

Characterization of the apple-tree resistance to the rosy apple aphid using a behavioral and physiological approach

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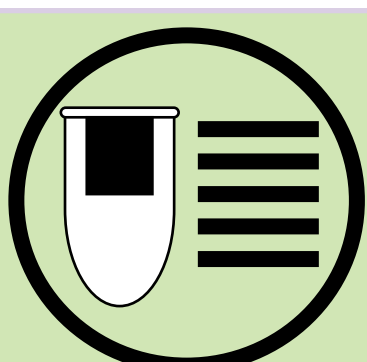
Introduction

Increasing resistance to insect pests through varietal selection represents a sustainable alternative to insecticides in crop protection. Various intrinsic plant resistance mechanisms, either physical or chemical, can impact the insect behavior (host plant preference) and/or its physiology (eg. growth, fecundity). For instance secondary metabolites can impact the conversion of ingested fluids into biomass or the insect metabolism itself. Apple trees which represent one of the most treated crops in the world (Drogué & DeMaria 2012) offer the opportunity to investigate varietal resistance. Although the rosy apple aphid *Dysaphis plantaginea* is the main pest of apple trees, very few studies have characterized apple tree resistance to this aphid through both a physiological and behavioral approach.



Biological model and Hypothesis

- ❖ We investigated the effect of three apple tree (*Malus domestica*) cultivars presenting contrasted resistance to the rosy apple aphid (*Dysaphis plantaginea*) on the physiology (antibiosis) and behavior (antixenosis) of this major aphid pest.
- ❖ The 3 tested cultivars were : **Gala** (susceptible), **Ariane** and **Green Sleeves** (resistant)
- ❖ We expected that apple tree cultivars exhibiting different levels of resistance would differently impact the rosy aphid physiology and behavior.



Methods

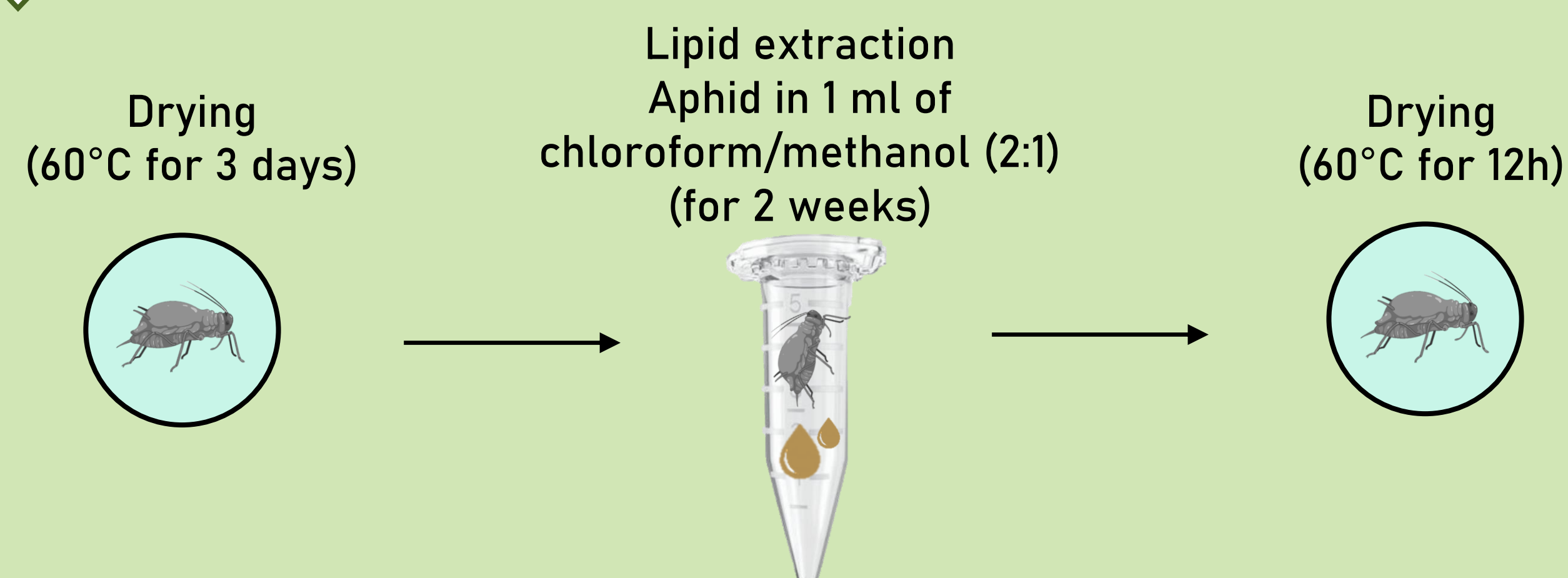
1 Measurement of aphid fresh mass (μg)



- Mass measurements were realized on :
 - Nymphs (4 days old)
 - Adults (10 days old)

i Measurements were recorded on 60 aphids per cultivar and per developmental stage

2 Measurement of lipid rate in aphids



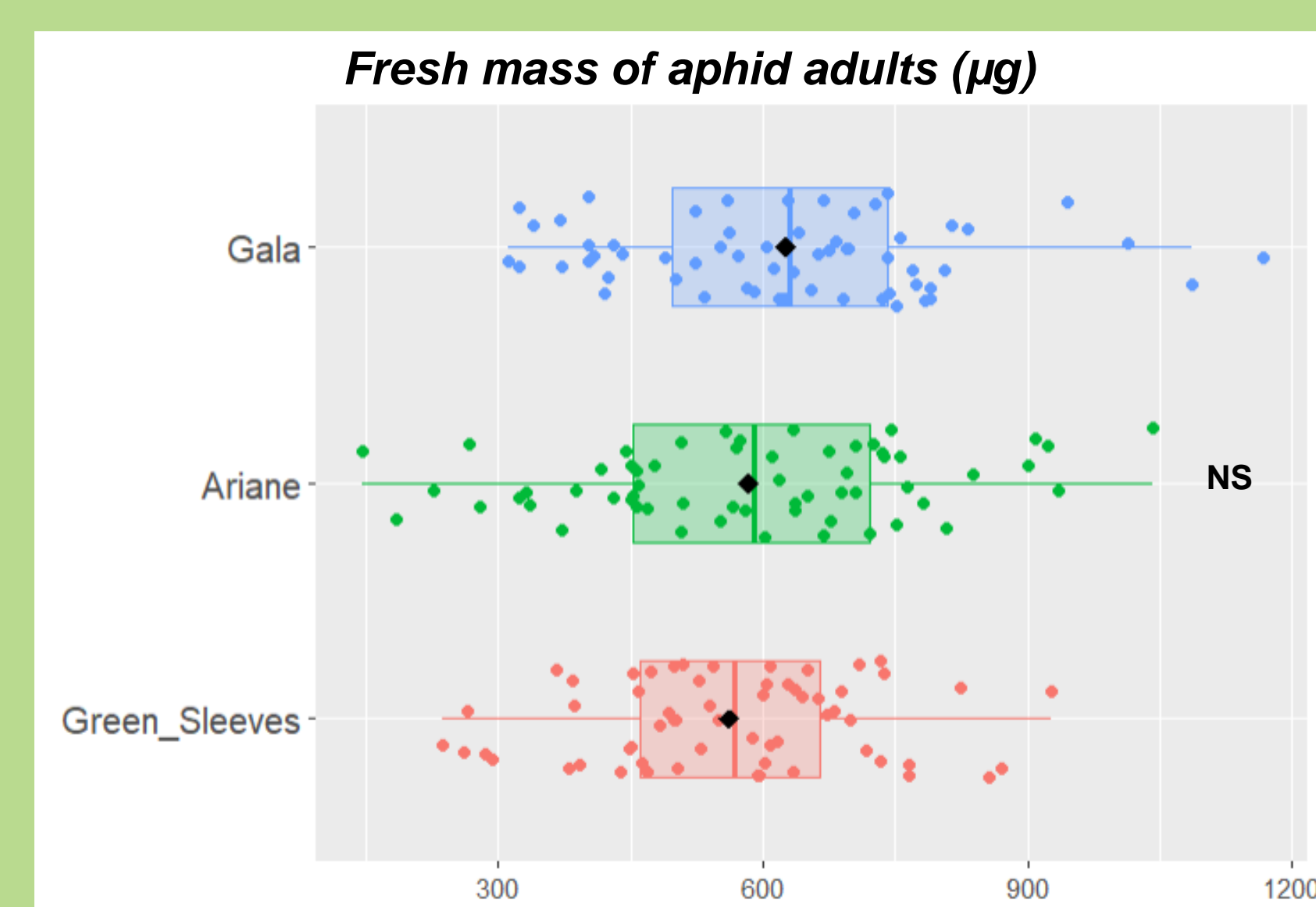
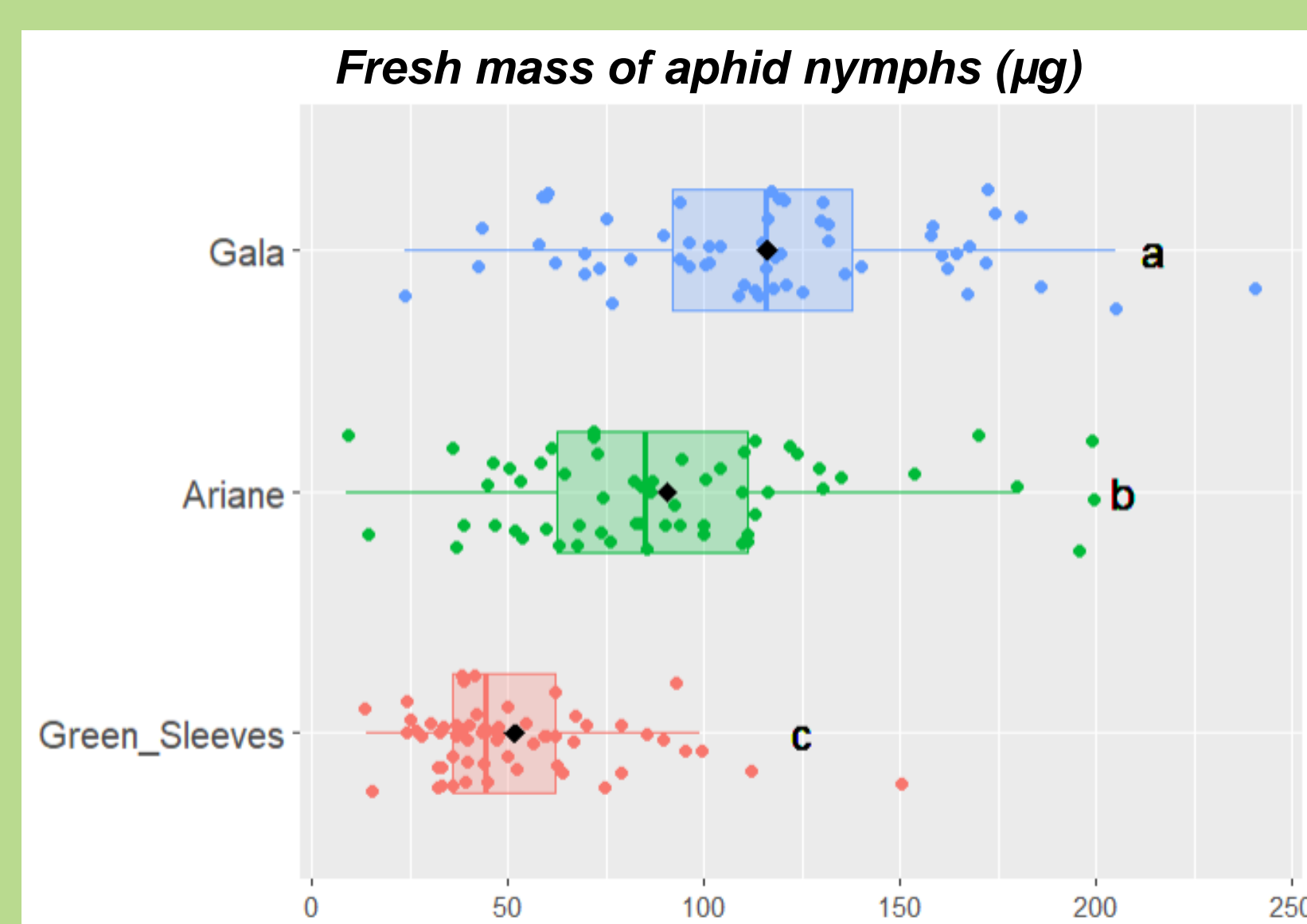
- Lipid content (μg) = dry mass before – dry mass after lipid extraction
- Lipid rate (in %) = 100 X (lipid content (μg)/aphid fresh mass (μg))

i Nymphs : Gala n = 49, Ariane n = 50, Green Sleeves n = 41
Adults : Gala n = 59, Ariane n = 56, Green Sleeves n = 59

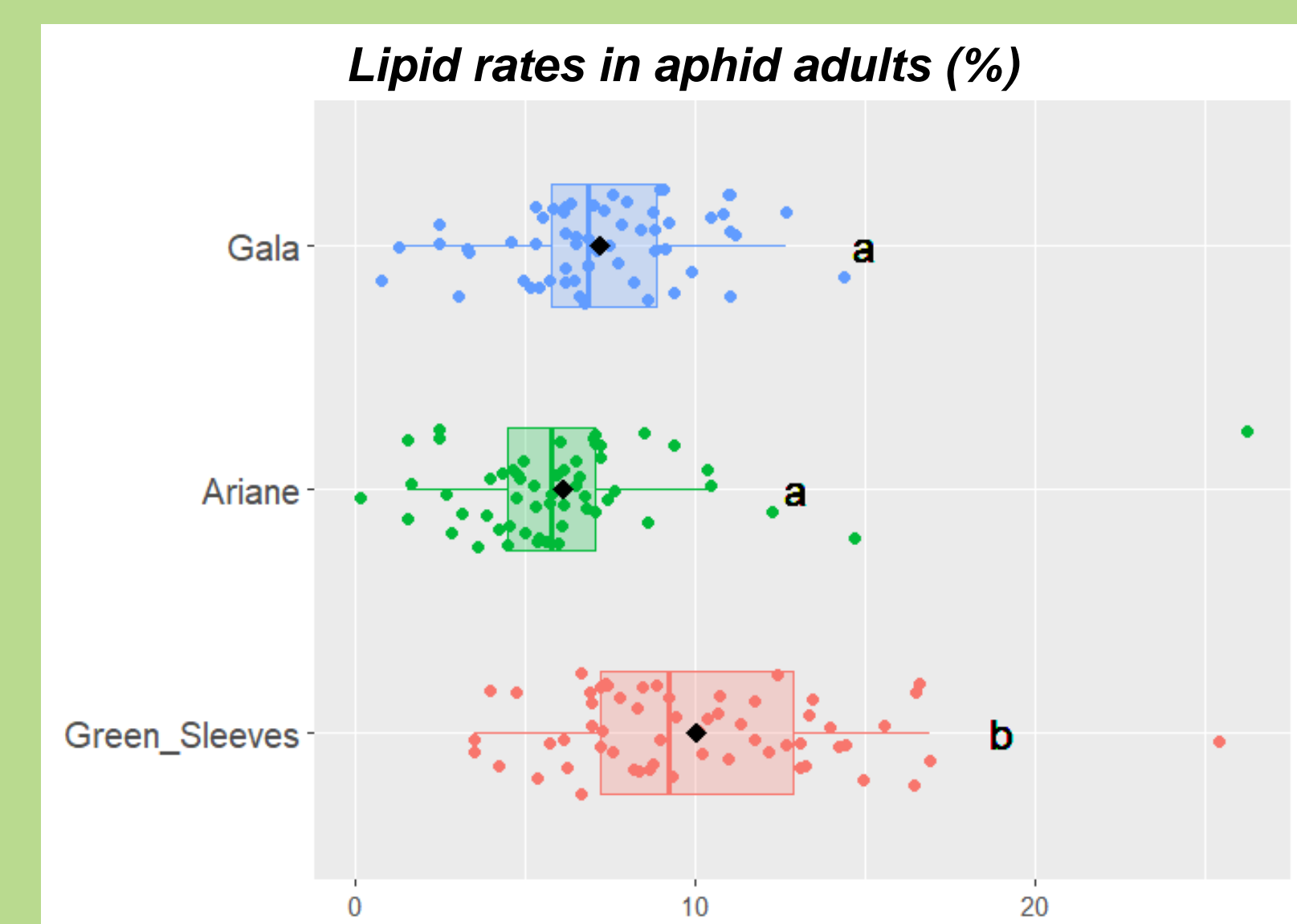
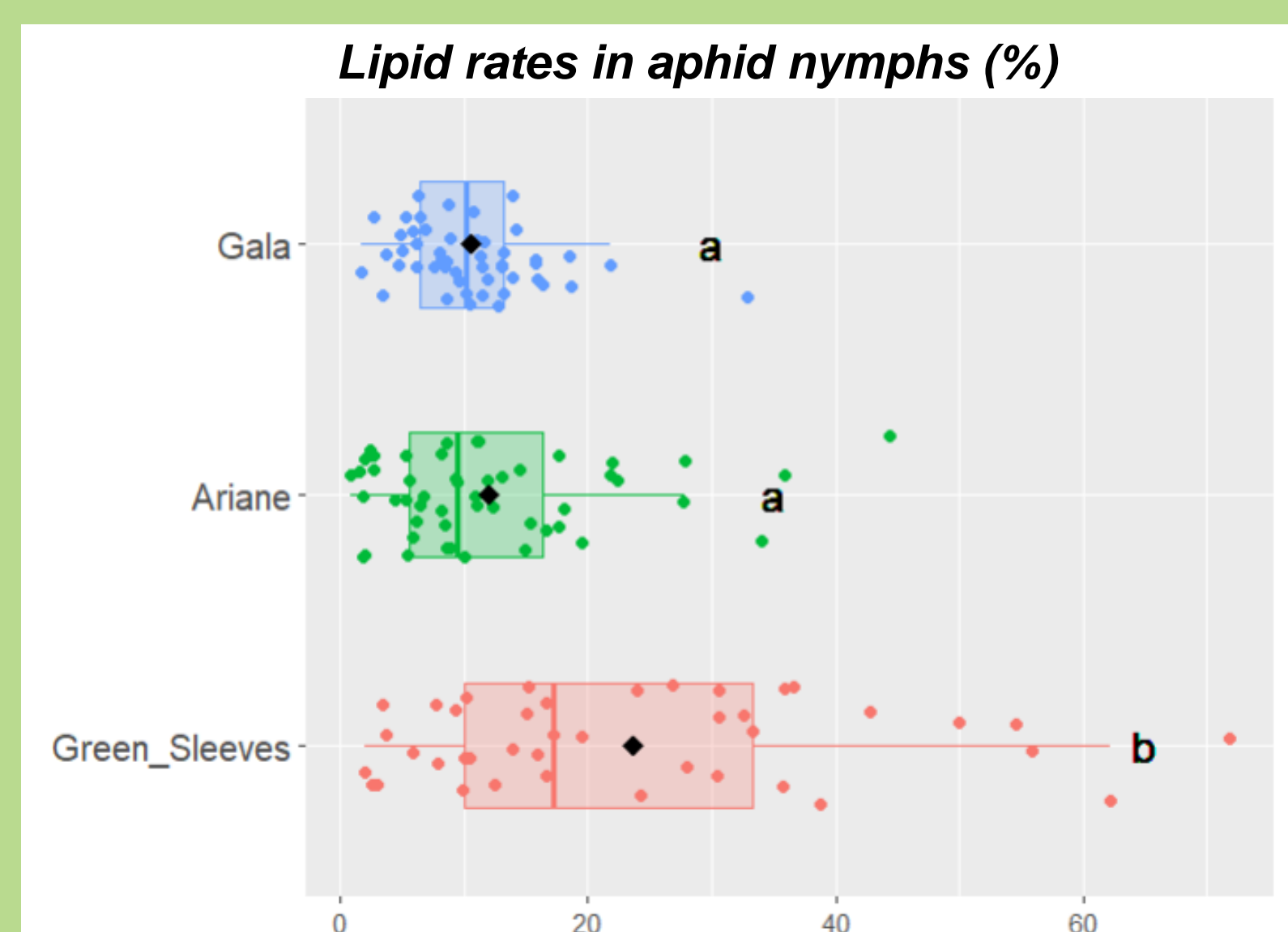


Results

1 Nymphs on resistant cultivars exhibited a smaller mass but this effect was not observed on adults

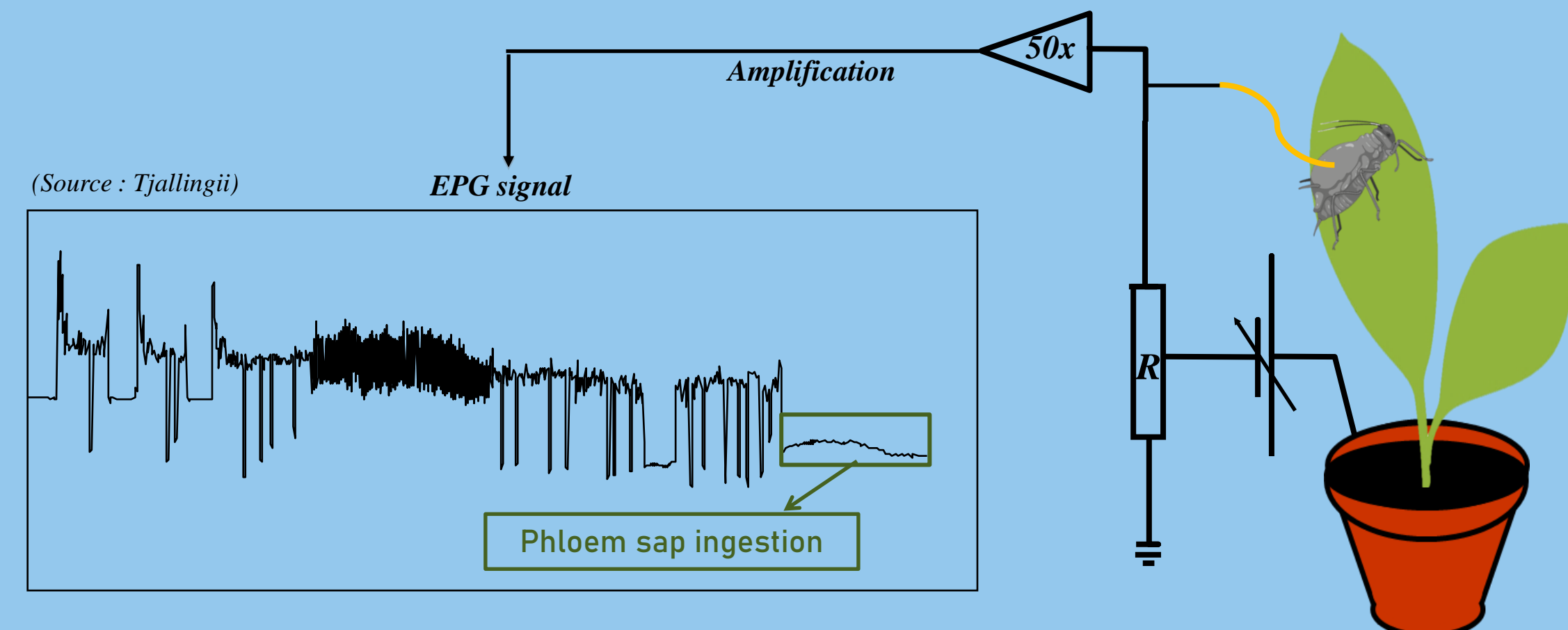


2 Aphids exhibited greater lipid rates only on Green Sleeves



Both adults and nymphs reared on Green Sleeves had a greater lipid rate

3 Aphid feeding behavior (electropenetrography)



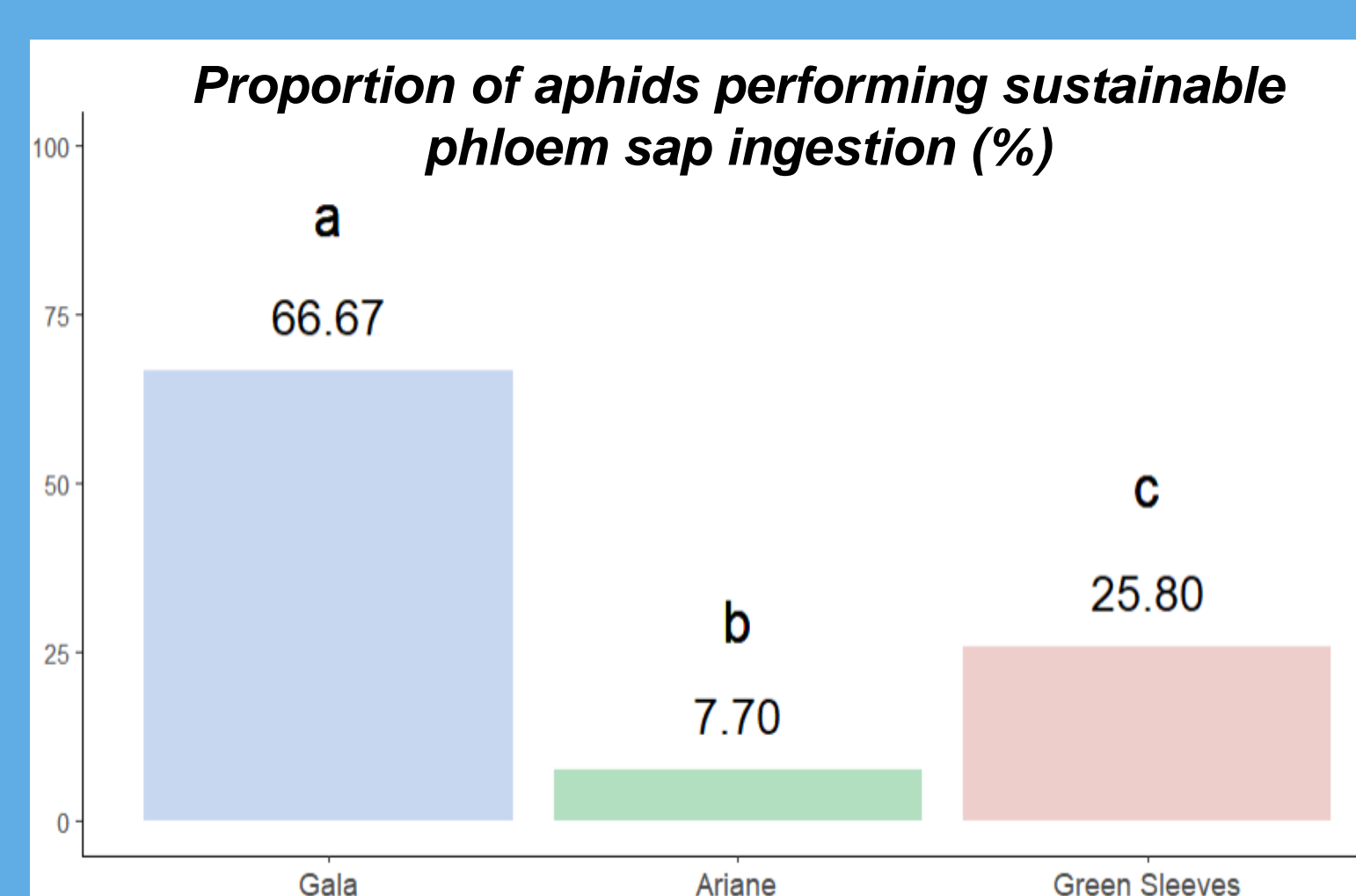
The feeding activity of aphid was recorded for 8 hours

i Parameters selected (in relation to plant acceptance) :

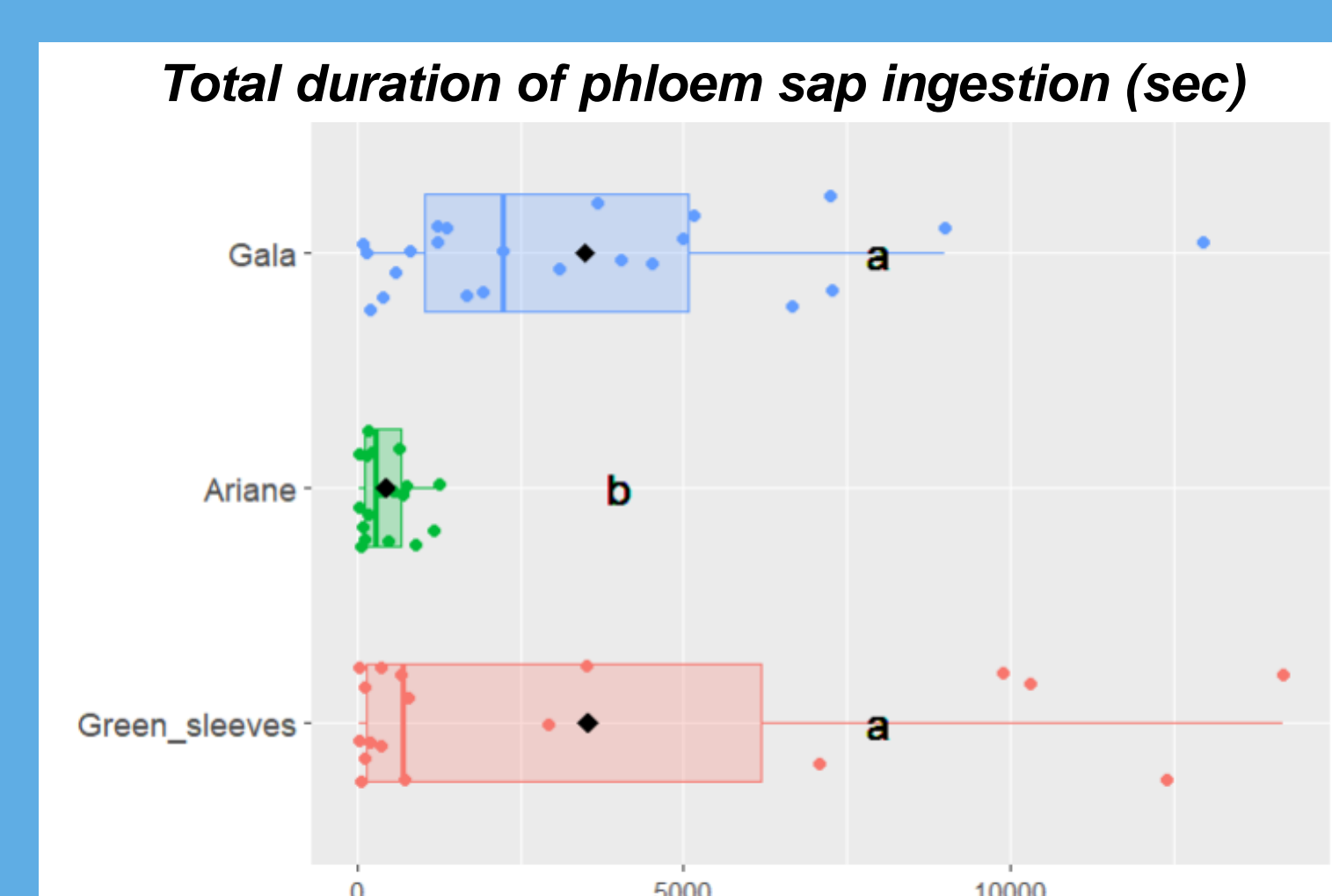
- Total duration of phloem sap ingestion
- Proportion of aphids performing sustained phloem sap ingestion (> 10 min)

Gala n = 27, Ariane n = 26, Green Sleeves n = 31

3 Aphid plant acceptance was impacted on the resistant cultivars



Fewer aphids performed sustained phloem sap ingestion on both resistant cultivars



The duration of phloem sap ingestion was shorter only on the Ariane cultivar

Discussion – Perspectives

Our results confirmed the resistance of both Ariane and Green Sleeves cultivars. The resistance revealed in Green Sleeves was based on antibiosis because aphids had a smaller mass and little or no change in behavior was observed. The greater lipid rate in aphids reared on Green Sleeves was not consistent with results obtained in other studies, in which the lipid content of insects reared on resistant plants was smaller than that of aphids on susceptible plants (Tabadkani et al. 2013). One possible explanation could be that the Green Sleeves resistance induced a decrease in xylem sap ingestion (i.e. rehydration), which would have mechanically increased the lipid rate. In Ariane, the resistance was due to antixenosis. In another resistant cultivar (Florina), reduced phloem sap ingestion was attributed to the presence of a resistance factor in the phloem sieve elements (Marchetti et al. 2009).

These results raise the question of the impact that such physiological differences could have on aphid parasitoids in a biological control context. The next step will be to investigate the differential effects of these resistant cultivars on parasitoids of the rosy apple aphid. Parasitoid size is usually positively correlated with its host size but it also depends on the lipid content of its host. We can therefore hypothesize that parasitoid size may be negatively impacted on Ariane, whereas it may not be affected in Green Sleeves as the lower mass of aphids may be compensated by their higher lipid content.

References

- Drogué, S. & DeMaria, F. 2012. Food Policy, 37, 641–649.
- Tabadkani & al. 2013. Physiol. Behav., 110–111, 221–225.
- Marchetti & al. 2009. *Bulletin of Insectology*, 62, 6.