Efficacy screening of various treatments for the control of Collembola (*Onychiurus armatus*) in sugar beet in 2022

Linda Frijters

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Stichting IRS
Postbus 20
4670 AA Dinteloord
Telefoon: +31 (0)165 – 51 60 70
E-mail: irs@irs.nl
Internet: https://www.irs.nl

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Contents

Summary

Collembola (*Onychiurus armatus*), also known as belowground springtails, feed from germinating sugar beets and can cause plant loss from germinating seeds up to the 2 to 4 leaf stage (BBCH12-14). In 2022, two trials on collembola control were carried out on fields with a natural collembola infestation in Elst and Angeren. In Elst, many plants were lost and no differences between treatments were seen. In Angeren, highest efficacy against springtails damage in relation to plant numbers was found from treatments Force, Belem, IRS857 and Vydate 10G. Additional application of these treatments to Force did not result in higher efficacy. Efficacy of IRS858 and the effect of application of two fertilizers did not differ from Force, but also not from the untreated control. No efficacy of IRS856 or IRS859 was found. Application of fertilisers did not result in a higher plant resilience or faster development and plant numbers were not influenced. A higher number of plants did not result in a higher yield in this trial.

Samenvatting

Ondergrondse springstaarten (*Onychiurus armatus*) vreten van kiemende suikerbieten en kunnen hierdoor plantwegval veroorzaken van kieming tot aan het 2- tot 4-bladstadium (BBCH12-14). In 2022 zijn twee proefvelden aangelegd in Elst en Angeren voor de beheersing van springstaarten, op percelen waar van nature een hoge besmetting van ondergrondse springstaarten aanwezig was. In Elst was er veel plantwegval, maar er zijn geen verschillen tussen behandelingen waargenomen. In Angeren gaven de behandelingen Force, Belem, IRS857 en Vydate 10G de hoogste effectiviteit tegen springstaarten in relatie tot plantwegval. Een combinatie van deze middelen met Force leidde niet tot een nog hogere effectiviteit. Effectiviteit van IRS858 was niet verschillend van toepassing met Force, maar ook niet van de onbehandelde controle. Het toepassen van de twee meststoffen leidde niet tot weerbaardere planten, die zich sneller ontwikkelden. Het plantaantal was niet verschillend van de onbehandelde controle. In de veldproef is geen effectiviteit tegen springstaarten van IRS856 of IRS859 gezien. Een groter plantaantal leidde niet tot een hogere opbrengst in deze proef.

1. Introduction

Various soil-borne pests are known to damage sugar beet seedlings causing plant loss. A reduced number of sugar beets plants can result in yield loss, difficulties in weed control, poor harvestability of the sugar beets and in severe cases complete loss of the sugar beet crop. Collembola (*Onychiurus armatus*) (Figure 1), also known as belowground springtails, are known to feed from soil organic matter. However, Collembola can also feed from germinating sugar beets and cause plant loss from germinating seeds up to the 2 to 4 leaf stage (BBCH12-14). In 2022, two field trials were carried out to control damage caused by belowground springtails. These field trials are part of a common trial project with different soil pests, carried out by various members of the IIRB study group 'Soil insect pests'.

The field trial was conducted according to Good Experimental Practice (GEP, annex A) guidelines.

Figure 1. Collembola (*Onychiurus armatus*) feeding from sugar beet roots.

2. Materials and methods

2.1 Trial sites and statistical design

Two field trials in the Netherlands, in Elst (22-03-01.01; Annex B1; B3) and Angeren (22-03-01.02; Annex C1; C3), with a natural infestation of Collembola were selected. The trials were designed as randomized blocks in four replications. Gross plot size was 3 meters wide (six rows) by 16 meters long, with a net plot size of 3 meters by 11 meters (Annex B2; C2).

2.2 Drilling

The field trial was drilled with sugar beet seeds from cultivar 'Caprianna KWS' (KWS SAAT SE & Co. KGaA, Einbeck, D.), using a standard precision sowing machine (Monosem) on the 21st of March (Angeren) and the 29th of March (Elst) 2022. This sowing machine is equipped with a system to change seed batches quickly. Sowing distance between rows was 50 cm and 18 cm within the rows. The trial was drilled relatively deep at about 4 cm, to slow down emergence of plants and thereby enhance the damage by Collembola. Due to a drilling error in Angeren, plots of treatment 10 in the A replicate (A10) and treatment 6 in the D replicate (D6) were lost and excluded from the field trial.

2.3 Treatments

All seeds, including the untreated control, were treated with the fungicides Tachigaren (14.7g hymexazol/100.000 seeds) and Rampart (7 g penthiopyrad/100.000 seeds). Treatments consisted of an insecticide seed treatment, granular insecticide or fertilizer (Table 1). Treatments Vydate 10G (oxamyl), Belem (cypermethrin), IRS859 and Quickstart were applied in the seed furrow at drilling. Brassitrel Pro foliar spray was carried out in BBCH10-12 on 13 April (Angeren) and 25 April (Elst). An overview of spraying equipment and the weather conditions during the time of application are given in Annex B4 & C4.

During emergence, a high number of slugs was seen on the field trial in Elst. To avoid plant loss caused by slugs, all plots were treated with 7 kg/ha slug pellets on 19 April. After the damage threshold of green peach aphids was exceeded in Elst, all plots were sprayed with 0.14 kg/ha Teppeki (flonicamid) on the14th of May, to prevent virus yellowing disease which can have a negative effect on yield.

Table 1. Overview of the treatments in at the field trial in Elst and Angeren. Products not registered for use in Dutch sugar beet growing are named under IRS code. Products participating in the IIRB trials are given an additional IIRB code.

treatment	*treatment*	*IIRB code*	*dosage (1 unit = 100.000 seeds)*
1	control	IIRB V1	-
2	Force (tefluthrin)	IIRB V2	10 g/ha
3	Vydate 10G (oxamyl)	-	10 kg/ha (granular)
4	IRS856	IIRB V4	120 ml/unit
5	IRS856 + 10g tefluthrin	IIRB V5	120 ml/unit
6	IRS857	IIRB V6	41,67 ml/unit
7	IRS857 + Force	IIRB V7	41,67 ml/unit
8	IRS858	IIRB V8	30 ml/unit
9	Vydate 10G + Force	-	10 kg/ha
10	IRS859	-	20 kg/ha (granular)
11	IRS859 + Force	-	20 kg/ha (granular)
12	Belem (cypermethrin)	-	12 kg/ha (granular)
13	Belem + Force	-	12 kg/ha (granular)
14	Quickstart (NPK + trace elements)	-	20 l/ha (liquid)
15	Quickstart + Force	-	20 l/ha (liquid)
16	Brassitrel Pro (micronutrients)	-	3 l/ha (foliar spray)

2.4 Assessments of efficacy

2.4.1 Plant damage

To establish plant loss, plants were counted in the central four rows of each plot over 11 meters length several times during emergence up to the 6 leaf stage (Table 2). Plants were counted at approximately 50% emergence (Elst: 19 April; Angeren: 8 April), 100% emergence (Elst: 25 April; Angeren: 14 April), BBCH 12-14 (Elst: 12 May; Angeren: 3 May) and finally at BBCH16-18 (19 May). The number of plants per plot was used to calculate the percentage of plants emerged in relation to the number of seeds sown (plant stand density).

On 3 May (Angeren) and 12 May (Elst), when plants reached BBCH12-14, a maximum of 24 plants per plot from the gross plots behind the 11m net plot, were collected and the number of bites per root were counted. Less plants were collected from plots with a low number of plants. The average number of bites per root per plot was calculated.

2.4.2 Assessment of phytotoxicity and vigour

Plants were scored for symptoms of phytotoxicity at BBCH12-14 (Elst: 12 May; Angeren: 3 May) and BBCH16-18 (19 May), by counting the number of plants in the central four rows that showed stunting, deformation, discoloration, necrosis or chlorosis caused by a treatment. Vigour was determined on 19 May by scoring the degree of development of the plants per plot on a scale from 0 (dead) to 10 (highly vigorous).

2.4.3 Yield

The field trial in Angeren was harvested on the 29th of September with the six row sugar beet harvester of IRS (PASSI). From each plot the gross weight was measured and a subsample of 60-80 kg was taken to the tare house of Cosun Beet Company (Dinteloord, NL). The soil tare, sugar-, potassium-, sodium-, amino nitrogen-, and glucose content was determined. Based on quality assessments and net weight (=gross weight - soil tare), sugar yield (t/ha) and financial yield (€/ha, based on 45 €/ton sugar beets with 17% sugar) were calculated. Costs of spraying and products were not taken into account. The field trial in Elst was not harvested.

2.5 Statistical analysis

Data were analyzed by ANOVA (balanced) using Genstat 21st edition. A multiple comparison test was carried out using Fisher's protected LSD when the significance level was smaller than 0.05 ($P<0.05$).

3. Results and discussion

3.1 Plant numbers and root damage

In Elst, high pest pressure caused a high number of plant loss. At early emergence (50%), most plants of plots treated with Force + Vydate 10G were emerged compared to plots of other treatments (Table 2; Annex B5). Emergence of these plots was not significantly different from plots treated with IRS857 + Force and Belem + Force. However, during further germination and early plant growth (100% to BBCH16-18), no significant differences in the number of plants was found between treatments. In Elst, pest pressure was likely too high for any of the treatments to have an effect. In addition damage by slugs may have influenced plant loss as well.

Table 2. The average percentage of plants in relation to the number of seeds sown on in Elst at 50% emergence (19 April; BBCH09-10), 100% emergence (25 April; BBCH09-10), BBCH12-14 (12 May) and BBCH16-18 (19 May). Different letters indicate significant differences in percentage of plants emerged between treatments at the same date.

treatment		*percentage of plants emerged in Elst (%)*							
		50%		100%		BBCH12-14		BBCH16-18	
1	control	25.9	abc	36.8	-	35.9	-	35.7	-
2	Force	25.4	ab	31.8	-	30.9	-	31.5	-
3	Vydate 10G	28.5	bc	37.2	-	34.4	-	34.8	-
4	IRS856	29.0	bc	39.8	-	40.3	-	41.8	-
5	IRS856 + 10g tefluthrin	24.6	ab	34.0	-	33.9	-	33.1	-
6	IRS857	25.4	ab	34.4	-	34.0	-	33.4	-
7	IRS857 + Force	31.6	bcd	40.5	-	38.9	-	40.1	-
8	IRS858	27.8	abc	37.9	-	38.4	-	38.0	-
9	Vydate 10G + Force	38.1	d	42.1	-	41.2	-	41.0	-
10	IRS859	25.0	ab	34.9	-	34.3	-	35.0	-
11	IRS859 + Force	25.0	ab	32.8	-	31.0	-	31.5	-
12	Belem	28.4	bc	38.0	-	34.3	-	34.6	-
13	Belem + Force	33.8	cd	40.0	-	36.1	-	36.7	-
14	Quickstart	20.0	a	29.7	-	30.6	-	31.1	-
15	Quickstart + Force	24.5	ab	34.8	-	31.6	-	31.9	-
16	Brassitrel Pro	23.6	ab	33.1	-	32.9	-	33.5	-
P-value		0.013		0.173		0.172		0.116	
LSD 5%		8.05		-		-		-	

In Angeren, plant loss was much lower compared to Elst (Table 3; Annex C5). Treatment with Force resulted in the highest number of plants per plot. Additional seed treatments, granular application or nutrients to Force did not lead to a significant higher number of plants compared to a solo application of Force. The number of plants per plot treated with IRS856 and plants per plot treated with IRS859 was not significantly different to the untreated control. The number of plants of treatment with IRS858, Quickstart and Brassitrel Pro was not significantly different from the untreated control, but did also not differ from the treatment with Force. At final plant stand density (BBCH 16-18), treatment with Force was most effective. Treatment with Force, Belem, IRS857 and Vydate 10G solo resulted in a significantly higher number of plants compared to the untreated control.

Table 3. The average percentage of plants in relation to the number of seeds sown on in Angeren at 50% emergence (8 April; BBCH09-10), 100% emergence (14 April; BBCH09-10), BBCH12-14 (3 May) and BBCH16-18 (19 May). Different letters indicate significant differences in percentage of plants emerged between treatments at the same date.

treatment		*percentage of plants emerged in Angeren (%)*							
		50%		100%		BBCH12-14		BBCH16-18	
1	control	45.3	bcde	60.8	a	59.2	ab	69.1	ab
2	Force	56.6	f	73.6	d	71.2	defg	80.4	defg
3	Vydate 10G	33.9	a	68.3	abcd	68.1	cdef	76.8	cde
4	IRS856	45.2	bcde	65.9	abcd	62.2	abc	72.3	bc
5	IRS856 + 10g tefluthrin	50.2	bcdef	73.2	d	72.2	efg	84.8	fg
6	IRS857	42.4	bcd	67.1	bcd	63.8	abc	76.8	cde
7	IRS857 + Force	42.5	abc	72.5	d	73.0	fg	82.5	efg
8	IRS858	54.7	def	71.8	cd	65.1	bcd	75.9	bcde
9	Vydate 10G + Force	40.8	ab	72.5	d	76.5	g	85.9	g
10	IRS859	46.9	abc	62.5	ab	56.2	a	64.6	a
11	IRS859 + Force	49.1	bcdef	69.4	abcd	70.2	def	77.8	cdef
12	Belem	44.5	bc	63.3	abc	67.3	cdef	76.7	cde
13	Belem + Force	52.4	cdef	69.5	bcd	70.3	defg	83.1	efg
14	Quickstart	51.0	cdef	66.7	abcd	66.0	cde	76.2	bcde
15	Quickstart + Force	55.0	ef	74.1	d	69.5	def	77.1	cde
16	Brassitrel Pro	48.9	bcdef	63.5	abc	62.8	abc	73.0	bcd
P-value		0.003		0.033		<0.001		<0.001	
LSD 5%		10.00		8.75		6.24		7.46	

Although the number of bites per root was highest for plants of the untreated control in Elst, no significant differences in root bites was found between treatments in Elst and/or Angeren (Table 4; Annex B6; C6). It is likely that plants with a very high number of root bites were killed before plants were sampled. Naturally, only plants that survived collembola attack, with a lower number of root bites, were scored for root bites.

Table 4. The average number of root bites per plant. No interaction was found between treatment and the location (p=0.761) and therefore the effect on treatment for both locations were analyzed together (p=0.701).

treatment		*average number of bites per root*		
		Elst	Angeren	average
1	control	5.6	2.3	3.9
2	Force	4.1	2.1	3.1
3	Vydate 10G	4.6	1.9	3.2
4	IRS856	3.7	2.1	2.9
5	IRS856 + 10g tefluthrin	3.0	1.5	2.2
6	IRS857	3.4	2.1	2.8
7	IRS857 + Force	3.1	1.9	2.5
8	IRS858	3.7	1.5	2.6
9	Vydate 10G + Force	4.0	1.3	2.7
10	IRS859	2.1	2.1	2.1
11	IRS859 + Force	3.6	2.4	3.0
12	Belem	3.9	2.2	3.0
13	Belem + Force	4.8	1.8	3.3
14	Quickstart	4.7	1.6	3.1
15	Quickstart + Force	3.6	1.7	2.7
16	Brassitrel Pro	3.9	1.7	2.8
P-value				0.701

3.2 Vigour and phytotoxicity

Treatment of Vydate 10G in combination with Force led to most vigorous plants in Angeren (Table 5; Annex B7; C7). Although this was not significantly different from a solo application of Force. Additional treatments to Force did not result in more vigorous plants. In Elst, no significant differences was found in vigour between treatments. Also, no symptoms of phytotoxicity were found for any of the treatments (Table 6; Annex B7; C7).

Table 5. Plant vigour (1=dead; 10=highly vigorous crop) on 19th of May in Elst and Angeren.

treatment		*vigour*			
		Elst		Angeren	
1	control	6.9	-	6.3	ab
2	Force	7.8	-	7.9	de
3	Vydate 10G	7.6	-	7.5	cde
4	IRS856	7.5	-	6.6	abc
5	IRS856 + 10g tefluthrin	7.5	-	7.4	cd
6	IRS857	7.4	-	7.3	bcd
7	IRS857 + Force	7.1	-	7.9	de
8	IRS858	7.6	-	7.5	cde
9	Vydate 10G + Force	7.4	-	8.5	e
10	IRS859	7.4	-	6.2	ab
11	IRS859 + Force	7.3	-	6.8	abc
12	Belem	7.1	-	7.4	cd
13	Belem + Force	7.4	-	7.4	cd
14	Quickstart	7.0	-	7.4	cd
15	Quickstart + Force	7.1	-	7.9	de
16	Brassitrel Pro	7.0	-	6.0	a
P-value		0.282		<0.001	
LSD 5%		-		1.04	

Table 6. The number of plants showing symptoms of phytotoxicity, caused by seed, granular or foliar treatments, assessed in BBCH 12-14 (Elst: 12th of May; Angeren: 3rd of May) and BBCH 16-18 (19th of May).

treatment		*symptoms of phytotoxicity*			
		Elst BBCH12-14	Elst BBCH16-18	Angeren BBCH12-14	Angeren BBCH16-18
1	control	0	0	0	0
2	Force	0	0	0	0
3	Vydate 10G	0	0	0	0
4	IRS856	0	0	0	0
5	IRS856 + 10g tefluthrin	0	0	0	0
6	IRS857	0	0	0	0
7	IRS857 + Force	0	0	0	0
8	IRS858	0	0	0	0
9	Vydate 10G + Force	0	0	0	0
10	IRS859	0	0	0	0
11	IRS859 + Force	0	0	0	0
12	Belem	0	0	0	0
13	Belem + Force	0	0	0	0
14	Quickstart	0	0	0	0
15	Quickstart + Force	0	0	0	0
16	Brassitrel Pro	0	0	0	0

3.3 Yield

The field trial in Elst was not harvested to determine yield, since no significant differences in final plant stand and root bites were found. In Angeren the field trial was harvested, no significant differences in root weight, sugar content and sugar yield were found between treatments (Table 7; Annex; C9). Although plant numbers were significantly higher when plants were treated with Force, Belem, IRS857 or Vydate 10G compared to untreated seeds, no significant difference in financial yield was seen. Application of additional treatments to seeds treated with Force, did not result in a higher financial yield compared to a solo application of Force.

Table 7. Average yield per treatment expressed in root weight (t/ha), sugar content (%), sugar yield (t/ha) and financial yield (€/ha) at the field trial in Angeren. Different letters indicate significant differences within a yield category. The field trial was harvested on 29 September 2022.

treatment		*Yield*							
		root weight (t/ha)		sugar content (%)		sugar yield (t/ha)		financial yield (€/ha)	
1	control	100.6	-	17.3	-	17.5	-	4700	bcd
2	Force	101.6	-	17.3	-	17.6	-	4722	cd
3	Vydate 10G	101.3	-	17.1	-	17.3	-	4613	abcd
4	IRS856	102.7	-	17.1	-	17.6	-	4677	bcd
5	IRS856 + 10g tefluthrin	104.1	-	17.3	-	18.0	-	4839	d
6	IRS857	105.4	-	17.0	-	17.9	-	4761	d
7	IRS857 + Force	97.7	-	17.4	-	17.0	-	4574	abcd
8	IRS858	97.2	-	17.2	-	16.7	-	4440	abc
9	Vydate 10G + Force	98.7	-	17.4	-	17.2	-	4627	abcd
10	IRS859	94.6	-	17.2	-	16.3	-	4340	a
11	IRS859 + Force	104.8	-	17.3	-	18.1	-	4846	d
12	Belem	95.6	-	17.3	-	16.6	-	4428	ab
13	Belem + Force	101.9	-	17.2	-	17.5	-	4660	bcd
14	Quickstart	102.0	-	17.1	-	17.4	-	4610	abcd
15	Quickstart + Force	103.6	-	17.3	-	17.9	-	4794	d
16	Brassitrel Pro	97.1	-	17.4	-	16.9	-	4565	abcd
P-value		0.067		0.332		0.08		0.049	
LSD 5%		6.95		0.34		1.11		292.6	

4. Conclusions

Based on these field trials it can be concluded that:

- Efficacy of the treatments in Elst could not be studied.
- In Angeren, efficacy against collembola (belowground springtails) on plant numbers was found from treatments Force, Belem, IRS857 and Vydate 10G. Additional application of these treatments to Force did not result in higher efficacy.
- Plant numbers for plots with treatments Quickstart, Brassitrel Pro or IRS858 resulted in a higher number of plants although this did not differ significantly from the untreated control.
- No efficacy of IRS856 or IRS859 was found against collembola.
- Plant losses at Angeren were not high enough to have an impact on yield.

Annex A GEP Certificate

Netherlands Food and Consumer Product Safety Authority
Ministry of Agriculture, Nature and Food Quality

Certificate

of Official Recognition of Efficacy Testing Organisations in the Netherlands
This certifies that, in conformity with the request of December 13, 2019

Stichting IRS

Residing: Kreekweg 1, Dinteloord the Netherlands

has officially been recognised as an organisation for efficacy testing in the Netherlands.

As has been laid down in the 'Regeling gewasbeschermingsmiddelen en biociden' (Regulation Crop Protection Products and Biocides) of September 26, 2007 (Staatscourant 2007, 386).

This recognition commences on: December 19, 2020
and expires on: December 19, 2026

The above organisation is competent to carry out efficacy trials/tests in the categories mentioned in the annex of this certificate.

Utrecht, October 27, 2020

For the Minister of Agriculture, Nature and Food Quality,

Ton van Arnhem

Director NPPO (National Plant Protection Organization)

CERTIFICATE NUMBER: NL_GEP_04209626

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Annex

ORGANISATION is officially recognised as being competent to carry out efficacy trials/tests in the following categories:

- Outdoor crops of sugar beet and cichory

This annex has been approved by Ton van Arnhem
Director NPPO (National Plant Protection Organisation)

Annex B Field trial Elst

Annex B1 Location field trial

Field trial code: 22-03-01.01
GPS coordinates: (51.922244; 5.893288)

Annex B2 Trial scheme

Trial field: 22-03-01.01
Number of replications: 4
Net plot size (m): 11x3
Gross plot size (m): 16x3

D

2	**11**	**6**	**13**	**10**	**3**	**1**	**5**
14	**4**	**9**	**8**	**15**	**16**	**12**	**7**
15	**10**	**7**	**12**	**1**	**9**	**16**	**14**
6	**2**	**3**	**4**	**11**	**5**	**13**	**8**
16	**11**	**5**	**13**	**2**	**3**	**14**	**6**
4	**8**	**9**	**1**	**10**	**7**	**12**	**15**
7	**10**	**15**	**12**	**8**	**9**	**16**	**2**
1	**5**	**3**	**6**	**11**	**14**	**13**	**4**

A

Annex B3 General data

soil type:	clay soil pH-CaCl= 6.9	Organic matter= parts < 16 µm = Pw =	4.9% 54% 22 mg P_2O_5 per L of soil

preceding crops:	2021 barley 2020 wheat 2019 sugar beets 2018 wheat 2017 potatoes 2016 wheat
drilling date:	29th of March
variety:	Caprianna KWS
distance in row:	18.0 cm

Annex B4 Overview of weather conditions during spraying

Method: **Foliar Spray**
Equipment: "AZO-perslucht" (van der Wey)
Nozzle type: Lechler 120.03
Nozzle distance: 50 cm
Boom height: 50 cm
Spray volume: 300 (l/ha)

Table B4.1. Overview of weather conditions during spraying.

conditions	*Elst* *25-4-2022*
BBCH	10-12
time of spraying	11:00-11:30
wind speed (m/s)	2
relative air humidity (%)	76
temperature during spraying (°C)	9
other	wet canopy, wet soil, heavily clouded

Annex B5 Plant emergence

Table B5.1. Total number of plants per plot (middle 4 rows), number of plants per hectare and percentage of emerged plants at 4 assessment dates in Elst.

treat.	*rep*	*plants per plot*				*plants per hectare*				*percentage plants emerged*			
		19-4	25-4	12-5	19-5	19-4	25-4	12-5	19-5	19-4	25-4	12-5	19-5
1	A	35	66	64	59	15909	30000	29091	26818	14.3	27.0	26.2	24.1
1	B	70	100	99	98	31818	45455	45000	44545	28.6	40.9	40.5	40.1
1	C	84	108	105	107	38182	49091	47727	48636	34.4	44.2	43.0	43.8
1	D	64	86	83	85	29091	39091	37727	38636	26.2	35.2	34.0	34.8
2	A	62	86	75	71	28182	39091	34091	32273	25.4	35.2	30.7	29.0
2	B	70	77	76	80	31818	35000	34545	36364	28.6	31.5	31.1	32.7
2	C	58	70	74	76	26364	31818	33636	34545	23.7	28.6	30.3	31.1
2	D	58	78	77	81	26364	35455	35000	36818	23.7	31.9	31.5	33.1
3	A	51	69	62	60	23182	31364	28182	27273	20.9	28.2	25.4	24.5
3	B	72	95	88	90	32727	43182	40000	40909	29.5	38.9	36.0	36.8
3	C	93	112	111	115	42273	50909	50455	52273	38.0	45.8	45.4	47.0
3	D	63	88	75	75	28636	40000	34091	34091	25.8	36.0	30.7	30.7
4	A	90	107	104	100	40909	48636	47273	45455	36.8	43.8	42.5	40.9
4	B	39	74	75	83	17727	33636	34091	37727	16.0	30.3	30.7	34.0
4	C	82	101	114	124	37273	45909	51818	56364	33.5	41.3	46.6	50.7
4	D	73	107	101	102	33182	48636	45909	46364	29.9	43.8	41.3	41.7
5	A	50	70	68	70	22727	31818	30909	31818	20.5	28.6	27.8	28.6
5	B	44	66	66	67	20000	30000	30000	30455	18.0	27.0	27.0	27.4
5	C	89	108	119	112	40455	49091	54091	50909	36.4	44.2	48.7	45.8
5	D	58	88	78	75	26364	40000	35455	34091	23.7	36.0	31.9	30.7
6	A	46	68	69	68	20909	30909	31364	30909	18.8	27.8	28.2	27.8
6	B	41	78	74	73	18636	35455	33636	33182	16.8	31.9	30.3	29.9
6	C	79	102	105	100	35909	46364	47727	45455	32.3	41.7	43.0	40.9
6	D	82	88	84	86	37273	40000	38182	39091	33.5	36.0	34.4	35.2
7	A	37	56	52	52	16818	25455	23636	23636	15.1	22.9	21.3	21.3
7	B	80	103	94	102	36364	46818	42727	46364	32.7	42.1	38.5	41.7
7	C	90	111	112	114	40909	50455	50909	51818	36.8	45.4	45.8	46.6
7	D	102	126	122	124	46364	57273	55455	56364	41.7	51.5	49.9	50.7
8	A	44	72	77	75	20000	32727	35000	34091	18.0	29.5	31.5	30.7
8	B	64	93	91	92	29091	42273	41364	41818	26.2	38.0	37.2	37.6
8	C	80	102	97	99	36364	46364	44091	45000	32.7	41.7	39.7	40.5
8	D	84	104	110	106	38182	47273	50000	48182	34.4	42.5	45.0	43.4
9	A	69	90	82	82	31364	40909	37273	37273	28.2	36.8	33.5	33.5
9	B	76	82	83	84	34545	37273	37727	38182	31.1	33.5	34.0	34.4
9	C	119	117	121	120	54091	53182	55000	54545	48.7	47.9	49.5	49.1
9	D	109	123	117	115	49545	55909	53182	52273	44.6	50.3	47.9	47.0

treat.	*rep*	*plants per plot*				*plants per hectare*				*percentage plants emerged*			
		19-4	25-4	12-5	19-5	19-4	25-4	12-5	19-5	19-4	25-4	12-5	19-5
10	A	57	82	80	86	25909	37273	36364	39091	23.3	33.5	32.7	35.2
10	B	56	91	94	93	25455	41364	42727	42273	22.9	37.2	38.5	38.0
10	C	72	99	103	103	32727	45000	46818	46818	29.5	40.5	42.1	42.1
10	D	59	69	58	60	26818	31364	26364	27273	24.1	28.2	23.7	24.5
11	A	45	54	54	53	20455	24545	24545	24091	18.4	22.1	22.1	21.7
11	B	67	88	80	79	30455	40000	36364	35909	27.4	36.0	32.7	32.3
11	C	68	83	78	82	30909	37727	35455	37273	27.8	34.0	31.9	33.5
11	D	64	96	91	94	29091	43636	41364	42727	26.2	39.3	37.2	38.5
12	A	58	84	73	72	26364	38182	33182	32727	23.7	34.4	29.9	29.5
12	B	53	79	74	76	24091	35909	33636	34545	21.7	32.3	30.3	31.1
12	C	97	115	104	107	44091	52273	47273	48636	39.7	47.0	42.5	43.8
12	D	70	94	84	83	31818	42727	38182	37727	28.6	38.5	34.4	34.0
13	A	60	89	78	82	27273	40455	35455	37273	24.5	36.4	31.9	33.5
13	B	101	97	92	92	45909	44091	41818	41818	41.3	39.7	37.6	37.6
13	C	84	103	86	82	38182	46818	39091	37273	34.4	42.1	35.2	33.5
13	D	85	102	97	103	38636	46364	44091	46818	34.8	41.7	39.7	42.1
14	A	46	67	61	62	20909	30455	27727	28182	18.8	27.4	25.0	25.4
14	B	44	65	77	78	20000	29545	35000	35455	18.0	26.6	31.5	31.9
14	C	59	91	89	88	26818	41364	40455	40000	24.1	37.2	36.4	36.0
14	D	47	67	72	76	21364	30455	32727	34545	19.2	27.4	29.5	31.1
15	A	33	42	43	44	15000	19091	19545	20000	13.5	17.2	17.6	18.0
15	B	75	115	94	94	34091	52273	42727	42727	30.7	47.0	38.5	38.5
15	C	76	107	104	105	34545	48636	47273	47727	31.1	43.8	42.5	43.0
15	D	56	76	68	69	25455	34545	30909	31364	22.9	31.1	27.8	28.2
16	A	55	78	78	80	25000	35455	35455	36364	22.5	31.9	31.9	32.7
16	B	56	78	74	78	25455	35455	33636	35455	22.9	31.9	30.3	31.9
16	C	66	94	95	95	30000	42727	43182	43182	27.0	38.5	38.9	38.9
16	D	54	74	75	75	24545	33636	34091	34091	22.1	30.3	30.7	30.7

Annex B6 Root bites

Table B6.1. The total number of collected plants and the average number of root bites per plant (Elst).

treat.	*rep*	*no. of plant roots assessed*	*average no. of bites per root*
1	A	16	4.9
1	B	21	5.7
1	C	21	8.8
1	D	17	3.0
2	A	14	4.5
2	B	10	2.8
2	C	23	4.8
2	D	16	4.4
3	A	21	7.8
3	B	23	5.3
3	C	13	2.2
3	D	18	3.1
4	A	20	3.3
4	B	23	5.2
4	C	20	3.6
4	D	17	2.8
5	A	6	3.5
5	B	16	5.3
5	C	17	2.8
5	D	20	0.4
6	A	14	6.2
6	B	11	2.6
6	C	21	3.3
6	D	14	1.5
7	A	18	1.9
7	B	19	4.7
7	C	19	3.1
7	D	21	2.8
8	A	21	2.6
8	B	21	4.6
8	C	22	1.3
8	D	18	6.1
9	A	17	2.8
9	B	18	4.6
9	C	19	3.3
9	D	22	5.4

treat.	*rep*	*no. of plant roots assessed*	*average no. of bites per root*
10	A	23	2.4
10	B	19	2.2
10	C	17	2.2
10	D	13	1.6
11	A	5	4.0
11	B	17	3.8
11	C	17	4.3
11	D	19	2.4
12	A	25	3.6
12	B	16	4.4
12	C	20	3.3
12	D	13	4.1
13	A	19	8.5
13	B	18	4.3
13	C	13	4.5
13	D	21	2.0
14	A	16	5.4
14	B	11	4.8
14	C	19	3.2
14	D	19	5.3
15	A	10	3.8
15	B	19	2.9
15	C	25	1.9
15	D	14	5.9
16	A	23	6.3
16	B	17	5.4
16	C	24	1.5
16	D	19	2.6

Annex B7 Phytotoxicity and plant vigour

Table B7.1. Percentage of plants showing signs of phytotoxicity, caused by insecticide treatment at two different dates. Also plant vigour (1=dead; 10=highly vigorous crop) on 19 May 2022 (Elst).

treatment	*replicate*	*phytotoxicity*		*vigour*
		12 May	19 May	
1	A	0	0	7.0
1	B	0	0	6.5
1	C	0	0	7.5
1	D	0	0	6.5
2	A	0	0	7.5
2	B	0	0	8.0
2	C	0	0	7.5
2	D	0	0	8.0
3	A	0	0	7.5
3	B	0	0	7.5
3	C	0	0	7.5
3	D	0	0	8.0
4	A	0	0	7.0
4	B	0	0	8.0
4	C	0	0	7.5
4	D	0	0	7.5
5	A	0	0	7.0
5	B	0	0	7.5
5	C	0	0	8.5
5	D	0	0	7.0
6	A	0	0	8.0
6	B	0	0	7.5
6	C	0	0	7.0
6	D	0	0	7.0
7	A	0	0	6.5
7	B	0	0	7.5
7	C	0	0	7.5
7	D	0	0	7.0
8	A	0	0	8.0
8	B	0	0	7.5
8	C	0	0	7.5
8	D	0	0	7.5
9	A	0	0	8.0
9	B	0	0	7.0
9	C	0	0	7.0
9	D	0	0	7.5

treatment	*replicate*	*phytotoxicity*		*vigour*
		12 May	19 May	
10	A	0	0	7.5
10	B	0	0	7.0
10	C	0	0	8.0
10	D	0	0	7.0
11	A	0	0	7.0
11	B	0	0	7.5
11	C	0	0	7.5
11	D	0	0	7.0
12	A	0	0	7.0
12	B	0	0	7.0
12	C	0	0	7.5
12	D	0	0	7.0
13	A	0	0	7.0
13	B	0	0	7.0
13	C	0	0	8.0
13	D	0	0	7.5
14	A	0	0	6.0
14	B	0	0	7.5
14	C	0	0	7.0
14	D	0	0	7.5
15	A	0	0	7.0
15	B	0	0	7.0
15	C	0	0	7.5
15	D	0	0	7.0
16	A	0	0	7.5
16	B	0	0	7.5
16	C	0	0	7.0
16	D	0	0	6.0

Annex B8 Photographs

Figure B8.1. Drone photo of A replicate on the 28th of June (Elst).

Figure B8.2. Drone photo of B replicate on the 28th of June (Elst).

Figure B8.3. Drone photo of C replicate on the 28th of June (Elst).

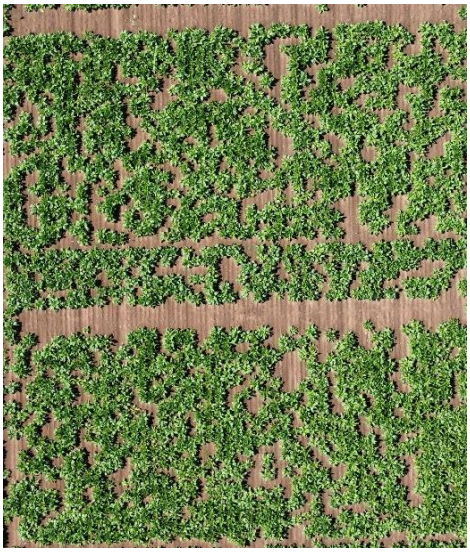

Figure B8.4. Drone photo of D replicate on the 28th of June- (Elst).

Annex C Field trial Angeren

Annex C1 Location field trial

Field trial code: 22-03-01.02
GPS coordinates: (51.914061; 5.938846)

Annex C2 Trial scheme

Trial field: 22-03-01.02
Number of replications: 4
Net plot size (m): 11x3
Gross plot size (m): 16x3

D

2	11	6	13	10	3	1	5
14	4	9	8	15	16	12	7
15	10	7	12	1	9	16	14
6	2	3	4	11	5	13	8
16	11	5	13	2	3	14	6
4	8	9	1	10	7	12	15
7	10	15	12	8	9	16	2
1	5	3	6	11	14	13	4

A

Annex C3 General data

soil type:	clay soil	Organic matter=	2.6%
	pH-CaCl= 7.0	parts < 16 µm =	34%
		Pw =	30 mg P_2O_5 per L of soil

preceding crops:	2021 grass (seeds) 2020 grass (seeds) 2019 potatoes 2018 sugar beets
drilling date:	21th of March 2022
variety:	Caprianna KWS
distance in row:	18.0 cm

Annex C4 Overview of weather conditions during spraying

Method:	**Foliar Spray**
Equipment:	"AZO-perslucht" (van der Wey)
Nozzle type:	Lechler 120.03
Nozzle distance:	50 cm
Boom height:	50 cm
Spray volume:	300 (l/ha)

Table C4.1. Overview of weather conditions during spraying in Angeren.

conditions	*Angeren* 13-4-2022
BBCH	10-12
time of spraying	10:00-10:30
wind speed (m/s)	1
relative air humidity (%)	72
temperature during spraying (°C)	15
other	dry canopy, wet soil, heavily clouded

Annex C5 Plant emergence

Table C5.1. Total number of plants per plot (middle 4 rows), number of plants per hectare and percentage of emerged plants at 4 assessment dates in Angeren.

treat.	*rep*	*plants per plot*				*plants per hectare*				*percentage plants emerged*			
		8-4	14-4	3-5	19-5	8-4	14-4	3-5	19-5	8-4	14-4	3-5	19-5
1	A	123	173	158	173	55909	78636	71818	78636	50.3	70.8	59.3	70.8
1	B	114	147	149	169	51818	66818	67727	76818	46.6	60.1	55.9	69.1
1	C	125	137	166	170	56818	62273	75455	77273	51.1	56.0	62.3	69.5
1	D	81	137	158	164	36818	62273	71818	74545	33.1	56.0	59.3	67.1
2	A	142	186	200	207	64545	84545	90909	94091	58.1	76.1	75.0	84.7
2	B	156	186	193	196	70909	84545	87727	89091	63.8	76.1	72.4	80.2
2	C	125	169	179	181	56818	76818	81364	82273	51.1	69.1	67.1	74.0
2	D	130	179	187	202	59091	81364	85000	91818	53.2	73.2	70.1	82.6
3	A	71	165	169	175	32273	75000	76818	79545	29.0	67.5	63.4	71.6
3	B	82	156	196	194	37273	70909	89091	88182	33.5	63.8	73.5	79.4
3	C	94	173	187	197	42727	78636	85000	89545	38.5	70.8	70.1	80.6
3	D	84	174	174	185	38182	79091	79091	84091	34.4	71.2	65.3	75.7
4	A	120	162	157	163	54545	73636	71364	74091	49.1	66.3	58.9	66.7
4	B	110	180	185	197	50000	81818	84091	89545	45.0	73.6	69.4	80.6
4	C	100	150	163	176	45455	68182	74091	80000	40.9	61.4	61.1	72.0
4	D	112	152	158	171	50909	69091	71818	77727	45.8	62.2	59.3	70.0
5	A	139	197	179	193	63182	89545	81364	87727	56.9	80.6	67.1	79.0
5	B	103	153	190	214	46818	69545	86364	97273	42.1	62.6	71.3	87.5
5	C	119	177	204	234	54091	80455	92727	106364	48.7	72.4	76.5	95.7
5	D	130	189	197	188	59091	85909	89545	85455	53.2	77.3	73.9	76.9
6	A	82	160	140	171	37273	72727	63636	77727	33.5	65.5	52.5	70.0
6	B	135	178	182	184	61364	80909	82727	83636	55.2	72.8	68.3	75.3
6	C	119	185	183	211	54091	84091	83182	95909	48.7	75.7	68.6	86.3
6	D	*	*	*	*	*	*	*	*	*	*	*	*
7	A	102	197	204	205	46364	89545	92727	93182	41.7	80.6	76.5	83.9
7	B	106	186	196	195	48182	84545	89091	88636	43.4	76.1	73.5	79.8
7	C	80	146	180	198	36364	66364	81818	90000	32.7	59.7	67.5	81.0
7	D	128	180	199	209	58182	81818	90455	95000	52.4	73.6	74.6	85.5
8	A	149	173	171	179	67727	78636	77727	81364	61.0	70.8	64.1	73.2
8	B	124	175	162	177	56364	79545	73636	80455	50.7	71.6	60.8	72.4
8	C	134	198	200	205	60909	90000	90909	93182	54.8	81.0	75.0	83.9
8	D	128	156	161	181	58182	70909	73182	82273	52.4	63.8	60.4	74.0
9	A	126	189	204	205	57273	85909	92727	93182	51.5	77.3	76.5	83.9
9	B	92	165	193	197	41818	75000	87727	89545	37.6	67.5	72.4	80.6
9	C	92	184	207	212	41818	83636	94091	96364	37.6	75.3	77.6	86.7
9	D	89	171	212	226	40455	77727	96364	102727	36.4	70.0	79.5	92.5

treat.	*rep*	*plants per plot*				*plants per hectare*				*percentage plants emerged*			
		8-4	14-4	3-5	19-5	8-4	14-4	3-5	19-5	8-4	14-4	3-5	19-5
10	A	*	*	*	*	*	*	*	*	*	*	*	*
10	B	136	165	166	170	61818	75000	75455	77273	55.6	67.5	62.3	69.5
10	C	87	145	136	159	39545	65909	61818	72273	35.6	59.3	51.0	65.0
10	D	92	146	157	157	41818	66364	71364	71364	37.6	59.7	58.9	64.2
11	A	119	183	197	173	54091	83182	89545	78636	48.7	74.9	73.9	70.8
11	B	123	183	194	210	55909	83182	88182	95455	50.3	74.9	72.8	85.9
11	C	132	172	194	208	60000	78182	88182	94545	54.0	70.4	72.8	85.1
11	D	106	141	164	170	48182	64091	74545	77273	43.4	57.7	61.5	69.5
12	A	89	143	164	171	40455	65000	74545	77727	36.4	58.5	61.5	70.0
12	B	130	174	189	205	59091	79091	85909	93182	53.2	71.2	70.9	83.9
12	C	118	149	180	182	53636	67727	81818	82727	48.3	61.0	67.5	74.5
12	D	98	153	185	192	44545	69545	84091	87273	40.1	62.6	69.4	78.5
13	A	164	174	183	180	74545	79091	83182	81818	67.1	71.2	68.6	73.6
13	B	108	163	195	231	49091	74091	88636	105000	44.2	66.7	73.1	94.5
13	C	137	181	190	203	62273	82273	86364	92273	56.0	74.0	71.3	83.0
13	D	103	162	182	199	46818	73636	82727	90455	42.1	66.3	68.3	81.4
14	A	128	141	164	171	58182	64091	74545	77727	52.4	57.7	61.5	70.0
14	B	129	165	181	201	58636	75000	82273	91364	52.8	67.5	67.9	82.2
14	C	103	164	183	180	46818	74545	83182	81818	42.1	67.1	68.6	73.6
14	D	139	182	176	193	63182	82727	80000	87727	56.9	74.5	66.0	79.0
15	A	136	174	180	182	61818	79091	81818	82727	55.6	71.2	67.5	74.5
15	B	140	192	197	200	63636	87273	89545	90909	57.3	78.5	73.9	81.8
15	C	134	176	184	182	60909	80000	83636	82727	54.8	72.0	69.0	74.5
15	D	128	183	180	190	58182	83182	81818	86364	52.4	74.9	67.5	77.7
16	A	142	147	164	157	64545	66818	74545	71364	58.1	60.1	61.5	64.2
16	B	122	179	185	200	55455	81364	84091	90909	49.9	73.2	69.4	81.8
16	C	115	137	158	183	52273	62273	71818	83182	47.0	56.0	59.3	74.9
16	D	99	158	163	174	45000	71818	74091	79091	40.5	64.6	61.1	71.2

Annex C6 Root bites

Table C6.1. The total number of collected plants to assess and the average number of root bites per plant (Angeren).

treat.	*rep*	*no. of plant roots assessed*	*average no. of bites per root*
1	A	25	2.3
1	B	18	2.1
1	C	25	3.0
1	D	22	1.8
2	A	22	0.9
2	B	25	2.1
2	C	25	2.0
2	D	24	3.6
3	A	17	0.7
3	B	25	1.8
3	C	17	3.2
3	D	21	1.9
4	A	20	1.1
4	B	26	0.8
4	C	24	4.9
4	D	23	1.7
5	A	23	1.5
5	B	23	2.3
5	C	23	1.3
5	D	23	0.7
6	A	16	2.1
6	B	22	1.4
6	C	22	2.9
6	D	0	*
7	A	25	1.7
7	B	22	1.2
7	C	22	3.4
7	D	23	1.1
8	A	25	0.8
8	B	20	1.0
8	C	23	1.1
8	D	19	3.2
9	A	24	0.5
9	B	24	0.8
9	C	23	1.2
9	D	22	2.7

treat.	*rep*	*no. of plant roots assessed*	*average no. of bites per root*
10	A	0	*
10	B	25	0.7
10	C	20	3.1
10	D	12	2.5
11	A	25	1.5
11	B	25	4.3
11	C	25	1.4
11	D	24	2.2
12	A	25	2.7
12	B	25	1.7
12	C	22	2.4
12	D	20	2.2
13	A	21	1.0
13	B	21	3.2
13	C	24	1.2
13	D	23	2.0
14	A	16	1.5
14	B	22	1.3
14	C	20	1.7
14	D	20	1.8
15	A	24	1.5
15	B	25	1.1
15	C	20	2.1
15	D	22	2.2
16	A	23	0.4
16	B	23	1.8
16	C	21	1.8
16	D	23	3.0

Annex C7 Phytotoxicity and plant vigour

Table C7.1. Percentage of plants showing signs of phytotoxicity, caused by insecticide treatment at two different dates. Also plant vigour (1=dead; 10=highly vigorous crop) on 19 May 2022 (Angeren).

treatment	*replicate*	*phytotoxicity*		*vigour*
		3 May	19 May	
1	A	0	0	6
1	B	0	0	6
1	C	0	0	6
1	D	0	0	7
2	A	0	0	9
2	B	0	0	8
2	C	0	0	7.5
2	D	0	0	7
3	A	0	0	7.5
3	B	0	0	7.5
3	C	0	0	7.5
3	D	0	0	7.5
4	A	0	0	7.5
4	B	0	0	7
4	C	0	0	6
4	D	0	0	6
5	A	0	0	6
5	B	0	0	8
5	C	0	0	8
5	D	0	0	7.5
6	A	0	0	6
6	B	0	0	8
6	C	0	0	8
6	D	*	*	*
7	A	0	0	8
7	B	0	0	8
7	C	0	0	7.5
7	D	0	0	8
8	A	0	0	8
8	B	0	0	7
8	C	0	0	7.5
8	D	0	0	7.5
9	A	0	0	8
9	B	0	0	9
9	C	0	0	8
9	D	0	0	9

treatment	*replicate*	*phytotoxicity*		*vigour*
		3 May	19 May	
10	A	*	*	*
10	B	0	0	7
10	C	0	0	4
10	D	0	0	7.5
11	A	0	0	7.5
11	B	0	0	6.5
11	C	0	0	7
11	D	0	0	6
12	A	0	0	7
12	B	0	0	8
12	C	0	0	7
12	D	0	0	7.5
13	A	0	0	7.5
13	B	0	0	7
13	C	0	0	7.5
13	D	0	0	7.5
14	A	0	0	7
14	B	0	0	7
14	C	0	0	7.5
14	D	0	0	8
15	A	0	0	7.5
15	B	0	0	7.5
15	C	0	0	8.5
15	D	0	0	8
16	A	0	0	6
16	B	0	0	7
16	C	0	0	6
16	D	0	0	5

Annex C8 Photographs

Overview photographs of each plot in the D replicate on the 19th of May (Angeren).

Figure C8.1. Untreated

Figure C8.2. Force

Figure C8.3. Vydate 10G

Figure C8.4. IRS856

Figure C8.5. IRS856+10g tefluthrin

Figure C8.6. IRS857

Figure C8.7. IRS857 + Force

Figure C8.8. IRS858

Figure C8.9. Vydate 10G + Force

Figure C8.10. IRS859

Figure C8.11. IRS859 + Force

Figure C8.12. Belem

Figure C8.13. Belem + Force

Figure C8.14. Quickstart

Figure C8.15. Quickstart + Force

Figure C8.16. Brassitrel Pro

Annex C9 Yield

Table C9.1. Average yield per treatment expressed in root weight (t/ha), sugar content (%), sugar yield (t/ha) and financial yield (€/ha). The field trial in Angeren was harvested on 29 September 2022.

treat.	*rep*	*root weight (t/ha)*	*sugar content (%)*	*sugar yield (t/ha)*	*financial yield (€/ha)*
1	A	102.3	17.4	17.8	4781
1	B	*	17.1	*	*
1	C	99.6	17.3	17.3	4649
1	D	99.8	17.4	17.4	4669
2	A	102.6	17.6	18.1	4927
2	B	96.4	17.2	16.6	4441
2	C	102.5	17.2	17.6	4697
2	D	104.7	17.3	18.1	4824
3	A	112.4	16.7	18.7	4906
3	B	96.4	17.0	16.4	4377
3	C	103.9	17.3	17.9	4812
3	D	92.6	17.4	16.1	4359
4	A	107.2	17.3	18.6	4983
4	B	99.5	17.1	17.0	4537
4	C	97.4	17.5	17.0	4574
4	D	106.9	16.7	17.8	4613
5	A	112.2	16.9	19.0	5024
5	B	107.5	17.5	18.8	5087
5	C	94.3	17.3	16.3	4385
5	D	102.5	17.5	17.9	4861
6	A	110.1	16.9	18.6	4910
6	B	100.7	17.3	17.4	4665
6	C	105.5	16.9	17.8	4707
6	D	*	*	*	*
7	A	96.7	17.5	16.9	4582
7	B	93.6	17.3	16.2	4335
7	C	100.1	17.4	17.4	4717
7	D	100.4	17.3	17.4	4660
8	A	94.7	16.8	16.0	4196
8	B	98.3	17.2	16.9	4496
8	C	99.8	17.3	17.3	4653
8	D	96.0	17.2	16.5	4418
9	A	93.4	17.2	16.1	4327
9	B	101.7	17.6	17.9	4810
9	C	94.3	17.5	16.5	4457
9	D	105.3	17.5	18.4	4914

treat.	*rep*	*root weight (t/ha)*	*sugar content (%)*	*sugar yield (t/ha)*	*financial yield (€/ha)*
10	A	*	*	*	*
10	B	89.8	17.1	15.4	4103
10	C	96.4	17.1	16.4	4344
10	D	97.6	17.5	17.1	4571
11	A	112.1	17.0	19.1	5096
11	B	101.4	17.3	17.5	4692
11	C	102.6	17.6	18.1	4907
11	D	102.9	17.1	17.6	4689
12	A	93.1	17.3	16.1	4302
12	B	92.3	17.3	16.0	4257
12	C	99.0	17.6	17.4	4666
12	D	98.2	17.2	16.9	4489
13	A	112.5	16.8	18.9	4949
13	B	101.8	17.2	17.5	4716
13	C	95.7	17.3	16.6	4442
13	D	97.5	17.3	16.9	4532
14	A	104.1	16.6	17.3	4515
14	B	99.4	17.1	17.0	4536
14	C	96.4	17.6	17.0	4574
14	D	108.2	17.0	18.4	4817
15	A	100.9	17.4	17.6	4762
15	B	101.4	17.2	17.4	4652
15	C	106.8	17.2	18.3	4894
15	D	105.3	17.3	18.2	4870
16	A	98.9	17.8	17.6	4811
16	B	101.4	17.1	17.3	4626
16	C	94.9	17.4	16.5	4433
16	D	93.2	17.5	16.3	4392

Annex D Weather data

Table D1.1. Weather data from the nearest KNMI weather station (275: Deelen) (Source: KNMI).

date	*wind speed (m/s)*	*mean air temperature (ºC)*	*min. air temperature (ºC)*	*max. air temperature (ºC)*	*precipitation (mm)*	*mean humidity (%)*	*max. humidity (%)*	*min. humidity (%)*
20220304	3.0	3.5	-1.5	10.0	0.0	65	85	41
20220305	3.0	2.0	-2.7	8.3	0.0	72	87	52
20220306	4.7	1.0	-3.4	6.8	0.0	73	89	46
20220307	2.6	1.3	-6.6	7.6	0.0	71	93	51
20220308	5.0	4.9	0.3	11.0	0.0	50	71	31
20220309	2.9	5.4	-1.8	13.4	0.0	51	70	31
20220310	3.6	8.2	-0.8	15.5	0.0	46	72	32
20220311	7.0	9.4	3.9	15.0	0.0	44	60	33
20220312	4.8	10.8	7.3	15.0	<0.05	56	66	34
20220313	4.5	11.7	7.4	16.9	<0.05	52	69	40
20220314	3.5	8.5	1.7	13.0	<0.05	81	95	65
20220315	1.6	6.5	1.0	12.7	0.0	81	96	59
20220316	5.0	9.3	0.0	14.3	0.0	70	97	51
20220317	4.1	7.1	-2.4	12.0	<0.05	71	94	47
20220318	2.6	6.6	-3.3	15.3	0.0	72	93	50
20220319	5.5	8.0	3.2	13.5	0.0	58	91	27
20220320	4.2	4.1	-2.8	8.9	<0.05	71	93	43
20220321	1.7	8.0	-3.3	17.0	0.0	70	97	46
20220322	2.2	11.5	3.3	19.7	0.0	57	80	30
20220323	1.7	9.3	0.9	19.6	0.0	54	80	24
20220324	1.7	8.8	-1.9	18.7	0.0	60	85	27
20220325	2.5	8.6	-1.5	17.3	0.0	64	91	37
20220326	2.7	10.8	0.6	18.5	0.0	66	93	38
20220327	2.7	9.0	3.7	16.1	0.0	72	96	41
20220328	1.6	8.2	1.0	16.2	0.0	79	98	50
20220329	3.0	7.5	2.9	13.7	0.0	79	99	48
20220330	3.0	5.2	-1.5	10.3	<0.05	75	96	54
20220331	4.6	1.0	0.0	3.1	26.7	94	97	92
20220401	7.3	1.4	-0.8	3.6	4.0	76	96	59
20220402	4.5	2.1	-4.2	6.4	<0.05	63	84	49
20220403	2.4	1.8	-6.3	8.3	0.1	75	92	54
20220404	7.3	6.1	0.9	9.8	20.7	88	96	67
20220405	4.5	9.1	6.8	11.2	7.1	94	98	89
20220406	7.4	9.1	8.3	10.2	7.2	85	94	73
20220407	8.8	7.6	3.4	11.1	21.3	81	94	54
20220408	4.1	5.4	1.5	9.4	<0.05	75	93	52
20220409	4.8	4.5	-0.1	8.5	1.8	77	90	53
20220410	2.3	4.5	-2.3	11.4	0.1	69	93	37
20220411	3.4	9.2	0.2	15.4	0.0	55	87	34
20220412	3.4	14.1	6.8	21.5	0.0	55	74	39
20220413	1.5	12.1	6.9	17.0	0.2	83	99	63
20220414	2.5	12.3	5.0	19.0	0.0	78	99	50
20220415	2.4	8.0	3.5	10.7	0.0	82	99	71
20220416	3.7	9.4	2.4	15.5	0.0	61	96	30
20220417	3.3	10.8	1.2	18.1	0.0	45	75	27
20220418	2.3	11.8	4.4	19.6	0.0	46	75	23
20220419	3.5	12.0	3.1	18.5	0.0	52	75	35
20220420	4.2	11.3	5.3	17.6	0.0	57	74	40

date	*wind speed (m/s)*	*mean air tempera-ture (ºC)*	*min. air tempera-ture (ºC)*	*max. air tempera-ture (ºC)*	*precipi-tation (mm)*	*mean humidity (%)*	*max. humidity (%)*	*min. humidity (%)*
20220421	4.7	12.3	5.9	17.8	0.0	59	83	41
20220422	5.5	12.2	7.6	17.3	0.0	66	89	42
20220423	6.2	13.0	8.0	18.8	0.0	60	87	43
20220424	6.0	11.7	6.8	17.9	0.0	59	84	37
20220425	3.5	7.8	4.5	11.0	1.6	86	94	70
20220426	4.5	9.2	3.0	14.7	0.0	68	88	42
20220427	2.0	7.4	-1.5	15.6	0.0	68	94	42
20220428	2.9	9.4	0.4	16.3	0.0	66	89	45
20220429	4.0	8.7	4.4	13.6	0.0	72	86	56
20220430	2.2	7.6	-1.0	12.3	0.0	74	95	55
20220501	1.4	9.4	3.4	14.6	0.0	68	91	44
20220502	2.3	11.0	1.2	18.8	0.0	60	93	32
20220503	2.5	9.5	1.2	16.7	0.0	72	91	54
20220504	1.8	10.4	4.7	17.2	0.0	63	85	37
20220505	1.1	11.6	2.8	18.7	<0.05	69	93	46
20220506	1.9	13.3	5.0	21.0	0.0	74	99	45
20220507	3.3	14.8	8.4	21.0	<0.05	70	92	50
20220508	3.7	12.4	7.0	18.1	0.0	59	86	30
20220509	1.9	15.4	5.6	23.3	0.0	54	84	31
20220510	4.0	17.9	10.1	25.7	0.0	59	81	42
20220511	5.1	17.1	11.1	22.5	0.5	59	92	41
20220512	3.8	13.8	6.7	20.0	0.0	62	96	35
20220513	4.8	13.7	7.4	19.6	0.0	66	88	44
20220514	2.0	15.0	6.7	22.7	0.0	64	93	34
20220515	3.2	18.6	10.4	25.5	0.0	51	78	25
20220516	3.5	17.8	10.7	25.7	<0.05	66	92	46
20220517	2.5	18.3	10.2	24.8	0.0	68	95	46
20220518	2.8	20.9	14.8	27.4	0.0	67	88	48
20220519	3.0	18.3	10.1	26.8	18.0	79	98	47
20220520	3.3	13.6	6.9	20.5	7.2	86	98	54
20220521	4.0	13.8	7.3	19.0	0.0	75	97	54
20220522	2.2	15.5	5.0	21.9	0.0	61	96	39
20220523	3.3	17.2	12.7	24.4	5.9	74	96	51
20220524	4.6	12.7	8.2	17.9	2.0	81	96	55
20220525	5.1	13.5	7.3	18.8	0.3	75	96	51
20220526	6.2	16.2	13.2	19.8	<0.05	73	90	53
20220527	5.3	13.5	9.3	17.1	3.3	68	95	44
20220528	4.5	11.3	7.0	16.5	0.2	68	94	39
20220529	3.3	10.1	7.0	13.5	2.0	81	96	61
20220530	1.3	10.6	4.6	15.6	<0.05	72	97	49
20220531	2.1	11.9	5.6	18.7	2.6	74	95	40
20220601	3.4	12.3	5.8	17.5	0.9	75	94	48
20220602	1.8	13.2	2.9	20.6	0.0	67	98	41
20220603	4.6	17.4	9.9	24.3	0.0	58	84	36
20220604	5.5	17.3	10.8	24.1	0.0	64	83	45
20220605	4.1	16.6	12.4	22.3	27.1	83	97	58
20220606	6.3	14.1	12.0	18.8	4.0	86	95	61
20220607	3.8	15.5	12.3	20.5	0.3	78	96	60

date	*wind speed (m/s)*	*mean air tempera-ture (ºC)*	*min. air tempera-ture (ºC)*	*max. air tempera-ture (ºC)*	*precipi-tation (mm)*	*mean humidity (%)*	*max. humidity (%)*	*min. humidity (%)*
20220608	3.3	15.2	12.2	19.9	11.9	90	97	70
20220609	3.4	15.6	9.4	21.2	0.4	74	98	47
20220610	3.0	17.3	9.4	22.8	<0.05	78	94	60
20220611	3.4	17.5	9.7	22.8	0.0	67	94	42
20220612	3.0	15.5	8.4	21.5	0.0	69	94	42
20220613	3.1	13.8	6.0	19.4	0.3	71	97	43
20220614	1.6	13.9	4.0	21.4	0.0	67	97	44
20220615	2.8	18.3	9.7	25.3	0.0	58	89	35
20220616	2.2	17.6	9.0	24.7	0.0	61	88	40
20220617	3.0	22.4	11.0	29.1	0.0	53	87	32
20220618	3.3	22.4	14.5	30.3	0.0	64	84	45
20220619	4.3	14.3	11.1	16.5	2.1	76	92	48
20220620	3.3	14.6	7.6	19.8	0.0	69	94	47
20220621	1.9	15.6	4.7	22.1	0.0	66	97	40
20220622	2.8	19.6	11.4	26.5	0.0	58	92	30
20220623	3.2	22.6	13.5	31.9	6.4	66	94	37
20220624	2.8	19.2	16.3	24.1	11.8	84	96	63
20220625	3.0	19.4	15.8	24.2	<0.05	77	97	56
20220626	2.2	17.4	15.2	19.9	1.0	79	97	62
20220627	1.6	15.8	10.5	20.7	3.9	84	96	62
20220628	2.4	17.6	8.4	23.7	0.0	64	97	42
20220629	2.3	21.8	15.3	28.1	0.0	55	84	35
20220630	3.3	19.5	13.1	26.8	9.4	73	96	49
20220701	3.8	15.9	10.7	21.5	0.0	74	97	46
20220702	2.4	17.9	10.4	24.7	0.0	65	93	37
20220703	3.0	17.0	10.5	23.5	0.0	71	94	48
20220704	2.9	16.4	7.7	23.5	0.0	70	94	44
20220705	3.0	15.2	7.7	22.0	0.0	68	94	46
20220706	3.0	15.9	6.5	21.5	<0.05	66	93	44
20220707	5.1	16.3	14.4	18.9	1.6	76	95	60
20220708	2.5	17.8	9.9	24.7	0.0	71	93	48
20220709	3.6	16.9	10.8	23.0	0.0	73	98	51
20220710	3.3	16.8	12.4	21.5	0.4	75	96	54
20220711	1.8	17.4	11.7	22.6	0.1	82	96	64
20220712	1.8	21.2	10.9	28.0	<0.05	65	98	41
20220713	3.9	22.1	11.8	30.0	<0.05	62	95	35
20220714	2.9	16.9	8.2	23.8	0.0	66	98	39
20220715	2.2	16.7	10.7	21.7	0.0	63	90	45
20220716	3.2	16.8	8.5	22.1	0.8	62	95	38
20220717	1.4	17.7	5.7	26.6	0.0	57	94	29
20220718	1.9	23.5	11.2	33.1	0.0	45	77	20
20220719	3.0	28.9	16.0	37.7	0.0	35	75	13
20220720	3.6	24.7	18.2	30.4	6.0	56	94	35
20220721	3.3	17.4	14.8	19.4	11.6	95	98	89
20220722	1.7	16.8	13.0	20.7	0.0	79	97	58
20220723	1.4	18.3	9.9	25.0	0.0	69	97	43
20220724	3.0	23.2	14.9	29.5	0.0	59	85	41
20220725	4.5	21.8	17.0	25.7	<0.05	63	82	47
20220726	3.3	16.6	10.6	20.5	5.3	78	95	51
20220727	2.3	15.2	10.1	21.1	<0.05	69	96	44
20220728	3.7	17.2	10.2	23.5	0.0	59	84	37

date	*wind speed (m/s)*	*mean air tempera-ture (ºC)*	*min. air tempera-ture (ºC)*	*max. air tempera-ture (ºC)*	*precipi-tation (mm)*	*mean humidity (%)*	*max. humidity (%)*	*min. humidity (%)*
20220729	2.3	18.3	12.8	25.5	0.5	68	92	43
20220730	2.4	19.9	13.2	25.4	0.0	65	99	43
20220731	3.5	19.2	16.3	23.2	3.9	85	95	68
20220801	2.2	17.5	9.4	23.1	1.5	75	97	34
20220802	3.5	21.1	9.9	28.4	0.0	64	89	33
20220803	2.8	23.9	16.7	30.8	0.0	65	93	37
20220804	2.8	23.0	17.5	28.4	1.6	67	94	47
20220805	3.5	17.4	8.2	22.8	0.0	68	94	35
20220806	1.9	14.9	6.1	22.3	0.0	64	93	38
20220807	1.9	17.0	6.9	25.2	0.0	61	93	34
20220808	2.8	17.4	9.0	24.7	0.0	69	97	46
20220809	3.5	20.1	12.7	26.9	0.0	63	96	36
20220810	3.3	22.3	13.8	30.4	0.0	52	88	25
20220811	3.4	24.2	16.2	32.3	0.0	45	79	20
20220812	2.9	25.1	16.8	32.9	0.0	41	75	23
20220813	2.7	25.2	16.8	32.0	0.0	35	54	19
20220814	2.4	25.1	18.7	32.1	0.0	49	69	29
20220815	2.3	22.8	17.0	26.3	<0.05	63	85	47
20220816	2.7	23.0	15.4	29.2	0.0	65	91	39
20220817	2.7	20.1	17.9	23.1	2.1	87	98	75
20220818	1.6	20.0	14.6	25.4	<0.05	81	96	60
20220819	2.2	19.5	12.7	26.0	3.6	84	98	55
20220820	2.1	19.1	11.3	25.1	0.3	73	98	39
20220821	2.5	18.2	10.4	26.1	0.0	70	94	37
20220822	1.7	20.4	15.8	26.0	0.0	64	87	36
20220823	2.0	22.8	13.6	30.1	0.0	60	92	33
20220824	2.0	23.9	14.5	32.1	0.0	64	97	35
20220825	3.1	25.8	20.2	33.0	0.0	49	87	24
20220826	4.6	19.6	13.9	21.7	<0.05	76	87	69
20220827	3.3	17.3	11.7	22.8	0.0	68	91	51
20220828	3.1	15.6	7.2	23.0	0.0	68	98	39
20220829	2.8	16.4	6.9	24.0	0.0	71	95	44
20220830	4.9	18.6	13.3	24.7	0.0	64	94	37
20220831	5.8	17.9	12.7	24.7	0.0	60	80	41
20220901	4.5	18.7	11.9	25.5	0.0	51	82	29
20220902	3.8	19.9	14.2	27.1	0.0	44	58	27
20220903	3.2	20.1	14.1	27.3	0.0	49	75	30
20220904	2.1	20.6	14.8	28.0	0.0	65	92	37
20220905	2.2	23.4	14.4	31.7	<0.05	50	83	23
20220906	2.9	22.3	16.5	28.9	9.0	65	96	32
20220907	2.5	19.3	15.7	25.3	<0.05	75	97	43
20220908	3.0	17.2	14.0	22.5	16.9	82	98	56
20220909	3.8	15.4	12.2	18.9	4.3	90	97	74
20220910	2.5	16.4	12.6	21.2	8.8	89	99	63
20220911	1.5	15.2	9.1	22.4	0.0	85	100	62
20220912	2.2	17.9	10.4	24.9	0.0	75	98	48
20220913	2.0	18.2	13.1	23.9	<0.05	74	89	41
20220914	1.2	14.6	10.5	19.1	<0.05	83	97	63
20220915	3.0	14.0	9.5	20.2	<0.05	79	98	50
20220916	4.0	12.7	9.0	17.5	0.6	76	96	44

date	*wind speed (m/s)*	*mean air temperature (ºC)*	*min. air temperature (ºC)*	*max. air temperature (ºC)*	*precipitation (mm)*	*mean humidity (%)*	*max. humidity (%)*	*min. humidity (%)*
20220917	3.8	10.8	6.3	15.1	10.1	84	97	64
20220918	3.0	10.2	6.9	12.8	7.8	94	98	88
20220919	3.1	11.4	6.8	17.1	3.1	82	97	54
20220920	1.7	10.7	6.6	16.4	1.3	82	98	55
20220921	0.9	9.9	3.2	17.7	0.0	77	96	44
20220922	1.7	10.9	2.8	19.5	0.0	71	93	41
20220923	2.3	12.8	6.4	17.6	0.3	78	95	54
20220924	2.5	12.3	8.0	13.5	14.5	95	98	92
20220925	2.0	10.4	3.7	17.9	<0.05	83	99	54
20220926	4.5	10.8	9.3	12.0	9.5	92	97	82
20220927	3.3	8.8	7.1	10.8	1.4	93	97	85
20220928	1.7	8.7	3.9	15.2	0.0	86	100	56
20220929	1.2	8.0	1.6	15.9	0.0	84	99	55