Efficacy evaluation of ISOCLAST against Philaenus spumarius on weeds in semi-field, Italy, 2017.

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Supervised by **Miguel Rodrigo Valverde Urrea**

INTRODUCTION (BACKGROUND)

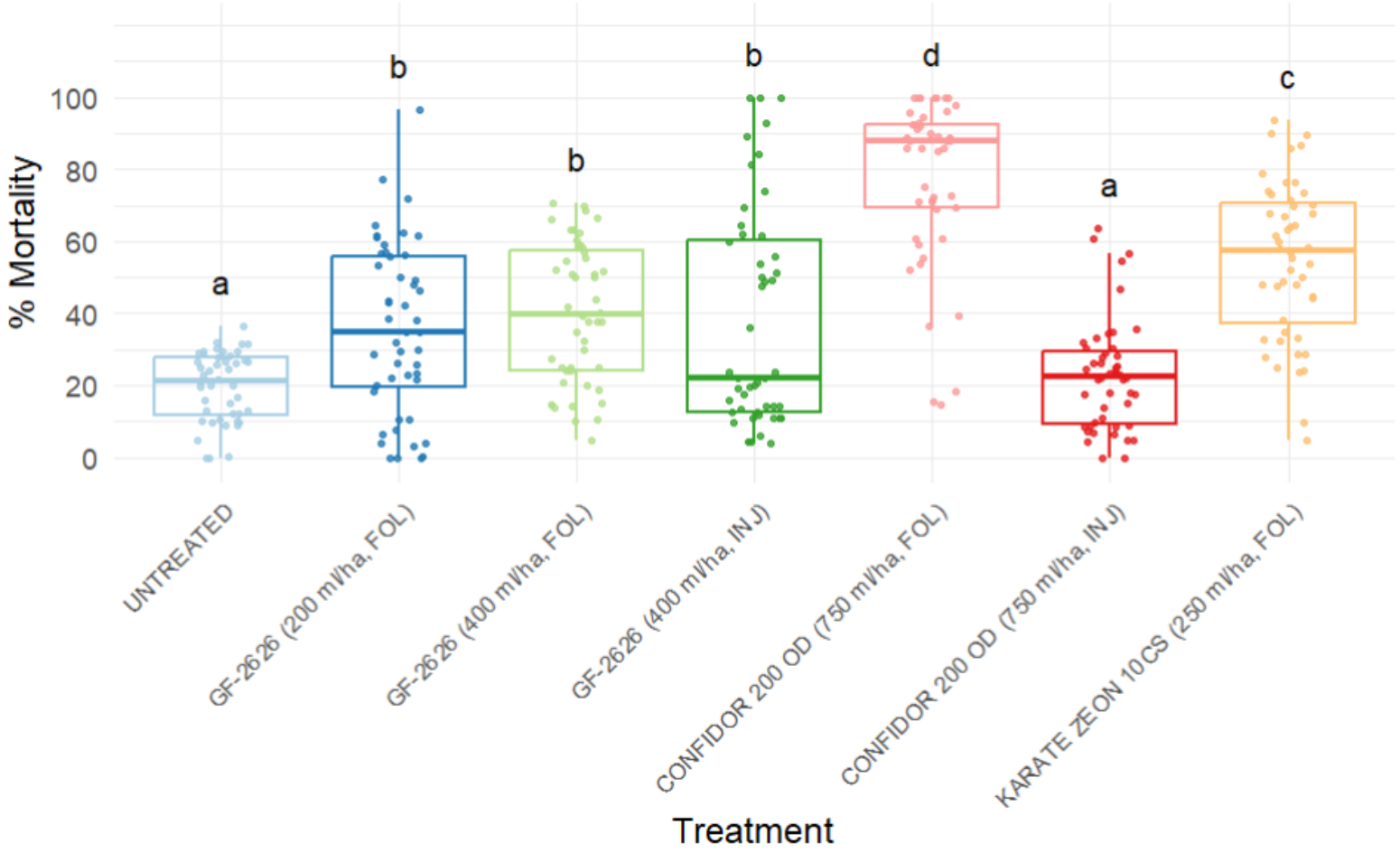
- Background: *Philaenus spumarius* ("meadow spittlebug") is a major vector of *Xylella fastidiosa* (also known as Pierce's disease), a devastating plant pathogen in Europe.
- Effective control of *P. spumarius* is important for managing *Xylella* outbreaks and ensuring crop health.
- Several insecticides, including ISOCLAST™ (sulfoxaflor), are available to control sap-feeding pests such as the aforementioned. There is a need to assess and compare their efficacy and persistence of these products under semi-field conditions.

INTRODUCTION (OBJECTIVES OF THE STUDY)

Key Objectives:

- **Identify the most effective treatment/insecticide**
  - It must be determined which of the tested products (see 2017 and 2018 tables) provides the highest efficacy against *Philaenus spumarius* under semi-field conditions in each year by studying the effects on cumulative mortality. We must also study if there is variability between plots, that is, if the plots have something to do with the differences between individual replicas.
- **Compare application methods**
  - It must be assessed whether foliar spray or trunk injection is more effective for delivering each treatment.
- **Evaluate persistence of control**
  - We should also measure how persistent each treatment is over time, and identify which offers the longest-lasting protection.

1. Which insecticide is more effective against *Philaenus spumarius*? (2017)



$$y_{ij} = \mu + \beta_i + b_j + \varepsilon_{ij}$$
$$b_j \sim N(0, \tau^2) \qquad \text{(Weighted LMM)}$$
$$\varepsilon_{ij} \sim N(0, \sigma_i^2)$$

INJ – trunk injection
FOL – foliar application

Among all treatments in 2017, a **foliar application of CONFIDOR 200 OD was the most effective against *P. spumarius***, followed by Lambda-cyhalothrin (KARATE ZEON 10 CS) and lastly, sulfoxaflor treatments.

An **application of CONFIDOR 200 OD via trunk injection has no effect on mortality.**

There appears to be **no significant difference in mortality between sulfoxaflor (GF-2626) treatments**, regardless of application and rate, but **there is a significant difference with respect to control.**

1.5. Variability between plots (2017)

```
Marginal R² (Treatment): 27.9 %
Conditional R² (Treatment + Plots): 29.077 %
Variance proportion explained by the plots in the model: 1.128 %
```

The **treatment alone explains nearly all of the variability in the data** that is accounted for by the selected model (**27.9%** out of 29.08%). This means that 70.92% of the variability remains unexplained by the model — likely due to other variables not included in the analysis, environmental conditions and/or unknown interactions.

The plots (the random effect in the model) explain **only 1.13% of the variance**, indicating **that plot-to-plot differences have very little influence on mortality** in this experiment.

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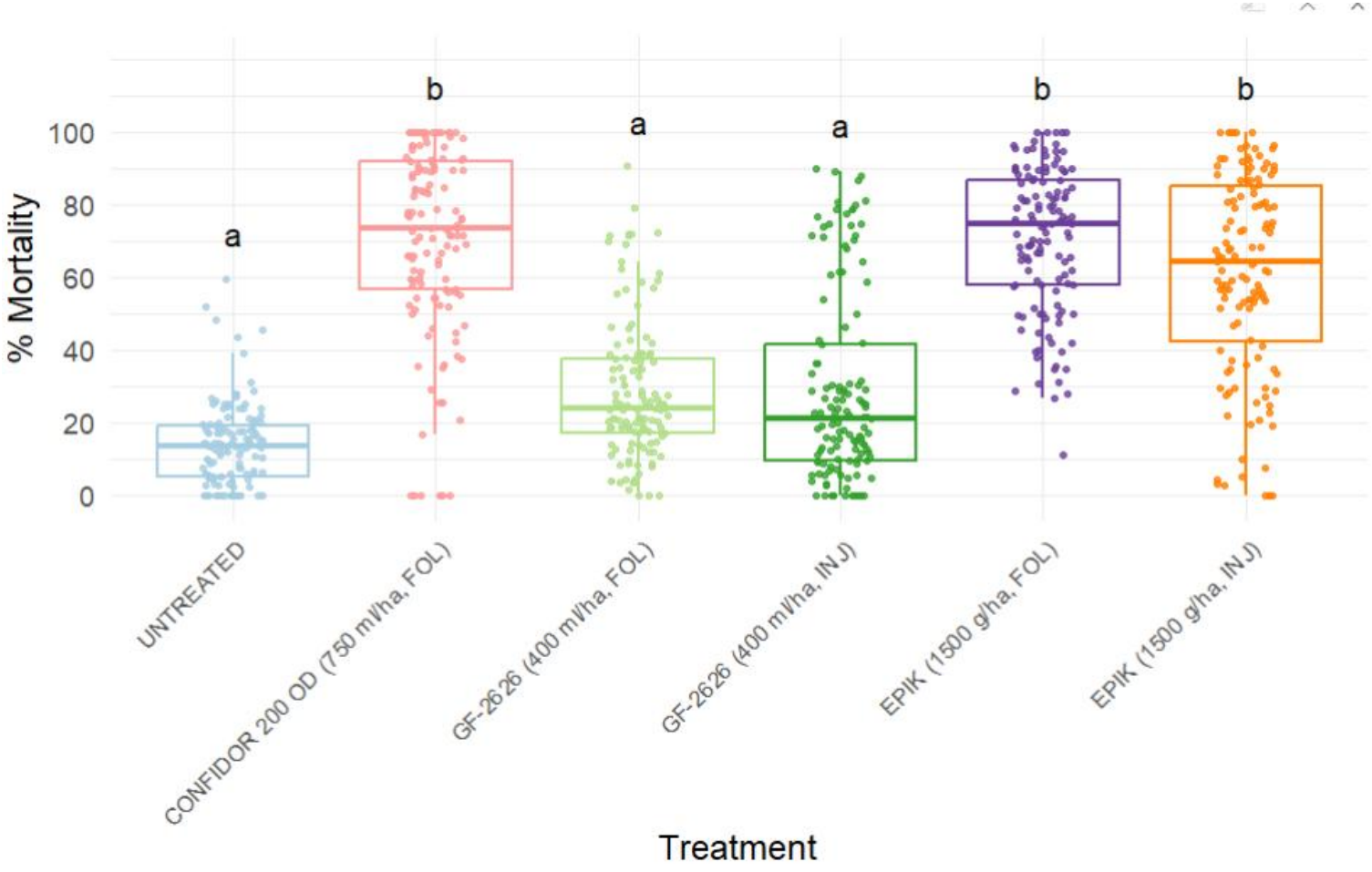

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We can see that, among all treatments in 2018, a **foliar application of CONFIDOR 200 OD or EPIK (regardless of dosage or application)** have the biggest impact on mortality as shown in the graph, compared to sulfoxaflor treatments (regardless of application).

There are **two groups of treatments**, a group consisting of **the three ones previously described**, which are statistically different to the control and **another group consisting on the sulfoxaflor treatments**, which are not significantly different to the control.

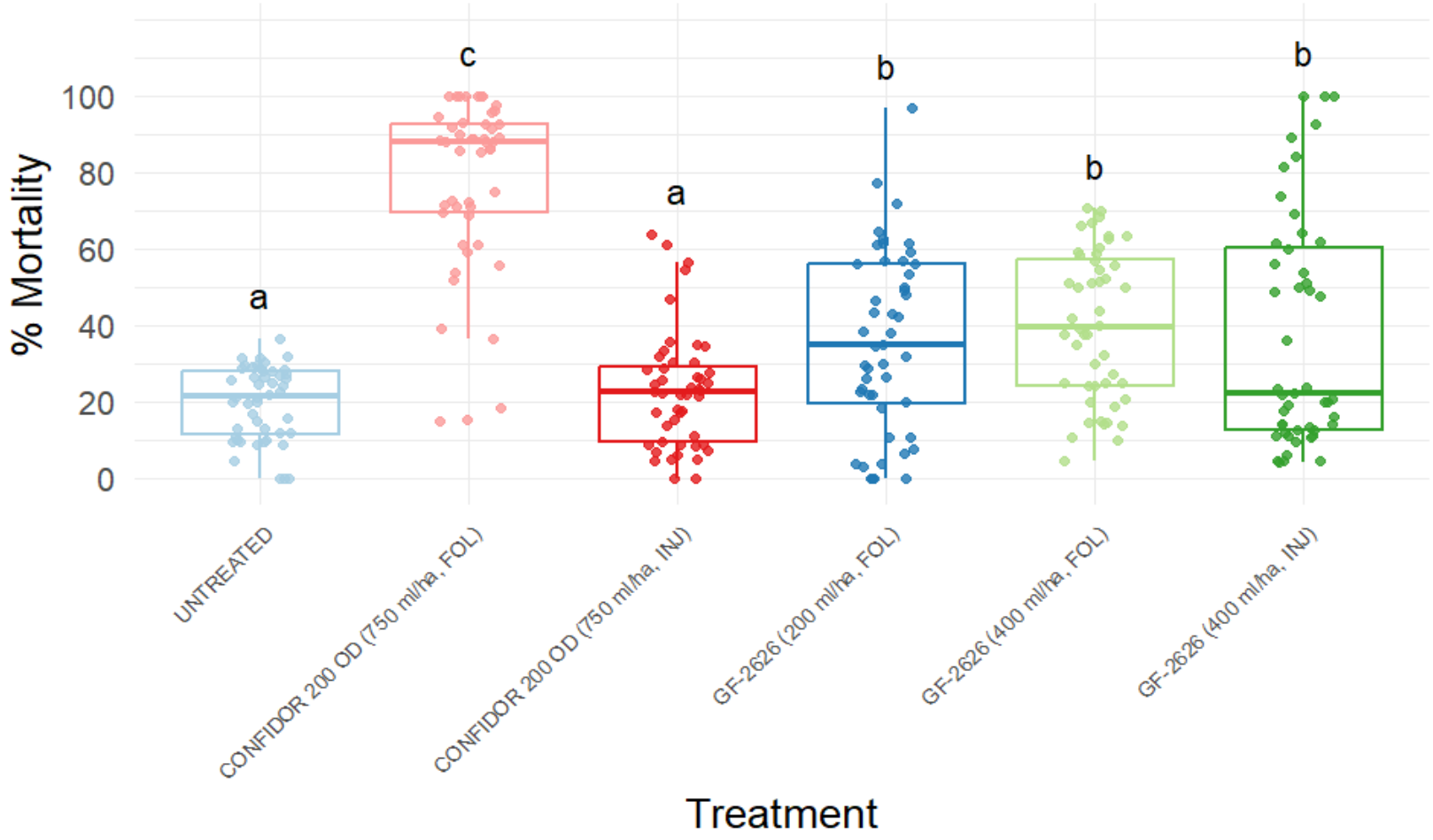
1.5. Variability between plots (2018)

```
Marginal R² (Treatment): 54.361 %
Conditional R² (Treatment + Plots): 69.737 %
Variance proportion explained by the plots in the model: 15.376 %
```

The **treatment alone explains most all of the variability in the data** that is accounted for by the selected model (**54.36%** out of 69.73%).

The plots (the random effect in the model) in this experiment in 2018 explain **about 15.38% of the variance**, indicating **that plot-to-plot differences have some influence on mortality, yet it is negligible compared to the influence the treatment has on mortality.**

2. Is foliar application or trunk injection more efficient for each treatment? (2017)



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FOL – foliar application

We can conclude that determining whether a foliar application or a trunk injection is better **depends on the treatment applied in 2017.**

For the **SULFOXAFLOR treatment, this has no statistical effect at all,** while **it is best to apply the CONFIDOR treatment foliarly.**

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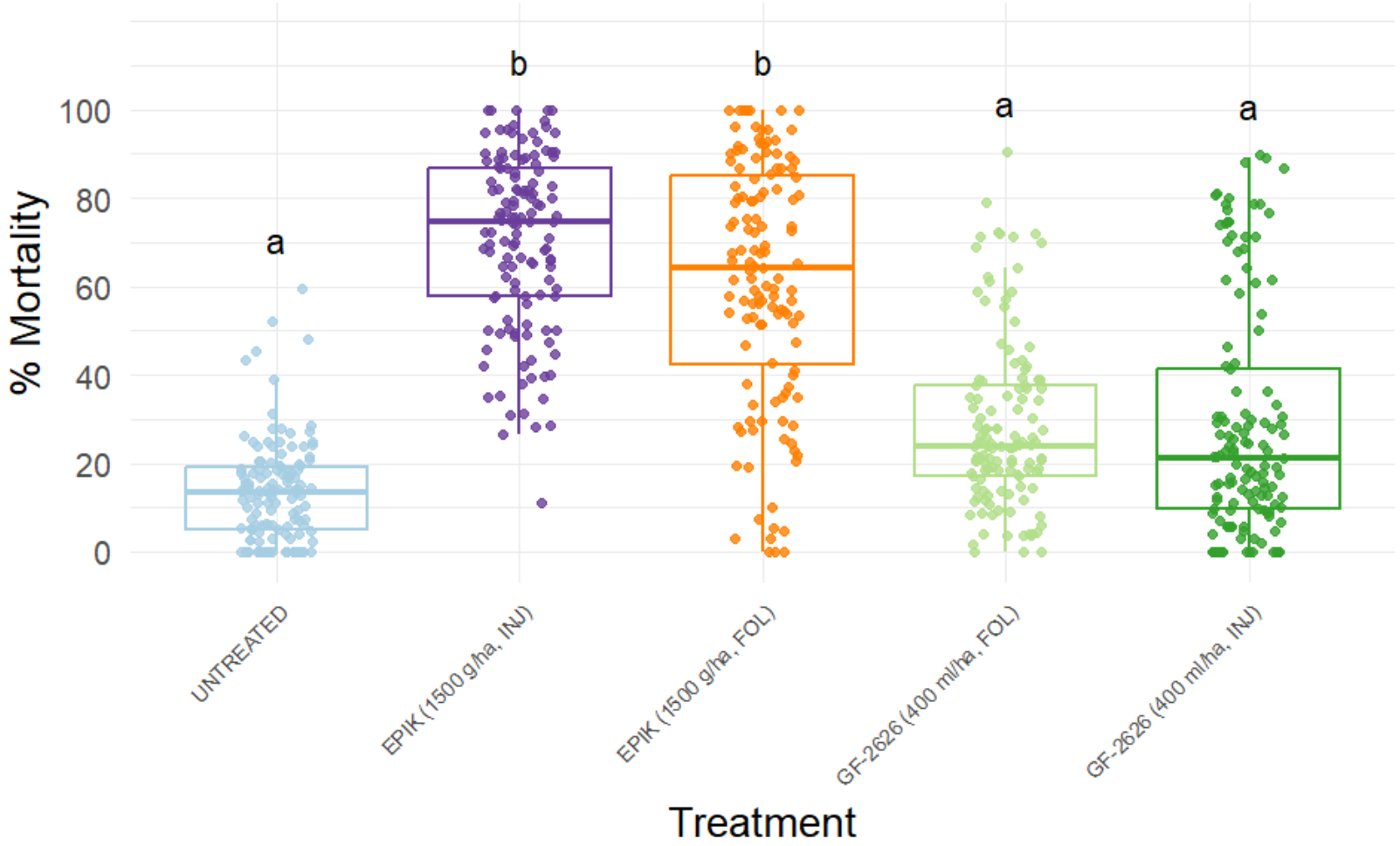

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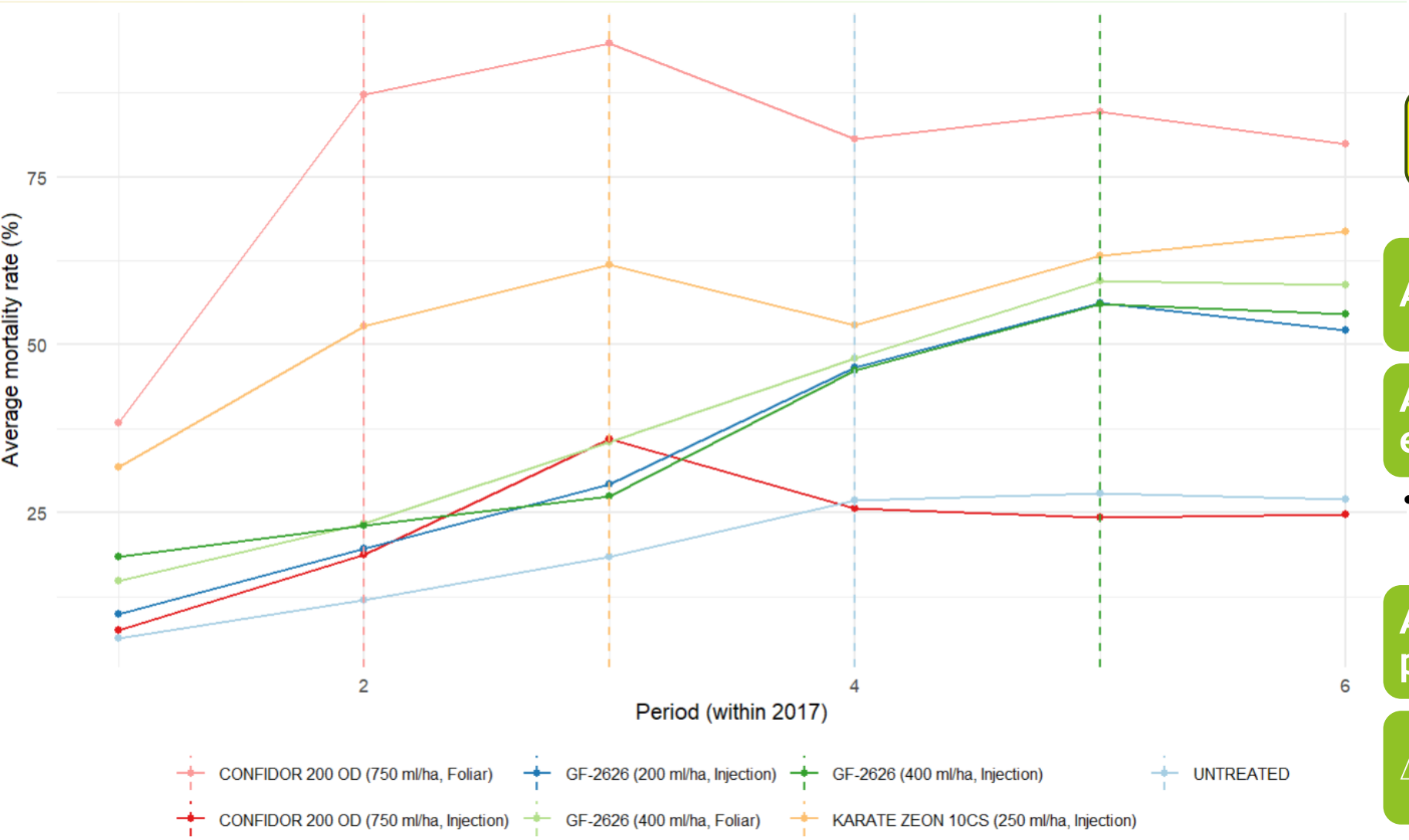
We conclude that **it is irrelevant (at least statistically) if we make a foliar application or a trunk injection for treatments applied in 2018 regarding mortality.**

Overall, we have found that, **unless CONFIDOR 200 OD is applied, the method of application has no effect on mortality.** However, there appears to be a general, non-statistical trend suggesting **that foliar application tends to be the most effective.**

3. How persistent is each treatment and which of them is more persistent on time?

The **graph** shows **average mortality rate by period within 2017.**



CONSIDERED VARIABLES

AUC (Area under the curve)

Average mortality at the elbow point (m_elbow)

- **Elbow point**: The point on the curve where the rate of change shifts, creating the most pronounced bend.

Average mortality at the final point (m_final)

$$\Delta\_elbow = m\_elbow - m\_final$$

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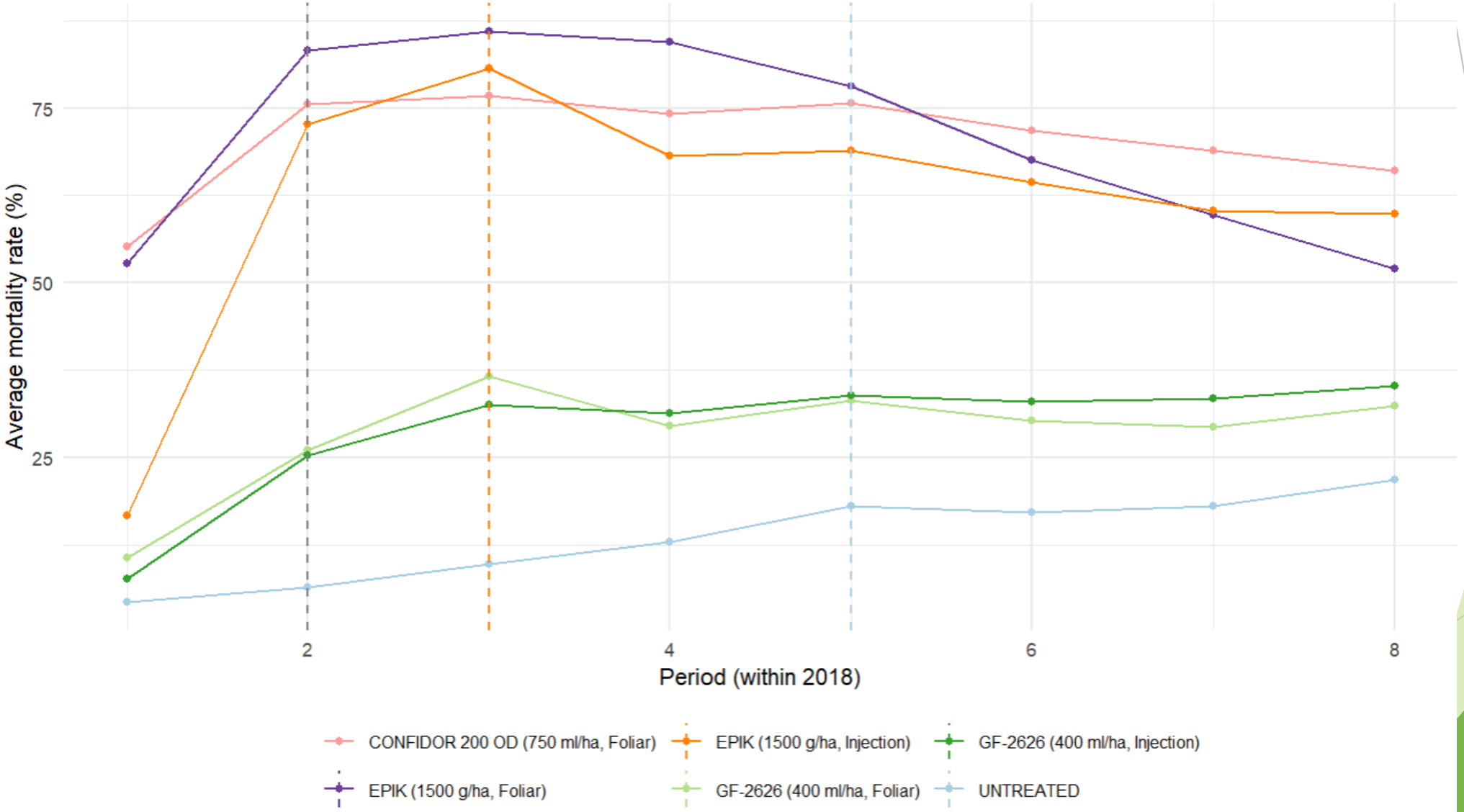

The **graph** shows **average mortality rate by period within 2018.**

3. How persistent is each treatment and which of them is more persistent on time?

Means ± sd and statistical grouping (as superscript) by treatment and variable (FDR-corrected).

Treatment	AUC	Final mortality	Elbow mortality	Post-elbow delta
UNTREATED	72.8 ± 37.8^{a}	20.5 ± 9.3^{a}	17.0 ± 12.0^{a}	3.5 ± 7.4^{a}
CONFIDOR_750_INJCTREE	120.8 ± 59.0^{ab}	24.7 ± 11.9^{a}	34.1 ± 19.0^{ab}	-9.3 ± 17.0^{ab}
SULFOXAFLOR_400_INJCTREE	158.8 ± 125.5^{b}	40.2 ± 26.8^{b}	34.0 ± 29.5^{b}	6.2 ± 23.2^{abc}
SULFOXAFLOR_400_FOLIAR	165.1 ± 76.6^{b}	39.9 ± 19.4^{b}	39.3 ± 23.1^{b}	0.5 ± 23.2^{abc}
SULFOXAFLOR_200_FOLIAR	182.6 ± 70.1^{b}	52.1 ± 23.6^{bc}	45.3 ± 21.6^{bc}	6.8 ± 30.9^{bc}
KARATE_250_FOLIAR	280.0 ± 78.5^{c}	66.8 ± 21.6^{cd}	64.2 ± 17.7^{cd}	2.6 ± 23.5^{abc}
EPIK_1500_INJCTREE	330.8 ± 93.2^{c}	64.3 ± 21.5^{cd}	79.3 ± 18.2^{de}	-15.0 ± 16.6^{c}
CONFIDOR_750_FOLIAR	379.2 ± 108.2^{c}	74.5 ± 17.3^{d}	83.0 ± 25.0^{de}	-8.5 ± 16.8^{c}
EPIK_1500_FOLIAR	391.7 ± 44.2^{c}	67.6 ± 13.7^{d}	87.7 ± 10.8^{e}	-20.2 ± 17.8^{bc}

Table showing **statistical grouping of treatments** using 4 LMM models and mean and standard deviation for each variable.

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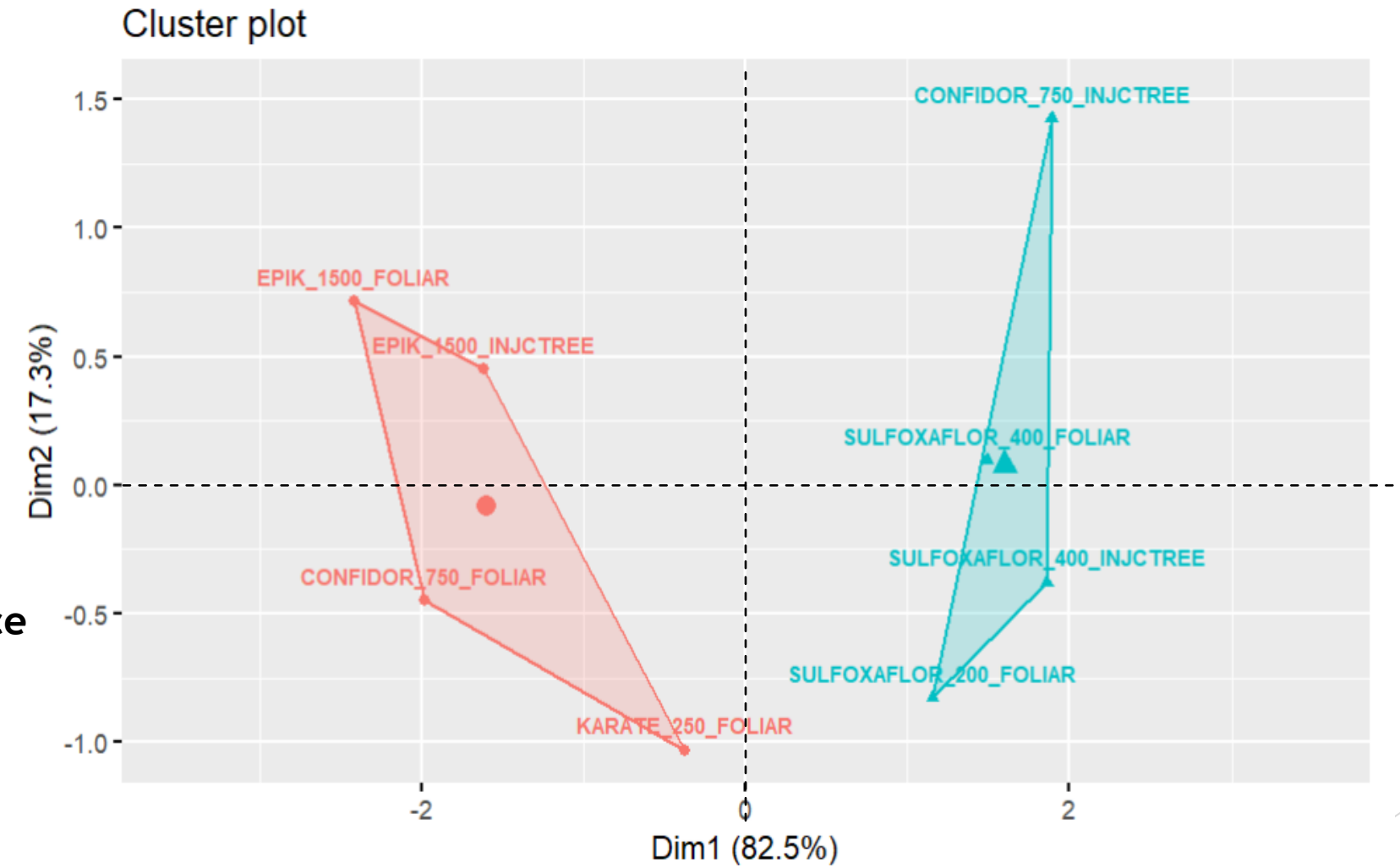
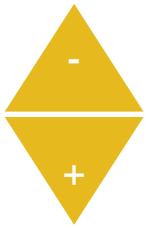
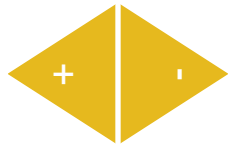




persistence



efficacy

INJCTREE – trunk injection
FOLIAR – foliar application

Summarizing all treatments into **two clusters** (the optimal number), we observe two main groups:

High efficacy, moderate-to-low persistence: red cluster
Low efficacy, moderate-to-high persistence: blue cluster

DIM1 primarily represents efficacy and shows a moderate positive correlation with persistence. **DIM2** mainly reflects persistence, distinguishing treatments within each cluster.

Final conclusions

- We see two main groups of treatments:
  - a group associated with **a higher effect on mortality** and relatively low persistence (KARATE ZEON 200 is a bit more persistent on average, though)
  - a group associated with a **lower effect on mortality** and slightly better persistence (yet variable)
- **Efficacy (or effectiveness) separates these groups more clearly than persistence does,** as persistence shows much greater variability across treatments**.** However, there is a trend: **treatments with slightly higher average persistence (e.g., Δ_elbow) tend to have lower average efficacy.**
- **CONFIDOR 200 OD and KARATE ZEON 10 CS, both applied foliarly, appear to be the most effective overall,** achieving higher scores in both efficacy and persistence**. EPIK treatments also perform well,** but are associated with lower average persistence (i.e., a more rapid decline in mortality over time**).**
- On the other hand, **CONFIDOR 200 OD applied via trunk injection** seems to be the least effective treatment of all.

SUMMARY OF CLUSTERS

EFFICACY VS. PERSISTENCE

BEST-PERFORMING TREATMENTS

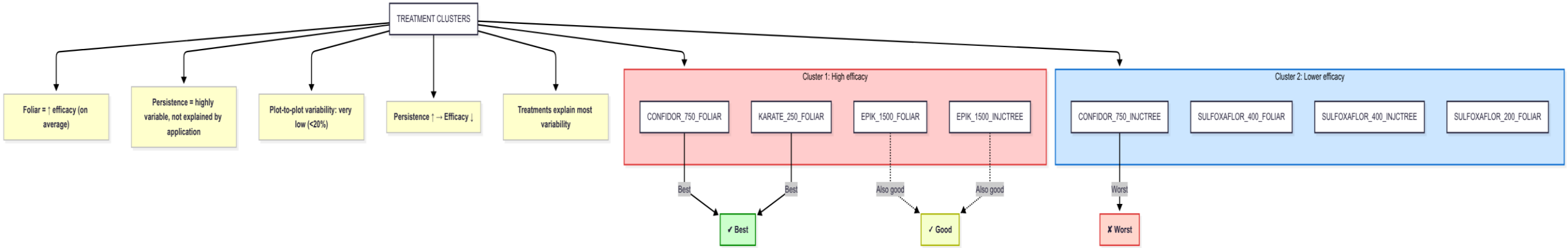
WORST-PERFORMING TREATMENTS

Final conclusions

- **The mode of application** generally has a **minor (statistically non-significant) effect on mortality rate,** except for CONFIDOR 200 OD. Nevertheless, **foliar applications** tend to be **slightly more effective on average** and show **less variability** in mortality rates (i.e., lower standard deviation).
- And finally, **variability between plots is generally very low to low, slightly higher in 2018 than in 2017**, but it just accounts for less than 1/5 of the total variability explained by our models and very low compared to the overall variability. Treatments explain a much higher proportion of it.

MODE OF APPLICATION

VARIABILITY BETWEEN PLOTS



APPENDIX: TABLE AND CODES OF TREATMENTS IN 2017

Trt Num	Appl Code	Treatment Name	Material Name	Form Conc	Conc Unit	Form Type	Rate	Rate Unit	Appl Method
1	B	SULFOXAFLOR	GF-2626	120	g ai/l	SC	200	ml pr/ha	FOLIAR
2	B	SULFOXAFLOR	GF-2626	120	g ai/l	SC	400	ml pr/ha	FOLIAR
3	A	SULFOXAFLOR	GF-2626	120	g ai/l	SC	400	ml pr/ha	INJCTREE
4	B	CONFIDOR 200 OD	CONFIDOR 200 OD	200	g ai/l	OD	750	ml pr/ha	FOLIAR
5	A	CONFIDOR 200 OD	CONFIDOR 200 OD	200	g ai/l	OD	750	ml pr/ha	INJCTREE
6	B	LAMBDA-CYHALOTHRIN	KARATE ZEON 10CS	100	g ai/l	CS	250	ml pr/ha	FOLIAR
7	B	UNTREATED	UNTREATED						

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1	A	CONFIDOR 200 OD	CONFIDOR 200 OD	200	g ai/l	OD	750	ml pr/ha	FOLIAR
2	A	SULFOXAFLOR	GF-2626	120	g ai/l	SC	400	ml pr/ha	FOLIAR
3	A	EPIK	EPIK	50	g ai/kg	WP	1500	g pr/ha	FOLIAR
4	B	SULFOXAFLOR	GF-2626	120	g ai/l	SC	400	ml pr/ha	INJCTREE
5	B	EPIK	EPIK	50	g ai/kg	WP	1500	g pr/ha	INJCTREE
6	B	UNTREATED	UNTREATED						