring of fluopyram-7-hydroxy at Silstrup is ongoing.

Faardrup

At Faardrup, fluopyram was detected in five drainage samples out of 51 (Figure 5.5.3B), with one detection in a concentration > 0.1 µg/L (0.14 µg/L). This detection was the first time fluopyram was detected in drainage at this field and it was in January 2023 approximately half a year after the May 2022 winter wheat application. Thereafter and until the end of the monitoring period in June 2023, fluopyram was detected in four out of 23 drainage samples, all in concentrations < 0.1 µg/l (0.017-0.033 µg/L). Fluopyram-7-hydroxy was detected in two out of 32 drainage samples. Both detections of fluopyram-7-hydroxy were in a concentration < 0.1 µg/L and both detections were in January 2023 simultaneously with the highest detections of fluopyram in drainage (Figure 5.5.3B-C).

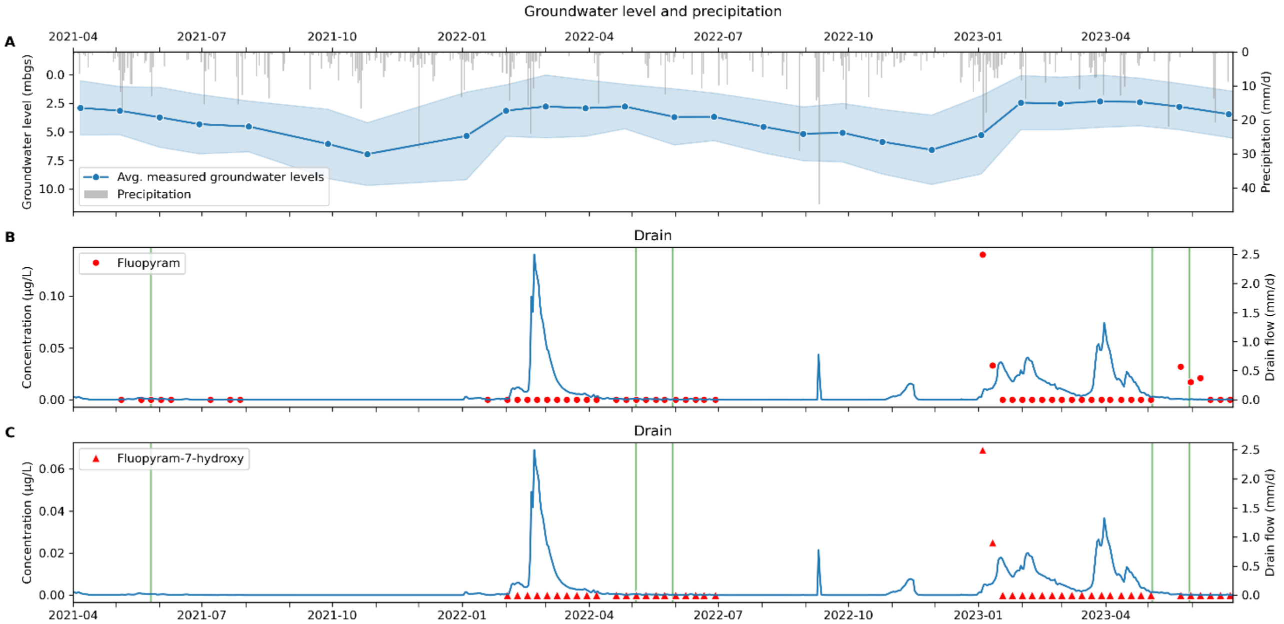

Figure 5.5.3. Fluopyram and fluopyram-7-hydroxy monitoring at Faardrup. Precipitation and measured groundwater levels, with standard deviations (A); measured fluopyram in the variably saturated zone (B); measured fluopyram-7-hydroxy in the variably saturated zone (C); The secondary y-axis (B-C) represents the drain flow. The vertical green lines indicate the date of fluopyram applications. Fluopyram was included in the monitoring in April 2021 and fluopyram-7-hydroxy was included in the monitoring in February 2022. Monitoring of Fluopyram and fluopyram-7-hydroxy at Faardrup is ongoing.

Groundwater monitoring wells

Jyndevad

During the approximately one year of monitoring from the fluopyram application in spring barley in May 2022 until the end of the monitoring period on June 30, 2023, fluopyram and fluopyram-7-hydroxy were not detected in groundwater at Jyndevad. During this period, the Jyndevad field was irrigated seven times. At three of the irrigation events, samples were collected and analysed for fluopyram and fluopyram-7-hydroxy. None of the irrigation water samples contained fluopyram or fluopyram-7-hydroxy.

Silstrup

At Silstrup, fluopyram was detected in groundwater for the first time in October 2021 in downstream well M5, and again in March 2022 in both downstream wells M5 and M9 (Figure 5.5.1C,D). The detections of fluopyram in groundwater coincided with the two peak detections observed in drainage. Fluopyram was first detected in groundwater in a concentration < 0.1 µg/L in October 2021 approximately four months after the June 2021 fluopyram application (Figure 5.5.1C). Here, fluopyram was detected in the downstream well M5 (2.5-3.5 mbgs) in a concentration of 0.014 µg/L. In March 2022, fluopyram was detected again in M5 in both 1.5-2.5 and 2.5-3.5 mbgs in a concentration of 0.023 µg/L. Fluopyram was additionally detected in the downstream well M9 (1.5-2.5 mbgs) in a concentration of 0.018 µg/L. As the sampling programme in M9 at the depth 2.5-3.5 mbgs was half-yearly before September 2022, no sample was collected at that depth in March 2022, when fluopyram was detected in M5. Fluopyram was not detected in the groundwater after March 2022 until September 2022, when it was detected in M5 and the horizontal well H1 (3.5 mbgs) in concentrations < 0.1 µg/L. From October 2022 onward, the concentration of fluopyram was increasing in M5, M9, and H1, and the concentration of fluopyram was peaking with maximum detections > 0.1 µg/L in January 2023 in M5 and H1, and in February 2023 in M9. In M5, fluopyram was detected in the two uppermost screens 1.5-2.5 and 2.5-3.5 mbgs in concentrations of 0.22 and 0.28 µg/L respectively, and the concentration was exceeding 0.1 µg/L from January through March 2023. In M9, fluopyram was only detected in the upper screen 1.5-2.5 mbgs but this was in a concentration of 0.15 and 0.16 µg/L in January and February 2023, respectively. In H1 the maximum detection of fluopyram coincided with the detection in January 2023 in M5, and the maximum detected concentration was 0.19 µg/L. After the detections exceeding 0.1 µg/L in January-March 2023, the fluopyram concentration was decreasing, and from April 2023 all detections were < 0.1 µg/L. At the last sampling event in June 2023, no drainage was present and fluopyram was not detected in any monitoring wells. No fluopyram was detected in the upstream monitoring well M12 during the monitoring period.

Fluopyram-7-hydroxy was detected for the first time in groundwater in M5 (2.5-3.5 mbgs, no samples in screen 1.5-2.5 mbgs due to low groundwater level) and H1 in September 2022. Both detections were < 0.1 µg/L, but similar to the detections of fluopyram, the concentration increased subsequently, and from October 2022, fluopyram-7-hydroxy was also detected in M9. Fluopyram-7-hydroxy was only detected in concentration > 0.1 µg/L in M5 and only in the two uppermost screens, M5.1 (0.12 µg/L; 1.5-2.5 mbgs) in October 2022 and M5.2 (0.11 µg/L; 2.5-3.5 mbgs) in January 2023. It should be noted that no groundwater was present in M5 (1.5-2.5 mbgs) in the period May-September 2022 due to low groundwater table. No fluopyram-7-hydroxy was detected in groundwater after April 2023 and until the end of the reporting period in June 2023.

Faardrup

At Faardrup, fluopyram and fluopyram-7-hydroxy were not detected in groundwater during the reported monitoring period from May 2021 to June 2023 and May 2022 to June 2023, respectively.

A total of 198, and 158 groundwater samples were collected from Silstrup and Faardrup, respectively (Table 5.5.1), during the monitoring period from May/June 2021 to July 2023, and 132 groundwater samples from Jyndevad in the period May 2022 to July 2023. Monitoring of fluopyram and fluopyram-7-hydroxy is still ongoing at all three fields.

5.5.4. Discussion and conclusion on the fluopyram and fluopyram-7-hydroxy monitoring

Fluopyram was tested in three different crops, rapeseed at Faardrup, spring barley at Jyndevad and Silstrup, and winter wheat at Silstrup and Faardrup during the monitoring period May/June 2021 - June 2023.

At Silstrup, fluopyram and the degradation product fluopyram-7-hydroxy were both detected in drainage following the application of fluopyram in spring barley in June 2021 and both fluopyram and fluopyram-7-hydroxy were detected in concentrations above 0.1 µg/L during the monitoring period covered by this report

Fluopyram and fluopyram-7-hydroxy were both detected in the groundwater at the Silstrup field and both in concentrations exceeding 0.1 µg/L. The maximum concentration of fluopyram (0.28 µg/L) was detected in January 2023, approximately six months after the split application of fluopyram in winter wheat in May/June 2022. The maximum detected fluopyram-7-hydroxy concentration (0.12 µg/L) in groundwater was detected in October 2022. Except for one detection of fluopyram in M5 (0.012 µg/L; 1.5-2.5 mbgs) in May 2023, no fluopyram or fluopyram-7-hydroxy were detected in May and June 2023, when the reporting period ended. Neither fluopyram nor fluopyram-7-hydroxy were detected in samples upstream of the field (M12).

Fluopyram and fluopyram-7-hydroxy were neither detected in groundwater samples from Jyndevad and Faardrup, nor in water from the variably saturated zone (suction cups) at Jyndevad. At Faardrup, fluopyram and fluopyram-7-hydroxy were detected in the drainage, and only fluopyram once in a concentration > 0.1 µg/L (0.14 µg/L). This detection was the first time fluopyram was detected in drainage at Faardrup and it was in January 2023.

Monitoring of fluopyram and fluopyram-7-hydroxy is ongoing at all three fields.

5.6. Lambda cyhalothrin

One degradation product, compound Ia from lambda cyhalothrin, was included in the monitoring in the current reporting period, July 2021-June 2023, following lambda cyhalothrin application on the sandy field Jyndevad. Detailed information on the field site is available in Chapter 2.

5.6.1. Application of lambda cyhalothrin at Jyndevad

Lambda cyhalothrin was tested in PLAP in connection with cropping of potatoes at Jyndevad in 2023. Lambda cyhalothrin was applied at Jyndevad on July 28 and August 25, 2023. Detailed information on agricultural management is available in Chapter 3 and Appendix 3.

Lambda cyhalothrin was previously applied in a potato crop at Jyndevad in 2010, but neither lambda cyhalothrin nor any of its degradation products were included in the monitoring. The agricultural management from this period is described in previous PLAP reports available at www.plap.dk.

5.6.2. Compounds included in the monitoring

The degradation product, compound Ia, from lambda cyhalothrin was selected for monitoring at Jyndevad starting in February 2023. The degradation product has not previously been included in the PLAP monitoring.

5.6.3. Results of compound Ia monitoring

Compound Ia was introduced in the monitoring in February 2023 meaning that background samples were collected before the first lambda cyhalothrin application on July 28, 2023. In total, 69 background samples were collected in suction cups and monitoring wells, before the lambda cyhalothrin application, and none of these contained compound Ia.

Water used for irrigation of the field was additionally analysed for compound Ia. Two irrigation water samples were collected in June 2023 before the lambda cyhalothrin application and compound Ia was not detected in any of the irrigation water samples.

5.6.4. Discussion and conclusion on the compound Ia monitoring

As the lambda cyhalothrin application dates are not within the present reporting period July 2021 to June 2023, no compound Ia monitoring results are available but will be included in the coming report covering the period July 2022 to June 2024.

5.7. Oxithiapiprolin

One degradation product, IN-E8S72 from oxathiapiprolin, was included in the monitoring in the current reporting period, July 2021-June 2023, following oxathiapiprolin application on the sandy field Jyndevad. Detailed information on the field site is available in Chapter 2.

5.7.1. Application of oxathiapiprolin at Jyndevad

Oxathiapiprolin was tested in PLAP in connection with cropping of potatoes at Jyndevad in 2023, and it was applied at Jyndevad on July 8 and 18, 2023. Detailed information on agricultural management is available in Chapter 3 and Appendix 3.

Oxathiapiprolin is not previously tested or applied in PLAP.

5.7.2. Compounds included in the monitoring

The degradation product, IN-E8S72, from oxathiapiprolin, was selected for monitoring at Jyndevad starting in February 2023. The degradation product has not previously been included in the monitoring in PLAP.

5.7.3. Results of IN-E8S72 monitoring

IN-E8S72 was introduced in the monitoring in February 2023 meaning that background samples were collected before oxathiapiprolin was applied on July 8 and 18, 2023. In total, 69 background samples were collected in suction cups and monitoring wells, and none of these contained IN-E8S72.

Water used for irrigation of the field was additionally analysed for IN-E8S72. Two irrigation water samples were collected in June 2023 before the oxathiapiprolin application and IN-E8S72 was not detected in any of the irrigation water samples.

5.7.4. Discussion and conclusion on the IN-E8S72 monitoring

As the oxathiapiprolin application date is not within the present reporting period July 2021 to June 2023, no IN-E8S72 monitoring results are available but will be included in the coming report covering the period July 2022 to June 2024.

5.8. Pendimethalin

One degradation product, M455H001 from pendimethalin, was included in the monitoring in the current reporting period, July 2021-June 2023, following pendimethalin application on the two clay till fields, Silstrup and Estrup. Detailed information on the field sites is available in Chapter 2.

5.8.1. Application of pendimethalin at Silstrup and Estrup

Pendimethalin is tested in PLAP in connection with sowing of winter rapeseed at Silstrup and Estrup in 2023, and it was applied on August 17, 2023 at both Silstrup and Estrup. Detailed information on agricultural management is available in Chapter 3 and Appendix 3.

Pendimethalin was previously applied at Silstrup in May 2004, at Estrup in 2001, 2005, 2017, and 2019, at Tylstrup in 2000 and 2007, at Jyndevad in 2004 and 2017, and at Faardrup in 2007.

Pendimethalin was included in the monitoring at Tylstrup in connection with the 2000 and 2007 applications, at Jyndevad and Silstrup with the 2004 applications, at Estrup with the 2001 and 2005 applications, and at Faardrup with the 2007 application.

Results from these pendimethalin tests are described in previous PLAP reports available at www.plap.dk.

5.8.2. Compounds included in the monitoring

The degradation product, M455H001, from pendimethalin, was selected for monitoring at Silstrup and Estrup starting in May 2023. The degradation product has not previously been included in the monitoring in PLAP.

5.8.3. Results of M455H001 monitoring

M455H001 was introduced in the monitoring in May 2023 meaning that background samples were collected before pendimethalin was applied on August 17, 2023. In total, 34 and 26 background samples were collected from drainage and monitoring wells at Silstrup and Estrup, respectively, before the pendimethalin application and none of these contained M455H001.

5.8.4. Discussion and conclusion on the M455H001 monitoring

As the pendimethalin application date is not within the present reporting period July 2021 to June 2023, no M455H001 monitoring results are available but will be included in the coming report covering the period July 2022 to June 2024.

5.9. Propyzamide

The herbicide propyzamide was monitored in the current reporting period, July 2021-June 2023, following propyzamide application at Faardrup. Detailed information on the field site included in the test is available in Chapter 2.

5.9.1. Application of propyzamide at Faardrup

Propyzamide was tested at Faardrup in connection with cropping of winter rapeseed in 2020 and monitored during the present monitoring period 2021-2023. Propyzamide was applied in winter rapeseed on November 25, 2020. Detailed information on agricultural management is available in Chapter 3 and Appendix 3.

Previous propyzamide tests in PLAP:

Propyzamide was recently tested in winter rapeseed on November 9, 2018 at Silstrup. The Silstrup test ended in February 2021 and a final evaluation was presented in the previous report (Badawi et al., 2023b).

Propyzamide was previously applied at Silstrup in 2005, at Tylstrup in 2007, at Lund in 2020, and at Faardrup in 2007 and 2013. Except for the test at Lund, the results from these propyzamide applications are described in previous PLAP reports available at www.plap.dk.

All pesticide monitoring at Lund was set on standby in October 2022, due to uncertainty of the hydraulic connectivity in the monitoring wells and the percolating water from the field. The propyzamide test done at Lund was evaluated in the previous report, but as the uncertainty and possible lack of hydraulic connectivity might have affected the outcome of the test, the results are regarded as uncertain. A new bromide tracer test to elucidate the connectivity was started at Lund in January 2023, as the bromide test in 2017, seemed to have been erroneous.

5.9.2. Compounds included in the monitoring

In the 2020 propyzamide test at Faardrup, only propyzamide was included in the monitoring and initiated in October 2020. Monitoring of propyzamide at Faardrup was finalized in November 2022.

5.9.3. Results of the propyzamide monitoring

At Faardrup, propyzamide was introduced in the monitoring in October 2020, meaning that background samples were collected before propyzamide was applied on November 25, 2020. In total, 7 samples were collected in monitoring wells before the propyzamide application and none of these contained propyzamide.

An overview of the entire monitoring at Faardrup is given in Table 5.9.1 and shows the number of detections in drainage and monitoring wells during the monitoring period from November 25, 2020 to November 2022 at Faardrup.

Table 5.9.1. Number of samples and detections of propyzamide at Faardrup in drainage (D), vertical monitoring wells (M) and horizontal wells (H). The counting comprises all samples collected from November 25, 2020 to November 2022 at Faardrup. Background samples collected before the application of propyzamide are not included in the counting.

	Total			D			M			H			Total Groundwater (M+H)		
	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L
Faardrup															
Propyzamide	149	6	2	36	5	2	90	0	0	23	1	0	113	1	0

Variably saturated zone

After propyzamide was applied on November 25, 2020 in Faardrup, no drainage occurred until the end of January 2021. Propyzamide was detected in drainage for the first time in February 2021, approximately two months after the application in a concentration of 7.0 µg/L. Hereafter, propyzamide was detected in decreasing concentrations until March 2021, where it was lastly detected in a concentration of 0.013 µg/L. The drainage stopped in August 2021 and did not reoccur until January 2022. No propyzamide was detected in the second period with drain flow from January 2022 to November 2022, although a large drainage event occurred in February-March 2022 (Figure 5.9.1B). Propyzamide was detected in five out of 36 drainage samples with two samples in a concentration > 0.1 µg/L.

Groundwater monitoring wells

At Faardrup, propyzamide was detected only in one out of 113 groundwater samples. This was in a sample collected in March 2021 (0.067 µg/L), from the horizontal well H2 (Figure 5.9.1F, 3.5 mbgs). The detection of propyzamide in the groundwater coincided with the maximum propyzamide concentration (7 µg/L) detected in drainage approximately three months after the propyzamide application. Due to the low groundwater table in March 2021, no sample was available in the second horizontal well H3 (2.5 mbgs). Propyzamide was not detected in any of the monitoring wells, M4, M5, and M6, and upstream well M2 during the monitoring period. It is noted that no samples were collected from October 2021 to January 2022, due to constraints related to Covid-restrictions. Monitoring of propyzamide at Faardrup ended in November 2022.

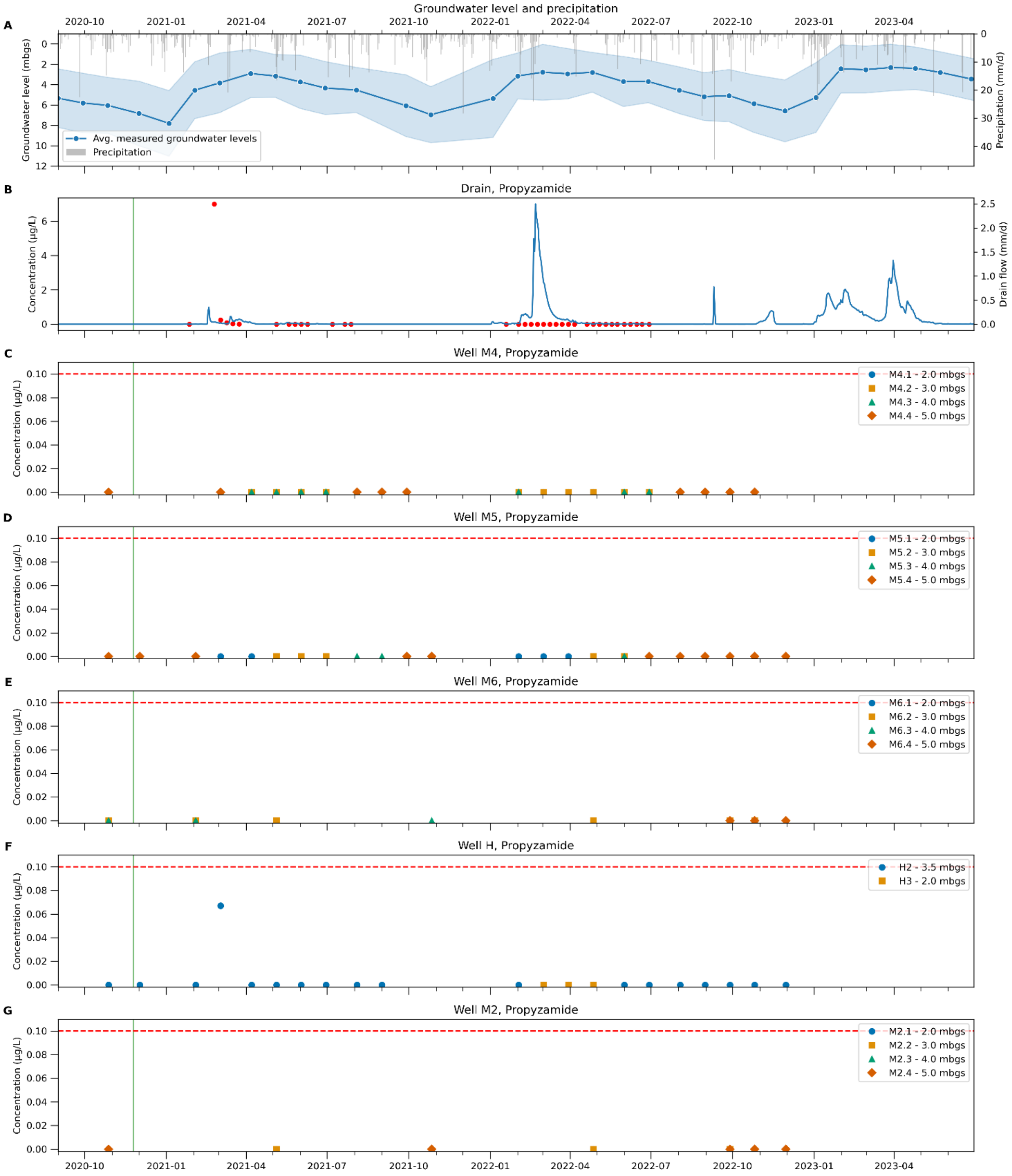

Figure 5.9.1. Propyzamide monitoring at Faardrup. Precipitation and measured groundwater levels, with standard deviations (A); measured propyzamide in the variably saturated zone (B); measured propyzamide in the downstream vertical groundwater monitoring wells (C-E); measured propyzamide in the horizontal groundwater wells (F); measured propyzamide in the downstream vertical groundwater monitoring well M2 (G); The secondary y-axis (B) represents the drain flow. The vertical green line indicates the date of propyzamide application. The horizontal red dashed line depicts the limit value of 0.1 µg/L. Propyzamide was included in the monitoring in October 2020 and the monitoring of propyzamide at Faardrup ended in November 2022.

5.9.4. Discussion and conclusion of the propyzamide monitoring

Propyzamide leaching was tested at Faardrup in the period from application in winter rapeseed in November 2020 and until the end of November 2022.

Propyzamide was twice detected in drainage in concentrations > 0.1 µg/L and the first detection occurred during the first drainage event after the propyzamide application. This was three months after application and propyzamide was detected in a concentration of 7.0 µg/L. A pattern of leaching to drainage at the first coming drainage event after a pesticide application is commonly observed at the clay till fields in PLAP (e.g., sections 5.3 Azoxystrobin, and Cycloxydim and Florasulam presented in the previous report Badawi et al. 2023b).

Propyzamide was detected once in groundwater from Faardrup, in a concentration < 0.1 µg/L. Propyzamide was previously detected in concentrations exceeding 0.1 µg/L only at Silstrup (Badawi et al., 2023b). The leaching of propyzamide to groundwater was generally observed with the first drainage event after application at the clay till fields. This was evident from e.g., detections of propyzamide in groundwater coinciding with detections in drainage both at Faardrup and Silstrup (Badawi et al., 2023b). From previous bromide tracer tests, travel times from the surface to the groundwater seem to be somewhat longer at Faardrup compared to Silstrup (Badawi et al., 2022). Nevertheless, since no further detections of propyzamide in groundwater occurred after the one detection in well H2 coinciding with the first drainage event after the propyzamide application (Figure 5.9.1), the monitoring ended in November 2022.

In conclusion, propyzamide was both leached to drainage, within the first drainage event after the propyzamide application, and to groundwater. Drainage sample concentrations exceeding 0.1 µg/L occurred at both Faardrup and Silstrup, but concentrations decreased rapidly, and only at Silstrup was the concentration exceeding 0.1 µg/L in groundwater approximately three months after application after which no more detections were made.

5.10. Thifensulfuron-methyl

Three degradation products, IN-B5528, IN-JZ789, and IN-L9223 from the sulfonylurea herbicide thifensulfuron-methyl, were monitored in the current reporting period, July 2021-June 2023, following thifensulfuron-methyl application on the clay till field Estrup. Detailed information on the field site included in the test is available in Chapter 2.

5.10.1. Application of thifensulfuron-methyl at Estrup

Thifensulfuron-methyl was tested in PLAP in connection with cropping of spring barley and perennial ryegrass during 2021-2023. Thifensulfuron-methyl was applied in spring barley in June 2021 and perennial ryegrass in July 2022 at Estrup. Detailed information on agricultural management is available in Chapter 3, Appendix 3.

Thifensulfuron-methyl was previously applied at both Estrup and Silstrup in 2015 and 2016. The results from these thifensulfuron-methyl applications are described in previous PLAP reports available at www.plap.dk.

5.10.2. Compounds included in the monitoring

Three degradation products, IN-B5528, IN-JZ789, and IN-L9223 from thifensulfuron-methyl, were selected for monitoring at Estrup. The monitoring started in April 2021 and the monitoring is still ongoing.

The degradation product IN-B5528 is a common degradation product from the sulfonylurea herbicides, thifensulfuron-methyl, tribenuron-methyl, iodosulfuron-methyl, and metsulfuron-methyl, and others. In the EFSA conclusions on the sulfonylurea herbicides, IN-B5528 is also mentioned under the synonym AE-F154781. Although several of the mentioned sulfonylurea herbicides were previously applied in PLAP, IN-JZ789 and IN-L9223 were not previously included in the monitoring. IN-B5528 was included in the monitoring at Jyndevad, Silstrup, and Faardrup in connection with tribenuron-methyl applications in April/May 2022 (refer to section 5.11 – tribenuron-methyl).

Triazinamin (EFSA synonyms, IN-A4098 and AE F059411), another common degradation product from thifensulfuron-methyl, tribenuron-methyl, and others, was included in the monitoring in connection with the 2016 applications of thifensulfuron-methyl at Estrup and Silstrup (refer to previous report from the monitoring period e.g., 1999-2017, available online, www.plap.dk).

5.10.3. Results of the IN-B5528, IN-JZ789, and IN-L9223 monitoring

Thifensulfuron-methyl was first applied on June 1, 2021, and again on July 19, 2022, at Estrup. The degradation products, IN-B5528, IN-JZ789, and IN-L9223 were included in the monitoring in April 2021, and in total 20 background samples were collected in drainage and monitoring wells before the 2021 thifensulfuron-methyl application. None of these samples contained any of the three degradation products.

An overview of the entire monitoring is given in Table 5.10.1 and shows the number of detections in water from drainage and monitoring wells during the monitoring from June 1, 2021 to June 30, 2023.

Table 5.10.1. Number of samples and detections of IN-B5528, IN-JZ789, and IN-L9223 at Estrup in drainage (D), vertical monitoring wells (M), and horisontal wells (H). The counting comprises all samples collected from June 1, 2021 to July 2023. Background samples collected before the application of thifensulfuron-methyl are not included in the counting.

	Total			D			M			H			Total Groundwater (M+H)		
	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L
Estrup															
IN-B5528	243	1	0	63	1	0	143	0	0	37	0	0	180	0	0
IN-JZ789	243	0	0	63	0	0	143	0	0	37	0	0	180	0	0
IN-L9223	243	0	0	63	0	0	143	0	0	37	0	0	180	0	0

Variably saturated zone and groundwater monitoring wells

The content of the thifensulfuron-methyl degradation products, IN-B5528, IN-JZ789, and IN-L9223 in water from drainage and groundwater was monitored at Estrup after the thifensulfuron-methyl application in June 2021 and July 2022. A total of 63 samples were collected from drainage and 180 samples were collected from the groundwater after the first application in 2021 until June 30, 2023 (Table 5.10.1). The degradation product IN-B5528 was detected once in a drainage sample from April 2023 in a concentration < 0.1 µg/L (0.078 µg/L). Apart from this one detection, no other detections of the three degradation products were made in samples from the variably saturated zone and the groundwater. The monitoring is ongoing.

5.10.4. Discussion and conclusion of the IN-B5528, IN-JZ789, and IN-L9223 monitoring

During 2021-2023, thifensulfuron-methyl was tested in two different crops, spring barley, and perennial ryegrass at Estrup. Three thifensulfuron-methyl degradation products not previously tested in PLAP, IN-B5528, IN-JZ789, and IN-L9223 were included in the monitoring. None of the degradation products are detected in groundwater, neither in the period before the thifensulfuron-methyl application (April-June 2021) nor in the monitoring period from June 1, 2021 to June 30, 2023. IN-B5528 was detected once in a drainage sample in a concentration < 0.1 µg/L after the thifensulfuron-methyl application, whereas IN-JZ789, and IN-L9223 were not detected. In conclusion, IN-B5528, IN-JZ789, and IN-L9223 do not give rise to groundwater detections above the limit value of 0.1 µg/L during the present monitoring period. However, the monitoring is ongoing, and a final evaluation will be presented when the monitoring is finalized minimum two years after the 2022 application.

5.11. Tribenuron-methyl

Three degradation products, IN-B5528, IN-R9805, and M2 from the sulfonylurea herbicide tribenuron-methyl, were monitored in the current monitoring period, July 2021-June 2023, following tribenuron-methyl applications on the sandy field Jyndevad, and the three clay till fields Silstrup, Faardrup and Lund. Detailed information on the field sites included in the test is available in Chapter 2.

All pesticide monitoring at Lund was set on standby in October 2022, due to uncertainty of the hydraulic connectivity in the monitoring wells and the percolating water from the field. Therefore, the tribenuron-methyl test done at Lund is currently regarded as uncertain due to a possible lack of hydraulic connectivity affecting the outcome of the test. Consequently, the tribenuron-methyl test on Lund will not be further evaluated and should not be used in risk assessment of tribenuron-methyl. A new bromide tracer test, to elucidate the connectivity, was started at Lund in January 2023, as the bromide test in 2017, seemed to have been erroneous.

5.11.1. Application of tribenuron-methyl at Jyndevad, Silstrup, and Faardrup

Tribenuron-methyl was tested in PLAP in connection with cropping of spring barley and winter wheat during 2021-2023. Tribenuron-methyl was applied in spring barley in April 2022 at Jyndevad, in winter wheat in April 2022 and May 2023 at Silstrup, and in April 2022 and 2023 at Faardrup. Detailed information on agricultural management is available in Chapter 3, Appendix 3.

Tribenuron-methyl was previously applied at Jyndevad in 1999, at Tylstrup in 2000 and 2006, at Silstrup in 2001, at Faardrup in 2002, and at Estrup in 2010. The results from the tribenuron-methyl applications from 1999-2010 are described in previous PLAP reports available at www.plap.dk.

5.11.2. Compounds included in the monitoring

Three degradation products, IN-B5528, IN-R9805, and M2 from tribenuron-methyl, were selected for monitoring at Jyndevad, Silstrup, and Faardrup. The monitoring started in February 2022 at all three fields and is ongoing.

The degradation product IN-B5528 is a common degradation product from the sulfonylurea herbicides, tribenuron-methyl, iodosulfuron-methyl, thifensulfuron-methyl, and metsulfuron-methyl. In the EFSA conclusions on these sulfonylurea herbicides, IN-B5528 is also mentioned under the synonym AE F154781. Several of the mentioned sulfonylurea herbicides were previously applied in PLAP, but IN-R9805 and M2 were not previously included in the monitoring. IN-B5528 was also included in the monitoring at Estrup in connection with the thifensulfuron-methyl application in April 2021 (refer to section 5.10 – thifensulfuron-methyl).

5.11.3. Results of the IN-B5528, IN-R9805, and M2 monitoring

IN-B5528, IN-R9805, and M2 were included in the monitoring in February 2022 meaning that background samples were collected from this date at all three fields, Jyndevad, Silstrup, and Faardrup.

At Jyndevad, tribenuron-methyl was applied on April 23, 2022. In total, 29 background samples were collected in suction cups and monitoring wells before the tribenuron-methyl application and none of these contained any of the three degradation products. The Jyndevad field was not irrigated in the period before the tribenuron-methyl application, but five irrigation samples were analysed for content of IN-B5528, IN-R9805, and M2 from April 23, 2022 to July 1, 2023. None of the degradation products were detected.

At Silstrup and Faardrup, tribenuron-methyl was applied on April 29 and 21, 2022, respectively. Before the tribenuron-methyl applications, background samples were collected from drainage and monitoring wells for analysis of IN-B5528, IN-R9805, and M2. A total of 32 background samples were collected at Silstrup and 25 at Faardrup, and none of these samples contained any of the three degradation products.

An overview of the entire monitoring is given in Table 5.11.1 and shows the number of detections in water from suction cups (Jyndevad), drainage, and monitoring wells during the monitoring period, April 2022 to July 1, 2023, after the tribenuron-methyl applications.

Table 5.11.1. Number of samples and detections of IN-B5528, IN-R9805, and M2 at Jyndevad, Silstrup, and Faardrup in suction cups/drainage (S/D), vertical monitoring wells (M), and horizontal wells (H). The counting comprises all samples collected from April 23, 2022 at Jyndevad, April 29, 2022 at Silstrup, and April 21, 2022 at Faardrup to July 1, 2023. Background samples collected before the application of tribenuron-methyl are not included in the counting.

	Total			S*/D			M			H			Total Groundwater (M+H)		
	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L	N	Det.	>0.1 µg/L
Jyndevad															
IN-B5528	171	0	0	28	0	0	140	0	0	3	0	0	143	0	0
IN-R9805	171	0	0	28	0	0	140	0	0	3	0	0	143	0	0
M2	171	0	0	28	0	0	140	0	0	3	0	0	143	0	0
Silstrup															
IN-B5528	167	0	0	28	0	0	123	0	0	16	0	0	139	0	0
IN-R9805	167	0	0	28	0	0	123	0	0	16	0	0	139	0	0
M2	167	0	0	28	0	0	123	0	0	16	0	0	139	0	0
Faardrup															
IN-B5528	158	1	0	34	1	0	108	0	0	16	0	0	124	0	0
IN-R9805	158	0	0	34	0	0	108	0	0	16	0	0	124	0	0
M2	158	0	0	34	0	0	108	0	0	16	0	0	124	0	0

*data from suction cups at Jyndevad

Variably saturated zone and groundwater monitoring wells

The degradation products, IN-B5528, IN-R9805, and M2 from tribenuron-methyl were monitored in samples from the variably saturated zone (drainage and water from suction cups) and groundwater at Jyndevad, Silstrup and Faardrup after tribenuron-methyl applications in April 2022. A total of 28, 28, and 34 samples were collected from suction cups/drainage and 143, 139, and 124 from the groundwater at Jyndevad, Silstrup, and Faardrup, respectively, after the tribenuron-methyl applications to June 30, 2023 (Table 5.11.1). The three degradation products were not detected in any of the collected samples, neither from the variably saturated zone nor in the groundwater at Jyndevad and Silstrup. The degradation product IN-B5528 was detected once in a concentration < 0.1 µg/L (0.081 µg/L) in a drainage sample from Faardrup in April 2023. IN-B5528 was not detected in groundwater at Faardrup. The monitoring is ongoing in all three fields.

5.11.4. Discussion and conclusion on the IN-B5528, IN-R9805, and M2 monitoring

In 2022, Tribenuron-methyl was tested in two different crops, spring barley at Jyndevad, and winter wheat at Silstrup and Faardrup. Three tribenuron-methyl degradation products not previously tested in PLAP, IN-B5528, IN-R9805, and M2 were included in the monitoring. Except for one detection of IN-B5528 in a concentration < 0.1 µg/L in a drainage sample from Faardrup in April 2023, was none of the three degradation products detected in water from the suction cups, drainage, groundwater, or irrigation water, neither in the period before the tribenuron-methyl application (April 2022) nor in the monitoring period from April 2022 to June 30, 2023. In conclusion, IN-B5528, IN-R9805, and M2 do not give rise to groundwater detections above the limit value of 0.1 µg/L during the present monitoring period. However, the monitoring is ongoing at the three fields Jyndevad, Silstrup, and Faardrup, and a final evaluation will be presented when the monitoring is finalized, minimum two years after the last application.

6. Pesticide quality assurance

Reliable results and scientifically valid methods of analysis are essential for the integrity of the present monitoring programme. Consequently, the field monitoring work is supported by intensive quality assurance entailing continuous evaluation of the analyses employed. Two types of samples are used in the quality control, 1) samples with known pesticide composition and concentration are used for internal monitoring of the laboratory method (internal QC), 2) externally spiked samples that are used to incorporate additional procedures such as sample handling, transport, and storage (external QC), and 3) externally blank samples prepared in the field from pure water and handled similar to the real samples (external QC blank). Pesticide analysis quality assurance (QA) data for the period July 2021 to June 2023 is presented below, while those for the preceding monitoring periods are presented in previous monitoring reports (available at www.plap.dk).

All pesticide analyses were carried out at a commercial laboratory selected based on a competitive EU tender. To assure the quality of the analyses, the call for tenders included requirements as to the laboratory's quality assurance (QA) system comprising both an internal and an external control procedure.

6.1. Internal QA – commercial laboratory

With each batch of samples, the laboratory analysed at least two control samples at two concentration levels, low QC 0.03 µg/L and high QC 3 µg/L prepared in-house at the laboratory as part of their standard method of analysis. In 2021, the low QC for several compounds was 0.05 µg/L. These compounds are noted in Appendix 6 and statistics on the 0.05 µg/L level are reported in the previous report Badawi et al. 2023b (available at www.plap.dk). For daily quantification of batches 5-point calibration curves within the concentration interval 0.01 µg/L to 0.2 µg/L are used. All analytical methods used in the monitoring programme have detection limits (LD, no distinction between lower limit of detection or quantification) of 0.01 µg/L (except DMSA LD 0.02 µg/L). For each compound included in the monitoring period from July 1, 2021, to June 30, 2023, a QC report is available from the laboratory and included in Appendix 6. Figure 6.1.1 is an example of the control charts included in the QC reports. The control chart is used to study how the analytical method performs and changes over time. In the chart, the central line represents the average, and the upper and lower lines are the upper and lower control limits, respectively. The upper chart (R-kort) shows the difference between the two QC replicates on a given day. The lower chart (X-kort) is the daily average concentration of the replicates. The table below the charts shows the method statistics: limit of detection (LD, green recalculated, yellow limit 0.01 µg/L), calculated recovery (% Genf., limit range 70 – 120%), standard deviation within (Sw) and between day (Sb), and the total standard deviation (St), the coefficient of variance (CV%), the absolute (µg/L, limit 0.05 µg/L in drinking water) and relative (in %) uncertainty and the number of duplicate QC-samples (Par) included in the charts.

N,N-dimethylsulfamid
Metode M0336 : Vand
Nominel: 0,03 µg/l

Vurdering U/LD for par 1 til par 195
Er sidste punkt i kontrol ?

Resultater

Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,01	86,1	0,00337	0,00352	0,0049	18,8	0,013	47		195		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- Flere oplysninger

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 02-07-2021 til d. 27-06-2023
Evalueringsperiode 01-07-2021 til 30-06-2023
Antal punkter 195
Antal udeladte Ingen

Figure 6.1.1. Example of a QC chart from the external laboratory. R-kort depicts the difference between the two replicates on a given day. X-kort depicts the daily average of the replicates. Limit of detection (LD, green: recalculated, yellow: limit 0.01 µg/L), calculated recovery (% Genf. Limit 70-120%), standard deviation within (Sw) and between day (Sb), and the total standard deviation (St), the coefficient of variance (CV%), the absolute (Uabs, µg/L, limit 0.05 µg/L in drinking water) and relative (Urel, in %) uncertainty and the number of duplicate QC-samples (Par) included in the charts. QC charts for all compounds included in the monitoring are available in Appendix 6.

6.2. External quality control

Six times during the period July 2021 to June 2022, two external control samples (QCLow and QCHigh) per test field were analysed at the commercial laboratory. In October 2021 at Faardrup, the groundwater table was too low for sampling in the well used for control sampling, hence no external control samples were available.

Preparation of external control samples before March 2022 is reported in the previous report (Badawi et al. 2023b). The procedure for external quality control was changed on March 1, 2022. Ampoules used for spiking were no longer prepared at LGC (www.lgcstandards.com), instead, all stock solutions and mixed standard solutions (Standard-mix, equal to the ampoules and used for spiking) were prepared freshly for each control sampling event at the Environmental Chemistry Laboratory at GEUS. The new procedure allows for higher flexibility of included compounds as compounds in the ampules from LGC (mixed solutions) could only be changed once a year. Further, compounds are now stored individually in high concentration stock solutions (-20°C) instead of in ampoules with a mix of compounds in low concentrations.

A Standard-mix of the selected compounds (preferably all compounds included in the monitoring) was prepared from the high concentration stock solutions two days before a control sampling day. This Standard-mix was further diluted (Field-mix) and used for preparation of control samples in the field. The Field-mix was stored cold (5°C) and dark until use. For the preparation of Field-mix, 50 µL for QCLow and 120 µL for QCHigh of the Standard-mix (1000 µg/l), were pipetted into a preparation glass containing 10 mL of ultrapure water. The glass was sealed, shaken thoroughly, and shipped to the staff collecting samples at the field locations. The staff finished the preparation of the external QC samples in the field by quantitatively transferring the Field-mix to a 1.0 L measuring flask. The Field-mix in the measuring flasks was diluted with groundwater from a defined groundwater well in each field. After thorough mixing, the final external QC sample was decanted into a sample bottle like the monitoring sample bottles, labelled, and transported to the laboratory together with the true samples.

As common procedure following each control sampling day, the Standard-mix used for spiking was sent to the commercial laboratory for confirmation of concentrations.

In the present reporting period, the final concentrations in the external QC samples prepared in the field were 0.050 µg/L for the QCLow and 0.117 µg/L for the QCHigh. The compounds included in the external QC samples, their concentration in the initial Standard-mix, and the final external QC samples sent for analysis are listed in Table 6.2.1.

Every month, field blank samples consisting only of ultra-pure HPLC water transferred to sample flasks in the field, were included as control for false-positive findings in the external QA procedure. All samples (both spiked and blanks) included in the QA procedure were labelled with coded reference numbers so that the laboratory was unaware of which samples were external QC controls, field blanks, or true samples. A total of 41 field blank samples were included in the period from July 1, 2021, to June 30, 2023.

Table 6.2.1. Pesticides and degradation products (in italics) included in the external QC samples in the period March 1, 2022 to June 30, 2023. Concentrations in the GEUS Standard-mix and in the final high-level (QCHigh) and low-level (QCLow) external control samples used. Standard-mix were prepared in methanol. Preparation of external control samples before March 2022 is reported in the previous report (Badawi et al. 2023).

Compound	**Standard-mix conc. (µg/L)**	**Lot. No.**	**In use from (date)**	**In use from (date)**
1,2,4-triazol	1100	VAP01_001_014	2022-03-01	2022-03-10
DMSA	837	VAP01_001_014	2022-03-01	2022-03-10
Fluopyram-7-hydroxy	980	VAP01_001_014	2022-03-01	2022-03-10
IN-B5528	1100	VAP01_001_014	2022-03-01	2022-03-10
IN-JZ789	1400	VAP01_001_014	2022-03-01	2022-03-10
IN-L9223	870	VAP01_001_014	2022-03-01	2022-03-10
IN-R9805	1100	VAP01_001_014	2022-03-01	2022-03-10
M2	1300	VAP01_001_014	2022-03-01	2022-03-10
Propyzamide	930	VAP01_001_014	2022-03-01	2022-03-10
1,2,4-triazol	1100	VAP01_001_014	2022-04-26	2022-05-05
DMSA	1010	VAP01_001_014	2022-04-26	2022-05-05
Fluopyram-7-hydroxy	1100	VAP01_001_014	2022-04-26	2022-05-05
IN-B5528	720	VAP01_001_014	2022-04-26	2022-05-05
*IN-JZ789**	3100	VAP01_001_014	2022-04-26	2022-05-05
IN-L9223	600	VAP01_001_014	2022-04-26	2022-05-05
IN-R9805	1100	VAP01_001_014	2022-04-26	2022-05-05
M2	1500	VAP01_001_014	2022-04-26	2022-05-05
Propyzamide	990	VAP01_001_014	2022-04-26	2022-05-05
1,2,4-triazol	1000	VAP01_001_015	2022-10-25	2022-11-03
DMS	890	VAP01_001_015	2022-10-25	2022-11-03
DMSA	1060	VAP01_001_015	2022-10-25	2022-11-03
Fluopyram-7-hydroxy	900	VAP01_001_015	2022-10-25	2022-11-03
IN-B5528	1100	VAP01_001_015	2022-10-25	2022-11-03
IN-JZ789	1100	VAP01_001_015	2022-10-25	2022-11-03
IN-L9223	1000	VAP01_001_015	2022-10-25	2022-11-03
IN-R9805	1100	VAP01_001_015	2022-10-25	2022-11-03
M2	3700	VAP01_001_015	2022-10-25	2022-11-03
Propyzamide	950	VAP01_001_015	2022-10-25	2022-11-03
DMS	830	VAP01_001_016	2023-04-24	2023-05-08
Fluopyram	1100	VAP01_001_016	2023-04-24	2023-05-08
Fluopyram-7-hydroxy	1100	VAP01_001_016	2023-04-24	2023-05-08
IN-B5528	1700	VAP01_001_016	2023-04-24	2023-05-08
*IN-L9223**	2000	VAP01_001_016	2023-04-24	2023-05-08
IN-R9805	840	VAP01_001_016	2023-04-24	2023-05-08
M2	1100	VAP01_001_016	2023-04-24	2023-05-08

**The Standard-mix was erroneously prepared, and the compound was omitted from QC evaluation of the QC samples from the period April 24 to May 8, 2023.*

6.3. Results and discussion

6.3.1. Comments on results from the monitoring period June 2021 to July 2023

Compounds included in the monitoring in this present period July 2021 to June 2023 but originating from pesticide applications in 2019-2020 are included in the evaluation of pesticide tests in Chapter 5, but quality assessments are reported in the QC section in previous reports, available at www.plap.dk.

6.3.2. Internal QA

Ideally, the analytical procedure provides precise and accurate results. However, results from the analyses are subject to a certain standard deviation. Such standard deviation may be the combined result of several contributing factors and overall, the accuracy of an analytical result reflects two types of error: Random errors related to precision and systematic errors relating to bias. In a monitoring programme like PLAP, it is relevant to consider possible changes in analytical reliability over time. As random and systematic errors may change over time, it is relevant to distinguish between standard deviations resulting from within-day variation as opposed to those associated with between-day variation in the analytical results. To this end, internal control samples are included in the analytical process as described above. Thus, by utilizing statistical analysis of the internal QA data (provided by the laboratory), it is possible to separate and estimate the different causes of the analytical variation in two categories: between-day variation and within-day variation (Funk et al., 1995; Miller et al., 2000). This kind of analysis can provide an extra indication of the reliability of the analytical results used in the PLAP. The statistical tool used is an analysis of variance (ANOVA) and encompasses all duplicate internal QC samples (single analyses are excluded). The analysis can be divided into three stages:

1. Normality: An initial test for normality is made as this is an underlying assumption for the one-way ANOVA.

2. Between-day contribution: In brief, this test will reveal any day-to-day contribution to the variance in the measurements. If there is none, the total standard deviation can be considered attributable to the within-day error of the analysis. For this purpose, an ANOVA-based test is used to determine if the between-day standard deviation (Sb) differs significantly from 0 (this test is made as an F-test with the H0: between-day mean square = within-day mean square).

3. Calculating standard deviations: If the F-test described above reveals a contribution from the between-day standard deviation (Sb), it is relevant to calculate three values: The within-day standard deviation (Sw), the between-day standard deviation (Sb), and the total standard deviation (St).

As the error associated with the analytical result is likely to be highly dependent on the compound analysed, the QA applied is compound specific. In the current reporting period, QC charts covering the statistics were made available by the external laboratory for the 29 compounds included in the monitoring. The QC charts are presented in Appendix 6.

In the latest PLAP report covering QC for the period 2020-2022, 22 new compounds, one new pesticide (fluopyram) and 21 new degradation products (5-OH-florasulam, 6-Cl-7-OH-pyroxsulam, 7-OH-pyroxsulam, CCIM, CTCA, DFP-ASTCA, DFP-TSA, DMS, DMSA, IM-1-4, IM-1-5, fluopyram-7-hydroxy, IN-B5528, IN-JZ789, IN-L9223, IN-R9805, M2, PSA, pyridine sulfonamide, TSA, X-729) were included in the monitoring program on top the pesticides (picloram and propyzamide) and nine degradation products (CGA287422, CGA290291, CGA294972, IN-MM671, IN-MM991, PPA, RH-24580 and RH-24644) that were introduced in the previous years. Except for the compounds that are part of the monitoring period 2021-2023 and listed below, internal QC data for these compounds are reported in the previous report, available at www.plap.dk.

This present report covering 2021-2023, includes monitoring of 16 compounds, two pesticides (fluopyram and propyzamide) and 14 degradation products (DMS, DMSA, CTCA, CCIM, fluopyram-7-hydroxy, IN-B5528, IN-JZ789, IN-L9223, IN-R9805, M2, CyPM, IM-1-4, IM-1-5, and 1,2,4-triazol) in the monitoring program. QC charts for these compounds are presented in Appendix 6.

The calculated limit of detection (LD) for each compound was all below the limit value of 0.01 µg/L, and all compounds had recoveries within the range of 70 – 120 %, and Uabs lower than the limit of 0.05 µg/L (Appendix 6). In general, the internal QC data shows that the analytical methods used for identification and quantification of the compounds in the PLAP samples are all acceptable.

6.3.3. External QC samples

As described above the external QC programme was based on samples spiked in the field. As part of the quality control, a set of QC blank samples consisting of HPLC water was additionally prepared in the fields and analysed to evaluate the possibility of false-positive findings. A total of 41 QC blank samples were analysed and, except from one sample at Jyndevad prepared in November 2022, no compounds were detected in any of these blank samples. The sample from Jyndevad was analysed for the content of fluopyram, fluopyram-7-hydroxy, IN-B5528, IN-R9805, M2, 1,2,4-triazol, CTCA, CCIM, DMS and DMSA, and DMSA was detected in a concentration of 0.04 µg/L. None of the other compounds were detected in the sample. A total of 12 QC blank samples were prepared at Jyndevad during the period and only this once with a false-positive detection. A contamination of the sample cannot be excluded. Although DMSA was detected once in one blank sample, samples analysed in the monitoring programme and detected to contain pesticides and/or degradation products are regarded as true positive findings. From these results, it is concluded that contamination of samples during collection, storage and analysis is not likely to occur.

Table 6.3.1 provides an overview of the recovery of all externally spiked samples. Since the results for each field in Table 7.3.1 are mainly based on a few samples for each concentration level (high/low) and that each concentration level is prepared in the fields and not spiked in duplicate, the data should be interpreted with precaution and not too rigorously. In this present report, recoveries are calculated from the nominal concentration (1000 µg/l) in the stock solution, when the measured concentration in the Standard-mix is in the range of 900-1100 µg/l (± 10%). For Standard-mix with concentrations out of this range, the measured concentration (averaged if measured several times) is used for calculating the recovery.

The external control samples are prepared on location in the field by spiking groundwater from a selected monitoring well. The groundwater used might therefore already contain the compounds of interest. To circumvent this error, a true sample from the selected well is sent for analysis together with the QC samples. The result from this sample is used for correction of the spiked control samples and compound content subtracted when calculating the recoveries. For the low-level QC samples (0.05 µg/L) in particular, a background content of a compound although subtracted can still result in calculation of elevated recovery percentages due to the uncertainty of the analyses (Max Uabs 0.05 µg/L, refer to section 6.3.2 internal QC) and the lack of replicates. For this reason, the QC data must be considered tentatively and used only to keep track of possible changes in the quality of the programme from period to period.

A total of 42 samples were spiked in this reporting period July 1, 2021 - June 30, 2023. In general, the recovery of the spiked compounds was acceptable i.e. in the range of 70% to 120% and the internal QC data shows that the analytical methods are acceptable and in good control. This year, only DFP-ASTCA and PSA have recoveries out of this range.

DMS was included in the external QC programme at Jyndevad three times during the period 1.7.2021-30.6.2023, in November 2021 and 2022, and May 2023. In November 2021 and 2022 no background content of DMS was present in the groundwater used for preparation of the QC samples, whereas in May 2023 the concentration of DMS was 0.079 µg/L. Hence the background concentration exceeded the concentration spiked to the low control sample (low 0.05 µg/l) and the control samples were therefore omitted.

DMSA was included in the external control programme at Jyndevad in March and May 2022. The water used for preparation of the control samples was sampled from upstream monitoring well M7. At the two control sample events the background concentration of DMSA (coming from the neighboring field, refer to Chapter 5.4 - cyazofamid) was higher (0.19 and 0.47 µg/l, respectively) than the spike concentrations and the control samples were omitted. Preparation of QC samples with groundwater from a different well was planned and will be presented in the next report.

Table 6.3.1. Recovery of compounds in externally spiked QC samples from the period 1.7.2021-30.6.2023. Average recovery (%) of the nominal- or measured concentration (when stock solutions deviated from 1000 ± 100 µg/L) at low/high concentration levels is indicated for each field, and as an average recovery from all fields (Total Average %). For each compound, no. of pairs (N_{pairs} LOW/HIGH) and Total pairs and Total samples refers to the number of pairs of samples with detections of the spiked compound at Low- and High-level and the total number of spiked samples (including all QCLow and QCHigh samples), respectively.

	Jyndevad			**Silstrup**			**Estrup**			**Faardrup**			**Total**		
Compound	Average % LOW	Average %, HIGH	N_{pairs} LOW/HIGH	Average % LOW	Average %, HIGH	N_{pairs} LOW/HIGH	Average % LOW	Average %, HIGH	N_{pairs} LOW/HIGH	Average % LOW	Average %, HIGH	N_{pairs} LOW/HIGH	Average recovery %	No. pairs	No. QC samples
1,2,4-triazole	101	94	4	83	93	4	91	96	4	102	88	3	93	15	30
CTCA	90	83	1										87	1	2
CyPM				73	75	1							74	1	2
DMS	94	74	2										84	2	4
DMSA	*	*											-	-	-
Fluopyram	90	85	1	82	94	1				90	94	1	88	3	6
Fluopyram-7-hydroxy	102	89	4	92	95	4				92	100	4	94	12	24
IN-B5528	105	79	4	84	79	4	105	79	4	84	78	4	88	16	32
IN-JZ789							109	102	2				105	2	4
IN-L9223							93	85	2				89	2	4
IN-R9805	104	111	4	86	82	4				87	84	4	94	12	24
M2	91	97	4	91	91	4				87	92	4	92	12	24
Propyzamide										91	94	3	91	3	6

**DMSA was part of the QC program but omitted due to high background content of DMSA in the groundwater used for preparation of the QC samples.*

All compounds included in the external spiking procedure (Table 6.3.1) are detected in all spiked QC samples and all recoveries were within the range of 70-120 %. The internal QC charts relating to pesticides and degradation products reported here and included in the monitoring are presented in Appendix 6.

6.4. Summary and concluding remarks

The QC system showed that:

- All analytical methods for the included compounds are within the limits of acceptance.
- Internal QA: The calculated limit of detection (LD) for each compound were all below the limit value of 0.01 µg/L, and all compounds had recoveries within the range of 70 – 120 %, and Uabs lower than the limit of 0.05 µg/L
- The low total standard deviation (St) (ranging from 0.0022 to 0.012 µg/L) on the internal QC samples indicates that the reproducibility of the analyses is in general very good.
- External QA: The recovery of compounds in externally spiked samples (External QC) is generally precise (within 70 to 120% recovery) and the change of procedure (starting January 2022) for the preparation of the external QC samples has increased the precision.

- The recovery of DMS in the external QC samples was within the range of 70-120% at both low and high QC level at the two QC sampling events included in the evaluation (no background content of DMS present in these samples).
- The background content of DMSA in the groundwater used for preparation of the external QC samples was higher than the spike concentrations used for the QC samples (>> 0.1 µg/L), hence the QC samples for DMSA were omitted for this period. Preparation of QC samples with groundwater from a different well was planned and will be presented in the next report.
- The analytical methods for analysis of DMS and DMSA were in good control.
- Based on the results from analysis of blank samples, consisting of HPLC water (shipped together with the true monitoring samples), it was concluded that contamination of samples during collection, storage, and analysis was not likely to occur. Although DMSA was detected in one blank sample at Jyndevad, no other compounds were detected in the sample (analysed for a total of 10 compounds). A total of 12 QC blank samples were prepared at Jyndevad during the period and only this once with a false-positive detection.

7. Historical perspectives or Leaching results from the entire monitoring period

In this report, the evaluation of compounds comprising the full monitoring period from 1999 to July 2023 is omitted due to structural changes in the report. Likewise, the table with colour-coding (Table 9.1 and 9.3 in previous PLAP reports covering 1999-2019) is currently being revised, and may be included in a renewed format in upcoming reports. A complete summary of previous monitoring data from the entire monitoring period covering 1999 to July 2019 is available in Rosenbom et al. (2021) (available online at www.plap.dk). As the structure of this current report is changed compared to previous reports published in 2021 and the years before, Chapter 5 now presents an evaluation of the pesticide tests done individually covering all fields included in the test primarily during the reporting period 2021-2023. The authors recommend reading Chapter 5 in this report as a follow-up to Chapter 6 in the previous report covering the period 1999-2022 (Badawi et al. 2023b). Additionally, we suggest referring to Chapter 9 in the reports published in 2021 and earlier. All previous reports and associated peer-reviewed articles can be found at www.plap.dk.

A summary of pesticide monitoring data from May 1999 – June 2023 from the variably saturated zone (drainage and suction cups at 1 mbgs) is presented in Table 7.1, and from groundwater in Table 7.2. A detailed description of monitoring results for each PLAP field is summarised in Appendix 5. From May 1999 to June 2023, 158 pesticides and/or degradation products (53 pesticides and 105 degradation products) were analysed in PLAP comprising five agricultural fields (ranging between 1.2 and 2.4 ha in size) cultivated with different crops.

As all pesticide monitoring at Lund was put on standby in October 2022 due to uncertainty of the hydraulic connectivity in the monitoring wells and the percolating water from the field, data from the Lund field is therefore not included. Pesticide tests that were active at Lund at that time, will not undergo evaluation and previous evaluated tests should not be used in pesticide assessments, as the uncertainty in hydraulic connectivity can affect the outcome of the tests (the lack of detections can be a consequence of lacking hydraulic connectivity). The bromide tracer experiment, initially done in 2017 when the field was established, appears to have been erroneous. Consequently, a new bromide tracer experiment was initiated in January 2023 and will be assessed in the upcoming years.

Table 7.1. Monitoring results from 1999-2023 from the variably saturated zone (drainage and suction cups at 1 m depth, suction cups at Tylstrup at 2 m depth. Total number of analysed samples (n), number of samples with detections (Det.), number of samples with detections in concentrations > 0.1 µg/L and the maximum detected concentration (Maz µg/L). The pesticides and degradation products are listed under Analyte. All listed pesticides were applied in PLAP, but for some only monitoring of the degradation product(s) was included in the programme. Analytes that are included in the PLAP monitoring for the first time are written in red. Note that Tylstrup is on standby.

	Tylstrup				Jyndevad				Silstrup				Estrup				Faardrup			
Analyte	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L
Acetamiprid																				
IM-1-4					60	0	0													
IM-1-5					60	0	0													
Aclonifen	68	0	0		43	0	0													
Amidosulfuron					23	3	1	0.11	1	0	0		99	0	0					
Desmethyl-amidosulfuron					23	0	0		1	0	0									
Aminopyralid	91	0	0										96	0	0					
Azoxystrobin	95	0	0		65	0	0		188	23	1	0.11	415	141	15	1.4	107	0	0	
CyPM	95	0	0		65	0	0		276	204	33	0.56	415	376	150	2.1	107	4	0	0.06
Bentazone	202	4	0	0.02	230	109	17	4.5	120	45	5	6.4	440	226	16	20	205	28	6	43
2-amino-N-isopropyl-benzamide	72	0	0		47	2	0	0.03	65	0	0		243	1	0	0.06	69	1	0	0.06
6-hydroxy-bentazone	65	0	0		43	0	0													
8-hydroxy-bentazone	65	0	0		43	0	0													
N-methyl-bentazone	65	0	0		43	0	0													
Bifenox	22	0	0		56	2	0	0.04	68	5	2	0.38	95	4	1	0.15	64	6	0	0.09
Bifenox acid	22	0	0		53	1	0	0.1	56	20	18	4.8	105	16	10	1.9	43	18	17	8.6
Nitrofen	22	0	0		56	0	0		68	5	3	0.34	95	0	0		64	6	1	0.16
Boscalid	56	0	0																	
Bromoxynil	72	0	0		61	0	0		48	0	0		142	3	2	0.6	174	0	0	
Chlormequat					28	0	0		21	1	0	0.01	46	1	0	0.02				
Clomazone	82	0	0		23	0	0		19	0	0		60	0	0		85	1	1	0.28
FMC 65317	74	0	0		23	0	0		19	0	0		60	0	0		85	1	1	0.3
Clopyralid	104	2	1	0.72					79	4	3	4.09	1	0	0		32	1	0	0.08
Cyazofamid	68	0	0		32	0	0													
CCIM					68	0	0													
CTCA					68	0	0													
DMSA					78	11	6	2.1												
N,N-DMS					78	46	13	0.39												
Cycloxydim																				
BH 517-T2SO2					39	0	0		51	0	0									
EZ-BH 517-TSO					39	11	3	0.53	51	15	1	0.11								
Desmedipham									159	0	0						128	0	0	
EHPC									88	0	0						99	0	0	

	Tylstrup				Jyndevad				Silstrup				Estrup				Faardrup			
Analyte	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L
Diflufenican					38	0	0		66	11	1	0.12	57	27	12	0.49				
AE-0542291					38	0	0		66	0	0		57	0	0					
AE-B107137					52	0	0		61	5	1	0.13	58	18	0	0.09				
Dimethoate	63	0	0		52	0	0		109	1	1	1.42	111	0	0		77	0	0	
Epoxiconazole	74	0	0		90	0	0		36	0	0		49	14	2	0.39	81	0	0	
Ethofumesate									201	20	3	0.23	126	35	8	3.36	192	15	6	12
Fenpropimorph	89	0	0		79	1	0	0.04	109	0	0		106	1	0	0.01	174	0	0	
Fenpropimorph acid	73	0	0		79	0	0		109	1	0	0.02	99	0	0		174	0	0	
Flamprop-M-isopropyl	63	0	0						109	12	1	0.11	155	20	0	0.07	71	1	0	0.04
Flamprop	63	0	0						106	7	0	0.1	155	13	0	0.03	77	1	0	0.09
Florasulam					54	0	0						92	0	0					
5-OH-florasulam					28	0	0		51	0	0		149	8	1	0.35				
DFP-ASTCA									51	0	0		68	0	0					
DFP-TSA									51	0	0		68	0	0					
TSA									106	1	0	0.06	69	0	0		35	0	0	
Fluazifop-P-butyl																	128	0	0	
Fluazifop-P	63	0	0		51	0	0		171	0	0						161	11	3	3.8
TFMP									132	53	23	0.64					93	0	0	
Fludioxonil																				
CGA 192155	65	0	0		34	0	0													
CGA 339833	65	0	0		34	0	0													
Fluopyram					34	0	0		60	45	8	0.34					54	5	1	0.14
Fluopyram-7-hydroxy					34	0	0		35	18	1	0.27					45	2	0	0.07
Flupyrsulfuron-methyl					30	0	0										36	0	0	
IN-JV460					30	0	0										36	0	0	
IN-KC576					30	0	0										36	0	0	
IN-KF311					32	0	0		69	0	0									
IN-KY374					30	4	3	0.45									36	0	0	
Fluroxypyr	68	0	0		55	0	0		50	0	0		90	3	2	1.4	256	1	1	0.19
Fluroxypyr-methoxypyridine																	29	0	0	
Fluroxypyr-pyridinol																	29	0	0	
Foramsulfuron									75	10	2	0.24	92	20	3	0.32				
AE-F092944					2	0	0		75	0	0		92	1	0	0.01				
AE-F130619									75	10	0	0.07	92	6	0	0.06				
Glyphosate					69	0	0		257	108	22	4.7	601	343	109	31	237	5	0	0.09
AMPA					69	1	0	0.01	258	203	18	0.35	601	499	120	1.6	237	15	1	0.11
Halauxifen-methyl																				
X-729													61	0	0		1	0	0	
X-757									53	0	0						34	0	0	

	Tylstrup				Jyndevad				Silstrup				Estrup				Faardrup			
Analyte	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L
Iodosulfuron-methyl									60	0	0									
Metsulfuron-methyl									60	0	0		154	1	0	0.05				
Ioxynil	72	0	0		61	0	0		48	0	0		142	20	5	0.25	173	1	0	0.01
Lambda-Cyhalothrin																				
Compound Ia *					10	0	0													
Linuron	67	0	0																	
Mancozeb																				
EBIS	27	0	0		10	0	0													
ETU	44	7	0	0.04																
MCPA					56	0	0		51	0	0		103	12	2	3.89	144	2	1	0.28
2-methyl-4-chlorophenol					56	0	0		51	0	0		103	1	0	0.05	144	1	1	0.24
Mesosulfuron-methyl					78	0	0						75	13	0	0.06				
AE-F099095	54	0	0		43	0	0		51	0	0		48	0	0					
AE-F147447					47	0	0		51	0	0		20	0	0					
AE-F160459	54	0	0		43	0	0		51	0	0		48	0	0					
Mesosulfuron					45	0	0						74	0	0					
Mesotrione					67	0	0		76	13	7	1.1	93	40	10	3.3				
AMBA					67	0	0		76	0	0		93	4	0	0.04				
MNBA					67	0	0		76	8	0	0.09	93	11	1	0.46				
Metalaxyl-M	156	4	0	0.03	95	11	0	0.04												
CGA 108906	153	128	35	4.8	105	68	34	3.7												
CGA 62826	154	35	5	0.12	105	73	20	1.2												
Metamitron									200	49	11	0.55	123	42	15	26.4	228	12	2	1.7
Desamino-metamitron									201	64	7	0.67	125	49	11	5.55	228	16	4	2.5
MTM-126-AMT																	33	0	0	
Metconazole **													61	1	0	0.01				
Metrafenone													120	20	0	0.07	60	0	0	
Metribuzin	91	2	0	0.02	6	0	0													
Desamino-diketo-metribuzin	247	81	51	2.1	6	0	0													
Desamino-metribuzin	85	0	0		4	0	0													
Diketo-metribuzin	318	253	61	0.69	6	3	0	0.09												
Oxathiapiprolin																				
IN-E8S72 *					10	0	0													
Pendimethalin	144	0	0		71	0	0		105	14	0	0.06	130	4	0	0.04	57	2	0	0.04
M455H001 *									1	0	0									
Phenmedipham									160	0	0						128	0	0	
3-aminophenol									89	0	0									
MHPC									155	0	0						128	2	1	0.19
Picloram									1	0	0						1	0	0	

	Tylstrup				Jyndevad				Silstrup				Estrup				Faardrup			
Analyte	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L
Picolinafen					36	1	0	0.02					81	17	0	0.07				
CL153815					36	0	0						81	31	11	0.5				
Pirimicarb	82	0	0		69	0	0		233	14	0	0.05	205	40	0	0.08	228	7	0	0.06
Pirimicarb-desmethyl	81	0	0		69	1	0	0.01	233	1	0	0.05	198	0	0		129	6	0	0.05
Pirimicarb-desmethyl-formamido	52	0	0		69	0	0		161	0	0		230	26	13	0.38	129	3	0	0.04
Propaquizafop																				
CGA287422									73	0	0									
CGA290291									73	0	0									
CGA294972									73	0	0									
PPA									74	0	0									
Propiconazole ***	89	0	0		87	0	0		109	6	0	0.03	241	26	3	0.86	251	0	0	
Propyzamide	82	0	0						126	38	12	5.1	5	0	0		161	9	4	7
RH-24580	82	0	0						66	2	0	0.02					125	0	0	
RH-24644	82	0	0						66	15	0	0.05					125	4	0	0.02
RH-24655	58	0	0						66	0	0						124	1	0	0.02
Proquinazid																				
IN-MM671					48	0	0		1	0	0						45	0	0	
IN-MM991					48	0	0		1	0	0						45	0	0	
Prosulfocarb	74	1	0	0.03					74	5	1	0.18					79	0	0	
Pyridate					39	0	0													
PHCP					59	0	0		66	4	4	2.69								
Pyroxsulam																				
5-OH-XDE-742									51	0	0		68	1	0	0.04				
6-Cl-7-OH-XDE-742									51	0	0		68	0	0					
7-OH-XDE-742									51	0	0		68	1	0	0.04				
PSA									51	0	0		68	4	2	0.25				
Pyridine sulfonamide									51	0	0		68	0	0					
Rimsulfuron	65	0	0		52	0	0													
PPU	268	194	3	0.15	233	194	64	0.29	1	0	0									
PPU-desamino	268	63	0	0.04	233	123	6	0.18	1	0	0									
Tebuconazole	77	0	0		58	0	0		19	2	0	0.08	81	41	17	2	54	4	0	0.05
Difenoconazole (SD) **																				
Epoxiconazole																				
Prothioconazole																				
1,2,4-triazole ***	98	20	2	0.16	185	94	9	0.27	141	137	6	0.17	268	267	250	0.47	142	138	6	0.2

	Tylstrup				Jyndevad				Silstrup				Estrup				Faardrup			
Analyte	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L
Terbuthylazine	72	0	0		79	0	0		91	60	9	1.55	161	112	34	11	111	41	11	10
2-hydroxy-desethyl-terbuthylazine	72	5	0	0.02					71	28	1	0.11	131	87	24	6.3	69	8	1	1
Desethyl-terbuthylazine	72	2	0	0.01	150	20	0	0.06	116	108	44	1.08	164	146	35	8.2	111	89	7	8.3
Desisopropylatrazine	72	17	0	0.04					71	43	0	0.04	161	71	1	0.44	111	25	1	0.36
Hydroxy-terbuthylazine	72	1	0	0.04					71	26	0	0.04	131	88	16	0.99	111	21	1	0.58
Thiacloprid													47	0	0					
M34													55	0	0					
Thiacloprid-amide													47	1	0	0.01				
Thiacloprid sulfonic acid													56	0	0					
Thiamethoxam	64	0	0														68	0	0	
CGA 322704	64	0	0														68	0	0	
Thiencarbazone-methyl																				
AE1394083																	35	0	0	
Thifensulfuron-methyl																				
IN-B5528 ****					34	0	0		35	0	0		69	1	0	0.08	45	1	0	0.08
IN-JZ789													69	0	0					
IN-L9223													69	0	0					
Thiophanate-methyl																				
Carbendazim					60	0	0						63	3	0	0.02				
Triasulfuron	82	0	0																	
Triazinamin	75	0	0						88	0	0		206	0	0					
Tribenuron-methyl ****																				
IN-R9805					34	0	0		35	0	0						45	0	0	
M2					34	0	0		35	0	0						45	0	0	
Triazinamin-methyl	137	0	0		77	0	0		109	0	0		54	2	0	0.04	77	0	0	
Triflusulfuron-methyl									32	0	0						63	0	0	
IN-D8526									32	0	0						63	0	0	
IN-E7710									32	5	0	0.01					63	0	0	
IN-M7222									32	0	0						63	0	0	

** Only background samples available in the current monitoring period. Preliminary evaluation of test in next PLAP report. ** Difenoconazole was only used as seed dressing (SD). *** 1,2,4-triazole can also be a degradation product from metconazole and propiconazole. **** IN-B5528 is also a degradation product from tribenuron-methyl.*

Table 7.2. Monitoring results from 1999-2023 from the groundwater (vertical and horizontal monitoring wells). Total number of analysed samples (n), number of samples with detections (Det.), number of samples with detections in concentrations > 0.1 µg/L and the maximum detected concentration (Maz µg/L). The pesticides and degradation products are listed under Analyte. All listed pesticides were applied in PLAP, but for some only monitoring of the degradation product(s) was included in the programme. Analytes that are included in the PLAP monitoring for the first time are written in red. Note that Tylstrup is on standby.

	Tylstrup				Jyndevad				Silstrup				Estrup				Faardrup			
Analyte	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L
Acetamiprid																				
IM-1-4					232	0	0													
IM-1-5					232	0	0													
Aclonifen	127	0	0		171	0	0													
Amidosulfuron					88	0	0						144	0	0					
Desmethyl-amidosulfuron					88	0	0													
Aminopyralid	212	2	0	0.06									152	0	0					
Azoxystrobin	216	0	0		233	0	0		644	8	0	0.03	766	3	0	0.04	286	0	0	
CyPM	216	0	0		233	0	0		987	151	15	0.52	766	41	5	0.46	286	0	0	
Bentazone	509	0	0		902	3	0	0.03	406	29	3	0.44	745	44	0	0.05	527	21	4	0.6
2-amino-N-isopropyl-benzamide	191	0	0		178	0	0		205	0	0		352	1	0	0.03	193	0	0	
6-hydroxy-bentazone	179	0	0		229	0	0													
8-hydroxy-bentazone	179	0	0		229	0	0													
N-methyl-bentazone	179	0	0		229	0	0													
Bifenox	49	0	0		222	2	0	0.05	183	5	0	0.1	192	0	0		104	0	0	
Bifenox acid	49	0	0		170	0	0		182	27	20	3.1	197	1	1	0.11	104	1	1	0.19
Nitrofen	49	0	0		222	0	0		183	0	0		192	0	0		104	0	0	
Boscalid	111	0	0																	
Bromoxynil	192	0	0		218	0	0		159	0	0		167	1	0	0.01	306	0	0	
Chlormequat					14	0	0		102	0	0		74	0	0					
Clomazone	224	0	0		104	0	0		49	0	0		98	0	0		235	0	0	
FMC 65317	208	0	0		105	0	0		49	0	0		98	0	0		235	0	0	
Clopyralid	132	0	0						286	1	0	0.03					96	0	0	
Cyazofamid	127	0	0		135	0	0													
CCIM					287	0	0													
CTCA					287	0	0													
DMSA					336	133	71	1.17												
N,N-DMS					336	181	81	0.44												
Cycloxydim																				
BH 517-T2SO2					207	0	0		154	0	0									
EZ-BH 517-TSO					200	2	0	0.03	154	37	0	0.05								
Desmedipham									348	1	0	0.03					231	0	0	
EHPC									180	0	0						175	0	0	

Analyte	Tylstrup				Jyndevad				Silstrup				Estrup				Faardrup			
	n	Det.	>0.1 μg/L	Max μg/L	n	Det.	>0.1 μg/L	Max μg/L	n	Det.	>0.1 μg/L	Max μg/L	n	Det.	>0.1 μg/L	Max μg/L	n	Det.	>0.1 μg/L	Max μg/L
Diflufenican					152	0	0		201	1	1	0.47	71	0	0					
AE-0542291					152	0	0		201	0	0		71	0	0					
AE-B107137					152	0	0		201	1	0	0.02	89	2	0	0.03				
Dimethoate	176	0	0		190	0	0		222	1	0	0.09	200	0	0		206	0	0	
Epoxiconazole	199	0	0		324	1	0	0.01	179	0	0		88	0	0		209	0	0	
Ethofumesate									529	5	0	0.04	205	0	0		361	31	6	1.4
Fenpropimorph	307	0	0		254	1	0	0.03	222	0	0		189	0	0		306	1	0	0.02
Fenpropimorph acid	276	0	0		260	0	0		221	0	0		158	0	0		306	0	0	
Flamprop-M-isopropyl	176	0	0						222	1	0	0.02	263	0	0		198	0	0	
Flamprop	176	0	0						222	0	0		263	0	0		206	0	0	
Florasulam					191	0	0						160	0	0					
5-OH-florasulam									142	0	0		248	0	0					
DFP-ASTCA									142	0	0		118	0	0					
DFP-TSA									142	0	0		118	0	0					
TSA									306	0	0		118	0	0		141	0	0	
Fluazifop-P-butyl																	231	0	0	
Fluazifop-P	178	0	0		190	0	0		440	1	0	0.07					298	6	1	0.17
TFMP	3	0	0		3	0	0		435	87	16	0.29					238	0	0	
Fludioxonil																				
CGA 192155	182	0	0		232	1	0	0.05												
CGA 339833	182	0	0		221	1	1	0.37												
Fluopyram					166	0	0		223	36	8	0.28					171	0	0	
Fluopyram-7-hydroxy					166	0	0		164	15	2	0.12					138	0	0	
Flupyrsulfuron-methyl					229	0	0										174	0	0	
IN-JV460					229	0	0										174	0	0	
IN-KC576					229	0	0										174	0	0	
IN-KF311					157	0	0		144	0	0		4	0	0					
IN-KY374					229	0	0										174	0	0	
Fluroxypyr	194	0	0		193	0	0		216	0	0		155	1	0	0.06	515	1	0	0.07
Fluroxypyr-methoxypyridine																	146	0	0	
Fluroxypyr-pyridinol																	146	0	0	
Foramsulfuron									215	5	0	0.04	153	0	0					
AE-F092944					7	0	0		220	0	0		153	0	0					
AE-F130619									215	9	0	0.03	153	0	0					
Glyphosate					223	0	0		647	40	0	0.05	###	53	6	0.67	451	5	0	0.03
AMPA					223	2	0	0.02	647	40	0	0.08	###	8	0	0.07	451	2	0	0.03
Halauxifen-methyl																				
X-729													109	0	0		4	0	0	
X-757									150	0	0						136	0	0	

	Tylstrup				Jyndevad				Silstrup				Estrup				Faardrup			
Analyte	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L
Iodosulfuron-methyl									250	0	0									
Metsulfuron-methyl									250	0	0		263	0	0					
Ioxynil	198	0	0		218	0	0		159	0	0		167	0	0		306	1	0	0.01
Lambda-Cyhalothrin																				
Compound Ia *					49	0	0													
Linuron	270	0	0																	
Mancozeb																				
EBIS	78	0	0		99	0	0													
ETU	200	2	0	0.02																
MCPA					210	0	0		190	0	0		147	1	0	0.02	364	0	0	
2-methyl-4-chlorophenol					210	0	0		191	0	0		147	0	0		363	0	0	
Mesosulfuron-methyl					285	0	0						126	0	0					
AE-F099095	144	0	0		196	0	0		131	0	0		87	0	0					
AE-F147447					196	2	0	0.04	124	0	0		35	0	0					
AE-F160459	144	0	0		189	0	0		131	0	0		87	0	0					
Mesosulfuron					12	0	0						107	0	0					
Mesotrione					237	0	0		223	0	0		157	5	1	0.13				
AMBA					237	0	0		223	0	0		157	0	0					
MNBA					237	0	0		223	0	0		155	1	0	0.02				
Metalaxyl-M	352	21	0	0.08	392	88	23	1.3												
CGA 108906	352	288	47	1.5	393	278	84	2.7												
CGA 62826	352	17	0	0.04	393	174	9	0.68												
Metamitron									529	29	2	0.17	205	0	0		473	24	4	0.63
Desamino-metamitron									529	30	4	0.19	204	0	0		473	48	12	1.3
MTM-126-AMT																	108	0	0	
Metconazole **													109	0	0					
Metrafenone													188	1	0	0.04	168	0	0	
Metribuzin	387	1	0	0.01	26	0	0													
Desamino-diketo-metribuzin	525	236	5	0.2	26	20	13	1.83												
Desamino-metribuzin	365	0	0		26	0	0													
Diketo-metribuzin	512	453	315	0.55	26	26	19	1.37												
Oxathiapiprolin																				
IN-E8S72 *					49	0	0													
Pendimethalin	430	0	0		257	0	0		344	0	0		188	0	0		180	0	0	
M455H001 *									22	0	0		17	0	0					
Phenmedipham									348	0	0						231	2	0	0.03
3-aminophenol									240	0	0									
MHPC									340	0	0						231	1	0	0.05
Picloram																	4	0	0	

Analyte	Tylstrup				Jyndevad				Silstrup				Estrup				Faardrup			
	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L
Picolinafen					35	0	0						158	0	0					
CL153815					35	0	0						158	0	0					
Pirimicarb	295	0	0		251	0	0		646	3	0	0.01	294	1	0	0.02	436	2	0	0.04
Pirimicarb-desmethyl	295	0	0		251	0	0		646	0	0		290	0	0		231	3	0	0.04
Pirimicarb-desmethyl-formamido	167	0	0		251	0	0		468	0	0		338	0	0		231	2	0	0.08
Propaquizafop																				
CGA287422									193	0	0									
CGA290291									193	0	0									
CGA294972									193	0	0									
PPA									193	0	0									
Propiconazole ***	307	0	0		287	0	0		222	0	0		398	2	0	0.02	510	1	0	0.04
Propyzamide	221	0	0						396	27	6	0.22	7	0	0		485	2	0	0.07
RH-24580	221	0	0						227	0	0						364	0	0	
RH-24644	221	0	0						227	2	0	0.03					364	0	0	
RH-24655	157	0	0						227	0	0						360	0	0	
Proquinazid																				
IN-MM671					187	0	0										107	0	0	
IN-MM991					187	0	0										107	0	0	
Prosulfocarb	168	4	0	0.03					226	1	0	0.03					187	0	0	
Pyridate					116	0	0													
PHCP					184	0	0		189	14	4	0.31								
Pyroxsulam																				
5-OH-XDE-742									142	0	0		118	0	0					
6-Cl-7-OH-XDE-742									142	0	0		118	0	0					
7-OH-XDE-742									142	0	0		118	0	0					
PSA									142	0	0		118	0	0					
Pyridine sulfonamide									142	0	0		118	0	0					
Rimsulfuron	178	0	0		189	0	0													
PPU	656	58	0	0.05	863	374	12	0.23												
PPU-desamino	656	9	0	0.03	863	98	0	0.09												
Tebuconazole	196	1	0	0.01	214	1	0	0.01	38	0	0		162	5	2	0.12	174	1	0	0.01
Difenoconazole (SD) **																				
Epoxiconazole																				
Prothioconazole																				
1,2,4-triazole ***	265	111	0	0.06	867	518	6	0.18	407	168	4	0.2	453	407	79	0.26	538	37	0	0.04

Analyte	Tylstrup				Jyndevad				Silstrup				Estrup				Faardrup			
	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L	n	Det.	>0.1 µg/L	Max µg/L
Terbuthylazine	179	0	0		260	0	0		316	36	1	0.12	286	1	0	0.02	283	51	21	1.9
2-hydroxy-desethyl-terbuthylazine	191	1	0	0.03					236	1	0	0.02	230	0	0		193	7	0	0.09
Desethyl-terbuthylazine	191	0	0		517	27	0	0.02	375	161	2	0.14	298	7	0	0.05	283	66	30	0.94
Desisopropylatrazine	191	1	0	0.01					236	4	0	0.05	286	27	0	0.03	283	60	0	0.04
Hydroxy-terbuthylazine	191	0	0						236	0	0		230	0	0		283	34	0	0.07
Thiacloprid													100	0	0					
M34													100	0	0					
Thiacloprid-amide													100	0	0					
Thiacloprid sulfonic acid													100	0	0					
Thiamethoxam	175	0	0														184	0	0	
CGA 322704	175	0	0														184	0	0	
Thiencarbazone-methyl																				
AE1394083																	111	0	0	
Thifensulfuron-methyl																				
IN-B5528 ****					166	0	0		164	0	0		194	0	0		138	0	0	
IN-JZ789													194	0	0					
IN-L9223													194	0	0					
Thiophanate-methyl																				
Carbendazim					238	0	0						105	0	0					
Triasulfuron	295	0	0																	
Triazinamin	285	0	0						341	0	0		345	1	0	0.04				
Tribenuron-methyl ****																				
IN-R9805					166	0	0		164	0	0						138	0	0	
M2					166	0	0		164	0	0						138	0	0	
Triazinamin-methyl	440	0	0		248	0	0		222	0	0		104	0	0		204	0	0	
Triflusulfuron-methyl									158	0	0						130	0	0	
IN-D8526									158	0	0						130	0	0	
IN-E7710									158	0	0						130	0	0	
IN-M7222									158	1	0	0.05					130	0	0	

** Only background samples available in the current monitoring period. Preliminary evaluation of test in next PLAP report. ** Difenoconazole was only used as seed dressing (SD). *** 1,2,4-triazole can also be a degradation product from metconazole and propiconazole. **** IN-B5528 is also a degradation product from tribenuron-methyl.*

8. References

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9. Appendices

Compared to the previous PLAP reports three appendices are no longer included: *Pesticides analysed at five PLAP fields in the period up to 2022*, *Horizontal wells,* and *Groundwater age from recharge modelling and tritium-helium analysis*. The data in the Appendix *Pesticides analysed at five PLAP fields in the period up to 2022* is now merged into the present Appendix 3 and Chapter 3. The other two appendices can be found in the previous report Badawi et al. (2023b) available at www.plap.dk.

We have included two new Appendices in the present report: Appendix 7, *Bromide tracer tests,* is a copy of Chapter 5 in the previous PLAP report (Badawi et al., 2023b). Appendix 8, *Detailed pesticide plots*, show the sample analysis results for each screen in individual plots.

List of appendices in present report:

Appendix 1

Pesticides and degradation products included in PLAP

Appendix 2

Sampling programme

Appendix 3

Agricultural management

Appendix 4

Precipitation at the PLAP fields

Appendix 5

Pesticide detections in samples from drains, suction cups and groundwater screens

Appendix 6

QC charts for internal quality control

Appendix 7

Bromide tracer tests

Appendix 8

Detailed pesticide plots

9.1. Appendix 1 – Pesticides and degradation products included in PLAP

Table A1.1. *EFSA nomenclature (pesticide and analyte), systematic chemical nomenclature, CAS no. for the pesticides and degradation products included in PLAP. P (parent). M (degradation product). Analyte: compound included in the monitoring. N: Total number of samples analysed in PLAP including QC samples. Monitoring is ongoing if latest analysis date is in June 2023.*

Pesticide	P/M	Analyte	CAS no.	Systematic name	Latest analysis	N
Acetamiprid	P	Acetamiprid	135410-20-7	N-[(6-chloropyridin-3-yl)methyl]-N'-cyano-N-methylethanimidamide	17-07-2020	2
Acetamiprid	M	IM-1-5		N-(6-chloropyridin-3-ylmethyl)-N-methyl-acetamidine	06-09-2022	327
Acetamiprid	M	IM-1-4	120739-62-0	1-(6-Chloro-3-pyridyl)-N-methylmethanamine; N-methyl(6-chloro-3-pyridyl)methylamine	06-09-2022	327
Aclonifen	P	Aclonifen	74070-46-5	2-chloro-6-nitro-3-phenoxyaniline	18-06-2013	471
Amidosulfuron	P	Amidosulfuron	120923-37-7	N-[[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-amino]sulfonyl]-N-methylmethanesulfonamide	01-03-2006	414
Amidosulfuron	M	desmethyl-amidosulfuron	935867-69-9	3-(4-hydroxy-6-methoxypyrimidin-2-yl)-1-(N-methyl-N-methylsulfonyl-aminosulfonyl)-urea	01-03-2006	129
Aminopyralid	P	Aminopyralid	150114-71-9	4-amino-3,6-dichloropyridine-2-carboxylic acid	08-04-2015	619
Amitrol	P	Amitrol	61-82-5	1H-1,2,4-triazol-5-amine	16-09-2020	62
Azoxystrobin	P	Azoxystrobin	131860-33-8	Methyl (E)-2-{2-[(6-(2-cyanophenoxy)-4-pyrimidin-4-yloxy]phenyl}-3-methoxyacrylate	16-06-2020	3432
Azoxystrobin	M	CyPM	1185255-09-7	E-2-(2-[6-cyanophenoxy)-pyrimidin-4-yloxy]-phenyl) – 3-methoxyacrylic acid	08-02-2023	3906
Bentazone	P	Bentazone	25057-89-0	3-(1-methylethyl)-1H-2,1,3-benzothiadiazin-4(3H)-one 2,2 dioxide	17-04-2018	4860
Bentazone	M	2-amino-N-isopropyl-benzamide	30391-89-0	2-amino-N-isopropylbenzamide	28-06-2007	1857
Bentazone	M	N-methyl-bentazone	61592-45-8	3-methyl-2,2-dioxo-1H-2?6,1,3-benzothiadiazin-4-one	17-04-2018	561
Bentazone	M	6-hydroxy-bentazone	60374-42-7	6-Hydroxy-3-isopropyl-1H-2,1,3-benzothiadiazin-4(3H)-one 2,2-dioxide	17-04-2018	561
Bentazone	M	8-hydroxy-bentazone	60374-43-8	8-Hydroxy-3-(1-methylethyl)-1H-2,1,3-benzothiadiazin-4(3H)-one 2,2-Dioxide	17-04-2018	561
Bifenox	P	Bifenox	42576-02-3	methyl 5-(2,4-dichlorophenoxy)-2-nitrobenzoate	27-12-2012	1191
Bifenox	M	Nitrofen	1836-75-5	2,4-dichlorophenyl 4'-nitrophenyl ether	27-12-2012	1191
Bifenox	M	Bifenox acid	53774-07-5	5-(2,4-dichlorophenoxy)-2-nitrobenzoic acid	27-12-2012	1109
Boscalid	P	Boscalid	188425-85-6	2-chloro-N-(4'-chlorobiphenyl-2-yl)nicotinamide	11-12-2012	190
Bromoxynil	P	Bromoxynil	1689-84-5	3,5-dibromo-4-hydroxybenzonitrile	31-03-2015	1745
Chlormequat	P	Chlormequat	7003-89-6	2-chloroethyltrimethylammonium	10-07-2008	335
Clomazone	P	Clomazone	81777-89-1	2-[(2-chlorphenyl)methyl]-4,4-dimethyl-3-isoxazolidione	08-04-2015	1118
Clomazone	M	FMC 65317	171569-37-2	(N-[2- chlorophenol)methyl] -3-hydroxy-2,2-dimethyl propanamide (Propanamide-clomazone)	08-04-2015	1090
Clopyralid	P	Clopyralid	1702-17-6	3,6-Dichloropyridine-2-carboxylic acid	12-03-2009	831
Cyazofamid	P	Cyazofamid	120116-88-3	4-chloro-2-cyano-N,N-dimethyl-5-(4-methylphenyl)imidazole-1-sulfonamide	22-06-2022	424
Cyazofamid	M	N,N-DMS	3984-14-3	N,N-dimethylsulfamide	13-06-2023	460
Cyazofamid	M	CTCA	1287189-46-1	4-chloro-5-(4-methylphenyl)-1H-imidazole-2-carboxylic acid	10-01-2023	396
Cyazofamid	M	CCIM	120118-14-1	Cyazofamid-dessulfonamide, 4-chloro-5-(4-methylphenyl)-1H-imidazole-2-carbonitrile	10-01-2023	396

Pesticide	P/M	Analyte	CAS no.	Systematic name	Latest analysis	N
Cyazofamid	M	DMSA	6623-40-1	dimethylsulfamic acid; n,n-dimethylsulfamic acid	13-06-2023	460
Cycloxydim	M	EZ-BH 517-TSO	119759-56-7	2-[1-(ethylimino)butyl]-3-hydroxy-5-(tetrahydro-2H-thiopyran-3-yl)-2-cyclohexen-1-one S-oxide	28-10-2020	486
Cycloxydim	M	BH 517-T2SO2	119725-80-3	2-propyl-6-(3-thianyl)-4,5,6,7-tetrahydrobenzoxazol-4-one S-dioxide	28-10-2020	493
Desmedipham	P	Desmedipham	13684-56-5	Ethyl 3-(phenylcarbamoyloxy)phenylcarbamate	24-06-2003	972
Desmedipham	M	EHPC	7159-96-8	Carbamic acid, (3-hydroxyphenyl)-ethyl ester	24-06-2003	608
Diflufenican	P	Diflufenican	83164-33-4	2',4'-difluoro-2-(?,?,?-trifluoro-m-tolyloxy)nicotinanilide	08-04-2015	662
Diflufenican	M	AE-B107137	36701-89-0	2-[3-(trifluoromethyl)phenoxy]pyridine-3-carboxylic acid	08-04-2015	690
Diflufenican	M	AE-0542291		2-[3-(trifluoromethyl)phenoxy]pyridine-3-carboxamide	08-04-2015	662
Dimethoate	P	Dimethoate	60-51-5	O,O-dimethyl S-methylcarbamoylmethyl-phosphorodithioate	13-06-2005	1620
Epoxiconazole	P	Epoxiconazole	106325-08-0	(2RS, 3SR)-1-(2-(2-chlorophenyl)-2,3-epoxy-2-(4-fluorophenyl)propyl)-1H-1,2,4-triazol	02-12-2009	1527
Ethofumesate	P	Ethofumesate	26225-79-6	(±)-2-ethoxy-2,3-dihydro-3,3-dimethylbenzofuran-5-yl-methanesulfonate	30-06-2011	1827
Fenpropimorph	P	Fenpropimorph	67564-91-4	Cis-4-[3-[4-(1,1-dimethylethyl)-phenyl]-2-methylpropyl]-2,6-imethylmorpholine	17-06-2003	2087
Fenpropimorph	M	Fenpropimorph acid	121098-45-1	Cis-4-[3-[4-(2-carboxypropyl)-phenyl]-2-methylpropyl]-2,6-dimethylmorpholine	17-06-2003	1979
Flamprop-M-isopropyl	P	Flamprop-M-isopropyl	63782-90-1	Isopropyl N-benzoyl-N-(3-chloro-4-flourophenyl)-D-alaninate	13-06-2005	1443
Flamprop-M-isopropyl	M	Flamprop	58667-63-3	N-benzoyl-N-(3-chloro-4-flourophenyl)-D-alanine	13-06-2005	1449
Florasulam	P	Florasulam	145701-23-1	2’,6’,8-Trifluoro-5-methoxy-s-triazolo [1,5-c]pyrimidine-2-sulfonanilide	03-05-2020	580
Florasulam	M	5-OH-florasulam	292085-54-2	N-(2,6-difluorophenyl)-8-fluoro-5-oxo-5,6-dihydro[1,2,4]triazolo[1,5-c]pyrimidine-2-sulfonamide	16-03-2022	698
Florasulam	M	DFP-ASTCA	313963-92-7	3-[(2,6-difluorophenyl)sulfamoyl]-1H-1,2,4-triazole-5-carboxylic acid	16-03-2022	423
Florasulam	M	DFP-TSA	313963-94-9	N-(2,6-difluorophenyl)-1H-1,2,4-triazole-3-sulfonamide	16-03-2022	423
Florasulam	M	TSA	89517-96-4	1H-1,2,4-triazole-3-sulfonamide	16-03-2022	854
Fluazifop-P-butyl	P	Fluazifop-P-butyl	79241-46-6	butyl (R)-2-{4-[5-(trifluoromethyl)-2-pyridyloxy]phenoxy}propionate	24-06-2003	401
Fluazifop-P-butyl	M	Fluazifop-P	83066-88-0	(R)-2-(4-((5-(trifluoromethyl)-2-pyridinyl)oxy)phenoxy-propanoic acid	28-03-2012	1759
Fluazifop-P-butyl	M	TFMP	33252-63-0	5-trifluoromethyl-pyridin-2-ol	08-04-2015	1012
Fludioxonil	M	CGA 339833		3-carbamoyl-2-cyano-3-(2,2-difluoro-1,3-benzodioxol-4-yl)oxirane-2-carboxylic acid	05-04-2016	558
Fludioxonil	M	CGA 192155	126120-85-2	2,2-difluoro-benzo[1,3]dioxol-4-carbocyclic acid	05-04-2016	569
Fluopyram	P	Fluopyram	658066-35-4	N-[2-[3-chloro-5-(trifluoromethyl)pyridin-2-yl]ethyl]-2-(trifluoromethyl)benzamide	28-06-2023	777
Fluopyram	M	Fluopyram-7-hydroxy	856699-69-9	N-{2-[3-chloro-5-(trifluoromethyl)-2-pyridinyl]-2-hydroxyethyl}-2-(trifluoromethyl)benzamide; M08	28-06-2023	632
Flupyrsulfuron-methyl	P	Flupyrsulfuron-methyl	144740-54-5	Methyl 2-[[[[(4,6-dimethoxy-2-pirimidinyl)amino]carbonyl]-amino]sulfonyl]-6-(trifluoromethyl)-3-pyridinecarboxylate sodium salt	08-05-2018	513

Pesticide	P/M	Analyte	CAS no.	Systematic name	Latest analysis	N
Flupyrsulfuron-methyl	M	IN-JV460	223660-64-8	1-(4-hydroxy-6-oxo-1H-pyrimidin-2-yl)-7-(trifluoromethyl)pyrido[2,3-d]pyrimidine-2,4-dione	11-10-2016	512
Flupyrsulfuron-methyl	M	IN-KF311	223660-64-8	1-(4,6-dihydroxypyrimidine-2-yl)-7-(trifluoromethyl)pyrido[2,3-d]pyrimidine-2,4(1H,3H)-dione	25-03-2020	444
Flupyrsulfuron-methyl	M	IN-KY374		N-(4,6-dimethoxypyrimidine-2-yl)-N-(3-methoxycarbonyl-6-trifluoromethylpyridine-2-yl)-amine	11-10-2016	512
Flupyrsulfuron-methyl	M	IN-KC576		4-(4-methoxy-6-oxo-1H-pyrimidin-2-yl)-7-(trifluoromethyl)-4H-2,6-naphthyridine-1,3-dione	11-10-2016	512
Fluroxypyr	P	Fluroxypyr	69377-81-7	(4-amino-3,5-dichloro-6-fluro-2-pyridinyl)oxy]acetic acid	12-06-2008	2044
Fluroxypyr	M	Fluroxypyr-methoxypyridine	35622-80-1	4-amino-3,5-dichloro-6-fluoro-2-pirydynil-2-methoxypyridine	08-05-2018	192
Fluroxypyr	M	Fluroxypyr-pyridinol	94133-62-7	4-amino-3,5-dichloro-6-fluoro-2-pyridinol	08-05-2018	192
Foramsulfuron	P	Foramsulfuron	173159-57-4		08-05-2018	594
Foramsulfuron	M	AE-F092944	36315-01-2	2-amino-4,6-dimethoxypyrimidine	07-05-2019	610
Foramsulfuron	M	AE-F130619	190520-75-3	4-amino-2-[3-(4,6-dimethoxypyrimidin-2-yl)ureidosulfonyl]-N, N-dimethylbenzamide	08-05-2018	594
Glyphosate	P	Glyphosate	1071-83-6	N-(phosphonomethyl)glycine	04-05-2016	3936
Glyphosate	M	AMPA	1066-51-9	Amino-methylphosphonic acid	04-05-2016	3936
Halauxifen-methyl	P	Halauxifen-methyl	943831-98-9	methyl 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)pyridine-2-carboxylate	22-05-2019	1
Halauxifen-methyl	M	X-729	943832-60-8	4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)pyridine-2-carboxylic acid (halauxifen)	30-03-2021	196
Halauxifen-methyl	M	X-757		4-amino-3-chloro-6-(4-chloro-2-fluoro-3-hydroxyphenyl)pyridine-2-carboxylic acid	25-09-2019	409
Iodosulfuron-methyl	P	Iodosulfuron-methyl	144550-36-7	sodium salt of methyl 4-iodo-2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]benzoate	22-12-2010	355
Iodosulfuron-methyl	M	Metsulfuron-methyl	74223-64-6	methyl 2-(4-methoxy-6-methyl-1,3,5-triazin-2-ylcarbamoylsulfamoyl)benzoate	11-05-2023	835
Ioxynil	P	Ioxynil	1689-83-4	4-hydroxy-3,5-diiodobenzonitrile	31-03-2015	1750
Lambda-cyhalothrin	M	Compound Ia		(1RS,3RS)-3-[(1Z)-2-chloro-3,3,3-trifluoro-1-propen-1-yl]-2,2-dimethylcyclopropanecarboxylic acid	13-06-2023	64
Linuron	P	Linuron	330-55-2	3-(3,4-dichlorophenyl)-1-methoxy-1-methylurea	13-09-2001	388
Mancozeb	M	ETU	96-45-7	Ethylenethiourea	03-04-2001	278
Mancozeb	M	EBIS	33813-20-6	ethylene bisisothiocyanate sulfide	19-03-2015	238
MCPA	P	MCPA	94-74-6	(4-chloro-2-methylphenoxy)acetic acid	29-06-2006	1460
MCPA	M	2-methyl-4-chlorophenol	1570-64-5	2-methyl-4-chlorophenol	29-06-2006	1458
Mesosulfuron-methyl	P	Mesosulfuron-methyl	208465-21-8	Methyl 2-[3-(4,6-dimethoxypyrimidin-2-yl)ureidosulfonyl]-4-methanesulfonamidomethylbenzoate	19-04-2018	649
Mesosulfuron-methyl	M	Mesosulfuron	400852-66-6	2-[[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-4-[[(methylsulfonyl)amino]methyl]benzoic acid	02-12-2009	270
Mesosulfuron-methyl	M	AE-F160459		Methyl 2-{[(4-methoxy-6-oxo-1,6-dihydropyrimidin-2-yl)carbamoyl]sulfamoyl}-4-{[(methylsulfonyl)amino]methyl}benzoate	31-03-2020	830

Pesticide	P/M	Analyte	CAS no.	Systematic name	Latest analysis	N
Mesosulfuron-methyl	M	AE-F147447	888225-62-5	N-[(1,1-Dioxido-3-oxo-2,3-dihydro-1,2-benzothiazol-6-yl)methyl]methanesulfonamide	25-03-2020	530
Mesosulfuron-methyl	M	AE-F099095	151331-81-6	4,6-dimethoxypyrimidin-2-yl-urea	31-03-2020	837
Mesotrione	P	Mesotrione	104206-82-8	2-(4-mesyl-2-nitrobenzoyl)cyclohexane-1,3-dione	08-05-2018	949
Mesotrione	M	MNBA	110964-79-9	methylsulfonyl-2-nitrobenzoic acid	08-05-2018	947
Mesotrione	M	AMBA	393085-45-5	2-amino-4-methylsulfonylbenzoic acid	08-05-2018	949
Metalaxyl-M	P	metalaxyl-M	70630-17-0	methyl N-(methoxyacetyl)-N-(2,6-xylyl)-D-alaninate	19-03-2015	1117
Metalaxyl-M	M	CGA 108906	104390-56-9	2-[(1-carboxyethyl)(methoxyacetyl)amino]-3-methylbenzoic acid	19-03-2015	1124
Metalaxyl-M	M	CGA 62826	75596-99-5	2-[(2,6-dimethylphenyl)(methoxyacetyl)amino]propanoic acid	19-03-2015	1126
Metamitron	P	Metamitron	41394-05-2	4-amino-4,5-dihydro-3-methyl-6-phenyl-1,2,4-triazin-5-one	31-03-2020	1984
Metamitron	M	MTM-126-AMT	70569-26-5	4-amino-3-methyl-1,2,4-triazin-5-one	31-03-2020	154
Metamitron	M	Desamino-metamitron		4,5-dihydro-3-methyl-6-phenyl-1,2,4-triazine-5-one	31-03-2020	1980
Metconazole	P	Metconazole	125116-23-6	(1RS,5RS:1RS,5SR)-5-(4-chlorobenzyl)-2,2-dimethyl-1-(1H-1,2,4-triazol-1-ylmethyl) cyclopentanol	30-03-2021	193
Metrafenone	P	Metrafenone	220899-03-6	3'-bromo-2,3,4,6'-tetramethoxy-2',6-dimethylbenzophenone	08-04-2015	608
Metribuzin	P	Metribuzin	21087-64-9	4-amino-6-tert-butyl-4,5-dihydro-3-methylthio-1,2,4-triazine-5-one	28-05-2002	576
Metribuzin	M	Diketo-metribuzin	56507-37-0	4-amino-6-tert-butyl-4,5-dihydro-1,2,4-triazine-3,5-dione	09-03-2011	944
Metribuzin	M	Desamino-diketo-metribuzin	52236-30-3	6-tert-butyl-4,5-dihydro-3-methylthio-1,2,4-triazine-3,5-dione	09-04-2008	889
Metribuzin	M	Desamino-metribuzin	35045-02-4	6-(1,1-dimethylethyl)-3-(methylthio)- 1,2,4-triazin-5-(4H)-one	28-05-2002	539
Metsulfuron	P	metsulfuron	79510-48-8		11-05-2023	4
Oxathiapiprolin	M	IN-E8S72		3-(trifluoromethyl)-1H-pyrazole-5-carboxylic acid	13-06-2023	64
Pendimethalin	P	Pendimethalin	40487-42-1	N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine	10-12-2009	2231
Pendimethalin	M	M455H001	127971-53-3	2-methyl-3,5-dinitro-4-(pentan-3-ylamino)benzoic acid	28-06-2023	42
Phenmedipham	P	Phenmedipham	13684-63-4	3-[(methoxycarbonyl)amino]phenyl (3-methylphenyl)carbamate	24-06-2003	973
Phenmedipham	M	MHPC	13683-89-1	Methyl-N-(3-hydoxyphenyl)-carbamate	24-06-2003	952
Phenmedipham	M	3-aminophenol	591-27-5	1-amino-3-hydroxybenzene	26-02-2002	362
Picloram	P	Picloram	6607	4-Amino-3,5,6-trichloropyridine-2-carboxylic acid	04-12-2019	6
Picolinafen	P	Picolinafen	137641-05-5	4'-fluoro-6-(a,a,a-trifluoro-m-tolyloxy)pyridine-2-carboxanilide	30-03-2010	352
Picolinafen	M	CL153815	137640-84-7	6-(3-trifluoromethylphenoxy)-2-pyridine carboxylic acid	30-03-2010	352
Pirimicarb	P	Pirimicarb	23103-98-2	2-(dimethylamino)-5,6-dimethyl-4-pyrimidinyldimethylcarbamate	26-06-2007	3117
Pirimicarb	M	Pirimicarb-desmethyl	30614-22-3	2-(dimethylamino)-5,6-dimethyl-4-pyrimidinylmethylcarbamate	26-06-2007	2763
Pirimicarb	M	Pirimicarb-desmethyl-formamido	27218-04-8	2-methylformamido-5,6-dimethylpyrimidine-4-yl dimethylcarbamate	26-06-2007	2388
Propaquizafop	P	propaquizafop	111479-05-1		09-04-2019	1

Pesticide	P/M	Analyte	CAS no.	Systematic name	Latest analysis	N
Propaquizafop	M	CGA294972		2-[4-(6-chloro-3-hydroxy-quinoxalin-2-yloxy)-phenoxy]-propionic acid;hydroxy quizalofop; 3-OH-quizalofop acid; Hydroxy-propaquizafop acid	29-12-2021	293
Propaquizafop	M	CGA290291	27925-27-5	6-chloro-3H-quinoxalin-2-one; 6-chloroquinoxalin-2-ol; hydroxy-quinoxaline	29-12-2021	293
Propaquizafop	M	CGA287422	76578-12-6	2-[4-(6-chloroquinoxalin-2-yl)oxyphenoxy]-propanoic acid (quizalofop; quizalofop acid; propaquizafop acid)	29-12-2021	293
Propaquizafop	M	PPA	94050-90-5	(R)-2-(4-hydroxy-phenoxy)-propionic acid	29-12-2021	294
Propiconazole	P	Propiconazole	60207-90-1	1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]-1H-1,2,4-triazole	22-03-2005	2857
Propyzamide	P	Propyzamide	23950-58-5	3,5-dichloro-N-(1,1-dimethylprop-2-ynyl)benzamide	30-11-2022	1682
Propyzamide	M	RH-24580	29918-41-0	3,5-Dichloro-N-(2-methyl-3-oxobutan-2-yl)benzamide	04-12-2019	1238
Propyzamide	M	RH-24644	29918409	2-(3,5-dichlorophenyl)-4,4-dimethyl-5-methylene-oxazoline	04-12-2019	1238
Propyzamide	M	RH-24655		3,5-Dichloro-N-(2-methylbut-3-en-2-yl)benzamide	08-04-2015	1134
Proquinazid	P	Proquinazid	189278-12-4	6-iodo-2-propoxy-3-propylquinazolin-4(3H)-one	09-05-2019	2
Proquinazid	M	IN-MM991	20297-19-2	3-propylquinazoline-2,4(1H,3H)-dione	24-03-2021	435
Proquinazid	M	IN-MM671	213271-86-4	2-propoxy-3-propylquinazolin-4(3H)-one	24-03-2021	435
Prosulfocarb	P	Prosulfocarb	52888-80-9	N-[[3-(4-methoxy-6-methyl-1,3,5-triazin-2-yl)-3-[2-(3,3,3,-trifluro=propyl)phenylsulfonyl]urea	19-03-2015	922
Prothioconazole	P	Prothioconazole	178928-70-6	(RS)-2-[2-(1-chlorocyclopropyl)-3-(2-chlorophenyl)-2-hydroxypropyl]-2,4-dihydro-1,2,4-triazole-3-thione	10-06-2022	10
Prothioconazole	M	Prothioconazole-desthio	120983-64-4	(2RS)-(1-chlorocyclopropyl)-1-(2-chlorophenyl)-3-(1H1,2,4-triazol-1-yl)-2-propanol	10-06-2022	6
Pyridate	P	Pyridate	55512-33-9	O-6-chloro-3-phenylpyridazin-4-yl S-octyl thiocarbonate	03-09-2002	183
Pyridate	M	PHCP	40020-01-7	3-phenyl-4-hydroxy-6-chloropyridazine	02-06-2004	571
Pyroxsulam	P	Pyroxsulam	422556-08-9	N-(5,7-dimethoxy-[1,2,4]triazolo[1,5-a]pyrimidin-2-yl)-2-methoxy-4-(trifluoromethyl)pyridine-3-sulfonamide	03-05-2020	2
Pyroxsulam	M	5-OH-XDE-742		5-OH-pyroxsulam; N-(5-hydroxy-7-methoxy[1,2,4]triazolo[1,5-a]pyrimidin-2-yl)-2-methoxy-4-trifluoromethyl)-3-pyridinesulfonamide	16-03-2022	423
Pyroxsulam	M	Pyridine sulfonamide	2757917-20-5	2-methoxy-4-(trifluoromethyl)pyridine-3-sulfonamide	16-03-2022	423
Pyroxsulam	M	7-OH-XDE-742		7-OH-pyroxsulam; N-(7-hydroxy-5-methoxy[1,2,4]triazolo[1,5-a]pyrimidin-2-yl)-2-methoxy-4-(trifluoromethyl)pyridine3-sulfonamide	16-03-2022	423
Pyroxsulam	M	PSA		2-methoxy-4-(trifluoromethyl)-3-pyridinesulfonic acid	16-03-2022	423
Pyroxsulam	M	6-Cl-7-OH-XDE-742		6-Cl-7-OH-pyroxsulam; N-(6-chloro-7-hydroxy-5-methoxy[1,2,4] triazolo[1,5-a]pyrimidin-2-yl)-2-methoxy-4-(trifluoromethyl)pyridine -3-sulfonamide	16-03-2022	423

Pesticide	P/M	Analyte	CAS no.	Systematic name	Latest analysis	N
Rimsulfuron	P	Rimsulfuron	122931-48-0	N-[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-3-(ethylsulfonyl)-2-pyridinesulfonamide	14-06-2006	561
Rimsulfuron	M	PPU	138724-53-5	N-(4,6-dimethoxy-2-pyrimidinyl-N-((3-ethylsulfonyl)-2-pyridinyl)urea (IN70941)	11-12-2012	2311
Rimsulfuron	M	PPU-desamino	151331-80-5	N-((3-(ethylsulfonyl)-2-pyridyl)-4,6 dimethoxy-2 pyrimidinamine (IN70942)	11-12-2012	2311
Tebuconazole	P	Tebuconazole	107534-96-3	a-[2-(4-chlorophenyl)ethyl]-a-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol	27-12-2012	1220
Tebuconazole	M	1,2,4-triazol	288-88-0	1,2,4-triazol	28-12-2022	3715
Terbuthylazine	P	Terbuthylazine	5915-41-3	6-chloro-N-(1,1-dimethylethyl)-N-ethyl-1,3,5,triazine-2,4-diamine	25-03-2009	2117
Terbuthylazine	M	2-hydroxy-desethyl-terbuthylazine	66753-06-8	6-hydroxy-N-(1,1-dimethylethyl)-1,3,5,triazine-2,4-diamine	19-06-2008	1372
Terbuthylazine	M	Hydroxy-terbuthylazine	66753-07-9	6-hydroxy-N-(1,1-dimethylethyl)-N´-ethyl-1,3,5,triazine-2,4-diamine	19-06-2008	1521
Terbuthylazine	M	Desethyl-terbuthylazine	30125-63-4	6-chloro-N-(1,1-dimethylethyl)-1,3,5,triazine-2,4-diamine	10-06-2009	2620
Terbuthylazine	M	Desisopropylatrazine	1007-28-9	6-chloro-N-ethyl-1,3,5-triazine-2,4-diamine	25-03-2009	1619
Thiacloprid	P	Thiacloprid	111988-49-9	(Z)-3-(6-chloro-3-pyridylmethyl)-1,3-thiazolidin-2-ylidenecyanamide	28-03-2012	168
Thiacloprid	M	M34		2-{carbamoyl[(6-chloropyridin-3-yl)methyl]amino}etanesulfonic acid	28-03-2012	176
Thiacloprid	M	Thiacloprid-amide	676228-91-4	(3-[(6-chloro-3-pyridinyl)methyl]-2-thiazolidinylidene) urea	28-03-2012	168
Thiacloprid	M	Thiacloprid sulfonic acid		sodium 2-[[[(aminocarbonyl)amino]-carbonyl][(6-chloro-3-pyridinyl)-methyl]amino]ethanesulfonate	28-03-2012	177
Thiamethoxam	P	Thiamethoxam	153719-23-4	3-(2-cholro-thiazol-5-ylmethyl)-5-methyl[1,3,5]oxadiazinan-4ylidene-N-nitroamine	18-06-2008	559
Thiamethoxam	M	CGA 322704	210880-92-5	[C(E)]-N-[(2-chloro-5-thiazolyl)methyl]-N'-methyl-N'-nitroguanidine	18-06-2008	559
Thiencarbazone-methyl	M	AE1394083	936331-72-5	4-((4,5-Dihydro-3-methoxy-4-methyl-5-oxo-1H-1,2,4-triazol-1-yl)carbonylsulfamoyl)-5-methylthiophene-3-carboxylic acid (Thiencarbazone)	31-03-2020	159
Thifensulfuron-methyl	P	Thifensulfuron-methyl	79277-27-3	Methyl 3-(4-methoxy-6-methyl-1,3,5-triazin-2-ylcarbamoylsulfamoyl)thiophene-2-carboxylate	19-07-2022	2
Thifensulfuron-methyl	M	IN-L9223	59337-97-2	3-sulfamoylthiophene-2-carboxylic acid; 2-acid-3-sulfonamide	28-06-2023	285
Thifensulfuron-methyl	M	Thifensulfuron	79277-67-1	3-[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)carbamoylsulfamoyl]thiophene-2-carboxylic acid	19-07-2022	1
Thifensulfuron-methyl	M	IN-JZ789		3-{[(4-hydroxy-6-methyl-1,3,5-triazin-2-yl)carbamoyl]sulfamoyl}thiophene-2-carboxylic acid	28-06-2023	285
Thifensulfuron-methyl	M	IN-B5528	16352-06-0	4-amino-6-methyl-1,3,5-triazin-2-ol	28-06-2023	915
Thiophanate-methyl	M	Carbendazim	10605-21-7	methyl benzimidazol-2-ylcarbamate	07-10-2020	525
Triasulfuron	P	Triasulfuron	82097-50-5	1-[2-(2-chloroethoxy)phenylsulfonyl]-2-(4-methoxy-6-methyl-1,3,5-triazine-2-yl)-urea	04-03-2003	439
Triasulfuron	M	Triazinamin	1668-54-8	2-amino-4-methoxy-6-methyl-1,3,5-triazine	04-04-2018	1534
Tribenuron-methyl	P	Tribenuron-methyl	101200-48-0	methyl 2-[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)-methylcarbamoyl]sulfamoyl]benzoate	11-05-2023	6

Pesticide	P/M	Analyte	CAS no.	Systematic name	Latest analysis	N
Tribenuron-methyl	M	Triazinamin-methyl	5248-39-5	4-methoxy-6-methyl-1,3,5-triazin-methylamine	29-08-2012	1898
Tribenuron-methyl	M	M2	220225-04-7	1-(4-methoxy-6-methyl-1,3,5-triazin-2-yl)-1-methylurea	28-06-2023	630
Tribenuron-methyl	M	IN-R9805	879554-45-7	4-methyl-6-(methylamino)-1,3,5-triazin-2(1H)-one N-{2-[3-chloro-5-(trifluoromethyl)-2-pyridinyl]-2-hydroxyethyl}-2-(trifluoromethyl)benzamide; M08; AE C656948-7-hydroxy	28-06-2023	630
Triflusulfuron-methyl	P	Triflusulfuron-methyl	126535-15-7	methyl 2-[4-dimethylamino-6-(2,2,2-trifluoroethoxy)-1,3,5-triazin-2-ylcarbamoylsulfamoyl]-m-toluate	30-06-2011	430
Triflusulfuron-methyl	M	IN-E7710	101988-70-9	N-methyl-6-(2,2,2-trifluoroethoxy)-1,3,5-triazine-2,4-diamine	30-06-2011	430
Triflusulfuron-methyl	M	IN-D8526	145963-84-4	N,N-dimethyl-6-(2,2,2-trifluoroethoxy)-1,3,5-triazine-2,4-diamine	30-06-2011	430
Triflusulfuron-methyl	M	IN-M7222	1418095-28-9	6-(2,2,2-trifluoroethoxy)-1,3,5-triazine-2,4-diamine	30-06-2011	430

9.2. Appendix 2 – Sampling programme

From each of the PLAP fields, samples of groundwater, drainage water and soil water in the variably saturated zone are collected. A full description of the original monitoring design is found in Lindhardt *et al*. (2001), and later revisions and changes to the sampling procedure are described in previous reports (see www.plap.dk). The sampling programme in PLAP is under constant revision as new knowledge about the hydrogeological conditions at the PLAP fields is continuously collected and processed.

The sampling programme up to September 2022 for each of the active PLAP fields is presented in table A2.1. Tylstrup was set on standby (January 1, 2019) and in connection with this, the sampling programme for the other fields was revised. In this period before September 2022, less samples were in general collected from the fields compared to earlier reporting periods. As such only the two upper-most water-filled screens were sampled from vertical monitoring wells. For the clay till fields, a sample from the drainage water was collected every week, when there was drain flow present. At the sandy field Jyndevad, samples from the variably saturated zone (suction cups) were collected once a month.

During three sampling events between September and December 2022, additional samples were collected from selected wells at each of the fields Jyndevad, Silstrup, Estrup and Faardrup. Funding for this was made possible as all sampling for pesticide analysis at Lund was put on hold. The purpose of collecting these extra samples was to assess which wells should continue to be part of the sampling programme.

From January 2023 and onward a new PLAP sampling strategy was implemented. This sampling strategy included samples collected in fewer wells but in contrast to the previous strategy, all water filled screens are always sampled. The purpose of this was to achieve coherent data series with analysis results from the same screens over longer time. It was additionally decided to not sample the upper-most horizontal wells (2-2.5 mbgs) at the fields, since it is generally not possible to samples these wells during most of the year when the groundwater level is low. An overview of the present sampling programme at the active PLAP fields can be found in Table A2.2.

Sampling from drainage is done flow-proportionally, which means that a small amount of water (100 or 200 mL) is collected for every 3000 L of flow through the drainage system. On the weekly sampling day, a representative sample of the collected drainage water is extracted for analysis. For details on this procedure, refer to Lindhardt et al. (2001), or previous PLAP reports available at www.plap.dk.

Although it is possible to collect maximum 52 samples from the drainage system per year, this is never the case because no drain flow occurs during most of the dry summer months. On average approximately 35 drainage samples are collected per year at the PLAP fields, with the least number of samples being collected at Faardrup. Likewise, the upper-most screen of most vertical wells cannot be sampled during the driest months.

Table A2.1. *Sampling programme July 2018-December 2022 for pesticide analysis in PLAP for suction cups (S), horizontal monitoring wells (H) and vertical monitoring wells (M). Numbers in parentheses denote the number of samples collected from the well.*

Field	**Period**	**Monthly sampling (Intensive)**	**Half-yearly sampling (medium)**	**Half-yearly sampling (Extensive)**	**Not sampled**
Jyndevad	before 1/1-2019	M1(2), M4(2), M7(3), S1a, S2a, H1(1)*	M1(2), M2(3), M4(2), M7(3), S1a, S2a, H1(1)*	M1(2), M2(3), M4(2), M5(2), M7(3), S1a, S2a, H1(1)*	M3, M6, S1b, S2b
	1/1-2019-30/6 2022	M1(2), M4(2), M7(2), S1a, S2a, H1(1)*	M1(2), M2(2), M4(2), M7(2), S1a, S2a, H1(1)*	M1(2), M2(2), M4(2), M5(2), M7(2), S1a, S2a, H1(1)*	M3, M6, S1b, S2b
Silstrup	1/7-2018-30/6-2022	M5(2), M9(1), H1.2(1), H3(1)*	-	M5(2), M9(2), M10(2), M12(2), H1.2(1), H3(1)*	M1-M4, M6-M8, M11, M13, H2
Estrup	before 1/1-2019	M4(2), M6(1), H1.2(1), H2(1)*	-	M1(2), M4(2), M5(2), M6(2), H1.2(1), H2(1)*	M2, M3, M7, S1, S2
	1/1-2019-30/6 2022	M4(2), H1.2(1), H2(1)*	-	M1(2), M4(2), M5(2), M6(2), H1.2(1), H2(1)*	M2, M3, M7, S1, S2
Faardrup	before 1/1-2019	M4(2), M5(2), M6(2), H2.3(1), H3(1)*	-	M2(2), M4(2), M5(2), M6(2), H2.3(1), H3(1)*	M1, M3, M7, H1, S1, S2
	1/1-2019-30/6 2022	M4(2), M5(1), H2.3(1), H3(1)*	-	M2(2), M4(2), M5(2), M6(2), H2.3(1), H3(1)*	M1, M3, M7, H1, S1, S2

*S1a and S1b refer to suction cups installed 1 and 2 mbgs, respectively, at location S1, whereas S2a and S2b refer to suction cups installed 1 and 2 mbgs, respectively, at location S2. * Mixed water samples from three screens.*

Table A2.2. *Sampling programme in effect from January 2023 for pesticide analysis in PLAP. Number of collected samples per sampling event/round from each well is indicated in parentheses.*

Sampling programme	**Samples from variably saturated zone**		**Samples from groundwater monitoring wells**		**Samples per sampling event**	**Samples per year**
January 2023 -	Suction cups	Drainage	Vertical	Horizontal **		
Jyndevad	S1 (1), S2 (1)	*	M2 (4), M4 (4), M7 (2)		12	144
Silstrup		Drainage (1 weekly sample)	M5 (4), M9 (4), M12 (2)	H1 (1)	11	184
Estrup		Drainage (1 weekly sample)	M3 (4), M4 (4), M8 (4)	H2 (1)	13	208
Faardrup		Drainage (1 weekly sample)	M4 (4), M5 (4), M2 (2)	H2 (1)	11	184

** No drainage system at Jyndevad. **Mixed water samples from three screens.*

9.3. Appendix 3 – Agricultural management

Table A3.1. Management practice at Tylstrup during 2018 to 2023 growing seasons. The active ingredients of the various pesticide products are indicated in parentheses.

Date	Management practice and growth stages – **Tylstrup**
15-08-2017	Stubble cultivated, depth 7 cm
16-08-2017	Stubble cultivated, depth 20 cm
17-08-2017	Winter rapeseed sown, cv. DK Exclaim, depth 2.0 cm, row distance 13 cm seed amount 1.8 kg/ha, final plant number 54 /m^2
18-08-2017	Command CS (clomazone) - weeds - 0.25 L/ha (90 g clomazone, a.i./ha)
24-08-2017	Fertilisation 34 N, kg/ha
30-08-2017	BBCH stage 09 - emergence
15-09-2017	Ploughed, depth 23 cm, due to poor emergence. Crust had formed on surface due to heavy rain - impeding the emergence
16-09-2017	Winter barley sown, cv. Hejmdal, seeding rate 165 kg/ha, sowing depth 4 cm, row distance 13 cm, final plant number 320 /m^2
16-09-2017	Seed dressing Redigo Pro 170 FS (12.38 g prothioconazole + 1.65 g tebuconazole, a.i./ha)
23-09-2017	BBCH stage 09 - emergence
27-09-2017	BBCH stage 10
02-10-2017	BBCH stage 11
18-10-2017	BBCH stage 13
18-10-2017	Lexus 50 WG (flupyrsulfuron) - weeds - 10 g/ha (4.63 g flupyrsulfuron, a.i./ha)
09-11-2017	BBCH stage 20
09-11-2017	Biomass 31.8 g/m^2 - 100% DM
09-04-2018	BBCH stage 24
09-04-2018	Fertilisation - 256.4 N, 36.6 P, 121 K, kg/ha
01-05-2018	BBCH stage 32
18-05-2018	BBCH stage 50
18-05-2018	Biomass 520.4 g/m^2 - 100% DM
18-05-2018	Irrigation 40 mm
24-05-2018	Irrigation 25 mm
05-06-2018	Irrigation 18 mm
06-06-2018	BBCH stage 75
06-06-2018	Biomass 1027.4 g/m^2 - 100% DM
09-06-2018	Irrigation 27 mm
19-06-2018	BBCH stage 82
11-07-2018	BBCH stage 91
11-07-2018	Harvest of winter barley. Grain yield 46.24 hkg/ha, total N 1.61% and total-C 43.54% - 85 % DM
12-07-2018	Straw yield 52.2 hkg/ha, total-N 0.61% and total-C 43.73% - 100% DM, stubble height 12 cm. Straw removed
28-09-2018	Liming 3.0 ton/ha
12-03-2019	Ploughed, depth not measured - likely depth 23 cm
05-04-2019	Harrowed, depth unknown
12-04-2019	Spring oats sown
25-04-2019	BBCH stage 09 - emergence (estimated based on seven years sowing of spring barley on the location)
30-04-2019	Fertilisation 95.5 N, 20.5 P, 102.3 K, kg/ha
28-05-2019	BBCH stage 31
28-05-2019	U46M (MCPA) - weeds - 1 L/ha (750 g MCPA, a.i./ha) - not monitored
24-08-2019	Harvest of spring oats, grain yield 46.7 hkg/ha - 85% DM
27-03-2020	Ploughed
28-03-2020	Fertilisation 143.2 N, 20.6 P, 68.2 K, kg/ha
07-04-2020	Sowing a mixture of spring barley varieties (to reduce need for fungicidal spraying)
20-04-2020	BBCH stage 09 - emergence (estimated based on past cultivation of spring barley at the field)
07-05-2020	BBCH stage 20-21
29-05-2020	BBCH stage 33
14-08-2020	Harvest of spring barley. Grain yield 46.24 hkg/ha - 85 % DM

Date	Management practice and growth stages – **Tylstrup**
21-08-2020	Stubble height 12 cm, straw removed
07-10-2020	Glyphomax HL (glyphosate) - weeds - 3.4 L-ha (1636 g glyphosate, a.i./ha) - not monitored
14-03-2021	Ploughed
19-03-2021	Furrows leveled out with cultivator
23-03-2021	Fertilisation 143.2 N, 20.6 P, 68.2 K, kg/ha
24-03-2021	Sowing a mixture of spring barley varieties (to reduce need for fungicidal spraying), seeding rate 182 kg/ha
22-04-2021	BBCH stage 11
18-05-2021	BBCH stage 31
18-05-2021	U46 M (MCPA) - weeds - 1 L/ha (750 g MCPA, a.i./ha) - not monitored
18-08-2021	Harvest of spring barley. Grain yield 48.2 hkg/ha - 85 % DM
20-08-2021	Straw yield 20.5 hkg/ha - fresh weight. Straw removed
21-03-2022	Ploughed
25-03-2022	Fertilisation 142.8 N, 20.4 P, 68.0 K, kg/ha
26-03-2022	Sowing a mixture of spring barley varieties, seeding rate 170 kg/ha
28-03-2022	Rolled
17-05-2022	Fertilisation 0.353 Mn, 0.165 N, kg/ha
23-05-2022	U46 M (MCPA) - weeds - 1 L/ha (750 g MCPA, a.i./ha) - not monitored
30-05-2022	Fertilisation 0.353 Mn, 0.165 N, kg/ha
13-08-2022	Harvest of spring barley. Grain yield 51.8 hkg/ha - fresh weight
15-08-2022	Straw yield 13.7 hkg/ha - fresh weight. Straw removed
17-08-2022	Stubble cultivation
21-09-2022	Glypper (glyphosate) - weeds - 3.5 L/ha (1260 g glyphosate, a.i./ha) - not monitored
29-09-2022	Sowing winter rye, cv. KWS Serafino (hybrid), seeding rate 84 kg/ha
06-03-2023	Fertilisation 50.4 N, 7.2 P, 24.0 K, kg/ha
04-04-2023	Fertilisation 79.8 N, 11.4 P, 38.0 K, kg/ha
17-05-2023	Fertilisation 0.353 Mn, 0.165 N, kg/ha
23-05-2023	BBCH stage 37
23-05-2023	U46 M (MCPA) - weeds - 1 L/ha (750 g MCPA, a.i./ha) - not monitored
30-05-2023	Fertilisation 0.353 Mn, 0.165 N, kg/ha

Table A3.2. Management practice at Jyndevad during 2016 to 2023 growing seasons. The active ingredients of the various pesticide products are indicated in parentheses.

Date	Management practice and growth stages – **Jyndevad**
21-03-2016	Sowing spring barley cv. KWS Irena, depth 4.0 cm, row distance 12 cm, seed rate 170 kg/ha, using a combine drill, final plant number 345 /m^2
21-03-2016	Rolled with concrete roller
21-03-2016	BBCH stage 00
30-03-2016	BBCH stage 09 - emergence
04-04-2016	BBCH stage 10
05-04-2016	BBCH stage 11
05-04-2016	Fertilisation 136.0 N, 17 P, 63 K, kg/ha
20-04-2016	BBCH stage 12
20-04-2016	Sowing catch crop of grass and clover (Foragemax 42)
27-04-2016	BBCH stage 13
03-05-2016	BBCH stage 16
03-05-2016	Fighter 480 (bentazone) - weeds - 1.5 L/ha
10-05-2015	BBCH stage 20
10-05-2016	BBCH stage 09 – emergence of catch crop
12-05-2016	Biomass 27.7 g/m^2 - 100% DM
17-05-2016	BBCH stage 27
23-05-2016	BBCH stage 32
31-05-2016	BBCH stage 37
02-06-2016	BBCH stage 50
02-06-2016	Bumper 25 EC (propiconazole) -fungi - 0.5 L/ha (125 g propiconazole, a.i./ha)
03-06-2016	Irrigation 30 mm
03-06-2016	BBCH stage 50
03-06-2016	Biomass 721.7 g/m^2 - 100% DM
06-06-2016	BBCH stage 53
08-06-2016	BBCH stage 56
08-06-2016	Irrigation 30 mm
13-06-2016	BBCH stage 57
20-06-2016	BBCH stage 58
27-06-2016	BBCH stage 67
06-07-2016	BBCH stage 72
12-07-2016	BBCH stage 75
12-07-2016	Biomass 1148.7 g/m^2 - 100% DM
25-07-2016	BBCH stage 89
01-08-2016	BBCH stage 90
08-08-2016	BBCH stage 95
17-08-2016	Harvest of spring barley. Seed yield 48.3 hkg/ha - 85% DM
30-08-2016	Straw yield 27.4 hkg/ha - 100% DM, stubble height 15 cm. Removal of straw
03-02-2017	Ploughing, 22 cm depth
20-02-2017	Rolled with concrete roller
15-03-2017	Fertilisation 28 P, 147 K, kg/ha
23-03-2017	Sowing pea cv. Mascara, depth 6.0 cm, row distance 12 cm, seed rate 235 kg/ha, using a combine drill, final plant number 74 /m^2
08-04-2017	BBCH stage 09 - emergence
08-04-2017	BBCH stage 10
17-04-2017	BBCH stage 11
23-04-2017	BBCH stage 12
09-05-2017	BBCH stage 33
09-05-2017	Stomp CS (pendimethalin) - weeds - 1.0 L/ha (455 g pendimethalin, a.i./ha) - not included
09-05-2017	Fighter 480 (bentazone) - weeds - 1.0 L/ha (480 g bentazone, a.i./ha)
19-05-2017	BBCH stage 52
19-05-2017	Biomass 335.1 g/m^2 - 100% DM
19-05-2017	Focus Ultra (cycloxydim) - weeds - 5.0 L/ha (500 g cycloxydim, a.i./ha)

Date	Management practice and growth stages – **Jyndevad**
27-05-2017	BBCH stage 59
27-05-2017	Irrigation 30 mm
30-05-2017	BBCH stage 60
08-06-2017	BBCH stage 64
08-06-2017	Biomass 64.8 g/m^2 - 100% DM
16-06-2017	BBCH stage 69
22-06-2017	BBCH stage 70
22-06-2017	Irrigation 30 mm
27-06-2017	BBCH stage 71
27-06-2017	Biomass 704.3 g/m^2 - 100% DM
10-07-2017	BBCH stage 75
18-07-2017	BBCH stage 78
26-07-2017	BBCH stage 82
26-07-2017	Biomass 1003.3 g/m^2 - 100% DM
28-07-2017	BBCH stage 82
07-08-2017	BBCH stage 85
10-08-2017	BBCH stage 89
18-08-2017	Harvest of pea. Seed yield 64.4 hkg/ha - 86 % DM. Straw yield 38.9 hkg/ha - 100% DM, stubble height 10 cm. Straw shredded at harvest
18-08-2017	Rotor harrowed, incorporation of the straw and stubble, 6 cm depth
08-09-2017	Ploughing, 22 cm depth
10-09-2017	Rolled with concrete roller
21-09-2017	Sowing winter wheat, cv. Sheriff (Redigo Pro 170 FS as seed dressing), depth 4.0 cm, seeding rate 168 kg/ha, row distance 12.5 cm, final plant number 320m-2
03-10-2017	BBCH stage 09 - emergence
16-10-2017	BBCH stage 12
16-10-2017	Lexus 50 WG (flupyrsulfuron) - weeds - 10 g/ha (4.63 g flupyrsulfuron, a.i./ha)
27-03-2018	BBCH stage 20
03-04-2018	BBCH stage 23
04-04-2018	Fertilisation 54 N, kg/ha
17-04-2018	BBCH stage 27
17-04-2018	Biomass 36.8 g/m^2 - 100% DM
20-04-2018	BBCH stage 28
20-04-2018	Hussar Plus OD (iodosulfuron-methyl-Na + mesosulfuron-methyl) - weeds - 0.14 L/ha (7 g iodosulfuron-methyl-Na + 1.05 g mesosulfuron-methyl, a.i./ha)
27-04-2018	Pig slurry (sow) application - trail hose applied at surface - 45 ton/ha - 110.4 Total-N, 73.9 NH_4-N, 27.5 P, 55.4 K, kg/ha, DM of slurry 2.18%
03-05-2018	BBCH stage 31
03-05-2018	Lexus 50 WG (flupyrsulfuron) - weeds - 10 g/ha (4.63 g flupyrsulfuron, a.i./ha)
05-05-2018	BBCH stage 32
08-05-2018	BBCH stage 33
08-05-2018	U46M (MCPA) - weeds - 1 L/ha (750 g MCPA, a.i./ha) - not included
13-05-2018	BBCH stage 41
13-05-2018	Irrigation 30 mm
14-05-2018	BBCH stage 41
20-05-2018	BBCH stage 45
20-05-2018	Irrigation 30 mm
24-05-2018	BBCH stage 50
24-05-2018	Biomass 65.0 g/m^2 - 100% DM
27-05-2018	BBCH stage 52
27-05-2018	Irrigation - 30 mm
02-06-2018	BBCH stage 65
02-06-2018	Irrigation 30 mm
04-06-2018	BBCH stage 69
06-06-2018	BBCH stage 70

Date	Management practice and growth stages – **Jyndevad**
06-06-2018	Topsin WG (thiophanat-methyl) - fungi - 1.1 kg/ha (770 g thiophanat-methyl, a.i ha^{-1})
06-06-2018	Irrigation 30 mm
10-06-2018	BBCH stage 70
10-06-2018	Irrigation 30 mm
13-06-2018	BBCH stage 72
22-06-2018	BBCH stage 73
26-06-2018	BBCH stage 74
26-06-2018	Irrigation 30 mm
04-07-2018	BBCH stage 75
04-07-2018	Irrigation 30 mm
09-07-2018	BBCH stage 75
09-07-2018	Biomass 3386.7 g/m^2 - 100% DM
17-07-2018	BBCH stage 80
25-07-2018	BBCH stage 89
26-07-2018	Harvest of winter wheat. Grain yield 82.4 hkg/ha - 85% DM. Straw yield 44.8 hkg/ha - 100% DM, stubble height 14 cm. Straw removed at harvest
22-08-2018	Glyfonova MAX HL (glyphosate) - weeds - 3.2 L/ha (1536 g glyphosate, a.i./ha)
18-10-2018	Ploughing, 20 cm depth
18-10-2018	Sowing winter rye, cv. Bono, depth 4.0 cm, seeding rate 105 kg/ha, row distance 12.0 cm, final plant number 220 /m^2
18-10-2018	Celeste Formula M (fludioxonil) - 210 mL/ha (5.25 g fludioxonil, a.i./ha) - seed dressing
05-11-2018	BBCH stage 09 - emergence
21-03-2019	BBCH stage 22
21-03-2019	Fertilisation 136 N, 26 P, 65 K, kg/ha
28-03-2019	BBCH stage 25
08-04-2019	BBCH stage 27
11-04-2019	BBCH stage 28
11-04-2019	Irrigation 30 mm
12-04-2019	BBCH stage 29
12-04-2019	Biomass 77.0 g/m^2 - 100% DM
17-04-2019	BBCH stage 30
17-04-2019	Fertilisation 63 N, 12 P, 30 K, kg/ha
19-04-2019	BBCH stage 30
22-04-2019	BBCH stage 30
22-04-2019	Irrigation 30 mm
25-04-2019	BBCH stage 31
25-04-2019	Talius (proquinazid) - fungi - 0.25 L/ha (50 g proquinazid, a.i./ha)
05-05-2019	BBCH stage 38
05-05-2019	Irrigation 30 mm
08-05-2019	BBCH stage 40
08-05-2019	Cerone (ethephone) - plant growth regulation - 1.0 L/ha (480 g ethephone, a.i./ha) - not monitored
08-05-2019	U46M (MCPA) - weeds - 1.0 L/ha (750 g MCPA, a.i./ha) - not monitored
09-05-2019	BBCH stage 41
09-05-2019	Talius (proquinazid) - fungi - 0.25 L/ha (50 g proquinazid, a.i./ha)
13-05-2019	BBCH stage 45
13-05-2019	Biomass 616.9 g/m^2 - 100% DM
20-05-2019	BBCH stage 48
24-05-2019	BBCH stage 50
24-05-2019	Irrigation 30 mm
27-05-2019	BBCH stage 51
08-06-2019	BBCH stage 57
08-06-2019	Irrigation 30 mm
10-06-2019	BBCH stage 59
24-06-2019	BBCH stage 65
26-06-2019	BBCH stage 66

Date	Management practice and growth stages – **Jyndevad**
26-06-2019	Irrigation 30 mm
04-07-2019	BBCH stage 75
04-07-2019	Irrigation 30 mm
09-07-2019	BBCH stage 77
09-07-2019	Biomass 1851.8 g/m^2 - 100% DM
22-07-2019	BBCH stage 85
02-08-2019	BBCH stage 89
11-08-2019	BBCH stage 91
11-08-2019	Harvest of winter rye. Grain yield 69.2 hkg/ha - 85% DM. Straw yield 36.5 hkg/ha - 100% DM, stubble height 22 cm. Straw removed at harvest
03-02-2020	Ploughing, 22 cm depth
25-04-2020	Planting of potatoes, cv. Kuras, row distance 75 cm, plant distance 30 cm, depth 14 cm, final plant number 4 /m^2
25-04-2020	Fertilisation 28 N, 6 P, 30 K, kg/ha placed, when planting the potato tubers
25-04-2020	Fertilisation 168 N, 135 K, kg/ha, with a pneumatic fertiliser spreader
20-05-2020	BBCH stage 08
20-05-2020	Glyphomax HL (glyphosate) + Centium 36 CS (clomazone) – weeds - 2 L/ha + 0.25 L/ha (960 g glyphosate + 90 g clomazone, a.i./ha) - neither monitored
24-05-2020	BBCH stage 09 - emergence
01-06-2020	BBCH stage 14
13-06-2020	BBCH stage 28
13-06-2020	Irrigation 20 mm
14-06-2020	BBCH stage 28
14-06-2020	Ranman Top (cyazofamid) - fungi – 0.5 L/ha (80 g cyazofamid, a.i./ha)
17-06-2020	Mechanical weeding - depth 5 cm (Einbøck Rollstar) - row hoe with rolling hoe stars
21-06-2020	BBCH stage 40
21-06-2020	Irrigation 20 mm
23-06-2020	BBCH stage 41
23-06-2020	Ranman Top (cyazofamid) - fungi - 0.5 L/ha (80 g cyazofamid, a.i./ha)
23-06-2020	Mospilan SG (acetamiprid) - pests – 0.25 kg/ha (50 g acetamiprid, a.i./ha)
23-06-2020	Biomass tuber 55.7 g/m^2, top 537.6 g/m^2 - 100 % DM
01-07-2020	BBCH stage 64
01-07-2020	Biomass tuber 164.6 g/m^2, top 901.1 g/m^2 - 100 % DM
03-07-2020	BBCH stage 65
03-07-2020	Dithane NT (mancozeb) - fungi - 2.0 kg/ha (1500 g mancozeb, a.i./ha) - not monitored
09-07-2020	BBCH stage 67
09-07-2020	Dithane NT (mancozeb) - fungi - 2.0 kg/ha (1500 g mancozeb, a.i./ha) - not monitored
17-07-2020	BBCH stage 68
17-07-2020	Ranman Top (cyazofamid) - fungi - 0.5 L/ha (80 g cyazofamid, a.i./ha)
17-07-2020	Mospilan SG (acetamiprid) - pests - 0.25 kg/ha (50 g acetamiprid, a.i./ha)
27-07-2020	BBCH stage 69
27-07-2020	Dithane NT (mancozeb) - fungi - 2.0 kg/ha (1500 g mancozeb, a.i./ha) - not monitored
02-08-2020	BBCH stage 70
02-08-2020	Irrigation 30 mm
03-08-2020	BBCH stage 70
03-08-2020	Dithane NT (mancozeb) - fungi - 2.0 kg/ha (1500 g mancozeb, a.i./ha) - not monitored
06-08-2020	BBCH stage 74
06-08-2020	Proxanil (propamocarb + cymoxanil) - fungi - 2.5 L/ha (834 g propamocarb + 125 g cymoxanil, a.i./ha) - neither monitored
08-08-2020	BBCH stage 75
08-08-2020	Irrigation 30 mm
12-08-2020	BBCH stage 77
12-08-2020	NeemAzal-T-S (azadirachtin) - pests - 2.5 L/ha (65 g azadirachtin, a.i./ha)
12-08-2020	Ranman Top (cyazofamid) - fungi - 0.5 L/ha (80 g cyazofamid, a.i./ha)
15-08-2020	BBCH stage 79

Date	Management practice and growth stages – **Jyndevad**
15-08-2020	Irrigation 30 mm
19-08-2020	BBCH stage 81
19-08-2020	Proxanil (propamocarb and cymoxanil) - fungi - 2.5 L/ha (834 g propamocarb + 125 g cymoxanil, a.i./ha) - neither monitored
27-08-2020	BBCH stage 87
27-08-2020	Dithane NT (mancozeb) - fungi - 2.0 kg/ha (1500 g mancozeb, a.i./ha) - not monitored
27-08-2020	Biomass tuber 1236.3 g/m^2, top 293.2 g/m^2 - 100 % DM
01-09-2020	BBCH stage 89
01-09-2020	NeemAzal-T-S (azadirachtin) - pests - 2.5 L/ha (65 g azadirachtin, a.i./ha)
01-09-2020	Ranman Top (cyazofamid) - fungi - 0.5 L/ha (80 g cyazofamid, a.i./ha)
10-09-2020	BBCH stage 91
10-09-2020	Ranman Top (cyazofamid) - fungi - 0.5 L/ha (80 g cyazofamid, a.i./ha)
16-09-2020	BBCH stage 95
16-09-2020	Dithane NT (mancozeb) - fungi - 2.0 kg/ha (1500 g mancozeb, a.i./ha) - not monitored
21-10-2020	Harvest of potatoes. Tuber yield 142.8 hkg/ha - 100% DM
21-10-2020	Rotor cultivated, incorporation of potato leaves and stems, depth 5 cm
21-10-2020	Sowing winter rye, cv. Serafino, depth 4 cm, seeding rate 159 kg/ha, row distance 12.0 cm, final plant number 320 /m^2
21-10-2020	Redigo Pro 170 FS (prothioconazole + tebuconazole) - 79.5 mL/ha (11.9 g prothioconazole + 1.6 g tebuconazole, a.i./ha) - seed dressing
05-11-2020	BBCH stage 09 - emergence
08-03-2021	BBCH stage 22
08-03-2021	Fertilisation 54.6 N, 10.4 P, 26.0 K, kg/ha
31-03-2021	BBCH stage 22
07-04-2021	BBCH stage 27
07-04-2021	Fertilisation 79.8 N, 15.4 P, 38.0 K, kg/ha
14-04-2021	BBCH stage 28
14-04-2021	Biomass 44.6 g/m^2 - 100% DM
20-04-2021	BBCH stage 31
20-04-2021	U46M (MCPA) - weeds - 1 L/ha (750 g MCPA, a.i./ha) - not monitored
27-04-2021	BBCH stage 32
27-04-2021	Irrigation 30 mm
05-05-2021	BBCH stage 35
11-05-2021	BBCH stage 45
19-05-2021	BBCH stage 49
19-05-2021	Biomass 550.3 g/m^2 - 100% DM
26-05-2021	BBCH stage 60
08-06-2021	Irrigation 27 mm
09-06-2021	BBCH stage 65
16-06-2021	BBCH stage 67
16-06-2021	Irrigation 35 mm
28-06-2021	BBCH stage 71
06-07-2021	BBCH stage 76
06-07-2021	Biomass 1892.3 g/m^2 - 100% DM
20-07-2021	BBCH stage 81
08-08-2021	BBCH stage 85
20-08-2021	BBCH stage 89
20-08-2021	Harvest of winter rye. Grain yield 59.6 hkg/ha - 85% DM. Straw yield 42.3 hkg/ha - 100% DM, stubble height 12 cm. Straw shredded and left in field at harvest
30-08-2021	Liming 3.6 ton/ha magnesium limestone
01-02-2022	Ploughing, 22 cm depth
02-02-2022	Disc harrowed, 8-10 cm depth
05-03-2022	Sowing spring barley, cv. Flair, sowing depth 4 cm, seeding rate 182 kg/ha, row distance 12.0 cm, final plant number 346 /m^2

Date	Management practice and growth stages – **Jyndevad**
05-03-2022	Redigo Pro 170 FS (prothioconazole + tebuconazole) - 91.0 mL/ha (13.65 g prothioconazole + 1.82 g tebuconazole, a.i./ha) - seed dressing
26-03-2022	BBCH stage 10 - emergence
28-03-2022	BBCH stage 11
28-03-2022	Fertilisation 46.2 N, 8.8 P, 21.0 K, kg/ha
13-04-2022	BBCH stage 15
23-04-2022	BBCH stage 22
23-04-2022	Nuance Max 75 WG (tribenuron-methyl) - weeds - 10 g/ha (7.5 g tribenuron-methyl, a.i./ha) - monitored
27-04-2022	Fertilisation 46.2 N, 8.8 P, 21.0 K, kg/ha
28-04-2022	BBCH stage 22
28-04-2022	Biomass 35.8 g/m^2 - 100% DM
28-04-2022	Irrigation 20 mm
05-05-2022	BBCH stage 27
05-05-2022	Fertilisation 46.2 N, 8.8 P, 21.0 K, kg/ha
07-05-2022	BBCH stage 28
07-05-2022	Irrigation 20 mm
18-05-2022	BBCH stage 38
18-05-2022	U46 M (MCPA) - weeds - 1 L/ha (750 g MCPA, a.i./ha) - not monitored
19-05-2022	Irrigation 25 mm
22-05-2022	BBCH stage 49
22-05-2022	Biomass 329.6 g/m^2 - 100% DM
22-05-2022	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 1 L/ha (125 g prothioconazole + 125 g fluopyram, a.i./ha) - monitored
05-06-2022	BBCH stage 55
05-06-2022	Irrigation 25 mm
12-06-2022	BBCH stage 62
22-06-2022	BBCH stage 71
22-06-2022	Irrigation 20 mm
28-06-2022	BBCH stage 75
28-06-2022	Biomass 3424.3 g/m^2 - 100% DM
13-07-2022	BBCH stage 84
13-07-2022	Irrigation 20 mm
20-07-2022	BBCH stage 87
20-07-2022	Roundup Flex (glyphosate) - weeds - 2.5 L/ha (1200 g glyphosate, a.i./ha) - not monitored
01-08-2022	Harvest of spring barley. Grain yield 75.7 hkg/ha - 85% DM. Straw yield 38.6 hkg/ha - 100% DM, stubble height 17 cm. Straw shredded and left in field at harvest
17-08-2022	Cultivated with disc harrow. Sowing catch crop of oat, cv. Dominik, 40 kg/ha and mixture of rye varieties 40 kg/ha, scattered after the disc harrow, 0.5-5 cm depth
24-08-2022	BBCH stage 11 – emergence of catch crop
30-08-2022	BBCH stage 21
13-09-2022	BBCH stage 25
27-09-2022	BBCH stage 28
12-10-2022	BBCH stage 32
20-10-2022	BBCH stage 42
31-10-2022	BBCH stage 53
31-10-2022	Biomass 182.4 g/m^2 - 100% DM (catch crop)
02-02-2023	Disc harrowed, 15 cm depth
20-03-2023	Disc harrowed, 15 cm depth
12-04-2023	Planting of potatoes, cv. Ydon, row distance 65 and 85 cm, plant distance 33 cm, depth 15 cm, final plant number 4 /m^2
12-04-2023	Maxim 100 FS (fludioxonil) - 0.4 L/ha (40 g fludioxonile, a.i./ha) - seed dressing
12-04-2023	Fertilisation Crop-set 0.3 L/ha (1.2% S, 0.2% Cu, 0.6% Fe, 1.5% Mn) – coated on the seed tubers
12-04-2023	Fertilisation 140.0 N, 30.0 P, 150.0 K, kg/ha placed, when planting the potato tubers
10-05-2023	BBCH stage 08
10-05-2023	Glypper (glyphosate) - weeds - 2 L/ha (720 g glyphosate, a.i./ha) - not monitored

Date	Management practice and growth stages – **Jyndevad**
12-05-2023	BBCH stage 11 - emergence
19-05-2023	BBCH stage 19
25-05-2023	BBCH stage 22
01-06-2023	BBCH stage 27
01-06-2023	Irrigation 20 mm
07-06-2023	BBCH stage 32
08-06-2023	Irrigation 20 mm
12-06-2023	BBCH stage 40
12-06-2023	Top 451.2 g/m^2 - 100 % DM
13-06-2023	BBCH stage 43
13-06-2023	Irrigation 25 mm
16-06-2023	BBCH stage 44
21-06-2023	BBCH stage 52
22-06-2023	BBCH stage 55
22-06-2023	Irrigation 30 mm
28-06-2023	BBCH stage 60
28-06-2023	Biomass tuber 163.3 g/m^2, top 884.5 g/m^2 - 100 % DM
28-06-2023	Mospilan SG (acetamiprid) - pests - 0.15 kg/ha (30 g acetamiprid, a.i./ha) - not monitored
28-06-2023	Revus (mandipropamid) - fungi - 0.3 L/ha (75 g mandipropamid, a.i./ha) - not monitored
28-06-2023	Shirlan Ultra (fluazinam) - fungi - 0.4 L/ha (200 g fluazinam, a.i./ha) - not monitored
08-07-2023	BBCH stage 63
08-07-2023	Zorvec Enicade (oxathiapiprolin) - fungi - 0.15 L/ha (i.e. 15 g a.i./ha oxathiapiprolin) - monitored
08-07-2023	Shirlan Ultra (fluazinam) - fungi - 0.4 L/ha (i.e. 200 g a.i./ha fluazinam) - not monitored
18-07-2023	BBCH stage 65
18-07-2023	Zorvec Enicade (oxathiapiprolin) - fungi - 0.15 L/ha (i.e. 15 g a.i./ha oxathiapiprolin) - monitored
18-07-2023	Shirlan Ultra (fluazinam) - fungi - 0.4 L/ha (i.e. 200 g a.i./ha fluazinam) - not monitored
18-07-2023	Narita (difenoconazol) - fungi - 0.4 L/ha (i.e. 100 g a.i./ha difenoconazol) - not monitored
28-07-2023	BBCH stage 66
28-07-2023	Lamdex (lambda-cyhalothrin) - pests - 0.5 kg/ha (i.e. 12.5 g a.i./ha lambda-cyhalothrin) - monitored
28-07-2023	Revus (mandipropamid) - fungi - 0.3 L/ha (i.e. 75 g a.i./ha mandipropamid) - not monitored
28-07-2023	Proxanil (propamocarb + cymoxanil) - fungi - 2 L/ha (i.e. 667.2 g a.i./ha propamocarb and 100 g a.i./ha cymoxanil) - not monitored
02-08-2023	Fertilisation 60.0 N, kg/ha
04-08-2023	BBCH stage 67
04-08-2023	Proxanil (propamocarb + cymoxanil) - fungi - 2 L/ha (i.e. 667.2 g a.i./ha propamocarb and 100 g a.i./ha cymoxanil) - not monitored
04-08-2023	Shirlan Ultra (fluazinam) - fungi - 0.4 L/ha (i.e. 200 g a.i./ha fluazinam) - not monitored
11-08-2023	BBCH stage 69
11-08-2023	Narita (difenoconazol) - fungi - 0.4 L/ha (i.e. 100 g a.i./ha difenoconazol) - not monitored
11-08-2023	Cymbal 45 (cymoxanil) - fungi - 0.25 kg/ha (i.e. 112.5 g a.i./ha cymoxanil) - not monitored
11-08-2023	Revus (mandipropamid) - fungi - 0.3 L/ha (i.e. 75 g a.i./ha mandipropamid) - not monitored
18-08-2023	BBCH stage 70
18-08-2023	Shirlan Ultra (fluazinam) - fungi - 0.4 L/ha (i.e. 200 g a.i./ha fluazinam) - not monitored
18-08-2023	Proxanil (propamocarb + cymoxanil) - fungi - 2 L/ha (i.e. 667.2 g a.i./ha propamocarb and 100 g a.i./ha cymoxanil) - not monitored
18-08-2023	Irrigation 25 mm
25-08-2023	BBCH stage 71
25-08-2023	Lamdex (lambda-cyhalothrin) - pests - 0.5 kg/ha (i.e. 12.5 g a.i./ha lambda-cyhalothrin) - monitored
25-08-2023	Shirlan Ultra (fluazinam) - fungi - 0.4 L/ha (i.e. 200 g a.i./ha fluazinam) - not monitored
25-08-2023	Cymbal 45 (cymoxanil) - fungi - 0.25 kg/ha (i.e. 112.5 g a.i./ha cymoxanil) - not monitored

Table A3.3. Management practice at Silstrup during 2018 to 2023 growing seasons. The active ingredients of the various pesticide products are indicated in parentheses.

Date	Management practice and growth stages – **Silstrup**
26-09-2017	Ploughed, 25 cm depth
28-09-2017	Seedbed preparation, depth 10 cm
28-09-2017	Fertilisation 12.6 N, 14.0 P, kg/ha (placed at sowing)
28-09-2017	Winter barley sown, cv. Kosmos, seeding rate 190 kg/ha, sowing depth 3.0 cm, row distance 13 cm, final plant number 216 /m^2
28-09-2017	Seed dressing Redigo Pro 170 FS (14.25 g prothioconazole + 1.9 g tebuconazole, a.i./ha)
09-10-2017	BBCH stage 09 - emergence
18-10-2017	BBCH stage 11
18-10-2017	Lexus (flupyrsulfuron) - weeds - 10 g/ha (4.63 g flupyrsulfuron, a.i./ha)
27-10-2017	BBCH stage 12-13
10-04-2018	BBCH stage 20
10-04-2018	Fertilisation 171.7 N, 24.5 P, 81.8 K, kg/ha
18-04-2018	BBCH stage 22
18-04-2018	Biomass 461.8 g/m^2 - 100% DM
19-04-2018	BBCH stage 22
19-04-2018	Hussar Plus OD (iodosulfuron-methyl-Na + mesosulfuron-methyl) - weeds - 0.05 L/ha (2.5 g iodosulfuron-methyl-Na + 0.375 g mesosulfuron-methyl, a.i./ha)
23-05-2018	Biomass 691.8 g/m^2 - 100% DM
23-05-2018	BBCH stage 53
23-05-2018	Proline 250 EC (prothioconazole) - fungi - 0.8 L/ha (200 g prothioconazole, a.i./ha)
01-06-2018	BBCH stage 65
01-06-2018	Proline 250 EC (prothioconazole) - fungi - 0.8 L/ha (200 g prothioconazole, a.i./ha)
06-06-2018	BBCH stage 77
06-06-2018	Biomass 1165.3 g/m^2 - 100% DM
21-06-2018	BBCH stage 83
20-07-2018	BBCH stage 89
20-07-2018	Harvest of winter barley. Grain yield 71.9 hkg/ha, total N 1.65% and total C 43.48% - 85% DM
24-07-2018	Straw yield 10.3 hkg/ha, total-N 0.37% and total-C 42.45% - 100% DM, stubble height 10 cm. Straw removed
17-08-2018	Sowing winter rapeseed, cv. DK Exclaim, sowing depth 2-3 cm, seeding rate 3.3 kg/ha, row distance 45 cm, final plant number 33 /m^2
17-08-2018	Seed dressing Thiram
23-08-2018	BBCH stage 09 – emergence
29-08-2018	BBCH stage 10
17-09-2018	BBCH stage 13 – 14
17-09-2018	Focus Ultra (cycloxydim) - weeds - 1.8 L/ha (180 g cycloxydim, a.i./ha)
26-09-2018	BBCH stage 15
10-10-2018	BBCH stage 15
17-10-2018	BBCH stage 16
24-10-2018	BBCH stage 16
24-10-2018	Biomass 71.8 g/m^2 - 100% DM
09-11-2018	BBCH stage 18
09-11-2018	Kerb 400 SC (propyzamide) - weeds - 1.25 L/ha (500 g propyzamide, a.i./ha)
01-03-2018	BBCH stage 30
01-03-2018	Fertilisation 81.0 N, kg/ha
02-04-2019	BBCH stage 52
02-04-2019	Pig slurry application - acidified at application 2 L 96% H_2SO_4 (pr. ton slurry) - trail hose applied at surface - 22.7 ton/ha - 92.8 Total-N, 57.2 NH_4-N, 21.6 P, 37.0 K, kg/ha, DM of slurry 4.19%
04-04-2019	BBCH stage 53
04-04-2019	Biomass 271.4 g/m^2 - 100% DM
09-04-2019	BBCH stage 54
09-04-2019	Agil 100 EC (propaquizifop) - weeds - 1.2 L/ha (120 g propaquizifop, a.i./ha)
16-04-2019	BBCH stage 55
24-04-2019	BBCH stage 60

Date	Management practice and growth stages – **Silstrup**
29-04-2019	BBCH stage 63
08-05-2019	BBCH stage 66
15-05-2019	BBCH stage 68
28-05-2019	BBCH stage 76
04-06-2019	BBCH stage 79
02-07-2019	BBCH stage 80
17-07-2019	BBCH stage 83
24-07-2019	BBCH stage 85
14-08-2019	BBCH stage 90
14-08-2019	Harvest of winter rapeseed. Seed yield 44.5 hkg/ha - 91% DM. Stubble height 41 cm, straw shredded at harvest - amount not determined
26-08-2019	Rapeseed stubble crushed with a mower
19-09-2019	Ploughed, 25 cm depth
20-09-2019	Seedbed preparation, depth 7 cm
21-09-2019	Sowing winter wheat, cv. Benchmark, seeding rate 190 kg/ha, sowing depth 5.0 cm, row distance 12.5 cm, final plant number 240 /m^2
21-09-2019	Celest Formula M (fludioxonile) - 380 mL/ha (9.5 g fludioxonil, a.i./ha) seed dressing - not monitored
07-10-2019	BBCH stage 09 - emergence
18-03-2020	BBCH stage 21
18-03-2020	Biomass 47.8 g/m^2 - 100% DM
25-03-2020	BBCH stage 21
25-03-2020	Fertilisation 177.2 N, 25.3 P, 84.4 K, kg/ha
07-04-2020	BBCH stage 30
07-04-2020	Broadway (pyroxsulam + florasulam) - weeds - 165 g/ha (11.27 g pyroxsulam + 3.76 g florasulam, a.i./ha)
15-04-2020	BBCH stage 30
27-04-2020	BBCH stage 32
07-05-2020	BBCH stage 32
19-05-2020	BBCH stage 37-39
26-05-2020	BBCH stage 41
28-05-2020	BBCH stage 42
28-05-2020	Proline 250 EC (prothioconazole) + Amistar (azoxystrobin) - fungi - 0.8 L/ha + 0.5 L/ha (200 g prothioconazole + 125 g azoxystrobin, a.i./ha)
03-06-2020	BBCH stage 50
08-06-2020	BBCH stage 53
08-06-2020	Biomass 1072.7 g/m^2 - 100% DM
16-06-2020	BBCH stage 68
16-06-2020	Proline 250 EC (prothioconazole) + Amistar (azoxystrobin) - fungi - 0.8 L/ha + 0.5 L/ha (200 g prothioconazole + 125 g azoxystrobin, a.i./ha)
08-07-2020	BBCH stage 75
08-07-2020	Biomass 1798.2 g/m^2 - 100% DM
15-07-2020	BBCH stage 77
22-07-2020	BBCH stage 79
13-08-2020	BBCH stage 89
13-08-2020	Harvest of winter wheat. Grain yield 97.0 hkg/ha - 85% DM. Straw yield estimated between 98 and 106 hkg/ha - 100% DM, stubble height 15 cm. Straw shredded and left in field at harvest
28-09-2020	Ploughed, 25 cm depth
30-09-2020	Sowing winter wheat, cv. Skyscraper, seeding rate 250 kg/ha, sowing depth 0-3.0 cm, row distance 12 cm
30-09-2020	Difend (difenoconazole) - seed dressing
10-10-2020	BBCH stage 09 – emergence
31-03-2021	Glyphomax HL (glyphosate) - winter wheat and weeds - 1.5 L/ha (720 g glyphosate, a.i./ha) - not monitored
15-04-2021	Seedbed preparation
15-04-2021	Sowing spring barley, mixture of varieties (not coated), seeding rate 200 kg/ha, sowing depth 5.0 cm, row distance 12 cm
15-04-2021	Fertilisation 136.9 N, 19.6 P, 65.2 K, kg/ha
29-04-2021	BBCH stage 09 – emergence

Date	Management practice and growth stages – **Silstrup**
05-05-2021	BBCH stage 11
11-05-2021	BBCH stage 12
26-05-2021	BBCH stage 22
27-05-2021	Biomass 41.8 g/m^2 - 100% DM
10-06-2021	BBCH stage 33
10-06-2021	U46M (MCPA) - weeds - 1 L/ha (750 g MCPA, a.i./ha) - not monitored
10-06-2021	Fertilisation 0.11 N, 0.24 Mn, kg/ha
16-06-2021	BBCH stage 42
23-06-2021	BBCH stage 55
23-06-2021	Biomass 497.8 g/m^2 - 100% DM
29-06-2021	BBCH stage 61
30-06-2021	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 1 L/ha (125 g prothioconazole + 125 g fluopyram, a.i./ha) - monitored
15-07-2021	BBCH stage 72
15-07-2021	Biomass 946.0 g/m^2 - 100% DM
23-08-2021	Harvest of spring barley. Grain yield 53.7 hkg/ha - 85% DM
23-08-2021	Straw shredded and left in field at harvest. Amount not determined
19-09-2021	Ploughed, 25 cm
20-09-2021	Seedbed preparation, 3 cm
21-09-2021	Sowing winter wheat, cv. Heerup, seeding rate 200 kg/ha, sowing depth 4.0 cm, row distance 12.5 cm
21-09-2021	Seedron (fludioxonile and tebuconazole) - seed dressing
13-10-2021	BBCH stage 11
03-11-2021	BBCH stage 12
17-11-2021	BBCH stage 21
17-11-2021	Biomass 11.6 g/m^2 - 100% DM
30-03-2022	BBCH stage 22
05-04-2022	Fertilisation 197.4 N, 28.2 P, 94.0 K, kg/ha
26-04-2022	BBCH stage 31
29-04-2022	Express Gold 33 SX (tribenuron-methyl + metsulfuron-methyl) - weeds - 18 g/ha (4 g tribenuron-methyl + 2 g metsulfuron-methyl, a.i./ha) - monitored
04-05-2022	BBCH stage 32
04-05-2022	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 0.5 L/ha (62.5 g prothioconazole + 62.5 g fluopyram, a.i./ha) - monitored
18-05-2022	BBCH stage 37
01-06-2022	BBCH stage 51
01-06-2022	Biomass 915.7 g/m^2 - 100% DM
10-06-2022	BBCH stage 60
10-06-2022	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 0.5 L/ha (62.5 g prothioconazole + 62.5 g fluopyram, a.i./ha) - monitored
22-06-2022	BBCH stage 67
29-06-2022	BBCH stage 72-73
06-07-2022	BBCH stage 77
06-07-2022	Biomass 1764.5 g/m^2 - 100% DM
16-08-2022	Harvest of winter wheat. Grain yield 94.0 hkg/ha - 85% DM. Straw yield not determined, shredded and left in the field after harvest
22-08-2022	Ploughed, 25 cm
01-09-2022	Seedbed preparation, 3 cm
01-09-2022	Sowing winter wheat, cv. Heerup, seeding rate 113.0 kg/ha, sowing depth 3.0 cm, row distance 12.5 cm
01-09-2022	Redigo FS 100 (prothioconazole) - 90.4 mL/ha (9.04 g prothioconazole, a.i./ha) - seed dressing
10-09-2022	BBCH stage 09 – emergence
16-09-2022	BBCH stage 11
16-09-2022	DFF (diflufenican) - weeds - 0.12 L/ha (60 g diflufenican, a.i./ha) - not monitored
26-10-2022	BBCH stage 21
26-10-2022	Biomass 165.9 g/m^2 - 100% DM
18-04-2023	BBCH stage 29

Date	Management practice and growth stages – **Silstrup**
18-04-2023	Fertilisation 180.0 N, 26.0 P, 86.0 K, kg/ha
04-05-2023	BBCH stage 32
11-05-2023	BBCH stage 37
11-05-2023	Express Gold 33 SX (tribenuron-methyl + metsulfuron-methyl) - weeds - 18 g/ha (4 g tribenuron-methyl + 2 g metsulfuron-methyl, a.i./ha) – monitored
15-05-2023	BBCH stage 38
15-05-2023	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 0.5 L/ha (62.5 g prothioconazole + 62.5 g fluopyram, a.i./ha) - monitored
24-05-2023	BBCH stage 43
07-06-2023	BBCH stage 57
07-06-2023	Biomass 655.1 g/m^2 - 100% DM
07-06-2023	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 0.5 L/ha (62.5 g prothioconazole + 62.5 g fluopyram, a.i./ha) - monitored
10-06-2023	BBCH stage 60
28-06-2023	BBCH stage 78
28-06-2023	Biomass 790.4 g/m^2 - 100% DM
02-08-2023	BBCH stage 88
14-08-2023	Biomass 688.9 g/m2 - 100% DM
14-08-2023	Harvest of winter wheat. Grain yield 29.4 hkg/ha, 85% DM. Straw yield not determined, shredded and left in the field after harvest, stubble height 14 cm
14-08-2023	Ploughed - 24 cm
17-08-2023	Sowing winter rapeseed cv. Haugustina. Sowing depth 2 cm, seeding rate 1.8 kg/ha, row distance 12 cm
17-08-2023	Integral Pro (Bacillus amyloliquefaciens MBI 600) - seed dressing
17-08-2023	Fertilisation 40.0 N, 5.7 P, 19.0 K, kg/ha
17-08-2023	BBCH stage 00
17-08-2023	Stomp CS (pendimethalin) - weeds - 0.44 L/ha (i.e. 200.2 g a.i./ha pendimethalin) - monitored

Table A3.4. Management practice at Estrup during 2018 to 2023 growing seasons. The active ingredients of the various pesticide products are indicated in parentheses.

Date	Management practice and growth stages – **Estrup**
22-09-2017	Ploughed, depth 20 cm
22-09-2017	Winter wheat sown, cv. Sheriff, depth 4.0 cm row distance 12 cm seeding rate 168 kg/ha, using a combined power harrow sowing equipment, final plant number 320 /m^2
22-09-2017	Seed dressing Redigo Pro 170 FS (12.6 g prothioconazole + 1.68 g tebuconazole, a.i./ha)
05-10-2017	BBCH stage 09 - emergence
16-10-2017	BBCH stage 12
16-10-2017	Lexus 50 WG (flupyrsulfuron) - weeds - 10 g/ha (4.63 g flupyrsulfuron, a.i./ha)
27-03-2018	BBCH stage 20
03-04-2018	BBCH stage 21
06-04-2018	BBCH stage 24
06-04-2018	Fertilisation 52.0 N kg/ha
18-04-2018	BBCH stage 25
18-04-2018	Biomass 60.1 g/m^2 - 100% DM
20-04-2018	BBCH stage 28
20-04-2018	Hussar Plus OD (iodosulfuron-methyl-Na + mesosulfuron-methyl) - weeds - 0.14 L/ha (7.0 g iodosulfuron-methyl-Na + 1.05 g mesosulfuron-methyl, a.i./ha)
30-04-2018	BBCH stage 30
30-04-2018	Pig slurry application (sow) - trail hose applied at surface - 41.7 ton/ha - 93.4 Total-N, 78.8 NH_4-N, 5.4 P, 135.5 K, kg/ha, DM of slurry 1.0%
03-05-2018	BBCH stage 31
03-05-2018	Lexus 50 WG (flupyrsulfuron) - weeds - 10 g/ha (4.63 g flupyrsulfuron, a.i./ha)
14-05-2018	BBCH stage 41
24-05-2018	BBCH stage 50
30-05-2018	BBCH stage 52
30-05-2018	Biomass 2581.7 g/m^2 - 100% DM
04-06-2018	BBCH stage 68-69
06-06-2018	BBCH stage 68-69
06-06-2018	Topsin WG (thiophanat-methyl) - fungi - 1.1 kg/ha (770 g thiophanat-methyl, a.i./ha)
13-05-2018	BBCH stage 71
21-06-2018	BBCH stage 73
21-06-2018	Karate 2.5 WG (lambda-cyhalothrin) - pests - 0.2 kg/ha (10 g lambda-cyhalothrin, a.i./ha) - not monitored
22-06-2018	BBCH stage 73
09-07-2018	BBCH stage 75
10-07-2018	BBCH stage 75
10-07-2018	Biomass 2836.3 g/m^2 - 100% DM
17-07-2018	BBCH stage 80
25-07-2018	BBCH stage 89
27-07-2018	Harvest of winter wheat. Grain yield 75.2 hkg/ha - 85% DM
27-07-2018	Straw yield 37.9 hkg/ha - 100% DM, stubble height 13 cm. Straw shredded at harvest
05-11-2018	Ploughed, depth 20 cm
08-04-2019	Fertilisation 137 N, 26 P, 65 K, kg/ha
08-04-2019	Spring barley sown, cv. Flair, depth 4 cm, seeding rate 165 kg/ha, row distance 12.0 cm, sown with combine seed drill (Amazone Drill-Star RP-AD 302), final plant number 360 /m^2
08-04-2019	Redigo Pro 170 FS (12.38 g prothioconazole + 1.65 g tebuconazole, a.i ha^{-1}) - seed dressing
17-04-2019	BBCH stage 09 - emergence
02-05-2019	BBCH stage 17
15-05-2019	BBCH stage 23
15-05-2019	Biomass 194.9 g/m^2 - 100% DM
22-05-2019	BBCH stage 31
22-05-2019	Pixxaro EC (fluroxypyr + halauxifen-methyl) - weeds - 0.35 L/ha (98 g fluroxypyr + 4.375 g halauxifen-methyl, a.i./ha)
22-05-2019	Juventus 90 (metconazole) - fungi - 1.0 L/ha (90 g metconazole, a.i./ha)
05-06-2019	BBCH stage 41

Date	Management practice and growth stages – **Estrup**
12-06-2019	BBCH stage 50
12-06-2019	Biomass 420.8 g/m^2 - 100% DM
13-06-2019	BBCH stage 50
13-06-2019	Juventus 90 (metconazole) - fungi - 1.0 L/ha (90 g metconazole, a.i./ha)
26-06-2019	BBCH stage 62
09-07-2019	BBCH stage 75
09-07-2019	Biomass 1096.2 g/m^2 - 100% DM
25-07-2019	BBCH stage 83
01-08-2019	BBCH stage 87
08-08-2019	BBCH stage 89
11-08-2019	Harvest of spring barley. Grain yield 70.4 hkg/ha - 85% DM
11-08-2019	Straw yield 23.3 hkg/ha - 100% DM, stubble height 20 cm. Straw shredded at harvest
16-09-2019	Ploughed - depth 20 cm
16-09-2019	Winter wheat sown cv. Sheriff, depth 4.0 cm row distance 12 cm, seeding rate 178 kg/ha, using a combined power harrow sowing equipment, final plant number 360 g/m^2
16-09-2019	Redigo Pro 170 FS (prothioconazole + tebuconazole) - 89 mL/ha (13.35 g prothioconazole + 1.78 g tebuconazole, a.i./ha) - seed dressing
26-09-2019	BBCH stage 09 – emergence
07-10-2019	BBCH stage 21
07-10-2019	Stomp CS (pendimethalin) - weeds - 1.0 L/ha (455 g pendimethalin, a.i./ha) - not monitored
07-04-2020	BBCH stage 21
07-04-2020	Fertilisation 136.5 N, 26 P, 65 K, kg/ha
15-04-2020	BBCH stage 22
15-04-2020	Fertilisation 73.5 N, 14P, 35 K, kg/ha
21-04-2020	BBCH stage 22
21-04-2020	Biomass 27.3 g/m^2 - 100% DM
03-05-2020	BBCH stage 31
03-05-2020	Broadway (pyroxsulam + florasulam) - weeds - 165 g/ha (11.27 g pyroxsulam + 3.76 g florasulam, a.i./ha)
14-05-2020	BBCH stage 35
24-05-2020	BBCH stage 41
29-05-2020	BBCH stage 49
29-05-2020	Biomass 450 g/m^2 - 100% DM
15-06-2020	BBCH stage 52
26-06-2020	BBCH stage 65
08-07-2020	BBCH stage 75
08-07-2020	Biomass 1298.3 g/m^2 - 100% DM
22-07-2020	BBCH stage 79
03-08-2020	BBCH stage 87
11-08-2020	BBCH stage 91
11-08-2020	Harvest of winter wheat. Grain yield 71.4 hkg/ha - 85% DM. Straw yield 38.4 hkg/ha - fresh weight, stubble height 15 cm. Straw shredded at harvest
02-02-2021	Liming 3.5 ton/ha magnesium limestone
19-04-2021	Spring barley sown cv. Flair, sowing depth 4.0 cm, row distance 12 cm, seeding rate 230 kg/ha, using combined power harrow sowing equipment, final plantnumber 385 /m^2
19-04-2021	Redigo Pro 170 FS (prothioconazole + tebuconazole) - 115 mL/ha (17.3 g prothioconazole + 2.3 g tebuconazole, a.i./ha) - seed dressing
21-04-2021	BBCH stage 00
21-04-2021	Fertilisation 120.0 N, 22.8 P, 57.0 K, kg/ha
27-04-2021	BBCH stage 11 - emergence
12-05-2021	BBCH stage 22
21-05-2021	BBCH stage 25
01-06-2021	BBCH stage 27
01-06-2021	Biomass 56.1 g/m^2 - 100% DM
01-06-2021	Harmony 50 SX (thifensulfuron-methyl) - weeds - 18 g/ha (9 g thifensulfuron-methyl, a.i./ha) - monitored
16-06-2021	BBCH stage 47

Date	Management practice and growth stages – **Estrup**
16-06-2021	Biomass 333.0 g/m^2 - 100% DM
24-06-2021	BBCH stage 61
08-07-2021	BBCH stage 75
08-07-2021	Biomass 1053.7 g/m^2 - 100% DM
22-07-2021	BBCH stage 78
06-08-2021	BBCH stage 83
15-08-2021	BBCH stage 89
15-08-2021	Harvest of spring barley. Grain yield 44.6 hkg/ha - 85% DM. Straw yield 29.0 hkg/ha - 100% DM, stubble height 12 cm. Straw shredded (left in field) at harvest
23-08-2021	Grass sown, mixture of perennial ryegrass varieties, Foragemax33, depth 2.0 cm, row distance 12 cm, seeding rate 29.5 kg/ha
01-09-2021	BBCH stage 09 - emergence
01-04-2022	Fertilisation 63.0 N, 12.0 P, 30.0 K, kg/ha
31-05-2022	BBCH stage 55
31-05-2022	Harvest of grass. Yield 26.7 hkg/ha - 100% DM
02-06-2022	Fertilisation 63.0 N, 12.0 P, 30.0 K, kg/ha
04-07-2022	BBCH stage 53
04-07-2022	Biomass 246.3 g/m^2 - 100% DM
04-07-2022	Harvest of grass. Yield 24.1 hkg/ha - 100% DM
06-07-2022	Fertilisation 63.0 N, 12.0 P, 30.0 K, kg/ha
19-07-2022	BBCH stage 30
19-07-2022	Harmony 50 SX (thifensulfuron-methyl) - weeds - 37.5 g/ha (18.75 g thifensulfuron-methyl, a.i./ha) - monitored
22-08-2022	BBCH stage 53
22-08-2022	Biomass 291.3 g/m^2 - 100% DM
22-08-2022	Harvest of grass. Yield 25.0 hkg/ha - 100% DM
04-04-2023	Fertilisation 63.0 N, 9.0 P, 30.0 K, kg/ha
30-05-2023	BBCH stage 55
30-05-2023	Biomass 269.9 g/m^2 - 100% DM
30-05-2023	Harvest of grass. Yield 21.5 hkg/ha - 100% DM
06-06-2023	Fertilisation 63.0 N, 9.0 P, 30.0 K, kg/ha
24-07-2023	BBCH stage 56
24-07-2023	Biomass 357.0 g/m2 - 100% DM
24-07-2023	Harvest of grass. Yield 21.0 hkg/ha, 100% DM
02-08-2023	BBCH stage 20
02-08-2023	Roundup Power Max (glyphosate) - weeds - 2.0 kg/ha (i.e. 1440 g a.i./ha glyphosate) - not monitored
16-08-2023	Sowing winter rapeseed cv. DK Exsteel. Sowing depth 2 cm, seeding rate 2 kg/ha, row distance 25 cm
16-08-2023	Integral Pro (Bacillus amyloliquefaciens MBI 600) - seed dressing
17-08-2023	BBCH stage 00
17-08-2023	Stomp CS (pendimethalin) - weeds - 0.44 L/ha (i.e. 200.2 g a.i./ha pendimethalin) - monitored

Table A3.5. Management practice at Faardrup during the 2017 to 2023 growing seasons. The active ingredients of the various pesticide products are indicated in parentheses.

Date	Management practice and growth stages – **Faardrup**
07-04-2017	Fertilisation 132 N, 17 P, 61 K, kg/ha
02-05-2017	Rotor harrowed at the time of sowing the spring barley, cv. Quench, depth 4 cm, seeding rate 180 kg/ha, row distance 13.0 cm, final plant number 365 /m^2. Seed coated with Fungazil A (imazalil) - not monitored
10-05-2017	BBCH stage 09 - emergence
11-05-2017	BBCH stage 10-11
18-05-2017	BBCH stage 12-13
02-06-2017	BBCH stage 22
02-06-2017	Hussar Plus OD (iodosulfuron-methyl-Na + mesosulfuron -methyl) - weeds - 0.035 L/ha (1.75 g iodosulfuron-methyl-Na + 0.27 g mesosulfuron-methyl, a.i./ha) - not monitored
14-06-2017	BBCH stage 43
19-06-2017	BBCH stage 45
19-06-2017	Biomass 115.8 g/m^2 - 100% DM
19-06-2017	Bumper 25 EC (propiconazole) - fungi - 0.5 L/ha (125 g propiconazole, a.i./ha)
19-06-2017	Zypar (halauxifen-methyl + florasulam) - weeds - 0.5 L/ha (3.125 g halauxifen-methyl + 2.5 g florasulam, a.i./ha)
07-07-2017	BBCH stage 65
07-07-2017	Bumper 25 EC (propiconazole) - fungi - 0.5 L/ha (125 g propiconazole, a.i./ha)
15-08-2017	BBCH stage 85
15-08-2017	Biomass 317.2 g/m^2 - 100% DM
22-08-2017	Harvest of spring barley. Grain yield 62.3 hkg/ha - fresh weight. Straw yield 35.5 hkg/ha - fresh weight, stubble height 9 cm
20-10-2017	Glyphomax (glyphosate) - weeds - 2.5 L/ha (900 g glyphosate, a.i./ha) - not monitored
03-12-2017	Ploughing - depth 22 cm
20-04-2018	Seedbed preparation, depth 10 cm
20-04-2018	Sowing sugar beet, cv. SMART JANNINKA KWS, depth 2.0 cm, row distance 50 cm, plant distance 25 cm, seeding rate 100.000 seeds/ha, seedbed uneven, final plant number 9 /m^2
20-04-2018	Seed dressing Gaucho WS70 (60 g imidacloprid, a.i./ha) + Tachigaren WP (14-18 g hymexazole, a.i./ha) - not monitored
20-04-2018	Fertilisation 140 N, 24.5 P, 65.3 K, kg/ha, done together with sowing
07-05-2018	BBCH stage 09 – emergence
18-05-2018	BBCH stage 11
22-05-2018	BBCH stage 11
25-05-2018	BBCH stage 12
29-05-2018	BBCH stage 12
29-05-2018	Betanal (phenmedipham) - weeds - 2.0 L/ha (320 g phenmedipham, a.i./ha) - not monitored Goltix (metamitron) - weeds - 1.0 L/ha (700 g metamitron, a.i./ha) Conviso One (foramsulfuron + thiencarbazone-methyl) – weeds - 0.16 L/ha (4.8 g foramsulfuron + 8.0 g thiencarbazone-methyl, a.i./ha) Nortron SC (ethofumesat) – weeds - 0.07 L/ha (35 g ethofumesat, a.i./ha) - not monitored
08-06-2018	BBCH stage 15
08-06-2018	Mechanical weeding between rows, depth 3 cm
12-06-2018	BBCH stage 15
12-06-2018	Betanal (phenmedipham) – weeds - 2.0 L/ha (320 g phenmedipham, a.i./ha) - not monitored Goltix (metamitron) - weeds - 1.0 L/ha (700 g metamitron, a.i./ha) Nortron SC (ethofumesat) - weeds - 0.07 L/ha (35 g ethofumesat, a.i./ha) - not monitored
27-06-2018	BBCH stage 15
27-06-2018	Betanal (phenmedipham) - weeds - 2.0 L/ha (320 g phenmedipham, a.i./ha) - not monitored Goltix (metamitron) - weeds - 1.0 L/ha (700 g metamitron, a.i./ha) Nortron SC (ethofumesat) - weeds - 0.07 L/ha (35 g ethofumesat, a.i./ha) - not monitored Karate 2.5 WG (lambda-cyhalothrin) - pests - 0.2 kg/ha (10 g lambda-cyhalothrin, a.i./ha) - not monitored
01-07-2018	BBCH stage 15
09-07-2018	BBCH stage 19
09-07-2018	Biomass 1248.1 g/m^2 – sugar beet top only - 100% DM

Date	Management practice and growth stages – **Faardrup**
28-09-2018	BBCH stage 49
28-09-2018	Harvest of sugar beets. Root yield 79.8 hkg/ha - 100% DM. Top yield 32.0 hkg/ha - 100% DM
18-12-2018	Ploughing, depth 22 cm
05-04-2019	Seedbed preparation, depth 3 cm
08-04-2019	Sowing spring barley, cv. IKWS Irina, depth 3 cm, seeding rate 170 kg/ha, row distance 12.5 cm, final plant number 365 /m^2
08-04-2019	Redigo Pro 170 FS (12.75 g prothioconazole + 1.70 g tebuconazole, a.i./ha) - seed dressing
09-04-2019	Fertilisation 113. 3 N, 19.8 P, 52.8 K, kg/ha
11-04-2019	Rolled with a ring roller
15-04-2019	BBCH stage 09 - emergence
23-04-2019	BBCH stage 10
26-04-2019	BBCH stage 12
26-04-2019	DFF (diflufenican) - weeds - 0.15 L/ha (75 g diflufenican, a.i./ha) - not monitored
29-04-2019	BBCH stage 20
15-05-2019	BBCH stage 20
15-05-2019	Biomass 50.1 g/m^2 - 100% DM
03-06-2019	BBCH stage 32
03-06-2019	Talius (proquinazid) - fungi - 0.125 L/ha (25 g proquinazid, a.i./ha)
17-06-2019	BBCH stage 45
17-06-2019	Talius (proquinazid) - fungi - 0.125 L/ha (25 g proquinazid, a.i./ha)
01-07-2019	BBCH stage 51
01-07-2019	Biomass 341.9 g/m^2 - 100% DM
18-07-2019	BBCH stage 75
18-07-2019	Biomass 1188.9 g/m^2 - 100% DM
12-08-2019	BBCH stage 89
12-08-2019	Harvest of spring barley. Grain yield 82.0 hkg/ha - 85% DM. Straw yield 35.5 hkg/ha – fresh weight (DM not measured), stubble height 13 cm
15-11-2019	Ploughing, depth 24 cm
20-03-2020	Seedbed preparation, depth 4.0 cm
26-03-2020	Sowing spring wheat, cv. Cornette, depth 4 cm, seeding rate 200 kg/ha, row distance 12.0 cm, final plant number 364 /m^2. Seeds coated with Celest Formula M (fludioxonile)
02-04-2020	Fertilisation 134.0 N, 26.0 P, 65.0 K, kg/ha
06-04-2020	BBCH stage 09 - emergence
15-04-2020	BBCH stage 10-12
16-04-2020	Rolled with a ring roller
04-05-2020	BBCH stage 20
12-05-2020	BBCH stage 20
12-05-2020	Biomass 72.7 g/m^2 - 100% DM
20-05-2020	BBCH stage 30
20-05-2020	Buctril EC 225 (bromoxynil) - weeds – 0.4 L/ha (90 g bromoxynil, a.i./ha) - not monitored
12-06-2020	BBCH stage 51
13-08-2020	BBCH stage 83
14-08-2020	Harvest of spring wheat. Grain yield 56.5 hkg/ha - 85% DM. Straw yield 43.1 hkg/ha - 100% DM, stubble height 10 cm. Straw shredded at harvest
14-08-2020	Ploughing, depth 23 cm
29-08-2020	Sowing winter rapeseed, cv. V3160L c, depth 2 cm, seeding rate 2 kg/ha, row distance 13 cm
29-08-2020	Integral Pro (Bacillus amyloliquefaciens MBI 600) - seed dressing
01-09-2020	BBCH stage 0
01-09-2020	Kalif 360 CS (clomazon) - weeds - 0.25 L/ha (90 g clomazon, a.i./ha) - not monitored
03-09-2020	BBCH stage 09 - emergence
25-11-2020	BBCH stage 15
25-11-2020	Kerb 400 SC (propyzamid) - weeds - 1.25 L/ha (500 g propyzamide, a.i./ha) - monitored
09-03-2021	BBCH stage 19
09-03-2021	Fertilisation 123.6 N, 21.6 P, 60.0 K, kg/ha
07-04-2021	BBCH stage 19

Date	Management practice and growth stages – **Faardrup**
07-04-2021	Biomass 104.5 g/m^2 - 100% DM
13-04-2021	Fertilisation 97.9 N, 3.5 P, 47.5 K, kg/ha
28-04-2021	BBCH stage 33
28-04-2021	Biomass 245.4 g/m^2 - 100% DM
11-05-2021	BBCH stage 55
12-05-2021	Biomass 440.3 g/m^2 - 100% DM
26-05-2021	BBCH stage 69
26-05-2021	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 1 L/ha (125 g prothioconazole + 125 g fluopyram, a.i./ha) - monitored
11-08-2021	Harvest of rapeseed. Seed yield 29.6 hkg/ha - fresh weight. Stubble height 20 cm, straw shredded at harvest
28-09-2021	Glyphomax HL (glyphosate) - weeds - 2.25 L/ha (1080 g glyphosate, a.i./ha) - not monitored
07-10-2021	Ploughing, depth 24 cm
08-10-2021	Sowing winter wheat, cv. Rembrandt, sowing depth 3 cm, seeding rate 200 kg/ha, row distance 12 cm, final plant number 320 /m^2
08-10-2021	Redigo Pro 170 FS (prothioconazole + tebuconazole) - 100 mL/ha (15 g prothioconazole + 2 g tebuconazole, a.i./ha) - seed dressing
22-10-2021	BBCH stage 09 - emergence
26-10-2021	BBCH stage 10
24-01-2022	BBCH stage 15
09-03-2022	BBCH stage 15-20
09-03-2022	Fertilisation 98.7 N, 18.8 P, 47.0 K, kg/ha
22-03-2022	BBCH stage 23
22-03-2022	Biomass 27.3 g/m^2 - 100% DM
06-04-2022	BBCH stage 28
21-04-2022	Express Gold 33 SX (tribenuron-methyl + metsulfuron-methyl) - weeds - 18 g/ha (4 g tribenuron-methyl + 2 g metsulfuron-methyl, a.i./ha) - monitored
27-04-2022	BBCH stage 30
27-04-2022	Fertilisation 57.8 N, 11.0 P, 27.5 K, kg/ha
02-05-2022	BBCH stage 31
04-05-2022	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 0.5 L/ha (62.5 g prothioxonazole + 62.5 g fluopyram, a.i./ha) - monitored
18-05-2022	BBCH stage 37
23-05-2022	BBCH stage 41
30-05-2022	BBCH stage 51
30-05-2022	Biomass 967.6 g/m^2 - 100% DM
30-05-2022	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 0.5 L/ha (62.5 g prothioxonazole + 62.5 g fluopyram, a.i./ha) – monitored
14-06-2022	BBCH stage 66
23-06-2022	BBCH stage 71
30-06-2022	BBCH stage 75
30-06-2022	Biomass 1927.9 g/m^2 - 100% DM
11-08-2022	Harvest of winter wheat. Grain yield 108.6 hkg/ha - fresh weight. Straw yield 70.2 hkg/ha - fresh weight, stubble height 12 cm. Straw shredded at harvest and left in the field
05-09-2022	Ploughing, depth 24 cm
05-09-2022	Rotor harrowed at the time of sowing winter wheat, cv. Heerup, seeding rate 133.5 kg/ha, sowing depth 3.5 cm, row distance 12 cm, final plant number 217 /m^2
05-09-2022	Redigo FS 100 (prothioconazole) - 106.8 mL/ha (10.68 g prothioconazole, a.i./ha) - seed dressing
19-09-2022	BBCH stage 09 - emergence
19-09-2022	DFF (diflufenican) - weeds - 0.12 L/ha (60 g diflufenican, a.i./ha) - not monitored
17-10-2022	BBCH stage 24
17-10-2022	Biomass 30.2 g/m^2 - 100% DM
27-10-2022	Mavrik (tau-fluvalinat) - pests - 0.15 L/ha (36 g tau-fluvalinat, a.i./ha) - not monitored
28-03-2023	BBCH stage 27
28-03-2023	Fertilisation 73.5 N, 10.5 P, 35.0 K, kg/ha
05-04-2023	BBCH stage 27

Date	Management practice and growth stages – **Faardrup**
18-04-2023	BBCH stage 30
18-04-2023	Express Gold 33 SX (tribenuron-methyl + metsulfuron-methyl) - weeds - 18 g/ha (4 g tribenuron-methyl + 2 g metsulfuron-methyl, a.i./ha) - monitored
19-04-2023	BBCH stage 30
19-04-2023	Fertilisation 115.5 N, 16.5 P, 55.0 K, kg/ha
24-04-2023	BBCH stage 31
04-05-2023	BBCH stage 33
04-05-2023	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 0.5 L/ha (62.5 g prothioxonazole + 62.5 g fluopyram, a.i./ha) - monitored
17-05-2023	BBCH stage 37
30-05-2023	BBCH stage 53
30-05-2023	Biomass 1310.8 g/m^2 - 100% DM
30-05-2023	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 0.5 L/ha (62.5 g prothioxonazole + 62.5 g fluopyram, a.i./ha) - monitored
07-06-2023	BBCH stage 65
20-06-2023	BBCH stage 71
29-06-2023	BBCH stage 75
29-06-2023	Biomass 2133.3 g/m^2 - 100% DM

Table A3.6. Management practice at Lund during the 2018 to 2023 growing seasons. The active ingredients of the various pesticide products are indicated in parentheses.

Date	Management practice and growth stages – **Lund**
19-10-2017	Glyphomax HL (glyphosate) - weeds - 3.2 L/ha (1536 g glyphosate, a.i./ha) (killing of the clover grass)
31-10-2017	Tracer (potassium bromide), 30 kg/ha
04-01-2018	Ploughing, 25 cm depth
12-04-2018	Seedbed preparation, 3 cm depth
19-04-2018	Pig slurry application - trail hose applied and subsequent harrowed - 50 ton/ha - 131.5 Total-N, 113.5 NH_4-N, 3.0 P, 72.5 K, 1.5 Mg and 0.1 Cu, kg/ha
20-04-2018	Sowing spring barley, cv. Quench, depth 3.5 cm, seeding rate 170 kg/ha, row distance 12 cm, final plant number 325 /m^2
20-04-2018	Seed dressing Redigo Pro 170 FS (12.75 g prothioconazole + 1.70 g tebuconazole, a.i./ha)
01-05-2018	BBCH stage 09 - emergence
30-05-2018	BBCH stage 20
30-05-2018	BBCH stage 31
30-05-2018	Proline 250 EC (prothioconazole) - fungi - 0.8 L/ha (200 g prothioconazole, a.i./ha)
30-05-2018	Zypar (halauxifen-methyl + florasulam) - weeds - 1.0 L/ha (6.25 g halauxifen-methyl + 5.0 g florasulam, a.i./ha)
12-06-2018	BBCH stage 42
12-06-2018	Proline 250 EC (prothioconazole) - fungi - 0.8 L/ha (200 g prothioconazole, a.i./ha)
06-08-2018	BBCH stage 89
06-08-2018	Harvest of spring barley. Grain yield 55.5 hkg/ha, total-N 1.87% and total-C 43.83% - 85 % DM. Straw yield 22.35 hkg/ha, total-N 0.69% and total-C 43.78% - 100% DM, stubble height 10 cm
18-09-2018	Ploughing, 25 cm depth
19-09-2018	Seedbed preparation, 5 cm depth
19-09-2018	Sowing winter barley, cv. Menento, depth 3.0 cm, seeding rate 160 kg/ha, row distance 12.5 cm, final plant number 300 /m^2
19-09-2018	Redigo Pro 170 FS (12.00 g prothioconazole + 1.60 g tebuconazole, a.i./ha) - seed dressing
19-09-2018	Rolled with a ring roller
28-09-2018	BBCH stage 09 – emergence
15-10-2018	BBCH stage 12
08-11-2018	BBCH stage 20
08-11-2018	DFF and Boxer (diflufenican + prosulfocarb) - weeds - 0.15 L/ha + 1.0 L/ha (75 g diflufenican + 800 g prosulfocarb, a.i./ha) - not monitored
05-04-2019	BBCH stage 20-23
05-04-2019	Biomass 168.0 g/m^2 - 100% DM
25-04-2019	BBCH stage 30
30-04-2019	BBCH stage 32
02-05-2019	BBCH stage 32
02-05-2019	Fertilisation 150 N 26,3 P 70 K, kg/ha
04-05-2019	BBCH stage 49
09-05-2019	BBCH stage 49
09-05-2019	Flurostar 180 (fluroxypyr) - weeds - 0.8 L/ha (144 g fluroxypyr, a.i./ha) - not monitored
11-05-2019	BBCH stage 49
11-05-2019	Zypar (halauxifen-methyl + florasulam) - weeds - 1.0 L/ha (6.25 g halauxifen-methyl + 5.0 g florasulam, a.i./ha)
13-05-2019	BBCH stage 50
13-05-2019	Biomass 247.6 g/m^2 - 100% DM
27-05-2019	BBCH stage 51
03-07-2019	BBCH stage 71
03-07-2019	Biomass 297.2 g/m^2 - 100% DM
12-07-2019	BBCH stage 89
13-07-2019	Harvest of winter barley. Grain yield 66.4 hkg/ha - 100% DM. Straw yield 35.9 hkg/ha – fresh weight (DM not determined), stubble height 15 cm
25-08-2019	Rotor harrow, sowing tillage, depth 6 cm

Date	Management practice and growth stages – **Lund**
25-08-2019	Direct drilling with deep loosening. Sowing winter rapeseed, cv. InVigor 1030, depth 2.0 cm, row distance 15 cm, seeding rate 2.5 kg/ha, final plant number 25 /m^2. Seed dressing - Bacillus amyloliquefaciens MBI 600
28-08-2019	Glyphomax HL (glyphosate) + Clomate (clomazone) - weeds - 0.5 L/ha + 0.25 L/ha (240 g glyphosate + 90 g clomazone, a.i./ha) - not monitored
30-08-2019	BBCH stage 09 - emergence
05-09-2019	Fertilisation 19.2 N, 7.4 P, kg/ha
17-12-2019	BBCH stage 13
17-12-2019	Kerb 400 SC (propyzamide) - weeds - 1.25 L/ha (500 g propyzamide, a.i./ha)
17-12-2019	Belkar (picloram + halauxifen-methyl) - weeds - 0.5 L/ha - (24 g picloram + 5 g halauxifen-methyl, a.i./ha)
20-03-2020	BBCH stage 17
23-03-2020	Fertilisation 97.9 N, 19.0 P, 47.5 K, kg/ha
24-04-2020	Fertilisation 80.3 N, 15.6 P, 39.0 K, kg/ha
07-05-2020	BBCH stage 50
01-08-2020	Harvest winter rapeseed. Seed yield 49.2 hkg/ha - fresh weight. Straw yield not measured, stubble height 45 cm. Straw shredded at harvest
03-09-2020	Seedbed preparation, depth 3.5 cm
18-09-2020	Ploughing
18-09-2020	Seedbed preparation
20-09-2020	Sowing winter wheat, cv. Sheriff, depth 4.0 cm, row distance 13 cm, seeding rate 190 kg/ha
20-09-2020	Redigo Pro 170 FS (prothioconazole + tebuconazole) - 95 mL/ha (14.3 g prothioconazole + 1.9 g tebuconazole, a.i./ha) - seed dressing
29-09-2020	BBCH stage 09 - emergence
06-11-2020	BBCH stage 19
06-11-2020	Buctril EC 225 (bromoxynil) - weeds - 0.42 L/ha (94.5 g bromoxynil, a.i./ha) - not monitored
01-04-2021	Fertilisation 151.0 N, 29.0 P, 72.0 K, kg/ha
21-04-2021	BBCH stage 22
21-04-2021	Biomass 41.4 g/m^2 - 100% DM
09-06-2021	BBCH stage 59
09-06-2021	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 1 L/ha (125 g prothioconazole + 125 g fluopyram, a.i./ha) - monitored
17-06-2021	BBCH stage 65
17-06-2021	Biomass 1371.0 g/m^2 - 100% DM
09-08-2021	BBCH stage 89
09-08-2021	Biomass 1933.5 g/m^2 - 100% DM
19-08-2021, 21-08-2021	Harvest winter wheat. Grain yield 92.0 hkg/ha - 85% DM. Straw yield 50.8 hkg/ha - fresh weight, stubble height 15 cm
14-02-2022	Ploughing, 25 cm depth
18-03-2022	Stubble cultivation, 5 cm depth
20-03-2022	Fertilisation 126.0 N, 18.0 P, 60.0 K, kg/ha
22-03-2022	Stubble cultivation, 5 cm depth
23-03-2022	Sowing spring barley, cv. Laureate, depth 3.5 cm, row distance 13 cm, seeding rate 180 kg/ha
23-03-2022	Redigo Pro 170 FS (prothioconazole + tebuconazole) - 90 mL/ha (13.5 g prothioconazole + 1.8 g tebuconazole, a.i./ha) - seed dressing
25-03-2022	Rolled with a ring roller
13-04-2022	BBCH stage 09 - emergence
27-04-2022	BBCH stage 13
10-05-2022	BBCH stage 24
10-05-2022	Biomass 53.2 g/m^2 - 100% DM
10-05-2022	Nuance Max 75 WG (tribenuron-methyl) - weeds - 10 g/ha (7.5 g tribenuron-methyl, a.i./ha) - monitored
24-05-2022	BBCH stage 37
31-05-2022	BBCH stage 48
31-05-2022	Biomass 410.8 g/m^2 - 100% DM
31-05-2022	Propulse SE 250 (prothioconazole + fluopyram) - fungi - 1 L/ha (125 g prothioconazole + 125 g fluopyram, a.i./ha) - monitored
23-06-2022	BBCH stage 71

Date	Management practice and growth stages – **Lund**
04-07-2022	BBCH stage 73
04-07-2022	Biomass 1486.1 g/m^2 - 100% DM
10-08-2022	Harvest spring barley. Grain yield 88.5 hkg/ha - fresh weight. Straw yield 39.5 hkg/ha - fresh weight, stubble height 12 cm
25-08-2022	Glyphomax HL (glyphosate) - weeds - 2.25 L/ha (1080 g glyphosate, a.i./ha) - not monitored
06-09-2022	Sowing winter wheat, cv. Heerup, seeding rate 164.0 kg/ha, sowing depth 2.5 cm, row distance 13 cm, final plant number 276 /m^2
06-09-2022	Redigo FS 100 (prothioconazole) - 131.2 mL/ha (13.12 g prothioconazole, a.i./ha) - seed dressing
12-09-2022	BBCH stage 09 - emergence
20-09-2022	BBCH stage 12
20-09-2022	DFF (diflufenican) - weeds - 0.12 L/ha (60 g diflufenican, a.i./ha) - not monitored
13-10-2022	BBCH stage 24
13-10-2022	Biomass 36.9 g/m^2 - 100% DM
19-10-2022	BBCH stage 24
19-10-2022	Mavrik (tau-fluvalinat) - pests - 0.15 L/ha (36 g tau-fluvalinat, a.i./ha) - not monitored
24-01-2023	Tracer (potassium bromide), 30 kg/ha
28-03-2023	BBCH stage 27
28-03-2023	Fertilisation 97.2 N, 18.0 P, kg/ha
03-04-2023	BBCH stage 27
22-04-2023	BBCH stage 31
22-04-2023	Broadway (florasulam + pyroxsulam + cloquintocet-mexyl) - weeds - 165 g/ha (3.76 g florasulam + 11.27 g pyroxsulam + 11.27 g cloquintocet-mexyl, a.i./ha) - not monitored
24-04-2023	BBCH stage 31
17-05-2023	BBCH stage 37
30-05-2023	BBCH stage 53
30-05-2023	Biomass 1062.0 g/m^2 - 100% DM
02-06-2023	BBCH stage 61
02-06-2023	Proline EC 250 (prothioconazole) - fungi - 0.8 L/ha (200 g prothioconazole, a.i./ha) - not monitored
07-06-2023	BBCH stage 65
29-06-2023	BBCH stage 75
29-06-2023	Biomass 1783.0 g/m^2 - 100% DM

9.4. Appendix 4 – Precipitation at the PLAP fields

Annual precipitation

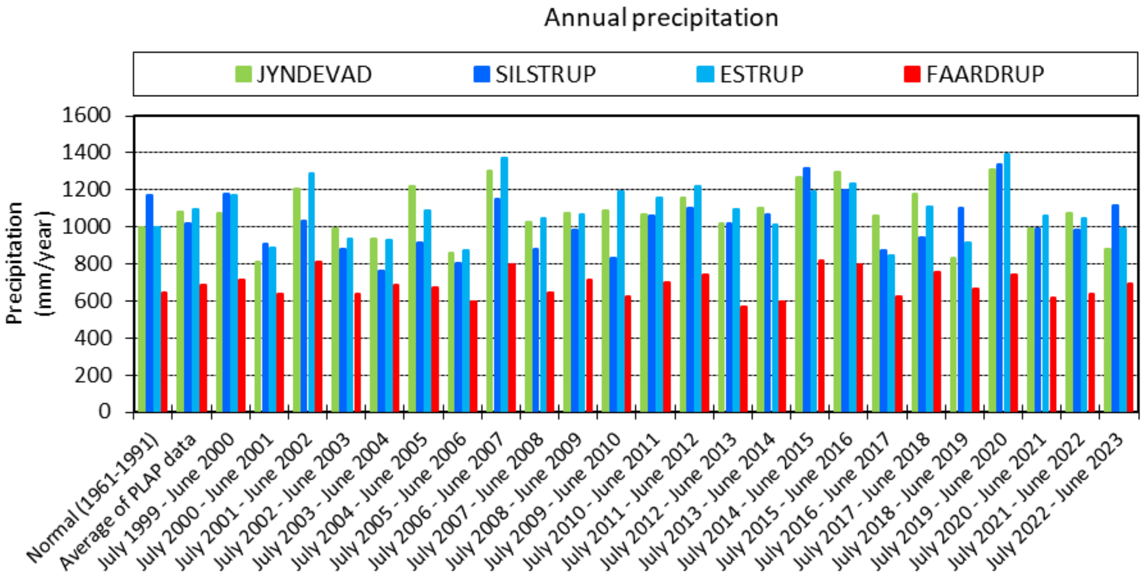


Figure A4.1. Annual precipitation at the active PLAP fields during the period July 1999 – June 2023. The location of the PLAP fields have been chosen so that they represent both areas of high and low annual precipitation.

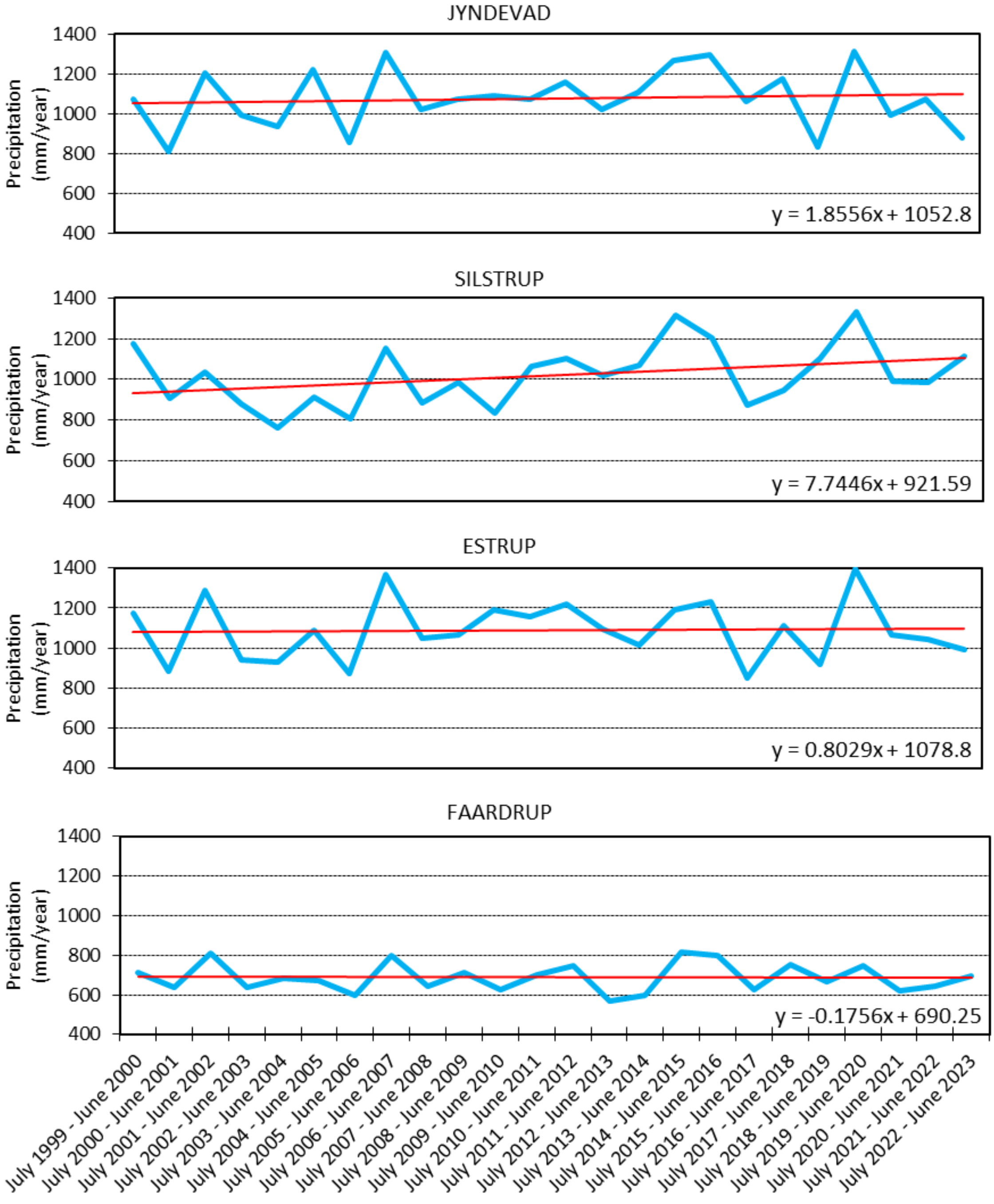


Figure A4.2. Annual precipitation development at the four active fields in PLAP. The red line denotes a linear regression of the measured annual precipitation values.

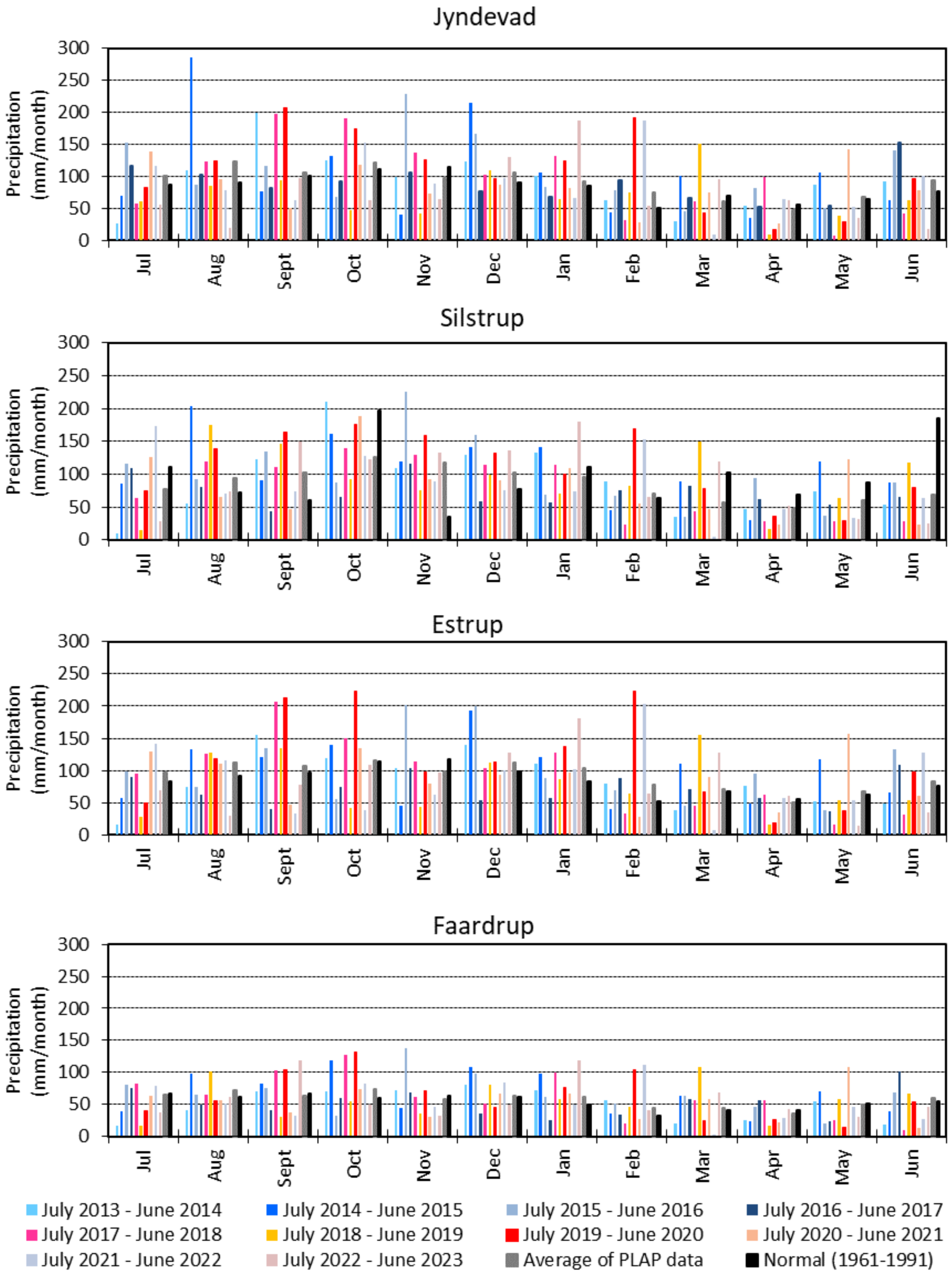


Figure A4.3. Monthly precipitation at the active PLAP fields for each reporting period since July 2013. "Average of PLAP data" is the average of all precipitation data recorded in PLAP, i.e. from 1999-2023. Regional normal values for 1960-1991 are included for comparison (Olesen, 1991).

9.5. Appendix 5 – Pesticide detections in samples from drains, suction cups and groundwater screens

Table A5.1. Number of samples from Tylstrup where pesticides were either not detected (nd), detected in concentrations ≤0.1 µg/L or detected in concentrations >0.1 µg/L, and total number of samples (T). Numbers are accumulated for the period up to 1 July 2023.

Tylstrup		Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
Aclonifen	Aclonifen	4	0	0	4	123	0	0	123	68	0	0	68
Aminopyralid	Aminopyralid	27	0	0	27	183	2	0	185	91	0	0	91
Azoxystrobin	Azoxystrobin					216	0	0	216	95	0	0	95
	CyPM					216	0	0	216	95	0	0	95
Bentazone	Bentazone	24	0	0	24	485	0	0	485	198	4	0	202
	2-amino-N-isopropyl-benzamide					191	0	0	191	72	0	0	72
	6-hydroxy-bentazone	24	0	0	24	155	0	0	155	65	0	0	65
	8-hydroxy-bentazone	24	0	0	24	155	0	0	155	65	0	0	65
	N-methyl-bentazone	24	0	0	24	155	0	0	155	65	0	0	65
Bifenox	Bifenox	8	0	0	8	41	0	0	41	22	0	0	22
	Bifenox acid	8	0	0	8	41	0	0	41	22	0	0	22
	Nitrofen	8	0	0	8	41	0	0	41	22	0	0	22
Boscalid	Boscalid	9	0	0	9	102	0	0	102	56	0	0	56
Bromoxynil	Bromoxynil					192	0	0	192	72	0	0	72
Clomazone	Clomazone					224	0	0	224	82	0	0	82
	FMC 65317					208	0	0	208	74	0	0	74
Clopyralid	Clopyralid					132	0	0	132	102	1	1	104
Cyazofamid	Cyazofamid	4	0	0	4	123	0	0	123	68	0	0	68
Dimethoate	Dimethoate					176	0	0	176	63	0	0	63
Epoxiconazole	Epoxiconazole					199	0	0	199	74	0	0	74
Fenpropimorph	Fenpropimorph					307	0	0	307	89	0	0	89
	Fenpropimorph acid					276	0	0	276	73	0	0	73
Flamprop-M-isopropyl	Flamprop-M-isopropyl					176	0	0	176	63	0	0	63
	Flamprop					176	0	0	176	63	0	0	63
Fluazifop-P-butyl	Fluazifop-P					178	0	0	178	63	0	0	63
	TFMP					3	0	0	3				
Fludioxonil	CGA 192155	22	0	0	22	160	0	0	160	65	0	0	65
	CGA 339833	22	0	0	22	160	0	0	160	65	0	0	65
Fluroxypyr	Fluroxypyr					194	0	0	194	68	0	0	68
Ioxynil	Ioxynil					198	0	0	198	72	0	0	72
Linuron	Linuron					270	0	0	270	67	0	0	67
Mancozeb	EBIS	8	0	0	8	70	0	0	70	27	0	0	27
	ETU					198	2	0	200	37	7	0	44
Mesosulfuron-methyl	AE-F099095	16	0	0	16	128	0	0	128	54	0	0	54
	AE-F160459	16	0	0	16	128	0	0	128	54	0	0	54
Metalaxyl-M	metalaxyl-M	28	0	0	28	303	21	0	324	152	4	0	156
	CGA 108906	3	25	0	28	61	216	47	324	25	93	35	153
	CGA 62826	27	1	0	28	308	16	0	324	119	30	5	154

Tylstrup		Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
Metribuzin	Metribuzin					386	1	0	387	89	2	0	91
	Desamino-diketo-metribuzin					289	231	5	525	166	30	51	247
	Desamino-metribuzin					365	0	0	365	85	0	0	85
	Diketo-metribuzin					59	138	315	512	65	192	61	318
Pendimethalin	Pendimethalin					430	0	0	430	144	0	0	144
Pirimicarb	Pirimicarb					295	0	0	295	82	0	0	82
	Pirimicarb-desmethyl					295	0	0	295	81	0	0	81
	Pirimicarb-desmethyl-formamido					167	0	0	167	52	0	0	52
Propiconazole	Propiconazole					307	0	0	307	89	0	0	89
Propyzamide	Propyzamide					221	0	0	221	82	0	0	82
	RH-24580					221	0	0	221	82	0	0	82
	RH-24644					221	0	0	221	82	0	0	82
	RH-24655					157	0	0	157	58	0	0	58
Prosulfocarb	Prosulfocarb	20	0	0	20	144	4	0	148	73	1	0	74
Rimsulfuron	Rimsulfuron					178	0	0	178	65	0	0	65
	PPU	9	0	0	9	589	58	0	647	74	191	3	268
	PPU-desamino	9	0	0	9	638	9	0	647	205	63	0	268
Tebuconazole	Tebuconazole					195	1	0	196	77	0	0	77
	1,2,4-triazol	6	30	0	36	148	81	0	229	78	18	2	98
Terbuthylazine	Terbuthylazine					179	0	0	179	72	0	0	72
	2-hydroxy-desethyl-terbuthylazine					190	1	0	191	67	5	0	72
	Desethyl-terbuthylazine					191	0	0	191	70	2	0	72
	Desisopropylatrazine					190	1	0	191	55	17	0	72
	Hydroxy-terbuthylazine					191	0	0	191	71	1	0	72
Thiamethoxam	Thiamethoxam					175	0	0	175	64	0	0	64
	CGA 322704					175	0	0	175	64	0	0	64
Triasulfuron	Triasulfuron					295	0	0	295	82	0	0	82
	Triazinamin					285	0	0	285	75	0	0	75
Tribenuron-methyl	Triazinamin-methyl					440	0	0	440	137	0	0	137

Table A5.2. Number of samples from Jyndevad where pesticides were either not detected (nd), detected in concentrations ≤0.1 µg/L, or detected in concentrations >0.1 µg/L, and total number of samples (T). Numbers are accumulated for the period up to 1 July 2023.

Jyndevad		Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
Acetamiprid	IM-1-4	17	0	0	17	215	0	0	215	60	0	0	60
	IM-1-5	17	0	0	17	215	0	0	215	60	0	0	60
Aclonifen	Aclonifen	9	0	0	9	162	0	0	162	43	0	0	43
Amidosulfuron	Amidosulfuron					88	0	0	88	20	2	1	23
	desmethyl-amidosulfuron					88	0	0	88	23	0	0	23
Azoxystrobin	Azoxystrobin					233	0	0	233	65	0	0	65
	CyPM					233	0	0	233	65	0	0	65
Bentazone	Bentazone	50	2	0	52	849	1	0	850	121	92	17	230
	2-amino-N-isopropyl-benzamide					178	0	0	178	45	2	0	47
	6-hydroxy-bentazone	22	0	0	22	207	0	0	207	43	0	0	43
	8-hydroxy-bentazone	22	0	0	22	207	0	0	207	43	0	0	43
	N-methyl-bentazone	22	0	0	22	207	0	0	207	43	0	0	43
Bifenox	Bifenox	4	0	0	4	216	2	0	218	54	2	0	56
	Bifenox acid	4	0	0	4	166	0	0	166	52	1	0	53
	Nitrofen	4	0	0	4	218	0	0	218	56	0	0	56
Bromoxynil	Bromoxynil					218	0	0	218	61	0	0	61
Chlormequat	Chlormequat					14	0	0	14	28	0	0	28
Clomazone	Clomazone	13	0	0	13	91	0	0	91	23	0	0	23
	FMC 65317	13	0	0	13	92	0	0	92	23	0	0	23
Cyazofamid	Cyazofamid	4	0	0	4	131	0	0	131	32	0	0	32
	CCIM	17	0	0	17	270	0	0	270	68	0	0	68
	CTCA	17	0	0	17	270	0	0	270	68	0	0	68
	DMSA	13	1	3	17	190	61	68	319	67	5	6	78
	N,N-DMS	3	7	7	17	152	93	74	319	32	33	13	78
Cycloxydim	BH 517-T2SO2	12	0	0	12	195	0	0	195	39	0	0	39
	EZ-BH 517-TSO	10	2	0	12	188	0	0	188	28	8	3	39
Diflufenican	Diflufenican	12	0	0	12	140	0	0	140	38	0	0	38
	AE-0542291	12	0	0	12	140	0	0	140	38	0	0	38
	AE-B107137	12	0	0	12	140	0	0	140	52	0	0	52
Dimethoate	Dimethoate					190	0	0	190	52	0	0	52
Epoxiconazole	Epoxiconazole					323	1	0	324	90	0	0	90
Fenpropimorph	Fenpropimorph					253	1	0	254	78	1	0	79
	Fenpropimorph acid					260	0	0	260	79	0	0	79
Florasulam	Florasulam					191	0	0	191	54	0	0	54
	5-OH-florasulam									28	0	0	28
Fluazifop-P-butyl	Fluazifop-P					190	0	0	190	51	0	0	51
	TFMP					3	0	0	3				
Fludioxonil	CGA 192155	28	0	0	28	203	1	0	204	34	0	0	34
	CGA 339833	28	0	0	28	192	0	1	193	34	0	0	34

Jyndevad		Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
Fluopyram	Fluopyram	6	0	0	6	160	0	0	160	34	0	0	34
	Fluopyram-7-hydroxy	6	0	0	6	160	0	0	160	34	0	0	34
Flupyrsulfuron-methyl	Flupyrsulfuron-methyl	28	0	0	28	201	0	0	201	30	0	0	30
	IN-JV460	28	0	0	28	201	0	0	201	30	0	0	30
	IN-KC576	28	0	0	28	201	0	0	201	30	0	0	30
	IN-KF311	8	0	0	8	149	0	0	149	32	0	0	32
	IN-KY374	28	0	0	28	201	0	0	201	26	1	3	30
Fluroxypyr	Fluroxypyr					193	0	0	193	55	0	0	55
Foramsulfuron	AE-F092944	1	0	0	1	6	0	0	6	2	0	0	2
Glyphosate	Glyphosate					223	0	0	223	69	0	0	69
	AMPA					221	2	0	223	68	1	0	69
Ioxynil	Ioxynil					218	0	0	218	61	0	0	61
Lambda-cyhalothrin	Compound Ia					49	0	0	49	10	0	0	10
Mancozeb	EBIS	12	0	0	12	87	0	0	87	10	0	0	10
MCPA	MCPA					210	0	0	210	56	0	0	56
	2-methyl-4-chlorophenol					210	0	0	210	56	0	0	56
Mesosulfuron-methyl	Mesosulfuron-methyl					285	0	0	285	78	0	0	78
	AE-F099095	10	0	0	10	186	0	0	186	43	0	0	43
	AE-F147447	8	2	0	10	186	0	0	186	47	0	0	47
	AE-F160459	10	0	0	10	179	0	0	179	43	0	0	43
	Mesosulfuron					12	0	0	12	45	0	0	45
Mesotrione	Mesotrione	30	0	0	30	207	0	0	207	67	0	0	67
	AMBA	30	0	0	30	207	0	0	207	67	0	0	67
	MNBA	30	0	0	30	207	0	0	207	67	0	0	67
Metalaxyl-M	metalaxyl-M	18	8	5	31	286	57	18	361	84	11	0	95
	CGA 108906	2	23	6	31	113	171	78	362	37	34	34	105
	CGA 62826	2	20	9	31	217	145	0	362	32	53	20	105
Metribuzin	Metribuzin					26	0	0	26	6	0	0	6
	Desamino-diketo-metribuzin					6	7	13	26	6	0	0	6
	Desamino-metribuzin					26	0	0	26	4	0	0	4
	Diketo-metribuzin					0	7	19	26	3	3	0	6
Oxathiapiprolin	IN-E8S72					49	0	0	49	10	0	0	10
Pendimethalin	Pendimethalin					257	0	0	257	71	0	0	71
Picolinafen	Picolinafen					35	0	0	35	35	1	0	36
	CL153815					35	0	0	35	36	0	0	36
Pirimicarb	Pirimicarb					251	0	0	251	69	0	0	69
	Pirimicarb-desmethyl					251	0	0	251	68	1	0	69
	Pirimicarb-desmethyl-formamido					251	0	0	251	69	0	0	69
Propiconazole	Propiconazole					287	0	0	287	87	0	0	87
Proquinazid	IN-MM671	12	0	0	12	175	0	0	175	48	0	0	48
	IN-MM991	12	0	0	12	175	0	0	175	48	0	0	48

Jyndevad		Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
Pyridate	Pyridate					116	0	0	116	39	0	0	39
	PHCP					184	0	0	184	59	0	0	59
Rimsulfuron	Rimsulfuron					189	0	0	189	52	0	0	52
	PPU	0	1	6	7	489	361	6	856	39	130	64	233
	PPU-desamino	0	7	0	7	765	91	0	856	110	117	6	233
Tebuconazole	Tebuconazole					213	1	0	214	58	0	0	58
	1,2,4-triazol	32	39	0	71	317	473	6	796	91	85	9	185
Terbuthylazine	Terbuthylazine					260	0	0	260	79	0	0	79
	Desethyl-terbuthylazine					490	27	0	517	130	20	0	150
Thiophanate-methyl	Carbendazim	12	0	0	12	226	0	0	226	60	0	0	60
Tribenuron-methyl	IN-B5528	6	0	0	6	160	0	0	160	34	0	0	34
	IN-R9805	6	0	0	6	160	0	0	160	34	0	0	34
	M2	6	0	0	6	160	0	0	160	34	0	0	34

Table A5.3. Number of samples from Silstrup where pesticides were either not detected (nd), detected in concentrations ≤0.1 µg/L, or detected in concentrations >0.1 µg/L, and total number of samples (T). Numbers are accumulated for the period up to 1 July 2023.

Silstrup		Drainage				Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
Amitrol	Amitrol	3	0	0	3	7	0	0	7	20	0	0	20				
Azoxystrobin	Azoxystrobin	165	22	1	188	231	3	0	234	405	5	0	410				
	CyPM	72	171	33	276	260	59	7	326	576	77	8	661				
Bentazone	Bentazone	75	40	5	120	133	8	1	142	244	18	2	264				
	2-amino-N-isopropyl-benzamide	65	0	0	65	74	0	0	74	131	0	0	131				
Bifenox	Bifenox	63	3	2	68	62	0	0	62	116	5	0	121				
	Bifenox acid	36	2	18	56	52	4	6	62	103	3	14	120				
	Nitrofen	63	2	3	68	62	0	0	62	121	0	0	121				
Bromoxynil	Bromoxynil	48	0	0	48	66	0	0	66	93	0	0	93				
Chlormequat	Chlormequat	20	1	0	21	36	0	0	36	66	0	0	66				
Clomazone	Clomazone	19	0	0	19	17	0	0	17	32	0	0	32				
	FMC 65317	19	0	0	19	17	0	0	17	32	0	0	32				
Clopyralid	Clopyralid	75	1	3	79	101	0	0	101	184	1	0	185				
Cycloxydim	BH 517-T2SO2	51	0	0	51	45	0	0	45	109	0	0	109				
	EZ-BH 517-TSO	36	14	1	51	30	15	0	45	87	22	0	109				
Desmedipham	Desmedipham	101	0	0	101	107	1	0	108	240	0	0	240	58	0	0	58
	EHPC	68	0	0	68	62	0	0	62	118	0	0	118	20	0	0	20
Diflufenican	Diflufenican	55	10	1	66	83	0	0	83	117	0	1	118				
	AE-0542291	66	0	0	66	83	0	0	83	118	0	0	118				
	AE-B107137	56	4	1	61	82	1	0	83	118	0	0	118				
Dimethoate	Dimethoate	81	0	1	82	73	1	0	74	148	0	0	148	27	0	0	27
Epoxiconazole	Epoxiconazole	36	0	0	36	62	0	0	62	117	0	0	117				
Ethofumesate	Ethofumesate	127	14	1	142	169	2	0	171	355	3	0	358	54	3	2	59
Fenpropimorph	Fenpropimorph	82	0	0	82	74	0	0	74	148	0	0	148	27	0	0	27
	Fenpropimorph acid	81	1	0	82	74	0	0	74	147	0	0	147	27	0	0	27
Flamprop-M-isopropyl	Flamprop-M-isopropyl	70	11	1	82	73	1	0	74	148	0	0	148	27	0	0	27
	Flamprop	73	7	0	80	74	0	0	74	148	0	0	148	26	0	0	26
Florasulam	5-OH-florasulam	51	0	0	51	42	0	0	42	100	0	0	100				
	DFP-ASTCA	51	0	0	51	42	0	0	42	100	0	0	100				
	DFP-TSA	51	0	0	51	42	0	0	42	100	0	0	100				
	TSA	105	1	0	106	91	0	0	91	215	0	0	215				
Fluazifop-P-butyl	Fluazifop-P	115	0	0	115	140	1	0	141	299	0	0	299	56	0	0	56
	TFMP	79	30	23	132	137	23	2	162	211	48	14	273				
Fluopyram	Fluopyram	15	37	8	60	35	7	1	43	152	21	7	180				
	Fluopyram-7-hydroxy	17	17	1	35	20	4	0	24	129	9	2	140				
Flupyrsulfuron-methyl	IN-KF311	69	0	0	69	44	0	0	44	100	0	0	100				
Fluroxypyr	Fluroxypyr	50	0	0	50	74	0	0	74	142	0	0	142				
Foramsulfuron	Foramsulfuron	65	8	2	75	69	3	0	72	141	2	0	143				
	AE-F092944	75	0	0	75	74	0	0	74	146	0	0	146				
	AE-F130619	65	10	0	75	66	6	0	72	140	3	0	143				

Silstrup		Drainage				Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
Glyphosate	Glyphosate	141	86	22	249	236	5	0	241	371	35	0	406	8	0	0	8
	AMPA	47	185	18	250	227	14	0	241	380	26	0	406	8	0	0	8
Halauxifen-methyl	X-757	53	0	0	53	45	0	0	45	105	0	0	105				
Iodosulfuron-methyl	Iodosulfuron-methyl	60	0	0	60	85	0	0	85	165	0	0	165				
	Metsulfuron-methyl	60	0	0	60	85	0	0	85	165	0	0	165				
Ioxynil	Ioxynil	48	0	0	48	66	0	0	66	93	0	0	93				
MCPA	MCPA	51	0	0	51	67	0	0	67	123	0	0	123				
	2-methyl-4-chlorophenol	51	0	0	51	67	0	0	67	124	0	0	124				
Mesosulfuron-methyl	AE-F099095	51	0	0	51	40	0	0	40	91	0	0	91				
	AE-F147447	51	0	0	51	38	0	0	38	86	0	0	86				
	AE-F160459	51	0	0	51	40	0	0	40	91	0	0	91				
Mesotrione	Mesotrione	63	6	7	76	76	0	0	76	147	0	0	147				
	AMBA	76	0	0	76	76	0	0	76	147	0	0	147				
	MNBA	68	8	0	76	76	0	0	76	147	0	0	147				
Metamitron	Metamitron	111	28	3	142	161	10	0	171	339	17	2	358	40	10	8	58
	Desamino-metamitron	97	42	3	142	165	3	3	171	334	23	1	358	40	15	4	59
Pendimethalin	Pendimethalin	91	14	0	105	122	0	0	122	222	0	0	222				
	M455H001	1	0	0	1	2	0	0	2	20	0	0	20				
Phenmedipham	Phenmedipham	101	0	0	101	108	0	0	108	240	0	0	240	59	0	0	59
	3-aminophenol	53	0	0	53	70	0	0	70	170	0	0	170	36	0	0	36
	MHPC	100	0	0	100	106	0	0	106	234	0	0	234	55	0	0	55
Picloram	Picloram	1	0	0	1												
Pirimicarb	Pirimicarb	160	14	0	174	210	0	0	210	433	3	0	436	59	0	0	59
	Pirimicarb-desmethyl	173	1	0	174	210	0	0	210	436	0	0	436	59	0	0	59
	Pirimicarb-desmethyl-formamido	141	0	0	141	160	0	0	160	308	0	0	308	20	0	0	20
Propaquizafop	CGA287422	73	0	0	73	56	0	0	56	137	0	0	137				
	CGA290291	73	0	0	73	56	0	0	56	137	0	0	137				
	CGA294972	73	0	0	73	56	0	0	56	137	0	0	137				
	PPA	74	0	0	74	56	0	0	56	137	0	0	137				
Propiconazole	Propiconazole	76	6	0	82	74	0	0	74	148	0	0	148	27	0	0	27
Propyzamide	Propyzamide	88	26	12	126	116	10	1	127	253	11	5	269				
	RH-24580	64	2	0	66	78	0	0	78	149	0	0	149				
	RH-24644	51	15	0	66	77	1	0	78	148	1	0	149				
	RH-24655	66	0	0	66	78	0	0	78	149	0	0	149				
Proquinazid	IN-MM671	1	0	0	1												
	IN-MM991	1	0	0	1												
Prosulfocarb	Prosulfocarb	69	4	1	74	78	1	0	79	147	0	0	147				
Pyridate	PHCP	62	0	4	66	66	2	0	68	109	8	4	121				

Silstrup		Drainage				Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
Pyroxsulam	Pyroxsulam																
	5-OH-XDE-742	51	0	0	51	42	0	0	42	100	0	0	100				
	6-Cl-7-OH-XDE-742	51	0	0	51	42	0	0	42	100	0	0	100				
	7-OH-XDE-742	51	0	0	51	42	0	0	42	100	0	0	100				
	PSA	51	0	0	51	42	0	0	42	100	0	0	100				
	Pyridine sulfonamide	51	0	0	51	42	0	0	42	100	0	0	100				
Rimsulfuron	PPU	1	0	0	1												
	PPU-desamino	1	0	0	1												
Tebuconazole	Tebuconazole	17	2	0	19	15	0	0	15	23	0	0	23				
	1,2,4-triazol	4	131	6	141	44	70	2	116	195	94	2	307				
Terbuthylazine	Terbuthylazine	31	51	9	91	107	5	0	112	173	30	1	204				
	2-hydroxy-desethyl-terbuthylazine	43	27	1	71	84	0	0	84	151	1	0	152				
	Desethyl-terbuthylazine	8	64	44	116	101	32	0	133	113	127	2	242				
	Desisopropylatrazine	28	43	0	71	84	0	0	84	148	4	0	152				
	Hydroxy-terbuthylazine	45	26	0	71	84	0	0	84	152	0	0	152				
Triasulfuron	Triazinamin	88	0	0	88	113	0	0	113	228	0	0	228				
Tribenuron-methyl	IN-B5528	35	0	0	35	24	0	0	24	140	0	0	140				
	IN-R9805	35	0	0	35	24	0	0	24	140	0	0	140				
	M2	35	0	0	35	24	0	0	24	140	0	0	140				
	Triazinamin-methyl	82	0	0	82	74	0	0	74	148	0	0	148	27	0	0	27
Triflusulfuron-methyl	Triflusulfuron-methyl	32	0	0	32	56	0	0	56	102	0	0	102				
	IN-D8526	32	0	0	32	56	0	0	56	102	0	0	102				
	IN-E7710	27	5	0	32	56	0	0	56	102	0	0	102				
	IN-M7222	32	0	0	32	55	1	0	56	102	0	0	102				

Table A5.4. Number of samples from Estrup where pesticides were either not detected (nd), detected in concentrations ≤0.1 µg/L, or detected in concentrations >0.1 µg/L, and total number of samples (T). Numbers are accumulated for the period up to 1 July 2023.

Estrup		Drainage				Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
Amidosulfuron	Amidosulfuron	99	0	0	99	35	0	0	35	109	0	0	109				
Aminopyralid	Aminopyralid	96	0	0	96	66	0	0	66	86	0	0	86				
Amitrol	Amitrol	6	0	0	6	6	0	0	6	11	0	0	11				
Azoxystrobin	Azoxystrobin	274	126	15	415	240	1	0	241	523	2	0	525				
	CyPM	39	226	150	415	207	29	5	241	518	7	0	525				
Bentazone	Bentazone	211	208	14	433	176	42	0	218	525	2	0	527	3	2	2	7
	2-amino-N-isopropyl-benzamide	237	1	0	238	80	1	0	81	271	0	0	271	5	0	0	5
Bifenox	Bifenox	91	3	1	95	60	0	0	60	132	0	0	132				
	Bifenox acid	89	6	10	105	63	0	0	63	133	0	1	134				
	Nitrofen	95	0	0	95	60	0	0	60	132	0	0	132				
Bromoxynil	Bromoxynil	136	1	2	139	41	1	0	42	125	0	0	125	3	0	0	3
Chlormequat	Chlormequat	45	1	0	46	18	0	0	18	56	0	0	56				
Clomazone	Clomazone	60	0	0	60	47	0	0	47	51	0	0	51				
	FMC 65317	60	0	0	60	47	0	0	47	51	0	0	51				
Clopyralid	Clopyralid	1	0	0	1												
Diflufenican	Diflufenican	30	15	12	57	26	0	0	26	45	0	0	45				
	AE-0542291	57	0	0	57	26	0	0	26	45	0	0	45				
	AE-B107137	40	18	0	58	38	2	0	40	49	0	0	49				
Dimethoate	Dimethoate	88	0	0	88	42	0	0	42	158	0	0	158	23	0	0	23
Epoxiconazole	Epoxiconazole	35	12	2	49	19	0	0	19	69	0	0	69				
Ethofumesate	Ethofumesate	91	27	8	126	47	0	0	47	158	0	0	158				
Fenpropimorph	Fenpropimorph	82	1	0	83	39	0	0	39	150	0	0	150	23	0	0	23
	Fenpropimorph acid	82	0	0	82	34	0	0	34	124	0	0	124	17	0	0	17
Flamprop-M-isopropyl	Flamprop-M-isopropyl	112	20	0	132	55	0	0	55	208	0	0	208	23	0	0	23
	Flamprop	119	13	0	132	55	0	0	55	208	0	0	208	23	0	0	23
Florasulam	Florasulam	92	0	0	92	35	0	0	35	125	0	0	125				
	5-OH-florasulam	141	7	1	149	72	0	0	72	176	0	0	176				
	DFP-ASTCA	68	0	0	68	42	0	0	42	76	0	0	76				
	DFP-TSA	68	0	0	68	42	0	0	42	76	0	0	76				
	TSA	69	0	0	69	42	0	0	42	76	0	0	76				
Flupyrsulfuron-methyl	IN-KF311					1	0	0	1	3	0	0	3				
Fluroxypyr	Fluroxypyr	87	1	2	90	34	0	0	34	120	1	0	121				
Foramsulfuron	Foramsulfuron	72	17	3	92	65	0	0	65	88	0	0	88				
	AE-F092944	91	1	0	92	65	0	0	65	88	0	0	88				
	AE-F130619	86	6	0	92	65	0	0	65	88	0	0	88				
Glyphosate	Glyphosate	235	234	109	578	284	6	1	291	679	41	5	725	23	0	0	23
	AMPA	79	379	120	578	291	1	0	292	719	7	0	726	23	0	0	23
Halauxifen-methyl	X-729	61	0	0	61	39	0	0	39	70	0	0	70				
Iodosulfuron-methyl	Metsulfuron-methyl	131	0	0	131	55	0	0	55	208	0	0	208	22	1	0	23
Ioxynil	Ioxynil	119	15	5	139	42	0	0	42	125	0	0	125	3	0	0	3

Estrup		Drainage				Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
MCPA	MCPA	91	10	2	103	35	0	0	35	111	1	0	112				
	2-methyl-4-chlorophenol	102	1	0	103	35	0	0	35	112	0	0	112				
Mesosulfuron-methyl	Mesosulfuron-methyl	62	13	0	75	27	0	0	27	99	0	0	99				
	AE-F099095	48	0	0	48	37	0	0	37	50	0	0	50				
	AE-F147447	20	0	0	20	16	0	0	16	19	0	0	19				
	AE-F160459	48	0	0	48	37	0	0	37	50	0	0	50				
	Mesosulfuron	74	0	0	74	24	0	0	24	83	0	0	83				
Mesotrione	Mesotrione	53	30	10	93	64	2	1	67	88	2	0	90				
	AMBA	89	4	0	93	67	0	0	67	90	0	0	90				
	MNBA	82	10	1	93	67	0	0	67	87	1	0	88				
Metamitron	Metamitron	81	27	15	123	47	0	0	47	158	0	0	158				
	Desamino-metamitron	76	38	11	125	47	0	0	47	157	0	0	157				
Metconazole	Metconazole	60	1	0	61	39	0	0	39	70	0	0	70				
Metrafenone	Metrafenone	100	20	0	120	68	0	0	68	119	1	0	120				
Pendimethalin	Pendimethalin	119	4	0	123	41	0	0	41	147	0	0	147	7	0	0	7
	M455H001					2	0	0	2	15	0	0	15				
Picolinafen	Picolinafen	64	17	0	81	40	0	0	40	118	0	0	118				
	CL153815	50	20	11	81	40	0	0	40	118	0	0	118				
Pirimicarb	Pirimicarb	159	40	0	199	68	0	0	68	225	1	0	226	6	0	0	6
	Pirimicarb-desmethyl	192	0	0	192	67	0	0	67	223	0	0	223	6	0	0	6
	Pirimicarb-desmethyl-formamido	199	13	13	225	77	0	0	77	261	0	0	261	5	0	0	5
Propiconazole	Propiconazole	192	23	3	218	87	0	0	87	309	2	0	311	23	0	0	23
Propyzamide	Propyzamide	5	0	0	5	4	0	0	4	3	0	0	3				
Pyroxsulam	5-OH-XDE-742	67	1	0	68	42	0	0	42	76	0	0	76				
	6-Cl-7-OH-XDE-742	68	0	0	68	42	0	0	42	76	0	0	76				
	7-OH-XDE-742	67	1	0	68	42	0	0	42	76	0	0	76				
	PSA	64	2	2	68	42	0	0	42	76	0	0	76				
	Pyridine sulfonamide	68	0	0	68	42	0	0	42	76	0	0	76				
Tebuconazole	Tebuconazole	40	24	17	81	39	0	0	39	118	3	2	123				
	1,2,4-triazol	1	17	250	268	3	162	13	178	43	166	66	275				
Terbuthylazine	Terbuthylazine	49	78	34	161	63	0	0	63	222	1	0	223				
	2-hydroxy-desethyl-terbuthylazine	44	63	24	131	50	0	0	50	180	0	0	180				
	Desethyl-terbuthylazine	18	111	35	164	59	7	0	66	232	0	0	232				
	Desisopropylatrazine	90	70	1	161	62	1	0	63	197	26	0	223				
	Hydroxy-terbuthylazine	43	72	16	131	50	0	0	50	180	0	0	180				
Thiacloprid	Thiacloprid	47	0	0	47	34	0	0	34	66	0	0	66				
	M34	55	0	0	55	34	0	0	34	66	0	0	66				
	Thiacloprid-amide	46	1	0	47	34	0	0	34	66	0	0	66				
	Thiacloprid sulfonic acid	56	0	0	56	34	0	0	34	66	0	0	66				

Estrup		Drainage				Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
Thifensulfuron-methyl	IN-B5528	68	1	0	69	41	0	0	41	153	0	0	153				
	IN-JZ789	69	0	0	69	41	0	0	41	153	0	0	153				
	IN-L9223	69	0	0	69	41	0	0	41	153	0	0	153				
Thiophanate-methyl	Carbendazim	60	3	0	63	41	0	0	41	64	0	0	64				
Triasulfuron	Triazinamin	184	0	0	184	89	0	0	89	255	1	0	256	22	0	0	22
Tribenuron-methyl	Triazinamin-methyl	52	2	0	54	36	0	0	36	68	0	0	68				

Table A5.5. Number of samples from Faardrup where pesticides were either not detected (nd), detected in concentrations ≤0.1 µg/L, or detected in concentrations >0.1 µg/L, and total number of samples (T). Numbers are accumulated for the period up to 1 July 2023.

Faardrup		Drainage				Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
Azoxystrobin	Azoxystrobin	107	0	0	107	92	0	0	92	194	0	0	194				
	CyPM	103	4	0	107	92	0	0	92	194	0	0	194				
Bentazone	Bentazone	177	22	6	205	152	13	1	166	354	4	3	361				
	2-amino-N-isopropyl-benzamide	68	1	0	69	61	0	0	61	132	0	0	132				
Bifenox	Bifenox	58	6	0	64	30	0	0	30	74	0	0	74				
	Bifenox acid	25	1	17	43	30	0	1	31	73	0	0	73				
	Nitrofen	58	5	1	64	30	0	0	30	74	0	0	74				
Bromoxynil	Bromoxynil	101	0	0	101	81	0	0	81	225	0	0	225	73	0	0	73
Clomazone	Clomazone	84	0	1	85	69	0	0	69	166	0	0	166				
	FMC 65317	84	0	1	85	69	0	0	69	166	0	0	166				
Clopyralid	Clopyralid	31	1	0	32	24	0	0	24	72	0	0	72				
Desmedipham	Desmedipham	99	0	0	99	66	0	0	66	165	0	0	165	29	0	0	29
	EHPC	83	0	0	83	52	0	0	52	123	0	0	123	16	0	0	16
Dimethoate	Dimethoate	77	0	0	77	58	0	0	58	148	0	0	148				
Epoxiconazole	Epoxiconazole	81	0	0	81	66	0	0	66	143	0	0	143				
Ethofumesate	Ethofumesate	150	7	6	163	104	0	0	104	226	25	6	257	27	2	0	29
Fenpropimorph	Fenpropimorph	101	0	0	101	80	1	0	81	225	0	0	225	73	0	0	73
	Fenpropimorph acid	101	0	0	101	81	0	0	81	225	0	0	225	73	0	0	73
Flamprop-M-isopropyl	Flamprop-M-isopropyl	70	1	0	71	56	0	0	56	142	0	0	142				
	Flamprop	76	1	0	77	58	0	0	58	148	0	0	148				
Florasulam	TSA	35	0	0	35	26	0	0	26	115	0	0	115				
Fluazifop-P-butyl	Fluazifop-P-butyl	99	0	0	99	66	0	0	66	165	0	0	165	29	0	0	29
	Fluazifop-P	124	5	3	132	87	0	0	87	205	5	1	211	26	3	0	29
	TFMP	93	0	0	93	76	0	0	76	162	0	0	162				
Fluopyram	Fluopyram	49	4	1	54	27	0	0	27	144	0	0	144				
	Fluopyram-7-hydroxy	43	2	0	45	21	0	0	21	117	0	0	117				
Flupyrsulfuron-methyl	Flupyrsulfuron-methyl	36	0	0	36	51	0	0	51	123	0	0	123				
	IN-JV460	36	0	0	36	51	0	0	51	123	0	0	123				
	IN-KC576	36	0	0	36	51	0	0	51	123	0	0	123				
	IN-KY374	36	0	0	36	51	0	0	51	123	0	0	123				
Fluroxypyr	Fluroxypyr	182	0	1	183	146	1	0	147	368	0	0	368	73	0	0	73
	Fluroxypyr-methoxypyridine	29	0	0	29	31	0	0	31	115	0	0	115				
Fluroxypyr	Fluroxypyr-pyridinol	29	0	0	29	31	0	0	31	115	0	0	115				
Glyphosate	Glyphosate	171	4	0	175	127	1	0	128	319	4	0	323	61	1	0	62
	AMPA	165	9	1	175	128	0	0	128	321	2	0	323	57	5	0	62
Halauxifen-methyl	X-729	1	0	0	1	1	0	0	1	3	0	0	3				
	X-757	34	0	0	34	25	0	0	25	111	0	0	111				
Ioxynil	Ioxynil	99	1	0	100	81	0	0	81	224	1	0	225	73	0	0	73

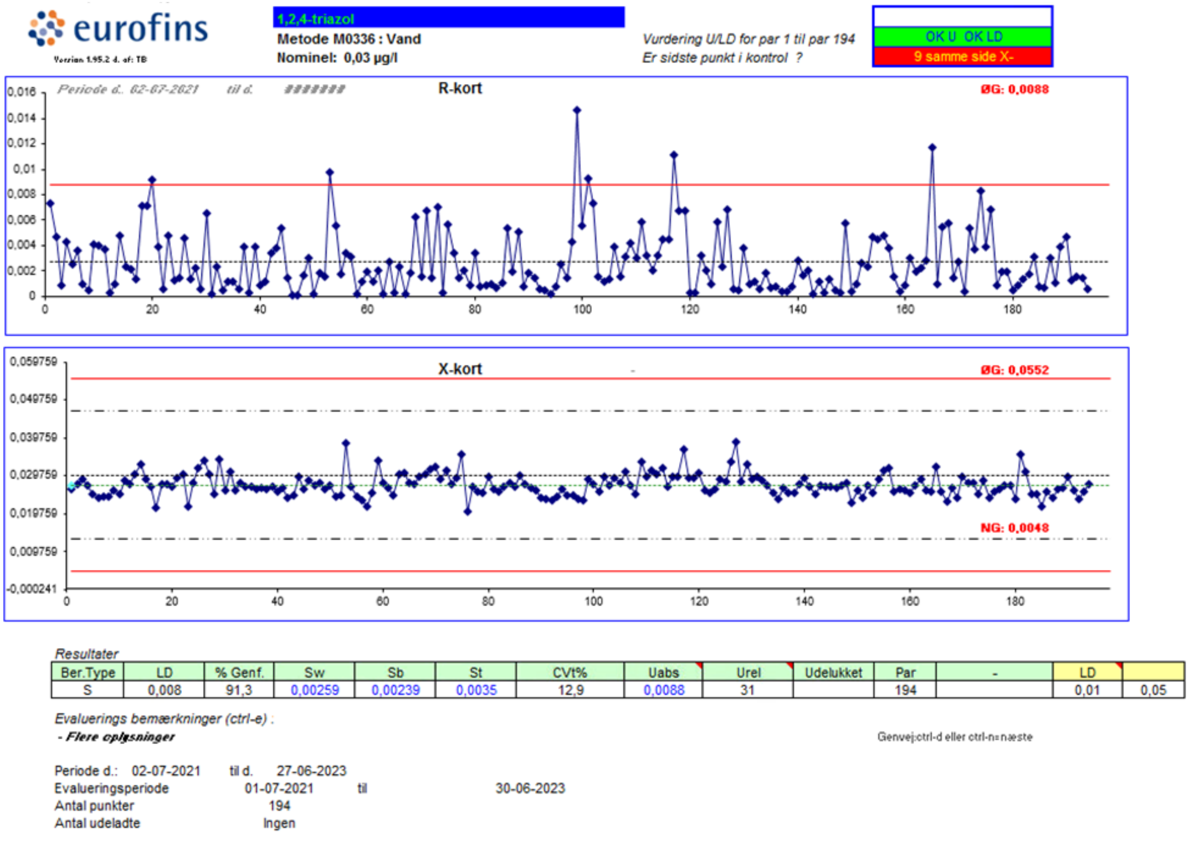
Faardrup		Drainage				Horizontal screens				Vertical screens				Suction cups			
Parent	Compound/analyte	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T	nd	≤ 0.1 µg/L	> 0.1 µg/L	T
MCPA	MCPA	142	1	1	144	109	0	0	109	255	0	0	255				
	2-methyl-4-chlorophenol	143	0	1	144	109	0	0	109	254	0	0	254				
Metamitron	Metamitron	187	10	2	199	126	0	0	126	323	20	4	347	29	0	0	29
	Desamino-metamitron	183	12	4	199	126	0	0	126	299	36	12	347	29	0	0	29
	MTM-126-AMT	33	0	0	33	22	0	0	22	86	0	0	86				
Metrafenone	Metrafenone	60	0	0	60	54	0	0	54	114	0	0	114				
Pendimethalin	Pendimethalin	55	2	0	57	55	0	0	55	125	0	0	125				
Phenmedipham	Phenmedipham	99	0	0	99	66	0	0	66	163	2	0	165	29	0	0	29
	MHPC	97	1	1	99	66	0	0	66	164	1	0	165	29	0	0	29
Picloram	Picloram	1	0	0	1	1	0	0	1	3	0	0	3				
Pirimicarb	Pirimicarb	148	7	0	155	116	0	0	116	318	2	0	320	73	0	0	73
	Pirimicarb-desmethyl	94	6	0	100	66	0	0	66	162	3	0	165	29	0	0	29
	Pirimicarb-desmethyl-formamido	97	3	0	100	66	0	0	66	163	2	0	165	29	0	0	29
Propiconazole	Propiconazole	178	0	0	178	138	0	0	138	371	1	0	372	73	0	0	73
Propyzamide	Propyzamide	152	5	4	161	137	2	0	139	346	0	0	346				
	RH-24580	125	0	0	125	115	0	0	115	249	0	0	249				
	RH-24644	121	4	0	125	115	0	0	115	249	0	0	249				
	RH-24655	123	1	0	124	114	0	0	114	246	0	0	246				
Proquinazid	IN-MM671	45	0	0	45	25	0	0	25	82	0	0	82				
	IN-MM991	45	0	0	45	25	0	0	25	82	0	0	82				
Prosulfocarb	Prosulfocarb	79	0	0	79	61	0	0	61	126	0	0	126				
Tebuconazole	Tebuconazole	50	4	0	54	53	0	0	53	120	1	0	121				
	1,2,4-triazol	4	132	6	142	102	18	0	120	399	19	0	418				
Terbuthylazine	Terbuthylazine	70	30	11	111	83	5	1	89	149	25	20	194				
	2-hydroxy-desethyl-terbuthylazine	61	7	1	69	60	1	0	61	126	6	0	132				
	Desethyl-terbuthylazine	22	82	7	111	68	21	0	89	149	15	30	194				
	Desisopropylatrazine	86	24	1	111	57	32	0	89	166	28	0	194				
	Hydroxy-terbuthylazine	90	20	1	111	85	4	0	89	164	30	0	194				
Thiamethoxam	Thiamethoxam	68	0	0	68	58	0	0	58	126	0	0	126				
	CGA 322704	68	0	0	68	58	0	0	58	126	0	0	126				
Thiencarbazone-methyl	AE1394083	35	0	0	35	22	0	0	22	89	0	0	89				
Tribenuron-methyl	IN-B5528	44	1	0	45	21	0	0	21	117	0	0	117				
	IN-R9805	45	0	0	45	21	0	0	21	117	0	0	117				
	M2	45	0	0	45	21	0	0	21	117	0	0	117				
	Triazinamin-methyl	77	0	0	77	57	0	0	57	147	0	0	147				
Triflusulfuron-methyl	Triflusulfuron-methyl	63	0	0	63	38	0	0	38	92	0	0	92				
	IN-D8526	63	0	0	63	38	0	0	38	92	0	0	92				
	IN-E7710	63	0	0	63	38	0	0	38	92	0	0	92				
	IN-M7222	63	0	0	63	38	0	0	38	92	0	0	92				

9.6. Appendix 6 – QC charts for internal quality control

The requirement for detection limit for all analysed compounds is 0.01 µg/L, except for DMSA, where the limit was 0.02 µg/L but changed to 0.01 µg/L in February 2023.

In the QC chart, the central line represents the average, and the upper- and lower lines are the upper and lower control limits, respectively. The upper chart (R-kort) shows the difference between the two QC replicates on a given day. The lower chart (X-kort) is the daily average concentration of the replicates. The table below the chart shows the method statistics: limit of detection (LD, green recalculated, yellow limit), calculated recovery (% Genf., limit 70-120%), standard deviation within- (Sw) and between day (Sb), and the total standard deviation (St), the coefficient of variance (CV%), the absolute- (µg/L, limit 0.05 µg/L in drinking water) and relative uncertainty (%), and the number of duplicate QC-samples (Par) included in the chart. All requirements for the analyses were met for all compounds.

QC charts for the compounds primarily monitored in the period from July 1, 2021 to June 30, 2023 and included in Chapter 5 are listed alphabetically in the following section.



1,2,4-triazol
Metode M0336 : Vand
Nominel: 0,03 µg/l

Vurdering U/LD for par 1 til par 194
Er sidste punkt i kontrol ?

Resultater

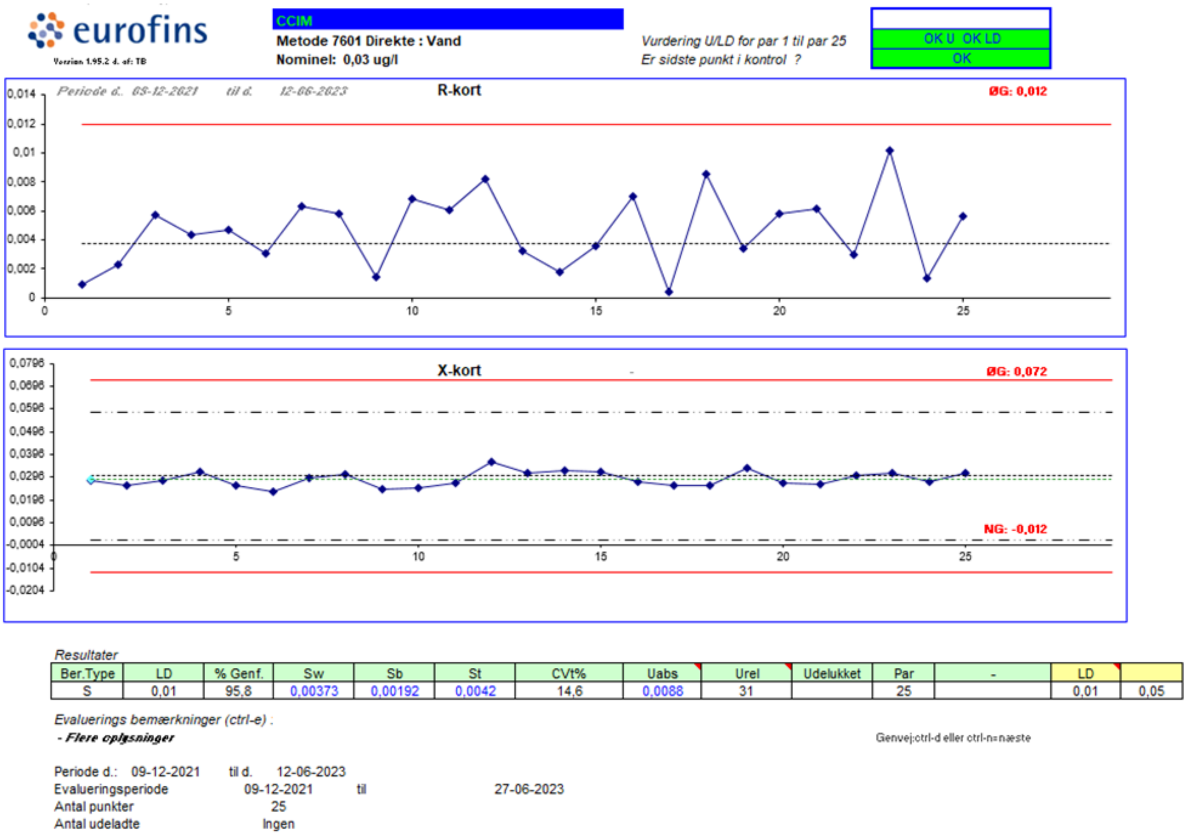
Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,008	91,3	0,00259	0,00239	0,0035	12,9	0,0088	31		194		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- **Flere oplysninger**

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 02-07-2021 til d. 27-06-2023
Evalueringsperiode 01-07-2021 til 30-06-2023
Antal punkter 194
Antal udeladte Ingen

Figure A6.1. QC chart for 1,2,4-triazole.



Metode 7601 Direkte : Vand
Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 25
Er sidste punkt i kontrol ?

Resultater

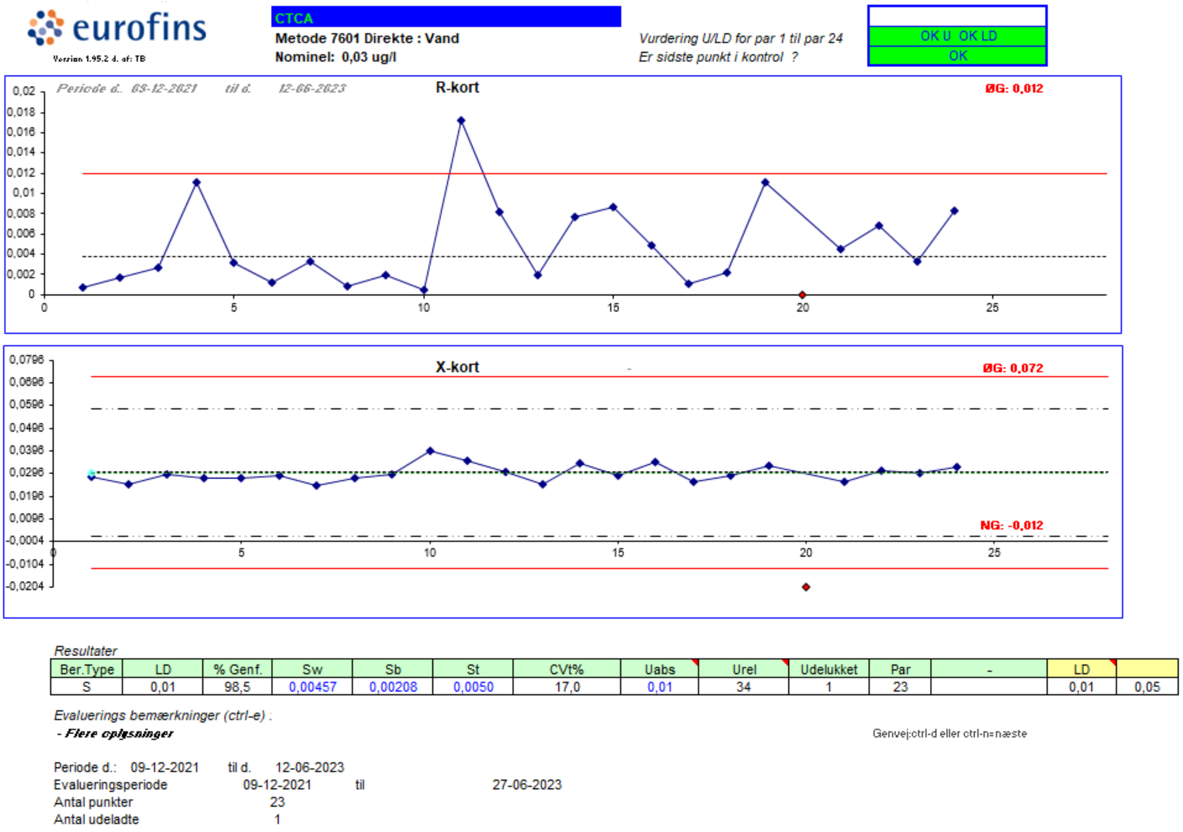
Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,01	95,8	0,00373	0,00192	0,0042	14,6	0,0088	31		25		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- Flere oplysninger

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 09-12-2021 til d. 12-06-2023
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 25
Antal udeladte Ingen

Figure A6.2. QC chart for CCIM.



Metode 7601 Direkte : Vand
Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 24
Er sidste punkt i kontrol ?

Resultater

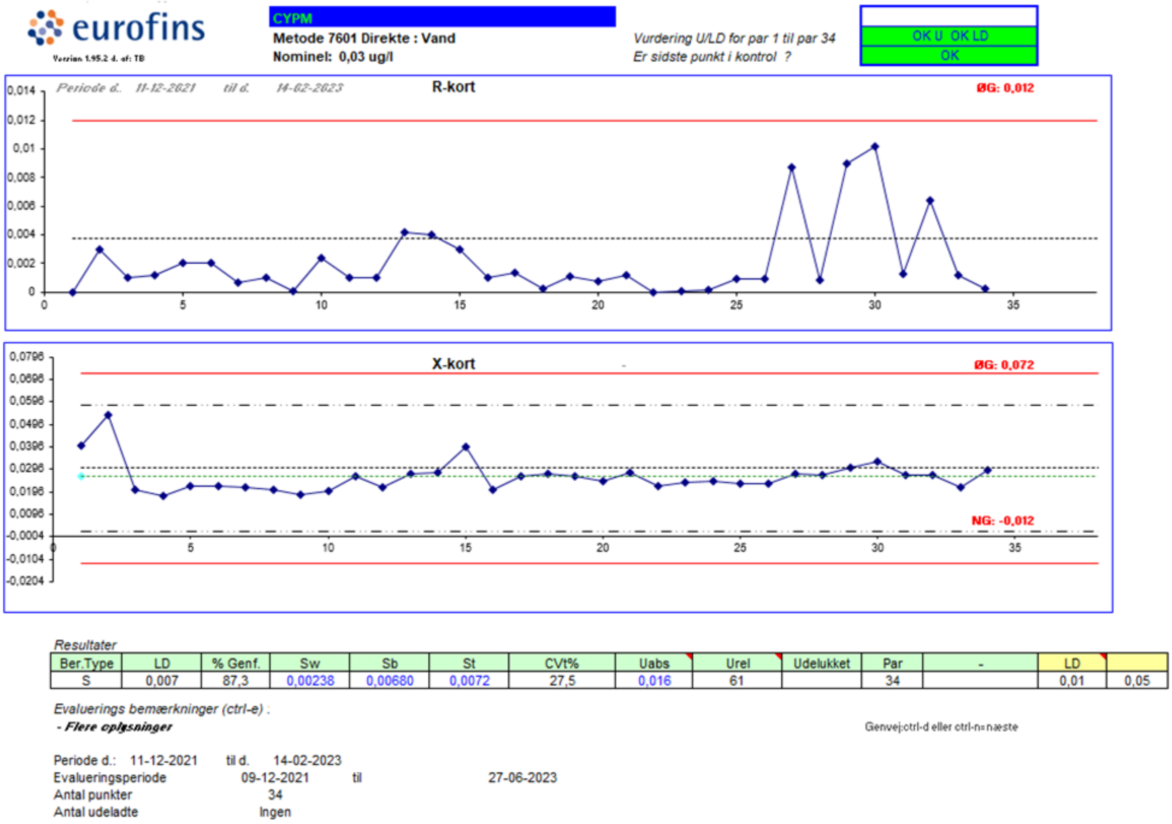
Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,01	98,5	0,00457	0,00208	0,0050	17,0	0,01	34	1	23		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- Flere oplysninger

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 09-12-2021 til d. 12-06-2023
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 23
Antal udeladte 1

Figure A6.3. QC chart for CTCA.



CYPM
Metode 7601 Direkte : Vand
Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 34
Er sidste punkt i kontrol ?

Resultater

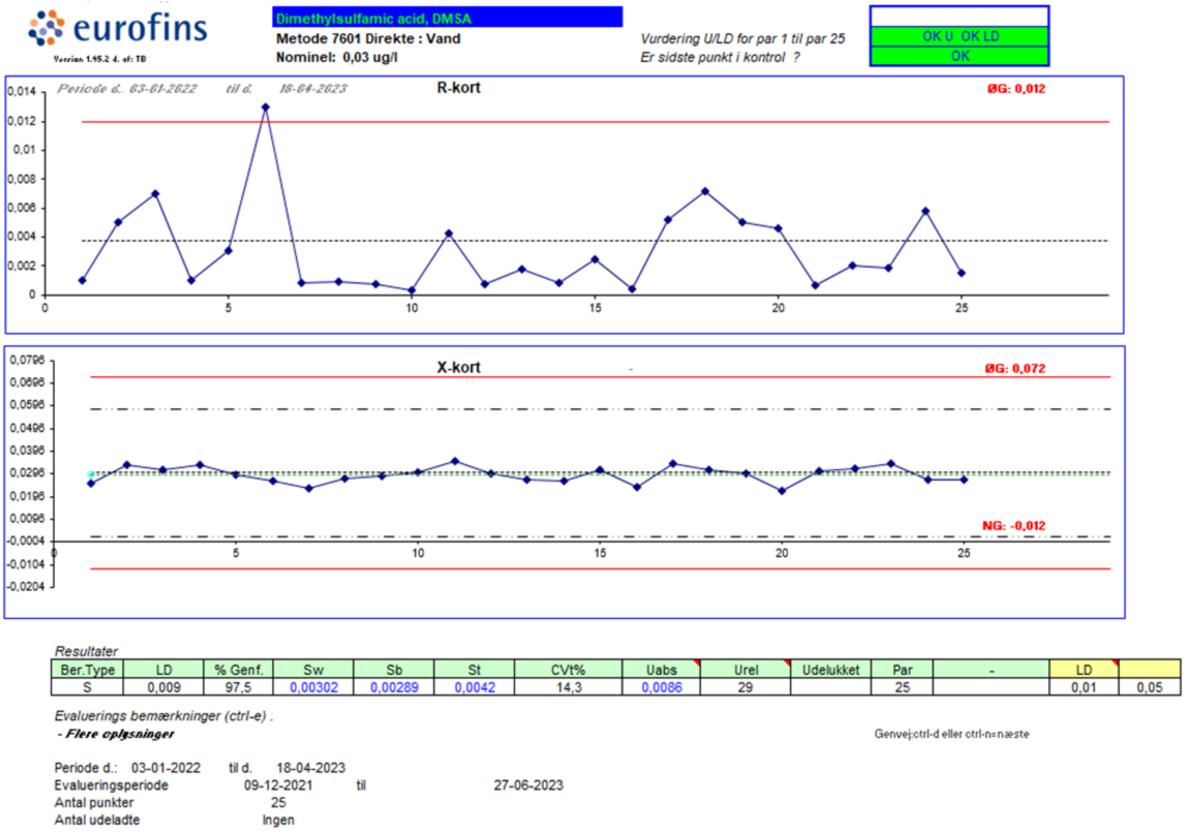
Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,007	87,3	0,00238	0,00680	0,0072	27,5	0,016	61		34		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- Flere oplysninger

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 11-12-2021 til d. 14-02-2023
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 34
Antal udeladte Ingen

Figure A6.4. QC chart for CyPM.



Dimethylsulfamic acid, DMSA
Metode 7601 Direkte : Vand
Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 25
Er sidste punkt i kontrol ?

Resultater

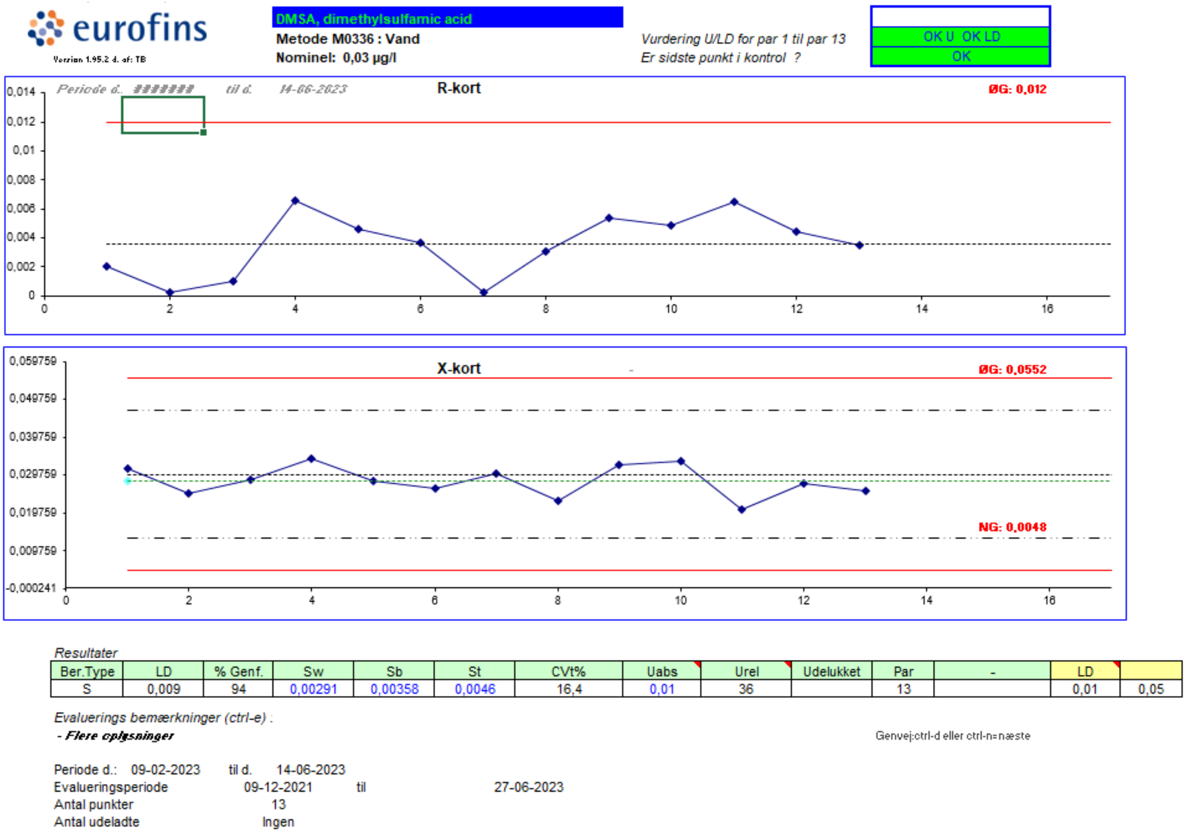
Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,009	97,5	0,00302	0,00289	0,0042	14,3	0,0086	29		25		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- Flere oplysninger

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 03-01-2022 til d. 18-04-2023
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 25
Antal udeladte Ingen

Figure A6.5. QC chart for DMSA, DL was 0.02 µg/L for this period January 3, 2022 to April 18, 2023.



DMSA, dimethylsulfamic acid
Metode M0336 : Vand
Nominel: 0,03 µg/l

Vurdering U/LD for par 1 til par 13
Er sidste punkt i kontrol ?

Resultater

Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,009	94	0,00291	0,00358	0,0046	16,4	0,01	36		13		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- Flere oplysninger

Periode d.: 09-02-2023 til d. 14-06-2023
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 13
Antal udeladte Ingen

Figure A6.6. QC chart for DMSA. DL was 0.01 µg/L from February 9, 2023 and onwards. Methods were run parallelly in the period February to April 2023.

N,N-dimethylsulfamid
Metode M0336 : Vand
Nominel: 0,03 µg/l

Vurdering U/LD for par 1 til par 195
Er sidste punkt i kontrol ?

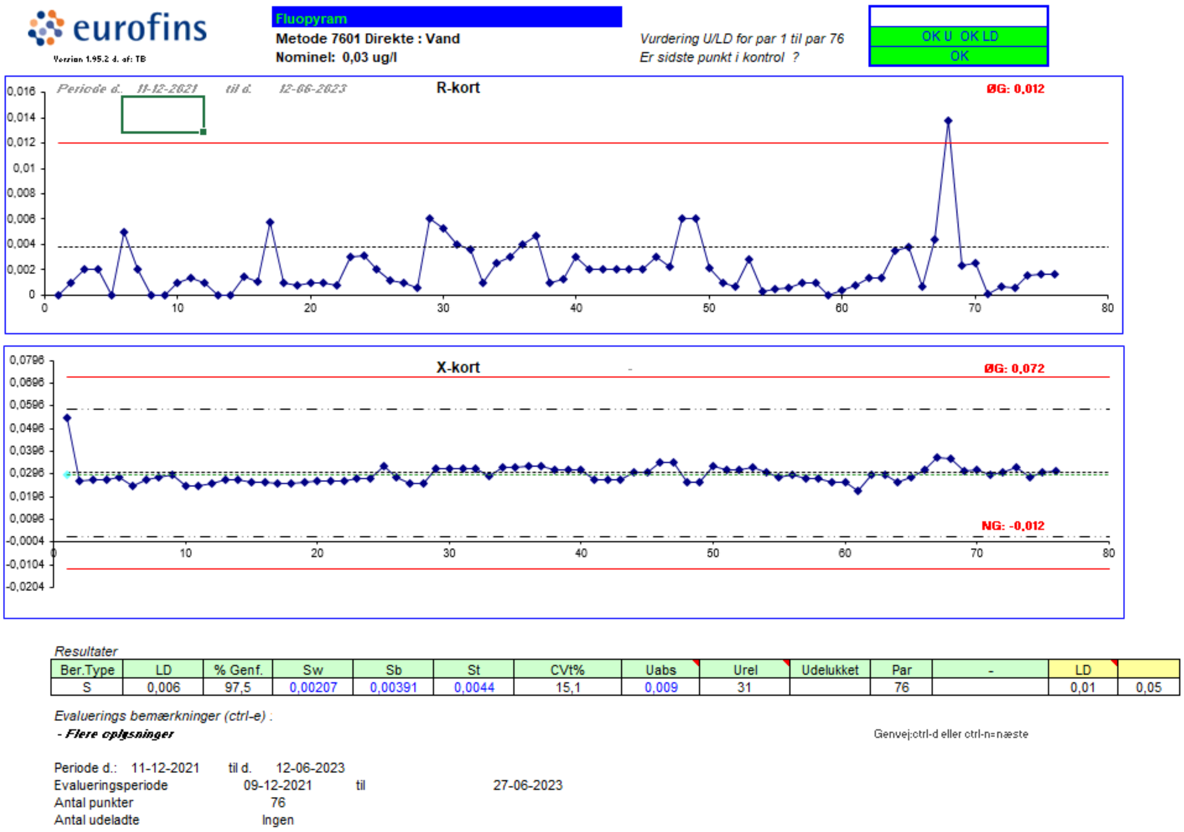
Resultater

Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,01	86,1	0,00337	0,00352	0,0049	18,8	0,013	47		195		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- Flere oplysninger

Periode d.: 02-07-2021 til d. 27-06-2023
Evalueringsperiode 01-07-2021 til 30-06-2023
Antal punkter 195
Antal udeladte Ingen

Figure A6.7. QC chart for DMS



Fluopyram

Metode 7601 Direkte : Vand

Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 76

Er sidste punkt i kontrol ?

Resultater

Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,006	97,5	0,00207	0,00391	0,0044	15,1	0,009	31		76		0,01	0,05

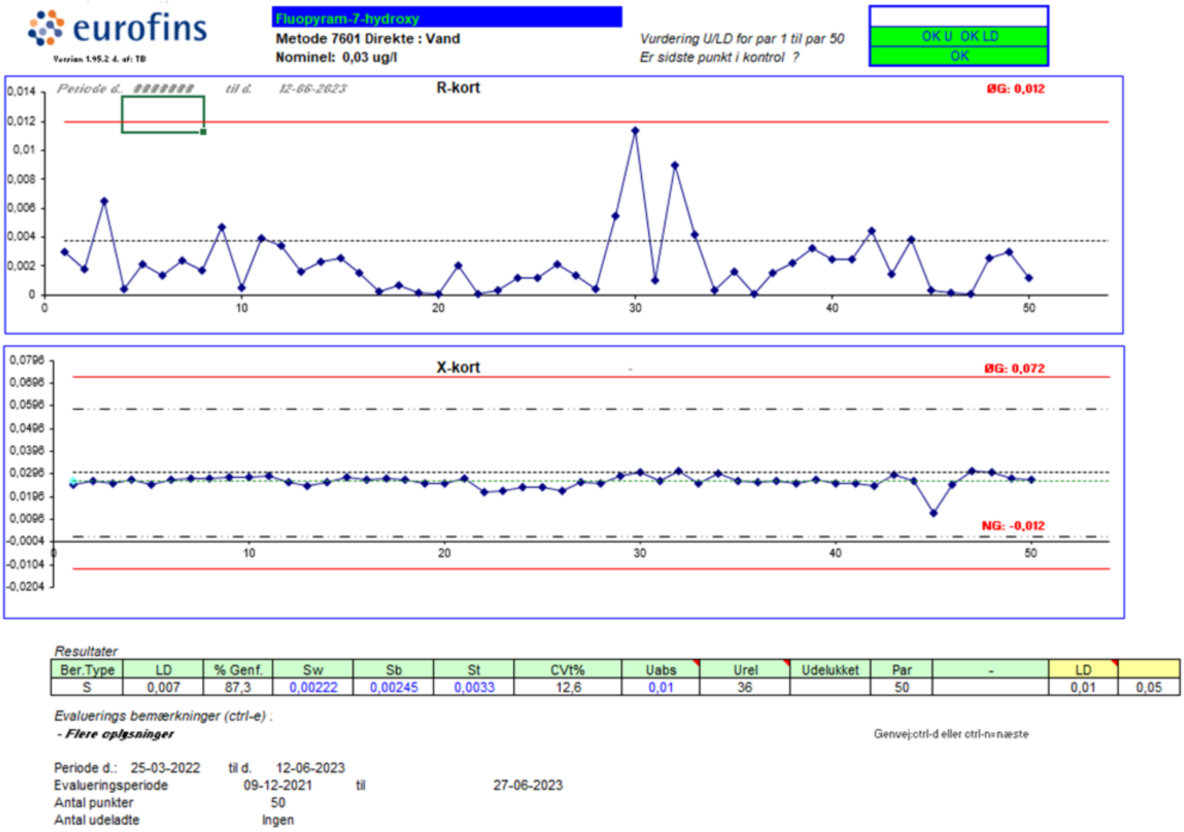
Evaluerings bemærkninger (ctrl-e) :

- Flere oplysninger

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 11-12-2021 til d. 12-06-2023
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 76
Antal udeladte Ingen

Figure A6.8. QC chart for Fluopyram.



Fluopyram-7-hydroxy

Metode 7601 Direkte : Vand

Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 50

Er sidste punkt i kontrol ?

Resultater

Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,007	87,3	0,00222	0,00245	0,0033	12,6	0,01	36		50		0,01	0,05

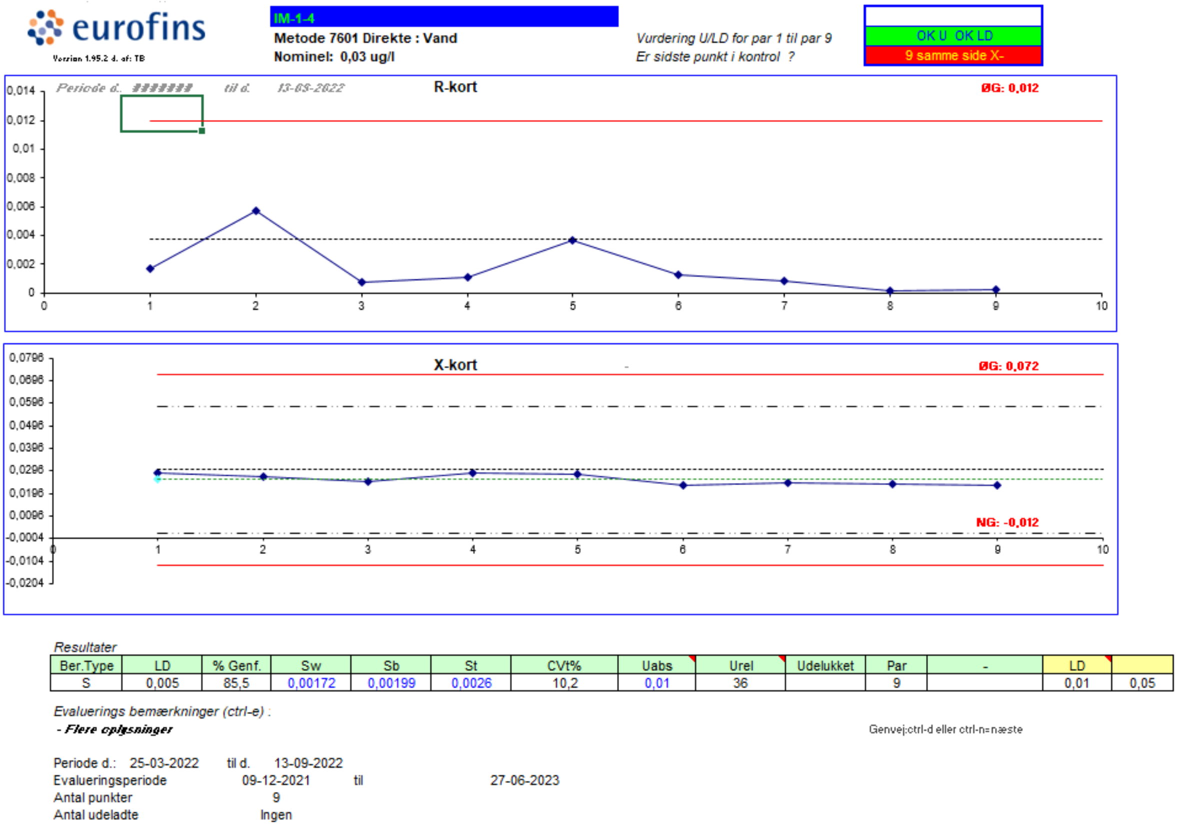
Evaluerings bemærkninger (ctrl-e) :

- Flere oplysninger

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 25-03-2022 til d. 12-06-2023
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 50
Antal udeladte Ingen

Figure A6.9. QC chart for Fluopyram-7-hydroxy.



IM-1-4
Metode 7601 Direkte : Vand
Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 9
Er sidste punkt i kontrol ?

OK U OK LD
9 samme side X-

Resultater

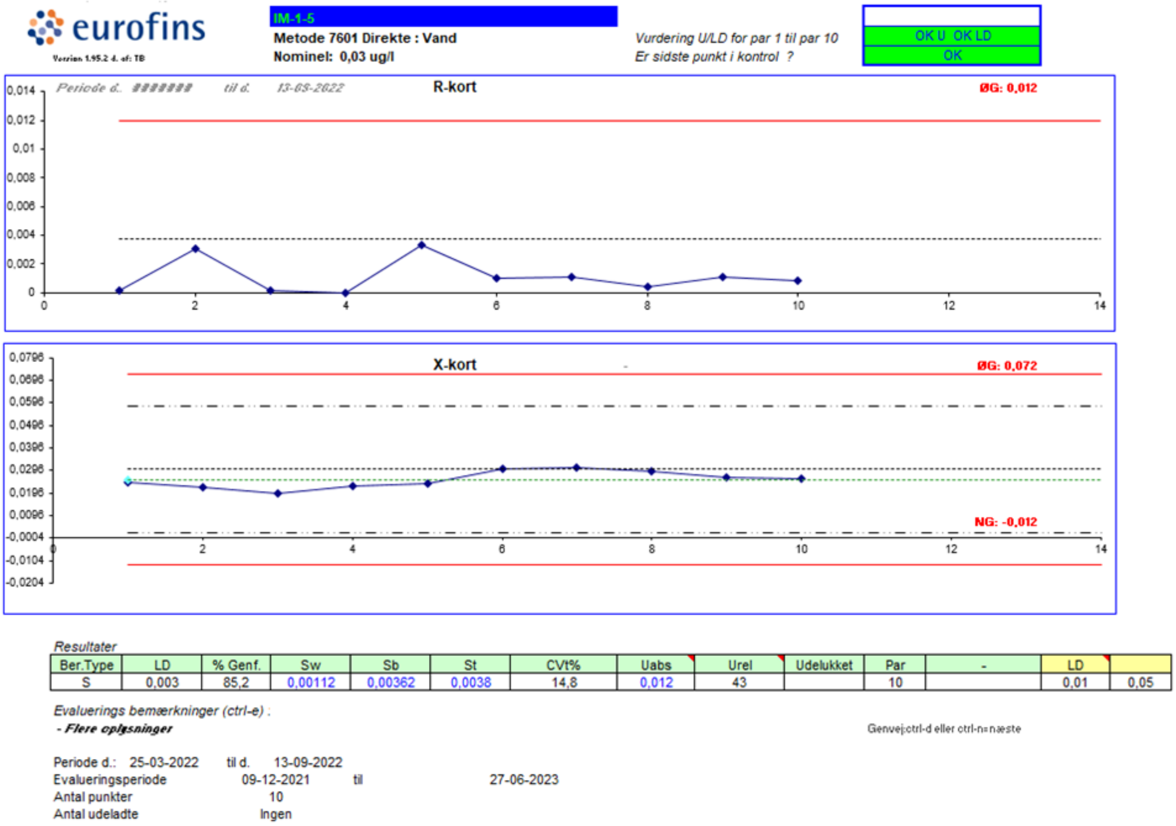
Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,005	85,5	0,00172	0,00199	0,0026	10,2	0,01	36		9		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- Flere oplysninger

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 25-03-2022 til d. 13-09-2022
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 9
Antal udeladte Ingen

Figure A6.10. QC chart for IM-1-4.



IM-1-5
Metode 7601 Direkte : Vand
Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 10
Er sidste punkt i kontrol ?

OK U OK LD
OK

Resultater

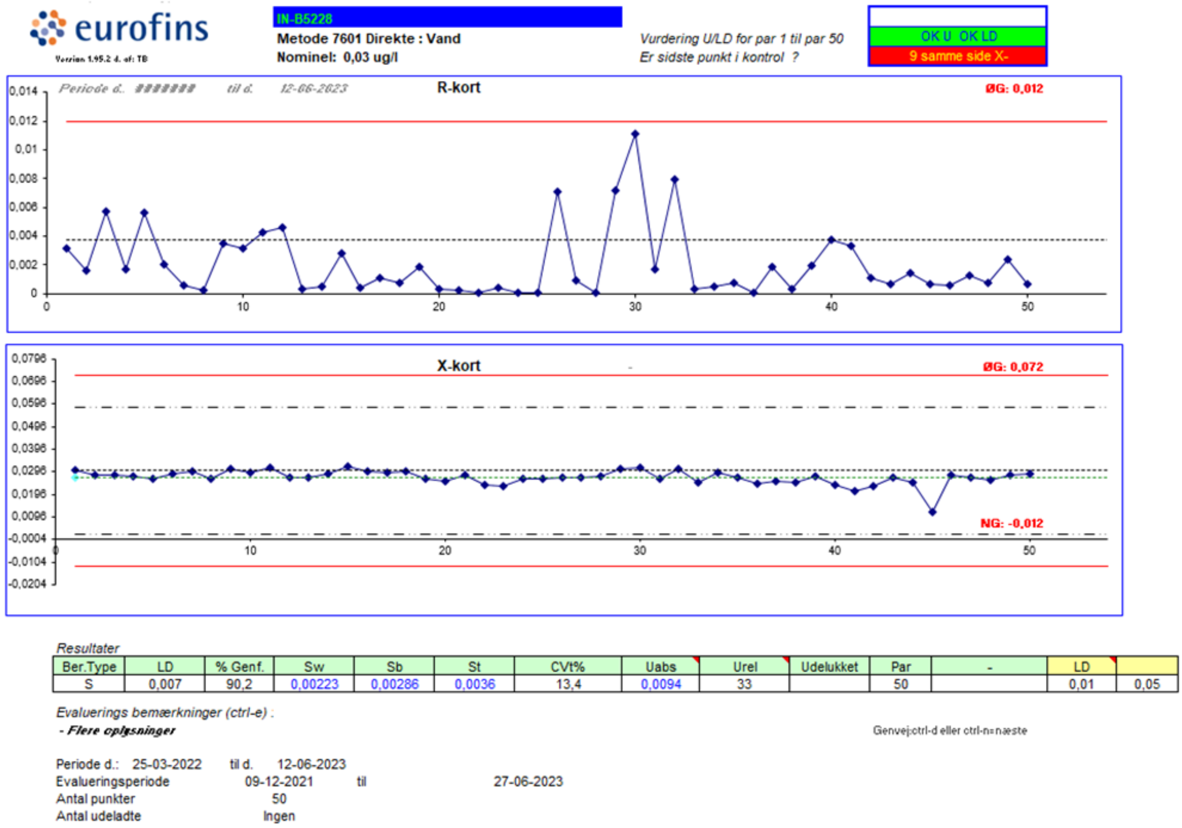
Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,003	85,2	0,00112	0,00362	0,0038	14,8	0,012	43		10		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- Flere oplysninger

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 25-03-2022 til d. 13-09-2022
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 10
Antal udeladte Ingen

Figure A6.11. QC chart for IM-1-5.



IN-B5228

Metode 7601 Direkte : Vand

Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 50

Er sidste punkt i kontrol ?

OK U OK LD

9 samme side X-

Resultater

Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,007	90,2	0,00223	0,00286	0,0036	13,4	0,0094	33		50		0,01	0,05

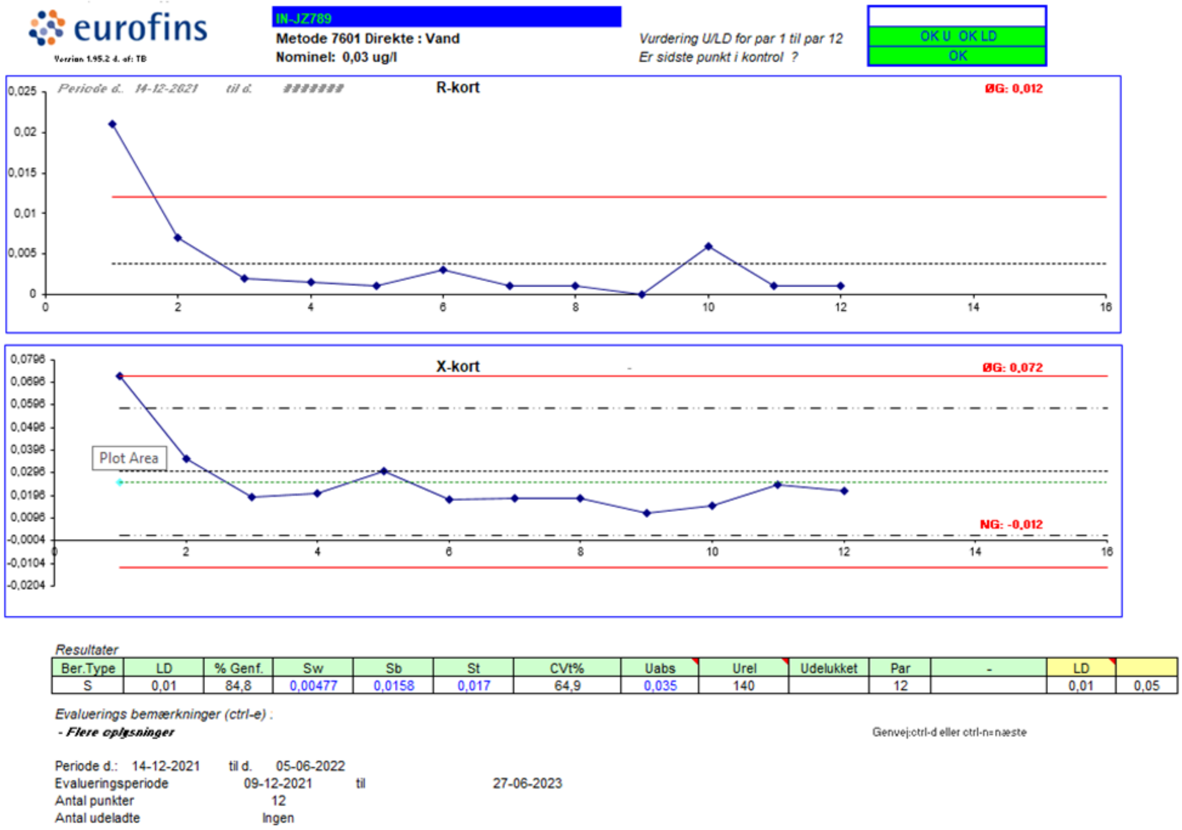
Evaluerings bemærkninger (ctrl-e) :

- Flere oplysninger

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 25-03-2022 til d. 12-06-2023
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 50
Antal udeladte Ingen

Figure A6.10. QC chart for IN-B5528.



IN-JZ789

Metode 7601 Direkte : Vand

Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 12

Er sidste punkt i kontrol ?

OK U OK LD

OK

Resultater

Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,01	84,8	0,00477	0,0158	0,017	64,9	0,035	140		12		0,01	0,05

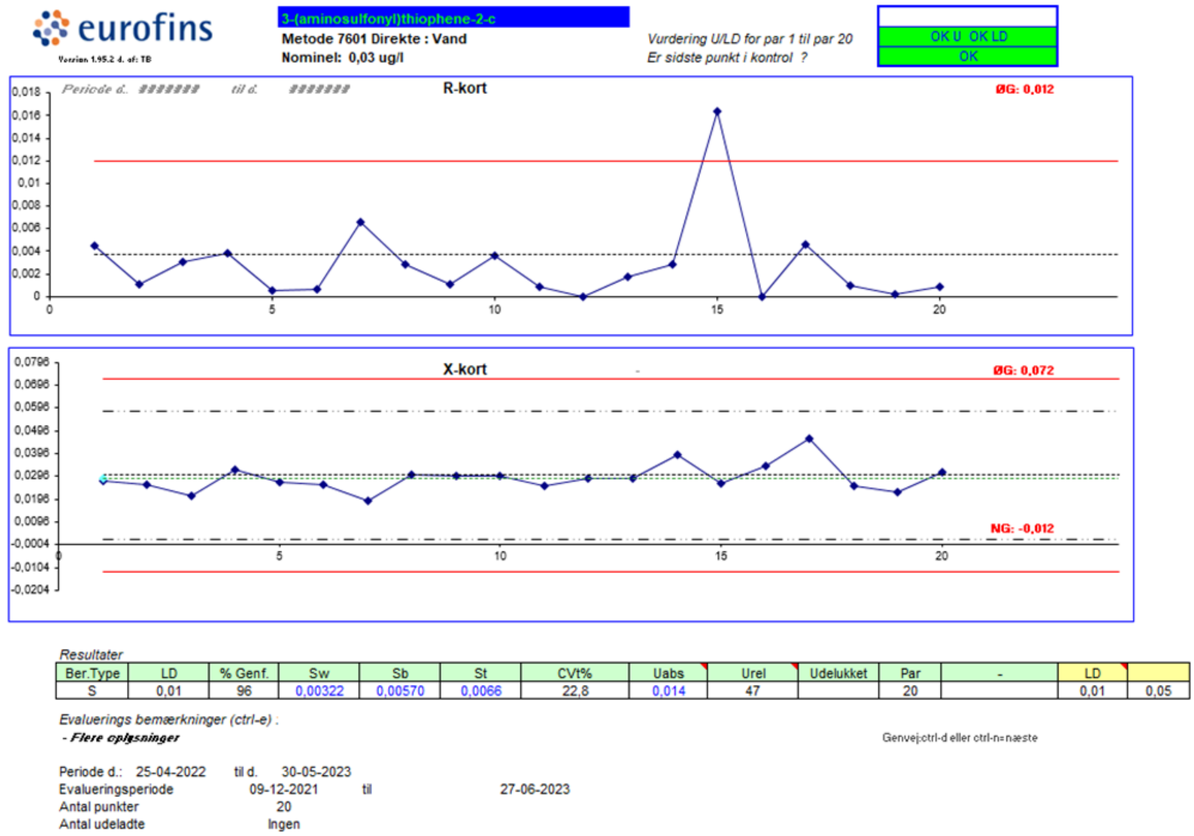
Evaluerings bemærkninger (ctrl-e) :

- Flere oplysninger

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 14-12-2021 til d. 05-06-2022
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 12
Antal udeladte Ingen

Figure A6.11. QC chart for IN-JZ789.



3-(aminosulfonyl)thiophene-2-c

Metode 7601 Direkte : Vand
Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 20
Er sidste punkt i kontrol ?

OK U OK LD
OK

Resultater

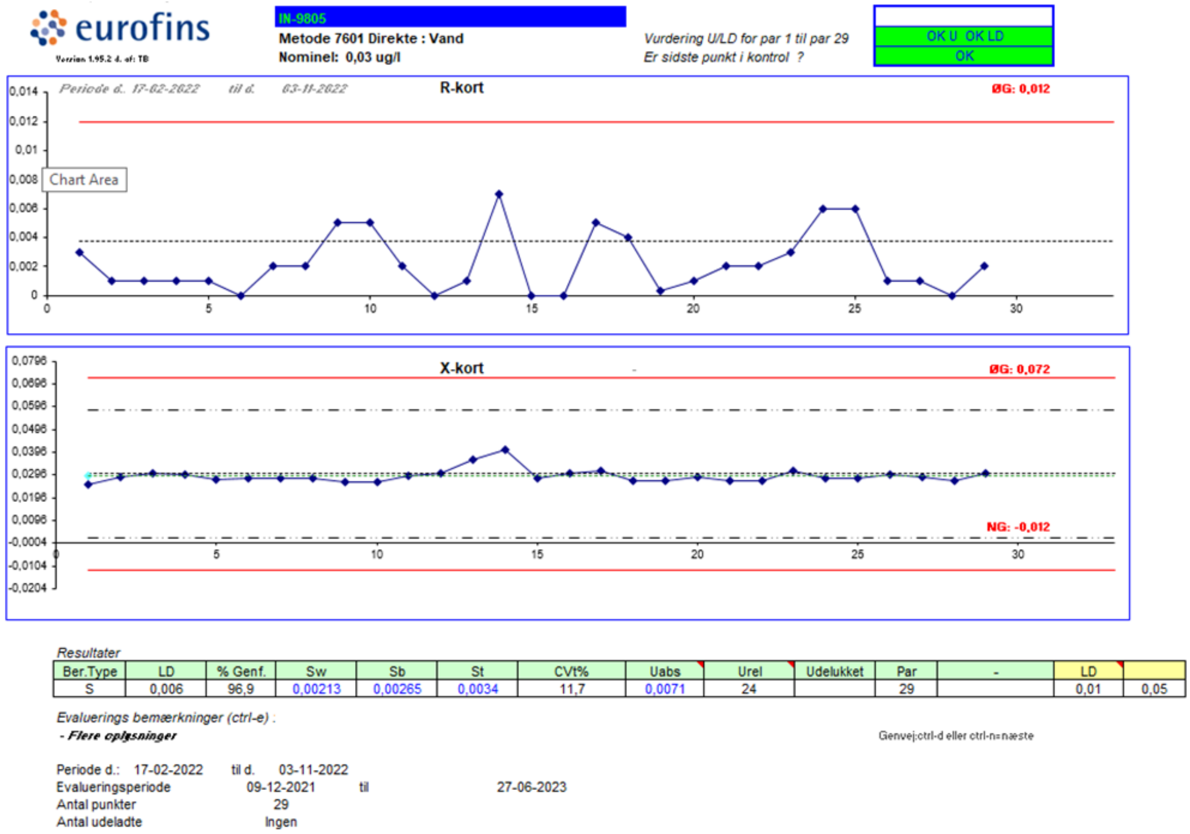
Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,01	96	0,00322	0,00570	0,0066	22,8	0,014	47		20		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- **Flere oplysninger**

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 25-04-2022 til d. 30-05-2023
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 20
Antal udeladte Ingen

Figure A6.12. QC chart for IN-L9223.



IN-9805

Metode 7601 Direkte : Vand
Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 29
Er sidste punkt i kontrol ?

OK U OK LD
OK

Resultater

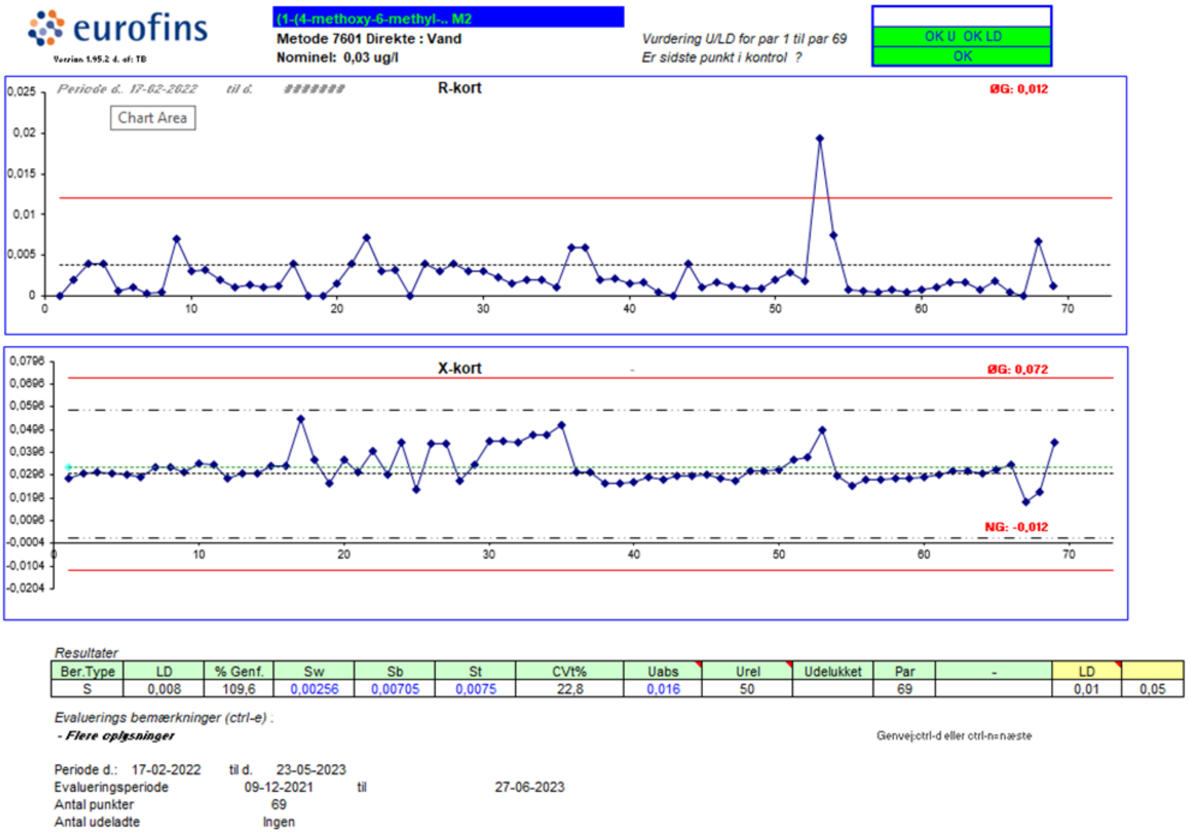
Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,006	96,9	0,00213	0,00265	0,0034	11,7	0,0071	24		29		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :
- **Flere oplysninger**

Genvej:ctrl-d eller ctrl-n=næste

Periode d.: 17-02-2022 til d. 03-11-2022
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 29
Antal udeladte Ingen

Figure A6.13. QC chart for IN-R9805.



(1-(4-methoxy-6-methyl-.. M2

Metode 7601 Direkte : Vand

Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 69

Er sidste punkt i kontrol ?

Resultater

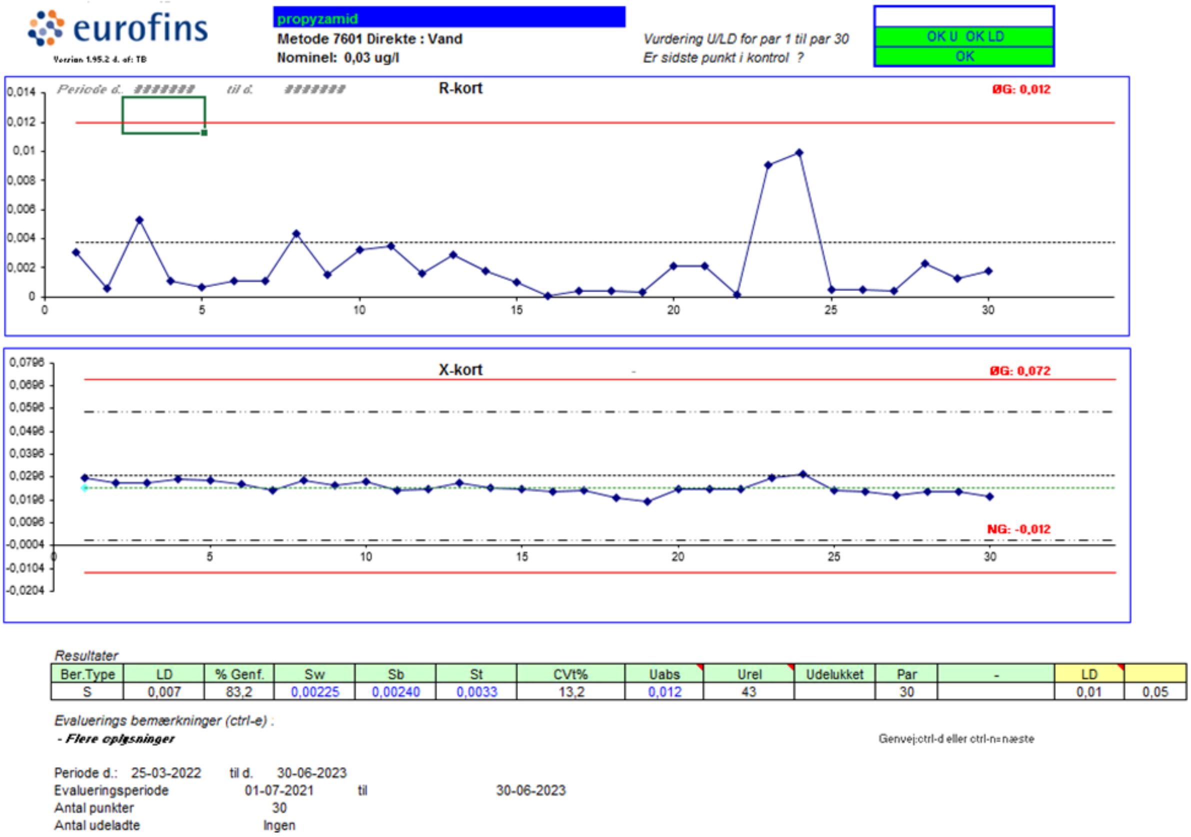
Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,008	109,6	0,00256	0,00705	0,0075	22,8	0,016	50		69		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :

- Flere oplysninger

Periode d.: 17-02-2022 til d. 23-05-2023
Evalueringsperiode 09-12-2021 til 27-06-2023
Antal punkter 69
Antal udeladte Ingen

Figure A6.14. QC chart for M2.



propyzamid

Metode 7601 Direkte : Vand

Nominel: 0,03 ug/l

Vurdering U/LD for par 1 til par 30

Er sidste punkt i kontrol ?

Resultater

Ber.Type	LD	% Genf.	Sw	Sb	St	CVt%	Uabs	Urel	Udelukket	Par	-	LD	
S	0,007	83,2	0,00225	0,00240	0,0033	13,2	0,012	43		30		0,01	0,05

Evaluerings bemærkninger (ctrl-e) :

- Flere oplysninger

Periode d.: 25-03-2022 til d. 30-06-2023
Evalueringsperiode 01-07-2021 til 30-06-2023
Antal punkter 30
Antal udeladte Ingen

Figure A6.15. QC chart for propyzamide.

9.7. Appendix 7 – Bromide tracer tests

This appendix includes the bromide tests done in the four fields, Jyndevad, Silstrup, Estrup, and Faardrup. No new data or interpretations are added since the previous reports (Badawi et al. 2022 and Badawi *et al.* 2023b), where the bromide leaching results from all fields were revisited and analysed to improve the fundamental understanding of the hydrogeology in the fields. As the bromide leaching plots are used in the evaluation of the present pesticide tests, the appendix has been included for convenience.

The bromide tracer experiment, initially done in 2017 at Lund when it was established, appears to have been erroneous. Consequently, a new bromide tracer experiment was initiated in January 2023 and will be assessed in the upcoming years.

In the analysis of the bromide results, the time until the maximum concentration of bromide reaches the different depths of water sampling was used to estimate transport times from the surface to the specific screen of interest and allow for comparison between depths. The time of maximum concentration was used in conjunction with the general pattern of breakthrough curves when possible. However, since the number of collected samples differed among the monitored well screens, continuous breakthrough curves were not equally available for all screens. Therefore, the time of maximum concentration was used to achieve transport time ranges within each monitoring depth regardless of the number of samples collected. These transport times are not to be conflated with average transport times. The average transport time (mean breakthrough time) represents when half of the applied mass has passed through the location of measurement which may not necessarily coincide with the breakthrough of maximum concentration. Consequently, bromide detections are generally occurring both before and after the time of the reported maximum concentration breakthroughs.

Bromide leaching at Jyndevad

At Jyndevad, bromide was applied three times (November 1999, March 2003, and May 2012) as 30 kg/ha potassium bromide.

In the suction cups located 1 mbgs, the maximum bromide concentrations after November 1999, March 2003, and May 2012 application are measured within 1-2, 7, and 3-4 months, respectively (Figure A7.1).

In the suction cups located 2 mbgs, the maximum bromide concentrations after November 1999, March 2003, and May 2012 applications are measured within 2-3, 8-11, and 4-11 months, respectively (Figure A7.1).

The maximum bromide concentrations generally reach the suction cup depth of 1 mbgs slower after the March 2003 application compared to the other applications. A similar pattern is seen at the Tylstrup field, and the reason is likely related to different precipitation and temperature conditions in 2003, resulting in different soil water conditions. That is, bromide transport is dependent on soil saturation, and for instance, with higher temperatures, more evaporation could lead to less soil saturation. In contrast, increased precipitation could lead to more soil saturation. Overall, the transport time for the maximum bromide concentration to 1 and 2 mbgs in the variably saturated zone is around 4 and 7 months, respectively.

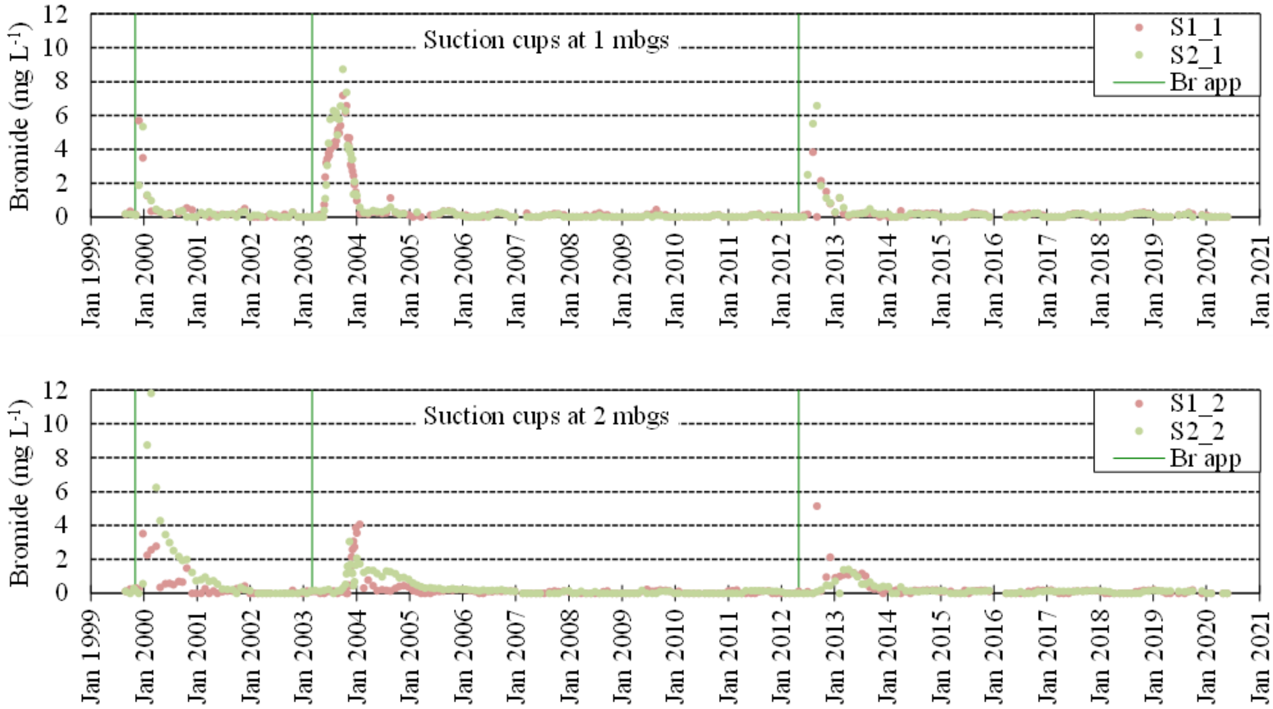


Figure A7.1 Measured bromide concentration in the variably saturated zone at Jyndevad.

For the groundwater samples, the current analysis is constricted to the monitoring wells; M1, M2, M3, M4, and H1 in the depth interval from around 2.5 to 4.5 mbgs (Figure A7.2). Sampling is conducted from ~1.5 mbgs in these wells also, but as measured concentrations are generally close to the detection limit or below (not shown but included in previous PLAP reports, e.g., Rosenbom *et al.*, 2021) the results are not included in the analysis. The measured bromide concentrations in the remaining monitoring wells, M5, M6, and M7 are generally less than 1 mg/L in all depths (not shown but included in previous PLAP reports, e.g., Rosenbom *et al.*, 2021). M7 is regarded as an upstream well and as bromide is measured in M7, further analysis of the flow field is needed to fully understand the groundwater flow dynamics across the field. Such analyses are under preparation for all the fields. However, for the sake of simplicity, in the present analysis, M5, M6, and M7 are not assumed to be part of the flow field represented by the remaining wells.

In the groundwater samples from ~2.5 mbgs, the maximum bromide concentrations after November 1999, March 2003, and May 2012 applications are measured within 10-11, 13-19, and 5-16 months (Figure A7.2).

In the groundwater samples from ~3.5 mbgs, the maximum bromide concentrations after November 1999, March 2003, and May 2012 applications are measured within 11-25, 13-25, and 14-19 months (Figure A7.2).

In the groundwater samples from ~4.5 mbgs, the maximum bromide concentrations after November 1999, March 2003, and May 2012 applications are measured within 18-32, 5-29, and 37-87 months (Figure A7.2).

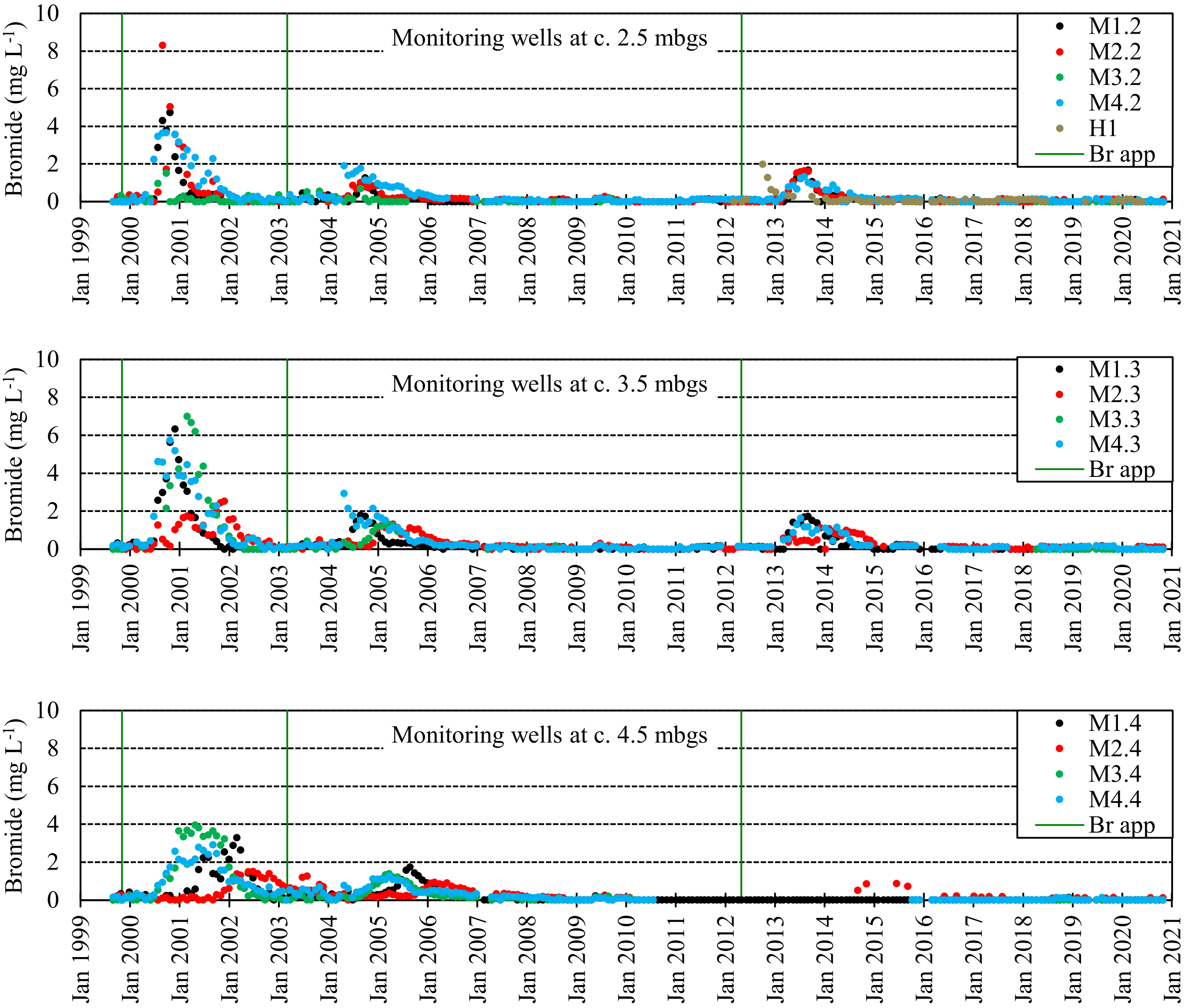


Figure A7.2. Measured bromide concentration in the groundwater at Jyndevad.

For a specific depth, the average breakthrough time for the maximum bromide concentration is calculated from the breakthrough time of the maximum concentration within each of the wells representing that particular depth. Thus, for the November 1999, March 2003, and May 2012 applications, the average time for maximum bromide concentrations reaching the screens at around 2.5, 3.5, and 4.5 mbgs are 14, 18, and 35 months, respectively. For the screens in ~4.5 mbgs, it is noted that the interval of 37-87 months in which the breakthrough of maximum concentrations is observed after the May 2012 application is relatively large compared to the intervals of maximum concentration breakthrough from the other applications. The relatively large interval in which maximum concentrations are observed after the May 2012 application is mainly due to lack of bromide detections in M3 and M4 up to four years after the application (Figure A7.2). The maximum concentrations do not exceed 0.14 mg/L in M1 and M4, and the concentrations are substantially lower compared to the maximum concentration of 0.87 mg/L measured after 37 months in M2. If the maximum concentrations from M1 and M4 after the May 2012 application are omitted in calculating the average time for maximum bromide concentrations reaching ~4.5 mbgs, the average time is changed from 35 months to 24 months.

Overall, the average breakthrough time of measured maximum concentrations within the different depths and locations coincides with the general breakthrough patterns. At ~2.5-3.5 mbgs, bromide pulses generally show breakthrough 0.5-1.5 years after application and at ~4.5 mbgs, the time of breakthrough is generally 1-2 years after application (Figure A7.2). For all the sampled depths, it is noted that bromide concentrations above the detection limit are measured before and after the transport times representing maximum concentrations.

Bromide leaching at Silstrup

At Silstrup, bromide was applied three times (May 2000, April 2009, and September 2012) as 30.0, 31.5, and 30.5 kg/ha potassium bromide, respectively.

In the suction cups, samples were only collected with the May 2000 and September 2012 applications. In the suction cups located 1 mbgs, the maximum bromide concentrations after May 2000 and September 2012 applications are observed within 5-9 and 2-5 months (Figure A7.3). For both applications, it is noted that concentrations are observed immediately after application and that bromide pulses extend up to several years.

In the suction cups located 2 mbgs, the maximum bromide concentrations after May 2000 and September 2012 applications are measured within 39-47 and 4-15 months (Figure A7.3). Again, for both applications, it is noted that concentrations are observed immediately after application and that bromide pulses extend up to several years.

The average breakthrough time for maximum concentration observations in the suction cups at 1 mbgs is overall five months after application. Although the maximum concentration is measured within five months of the May 2000 application in both suction cups, it is evident that another pulse of bromide is measured after around four years (Figure A7.3). In the suction cups at 2 mbgs, the average time for the maximum concentration breakthrough is much longer around 26 months (Figure A7.3). The reason for the overall longer transport times of maximum concentrations at around 2 mbgs is related to a pattern of wider bromide pulses. In fact, the maximum concentration measured at ~2 mbgs after the May 2000 application coincides with the second breakthrough (in January 2004) of bromide at ~1 mbgs. However, though the maximum concentrations are observed quite long after application, it is clear that increased bromide concentrations are occurring immediately after application (Figure A7.3). The results from the suction cups at around 1 mbgs with a bimodal bromide breakthrough pattern together with relatively wide bromide pulses reaching ~2 mbgs contrast with what was observed in the variably saturated zone of the sandy fields. At the sandy field Jyndevad, the bromide pulses in the variably saturated zone are relatively narrow and patterns of bimodal bromide breakthrough are not observed (Figure A7.3). The Silstrup field is characterized as a clay-till field, and the observed pattern in bromide breakthrough in the variably saturated zone indicates that flow and transport pathways are more heterogeneous compared to the sandy fields.

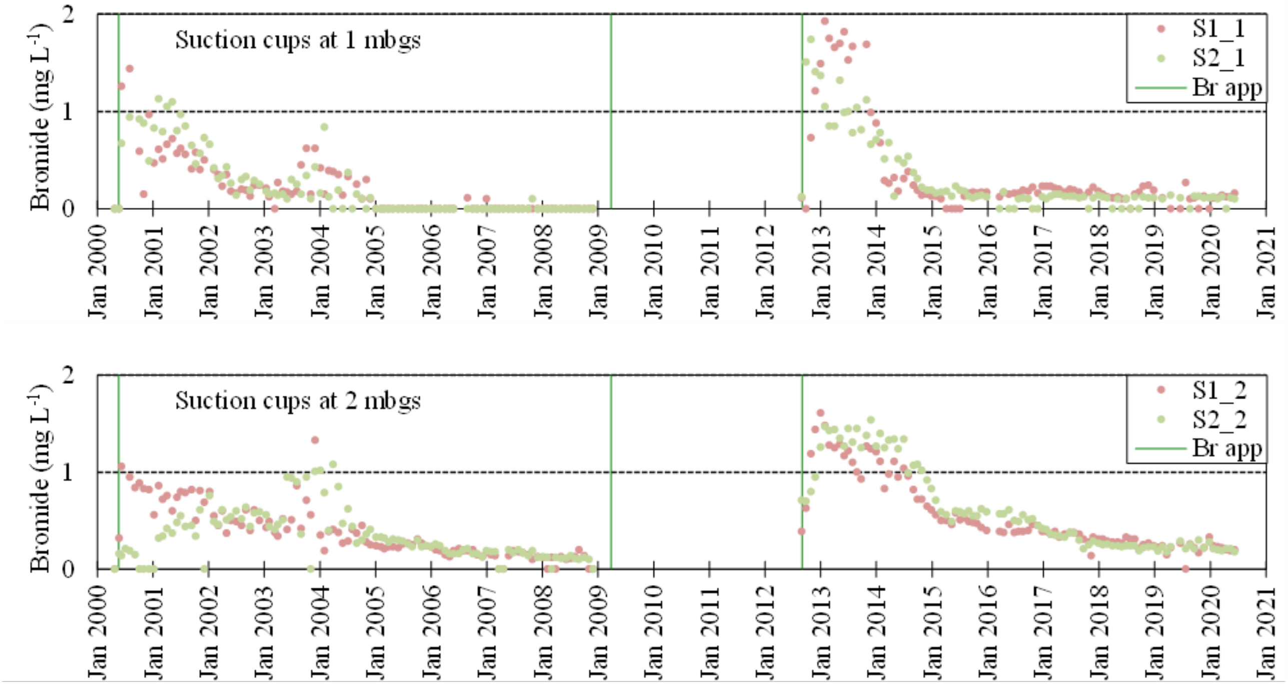


Figure A7.3. Measured bromide concentration in the variably saturated zone at Silstrup.

The samples representing drainage from around 1 mbgs are collected in a drain well collecting drainage from the entire field (Figure A7.4). Therefore, there are no time ranges reported for the drainage samples, and the maximum concentrations in the drainage after May 2000, April 2009, and September 2012 applications are measured after 43, 7, and 3 months, respectively (Figure A7.4). However, it is noted that increased bromide concentrations were detected in drainage samples already in the first event after each application. Though the breakthrough of maximum concentrations varies considerably in this field, it is evident that a fraction of the applied bromide is transported fast to the drains.

Similar to the bimodal breakthrough of bromide in suction cups at around 1 mbgs, the bromide concentrations in drainage samples after the May 2000 application also show a pattern resembling bimodal behavior (Figure A7.4). As such, maximum concentrations around 1.5 mg/L are measured around January 2002 as well as January 2004, which also represented the time of the maximum concentration in suction cups (Figure A7.3). Generally, it is noted that the maximum bromide concentrations are measured after the first drainage event following an application. Although the maximum concentrations are measured relatively fast in drainage samples after bromide applications, detections of bromide are continuous throughout all monitoring periods.

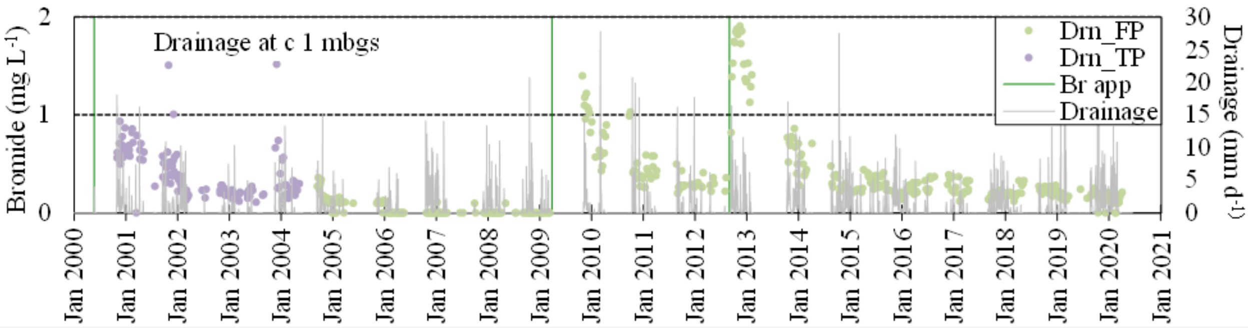


Figure A7.4. Measured bromide concentration in drainage at Silstrup. The suffix FP and TP refer to flow- and time-proportional sampling, respectively, which are described in Kjær et al. (2004) and Appendix 2.

M12 is regarded as an upstream well. However, as bromide is measured in M12, although in low concentration (generally < 0.5 mg/L) further analysis of the flow field is needed to fully understand the groundwater flow dynamics across the field. Such analyses are under preparation for all the fields. However, for the sake of simplicity, in the present analysis, M12 is assumed not to be part of the flow field represented by the remaining wells. Further, at ~5 mbgs, only sampling in a single well, M5 is performed after the application in September 2012.

In the groundwater samples from ~2 mbgs, the maximum bromide concentrations after May 2000, April 2009, and September 2012 applications are measured within 1-44, 5-25, and 3 months (Figure A7.5).

In the groundwater samples from ~3 mbgs, the maximum bromide concentrations after May 2000, April 2009, and September 2012 applications are measured within 10-46, 2-29, and 2-18 months (Figure A7.5).

In the groundwater samples from ~4 mbgs, the maximum bromide concentrations after May 2000, April 2009, and September 2012 applications are measured within 16-45, 1-13, and 15-36 months (Figure A7.5).

In the groundwater samples from ~5 mbgs, the maximum bromide concentrations after May 2000, April 2009, and September 2012 applications are measured within 10-50, 4-23, and 16 months (Figure A7.5).

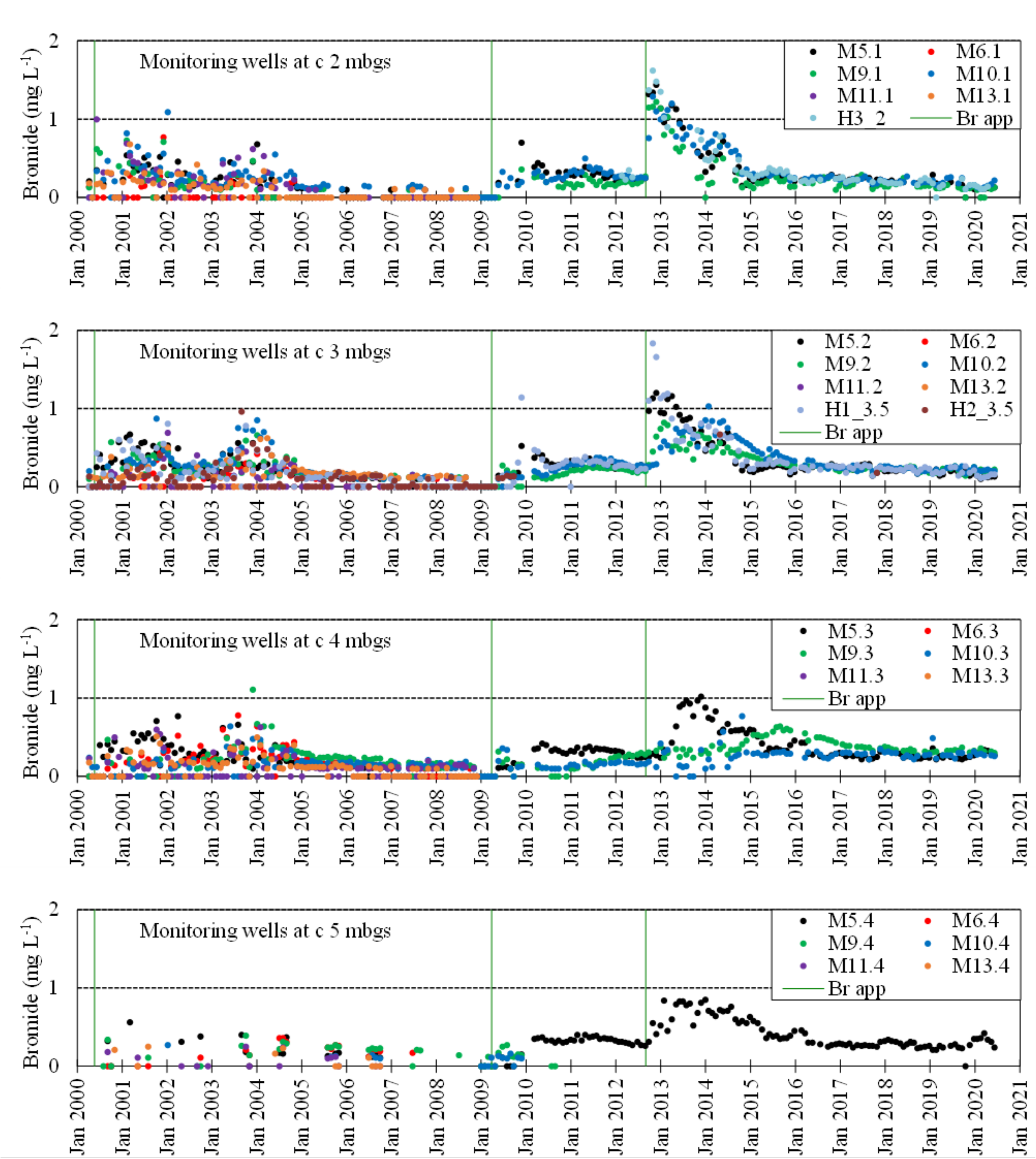


Figure A7.5. Measured bromide concentration in the groundwater at Silstrup.

For a specific depth, the average breakthrough time for the maximum bromide concentration is calculated from the time of measured maximum concentration within each of the wells representing that particular depth. Hence, for the May 2000, April 2009, and September 2012 applications, the average time for maximum bromide concentrations reaching depths at around 2, 3, 4, and 5 mbgs are 11, 18, 23, and 23 months, respectively. Although there is a general pattern of longer transport times before reaching maximum concentrations with increasing depths, the intervals in which the maximum concentrations are measured within the different screens have a relatively large range. For instance, at ~2 mbgs and ~4 mbgs, the maximum concentrations are measured within 1-44 months for the May 2000 application and 15-36 months for the September 2012 application. From the general pattern of bromide pulses at ~2-3 mbgs, it seems that two breakthroughs are occurring after the May 2000 application: one immediately after and another around three years after application (Figure A7.5). These are likely related to heavy precipitation events enabling fast flow and solute transport. Following the April 2009 application, the bromide pulses are occurring within half a year in all depths. After the September 2012 application, bromide pulses are detected immediately at ~2 mbgs and seem to move further down to ~5 mbgs within 1-1.5 years in M5 while the transport to deeper levels in other wells is less evident.

The intervals in which maximum bromide concentrations are measured at the different depths are specified above and show that maximum bromide concentrations are measured up to around four years after applications depending on the well location. The variation in the time of measured maximum concentrations in the variably saturated zone, drainage, and groundwater samples also indicate that flow and transport of solutes are affected by heterogeneity. It is noted that the breakthrough of maximum concentrations also occurs relatively fast within a few months after application, e.g., at ~2 mbgs, the maximum concentrations are measured within one and three months after the May 2000, and September 2012 applications, respectively (Figure A7.5). Similarly, around 3 and 4 mbgs, maximum concentrations are measured within 2 months after April 2009 and September applications (Figure 5.2.3). A similar pattern was also seen from the occurrences of bromide pulses in the various depths. These fast occurrences of maximum concentrations or bromide pulses, in general, are not observed at the sandy fields, and with well-known development of preferential flows at the clay-till fields (Lindhardt *et al.*, 2001), the fast maximum breakthroughs are likely caused by preferential transport of solutes. Additionally, the observed fast breakthrough of maximum bromide concentrations in drainage samples within three months of the September 2012 application may be due to preferential flows (Figure A7.4).

Overall, the majority of the maximum bromide concentrations reach the screens at ~2-5 mbgs within 1-2 years after application, but maximum concentration levels are measured up to four years after application. For all the sampled depths, it is noted that increased bromide concentrations above the detection limit are measured before and after the transport times representing maximum concentrations.

Bromide leaching at Estrup

At Estrup, bromide was applied four times (May 2000, November 2005, April 2009, and September 2012) as 30 kg/ha potassium bromide.

In the suction cups, samples were only collected with the May 2000, November 2005, and September 2012 applications. In the suction cups located 1 mbgs, the maximum bromide concentrations after May 2000, November 2005, and September 2012 applications are measured within 2, 3-6, and 4-14 months (Figure A7.6). For all applications, it is noted that increased concentrations are observed more or less immediately after application and that bromide pulses extend up to several years.

In the suction cups located 2 mbgs, the maximum bromide concentrations after May 2000, November 2005, and September 2012 applications are measured within 43-44, 6-13, and 14-19 months, respectively (Figure A7.6). Again, it is noted that concentrations are observed shortly after application and that bromide pulses extend up to several years.

In general, at 1 mbgs, the maximum concentrations are measured six months after application. At 2 mbgs, the average breakthrough time for the maximum concentration is much longer, around 23 months (Figure

A7.6). The patterns of wide bromide pulses and immediate occurrence of increased bromide concentrations just after application in the variably saturated zone are similar to what is observed at Silstrup. As such both Silstrup and Estrup are characterized as clay-till fields and the low permeable properties of the sediment matrix are likely causing the relatively slow passing of maximum bromide pulses (and the wider pulses) as well as fast occurrence of increased concentrations related to preferential flows.

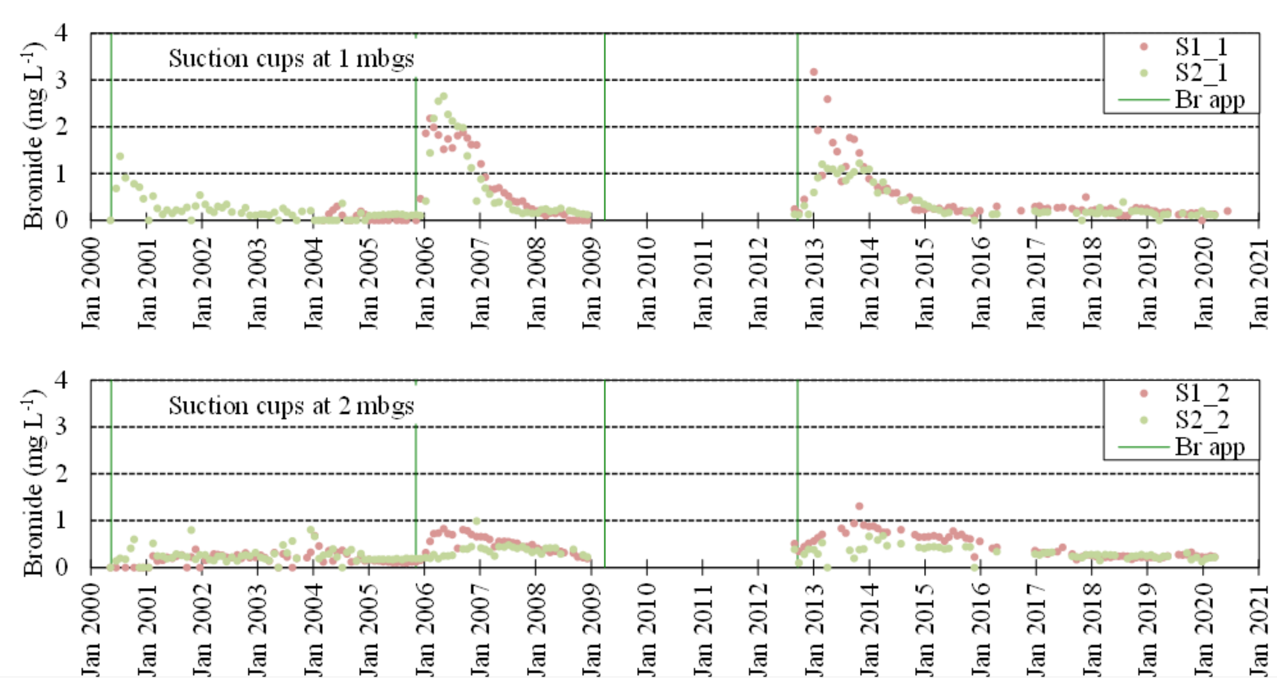


Figure A7.6. Measured bromide concentration at Estrup.

The samples representing drainage from around 1 mbgs are collected in a drain well collecting drainage from the entire field (Figure A7.7). Therefore, no ranges are reported for the drainage samples. The maximum concentrations in the drainage after May 2000, November 2005, and September 2012 applications are measured after 5, 0, 5, and 1 month, respectively (Figure A7.7). After the November 2005 application, the maximum concentration is measured within the same month of application and therefore reported as zero. Generally, it is noted that the maximum bromide concentrations are measured after the first drainage event following an application. Although the maximum concentrations are measured relatively fast in drainage samples after bromide applications, detections of bromide are continuous throughout all monitoring periods.

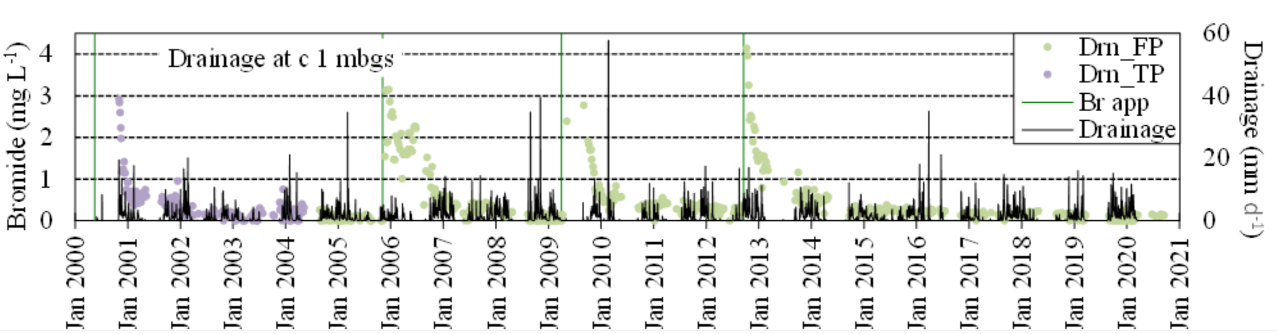


Figure A7.7. Measured bromide concentration in drainage at Estrup. The suffix FP and TP refer to flow- and time-proportional sampling, respectively, which are described in Kjær et al. (2004).

In groundwater, sampling results are based on measured bromide concentrations in wells M1-M6 and the horizontal monitoring wells (Figure A7.8). M7 is regarded as an upstream well. However, as bromide is measured in M7, although in low concentrations (generally < 0.5 mg/L), further analysis of the flow field is needed to fully understand the groundwater flow dynamics across the field. Such analyses are under preparation for all the fields. However, for the sake of simplicity, in the present analysis, M7 is assumed not to be part of the flow field represented by the remaining wells.

In the groundwater samples from ~2 mbgs, the maximum bromide concentrations after May 2000, November 2005, and September 2012 applications are measured within 18-44, 10-40, 1-41, and 5-88 months (Figure A7.8).

In the groundwater samples from ~3 mbgs, the maximum bromide concentrations after May 2000, November 2005, and September 2012 applications are measured within 9-46, 7-25, 5-34, and 5-20 months (Figure A7.8).

In the groundwater samples from ~4 mbgs, the maximum bromide concentrations after May 2000, November 2005, and September 2012 applications are measured within 4-49, 2-30, 2-39, and 4-20 months (Figure A7.8).

In the groundwater samples from ~5 mbgs, the maximum bromide concentrations in May 2000, November 2005, and September 2012 applications are measured within 9-49, 10-33, 2, and 5 months (Figure A7.8).

For each depth, the average breakthrough time for maximum bromide concentrations is calculated from the time of measured maximum concentration within each of the wells representing that particular depth. Thus, for the May 2000, November 2005, April 2009, and September 2012 applications, the average breakthrough time for maximum bromide concentrations reaching depths at around 2, 3, 4, and 5 mbgs are 27, 21, 20, and 24 months, respectively. However, in general, continuous data series are scarce and therefore challenging to interpret overall bromide breakthrough patterns.

After the May 2000 application, there seems to be a pattern of bimodal breakthrough (Figure A7.8) which was also seen at Silstrup (Figure A7.5) and also the timing of the breakthroughs is similar. This indicates that the breakthroughs are governed by precipitation events generating fast flows. In general, there are no clear patterns in the average breakthrough time for the maximum concentrations reaching the different screen depths, although increasing transport time with increasing depth would be expected in a homogeneous setting. Also, the sampling is not sufficient to achieve a general pattern of the bromide pulse breakthroughs within the different depths. After the April 2009 and September 2012 applications, the fast occurrences in some well locations are lowering the average breakthrough time for maximum concentration. However, these fast occurrences immediately after an application may not represent the actual application. E.g., in M1 at ~2 mbgs, the maximum concentration is observed within a month from the April 2009 application, while the maximum concentration of the previous application is measured within a month before the April 2009 application (Figure A7.8). Hence, it is difficult to discern which application the maximum concentration following the April 2009 application represents. Nevertheless, the fast breakthrough of maximum bromide concentrations in drainage samples affirms that preferential flow paths are present in the variably saturated zone. Further, the range in which the maximum bromide concentrations are measured varies substantially from a few months to several years and supports that the flow and transport field is affected by heterogeneity related to clay-till settings comprising preferential flow paths as well as low permeable sediments.

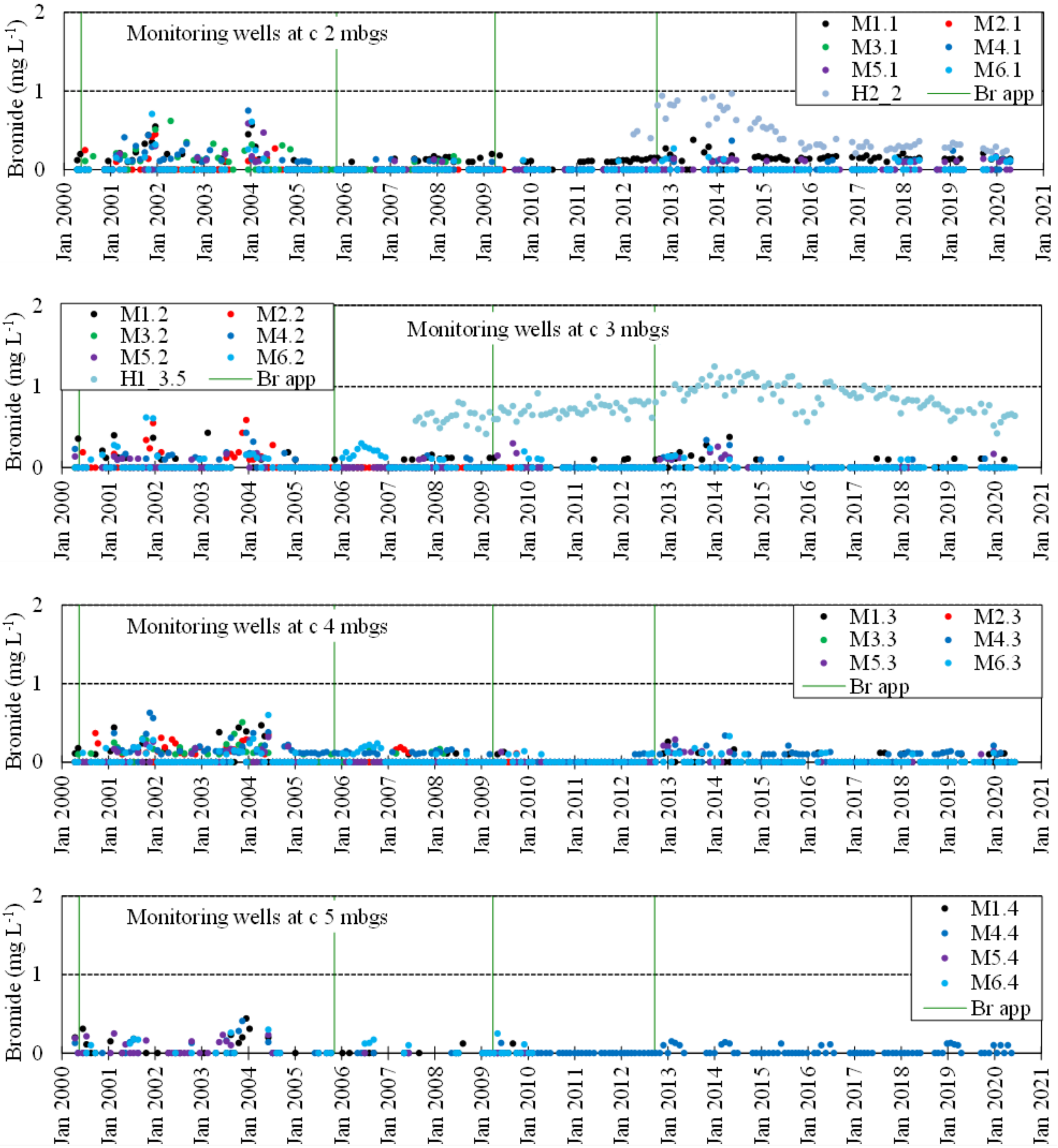


Figure A7.8. Measured bromide concentrations in the groundwater at Estrup.

In general, the majority of the maximum bromide concentrations reach the screens at ~2-5 mbgs within ~2 years after application, but maximum concentration levels are measured up to several years after application. For all the sampled depths, it is noted that bromide concentrations above the detection limit are measured before and after the transport times representing maximum concentrations.

Bromide leaching at Faardrup

At Faardrup, bromide was applied three times (October 1999, August 2008, and April 2012) as 30 kg/ha potassium bromide.

In the suction cups, samples were only collected with the October 1999 and April 2012 applications. In the suction cups located 1 mbgs, the maximum bromide concentrations after October 1999 and April 2012 applications are measured within 6-15 and 13-15 months (Figure A7.9).

In the suction cups located 2 mbgs, the maximum bromide concentrations after October 1999 and April 2012 applications are measured within 48 and 26-43 months (Figure A7.9).

The time range in which the maximum concentrations are measured in the suction cups at 1 mbgs is overall 12 months after application, while at 2 mbgs, the average time for the breakthrough of maximum concentrations is much slower around 41 months (Figure A7.9). After the April 2012 application, it is noted that at suction cups in the S1 nest, the measured concentrations are substantially higher compared to those measured at nest S2. Here, concentrations are up to a factor of 20 higher in nest S1 compared to S2. The reason for this is unknown and not readily explained. Despite the difference in concentration magnitude, the pattern of the measured breakthrough curve at 1 mbgs of S1 and S2 is similar. Generally, the pulse of breakthrough curves in the variably saturated zone is wider compared to those observed at the sandy field Jyndevad (Figure A7.1) and coincident with those observed at the other clay-till fields (Fig A7.4 and A7.7).

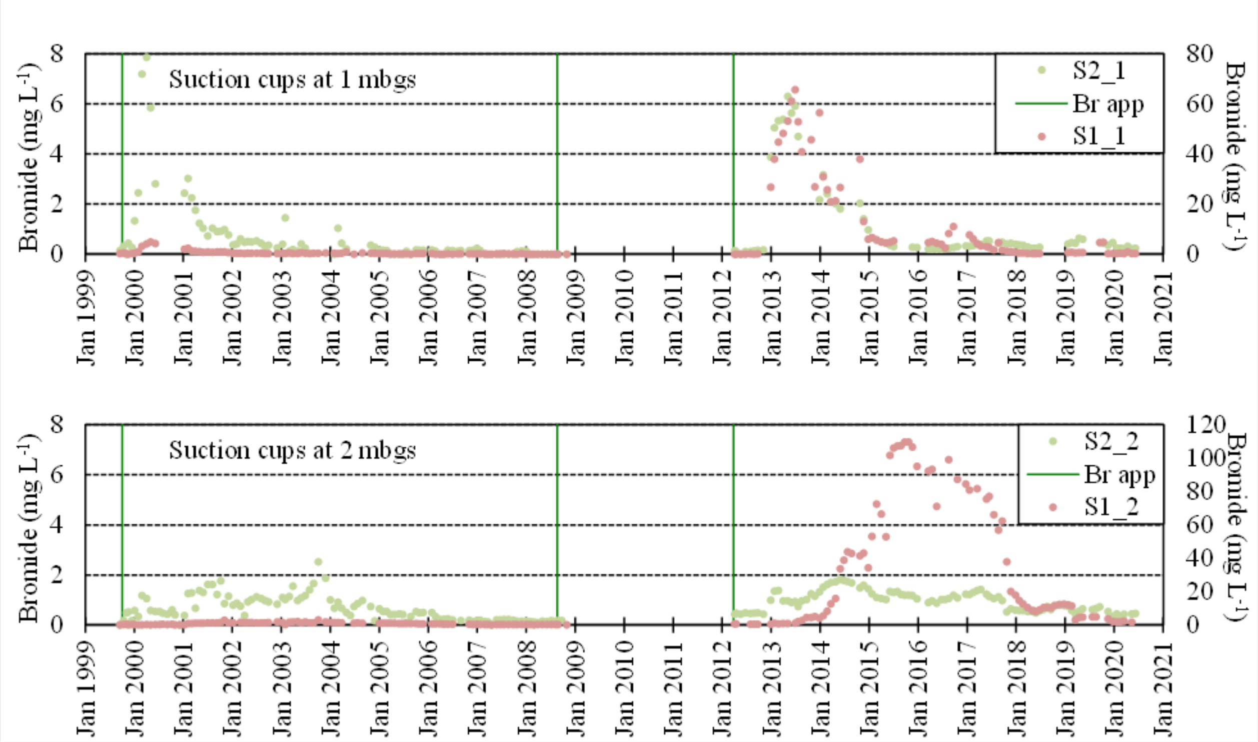


Figure A7.9. Measured bromide concentrations at Faardrup. The measured concentrations in the S1 nest are substantially larger than those measured in the nest S2. Therefore, the S1 measurements are denoted on the right y-axis.

The samples representing drainage from around 1 mbgs are collected in a drain well collecting drainage from the entire field (Figure A7.10). Therefore, no ranges are reported for the drainage samples. The maximum concentrations in the drainage after October 1999, August 2008, and April 2012 applications are measured after 16, 10, and 9 months, respectively (Figure A7.10). Compared to the other clay-till fields (Silstrup and

Estrup), where the maximum bromide concentrations are measured after the first drainage event following an application, Faardrup seems to differ. Here, maximum concentrations are not necessarily coincident with the first drainage event. Still, detections of bromide during drainage events are continuous throughout all monitoring periods.

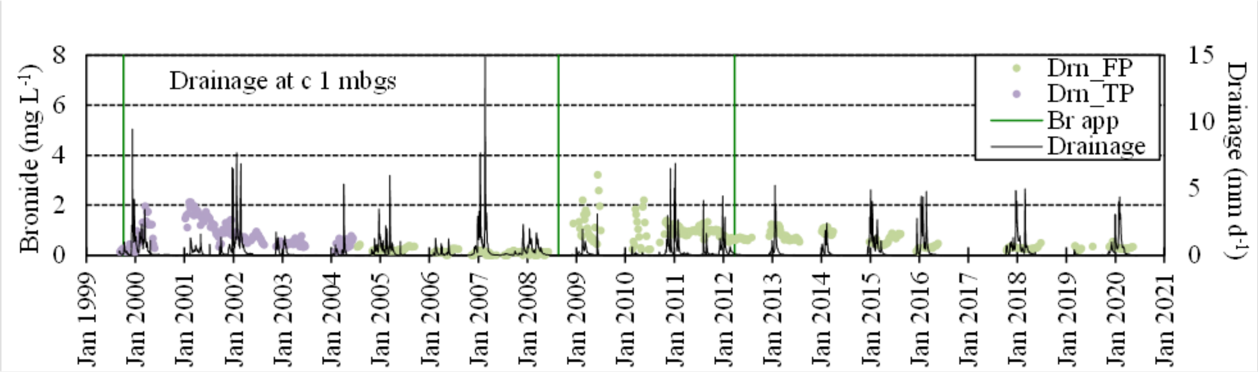


Figure A7.10. Measured bromide concentrations in the drainage at Faardrup. The suffix FP and TP refer to flow- and time-proportional sampling, respectively, which are described in Kjær et al. (2004).

In the groundwater sampling, results are based on measured bromide concentrations in all wells except M2 (Figure A7.11). M2 is regarded as an upstream well. However, as bromide is measured in M2, although in low concentrations (generally < 0.5 mg/L), further analysis is needed to fully understand the groundwater flow dynamics across the field. Such analyses are under preparation for all the fields. However, for the sake of simplicity, in the present analysis, M2 is assumed not to be part of the flow field represented by the remaining wells.

In the groundwater samples from ~2 mbgs, the maximum bromide concentrations after October 1999, August 2008, and April 2012 applications are measured within 24-56, 10-34, and 3-25 months (Figure A7.11).

In the groundwater samples from ~3 mbgs, the maximum bromide concentrations after October 1999, August 2008, and April 2012 applications are measured within 24-57, 10-40, and 26-62 months (Figure A7.11).

In the groundwater samples from ~4 mbgs, the maximum bromide concentrations after October 1999, August 2008, and April 2012 applications are measured within 26-67, 11-42, and 61-90 months (Figure A7.11).

In the groundwater samples from ~5 mbgs, the maximum bromide concentrations in October 1999, August 2008, and April 2012 applications are measured within 49-55, 11-34, and 62-63 months (Figure A7.11).

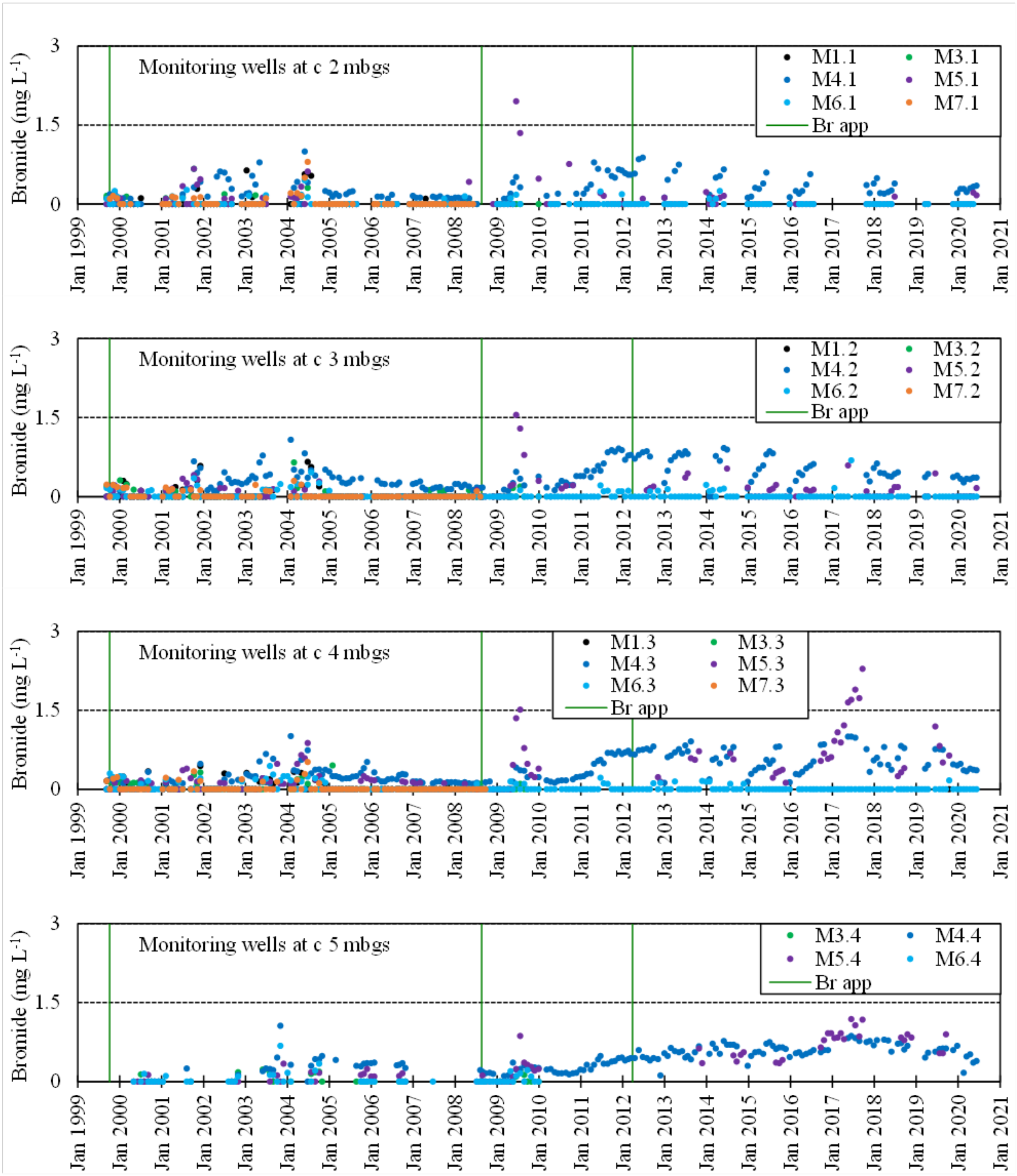


Figure A7.11. Measured bromide concentrations in the groundwater at Faardrup.

The average breakthrough time for maximum bromide concentrations is calculated from the time of measured maximum concentration within each of the wells representing a particular depth. Thus, for the October 1999, August 2008, and April 2012 applications, the average time for maximum bromide concentrations reaching depths at around 2, 3, 4, and 5 mbgs are 31, 44, 51, and 47 months, respectively. However, especially in the case of Faardrup, the average breakthrough time for the maximum concentration is difficult to use as a proxy for transport to the well screens. Hence, the sampling is not sufficiently detailed to achieve a general pattern of the bromide breakthroughs within the different depths. But from the depth interval around 2 to 4 mbgs, the average breakthrough times for maximum concentrations reaching the screens are increasing with depth from around 12 months to 51 months. From the depth interval around 4 to 5 mbgs, the average breakthrough time for the maximum concentration decreases from 51 to 47 months. This could be an artifact of having samples from fewer screens at ~5 mbgs, where the number of screens used to compute the average maximum concentration times is based on the average of eight screens compared to an average of 12-13 screens at the other depths.

Compared to the other clay-till fields (Silstrup and Estrup), the average breakthrough time for maximum concentrations to reach the different monitoring depths is longer at Faardrup. In the variably saturated zone in Faardrup, the average breakthrough time for maximum concentration to reach 1 mbgs is one year compared to half a year or less at the other clay-till fields. Similarly, at 2 mbgs at Faardrup, the maximum concentrations arrive after more than three years compared to around two years at the other clay-till fields. In the groundwater monitoring wells at Faardrup, the average breakthrough time for maximum concentrations at depths of ~2-5 mbgs vary between ~3-4 years, whereas the average breakthrough time at similar depths at the other clay-till sites varies between ~1-2 years. Based on these results, it seems that there is a general pattern of slower transport of bromide at Faardrup compared to the other clay-till fields.

In general, the majority of the breakthroughs for maximum bromide concentrations reach the screens at ~2-5 mbgs within 3.5 years after application, but bromide is detected in concentrations similar to the maximum concentration levels up to several years after application. For all the sampled depths, it is noted that bromide concentrations above the detection limit are measured before and after the transport times representing maximum concentrations.

9.8. Appendix 8 – Detailed pesticide plots

This appendix presents single plots at screen level for pesticide and/or degradation products leaching in concentrations exceeding the limit value of 0.1 µg/L in groundwater.

Azole tests at Jyndevad, 1,2,4-triazole monitoring

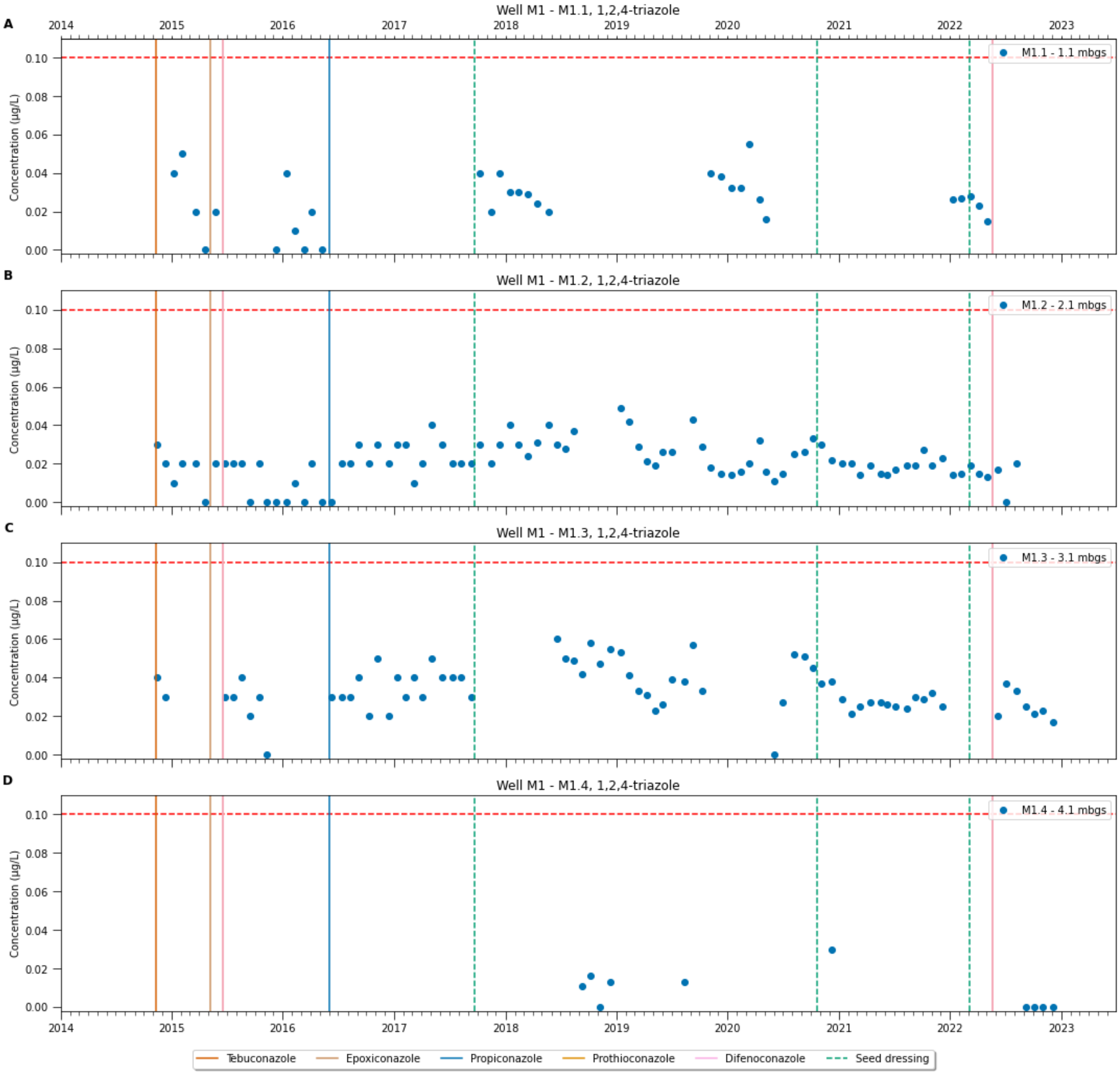


Figure A8.1. Leaching of 1,2,4-triazole at Jyndevad in well M1. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

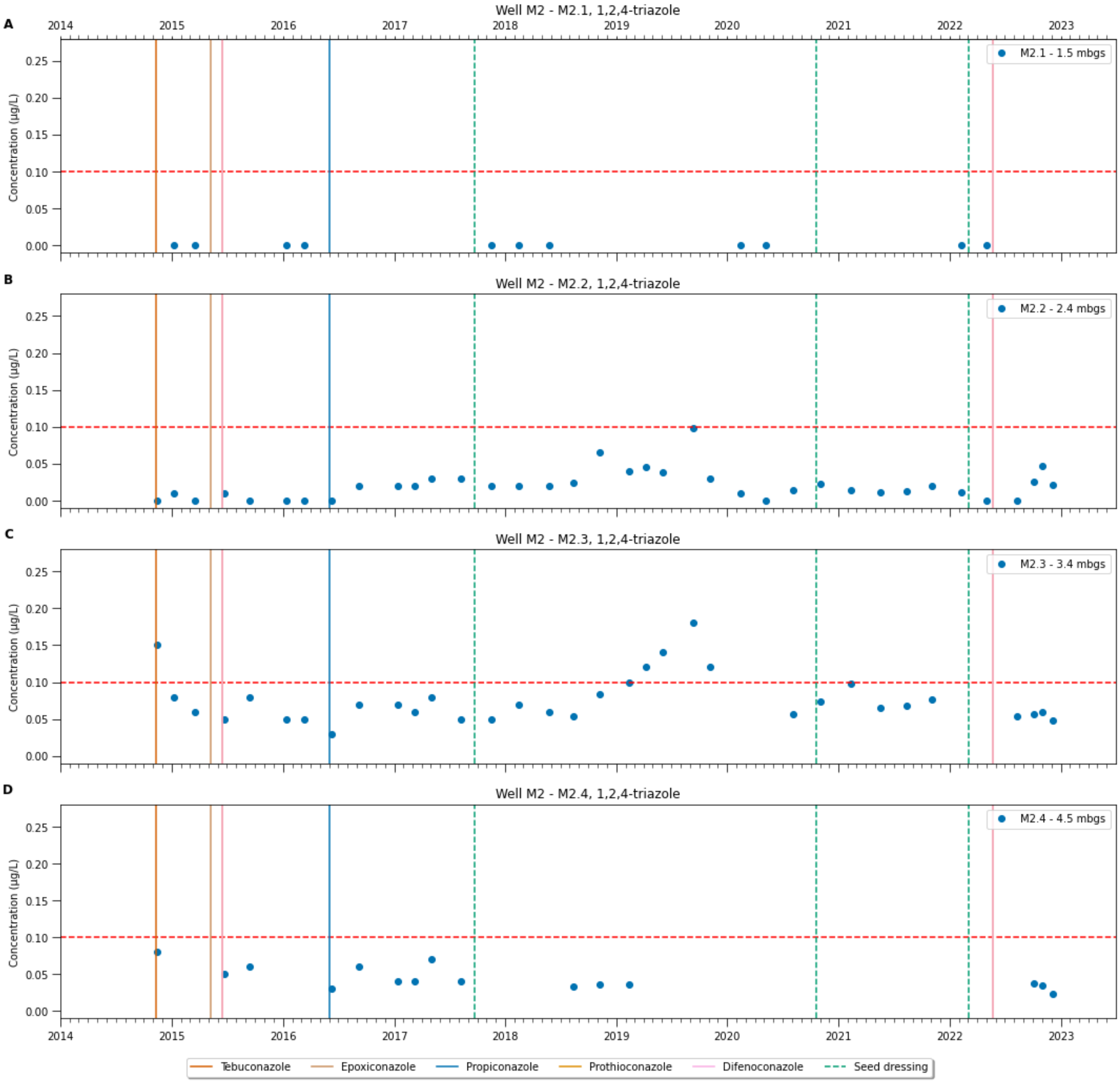


Figure A8.2. Leaching of 1,2,4-triazole at Jyndevad in well M2. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

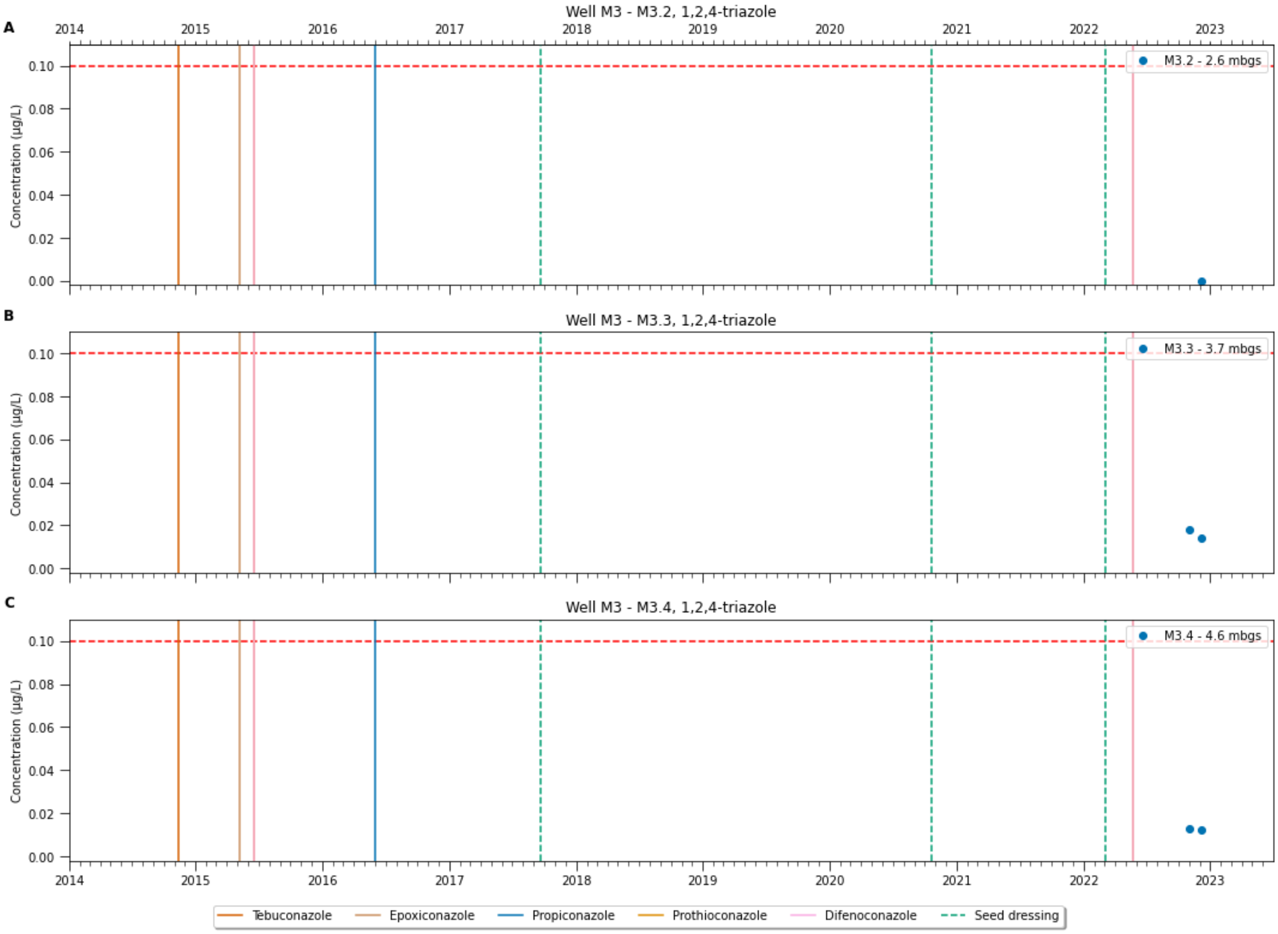


Figure A8.3. Leaching of 1,2,4-triazole at Jyndevad in well M3. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-C depicts the screen depths from which samples were collected.

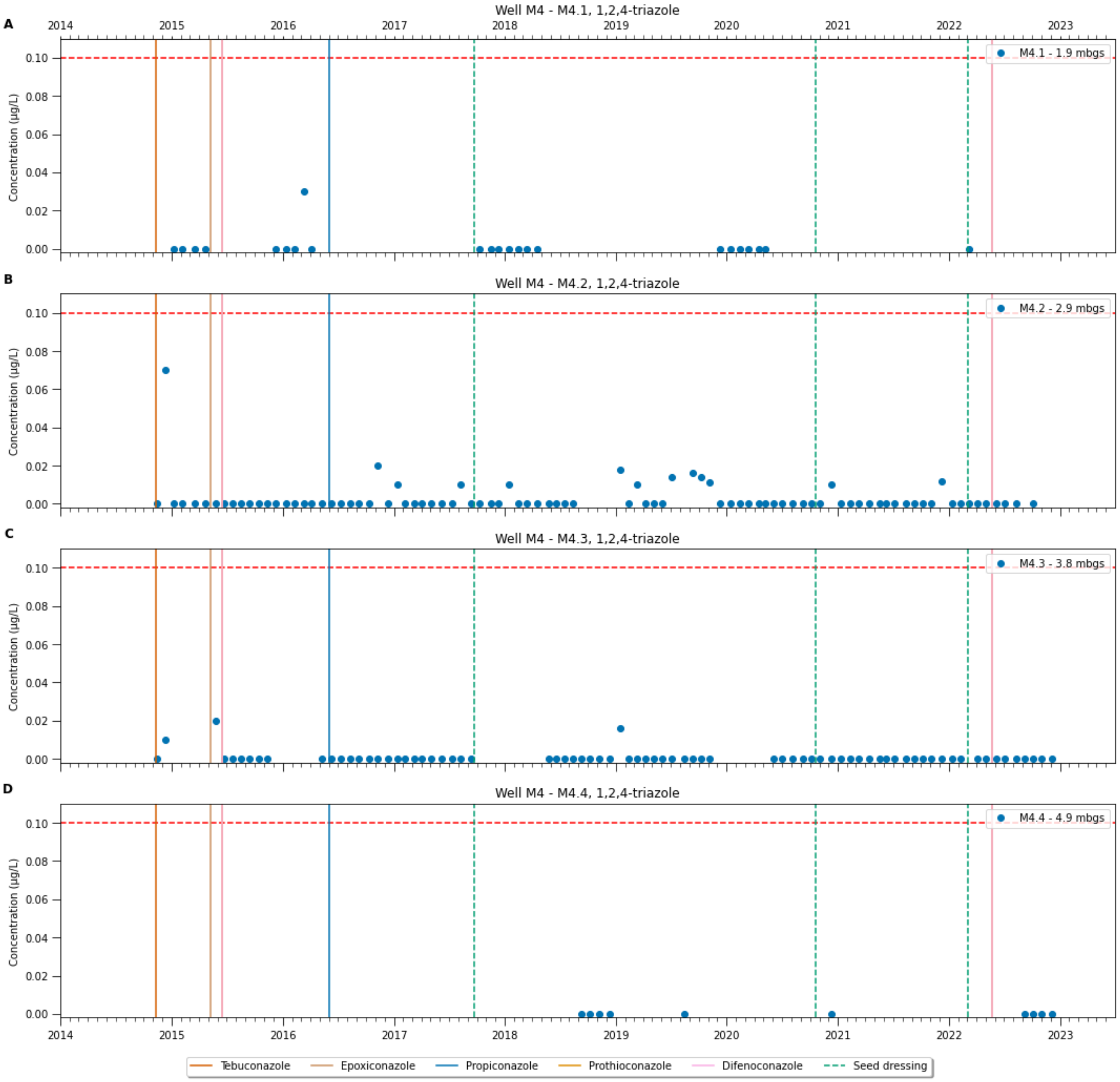


Figure A8.4. Leaching of 1,2,4-triazole at Jyndevad in well M4. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

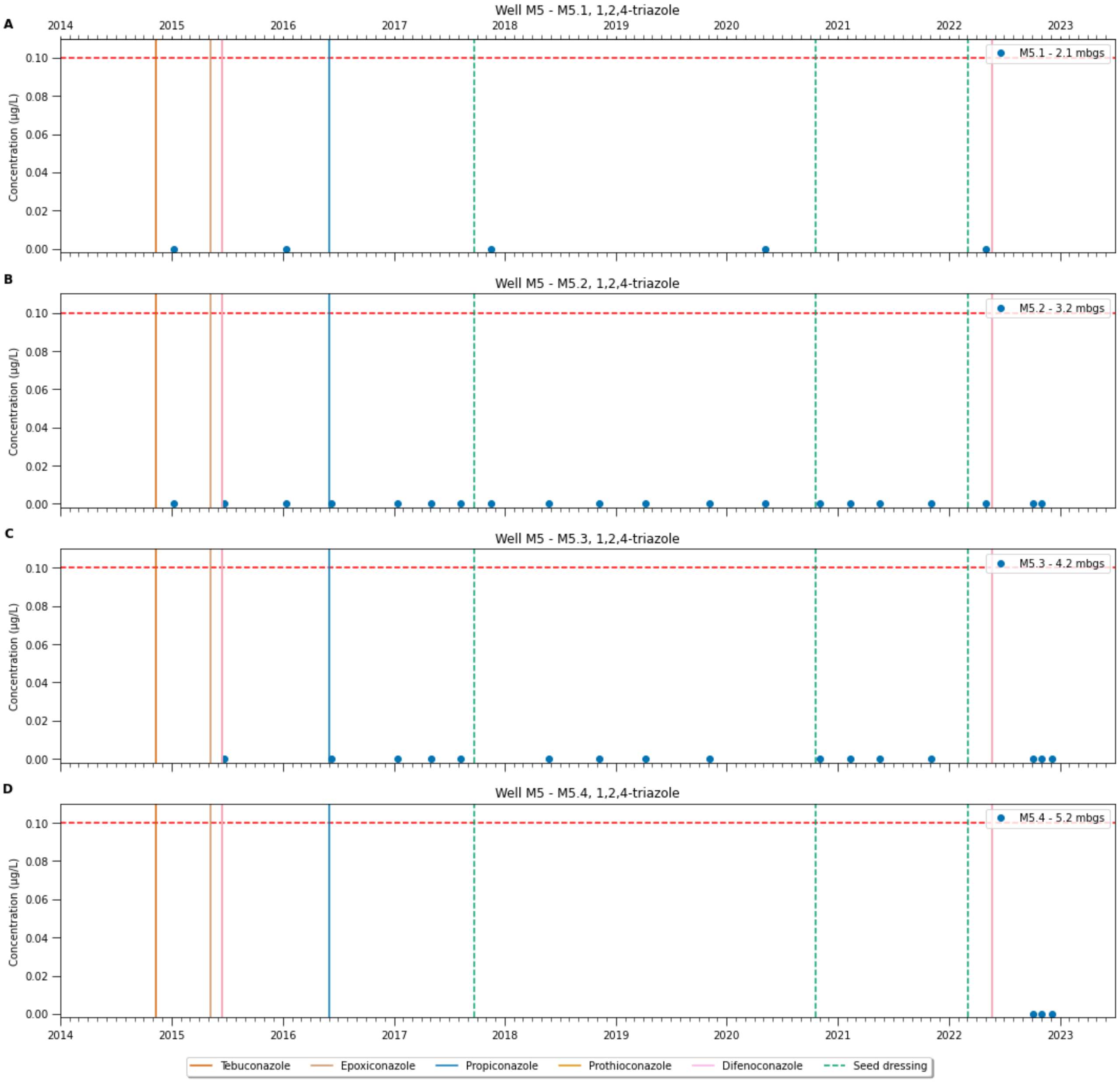


Figure A8.5. Leaching of 1,2,4-triazole at Jyndevad in well M5. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

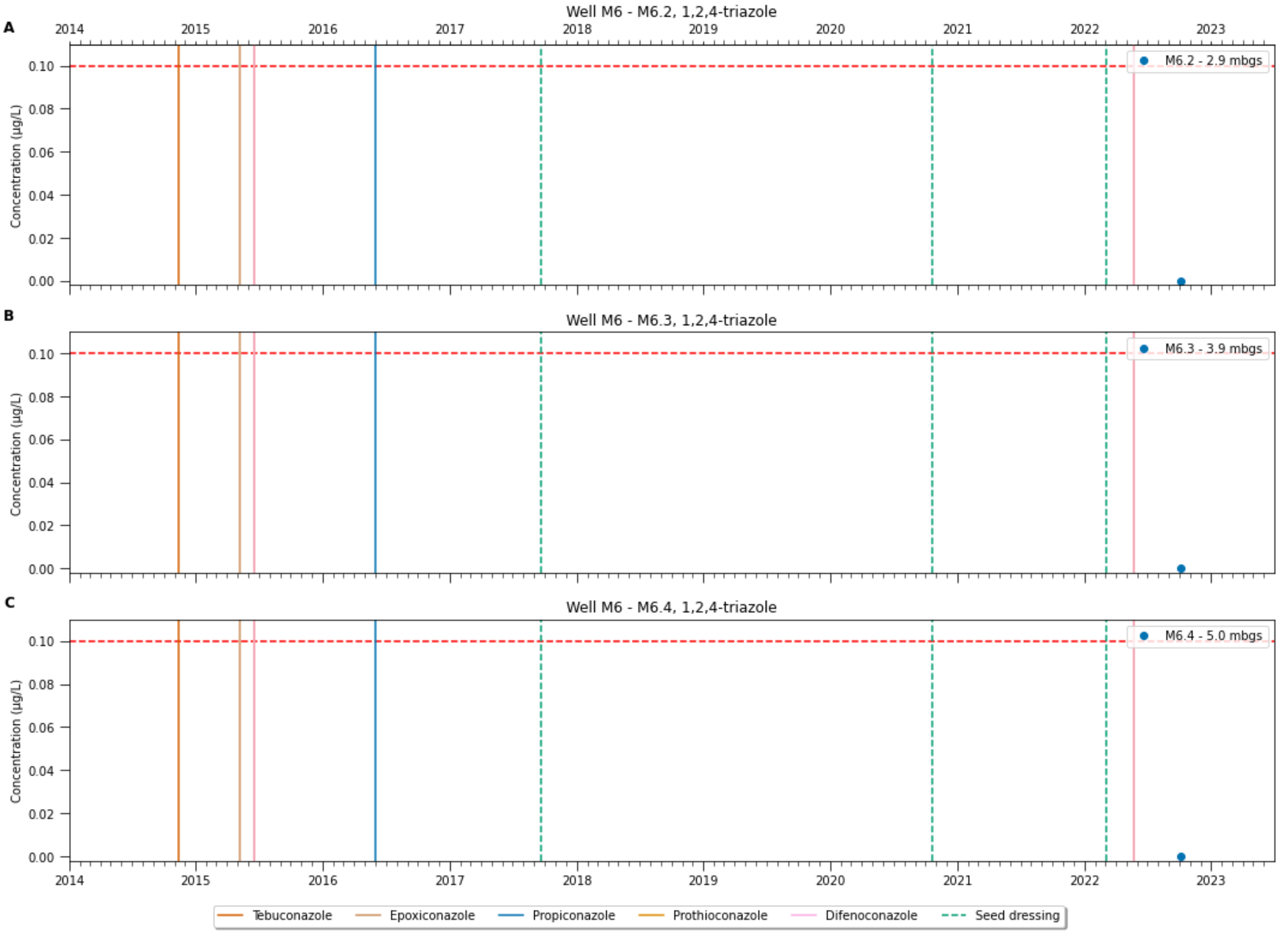


Figure A8.6. Leaching of 1,2,4-triazole at Jyndevad in well M6. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-C depicts the screen depths from which samples were collected.

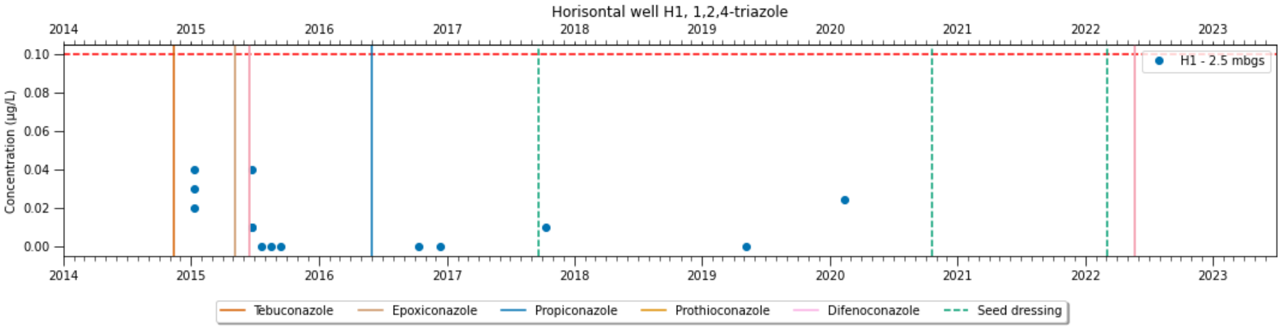


Figure A8.7. Leaching of 1,2,4-triazole at Jyndevad in the horisontal well, H1. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L.

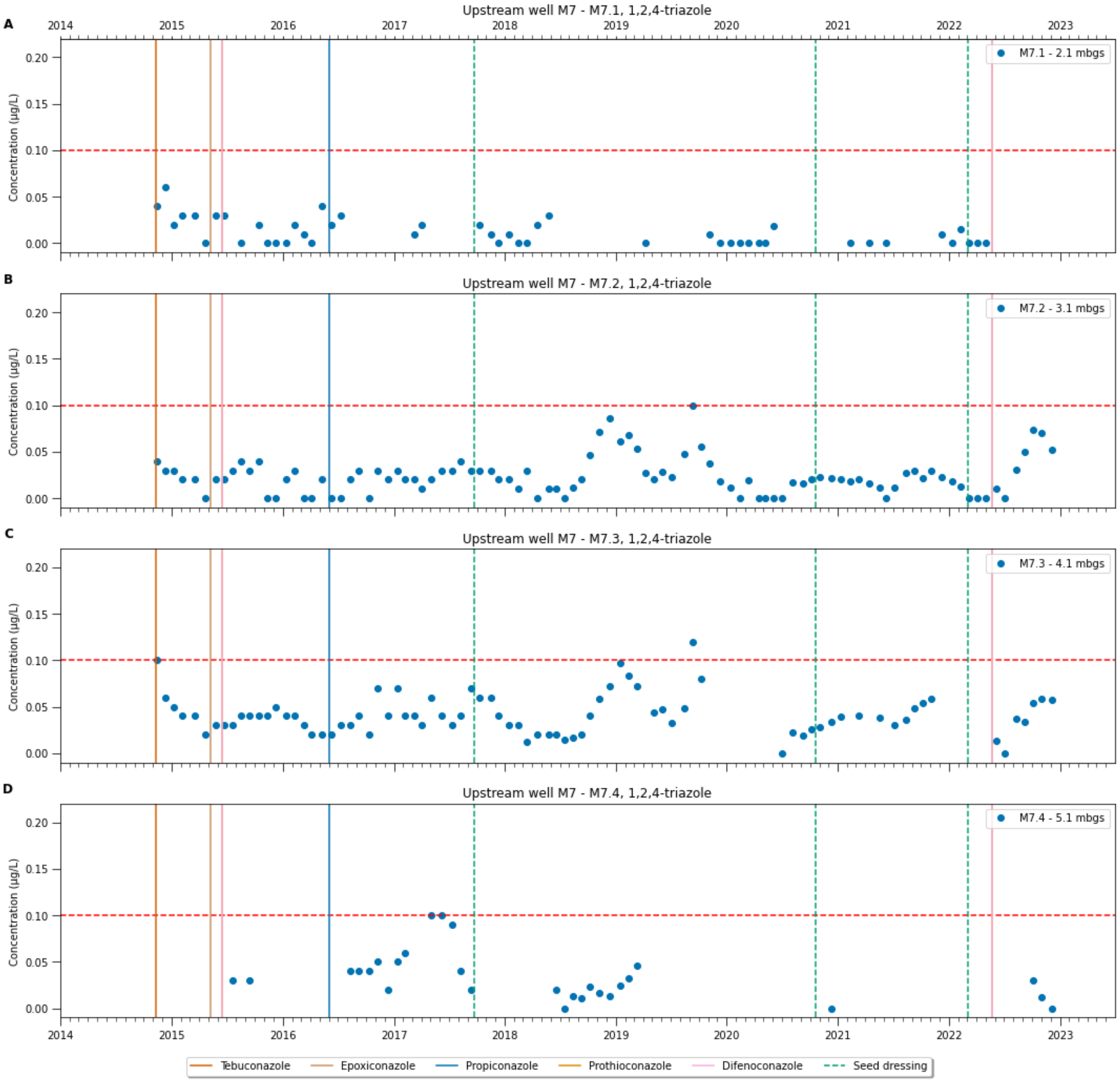


Figure A8.8. Leaching of 1,2,4-triazole at Jyndevad in the upstream well, M7. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

Azole tests at Silstrup, 1,2,4-triazole monitoring

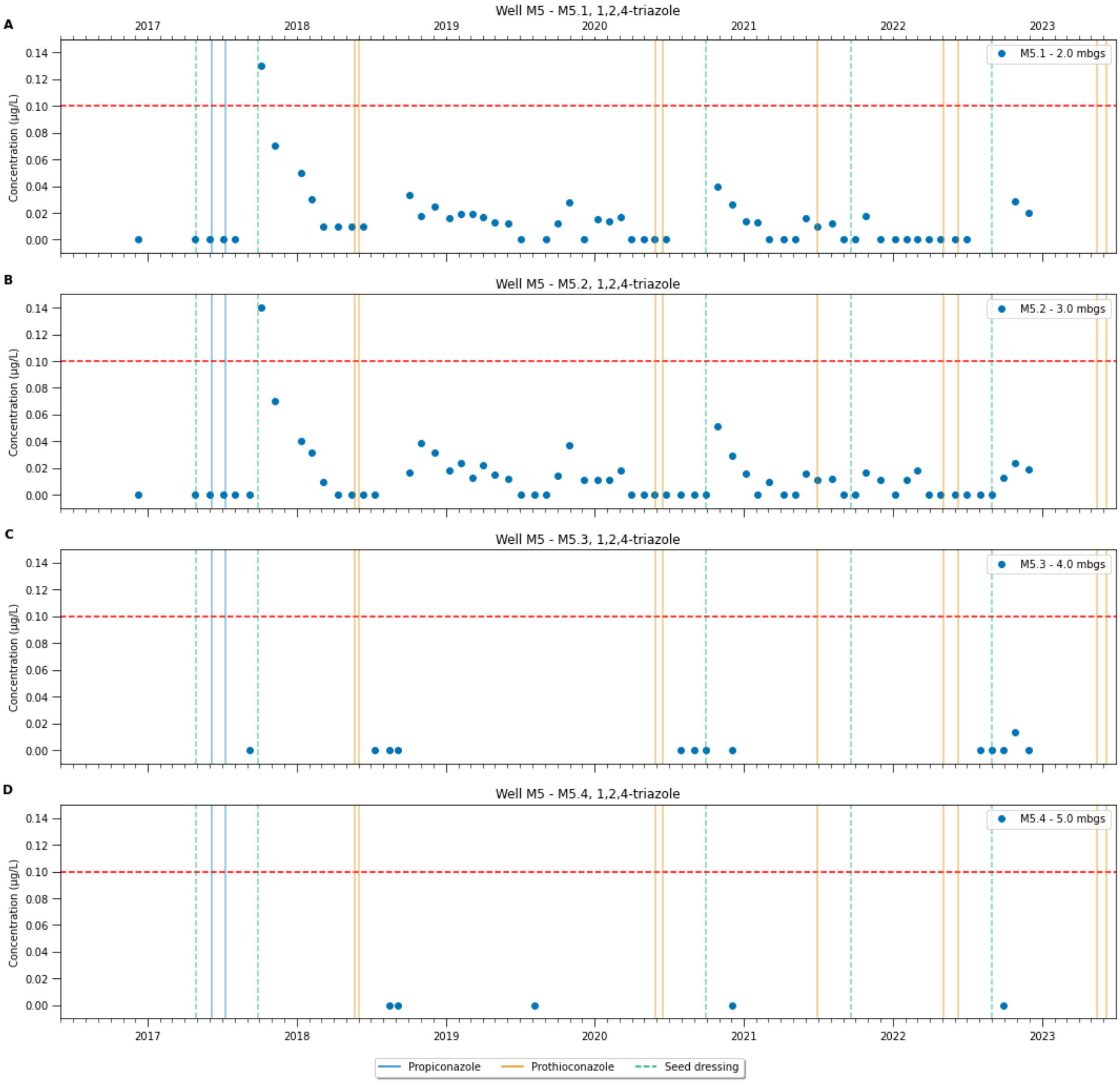


Figure A8.9. Leaching of 1,2,4-triazole at Silstrup in well M5. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

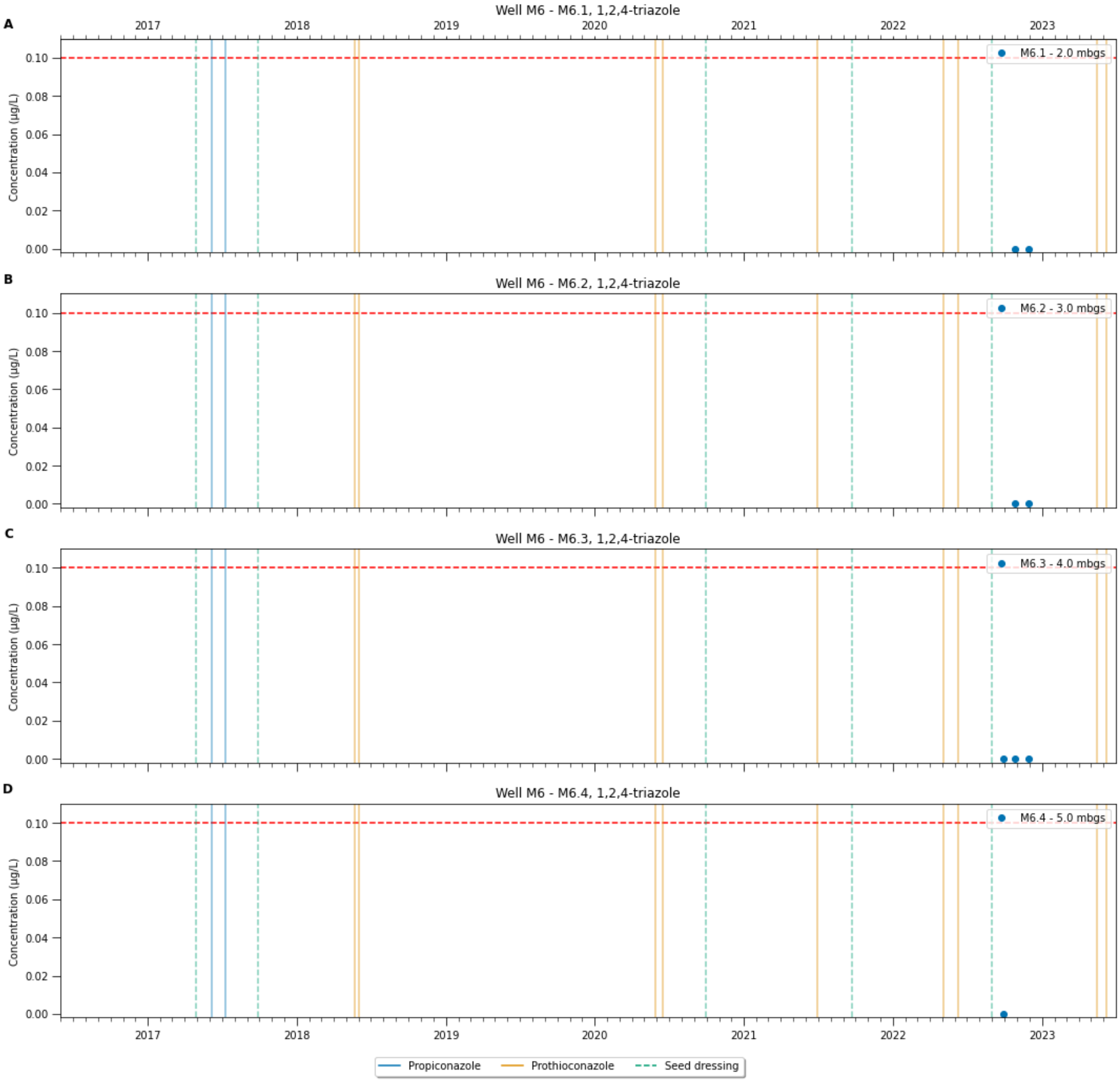


Figure A8.10. Leaching of 1,2,4-triazole at Silstrup in well M6. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

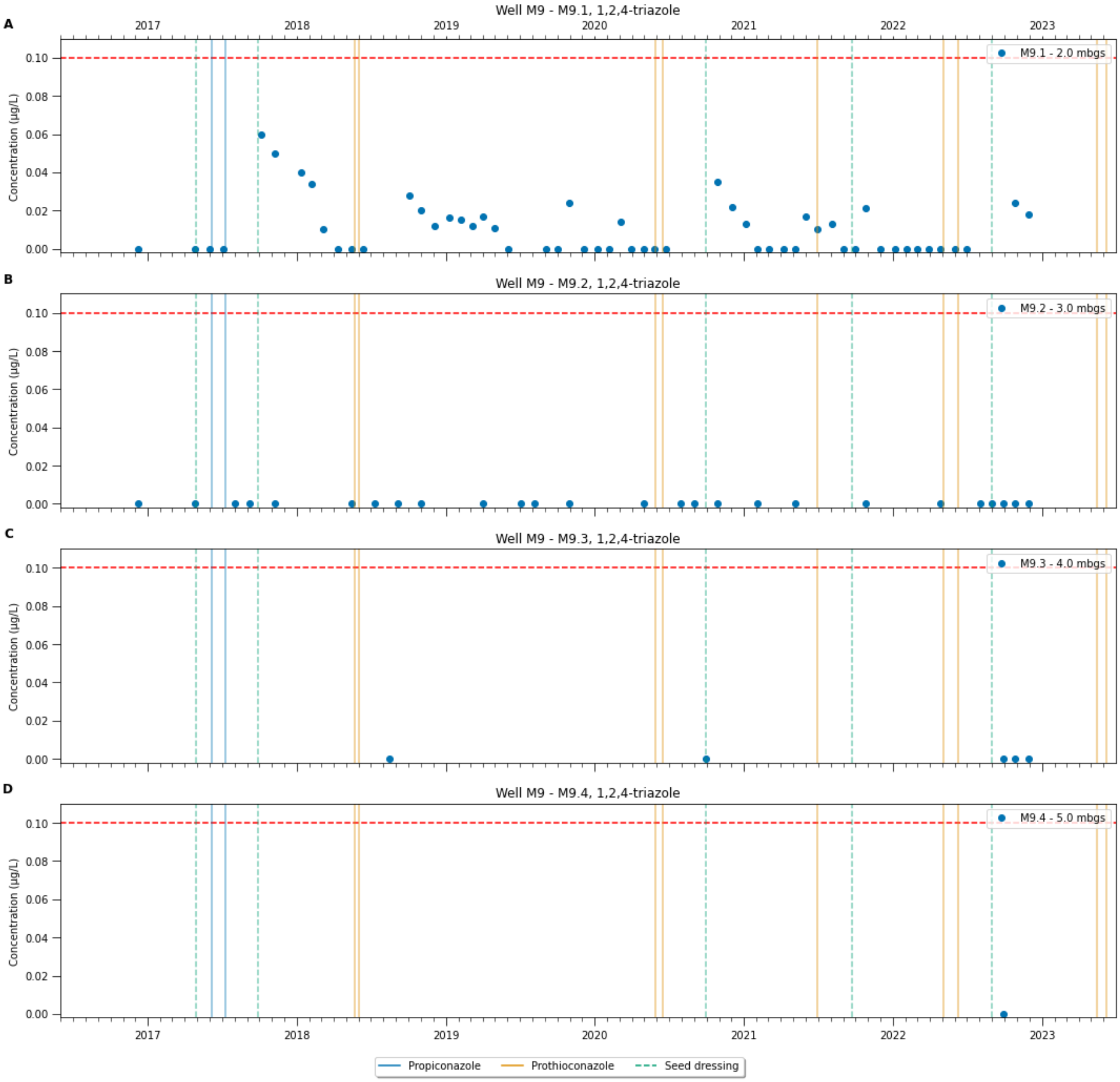


Figure A8.11. Leaching of 1,2,4-triazole at Silstrup in well M9. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

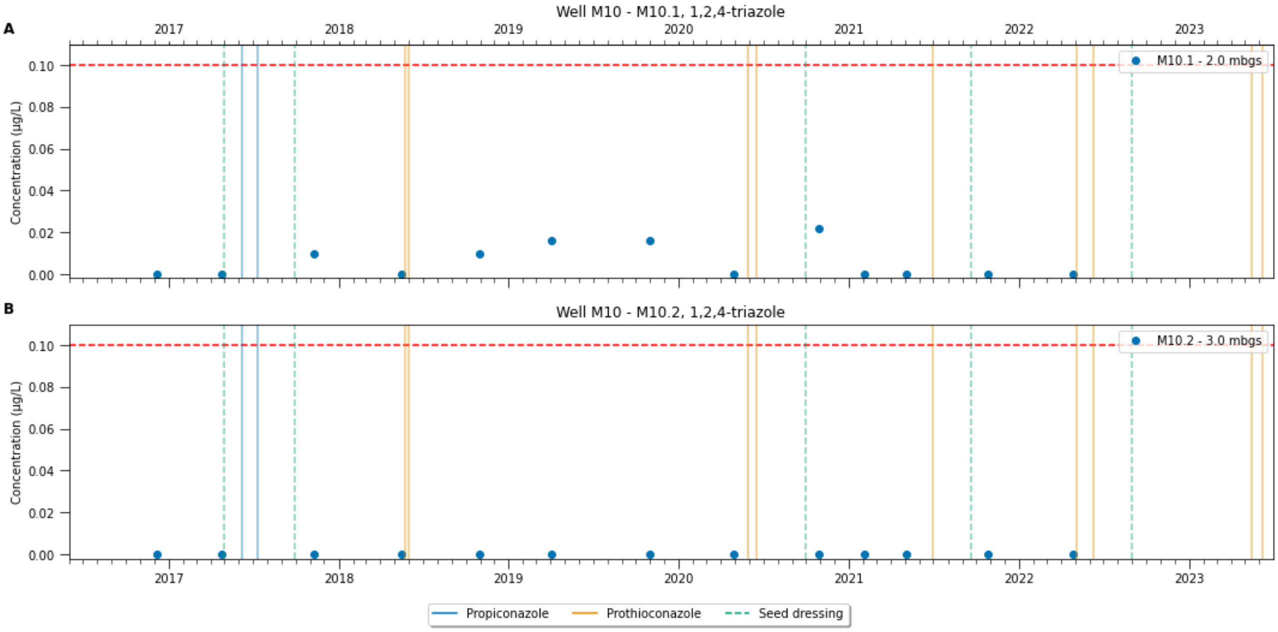


Figure A8.12. Leaching of 1,2,4-triazole at Silstrup in well M10. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

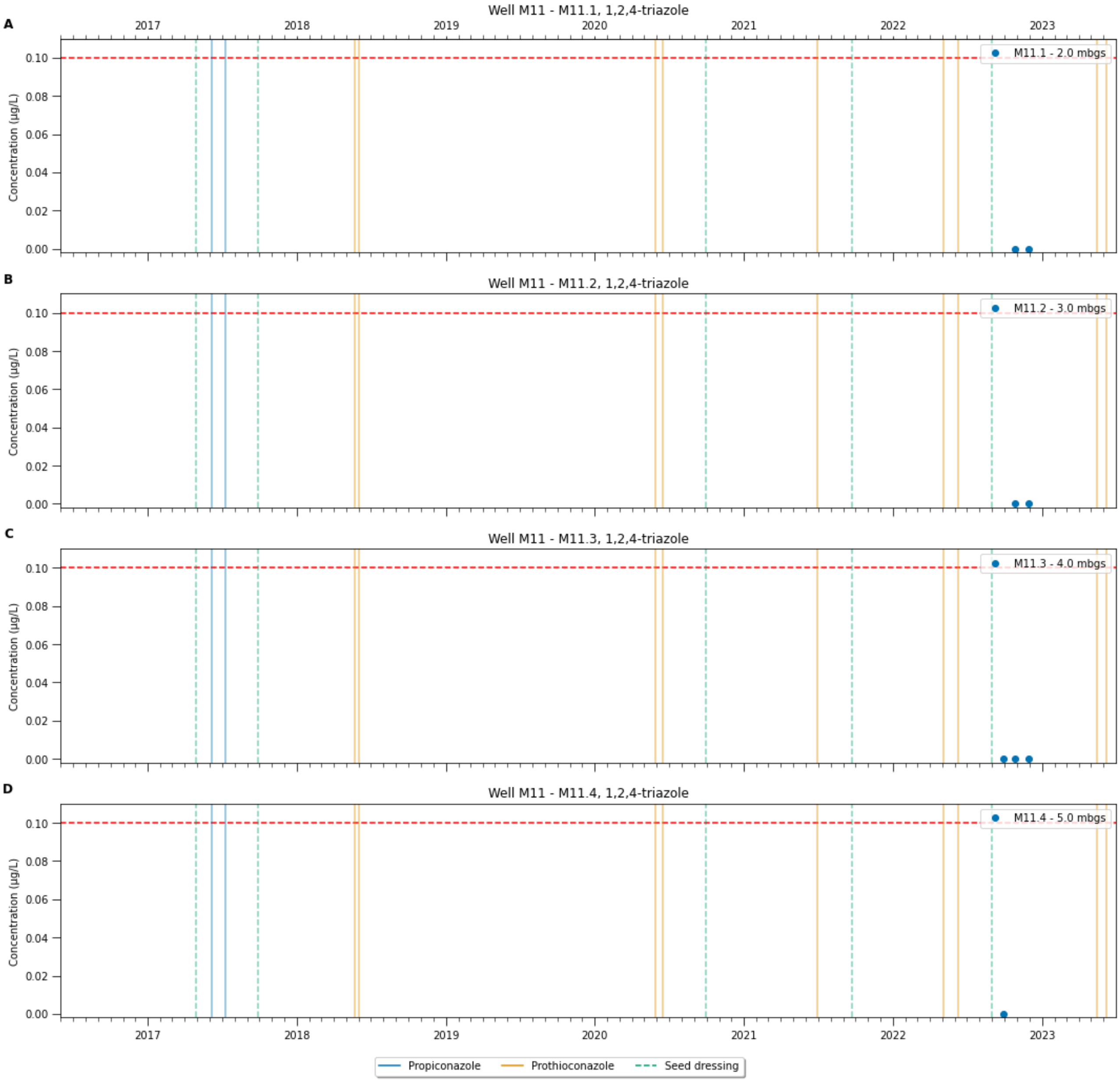


Figure A8.13. Leaching of 1,2,4-triazole at Silstrup in well M11. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

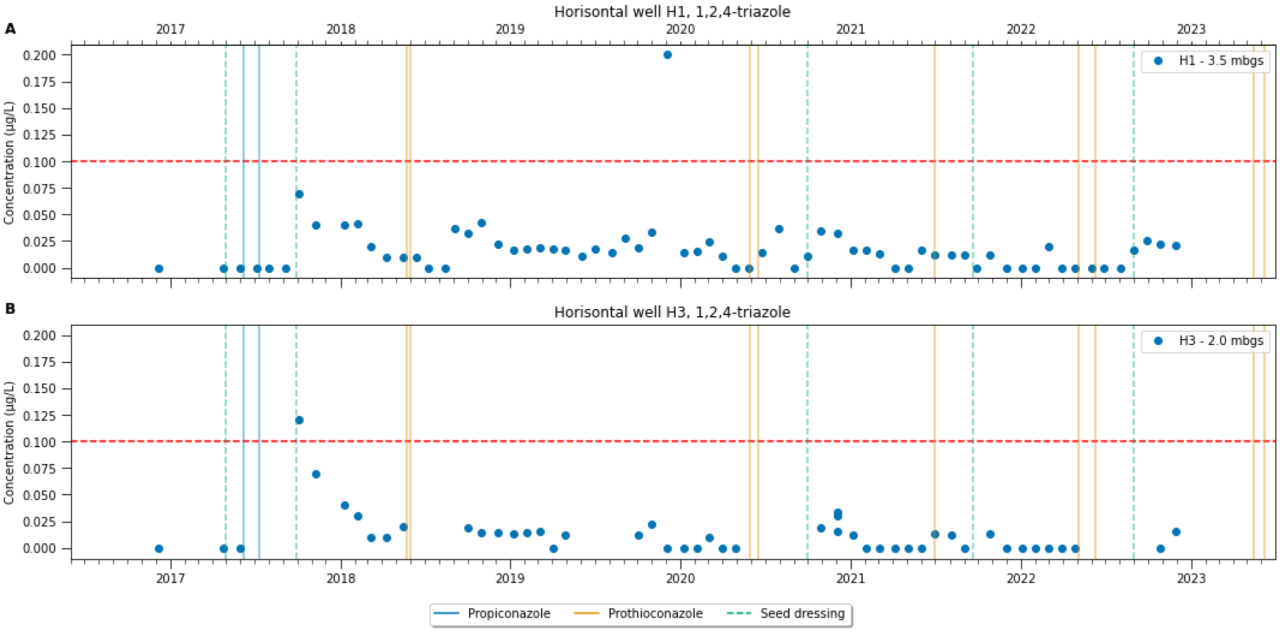


Figure A8.14. Leaching of 1,2,4-triazole at Silstrup in the horisontal wells, H1 and H3. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

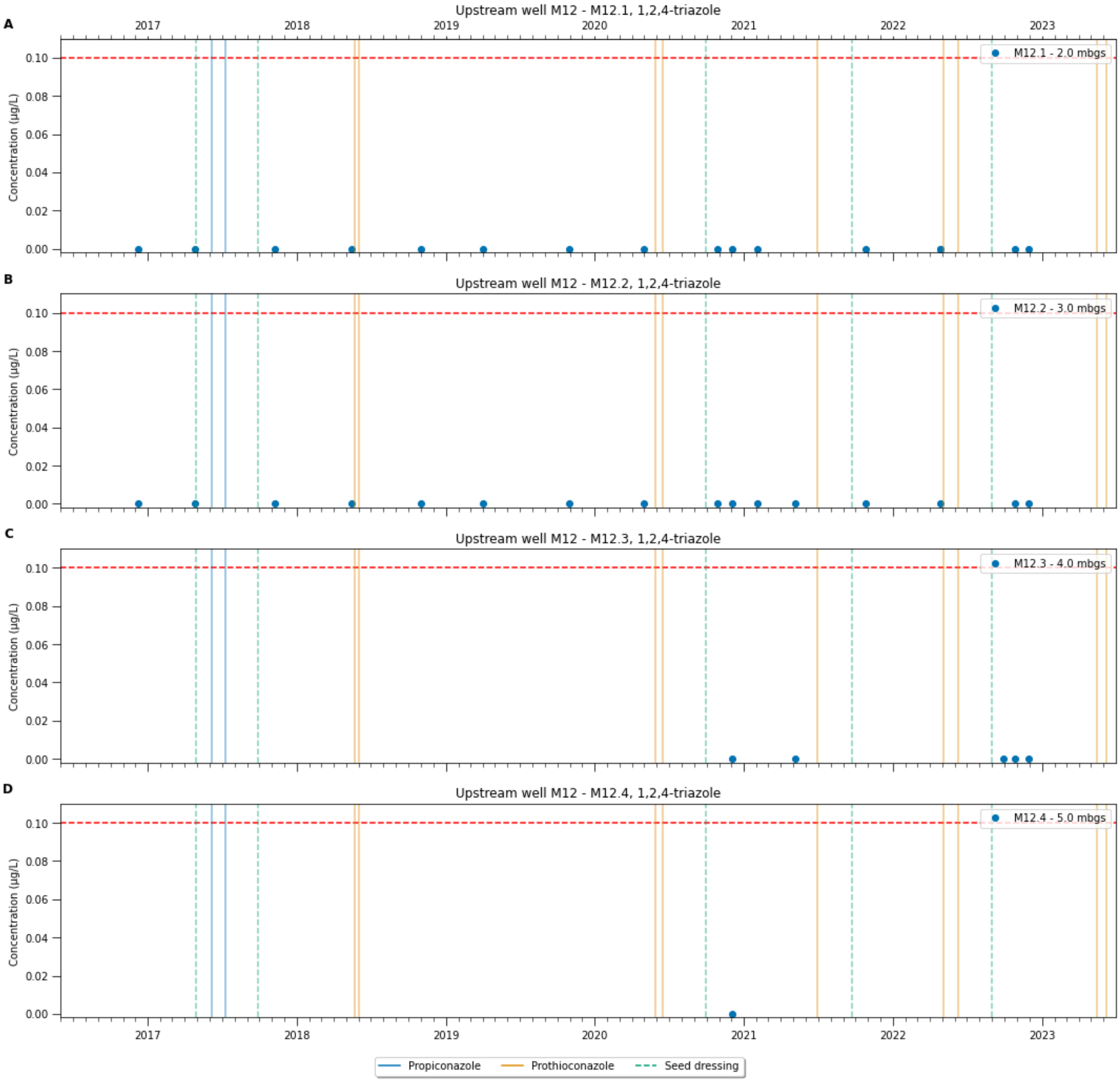


Figure A8.15. Leaching of 1,2,4-triazole at Silstrup in the upstream well, M12. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

Azole tests at Estrup, 1,2,4-triazole monitoring

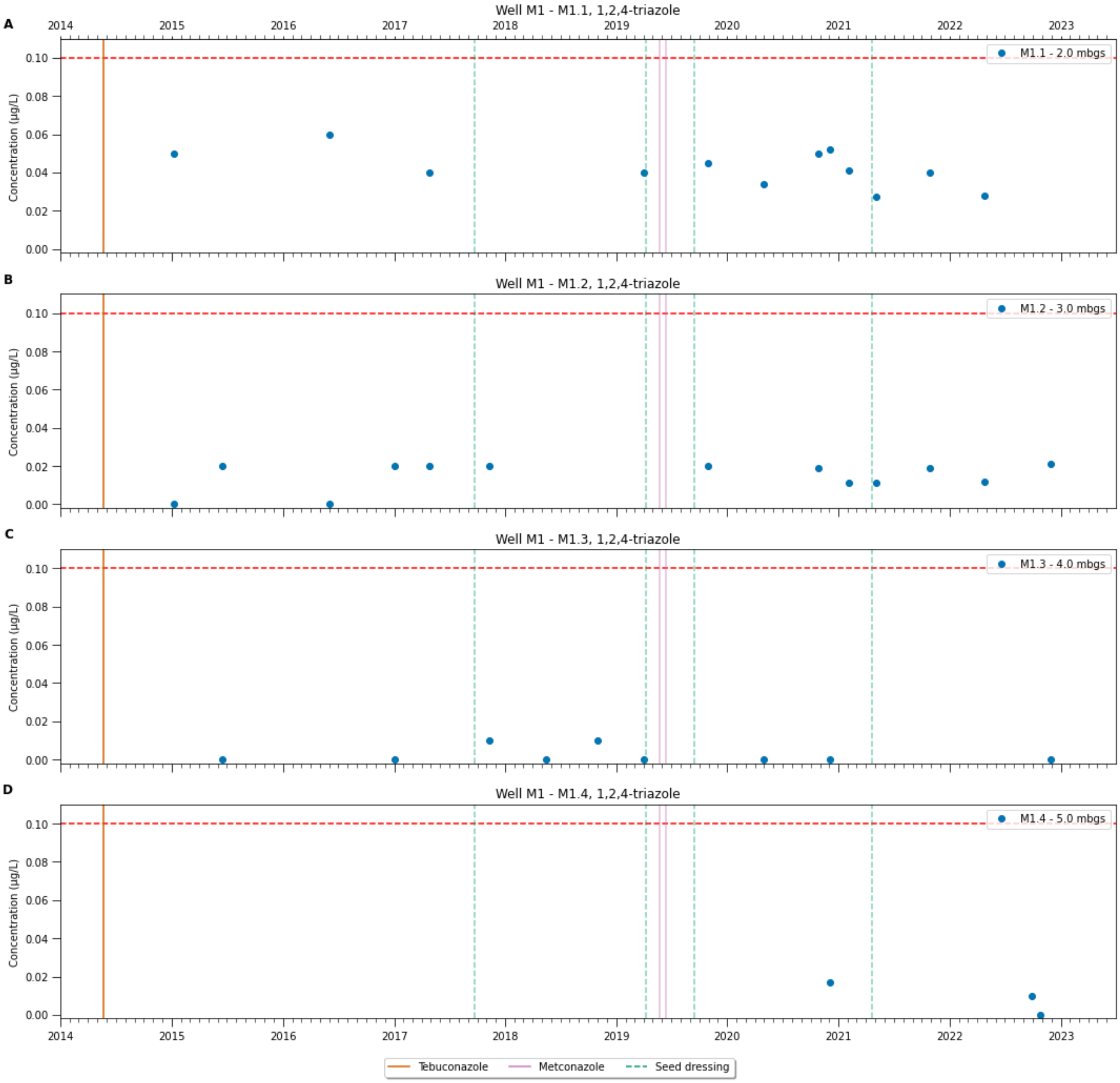


Figure A8.16. Leaching of 1,2,4-triazole at Estrup in well M1. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

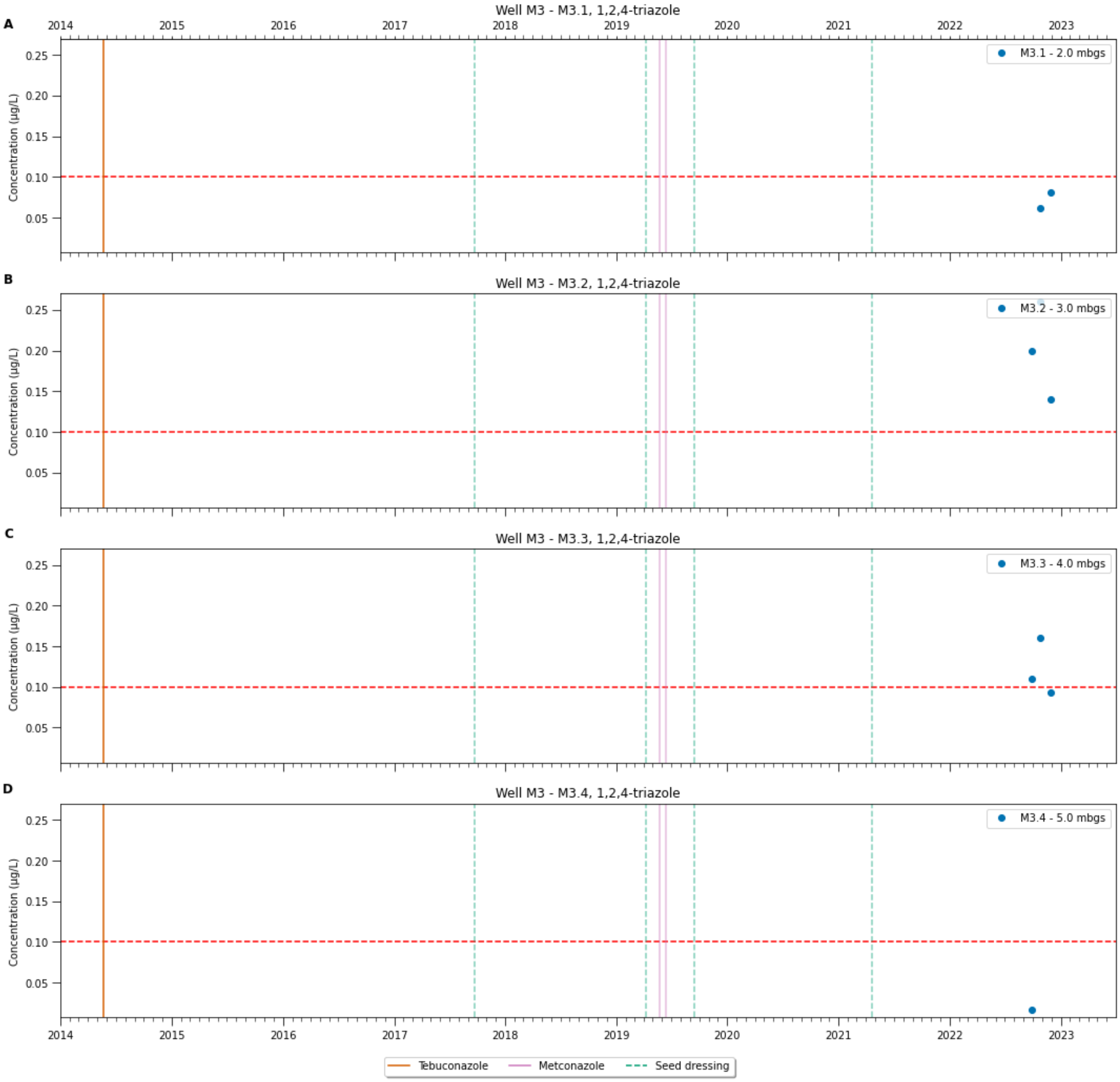


Figure A8.17. Leaching of 1,2,4-triazole at Estrup in well M3. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

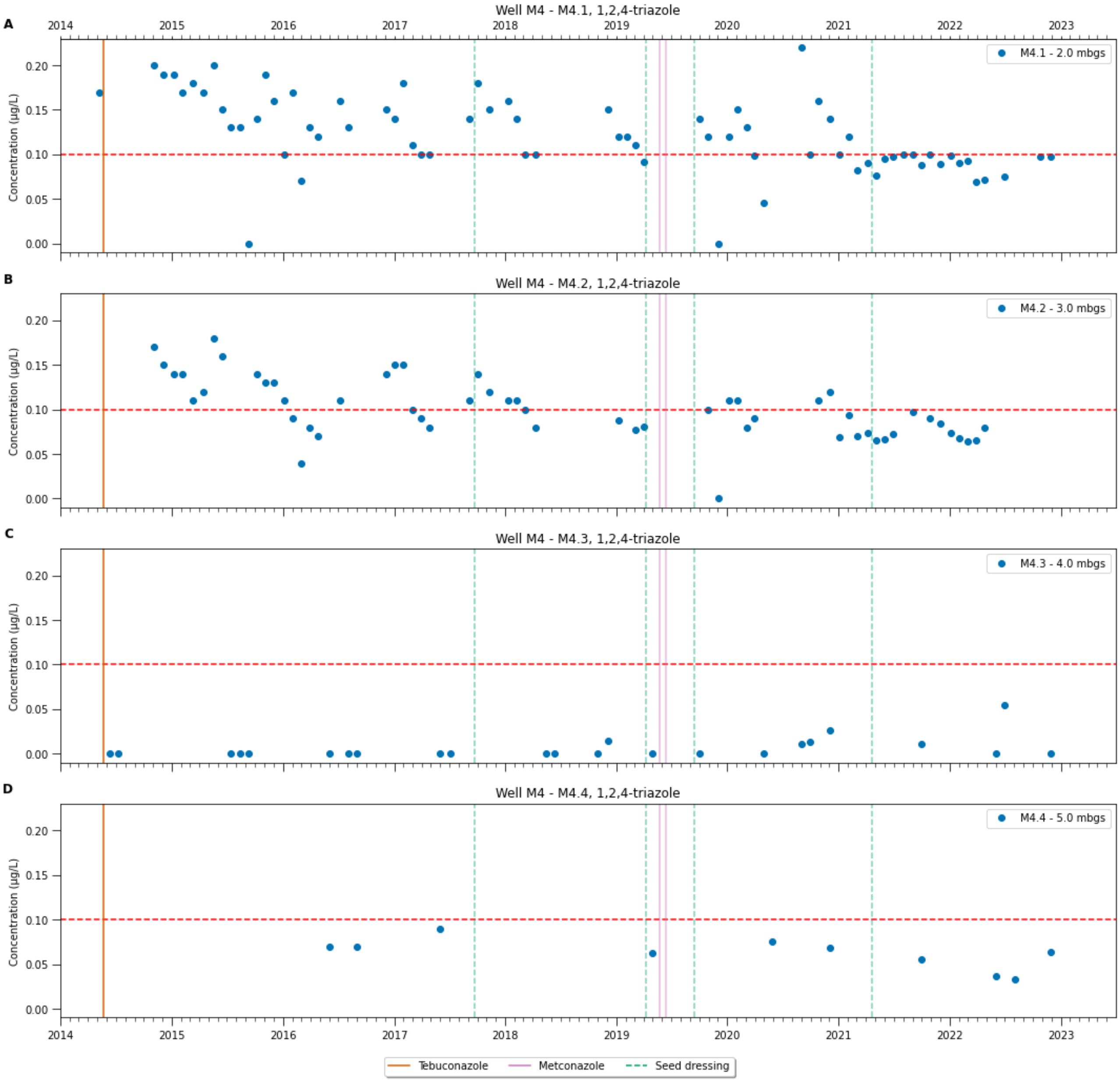


Figure A8.18. Leaching of 1,2,4-triazole at Estrup in well M4. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

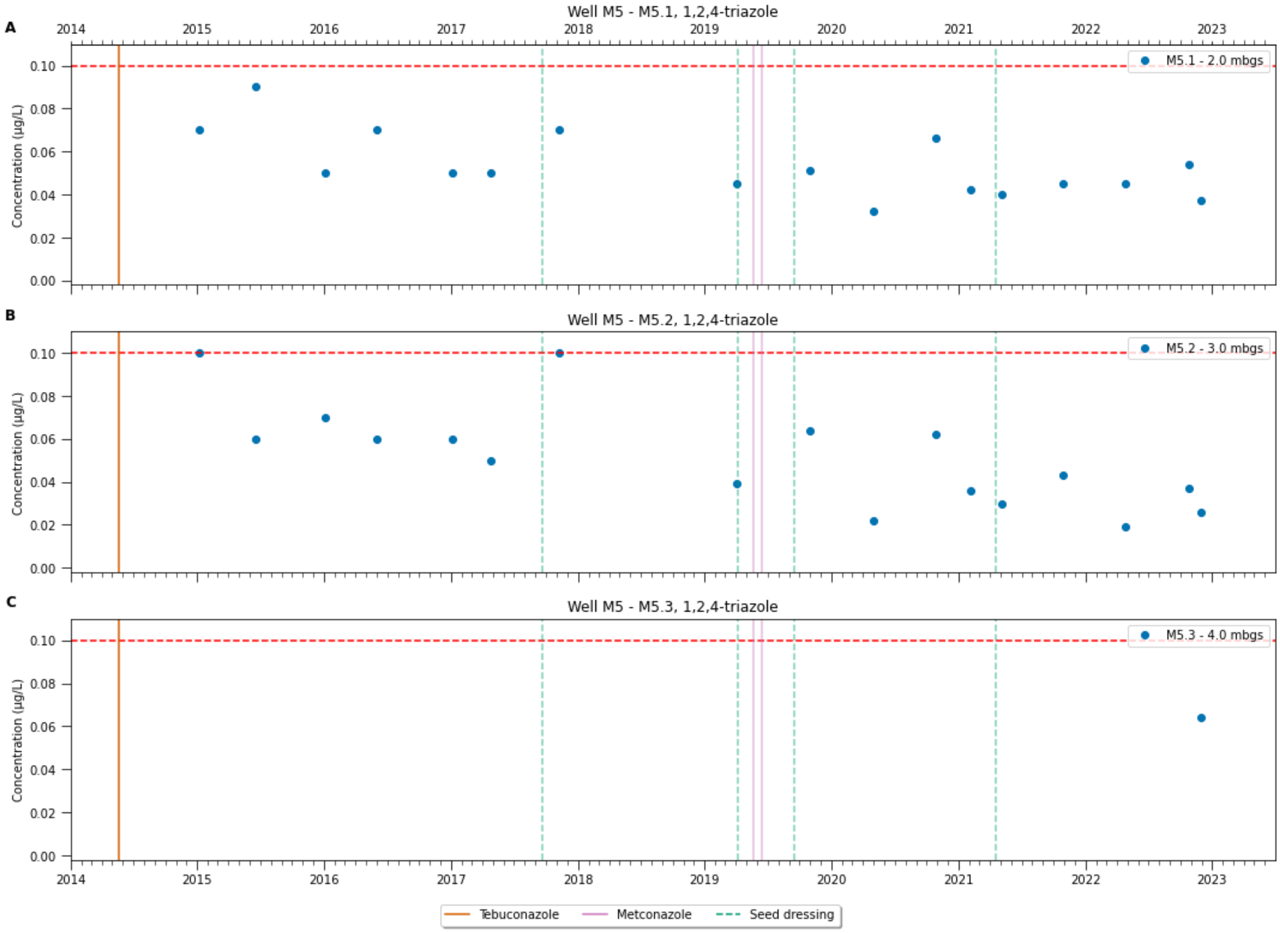


Figure A8.19. Leaching of 1,2,4-triazole at Estrup in well M5. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-C depicts the screen depths from which samples were collected.

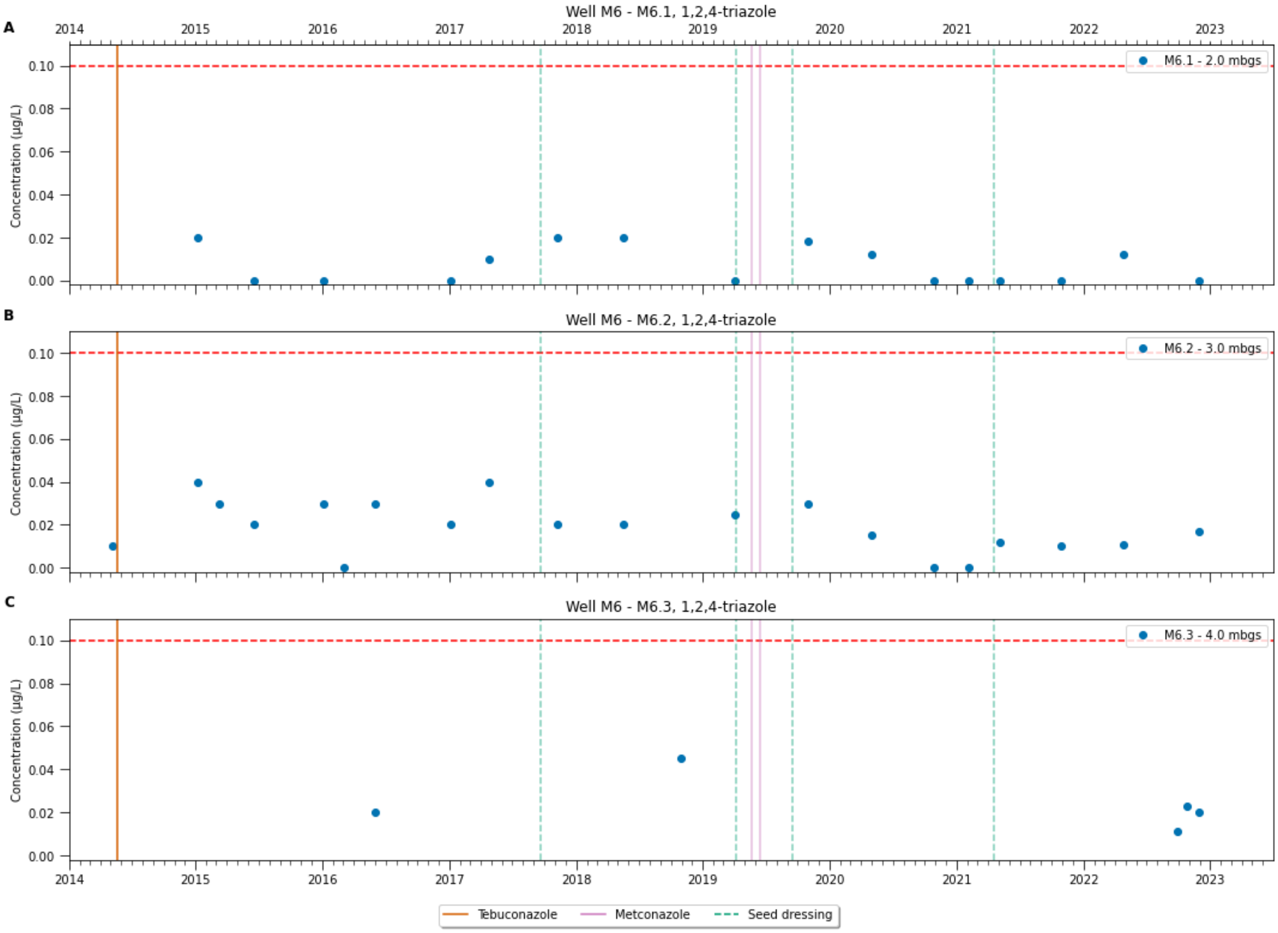


Figure A8.20. Leaching of 1,2,4-triazole at Estrup in well M6. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-C depicts the screen depths from which samples were collected.

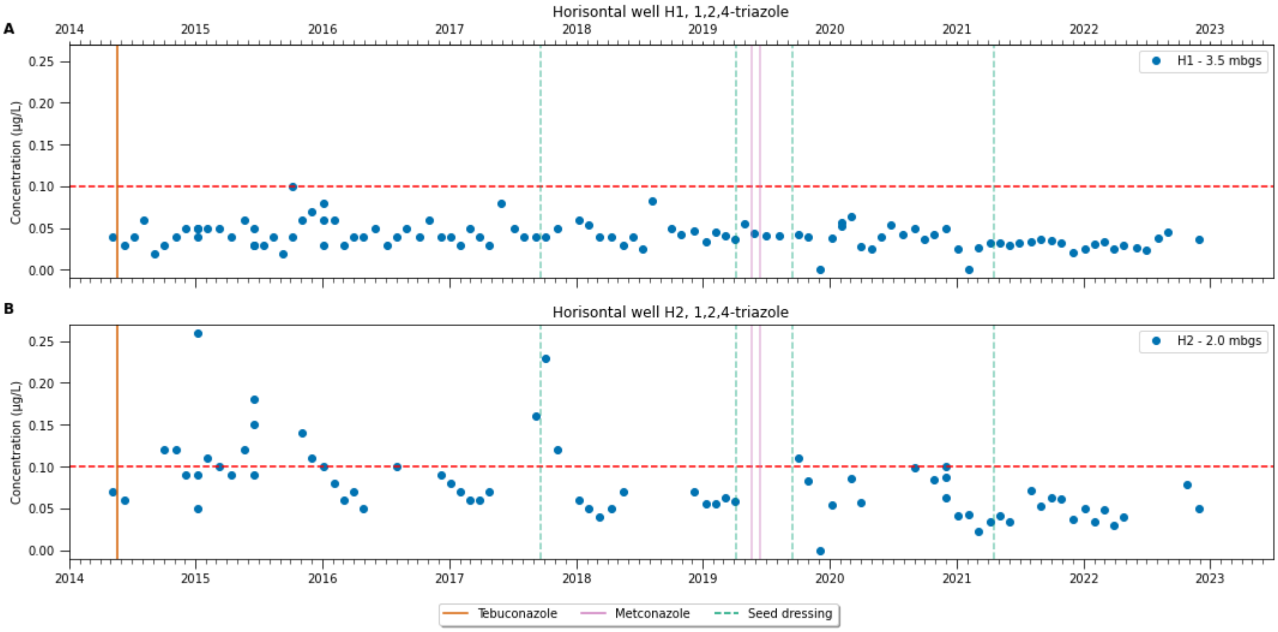


Figure A8.21. Leaching of 1,2,4-triazole at Estrup in the horisontal wells, H1 and H2. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-B depicts the screen depths from which samples were collected.

Azole tests at Faardrup, 1,2,4-triazole monitoring

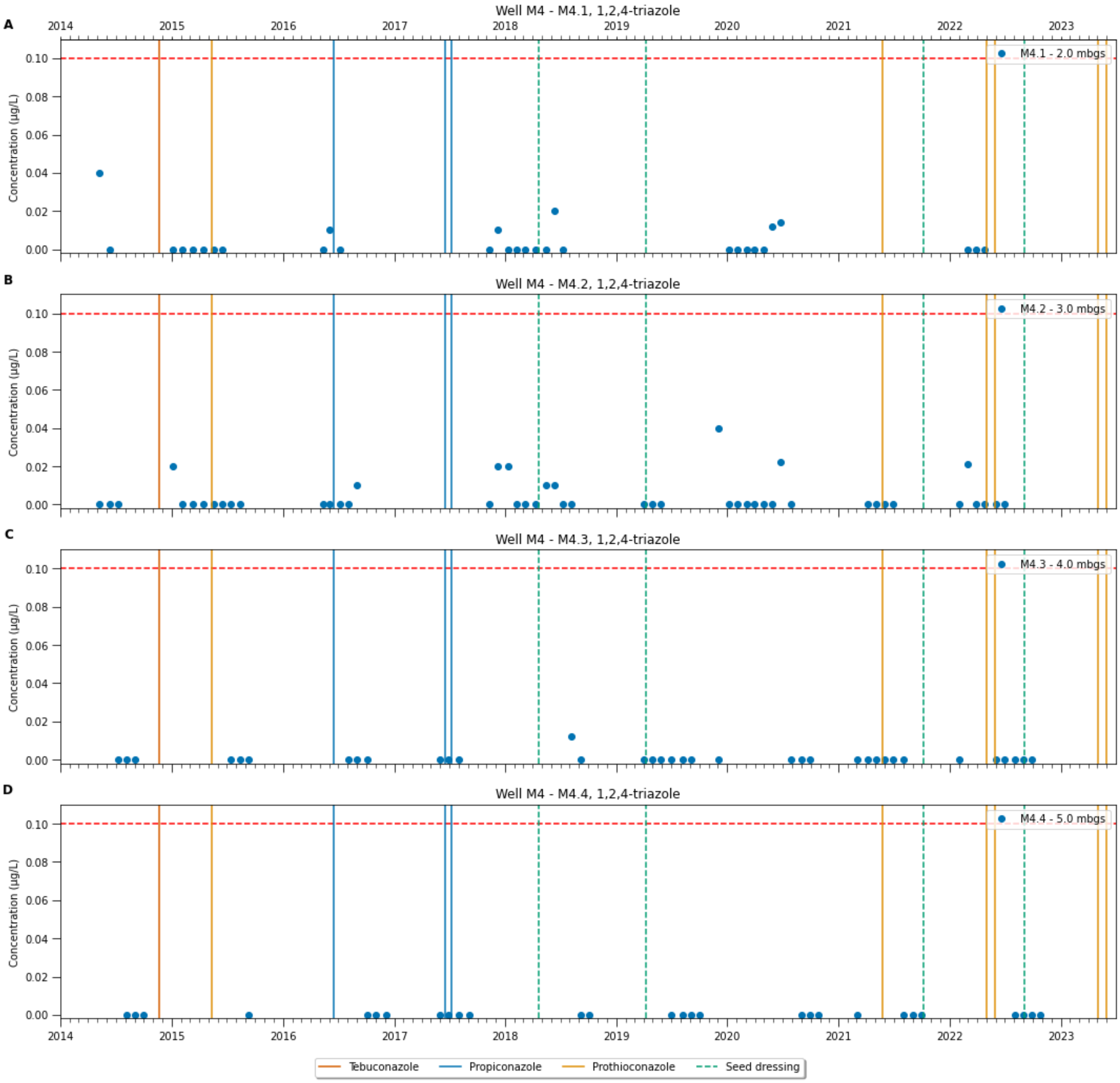


Figure A8.22. Leaching of 1,2,4-triazole at Faardrup in well M4. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

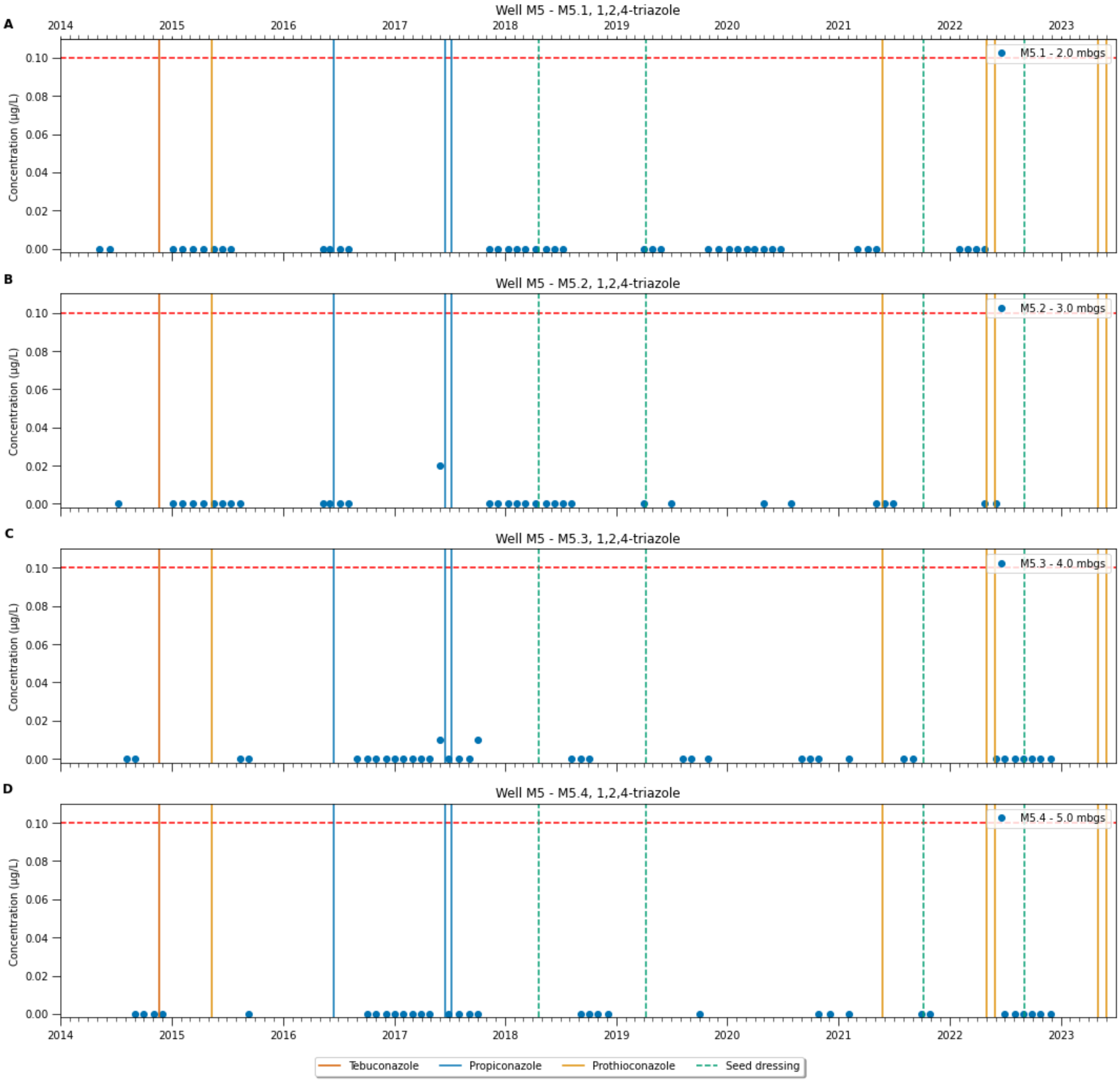


Figure A8.23. Leaching of 1,2,4-triazole at Faardrup in well M5. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

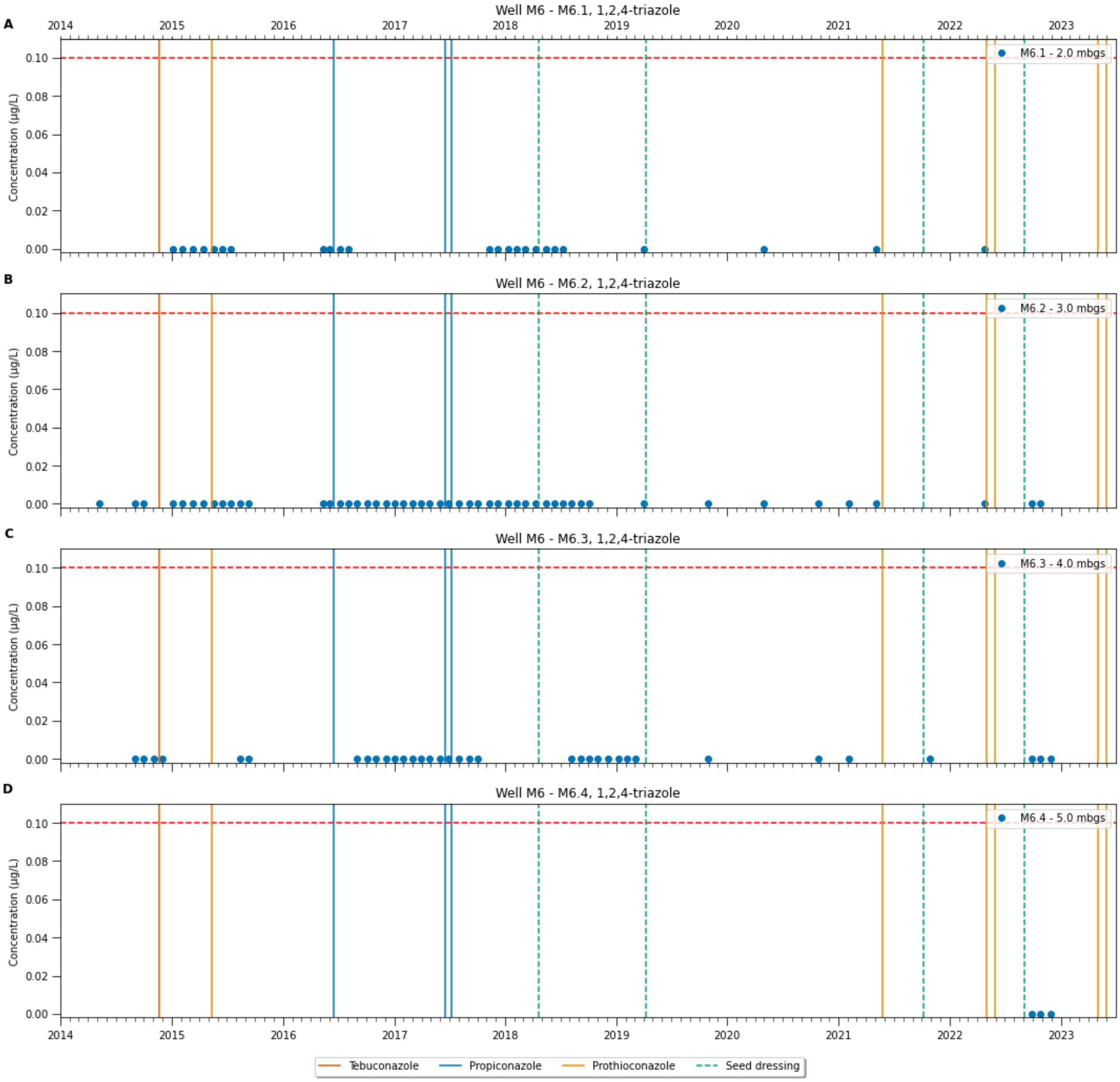


Figure A8.24. Leaching of 1,2,4-triazole at Faardrup in well M6. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

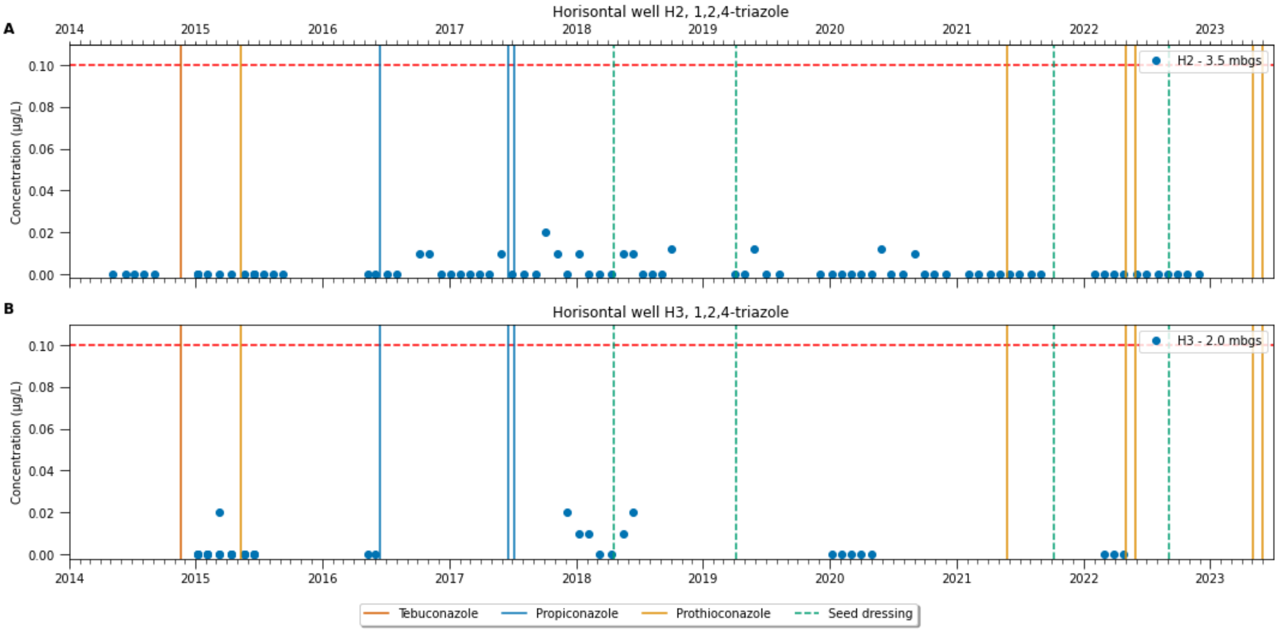


Figure A8.25. Leaching of 1,2,4-triazole at Faardrup in the horisontal wells, H2 and H3. The vertical lines represent different azole applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-B depicts the screen depths from which samples were collected.

Azoxystrobin test at Silstrup, CyPM monitoring

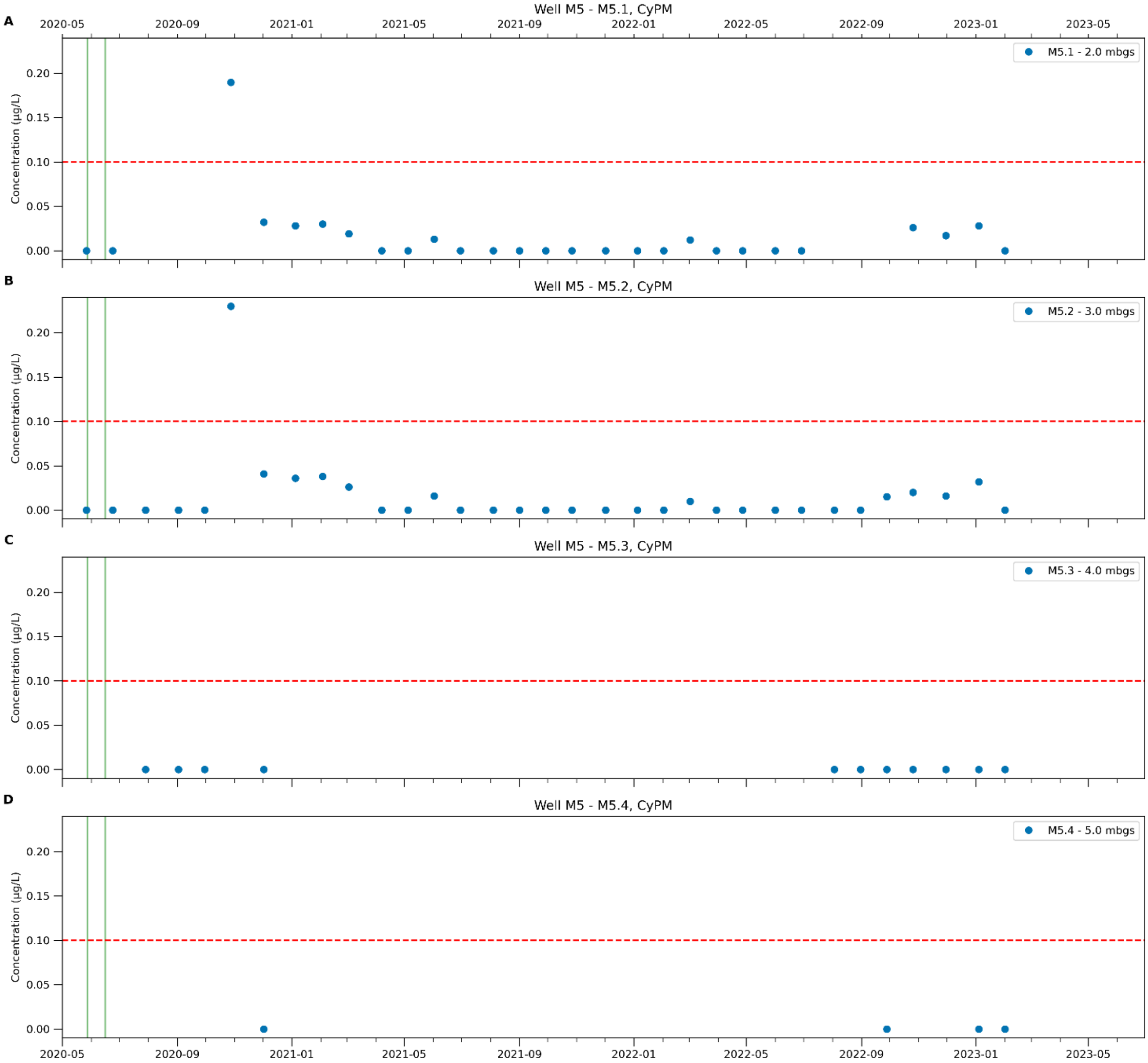


Figure A8.26. Leaching of CyPM at Silstrup in well M5. The vertical green line represents the CyPM applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

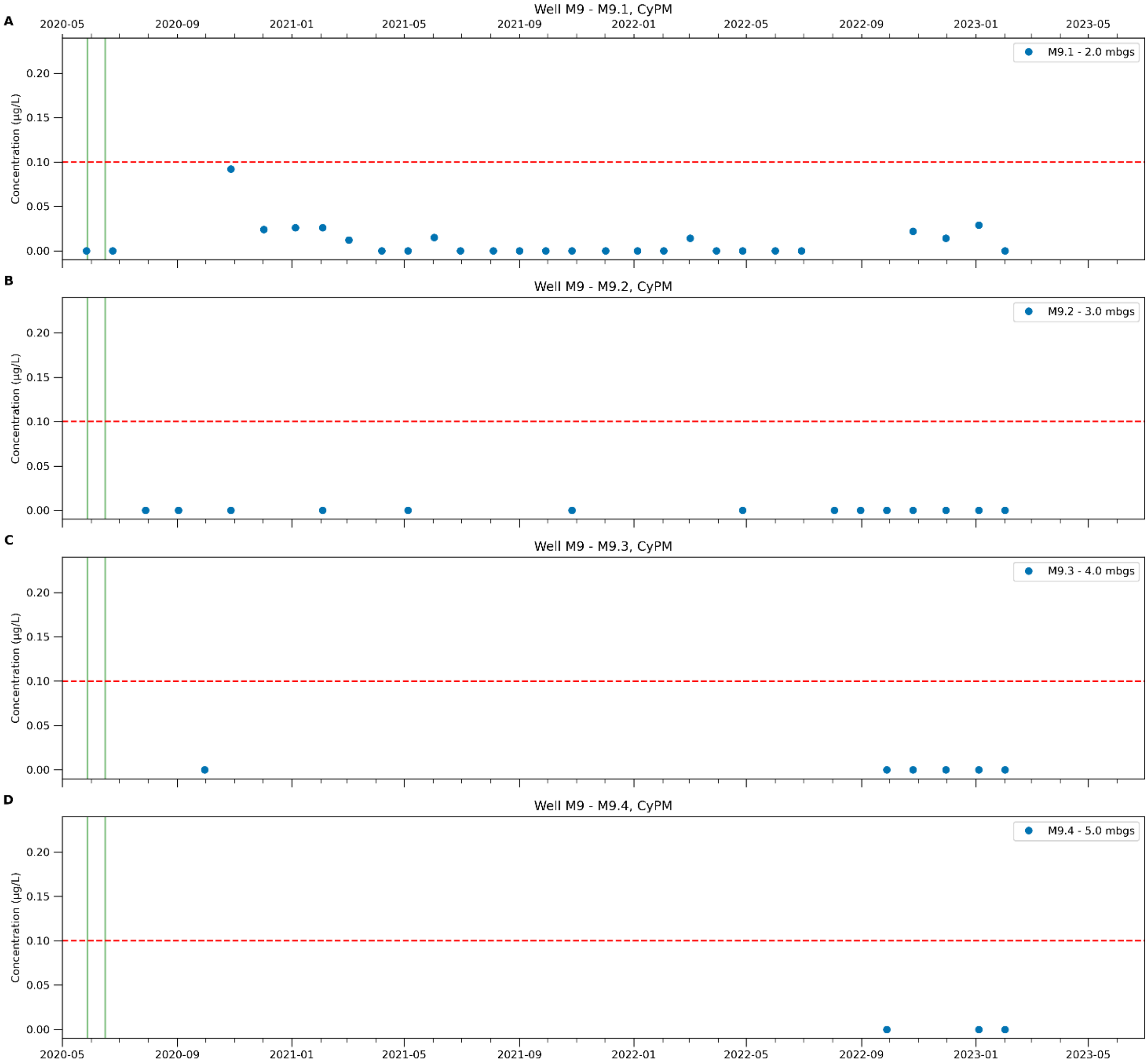


Figure A8.27. Leaching of CyPM at Silstrup in well M9. The vertical green line represents the CyPM applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

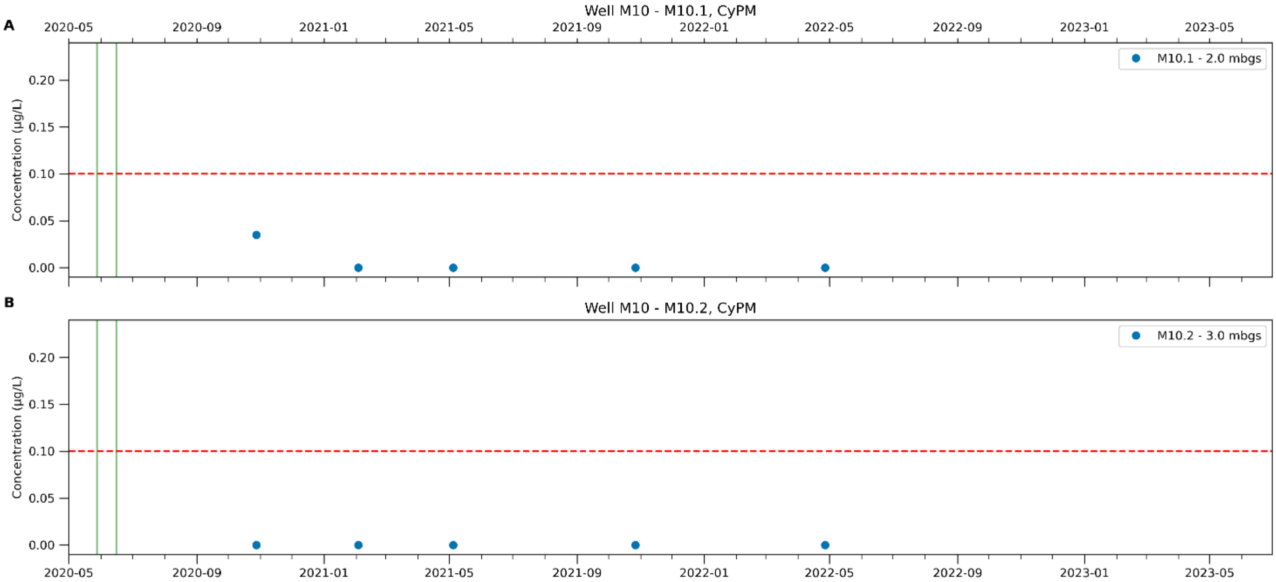


Figure A8.28. Leaching of CyPM at Silstrup in well M10. The vertical green line represents the CyPM applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-B depicts the screen depths from which samples were collected.

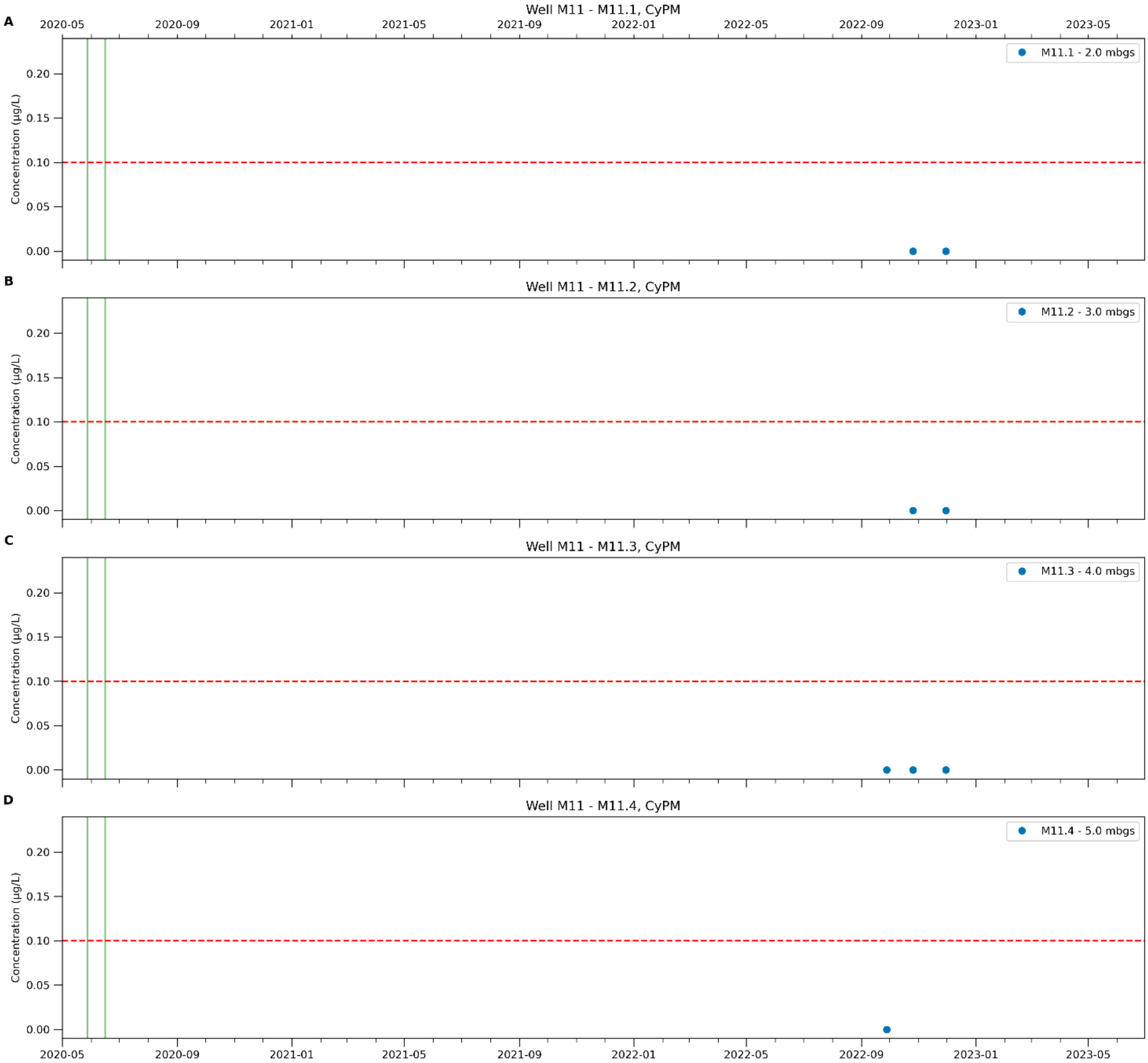


Figure A8.29. Leaching of CyPM at Silstrup in well M11. The vertical green line represents the CyPM applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

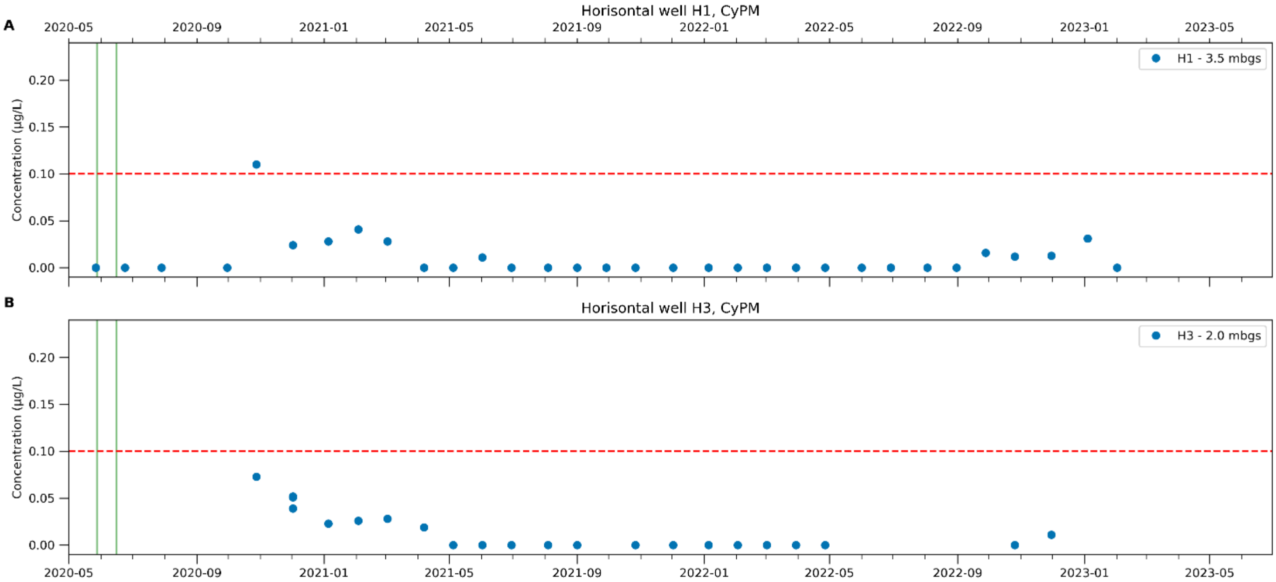


Figure A8.30. Leaching of CyPM at Silstrup in the horisontal wells, H1 and H3. The vertical green line represents the CyPM applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-B depicts the screen depths from which samples were collected.

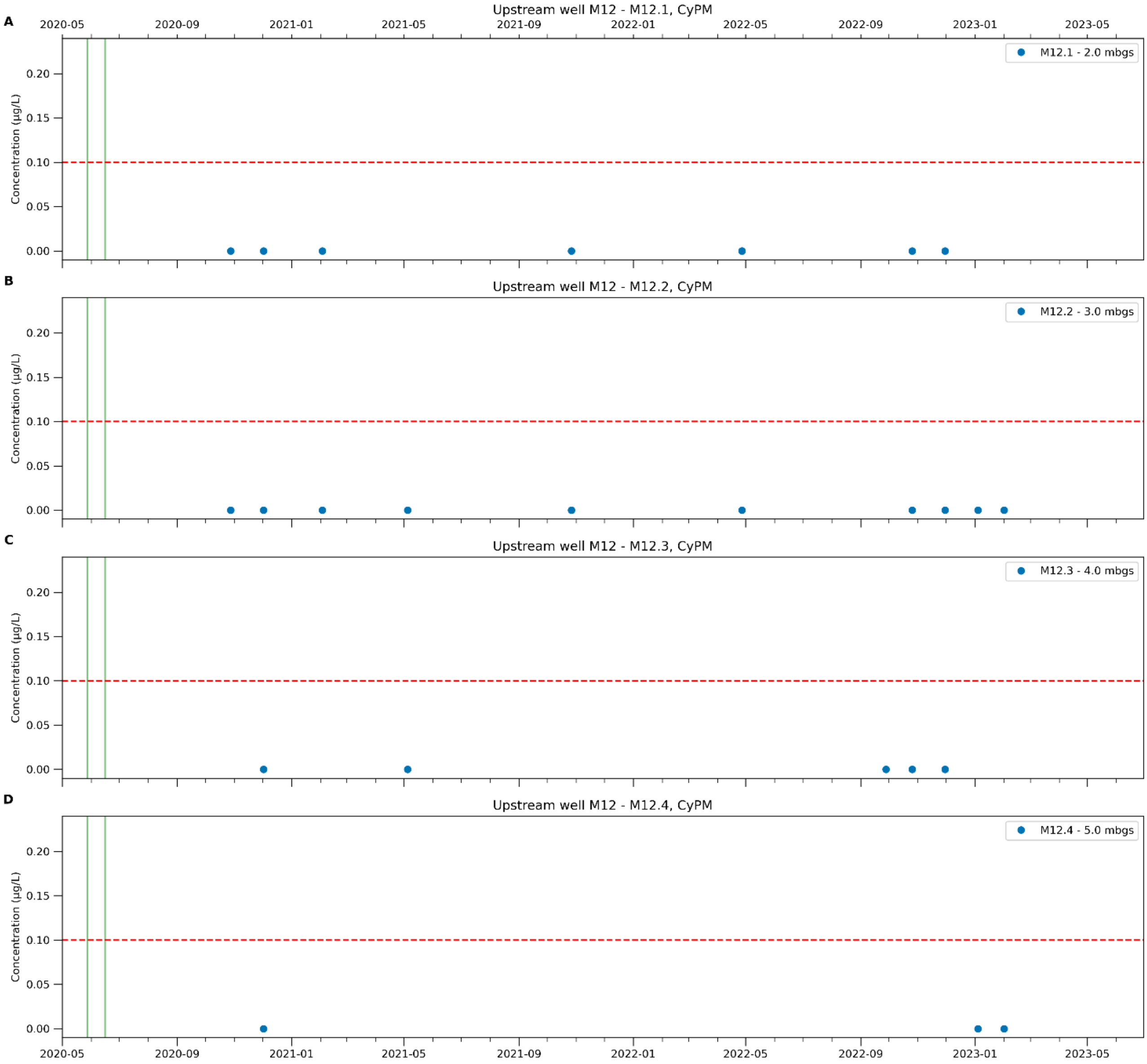


Figure A8.31. Leaching of CyPM at Silstrup in the upstream well, M12. The vertical green line represents the CyPM applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

Cyazofamid test at Jyndevad, DMS monitoring

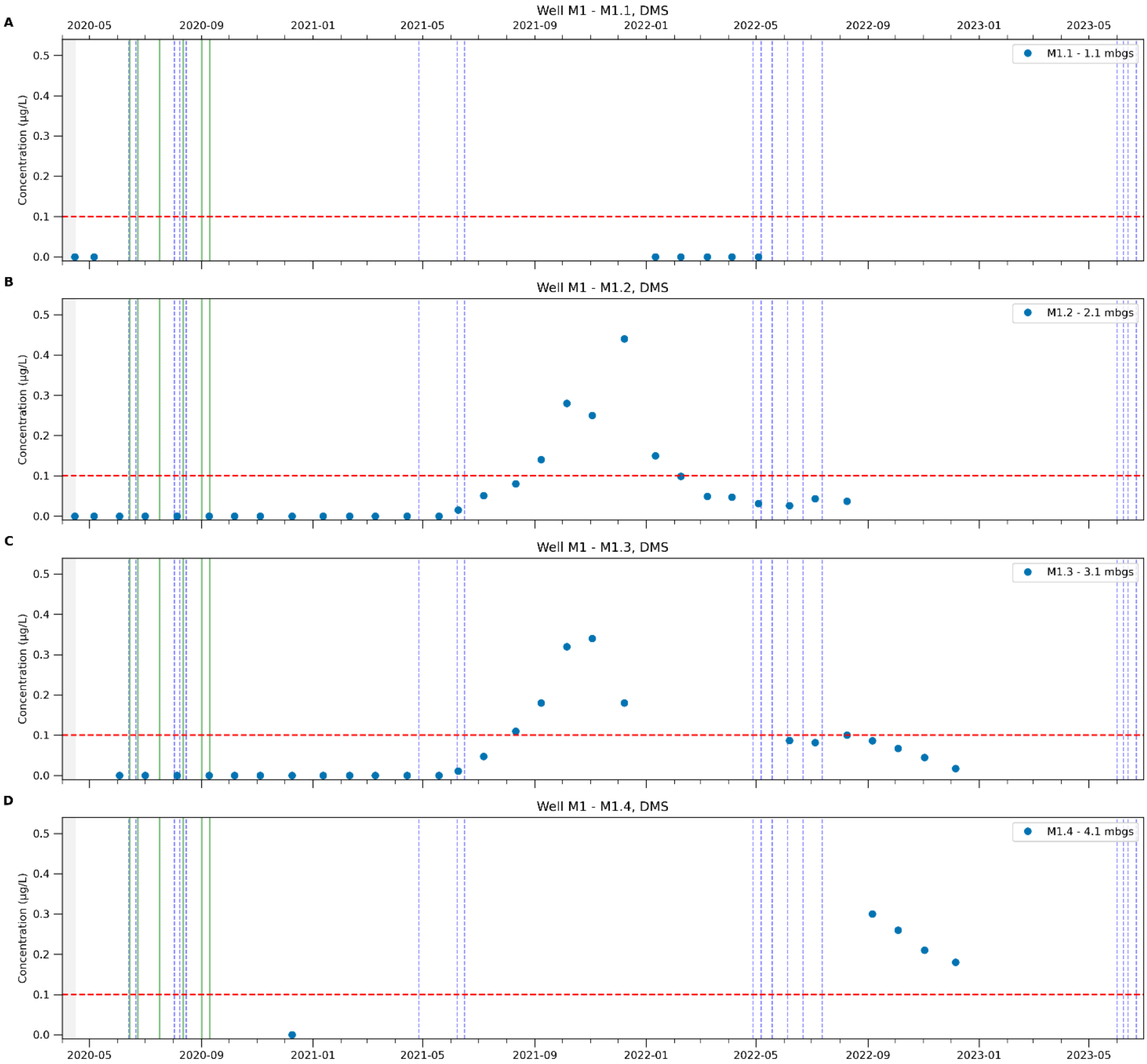


Figure A8.32. Leaching of DMS at Jyndevad in well M1. Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

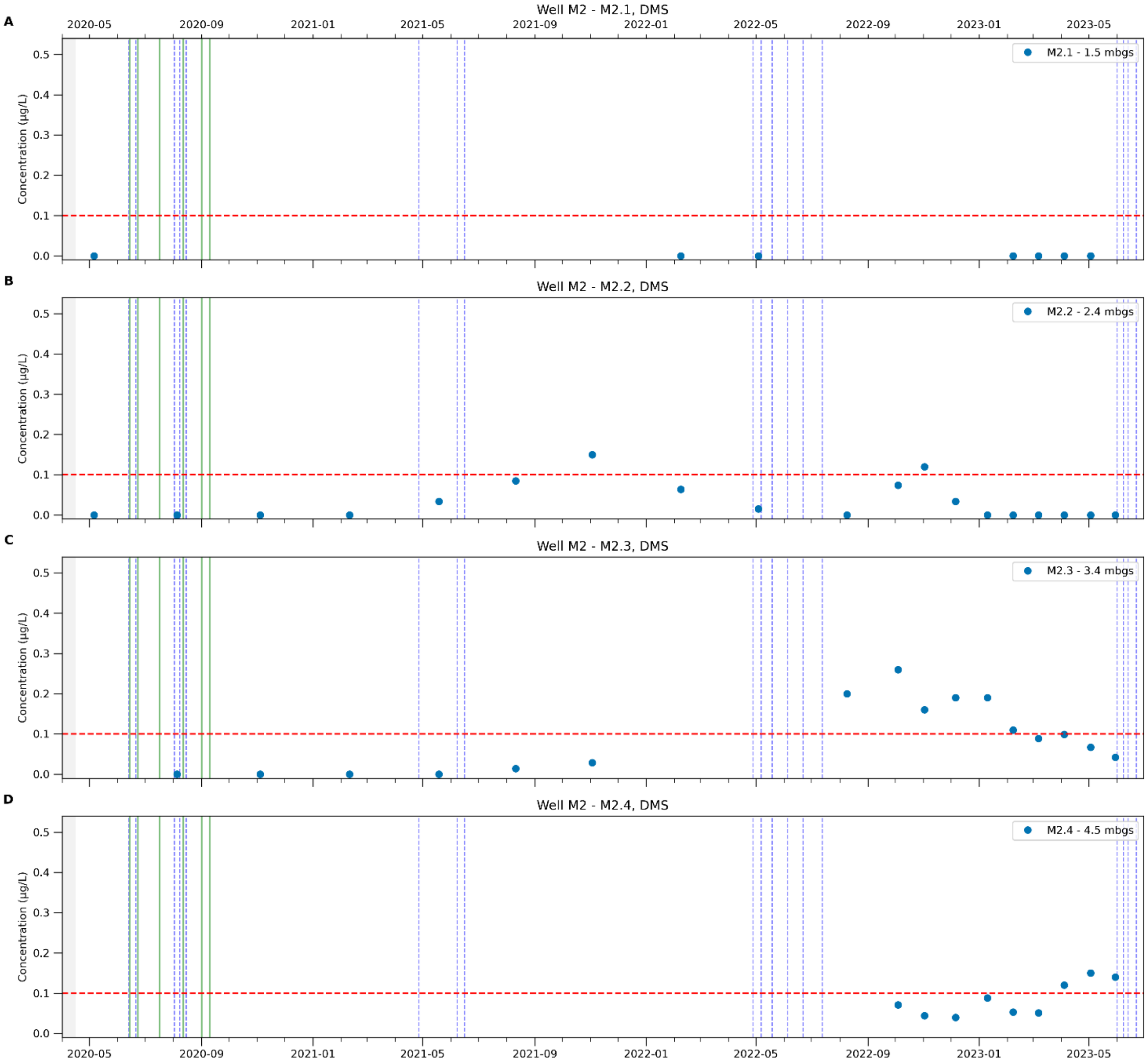


Figure A8.33. Leaching of DMS at Jyndevad in well M2. Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

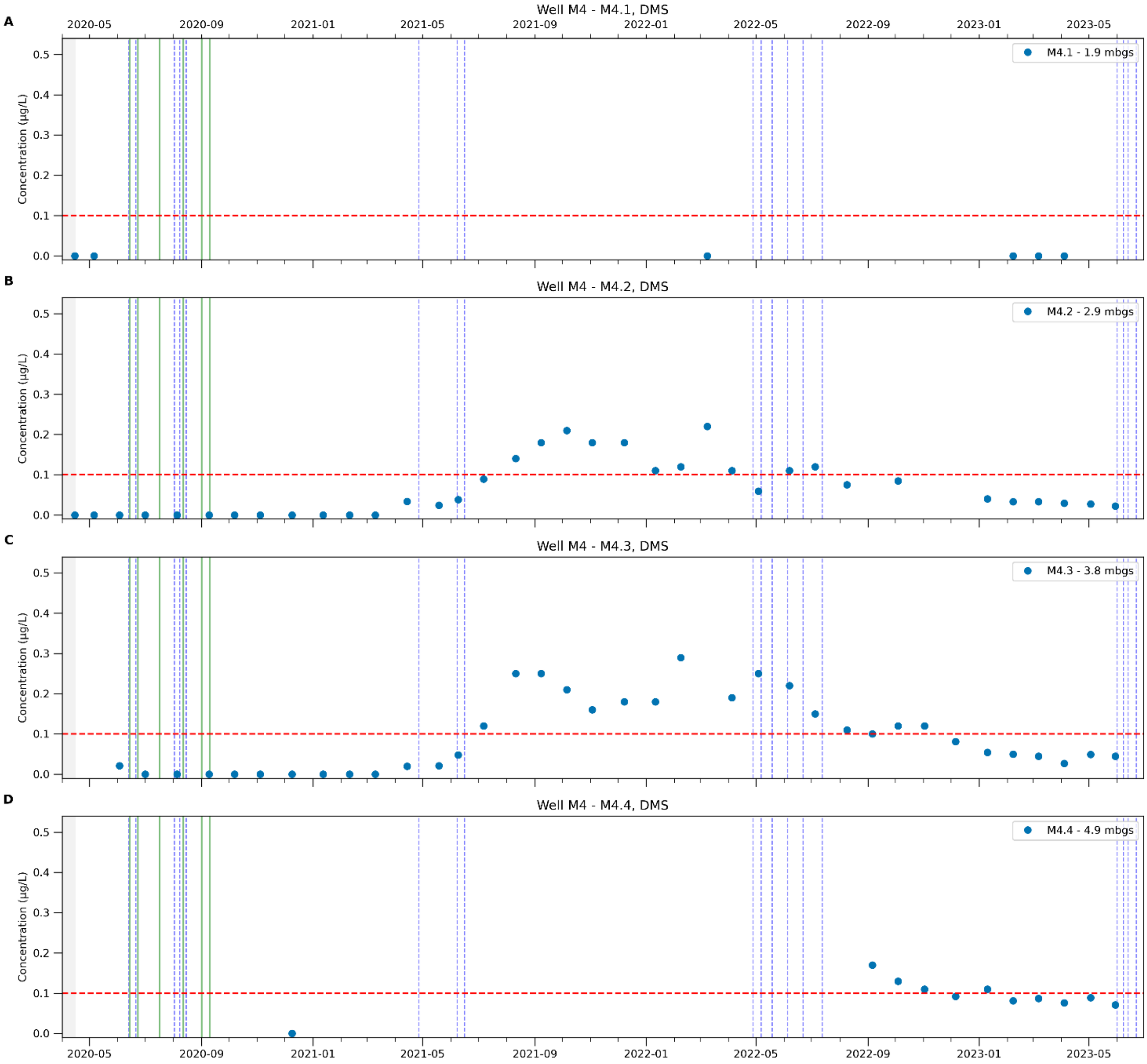


Figure A8.34. Leaching of DMS at Jyndevad in well M4. Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

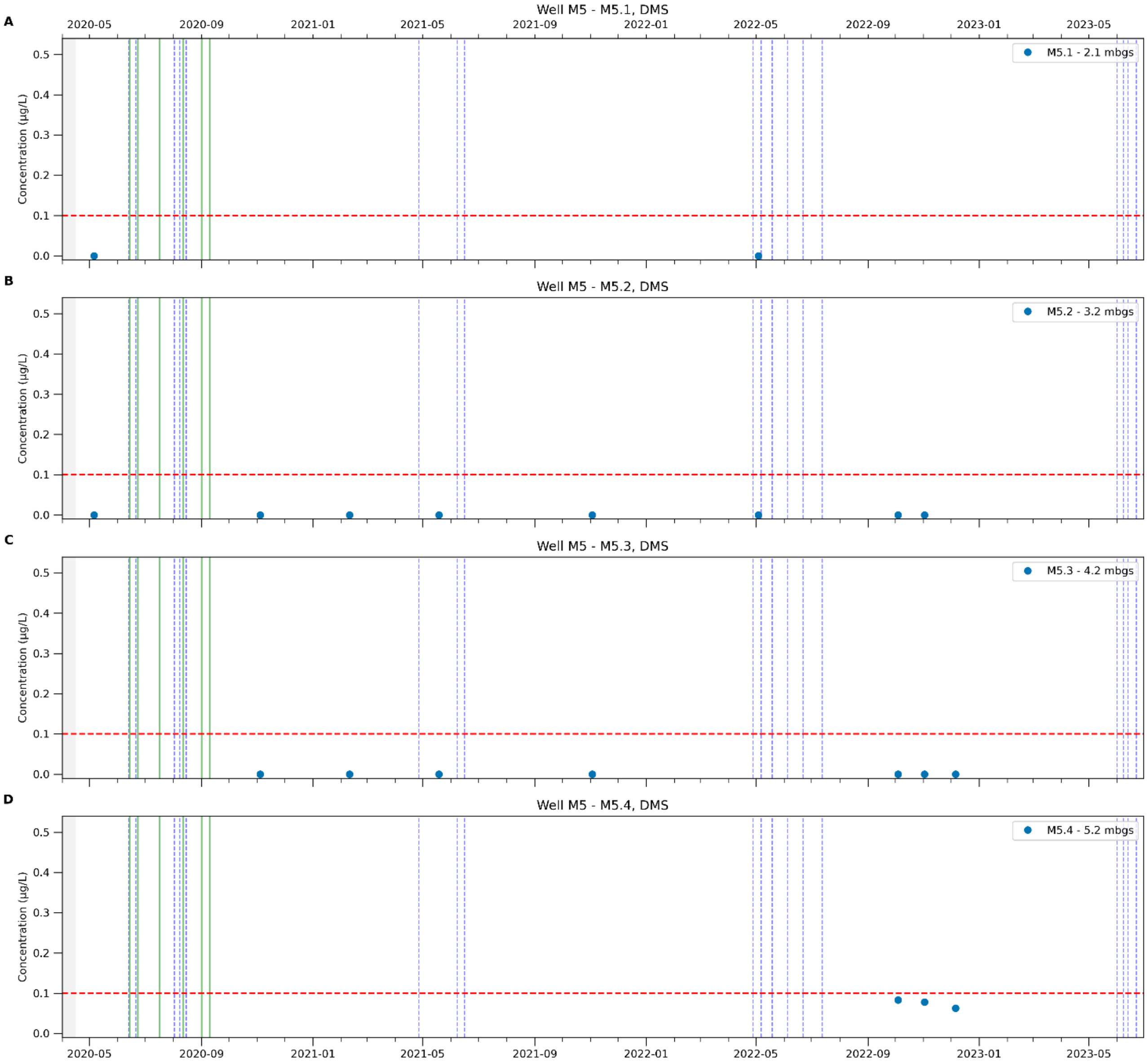


Figure A8.35. Leaching of DMS at Jyndevad in well M5. Gray shaded areas delineate periods when samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

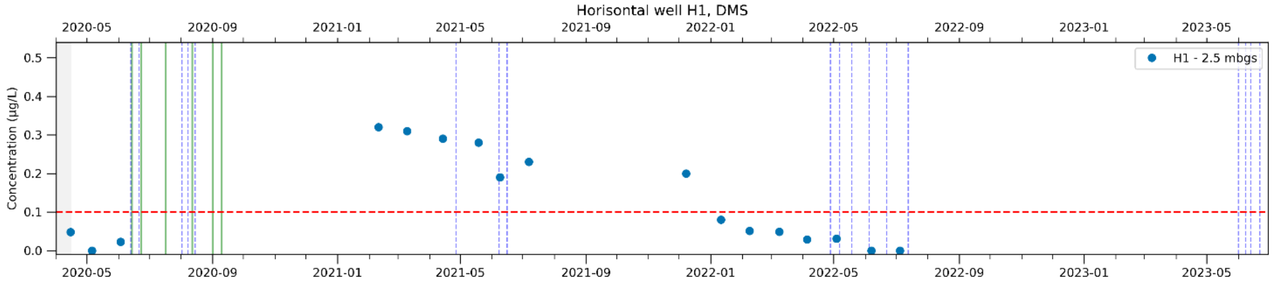


Figure A8.36. Leaching of DMS at Jyndevad in the horisontal well, H1. Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L.

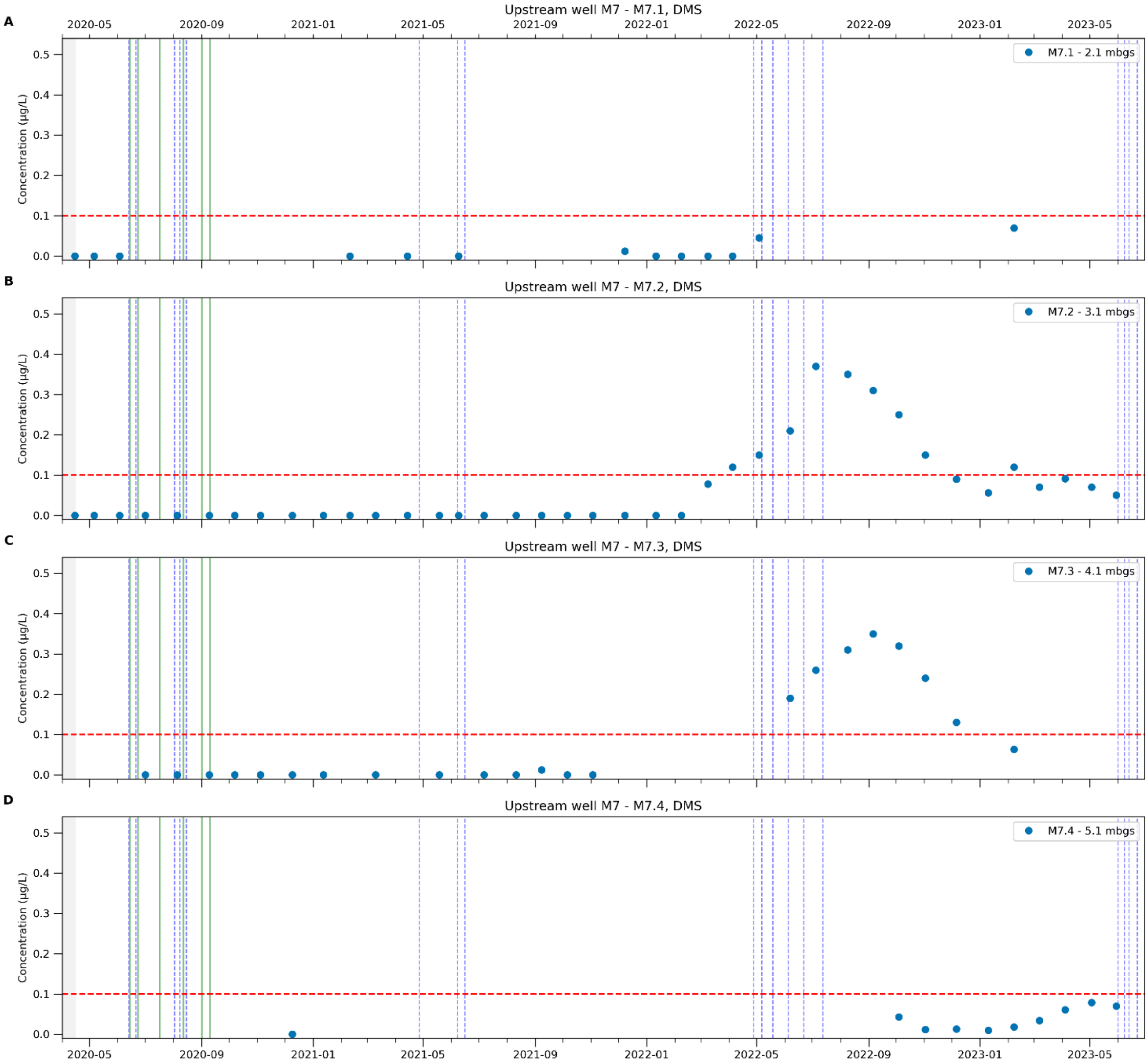


Figure A8.37. Leaching of DMS at Jyndevad in the upstream well M7. Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

Cyazofamid test at Jyndevad, DMSA monitoring

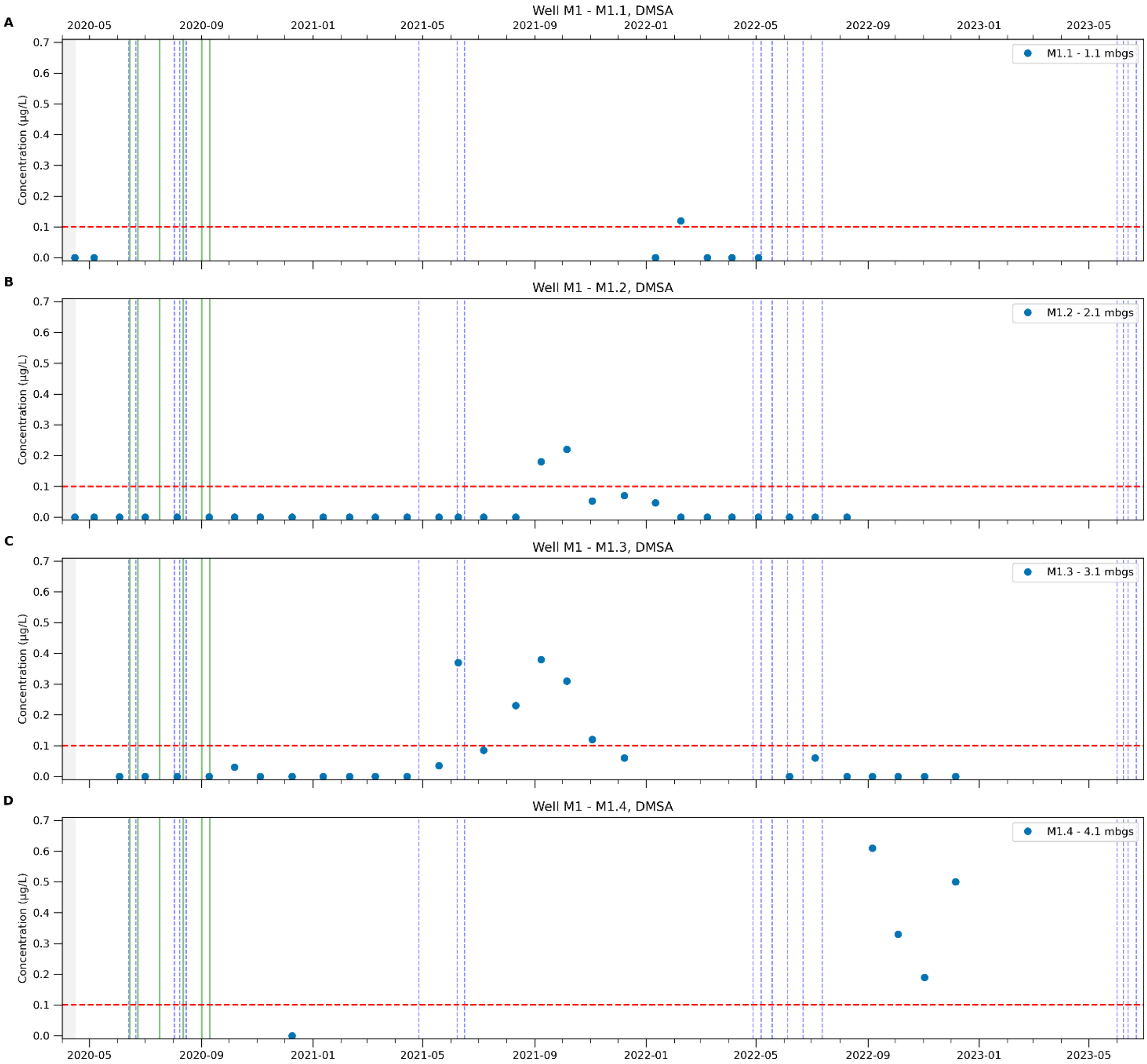


Figure A8.38. Leaching of DMSA at Jyndevad in well M1. Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

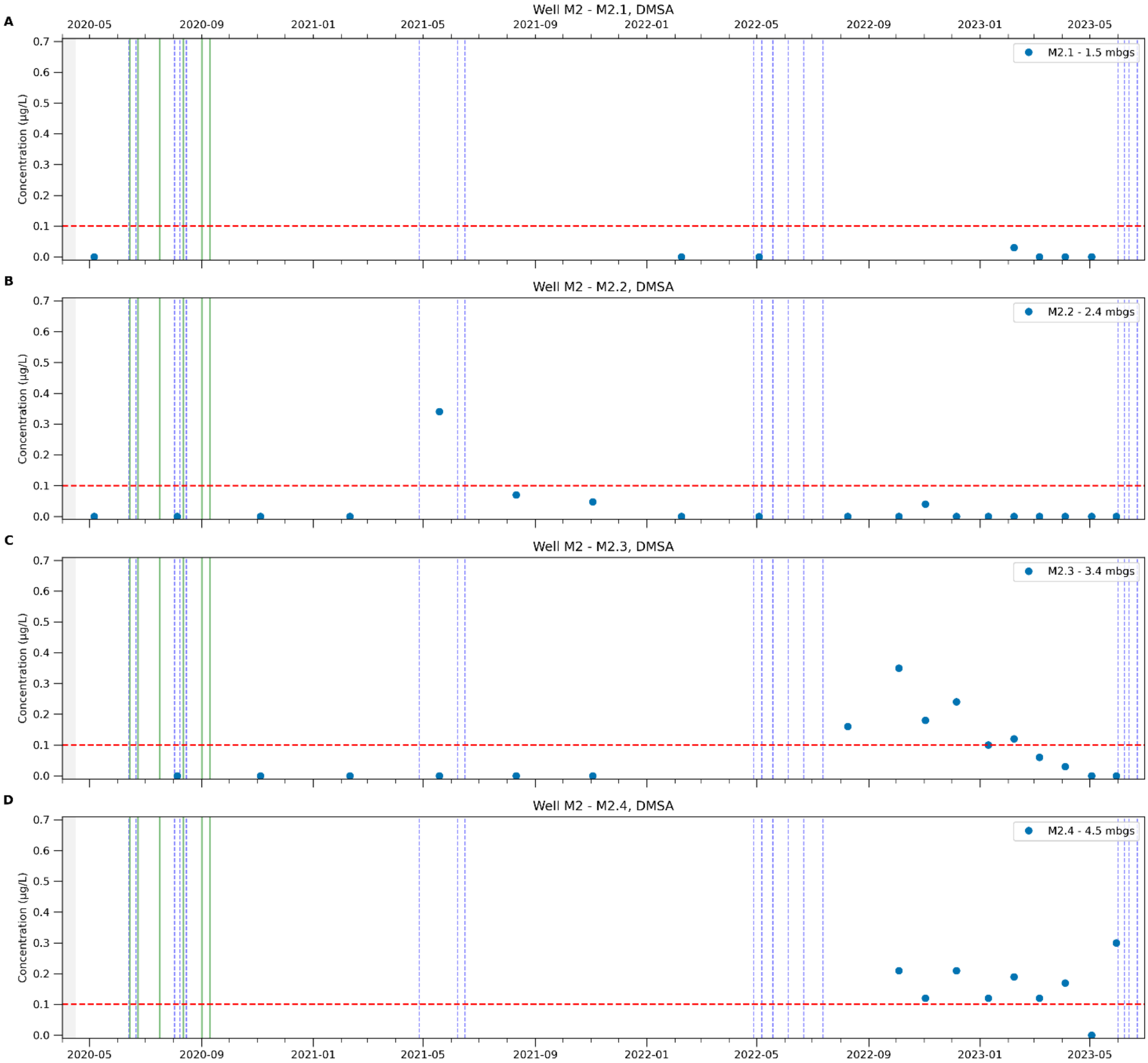


Figure A8.39. Leaching of DMSA at Jyndevad in well M2. Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

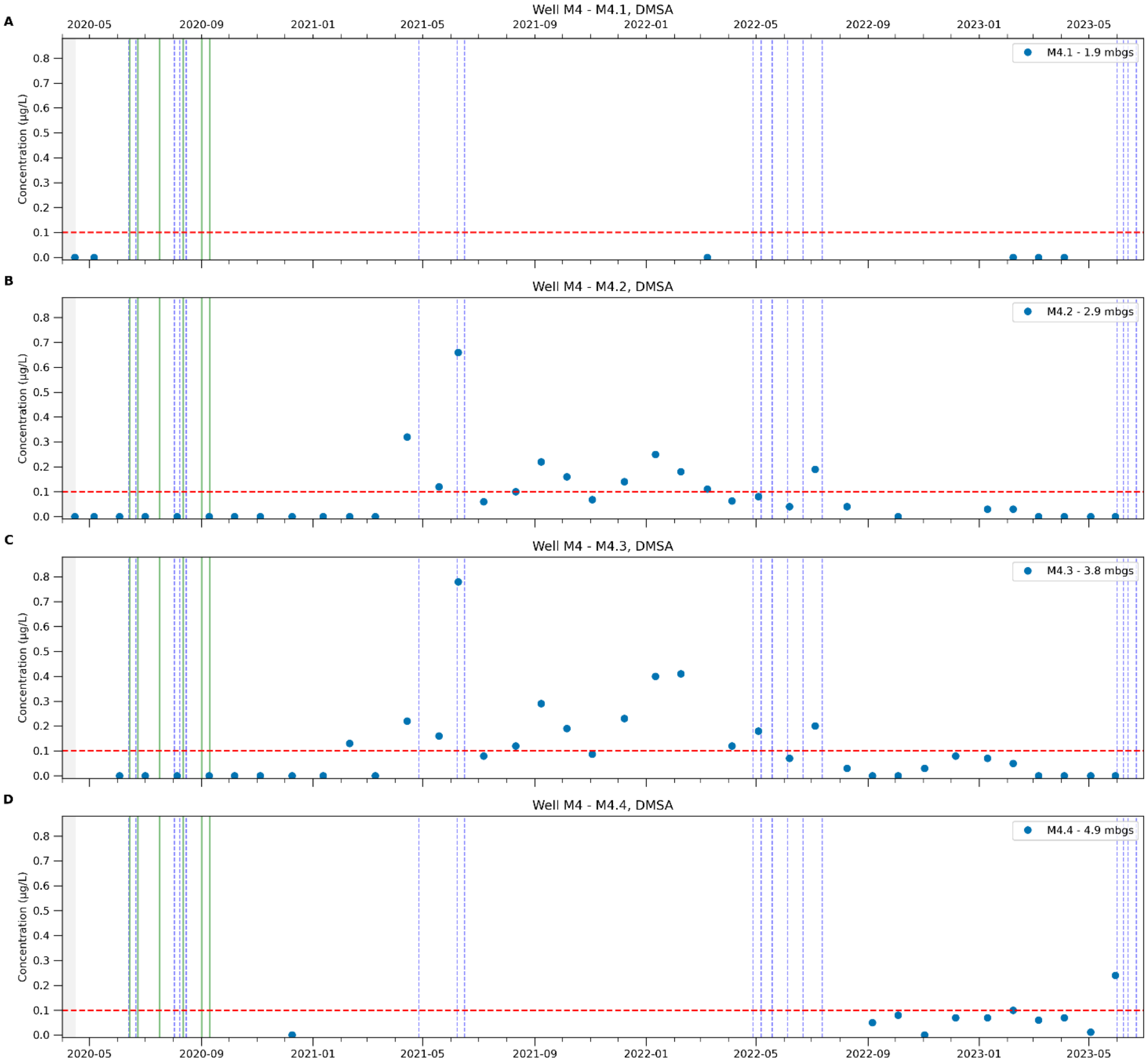


Figure A8.40. Leaching of DMSA at Jyndevad in well M4. Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

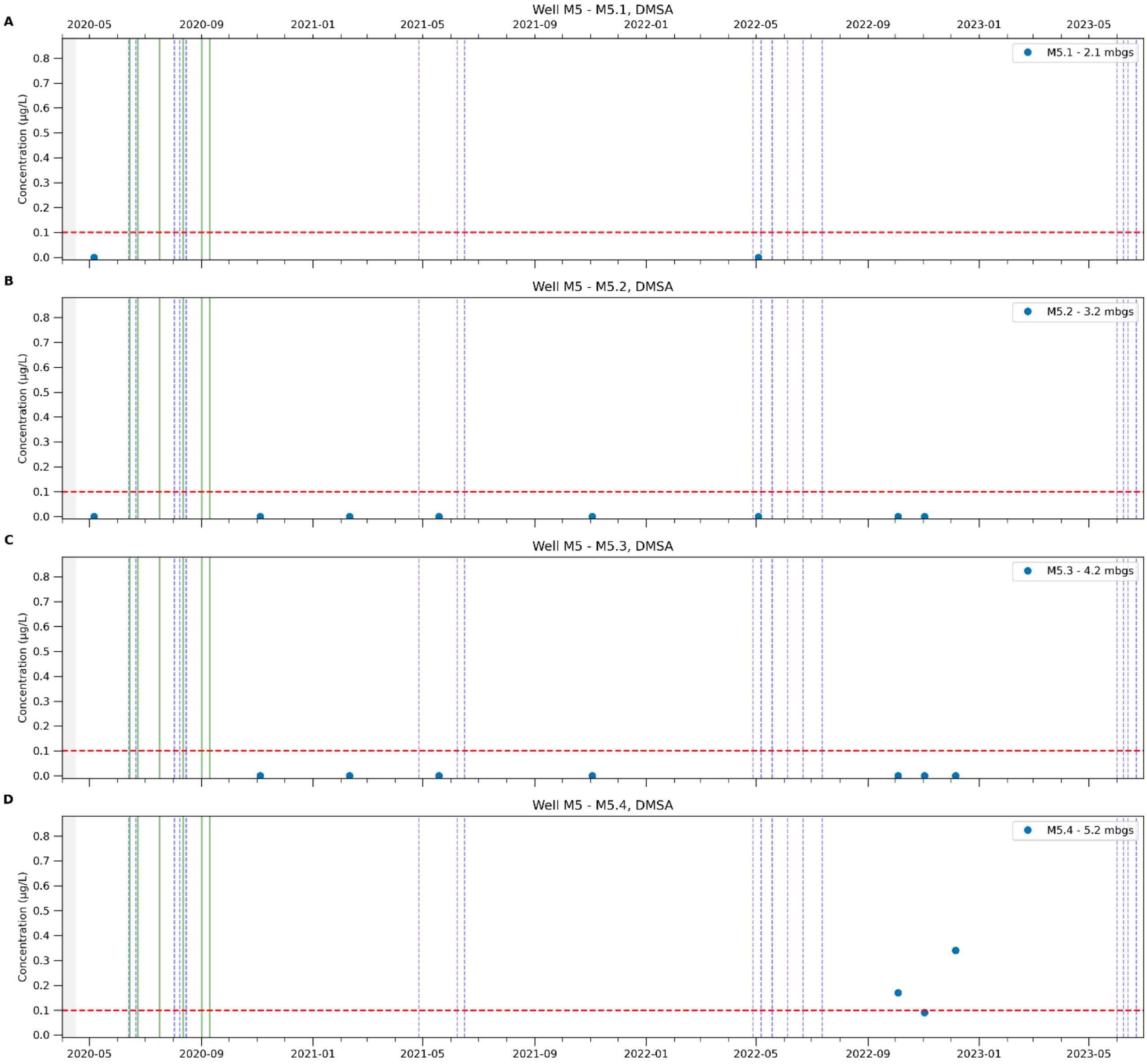


Figure A8.41. Leaching of DMSA at Jyndevad in well M5. Gray shaded areas delineate periods when samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

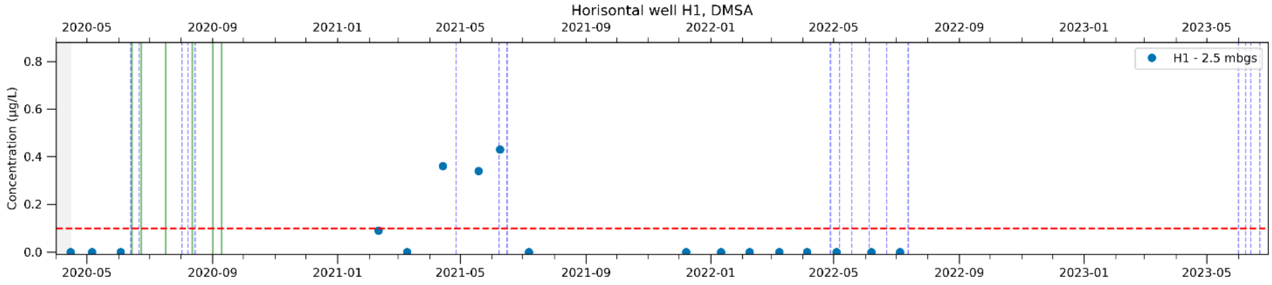


Figure A8.42. Leaching of DMSA at Jyndevad in the horisontal well, H1. Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L.

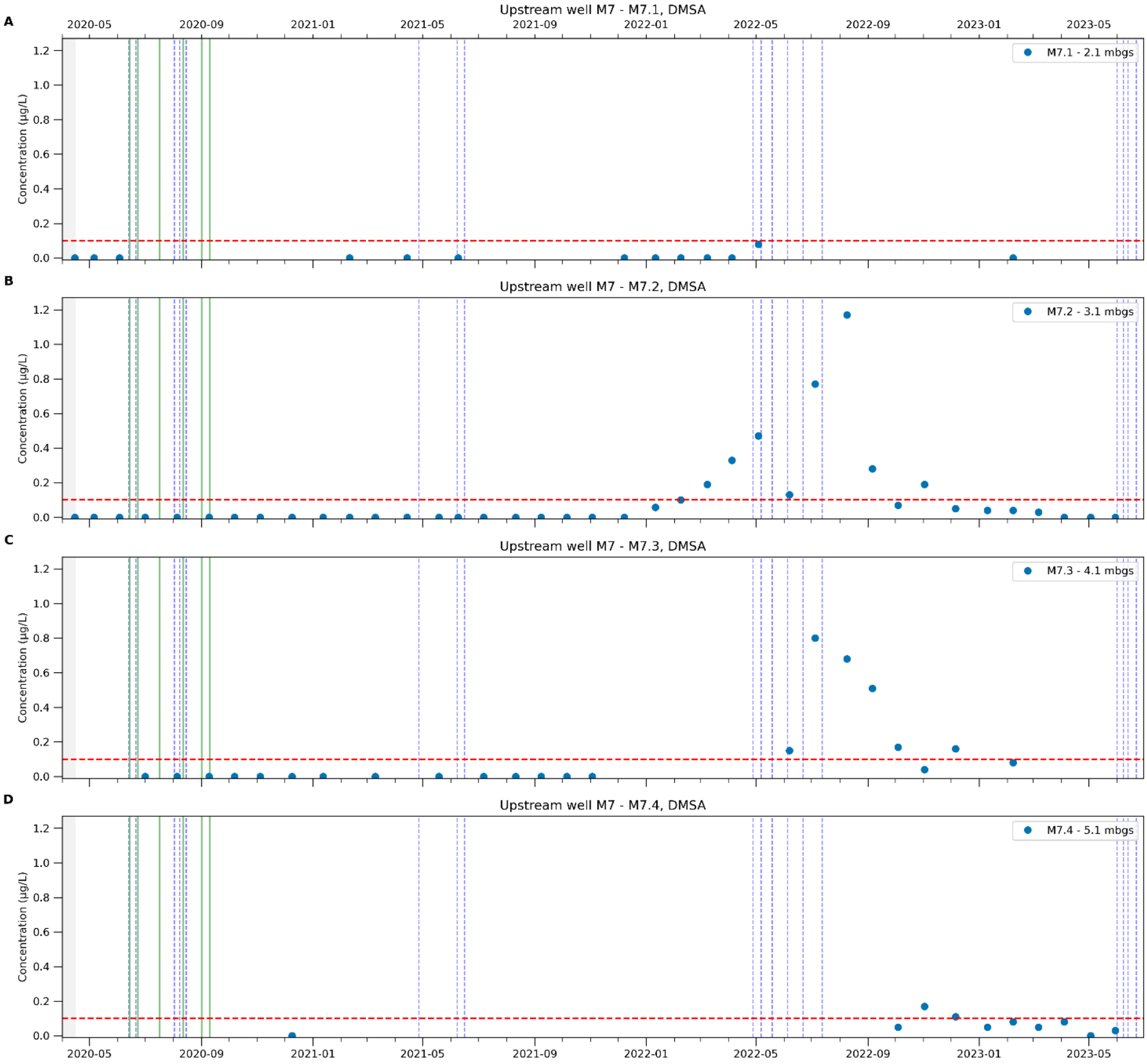


Figure A8.43. Leaching of DMSA at Jyndevad in the upstream well M7. Gray shaded areas delineate periods, where samples were stored at -20°C before analysis. The vertical green and dashed blue lines represent the cyazofamid applications and field irrigations, respectively. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

Fluopyram test at Silstrup, fluopyram monitoring

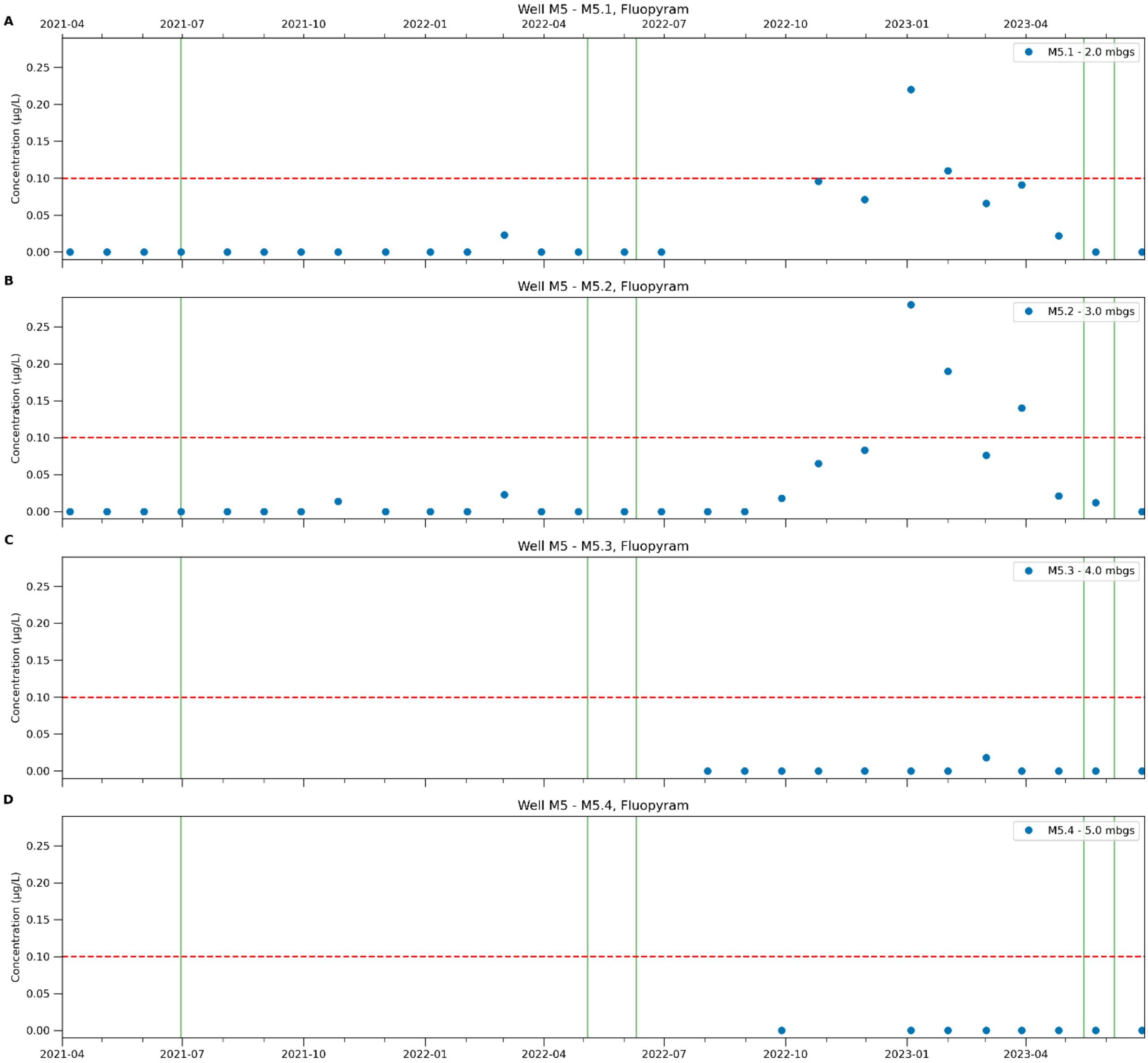


Figure A8.44. Leaching of fluopyram at Silstrup in well M5. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

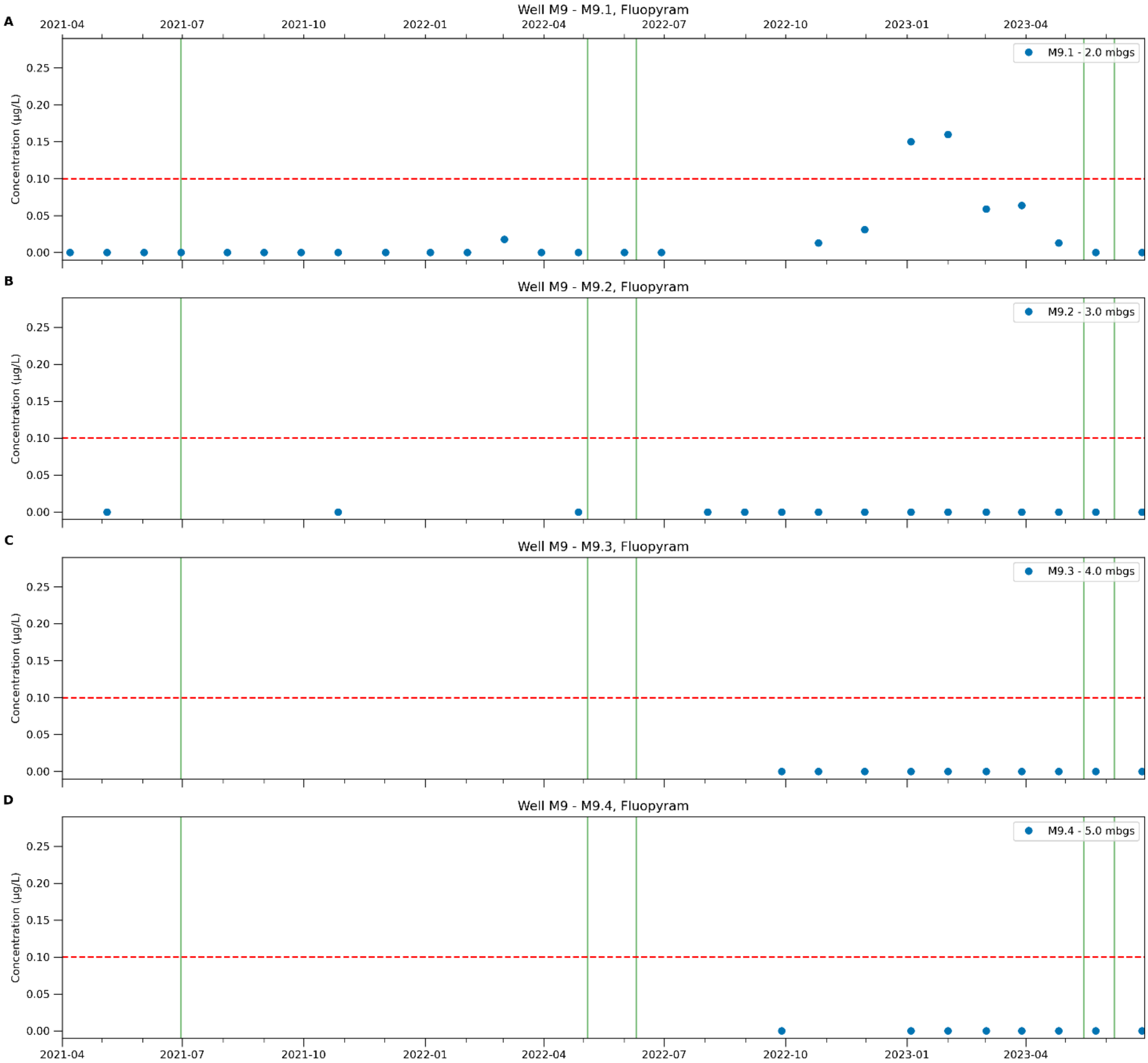


Figure A8.45. Leaching of fluopyram at Silstrup in well M9. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

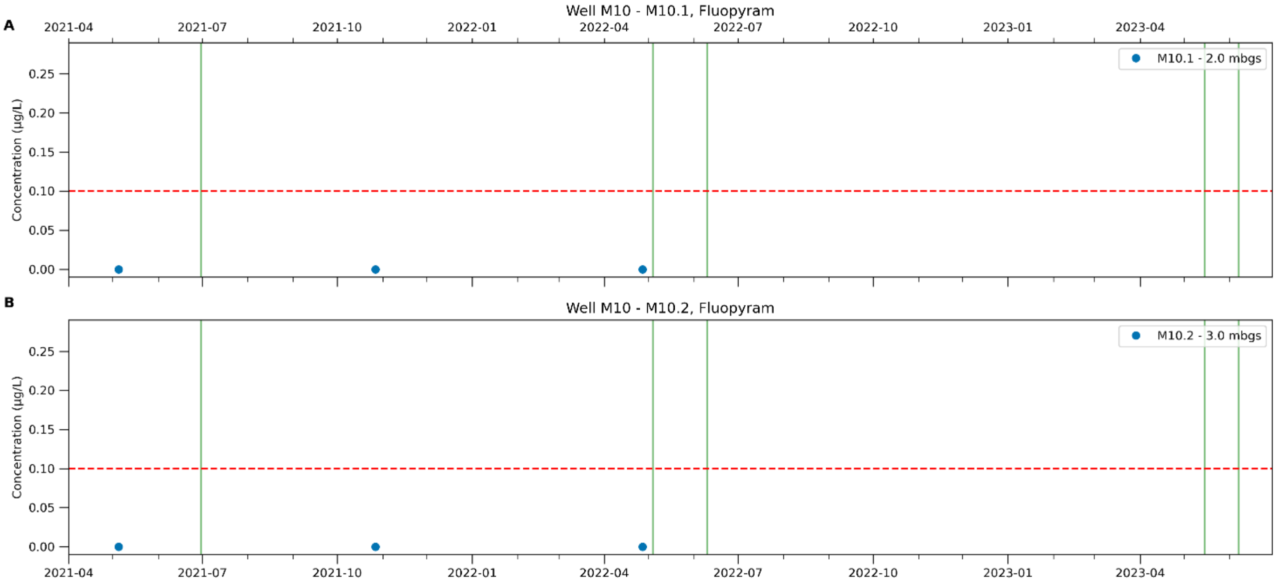


Figure A8.46. Leaching of fluopyram at Silstrup in well M10. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-B depicts the screen depths from which samples were collected.

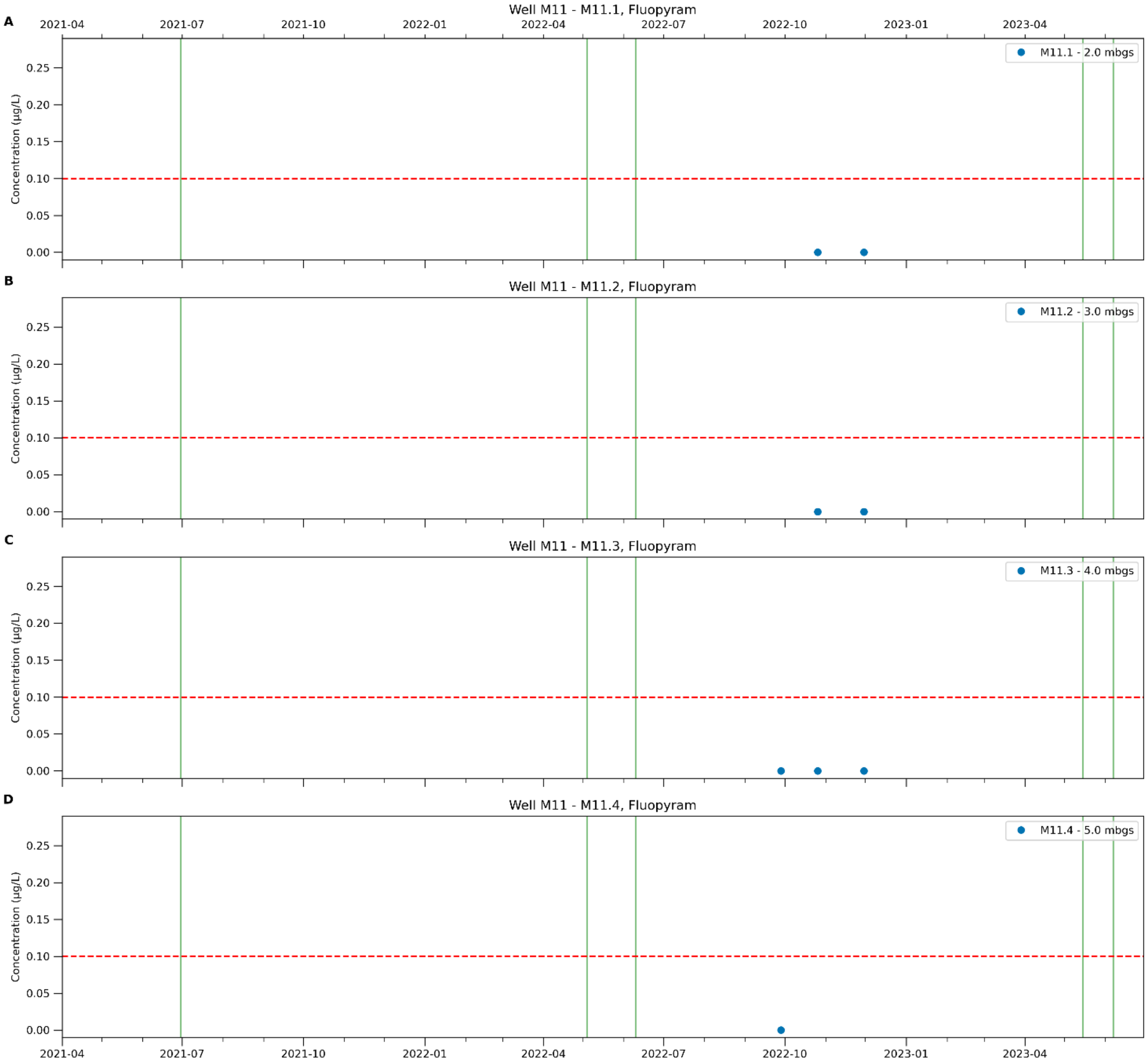


Figure A8.47. Leaching of fluopyram at Silstrup in well M11. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

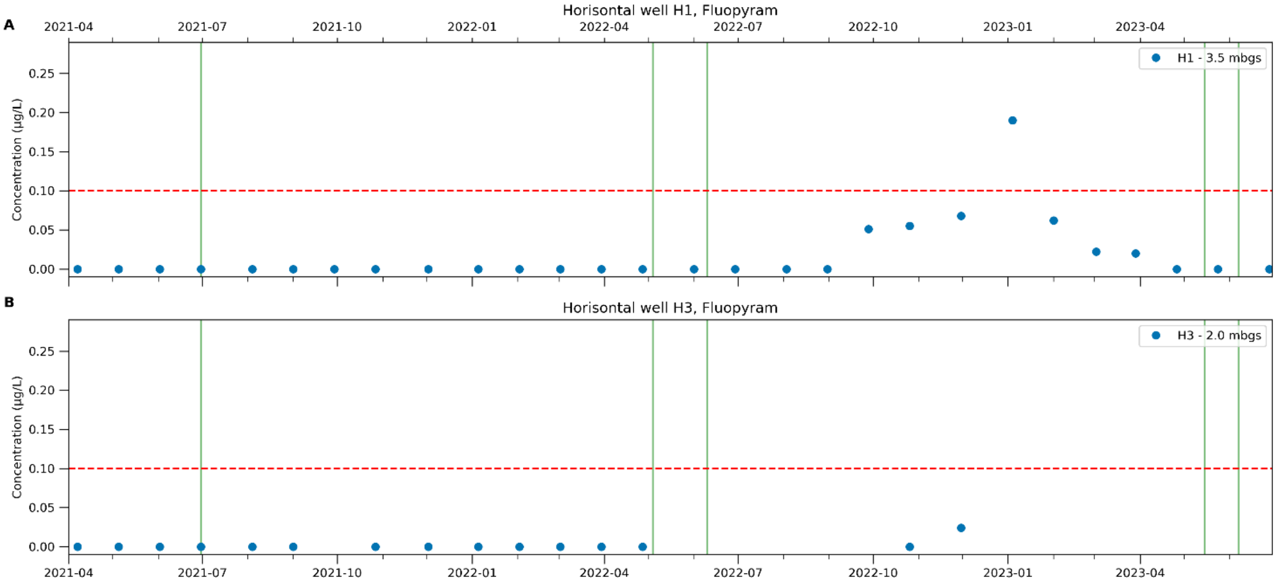


Figure A8.48. Leaching of fluopyram at Silstrup in the horisontal wells, H1 and H3. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-B depicts the screen depths from which samples were collected.

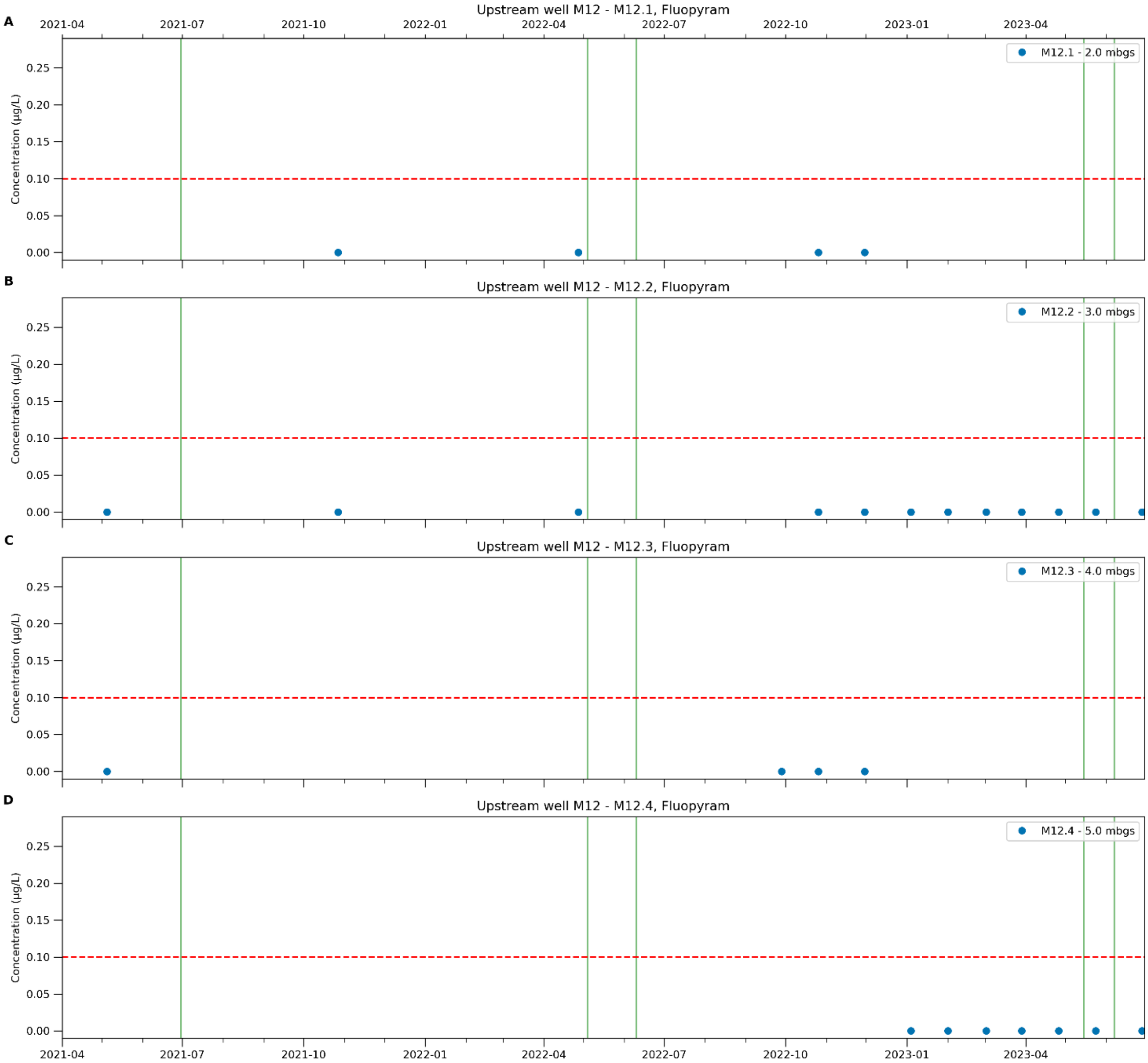


Figure A8.49. Leaching of fluopyram at Silstrup in the upstream well, M12. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

Fluopyram test at Silstrup, fluopyram-7-hydroxy monitoring

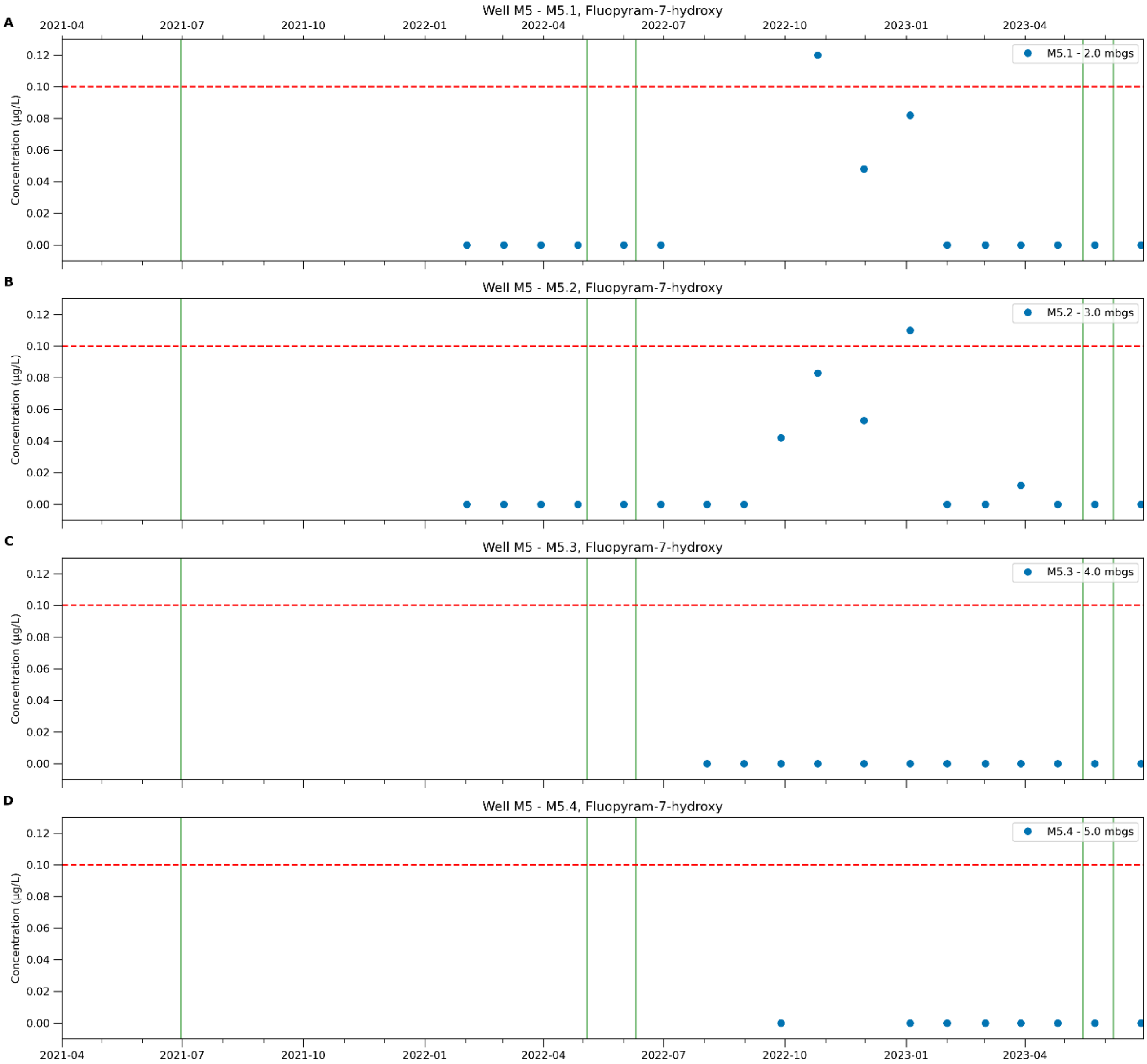


Figure A8.50. Leaching of fluopyram-7-hydroxy at Silstrup in well M5. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

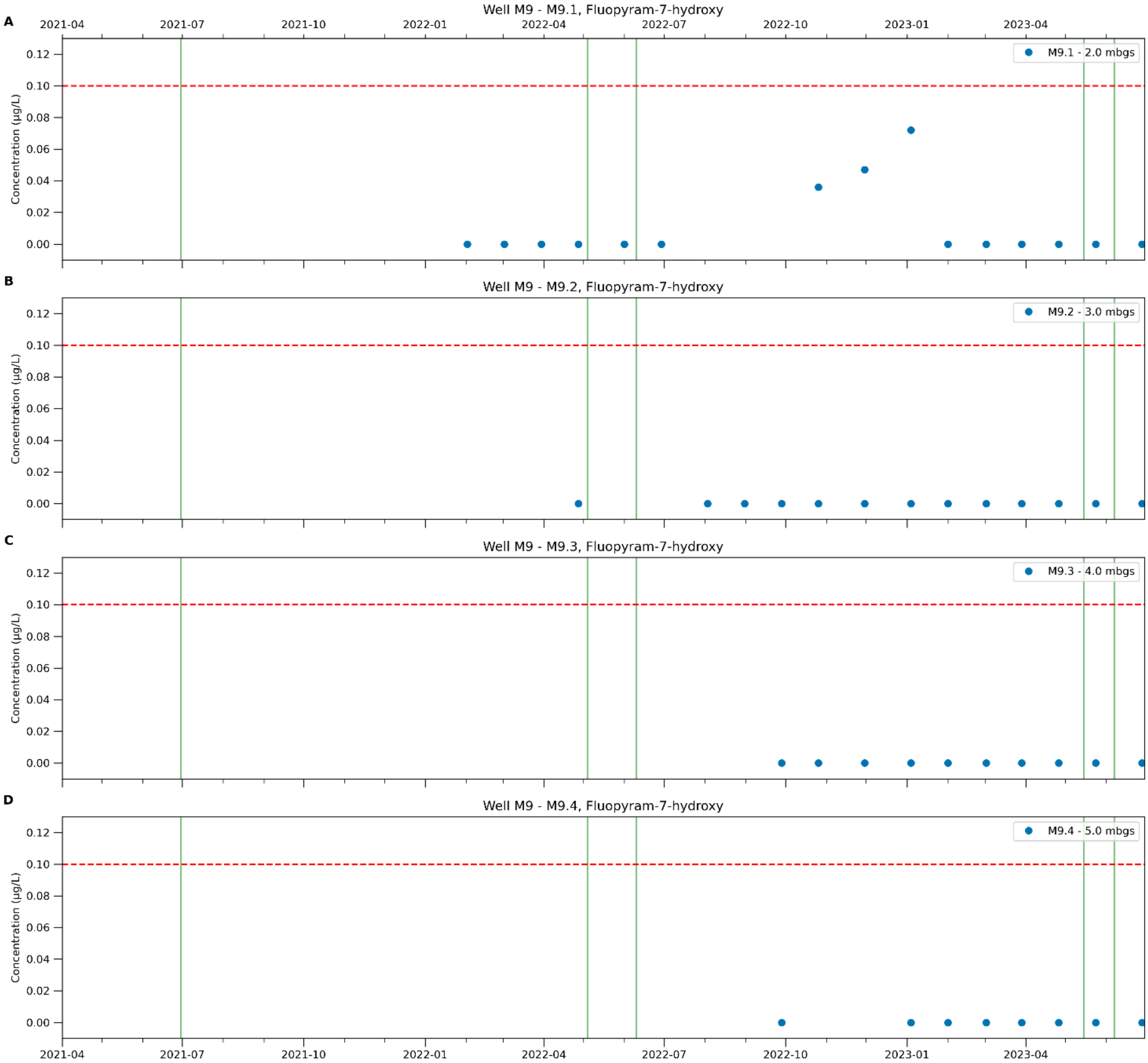


Figure A8.51. Leaching of fluopyram-7-hydroxy at Silstrup in well M9. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

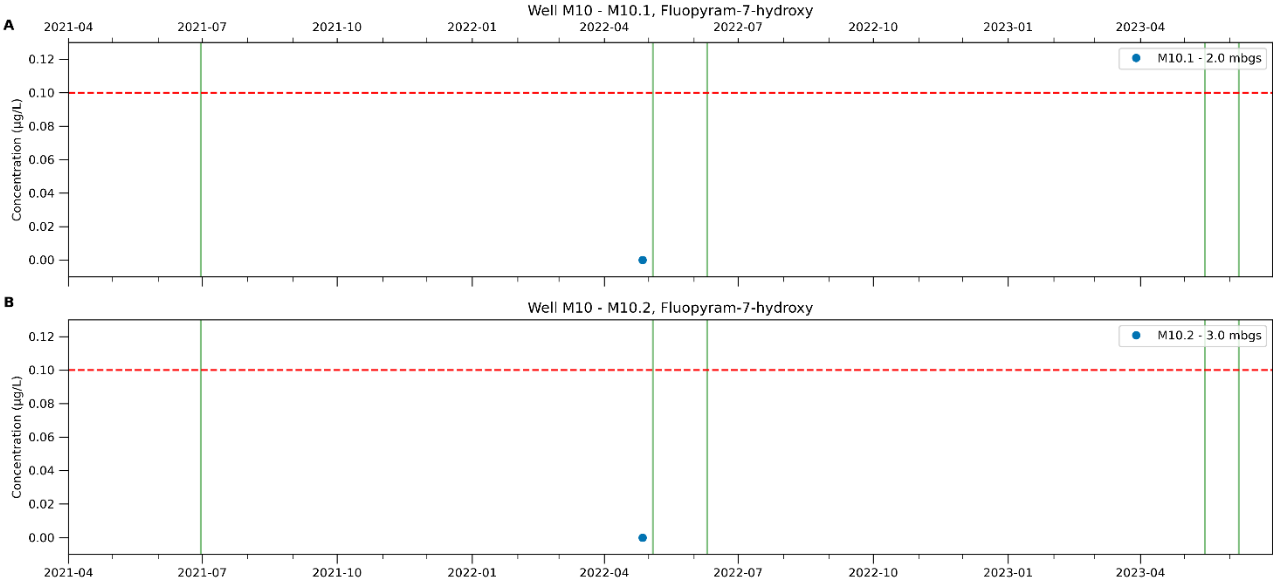


Figure A8.52. Leaching of fluopyram-7-hydroxy at Silstrup in well M10. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-B depicts the screen depths from which samples were collected.

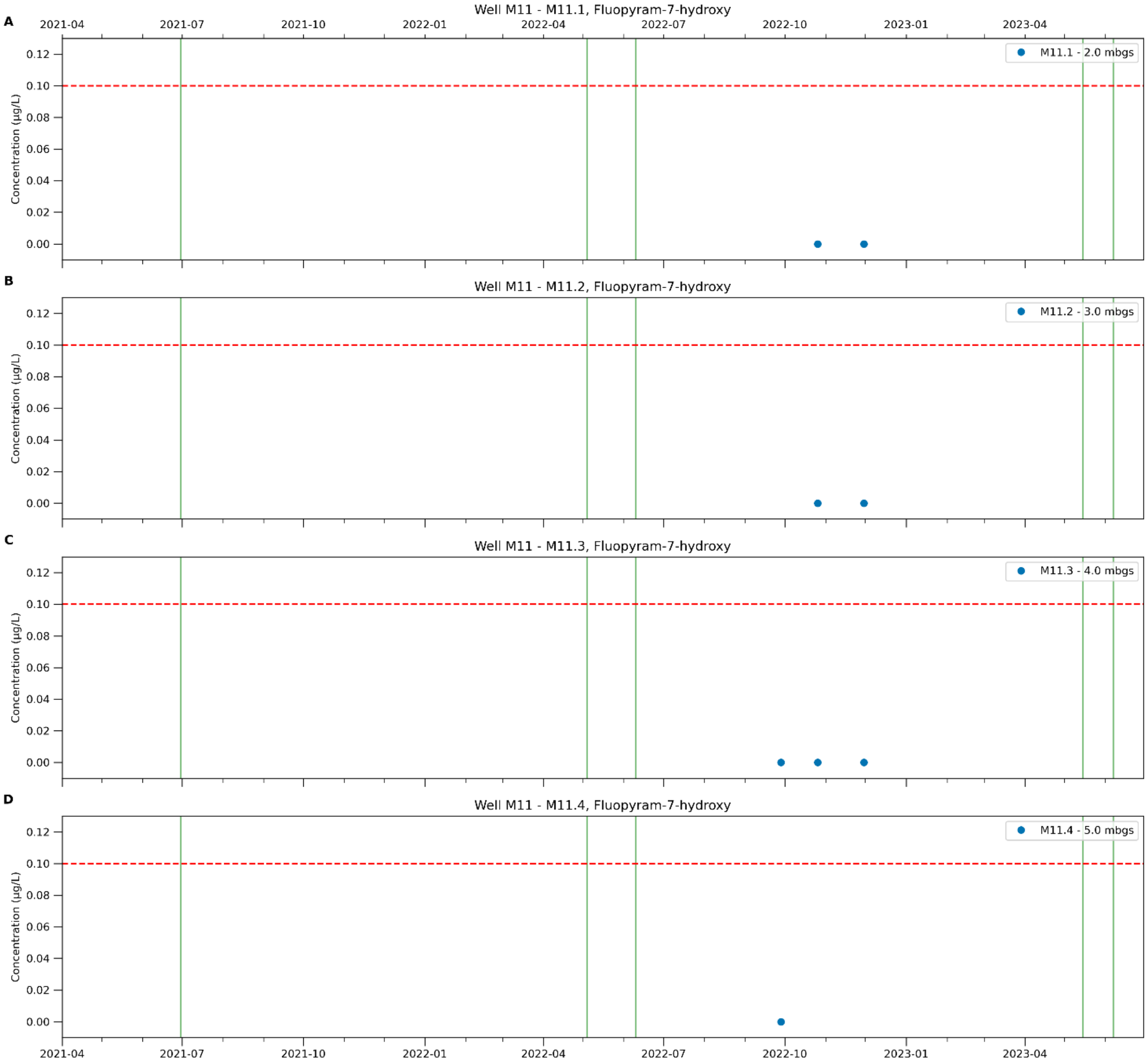


Figure A8.53. Leaching of fluopyram-7-hydroxy at Silstrup in well M11. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.

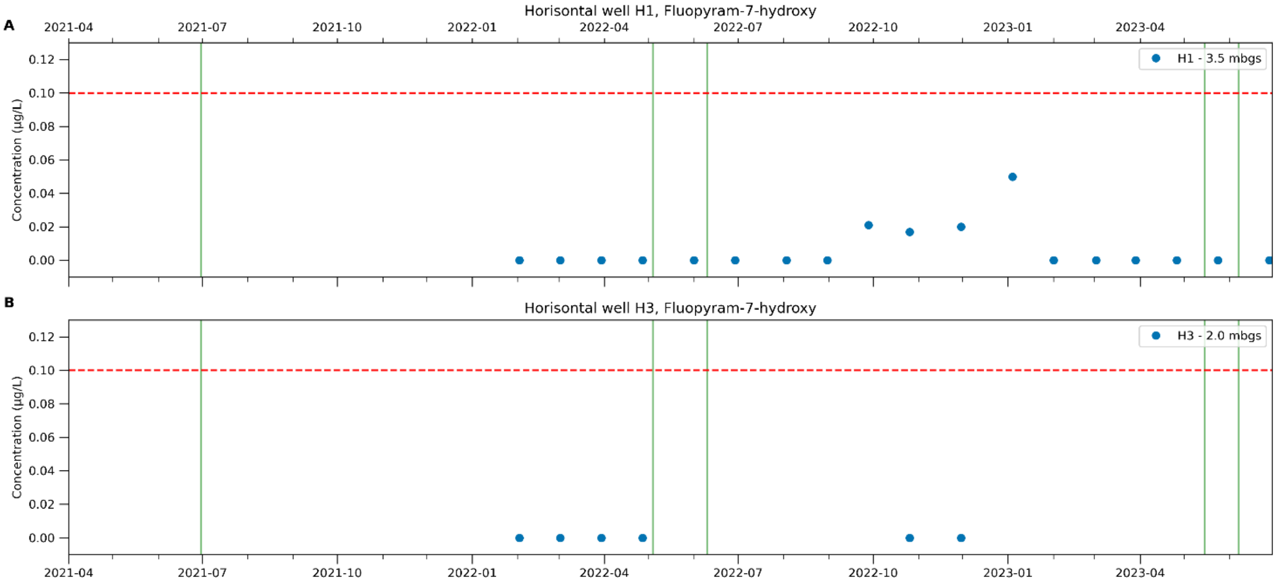


Figure A8.54. Leaching of fluopyram-7-hydroxy at Silstrup in the horisontal wells, H1 and H3. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-B depicts the screen depths from which samples were collected.

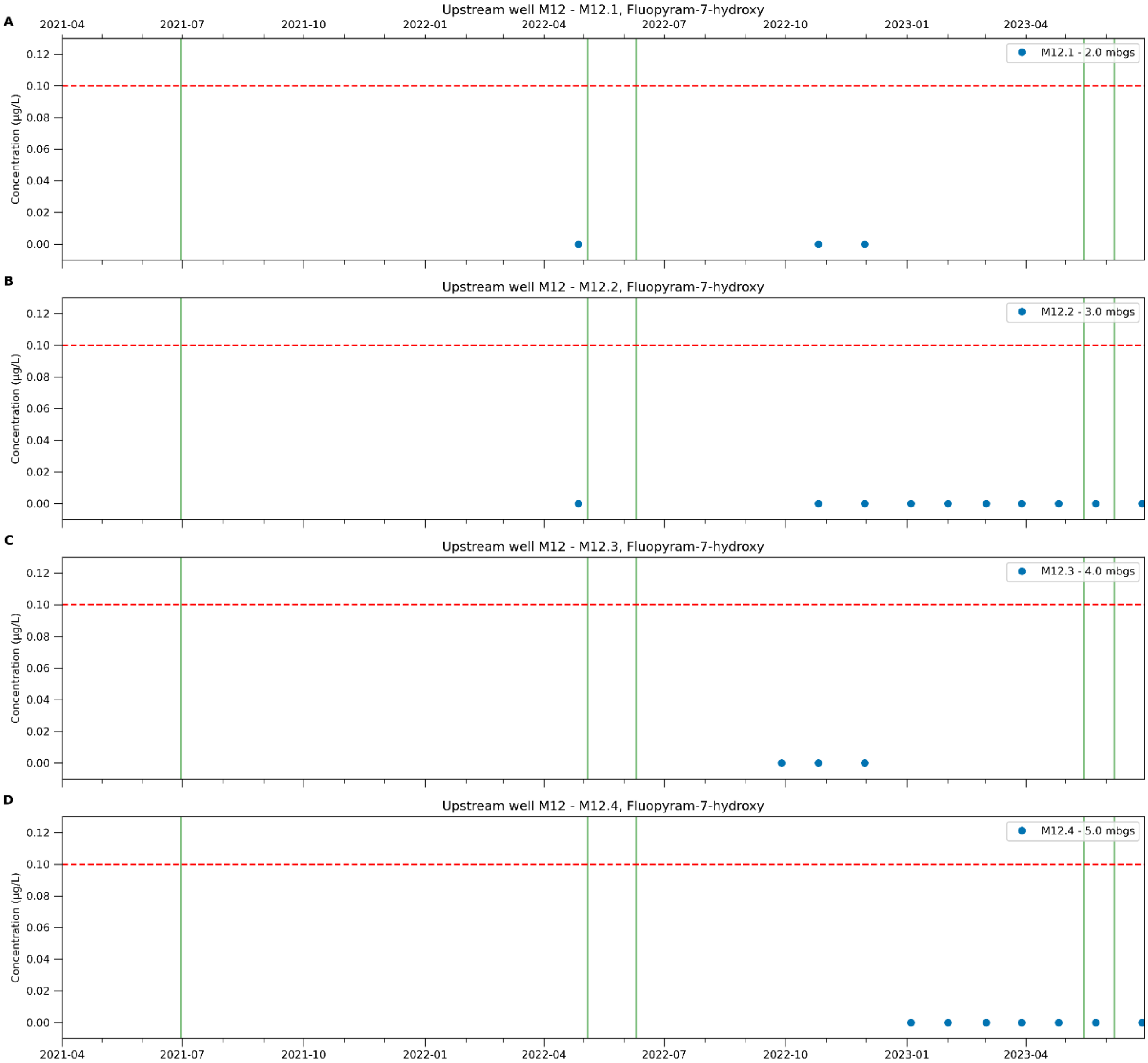


Figure A8.55. Leaching of fluopyram-7-hydroxy at Silstrup in the upstream well, M12. The vertical green line represents the fluopyram applications. The horizontal red dashed line depicts the limit value of 0.1 µg/L. A-D depicts the screen depths from which samples were collected.