Efficacy of different insecticides to control the green peach aphid (*Myzus persicae*), black bean aphid (*Aphis fabae*) and virus yellows (BMYV) in sugar beets in the Netherlands in 2023

Results of field trial 23-11-12.01 at Westmaas (NL)

Elma Raaijmakers (IRS)

24R04
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Samenvatting

Vergelingsziektevirus wordt overgebracht door bladluizen, waarvan de groene perzikluis (*Myzus persicae*) de meeste efficiënte vector is. De drie belangrijkste soorten vergelingsziektevirussen in suikerbieten zijn: Beet Yellows Virus (BYV), Beet Chlorotic Virus (BChV) en Beet Mild Yellowing Virus (BMYV). De virussen kunnen worden beheerst door de bladluizen te bestrijden. Doel van deze veldproef is de effectiviteit bepalen van verschillende soorten insecticiden voor de bestrijding van groene perzikluizen. Omdat de zwarte bonenluis van nature ook voorkwam in de proef, is het effect op deze bladluissoort ook meegenomen.

Er is een proefveld aangelegd in Westmaas waarbij groene perzikluizen op 24 mei 2023 in het 4 bladstadium werden uitgezet. Vervolgens zijn diverse insecticiden gespoten.

Op basis van dit proefveld kunnen de volgende conclusies worden getrokken:
- zowel een volveldstoepassing als rijentoepassing met IRS 785 and IRS 810 (2x toegepast) waren effectief in de beheersing van groene perzikluizen (*Myzus persicae*);
- een zijwaartse bespuiting met pyrethroïden was effectief in de beheersing van groene perzikluizen (*Myzus persicae*), wat betekent dat deze spuittechniek gebruikt kan worden in onderzoek voor het testen van groene contactmiddelen;
- Teppeki + Batavia, IRS 810 (zowel 1x als 2x toegepast), zijwaartse bespuitingen met pyrethroïden en IRS 785 (zowel volvelds als rijenbespuiting) waren effectief in de beheersing van zwarte bonenluizen (*Aphis fabae*);
- een rijentoepassing met IRS 785 was even effectief als een volveldstoepassing met ditzelfde middel in de beheersing van groene perzikluizen en zwarte bonenluizen;
- Teppeki + Batavia, IRS 810 (zowel 1x als 2x toegepast) en een rijenbespuiting met IRS 785 waren effectief in de beheersing van BMYV;
- er was geen effect op opbrengst zichtbaar in dit proefveld. Dit komt door de zeer lage percentages planten met vergelingsvirus.

Summary

Virus yellows is an important disease in sugar beet. Virus yellows is caused by the viruses Beet Yellows Virus (BYV), Beet Chlorotic Virus (BChV) and Beet Mild Yellowing Virus (BMYV), which can cause up to 50%, 30% and 35% yield reduction, respectively. The green peach aphid (*Myzus persicae*) is the most important vector. The spread of the virus in a sugar beet field can be controlled by controlling aphids with insecticides. Also the black bean aphid (*Aphis fabae*) can cause problems in sugar beet. This aphid has a much higher damage threshold, since damage to sugar beets is mainly caused by feeding from the leaves and it hardly transmits viruses. Because this is a dominant species in sugar beet and it was present in the field trial, it was also included in this report.

Different insecticides were compared with a treatment without insecticide.
Therefore a field trial was conducted in Westmaas. In this trial, green peach aphids were inoculated in sugar beet in the 4th leaf stage (BBCH 14) at the 24th of May, 2023. Plots were sprayed with insecticides according to the protocols.

The aim was to study the efficacy of different insecticides on the control of aphids and virus yellows in sugar beet. From this trial, with a low incidence of aphids and virus yellows in the untreated control, it can be concluded that:

- IRS 785 applied as a broadcast and a band spray application and IRS 810 (applied twice) were effective in the control of green peach aphids;
- a side application with pyrethroids was effective in the control of green peach aphids, which means that this spraying technique can be used for testing green contact insecticides;
- Teppeki + Batavia, IRS 810 (applied once and twice), pyrethroids sidewards and IRS 785 (broadcast and band application) were effective in the control of black bean aphids;
- a band application with IRS 785 had the same efficacy as a broadcast application in the control of green peach aphids and black bean aphids;
- Teppeki + Batavia, IRS 810 (applied once and twice) and IRS 785 (band application) were effective in the control of BMYV;
- No effect on yield was observed. Percentages of virus were too low to impact yield.

1. Introduction

Virus yellows is an important disease in sugar beet. Virus yellows is caused by the viruses Beet Yellows Virus (BYV), Beet Chlorotic Virus (BChV) and Beet Mild Yellowing Virus (BMYV), which can cause up to 50%, 30% and 35% yield reduction, respectively. The green peach aphid (*Myzus persicae*) is the most important vector. The spread of the virus in a sugar beet field can be controlled by controlling aphids with insecticides. Since virus yellows occurs in spots in the field, it is recommended to artificially inoculate field trials with *Myzus persicae* infected with one the viruses to achieve a homogeneous distribution of virus in field trials. The black bean aphid (*Aphis fabae*) can also cause damage in sugar beet. This aphid has a much higher damage threshold compared to the green peach aphid, since damage to sugar beets is mainly caused by feeding from the leaves and it hardly transmits viruses. Because this is an important species in sugar beet, it is also included in this research.
Since 2019, several field trials were conducted to test the efficacy of new insecticides and/or new spraying techniques against aphids and virus yellows. This is necessary for farmers to have enough active ingredients to control aphids and virus yellows in the future and to achieve the goals of the Farm-to-Fork strategy of the European Commission, in which it is mentioned that farmers have to reduce the amount of pesticides in 2030 compared to the reference years 2015-2017. It is important to have different active ingredients available for farmers to prevent the development of insecticide resistant aphids. It has already been reported that *Myzus persicae* can be resistant against different insecticides, like pyrethroids and pirimicarb (Bass et al., 2014).

This field trial was conducted under Good Experimental Practises (GEP, Annex A).

2. Materials and methods

2.1 Trial site

The field trial was located in a sugar beet field in Westmaas, the Netherlands (Annex B).

2.2 List of products

Table 1 gives an overview of the treatments used in this study. Sugar beet seeds of the variety Leontina KWS were treated and delivered by KWS (Einbeck, Germany). All seeds, including the untreated control, were treated with the fungicide Tachigaren (14.7 g hymexazol per 100.000 seeds) and the insecticide Force (10 g tefluthrin per 100.000 seeds) to prevent influences of fungi and soil pests on plant establishment. Tefluthrin does not have any effect on green peach or black bean aphids (Wauters & Dewar, 1995). A homogeneous plant establishment in this trial is necessary, since the spread of virus yellows is influenced by plant spacing (Heathcote, 1974).

2.3 Drilling

Drilling was done with a precision sowing machine (Monosem Mecca 2017) adapted for sowing of field trials. Sowing distance within the rows was 18.0 cm and 50 cm between rows. The field trial was sown on the 29th of April 2023. The trial was designed as randomised blocks in four replications (Annex C). Gross plot size: 3 meters wide (6 rows) and 14 meters long. Nett plot size: 3 meters wide (6 rows) and 10 meters long. General field data can be found in Annex D.

2.4 Inoculation with aphids

To obtain a homogenous distribution of green peach aphids and BMYV, the trial was inoculated with reared green peach aphids infected with BMYV in BBCH14 on the 24th of May, 2023 (treatments 1, 3-9).

In 2021, sugar beets containing Beet Mild Yellowing virus (BMYV) were collected from a sugar beet field in Klaaswaal (Netherlands; IRS diagnostic sample 21-260-1). These sugar beets were potted in a sand-potting soil mixture with a ratio of 1:1 and were placed in the climate chambers at IRS (Dinteloord). Climate room conditions were 23°C for 16 hours under LED lights and at 16°C for 8 hours in the dark each day. Green peach aphids (*Myzus persicae*), originally obtained from the Laboratory of Entomology of Wageningen University and Research (NL) in 2018, were transferred from virus free sugar beets to the leaves of the infected sugar beets. After 48 hours, the aphids were collected and transferred to six-week-old sugar beet plants (grown in 700 ml pots; variety Kleist, Strube GmbH, Söllingen, Germany) in the climate chambers and placed in an aphid rearing cage. Every three to four weeks, leaves with aphids were cut off and transferred to new, six weeks old plants to maintain the culture of BMYV containing green peach aphids in the climate chambers.

For field inoculation, leaves with aphids from the plants with BMYV in aphid rearing cages in the climate chambers were cut off and carefully transported to the field trials in small boxes. In row 2 plants at 1.5, 5 and 8.5 meters and in row 5 plants at 3 and 7 meters were marked with a small yellow stick and inoculated. These five plants were inoculated with 10 aphids per plant, by transferring the aphids using a small paint brush. All plots were inoculated, except plots of treatment 2 (non-inoculated control).

A few hours before inoculation, the borders around the field trial were sprayed with Teppeki (0.14 kg/ha) to prevent spread of aphids over the field.

Table 1. Overview of treatments in the field trial in Westmaas, 2023 (trial code: 23-11-12.01). Trial was inoculated with green peach aphids (*Myzus persicae*) on the 24th of May.

number	*treatment*	*treatment*			
		25 May (T1)	31 May (T2)	8 June (T3)	15 June (T4)
1	untreated control	-	-	-	-
2	non inoculated control[1]	Teppeki (0.14 kg/ha)	-	-	-
3	Teppeki (T1)	Teppeki (0.14 kg/ha)	-	-	-
4	Teppeki (T1) + Batavia (T3)	Teppeki (0.14 kg/ha)	-	Batavia (0.45 l/ha) + Robbester (1 l/ha)	-
5	IRS 810 (T1)	IRS 810 (0.2 l/ha)	-	-	-
6	IRS 810 (T1+T3)	IRS 810 (0.2 l/ha)	-	IRS 810 (0.2 l/ha)	-
7	Pyrethroids sidewards	IRS 872 (0.2 l/ha) + Silwet Gold (0.1%)	IRS 873 (0.05 l/ha) + Silwet Gold (0.1%)	IRS 872 (0.2 l/ha) + Silwet Gold (0.1%)	IRS 742 (0.5 l/ha) + Silwet Gold (0.1%)
8	IRS 785	IRS 785 (0.25 kg/ha)	-	-	-
9	IRS 785 band application[2]	IRS 785 (0.08 kg/ha)	-	-	-

[1] This treatment was sprayed with Teppeki (0.14 kg/ha) to prevent damage by naturally occurring green peach aphids.
[2] This treatment was sprayed with a row sprayer (16 cm of the row was sprayed instead of 50 cm). The concentration of the treatment was kept similar as in treatment 8, which means that only 32% of the dosage was used compared to a full field application.

2.5 Application of treatments

Treatment 1 was the inoculated, untreated control. Treatments 2 to 9 were sprayed according to the schedule in table 1. Insecticides in treatments 2 to 6 and 8 were applied with a broadcast application, where the entire area of each plot was sprayed. Applications of these treatments were conducted by Wageningen Plant Research (WPR; location Westmaas), using a CHD field trial sprayer (system Van der Wey, with Lechler Nozzle 120-02 at 3.0 bar, at 2.3 km/h and 400 liter spraying solution per hectare) to apply the different treatments (Annex D). These nozzles had a 75% drift reduction at the pressure used (TCT, 2019). Application of treatment 7 was applied by IRS, using a selfmade equipment for side spraying, consisting of one spraying boom with a TeeJet TTJ60-11003VP - Turbo TwinJet Twin Flat Spray Nozzle. Rows were sprayed from two sides at 3.6 km/h, 3.5 bar and 806 liters spraying solution per hectare. Application of treatment 9 was conducted by IRS, using a row sprayer (6 rows width, with Nozzle 6503 E, at 3.6 km/h and 300 liters spraying solution per hectare). With the band sprayer the dosage was kept the same as with the broadcast sprayer, but only 16 centimeters out of 50 centimeters row width was sprayed (32%), resulting in a 68% reduction in active ingredient per hectare of sugar beets.

2.6 Assessment of efficacy

The effect of various treatments on the plants and aphids was measured by assessing plant establishment, the number of aphids per plant, phytotoxicity, vigour, canopy closure and percentage of plants with virus yellows.
Final plant stand density was determined at BBCH 14-16 (25th of May) by counting the number of plants in the middle four rows of each plot. Plant stand density was determined by calculating the percentage of plants related to the number of seeds sown.

Efficacy of the treatments against aphids was established by counting the number of green peach aphids per plant on various moments in time (Table 2). Plants were counted in row 2 and 5. Till BBCH 19, 25 plants per plot were assessed. From BBCH 19, 15 plants per plot were assessed (see scheme in Annex C). Because black bean aphids (*Aphis fabae*) can also cause yield loss in sugar beets, the number of naturally occurring black bean aphids was noted during aphid counting as well. Damage by black bean aphids is mainly caused by feeding from the leaves. Black bean aphids are very inefficient vectors for the virus yellowing disease. In addition, all other aphids were counted when seen on the plants (data only shown in Annex I).

Table 2. Overview of dates and assessed plants during aphid observations.

date	*days after aphid inoculation*	*number of plants counted in row 2*	*number of plants counted in row 5*	*leaf stage*
22-5-2023	-2 (before inoculation)	15	10	BBCH12-14
26-5-2023	2	15	10	BBCH14-16
2-6-2023	9	15	10	BBCH16-18
5-6-2023	12	15	10	BBCH18-19
23-6-2023	30	9	6	BBCH35

Plants were scored for symptoms of phytotoxicity when they showed stunting, deformation, discoloration, necrosis or chlorosis caused by insecticide application. The percentage of plants showing phytotoxicity symptoms was assessed on the 26th of May, 2nd of June, 6th of June, 7th of July and 21st of July. In addition, whole plots were scored for vigour on a scale from 1 (dead crop) to 10 (highly vigorous crop) on the 6th of June and 7th of July.

The number of plants showing symptoms of yellowing were counted in the middle four rows (row 2-5) of each plot on 23rd of June, the 7th of July, 21st of July, 14th of August and the 13th of September. The percentage of plants with yellowing virus was calculated based on the total number of emerged plants on the 25th of May.

2.7 Harvest

The field trial was harvested on 26th of September 2023 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 percentage, sugar yield (t/ha) and financial yield (€/ha, based on 50 €/ton sugar beets with 17% sugar) were calculated. Costs of spraying and products were not included.

2.8 Analysis of data

Since data on number of aphids per plant did not follow a normal distribution, these data were log transformed ($y = \log10(x+1)$) before statistical analysis.
Data was analysed by using a one-way ANOVA using Fisher Protected LSD. Analyses were performed using Genstat Software Package 21.0.

3. Results and discussion

3.1 Effect on phytotoxicity and vigour

No symptoms of phytotoxicity were observed in any of the treatments at any assessment date (Table 3; Annex F) and also, no significant effect on vigour at canopy closure was observed between treatments (Table 4; Annex F).

Table 3. Number of plants showing symptoms of phytotoxicity.

treatment	*number of plants with phytotoxicity*				
	26 May	2 June	6 June	7 July	21 July
1 untreated control	0	0	0	0	0
2 non inoculated control	0	0	0	0	0
3 Teppeki (T1)	0	0	0	0	0
4 Teppeki (T1) + Batavia (T3)	0	0	0	0	0
5 IRS 810 (T1)	0	0	0	0	0
6 IRS 810 (T1+T3)	0	0	0	0	0
7 Pyrethroids sidewards	0	0	0	0	0
8 IRS 785	0	0	0	0	0
9 IRS 785 band application	0	0	0	0	0
P	-*	-*	-*	-*	-*

*no statistical analysis was performed, since plant vigour was exactly the same in each plot.

Table 4. Plant vigour (1=dead; 10=highly vigorous crop) at 6th of June and 7th of July (Westmaas, 2023).

treatment	*vigour*	
	6 June	7 July
1 untreated control	8.1	10.0
2 non inoculated control	8.0	10.0
3 Teppeki (T1)	8.0	10.0
4 Teppeki (T1) + Batavia (T3)	8.1	10.0
5 IRS 810 (T1)	8.1	10.0
6 IRS 810 (T1+T3)	8.0	10.0
7 Pyrethroids sidewards	8.1	10.0
8 IRS 785	8.3	10.0
9 IRS 785 band application	8.1	10.0
P	0.811	-*
significance	not significant	-*

*no statistical analysis was performed, since plant vigour was exactly the same in each plot.

3.2 Effect on aphids

Due to cold and windy conditions, the natural decline of aphids was quite high in this trial. However, there were still effects of different treatments.

On the 26th of May, plants of the non-inoculated control, pyrethroids sidewards and IRS 785 (both kind of applications) had significantly less green peach aphids compared to the plants of the untreated control (Table 5; Annexes E and I).

On the 2nd of June, 5th of June and 23rd of June there were no significant differences between the treatments.

The mean of all assessment dates shows that the treatments with IRS 810 (applied twice), pyrethroids sidewards and IRS 785 (both kind of applications) had significantly less green peach aphids compared to the untreated control.

The treatment with a band application (treatment 9), in which only 32% of the ground surface were sprayed, was different in the number of green aphids per plant from treatment 8 (IRS 785 broadcast application). As the concentration of the product was exactly the same for these treatments, it is not clear how this can be explained. However, this means that the amount of the insecticides per hectare can be reduced by band spraying on small plants without any reduction of the efficacy of these systemic products to control green peach aphids.

It is interesting to see that pyrethroids were effective when applied with the sidewards technique. In this research the pyrethroids were used as a kind of 'model' insecticide. This means that this technique can be used for testing green contact insecticides in the future to achieve goals of the Farm-to-Fork strategy. Farmers are advised not to use pyrethroids, since they have a negative effect on beneficials. Moreover, when pyrethroids are sprayed from above, it is known that they are not effective in the control of aphids.

Table 5. Average number of green peach aphids (*Myzus persicae*) per plant on the 26th of May and 2nd, 5th and 23rd of June. Plants were inoculated with green peach aphids on the 24th of May (Westmaas, 2023). Different letters indicate significant differences within a column.

treatment	*mean number of* Myzus persicae *per plant*						
	26 May		2 June	5 June	23 June	mean of 26 May, 2 June, 5 June and 23 June	
1 untreated control	1.4	a	0.4	0.4	0.0	0.5	a
2 non inoculated control	0.2	d	0.5	0.4	0.0	0.3	cd
3 Teppeki (T1)	1.0	ab	0.3	0.3	0.0	0.4	abc
4 Teppeki (T1) + Batavia (T3)	1.3	a	0.3	0.5	0.1	0.5	ab
5 IRS 810 (T1)	1.1	ab	0.1	0.3	0.1	0.3	abc
6 IRS 810 (T1+T3)	1.2	ab	0.2	0.2	0.0	0.3	bc
7 Pyrethroids sidewards	0.4	cd	0.2	0.6	0.1	0.3	bc
8 IRS 785	0.7	bc	0.2	0.5	0.0	0.3	bc
9 IRS 785 band application	0.4	cd	0.2	0.1	0.0	0.2	d
P	<0.001		0.191	0.099	0.286	0.002	
significance	very significant		not significant	not significant	not significant	significant	

[1] Data is log transformed for statistical analysis; therefore LSD-value is not available.

On the 26th of May, 2nd of June, 5th of June and 23rd of June there were no significant differences between the treatments for the number of black bean aphids per plant (Table 6).

The mean of all assessment dates shows that all treatments had significantly less black bean aphids compared to the untreated control. Treatment 4, the combination of Teppeki at T1 with Batavia at T3 had significantly the lowest number black bean aphids per plant, although this was not significantly different from treatments 2, 5, 6, 7, 8 and 9. However, it was significantly different from treatment 3, which means that an extra application of Batavia in T3 was effective.

Table 6. Average number of natural occurring black bean aphids (*Aphis fabae*) per plant on the 26th of May and 2nd, 5th and 23rd of June. (Westmaas, 2023). Different letters indicate significant differences within a column.

treatment	*mean number of* Aphis fabae *per plant*				
	26 May	2 June	5 June	23 June	mean of 26 May, 2 June, 5 June and 23 June
1 untreated control	0.6	0.8	0.5	4.6	1.2 a
2 non inoculated control	0.3	0.1	0.0	2.5	0.5 bc
3 Teppeki (T1)	0.4	0.2	0.2	3.9	0.8 b
4 Teppeki (T1) + Batavia (T3)	0.2	0.1	0.1	1.2	0.4 c
5 IRS 810 (T1)	0.2	0.2	0.2	1.9	0.5 bc
6 IRS 810 (T1+T3)	0.2	0.3	0.2	2.9	0.6 bc
7 Pyrethroids sidewards	0.1	0.0	0.1	3.4	0.5 bc
8 IRS 785	0.3	0.0	0.1	2.8	0.5 bc
9 IRS 785 band application	0.1	0.1	0.1	3.6	0.6 bc
P	0.250	0.111	0.292	0.368	0.003
significance	not significant	not significant	not significant	not significant	significant

[1] Data is log transformed for statistical analysis; therefore LSD-value is not available.

3.3 Effect on virus yellows

On the 23rd of June, the first assessment was done on the percentage of plants with virus yellows per plot (Table 7; Annex G), but no virus yellows was visible yet. On the 7th of July, the first plants showed symptoms of virus yellows. However, there were no significant differences between the treatments.

On the 21st of July, the non-inoculated control, Teppeki + Batavia, IRS 810 (applied at T1) and IRS 785 (broadcast application) had a significantly lower percentage of plants with virus yellows compared to the untreated control.

On the 14th of August, the non-inoculated control, Teppeki + Batavia, and both applications with IRS 810 had a significantly lower percentage of plants with virus yellows compared to the untreated control.

Data of the assessment at the 13th of September are not shown, because magnesium deficiency was also visible at that time, making assessment on virus yellows questionable.

Table 7. Average percentage of plants showing yellowing symptoms in the middle four rows per plot. Different letters indicate significant differences within a column.

treatment		*percentage of virus yellows*			
		23 June	7 July	21 July	14 August
1	untreated control	0.0	1.1	6.6 a	8.3 a
2	non inoculated control	0.0	0.2	0.0 c	0.1 c
3	Teppeki (T1)	0.0	1.1	5.1 ab	5.0 ab
4	Teppeki (T1) + Batavia (T3)	0.0	0.9	3.8 b	4.4 b
5	IRS 810 (T1)	0.0	0.7	3.3 b	3.4 bc
6	IRS 810 (T1+T3)	0.0	1.6	5.1 ab	3.6 bc
7	Pyrethroids sidewards	0.0	0.6	5.0 ab	5.8 ab
8	IRS 785	0.0	1.0	4.5 b	6.4 ab
9	IRS 785 band application	0.0	1.1	4.8 ab	4.7 ab
P		-*	0.100	<0.001	0.016
significance		not significant	not significant	very significant	significant

*no statistical analysis was performed, since no virus was visible yet.

3.4 Effect on yield

There was no significant effect of treatment on root yield, sugar percentage, sugar yield and/or financial yield (table 8; Annex H).
This might be due to the very low percentages of virus yellows in the trial.

Table 8. Average yield per treatment expressed in root weight (t/ha), sugar content (%), sugar yield (t/ha) and financial yield (€/ha). The field trial was harvested on 26th of September 2023.

treatment		*root yield (t/ha)*	*sugar percentage*	*sugar yield (t/ha)*	*financial yield (€/ha)*
1	untreated control	102.9	16.3	16.76	4797.5
2	non inoculated control	101.6	16.3	16.54	4727.4
3	Teppeki (T1)	99.9	16.4	16.37	4723.3
4	Teppeki (T1) + Batavia (T3)	102.7	16.3	16.72	4769.7
5	IRS 810 (T1)	103.5	16.3	16.86	4828.6
6	IRS 810 (T1+T3)	99.4	16.5	16.42	4755.6
7	Pyrethroids sidewards	100.5	16.4	16.52	4759.8
8	IRS 785	102.4	16.4	16.82	4844.4
9	IRS 785 band application	103.7	16.2	16.77	4748.9
P		0.742	0.197	0.935	0.990
LSD 5%		5.84	0.26	0.89	285.44
significance		not significant	not significant	not significant	not significant

4. Conclusions

The aim was to study the efficacy of different insecticides on the control of aphids and virus yellows in sugar beet. From this trial, with a low incidence of aphids and virus yellows in the untreated control, it can be concluded that:

- IRS 785 applied as a broadcast and a band spray application and IRS 810 (applied twice) were effective in the control of green peach aphids;
- a side application with pyrethroids was effective in the control of green peach aphids, which means that this spraying technique can be used for testing green contact insecticides;
- Teppeki + Batavia, IRS 810 (applied once and twice), pyrethroids sidewards and IRS 785 (broadcast and band application) were effective in the control of black bean aphids;
- a band application with IRS 785 had the same efficacy as a broadcast application in the control of green peach aphids and black bean aphids;
- Teppeki + Batavia, IRS 810 (applied once and twice) and IRS 785 (band application) were effective in the control of BMYV;
- No effect on yield was observed. Percentages of virus were too low to impact yield.

5. Literature

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Annex A GEP CERTIFICATE IRS

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

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

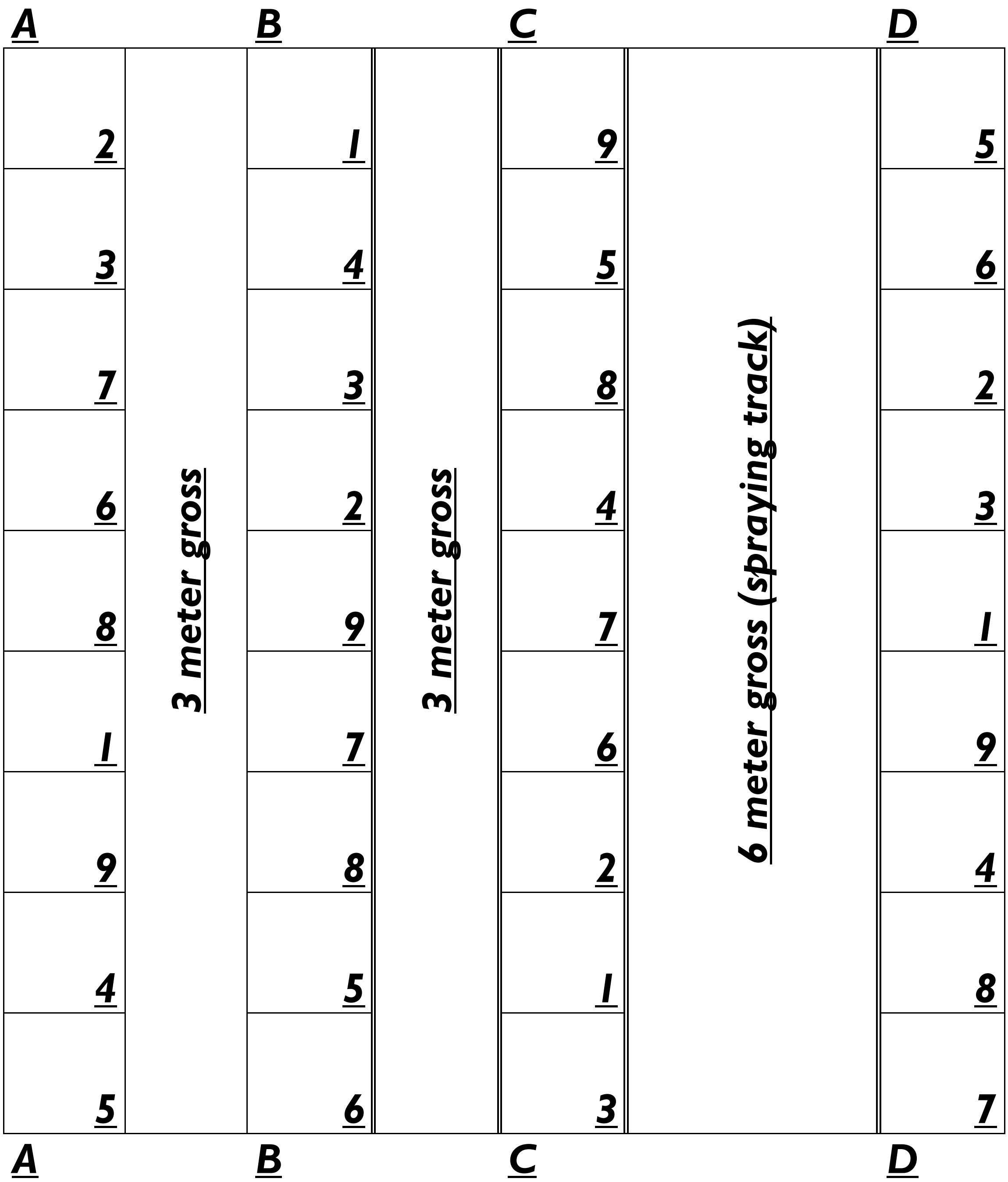
This annex has been approved by Ton van Arnhem
Director NPPO (National Plant Protection Organisation)

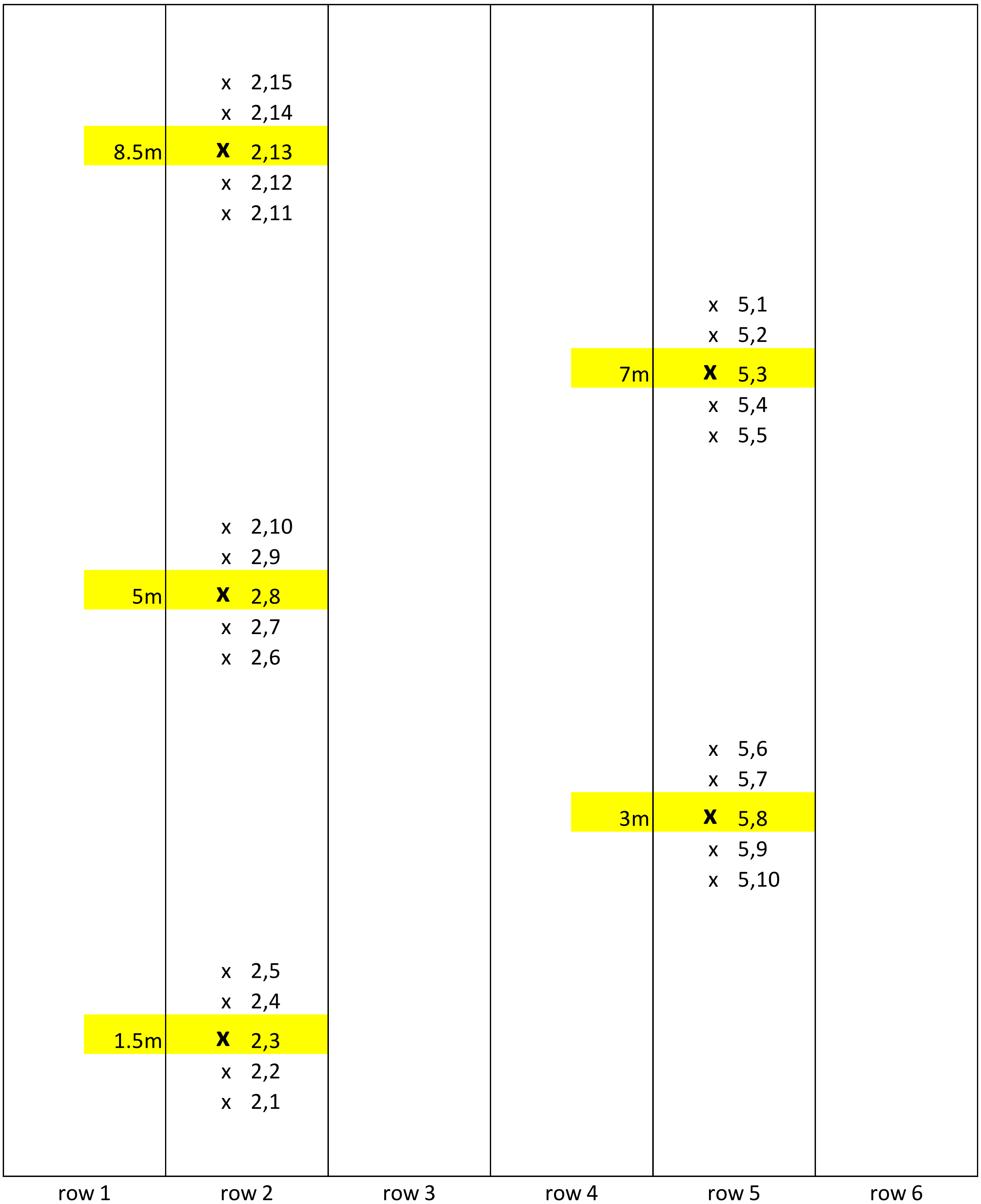
Annex B Location field trial

IRS trial field 23-11-12.01
GPS location:
51.787408, 4.448378

Annex C Trail scheme

Trial field:	Westmaas
Number of replications:	4
Net size (m):	10×3	Gross size (m):	14×3





Scheme of the plants used for aphid counting.
Till BBCH 19 - 25 plants were assessed
After BBCH 19 - 15 plants were assesed (the inoculated plant (yellow marked plant) + two plants in front of the inoculated plant

Annex D General field data and spraying conditions

soil type:	marine soil (clay loam) Organic matter = 2.6% pH-$CaCl_2$ = 7.1 K-value = 28 clay (<2 µm) = 18% silt (2-50 µm) = 35 % sand (>50 µm) = 37% parts <16 µm = 29% PAL = 61 mg P_2O_5/100g of soil
preceding crop:	2022 winter wheat
drilling date:	29th of April, 2023
variety:	Leontina KWS (KWS Einbeck, Germany)
distance in row:	18.0 cm
distance between rows:	50 cm

equipment:	CHD field trial sprayer (system van der Wey); Wageningen Plant Research (WPR; location Westmaas)
speed:	2.3 km/h
nozzle type:	Lechler 120-02
pressure:	3.0 bar
spray volume:	400 l/ha

Table D.1. Overview of weather conditions during insecticide spraying with the CHD field trial sprayer at the field trial in Westmaas (2023).

conditions	*date of spraying*	
	25 May	*8 June*
treatments sprayed	2, 3, 4, 5, 6, 8	4, 6
BBCH	14-16	18-19
time of spraying (h)	08:50	08:40
wind speed (km/h)	11	11.5
temperature (°C)	13.2	15.8
relative humidity (%)	77	73
wind direction	North East	North East

equipment:	band sprayer (IRS, Dinteloord)
speed:	3.6 km/h
pressure:	3.1 bar
nozzle type:	Teejet 6503 E
spray volume:	300 l/ha

equipment:	side sprayer (IRS, Dinteloord)
speed:	3.6 km/h
pressure:	3.5 bar
nozzle type:	Teejet TTJ 110.03
spray volume:	800 l/ha

Table D.2. Overview of weather conditions during insecticide spraying with the band application sprayer (treatment 9) and side sprayer (treatment 7) at the field trial in Westmaas (2023).

conditions	*date of spraying*			
	25 May	31 May	8 June	15 June
treatments sprayed	7, 9	7	7	7
BBCH	14-16	16	18-19	19
time of spraying (h)	7:30-10:00	8:15-8.45	7:30-8:00	21:00-21:30
wind speed (m/s)	2	3.25	3	2
temperature (°C)	14	14	13	22
relative humidity (%)	75	78	86	41
wind direction	North East	North	North East	North

Table D.3. Overview of assessments at the field trial in Westmaas (2023).

date	*days after aphid inoculation*	*assessment*	*leaf stage*
29-Apr-2023	-25	trial sown	BBCH 00
8-May-2023	-16	checking emergence	BBCH 10
22-May-2023	-2	1st aphid assessment	BBCH 12-14
24-May-2023	0	treatments applied (1st time)	BBCH 14
24-May-2023	0	inoculation with aphids	BBCH 14
25-May-2023	1	plant counting + application T1	BBCH 14
26-May-2023	2	2nd aphid assessment	BBCH 14-16
31-May-2023	7	application T2	BBCH 16
2-Jun-2023	9	assessment phytotoxicity + vigour	BBCH 16-18
5-Jun-2023	12	4th aphid assessment	BBCH 18-19
6-Jun-2023	13	phytotoxicity + vigour	BBCH 18-19
8-Jun-2023	15	application T3	BBCH 18-19
15-Jun-2023	22	application T4	BBCH 19
23-Jun-2023	30	5th aphid assessment + assessment virus yellows + vigour	BBCH 35
7-Jul-2023	44	assessment virus yellows + phytotoxicity + vigour	BBCH 38
21-Jul-2023	58	assessment virus yellows + phytotoxicity + vigour	BBCH 49
14-Aug-2023	82	assessment virus yellows	BBCH 49
13-Sep-2023	112	assessment virus yellows	BBCH 49
26-Sep-2023	125	trial harvested	BBCH 49

Annex E Raw data number of aphids

Table E.1. Mean number of aphid per plant and percentage of plants with aphids per plot at the field trial in Westmaas (22nd of May, 2023).

treatment	*replicate*	*mean number of aphids per plant*				*percentage of plants with*		
		Myzus persicae	*Aphis fabae*	other aphids	total aphids	aphids	*Myzus persicae*	*Aphis fabae*
1	A	0.12	0.08	0.00	0.20	12	12	4
1	B	0.24	0.84	0.04	1.12	16	12	4
1	C	0.16	0.08	0.20	0.44	12	4	4
1	D	0.16	0.04	0.00	0.20	12	8	4
5	A	0.12	0.00	0.04	0.16	12	8	0
5	B	0.08	0.00	0.00	0.08	4	4	0
5	C	0.04	0.20	0.04	0.28	12	4	8
5	D	0.00	0.00	0.00	0.00	0	0	0
9	A	0.04	0.20	0.04	0.28	16	4	8
9	B	0.08	0.00	0.04	0.12	8	4	0
9	C	0.12	0.00	0.16	0.28	12	8	0
9	D	0.00	0.00	0.00	0.00	0	0	0

Table E.2. Mean number of aphids, beneficials and other pests per plant and percentage of plants with aphids per plot at the field trial in Westmaas (26th of May, 2023).

treatment	*replicate*	*mean number of aphids per plant*				*percentage of plants with*		
		Myzus persicae	*Aphis fabae*	other aphids	total aphids	aphids	*Myzus persicae*	*Aphis fabae*
1	A	1.12	1.08	0.04	2.24	52	36	16
1	B	1.88	0.80	0.00	2.68	56	44	12
1	C	2.04	0.64	0.24	2.92	48	36	20
1	D	0.80	0.04	0.00	0.84	28	24	4
2	A	0.20	0.76	0.04	1.00	24	8	12
2	B	0.20	0.00	0.16	0.36	16	8	0
2	C	0.20	0.60	0.00	0.80	24	8	16
2	D	0.04	0.08	0.08	0.20	12	4	4
3	A	1.80	0.04	0.04	1.88	32	28	4
3	B	1.20	0.52	0.00	1.72	40	28	12
3	C	0.64	1.32	0.16	2.12	48	28	20
3	D	0.56	0.12	0.00	0.68	28	24	8
4	A	1.28	0.12	0.12	1.52	44	28	8
4	B	1.36	0.32	0.00	1.68	32	28	8
4	C	0.80	0.20	0.00	1.00	36	32	8
4	D	1.76	0.24	0.08	2.08	48	36	8
5	A	1.12	0.20	0.32	1.64	40	24	8
5	B	1.48	0.40	0.04	1.92	52	36	16
5	C	0.60	0.12	0.00	0.72	28	20	8
5	D	1.36	0.00	0.04	1.40	32	28	0
6	A	0.72	0.44	0.04	1.20	40	28	8
6	B	1.36	0.12	0.04	1.52	40	32	12
6	C	1.08	0.24	0.04	1.36	36	28	16
6	D	1.68	0.08	0.04	1.80	40	36	4
7	A	0.40	0.16	0.00	0.56	28	24	4
7	B	0.72	0.24	0.00	0.96	32	20	12
7	C	0.48	0.20	0.00	0.68	20	12	12
7	D	0.16	0.00	0.00	0.16	8	8	0
8	A	0.92	0.08	0.00	1.00	32	28	4
8	B	0.60	0.40	0.00	1.00	32	28	8
8	C	0.48	0.20	0.04	0.72	52	36	12
8	D	0.80	0.76	0.04	1.60	32	20	12
9	A	0.16	0.04	0.00	0.20	16	12	4
9	B	0.36	0.12	0.00	0.48	24	16	8
9	C	0.56	0.12	0.00	0.68	32	28	8
9	D	0.48	0.00	0.00	0.48	12	12	0

Table E.3. Mean number of aphids, beneficials and other pests per plant and percentage of plants with aphids per plot at the field trial in Westmaas (2nd of June, 2023).

treatment	*replicate*	*mean number of aphids per plant*				*percentage of plants with*		
		Myzus persicae	*Aphis fabae*	other aphids	total aphids	aphids	*Myzus persicae*	*Aphis fabae*
1	A	0.52	0.24	0.12	0.88	28	24	4
1	B	0.52	3.92	0.24	4.68	32	20	8
1	C	0.36	0.76	0.00	1.12	32	16	20
1	D	0.28	0.00	0.08	0.36	20	20	0
2	A	0.56	0.00	0.00	0.56	12	12	0
2	B	0.16	0.00	0.04	0.20	12	8	0
2	C	1.32	0.56	0.00	1.88	28	20	8
2	D	0.08	0.04	0.04	0.16	12	8	4
3	A	0.16	0.12	0.00	0.28	20	12	8
3	B	0.28	0.44	0.00	0.72	32	20	12
3	C	0.64	0.40	0.00	1.04	28	20	8
3	D	0.32	0.00	0.00	0.32	8	8	0
4	A	0.24	0.00	0.00	0.24	16	16	0
4	B	0.52	0.20	0.08	0.80	32	20	4
4	C	0.40	0.32	0.04	0.76	28	20	8
4	D	0.12	0.00	0.12	0.24	16	8	0
5	A	0.00	0.00	0.04	0.04	4	0	0
5	B	0.08	0.44	0.00	0.52	24	8	16
5	C	0.20	0.24	0.00	0.44	16	12	4
5	D	0.00	0.00	0.08	0.08	8	0	0
6	A	0.00	0.28	0.00	0.28	8	0	8
6	B	0.36	0.16	0.08	0.60	36	24	8
6	C	0.20	0.76	0.16	1.12	32	12	12
6	D	0.08	0.00	0.17	0.25	13	8	0
7	A	0.08	0.00	0.00	0.08	8	8	0
7	B	0.80	0.00	0.16	0.96	48	36	0
7	C	0.24	0.00	0.00	0.24	12	12	0
7	D	0.00	0.04	0.00	0.04	4	0	4
8	A	0.08	0.00	0.00	0.08	8	8	0
8	B	0.00	0.12	0.00	0.12	4	0	4
8	C	0.28	0.04	0.00	0.32	24	20	4
8	D	0.32	0.00	0.08	0.40	20	12	0
9	A	0.00	0.00	0.04	0.04	4	0	0
9	B	0.56	0.00	0.00	0.56	12	12	0
9	C	0.24	0.60	0.00	0.84	8	4	4
9	D	0.00	0.00	0.08	0.08	8	0	0

Table E.4. Mean number of aphids, beneficials and other pests per plant and percentage of plants with aphids per plot at the field trial in Westmaas (5th of June, 2023).

treatment	*replicate*	*mean number of aphids per plant*				*percentage of plants with*		
		Myzus persicae	*Aphis fabae*	other aphids	total aphids	aphids	*Myzus persicae*	*Aphis fabae*
1	A	0.44	0.00	0.04	0.48	28	24	0
1	B	0.36	1.44	0.08	1.88	32	20	8
1	C	0.44	1.28	0.00	1.72	36	28	8
1	D	0.56	0.00	0.00	0.56	40	40	0
2	A	0.60	0.00	0.00	0.60	32	32	0
2	B	0.08	0.00	0.00	0.08	4	4	0
2	C	0.64	0.04	0.00	0.68	48	48	4
2	D	0.44	0.00	0.16	0.60	28	20	0
3	A	0.52	0.00	0.04	0.56	24	20	0
3	B	0.20	0.20	0.08	0.48	32	16	12
3	C	0.44	0.48	0.00	0.92	32	28	8
3	D	0.20	0.04	0.08	0.32	16	12	4
4	A	0.40	0.04	0.04	0.48	32	24	4
4	B	0.40	0.00	0.00	0.40	12	12	0
4	C	0.80	0.32	0.08	1.20	40	28	16
4	D	0.36	0.24	0.08	0.68	32	20	4
5	A	0.12	0.08	0.00	0.20	16	12	4
5	B	0.44	0.28	0.04	0.76	36	24	8
5	C	0.50	0.30	0.00	0.80	30	30	5
5	D	0.28	0.00	0.08	0.36	28	20	0
6	A	0.00	0.64	0.04	0.68	8	0	4
6	B	0.28	0.00	0.12	0.40	28	24	0
6	C	0.32	0.04	0.04	0.40	28	20	4
6	D	0.16	0.12	0.00	0.28	16	12	4
7	A	0.20	0.00	0.00	0.20	16	16	0
7	B	0.48	0.00	0.00	0.48	20	20	0
7	C	0.72	0.52	0.00	1.24	40	36	4
7	D	1.12	0.00	0.00	1.12	28	28	0
8	A	0.08	0.00	0.04	0.12	12	8	0
8	B	0.12	0.00	0.24	0.36	16	8	0
8	C	0.68	0.00	0.16	0.84	24	24	0
8	D	1.52	0.24	0.04	1.80	36	32	4
9	A	0.04	0.12	0.04	0.20	12	4	4
9	B	0.08	0.08	0.08	0.24	20	8	8
9	C	0.20	0.20	0.00	0.40	20	12	8
9	D	0.08	0.00	0.04	0.12	8	4	0

Table E.5. Mean number of aphids, beneficials and other pests per plant and percentage of plants with aphids per plot at the field trial in Westmaas (23rd of June, 2023).

		mean number of aphids per plant				*percentage of plants with*		
treatment	*replicate*	*Myzus persicae*	*Aphis fabae*	other aphids	total aphids	aphids	*Myzus persicae*	*Aphis fabae*
1	A	0.00	2.13	0.00	2.13	40	0	40
1	B	0.00	8.53	0.00	8.53	60	0	60
1	C	0.00	13.80	0.07	13.87	73	0	73
1	D	0.00	1.27	0.00	1.27	33	0	33
2	A	0.07	1.47	0.00	1.53	33	7	33
2	B	0.07	4.07	0.00	4.13	47	7	40
2	C	0.00	4.33	0.00	4.33	60	0	60
2	D	0.07	1.20	0.07	1.33	40	7	40
3	A	0.00	3.60	0.07	3.67	33	0	27
3	B	0.00	1.73	0.00	1.73	20	0	20
3	C	0.00	7.00	0.07	7.07	53	0	53
3	D	0.00	4.67	0.07	4.73	60	0	53
4	A	0.20	2.07	0.00	2.27	60	20	53
4	B	0.00	0.93	0.00	0.93	27	0	27
4	C	0.00	0.73	0.00	0.73	33	0	33
4	D	0.07	1.47	0.20	1.73	47	7	40
5	A	0.00	2.47	0.07	2.53	47	0	47
5	B	0.13	5.53	0.00	5.67	67	13	67
5	C	0.00	1.20	0.00	1.20	47	0	47
5	D	0.13	0.40	0.07	0.60	33	13	27
6	A	0.07	8.40	0.07	8.53	53	7	53
6	B	0.07	1.67	0.00	1.73	60	7	60
6	C	0.00	2.27	0.00	2.27	27	0	27
6	D	0.00	1.93	0.00	1.93	47	0	47
7	A	0.07	2.40	0.00	2.47	40	7	40
7	B	0.20	5.53	0.07	5.80	73	20	60
7	C	0.07	4.00	0.00	4.07	60	7	53
7	D	0.00	2.53	0.00	2.53	47	0	47
8	A	0.07	3.27	0.00	3.33	47	7	47
8	B	0.00	4.00	0.00	4.00	53	0	53
8	C	0.00	1.73	0.13	1.87	53	0	40
8	D	0.00	2.53	0.67	3.20	60	0	47
9	A	0.00	7.13	0.00	7.13	80	0	80
9	B	0.00	5.00	0.00	5.00	60	0	60
9	C	0.07	1.07	0.00	1.13	33	7	33
9	D	0.00	3.60	0.20	3.80	53	0	47

Annex F Raw data plant numbers, phytotoxicity and vigour

Table F.1. Number of plants per plot, number of plants per hectare and percentage of emerged plants and (Westmaas, 25th of May, 2023).

treatment	*replicate*	*number of plants per plot*	*number of plants per hectare*	*percentage of plants**
1	A	217	108500	97.7
1	B	215	107500	96.8
1	C	225	112500	101.3
1	D	219	109500	98.6
2	A	218	109000	98.1
2	B	230	115000	103.5
2	C	225	112500	101.3
2	D	222	111000	99.9
3	A	215	107500	96.8
3	B	213	106500	95.9
3	C	222	111000	99.9
3	D	226	113000	101.7
4	A	219	109500	98.6
4	B	225	112500	101.3
4	C	225	112500	101.3
4	D	222	111000	99.9
5	A	225	112500	101.3
5	B	218	109000	98.1
5	C	221	110500	99.5
5	D	224	112000	100.8
6	A	221	110500	99.5
6	B	229	114500	103.1
6	C	220	110000	99.0
6	D	220	110000	99.0
7	A	215	107500	96.8
7	B	222	111000	99.9
7	C	224	112000	100.8
7	D	228	114000	102.6
8	A	218	109000	98.1
8	B	232	116000	104.4
8	C	221	110500	99.5
8	D	220	110000	99.0
9	A	217	108500	97.7
9	B	224	112000	100.8
9	C	219	109500	98.6
9	D	222	111000	99.9

*percentage could be higher than 100, because of a small percentage of the seed might have been multigerm or two seeds were placed together.

Table F.2. Number of plants showing signs of phytotoxicity, caused by insecticide treatment and vigour (1=dead; 10=highly vigorous crop). at different dates (Westmaas, 2023).

treatment	*replicate*	*number of plants with symptoms of phytotoxicity*					*vigour*	
		26 May	2 June	6 June	7 July	21 July	6 June	7 July
1	A	0	0	0	0	0	8.5	10
1	B	0	0	0	0	0	8.0	10
1	C	0	0	0	0	0	7.5	10
1	D	0	0	0	0	0	8.5	10
2	A	0	0	0	0	0	8.0	10
2	B	0	0	0	0	0	8.0	10
2	C	0	0	0	0	0	7.5	10
2	D	0	0	0	0	0	8.5	10
3	A	0	0	0	0	0	8.0	10
3	B	0	0	0	0	0	7.5	10
3	C	0	0	0	0	0	8.0	10
3	D	0	0	0	0	0	8.5	10
4	A	0	0	0	0	0	8.0	10
4	B	0	0	0	0	0	8.0	10
4	C	0	0	0	0	0	8.0	10
4	D	0	0	0	0	0	8.5	10
5	A	0	0	0	0	0	8.0	10
5	B	0	0	0	0	0	8.0	10
5	C	0	0	0	0	0	8.0	10
5	D	0	0	0	0	0	8.5	10
6	A	0	0	0	0	0	8.0	10
6	B	0	0	0	0	0	8.0	10
6	C	0	0	0	0	0	7.5	10
6	D	0	0	0	0	0	8.5	10
7	A	0	0	0	0	0	8.0	10
7	B	0	0	0	0	0	8.5	10
7	C	0	0	0	0	0	7.5	10
7	D	0	0	0	0	0	8.5	10
8	A	0	0	0	0	0	8.5	10
8	B	0	0	0	0	0	8.0	10
8	C	0	0	0	0	0	8.0	10
8	D	0	0	0	0	0	8.5	10
9	A	0	0	0	0	0	8.0	10
9	B	0	0	0	0	0	8.0	10
9	C	0	0	0	0	0	8.0	10
9	D	0	0	0	0	0	8.5	10

Annex G Raw data virus yellows

Table G.1. Number of plants in the middle four rows per plot with virus yellows (Westmaas, 2023).

treatment	*replicate*	*number of plants with virus yellows per plot*				
		23 June	7 July	21 July	14 August	13 September
1	A	0	2	12	18	16
1	B	0	3	16	27	30
1	C	0	1	15	13	9
1	D	0	4	15	14	20
2	A	0	1	0	0	0
2	B	0	1	0	0	0
2	C	0	0	0	0	0
2	D	0	0	0	1	0
3	A	0	2	5	2	5
3	B	0	2	8	10	11
3	C	0	2	19	24	16
3	D	0	4	13	8	9
4	A	0	1	8	11	13
4	B	0	3	5	3	6
4	C	0	1	13	14	14
4	D	0	3	8	11	14
5	A	0	0	8	15	16
5	B	0	3	7	5	12
5	C	0	2	9	5	9
5	D	0	1	5	5	16
6	A	0	3	9	8	4
6	B	0	5	12	13	18
6	C	0	2	10	5	8
6	D	0	4	14	6	10
7	A	0	1	7	5	15
7	B	0	1	13	22	25
7	C	0	2	12	12	20
7	D	0	1	13	13	31
8	A	0	1	10	19	20
8	B	0	3	5	14	13
8	C	0	2	10	11	11
8	D	0	3	15	13	17
9	A	0	0	11	11	21
9	B	0	2	7	6	7
9	C	0	6	14	17	25
9	D	0	2	10	7	17

Table G.2. Percentage of plants with virus yellows, assessed in the middle four rows per plot (Westmaas, 2023).

treatment	*replicate*	*percentage of plants with virus yellows*				
		23 June	7 July	21 July	14 August	13 September
1	A	0.0	0.9	5.5	8.3	7.4
1	B	0.0	1.4	7.4	12.6	14.0
1	C	0.0	0.4	6.7	5.8	4.0
1	D	0.0	1.8	6.8	6.4	9.1
2	A	0.0	0.5	0.0	0.0	0.0
2	B	0.0	0.4	0.0	0.0	0.0
2	C	0.0	0.0	0.0	0.0	0.0
2	D	0.0	0.0	0.0	0.5	0.0
3	A	0.0	0.9	2.3	0.9	2.3
3	B	0.0	0.9	3.8	4.7	5.2
3	C	0.0	0.9	8.6	10.8	7.2
3	D	0.0	1.8	5.8	3.5	4.0
4	A	0.0	0.5	3.7	5.0	5.9
4	B	0.0	1.3	2.2	1.3	2.7
4	C	0.0	0.4	5.8	6.2	6.2
4	D	0.0	1.4	3.6	5.0	6.3
5	A	0.0	0.0	3.6	6.7	7.1
5	B	0.0	1.4	3.2	2.3	5.5
5	C	0.0	0.9	4.1	2.3	4.1
5	D	0.0	0.4	2.2	2.2	7.1
6	A	0.0	1.4	4.1	3.6	1.8
6	B	0.0	2.2	5.2	5.7	7.9
6	C	0.0	0.9	4.5	2.3	3.6
6	D	0.0	1.8	6.4	2.7	4.5
7	A	0.0	0.5	3.3	2.3	7.0
7	B	0.0	0.5	5.9	9.9	11.3
7	C	0.0	0.9	5.4	5.4	8.9
7	D	0.0	0.4	5.7	5.7	13.6
8	A	0.0	0.5	4.6	8.7	9.2
8	B	0.0	1.3	2.2	6.0	5.6
8	C	0.0	0.9	4.5	5.0	5.0
8	D	0.0	1.4	6.8	5.9	7.7
9	A	0.0	0.0	5.1	5.1	9.7
9	B	0.0	0.9	3.1	2.7	3.1
9	C	0.0	2.7	6.4	7.8	11.4
9	D	0.0	0.9	4.5	3.2	7.7

Annex H Data on yield

Table H.1. Average yield per plot expressed in root weight (t/ha), sugar content (%), sugar yield (t/ha), soil tare (%), potassium (mmol/kg), sodium (mmol/kg), amino nitrogen (mmol/kg) and financial yield (€/ha). The field trial was harvested on 26th of September 2023.

treatment	*replicate*	*root yield (t/ha)*	*sugar percentage*	*sugar yield (t/ha)*	*soil tare (%)*	*potassium (mmol/kg)*	*sodium (mmol/kg)*	*amino nitrogen (mmol/kg)*	*financial yield (€/ha)*
1	A	104.2	16.3	17.0	3.0	35.3	3.9	5.3	4879
1	B	107.8	16.1	17.4	4.2	36.2	3.5	5.5	4919
1	C	98.2	16.4	16.1	3.3	34.6	3.5	5.2	4647
1	D	101.3	16.3	16.5	3.8	34.9	3.7	4.8	4745
2	A	102.8	16.3	16.8	2.2	35.9	3.9	4.2	4829
2	B	107.6	16.1	17.4	3.2	34.7	3.9	5.6	4943
2	C	98.8	16.3	16.2	4.8	34.9	3.8	5.1	4620
2	D	97.4	16.3	15.9	5.4	34.8	3.2	5.3	4517
3	A	96.9	16.4	15.9	3.2	35.5	3.3	4.3	4582
3	B	100.1	16.5	16.6	3.7	33.3	3.0	5.2	4800
3	C	98.7	16.4	16.2	2.4	34.9	3.9	5.2	4668
3	D	104.0	16.2	16.9	1.6	35.6	4.3	5.4	4843
4	A	97.0	15.9	15.4	8.3	37.2	4.4	6.1	4253
4	B	105.0	16.5	17.3	2.2	35.8	2.9	4.6	5031
4	C	102.2	16.5	16.9	4.5	33.5	3.1	5.0	4862
4	D	106.4	16.2	17.3	3.3	35.0	4.5	5.9	4934
5	A	103.1	16.3	16.8	3.3	35.2	3.7	5.0	4828
5	B	102.8	16.3	16.7	1.3	36.4	3.4	5.7	4818
5	C	103.9	16.0	16.6	4.8	36.6	3.8	4.8	4664
5	D	104.3	16.5	17.2	3.8	32.8	3.5	4.6	5003
6	A	93.6	16.5	15.5	5.9	32.3	3.2	4.6	4455
6	B	100.0	16.7	16.6	1.9	34.6	2.9	4.7	4873
6	C	96.2	16.4	15.8	4.5	36.2	3.5	4.7	4531
6	D	107.8	16.5	17.8	2.0	33.2	3.6	5.2	5163
7	A	92.9	16.6	15.4	3.9	33.4	3.1	4.1	4492
7	B	107.7	16.4	17.6	4.2	34.8	3.9	5.7	5054
7	C	98.7	16.5	16.3	3.0	35.5	4.2	5.0	4713
7	D	102.6	16.3	16.7	4.2	34.4	3.9	5.1	4781
8	A	92.7	16.6	15.3	5.5	33.3	3.2	4.8	4426
8	B	104.7	16.5	17.3	3.1	35.3	3.5	5.5	4988
8	C	105.5	16.2	17.1	2.9	35.1	3.9	4.8	4895
8	D	106.9	16.4	17.6	3.1	35.8	3.6	4.8	5068
9	A	104.9	16.1	16.9	2.2	36.6	4.1	5.7	4797
9	B	105.4	16.0	16.8	5.4	36.8	5.3	6.3	4697
9	C	104.6	16.2	16.9	2.2	36.7	3.9	5.2	4839
9	D	100.2	16.4	16.4	7.0	37.0	3.5	5.3	4662

Table H.2. Average yield per treatment expressed in soil tare (%), potassium (mmol/kg), sodium (mmol/kg) and amino nitrogen (mmol/kg). The field trial was harvested on 26th of September 2023. Analysed data of root weight (t/ha), sugar content (%), sugar yield (t/ha) and financial yield (€/ha) are shown in paragraph 3.4.

treatment	*soil tare (%)*	*potassium (mmol/kg)*	*sodium (mmol/kg)*	*amino nitrogen (mmol/kg)*
1	3.6	35.2	3.6	5.2
2	3.9	35.1	3.7	5.0
3	2.7	34.8	3.6	5.0
4	4.6	35.4	3.7	5.4
5	3.3	35.3	3.6	5.0
6	3.6	34.1	3.3	4.8
7	3.8	34.5	3.8	5.0
8	3.7	34.9	3.5	5.0
9	4.2	36.8	4.2	5.6
P	0.923	0.195	0.585	0.400
lsd 5%	2.47	1.76	0.77	0.71
significantie	not significant	not significant	not significant	not significant

Annex I Analysed data aphids

Table I.1. Percentage of assessed plants with green peach aphids (*Myzus persicae*) on the 26th of May, 2nd, 5th and 23rd of June. Plants were inoculated with green peach aphids on the 24th of May (Westmaas, 2023). Different letters indicate significant differences within a column.

treatment		*percentage of plants with* Myzus persicae				
		26 May		2 June	5 June	23 June
1	untreated control	35	a	20	28	0
2	non inoculated control	7	c	12	26	5
3	Teppeki (T1)	27	a	15	19	0
4	Teppeki (T1) + Batavia (T3)	31	a	16	21	7
5	IRS 810 (T1)	27	a	5	22	7
6	IRS 810 (T1+T3)	31	a	11	14	3
7	Pyrethroids sidewards	16	b	14	25	8
8	IRS 785	28	a	10	18	2
9	IRS 785 band application	17	b	4	7	2
P		<0.001		0.075	0.054	0.294
significance		very significant		not significant	not significant	not significant

Table I.2. Percentage of assessed plants with natural occurring black bean aphids (*Aphis fabae*) on the 26th of May, 2nd, 5th and 23rd of June (Westmaas, 2022).

treatment		*percentage of plants with* Aphis fabae			
		26 May	2 June	5 June	23 June
1	untreated control	13	8	4	52
2	non inoculated control	8	3	1	43
3	Teppeki (T1)	11	7	6	38
4	Teppeki (T1) + Batavia (T3)	8	3	6	38
5	IRS 810 (T1)	8	5	4	47
6	IRS 810 (T1+T3)	10	7	3	47
7	Pyrethroids sidewards	7	1	1	50
8	IRS 785	9	2	1	47
9	IRS 785 band application	5	1	5	55
P		0.384	0.153	0.225	0.795
significance		not significant	not significant	not significant	not significant

Table I.3. Average number of natural occurring other aphids per plant on the 26th of May and 2nd, 5th and 23rd of June. (Westmaas, 2023).

treatment		*mean number of other aphids per plant*			
		26 May	2 June	5 June	23 June
1	untreated control	0.07	0.11	0.03	0.02
2	non inoculated control	0.07	0.02	0.04	0.02
3	Teppeki (T1)	0.05	0.00	0.05	0.05
4	Teppeki (T1) + Batavia (T3)	0.05	0.06	0.05	0.05
5	IRS 810 (T1)	0.09	0.03	0.03	0.03
6	IRS 810 (T1+T3)	0.04	0.10	0.05	0.02
7	Pyrethroids sidewards	0.00	0.04	0.00	0.02
8	IRS 785	0.02	0.02	0.12	0.17
9	IRS 785 band application	0.00	0.03	0.04	0.05
P		0.611	0.100	0.208	0.382
significance		not significant	not significant	not significant	not significant

Table I.4. Average number of total aphids per plant on the 26th of May and 2nd, 5th and 23rd of June. (Westmaas, 2023). Different letters indicate significant differences within a column.

treatment		*mean number of total aphids per plant*					
		26 May		2 June		5 June	23 June
1	untreated control	2.0	a	1.4	a	1.1	4.6
2	non inoculated control	0.6	cd	0.6	b	0.5	2.6
3	Teppeki (T1)	1.5	ab	0.6	b	0.6	3.9
4	Teppeki (T1) + Batavia (T3)	1.5	ab	0.5	b	0.7	1.3
5	IRS 810 (T1)	1.4	ab	0.3	b	0.5	2.0
6	IRS 810 (T1+T3)	1.5	ab	0.5	b	0.4	3.0
7	Pyrethroids sidewards	0.6	cd	0.3	b	0.7	3.5
8	IRS 785	1.1	bc	0.2	b	0.7	3.0
9	IRS 785 band application	0.4	d	0.3	b	0.2	3.7
P		<0.001		0.037		0.167	0.434
significance		very significant		significant		not significant	not significant

Table I.5. Percentage of assessed plants with natural occurring black bean aphids (*Aphis fabae*) on the 26th of May, 2nd, 5th and 23rd of June (Westmaas, 2023). Different letters indicate significant differences within a column.

treatment		*percentage of plants with aphids*				
		26 May		2 June	5 June	23 June
1	untreated control	46	a	28	34	52
2	non inoculated control	19	b	16	28	45
3	Teppeki (T1)	37	a	22	26	42
4	Teppeki (T1) + Batavia (T3)	40	a	23	29	42
5	IRS 810 (T1)	38	a	13	28	48
6	IRS 810 (T1+T3)	39	a	22	20	47
7	Pyrethroids sidewards	22	b	18	26	55
8	IRS 785	37	a	14	22	53
9	IRS 785 band application	21	b	8	15	57
P		<0.001		0.082	0.232	0.843
significance		very significant		not significant	not significant	not significant

Annex J Weather data

Table J.1. Weather data from the nearest KNMI weather station (344: Rotterdam), 17 km from trial.

date	*wind speed (m/s)*	*mean air tempera-ture (˚C)*	*min. air tempera-ture (˚C)*	*max. air tempera-ture (˚C)*	*precipi-tation (mm)*	*precipi-tation duration (h)*	*mean humidity (%)*	*min. humidity (%)*	*max. humidity (%)*
20230301	2.9	1.5	-5.2	7.2	0.0	0.0	79	53	100
20230302	4.3	3.5	0.0	8.0	0.0	0.0	88	69	98
20230303	3.4	4.7	0.7	8.3	0.0	0.0	84	67	98
20230304	3.5	5.7	2.3	8.7	0.4	0.7	88	76	97
20230305	2.1	3.5	0.6	6.7	2.8	1.6	91	70	97
20230306	4.2	4.2	-0.7	7.2	3.5	5.7	89	66	98
20230307	2.8	2.4	-2.0	5.8	8.1	10.3	93	79	98
20230308	4.2	0.6	-2.7	3.7	5.7	9.6	96	83	100
20230309	3.6	1.9	0.6	2.7	13.0	11.1	97	94	98
20230310	5.8	2.3	0.4	3.1	11.7	12.8	89	61	98
20230311	1.7	2.5	-3.6	7.5	0.0	0.0	73	42	97
20230312	6.5	7.8	2.8	11.4	3.2	5.0	88	66	98
20230313	9.8	12.4	9.3	15.5	2.4	3.6	81	63	98
20230314	6.5	6.4	1.1	10.7	7.5	4.9	81	58	98
20230315	2.8	5.2	-0.1	8.6	1.1	0.8	74	51	97
20230316	6.3	9.5	5.5	14.0	0.7	3.0	66	45	92
20230317	3.3	11.8	8.5	15.6	<0.05	0.0	72	63	97
20230318	3.8	11.8	8.2	16.1	4.4	3.4	89	67	98
20230319	3.4	8.8	6.8	12.2	0.0	0.0	96	84	98
20230320	5.4	8.3	5.8	9.7	3.0	9.3	96	89	98
20230321	5.5	10.4	8.9	12.9	1.6	2.0	90	79	98
20230322	7.2	10.8	9.0	12.4	3.9	5.8	92	86	98
20230323	7.8	12.6	10.9	15.1	7.0	7.2	84	67	96
20230324	9.6	11.1	9.2	13.8	0.7	0.9	81	71	94
20230325	8.7	9.8	7.0	12.1	1.1	0.6	84	72	97
20230326	4.3	7.2	4.2	9.3	7.2	6.1	85	65	98
20230327	4.2	4.3	-1.3	8.2	2.0	2.1	79	59	97
20230328	4.5	4.9	-1.5	8.9	0.3	1.4	80	52	97
20230329	4.7	11.4	6.4	15.2	<0.05	0.0	85	71	94
20230330	9.1	12.4	10.5	14.3	0.7	0.9	85	70	92
20230331	7.1	10.5	9.0	12.0	18.0	16.3	96	92	98
20230401	5.2	9.1	7.1	10.4	4.3	6.4	97	94	98
20230402	5.5	6.1	2.8	9.8	<0.05	0.0	79	59	93
20230403	4.5	5.2	-0.7	9.9	0.0	0.0	65	38	94
20230404	2.3	5.1	-1.2	10.6	0.0	0.0	70	40	97
20230405	1.6	6.4	-1.2	12.0	0.0	0.0	71	42	98
20230406	4.3	7.8	5.4	9.5	9.1	9.2	89	64	98
20230407	3.1	8.3	4.3	9.7	0.0	0.0	92	82	98
20230408	2.0	9.4	4.9	14.8	<0.05	0.0	82	48	100
20230409	2.6	10.6	3.7	15.8	0.0	0.0	79	58	100
20230410	6.5	11.0	7.8	14.7	7.5	4.6	78	61	98
20230411	6.9	10.0	7.6	13.0	2.5	3.0	75	53	97

date	*wind speed (m/s)*	*mean air tempera-ture (˚C)*	*min. air tempera-ture (˚C)*	*max. air tempera-ture (˚C)*	*precipi-tation (mm)*	*precipi-tation duration (h)*	*mean humidity (%)*	*min. humidity (%)*	*max. humidity (%)*
20230412	7.2	9.4	6.6	12.1	8.1	7.0	77	56	98
20230413	6.6	8.6	5.9	12.0	3.3	2.4	77	58	95
20230414	3.8	9.7	4.8	15.0	0.0	0.0	71	48	96
20230415	5.2	9.4	4.3	14.4	0.0	0.0	77	57	92
20230416	4.2	8.5	7.6	9.9	0.1	0.2	95	90	98
20230417	3.8	10.0	7.2	15.1	0.0	0.0	87	62	98
20230418	5.3	9.1	5.5	13.2	0.0	0.0	78	66	96
20230419	6.5	10.9	6.8	15.1	0.0	0.0	62	36	90
20230420	5.0	8.2	5.0	11.6	1.1	2.0	73	55	94
20230421	4.1	10.6	5.8	15.9	4.3	3.8	85	63	98
20230422	1.8	9.1	3.6	14.0	2.9	2.5	92	72	100
20230423	4.7	11.5	8.6	16.1	10.6	5.9	90	68	98
20230424	5.5	8.5	5.1	10.5	13.5	7.4	86	75	98
20230425	3.3	6.8	2.3	10.7	0.6	0.4	77	60	97
20230426	2.0	6.1	1.5	10.9	0.0	0.0	75	48	98
20230427	3.7	8.9	1.0	12.9	<0.05	0.0	63	45	97
20230428	4.5	10.5	8.0	13.3	3.1	5.7	92	65	98
20230429	3.0	10.9	6.0	16.1	0.0	0.0	79	62	97
20230430	2.5	12.0	4.6	17.8	0.0	0.0	76	54	98
20230501	2.3	11.9	8.4	16.9	0.9	1.5	85	65	98
20230502	3.6	9.4	3.6	12.9	0.0	0.0	73	54	97
20230503	4.0	9.5	1.8	15.0	0.0	0.0	73	52	97
20230504	4.3	14.7	5.3	22.2	<0.05	0.0	68	42	95
20230505	2.8	14.2	10.8	17.1	3.9	3.2	90	77	98
20230506	2.1	15.3	9.9	20.2	1.1	2.7	87	61	98
20230507	1.7	15.5	10.8	19.9	12.4	2.4	93	71	100
20230508	2.3	14.1	9.5	17.9	0.0	0.0	93	86	100
20230509	3.7	13.5	10.0	14.7	14.5	12.0	97	92	98
20230510	2.4	12.9	11.0	15.1	<0.05	0.0	94	88	98
20230511	1.9	13.5	11.2	15.8	5.4	4.1	93	83	98
20230512	4.6	15.5	11.0	21.6	2.4	3.4	79	46	98
20230513	3.5	15.6	10.6	20.7	0.0	0.0	73	51	90
20230514	2.7	12.5	8.6	18.9	0.0	0.0	84	65	97
20230515	3.8	10.5	7.1	13.8	<0.05	0.0	84	73	98
20230516	3.4	10.5	5.9	15.2	0.0	0.0	72	49	95
20230517	3.3	10.9	5.4	14.9	<0.05	0.0	68	47	92
20230518	3.2	10.6	5.2	15.3	0.0	0.0	64	47	84
20230519	3.8	13.7	5.9	19.3	0.0	0.0	64	40	90
20230520	5.5	15.8	10.9	20.7	0.0	0.0	61	43	80
20230521	3.8	15.7	11.3	21.6	0.0	0.0	76	56	95
20230522	3.5	15.6	11.1	21.3	0.0	0.0	83	67	97
20230523	5.1	12.1	6.8	15.2	0.0	0.0	72	53	94
20230524	2.5	12.3	5.7	17.5	0.0	0.0	73	50	97
20230525	3.6	13.1	7.9	17.7	0.0	0.0	71	49	96
20230526	5.7	12.9	7.5	18.3	0.0	0.0	64	46	86

date	*wind speed (m/s)*	*mean air tempera-ture (˚C)*	*min. air tempera-ture (˚C)*	*max. air tempera-ture (˚C)*	*precipi-tation (mm)*	*precipi-tation duration (h)*	*mean humidity (%)*	*min. humidity (%)*	*max. humidity (%)*
20230527	3.5	14.4	6.3	20.9	0.0	0.0	68	43	92
20230528	4.6	16.0	10.1	21.8	0.0	0.0	69	40	97
20230529	5.8	13.3	10.0	17.5	0.0	0.0	63	42	81
20230530	4.5	13.1	9.1	17.0	0.0	0.0	72	57	88
20230531	4.9	15.8	9.6	22.5	0.0	0.0	71	45	90
20230601	5.0	13.1	10.9	17.6	0.0	0.0	72	62	84
20230602	4.0	13.4	10.2	18.1	0.0	0.0	69	58	88
20230603	4.4	16.6	9.4	21.7	0.0	0.0	54	29	90
20230604	4.3	15.9	9.1	22.1	0.0	0.0	60	37	85
20230605	4.3	14.4	10.3	19.4	0.0	0.0	73	57	87
20230606	4.1	15.8	10.0	22.0	0.0	0.0	71	53	88
20230607	4.0	16.5	11.0	22.6	0.0	0.0	70	53	89
20230608	5.0	17.8	11.6	24.1	0.0	0.0	68	50	91
20230609	4.6	21.5	12.7	28.6	0.0	0.0	57	32	82
20230610	4.7	23.4	16.2	29.7	0.0	0.0	48	27	74
20230611	3.6	25.0	16.4	30.5	0.0	0.0	49	31	76
20230612	4.6	24.6	18.9	29.8	0.0	0.0	41	23	69
20230613	5.3	22.3	15.0	27.8	0.0	0.0	43	27	65
20230614	3.9	20.6	13.3	26.4	0.0	0.0	48	30	75
20230615	2.8	20.2	13.0	26.3	0.0	0.0	58	37	95
20230616	2.3	19.7	11.8	26.3	0.0	0.0	54	30	98
20230617	1.8	20.6	10.2	27.2	0.0	0.0	54	28	94
20230618	3.5	22.0	18.3	25.3	<0.05	0.0	58	47	70
20230619	4.5	20.4	17.0	24.4	0.1	0.2	68	53	91
20230620	3.7	22.2	18.6	29.9	3.4	4.2	70	42	93
20230621	3.5	20.1	15.3	23.8	<0.05	0.0	72	49	92
20230622	2.5	19.2	13.3	24.7	1.1	2.4	79	52	98
20230623	2.3	20.3	13.1	25.1	0.0	0.0	67	45	98
20230624	2.5	21.3	15.0	26.9	0.0	0.0	67	50	94
20230625	3.4	25.7	15.2	32.0	0.0	0.0	52	30	97
20230626	4.7	19.2	16.0	22.0	0.0	0.0	64	49	84
20230627	2.9	18.1	14.2	21.7	<0.05	0.0	65	48	89
20230628	3.5	19.7	16.0	22.9	0.3	1.2	76	64	89
20230629	3.9	17.7	10.5	22.9	0.1	0.2	82	71	93
20230630	5.0	17.6	9.5	23.5	0.1	0.1	66	44	95
20230701	5.6	17.9	15.8	20.5	3.0	4.9	83	68	95
20230702	6.2	17.7	14.7	20.6	0.0	0.0	59	39	80
20230703	7.2	16.9	12.8	20.6	9.9	2.4	65	47	91
20230704	4.8	17.3	13.1	21.5	0.7	1.6	65	44	88
20230705	8.0	15.5	11.7	19.9	13.9	5.4	77	61	93
20230706	3.4	17.4	12.3	21.9	0.7	0.4	69	45	91
20230707	3.7	22.2	11.5	28.7	0.0	0.0	49	27	89
20230708	2.2	24.5	15.5	32.9	0.0	0.0	56	28	85
20230709	2.5	21.3	17.4	27.8	8.7	0.7	77	56	92
20230710	3.0	20.3	15.4	24.9	0.0	0.0	65	39	92

date	*wind speed (m/s)*	*mean air tempera-ture (˚C)*	*min. air tempera-ture (˚C)*	*max. air tempera-ture (˚C)*	*precipi-tation (mm)*	*precipi-tation duration (h)*	*mean humidity (%)*	*min. humidity (%)*	*max. humidity (%)*
20230711	4.4	21.4	16.3	26.3	<0.05	0.0	66	53	81
20230712	6.5	18.7	16.6	22.0	1.5	1.4	72	48	90
20230713	5.0	18.5	15.4	21.8	1.2	0.2	71	57	87
20230714	4.1	20.0	14.8	23.4	<0.05	0.0	64	50	84
20230715	6.4	20.7	17.0	27.0	2.0	1.1	64	42	85
20230716	8.2	18.8	16.3	23.0	0.2	0.6	64	53	78
20230717	5.7	17.6	14.9	22.0	0.3	0.3	70	50	84
20230718	2.5	18.3	14.0	23.2	<0.05	0.0	70	52	85
20230719	2.6	17.9	14.9	21.8	8.7	1.1	78	63	97
20230720	1.7	17.4	12.4	21.8	0.0	0.0	71	47	99
20230721	2.7	16.0	12.3	20.9	2.1	0.9	77	54	96
20230722	5.0	16.5	12.5	19.4	2.1	4.6	78	62	90
20230723	7.1	18.4	15.3	22.7	1.3	2.9	79	59	91
20230724	4.2	16.9	10.4	21.5	1.1	0.6	79	66	92
20230725	3.0	15.7	10.1	19.4	3.1	0.6	71	53	95
20230726	3.7	16.7	10.2	20.6	<0.05	0.0	67	44	96
20230727	6.4	17.5	14.4	19.1	15.2	13.8	92	88	95
20230728	4.4	19.5	16.7	21.7	<0.05	0.0	83	72	92
20230729	6.0	18.9	16.6	22.9	1.1	0.6	76	56	88
20230730	7.1	17.9	15.6	21.4	10.8	5.2	79	56	96
20230731	6.9	17.4	15.8	19.4	19.1	11.6	91	83	96
20230801	6.1	17.6	15.3	20.5	1.9	0.8	77	65	88
20230802	6.8	17.6	15.5	22.0	14.4	7.4	84	63	95
20230803	5.3	17.0	14.1	19.9	5.8	2.8	85	74	94
20230804	2.7	16.6	12.3	20.6	1.5	0.6	82	64	97
20230805	4.1	15.5	12.3	18.0	8.6	4.0	85	70	96
20230806	5.5	15.5	13.5	19.3	18.1	7.3	81	63	97
20230807	5.8	16.4	13.3	18.9	1.4	0.8	71	54	85
20230808	4.5	16.1	12.8	19.6	3.3	2.3	74	57	97
20230809	2.9	16.2	11.9	20.5	0.0	0.0	78	56	99
20230810	2.0	18.9	11.5	25.4	0.0	0.0	70	49	97
20230811	3.8	20.8	16.5	26.1	0.0	0.0	75	60	88
20230812	5.1	19.6	16.7	22.1	18.7	2.7	78	57	97
20230813	4.6	18.8	15.8	23.1	<0.05	0.0	76	53	89
20230814	3.1	20.8	14.5	26.9	0.0	0.0	67	45	90
20230815	3.2	18.8	12.9	23.2	<0.05	0.0	79	58	97
20230816	3.4	19.1	11.1	25.0	0.0	0.0	71	46	98
20230817	5.1	18.9	16.1	23.0	0.0	0.0	78	64	93
20230818	3.3	21.2	16.1	25.8	0.0	0.0	81	70	92
20230819	4.3	22.0	17.0	25.7	0.1	0.3	74	57	87
20230820	2.5	20.1	14.7	25.0	0.0	0.0	74	54	97
20230821	1.8	19.7	14.7	24.8	0.0	0.0	78	53	96
20230822	2.6	18.6	14.3	23.2	0.0	0.0	81	64	97
20230823	2.3	19.4	13.8	25.1	0.0	0.0	77	53	98
20230824	3.1	21.0	16.2	25.8	1.3	1.2	81	64	97

date	*wind speed (m/s)*	*mean air tempera-ture (˚C)*	*min. air tempera-ture (˚C)*	*max. air tempera-ture (˚C)*	*precipi-tation (mm)*	*precipi-tation duration (h)*	*mean humidity (%)*	*min. humidity (%)*	*max. humidity (%)*
20230825	2.1	19.2	16.2	23.3	<0.05	0.0	84	73	98
20230826	4.6	16.7	13.4	20.9	3.2	0.7	78	59	94
20230827	4.0	15.2	12.3	18.4	3.6	3.2	82	64	96
20230828	1.8	15.9	11.4	20.6	0.1	0.2	81	61	98
20230829	2.4	15.5	10.2	20.0	0.0	0.0	77	58	98
20230830	4.0	14.8	11.6	18.5	8.0	3.1	81	66	95
20230831	3.1	16.2	10.6	20.2	0.4	0.5	71	54	91
20230901	1.8	16.8	14.6	20.4	4.0	1.8	89	74	100
20230902	2.0	17.4	13.0	22.6	0.0	0.0	88	70	99
20230903	1.7	17.7	10.8	23.9	0.0	0.0	76	51	100
20230904	2.8	18.5	11.5	25.1	0.0	0.0	77	52	97
20230905	2.6	21.6	13.7	28.8	0.0	0.0	71	49	91
20230906	1.9	22.8	15.8	29.6	0.0	0.0	72	46	97
20230907	2.9	22.1	15.2	29.0	0.0	0.0	72	43	94
20230908	1.5	22.2	14.8	30.2	0.0	0.0	77	45	99
20230909	1.3	22.2	13.7	29.0	0.0	0.0	75	51	100
20230910	2.4	25.5	19.2	31.4	0.0	0.0	66	45	89
20230911	2.6	21.3	17.0	24.9	3.5	1.0	83	71	98
20230912	1.8	19.8	15.8	23.6	0.2	0.2	90	74	99
20230913	3.3	16.7	11.0	19.9	2.8	0.7	80	56	99
20230914	1.7	16.2	9.8	21.8	0.0	0.0	77	51	99
20230915	2.3	16.7	10.7	21.9	0.0	0.0	75	53	95
20230916	2.7	19.0	11.8	24.5	1.6	1.4	75	49	97
20230917	2.9	17.3	15.2	19.3	0.4	1.4	88	77	96
20230918	6.2	18.8	14.7	22.6	18.2	3.4	81	66	97
20230919	8.7	16.9	14.7	19.4	1.3	1.6	77	67	87
20230920	7.8	18.9	16.6	21.4	0.0	0.0	74	67	83
20230921	3.1	15.4	11.2	20.4	24.5	12.0	91	69	97
20230922	4.6	13.7	11.3	17.4	11.4	5.5	85	68	94
20230923	3.6	13.6	10.2	17.4	9.3	3.8	86	70	95
20230924	4.7	15.5	10.8	19.7	0.0	0.0	69	52	90
20230925	3.3	15.9	12.3	21.1	0.0	0.0	78	63	99
20230926	2.2	17.1	11.6	22.7	0.0	0.0	80	56	98
20230927	3.0	18.8	11.7	23.7	0.0	0.0	78	58	98
20230928	4.8	17.8	16.2	19.9	0.0	0.0	75	66	80
20230929	4.1	16.4	10.9	20.1	1.6	1.6	83	69	95
20230930	2.8	16.0	12.2	19.8	0.0	0.0	78	58	96