DO *SCAPHOIDEUS TITANUS* LARVAE AGGREGATE FOR FEEDING?

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Summary

The leafhopper *Scaphoideus titanus* is the harmful vector of the phytoplasma causing the Flavescence dorée, one of the current major threats in European viticulture. The ecology of this insect is however poorly known even if better understanding of this species' life history traits and behavior will improve our ability to foresee the epidemiology of the disease. We investigated the aggregative behavior of the larvae. We conclude from different experiments that larval aggregation occurs at the plant scale, but we could not clarify the factors cueing such an aggregation. Also aggregative oviposition patterns may occur and reinforce such aggregation under young leaves. These aggregation patterns should be studied in more details in order to gain knowledge in the epidemiology of Flavescence dorée and eventually to develop control strategies based on inter-individual epideictic regulation.

INTRODUCTION

Aggregative patterns are rather common in various insect families. For example, aggregative behavior of juvenile stages may participate in collective defensive behaviors like in several species of *Corythuca* (Aldrich, 1988). Aggregative patterns of juvenile stages may also influence the dispersive behavior and in the case of insect vectors it influences the spatial dispersion of the diseases. In *Scaphoideus titanus* (Homoptera: Cicadellidae), the vector of Flavescence dorée on grapes, aggregative patterns have been observed at vineyard scales for larvae (Lessio *et al.*, 2006) as well as for imagoes (Bosco *et al.*, 1997). These apparent aggregative patterns have however never been clearly attributed to plant quality differences nor to specific aggregative behaviors at different scales (intra stock or intra plot). In field study, it is difficult to distinguish between larval aggregation due to their behavior and aggregation linked to adults ones, especially caused by the females egg-laying. To study the aggregation of the neonate larvae, we made aggregation tests to determine if the aggregation observed in the vineyard could be due to their feeding site choice and what plant stimulus could determine their choice. The present work investigates intra stock aggregative patterns in newly hatched and developing larvae.

MATERIAL AND METHODS

To test whether the L1 tend to aggregate, four identical grapevine cuttings were placed in each corner of an Altuglass® cage (60 x 60 x 60 cm). 140 – 350 larvae were placed in the centre of the cage at equal distance of each plant. After 9 hours, the number of larvae on each plant was numbered. Six repetitions were made.

To study the aggregation behavior of neonate larvae on plant scale, two 8/9 leaves grapevine cuttings were placed in each hatching cage and were the only food source. Four categories of leaves were distinguished from their position on the plant and their size: 1) small leaves on the top which were young leaves with leaf area < 11 cm², 2) small leaves on the bottom which were old leaves with leaf area < 23 cm², 3) large leaves in intermediate position with leaf are > 60 cm² and 4) buds shoots on woods with bud burst. The number of L1 on each leaves were checked daily and the leaf area index of each leaf were measured with a LAI meter.

To check the influence of the color on food choice, we placed on the lid internal side of hatching cages without any food resource, 4 colored traps 8 x 23.6 cm representing grapevine organs (brown: bark, green: chlorophyllian organs, red and yellow: mature berries an/or symptoms of Flavescence dorée on leaves) sprayed with insect glue. Larvae glued on the traps were daily counted. After each monitoring, traps were randomly rotated to avoid any position effect. Traps were changed as soon as they were not sufficiently sticking anymore.

Results were analyzed with Friedman Anova using R software and the "agricolae" package.

RESULTS AND DISCUSSION

Aggregation test: As it was observed in vineyards, the larvae were aggregated. Indeed, on average, almost the half of the larvae was chosen the same plant to feed (Table 1).

Table 1. Preferences of ***S. titanus*** neonate larvae between identical grapevine cuttings. Rows with different letters are significatively different under the Friedman Anova and LSD post hoc tests at 1 % treshold.

	Percentage of larvae			
	Mean	*Standard deviation*	*Interval*	
1st favorite plant	50.51	7.5	39.02-60.38	a
2nd favorite plant	27.15	4.6	21.49-33.02	b
3rd favorite plant	19.37	6.4	10.22-29.27	c
4th favorite plant	8.49	2.5	1.63-12.69	d

Intra-plant distribution of larvae. Densities of larvae were not uniform (Fig. 1). Higher densities were observed on the youngest organs: the buds shoots and the apical leaves.

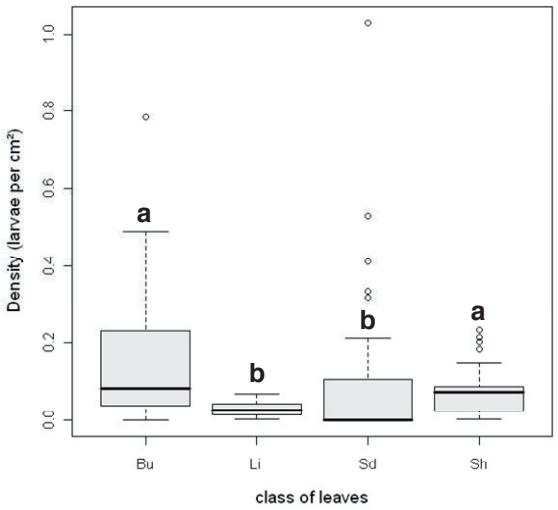

Figure 1. Larval density on different leaves class**.** Bu: bud shoots; Li: large and intermediate leaves; Sd: small and down leaves; Sh:small and high leaves. Boxplots with different letters are significatively different under the Friedman Anova and LSD post hoc tests at 1 % treshold.

Color attraction. The major part of the larvae was caught on yellow traps (Fig. 2). These results are in contradiction with Lessio & Alma (2004) who caught more imagoes with red traps. On the other hand, these results could be related with the L1 preferences for the youngest organs. Indeed, young leaves are yellowish and have higher nitrogen content (Mooney & Gulmon, 1982) which in turn increases the fitness of other leafhoppers (Rossi & Strong, 1991) and yellow wavelengths are known to be attractive for sap-sucking insects (Saxena *et al.*, 1974; Prokopy & Owens, 1983; Todd *et al.* 1990).

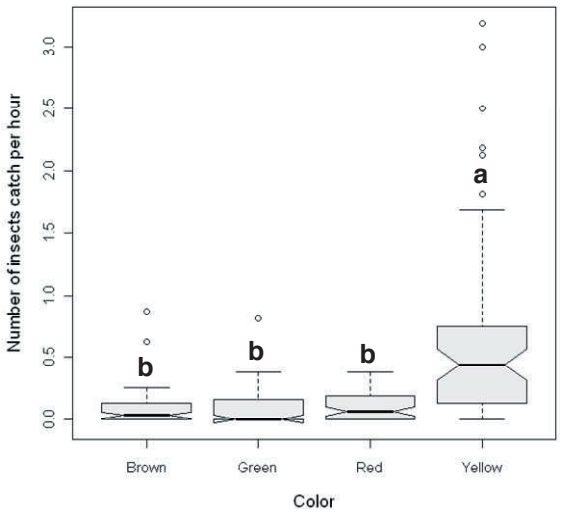

Figure 2. Color choice by neonate larvae. Boxplots with different letters are significatively different under the Friedman Anova and LSD post hoc tests at 1 % treshold.

Larval aggregation could lead to a better efficiency for the phytoplasma acquisition. With aggregation, an infectious individual could transmit, via the leaf where it feeds, the phytoplasma to other individuals without the need for the infectious agent to drop in the roots, multiply and rise in the aerial organs on the following year (Boudon-Padieu, 2000).

Our results for *S. titanus* do not allow us to establish what stimuli cause gathering of the larvae. This work is a first step toward understanding the aggregation behavior of the Flavescence dorée vector and how it influences the epidemiology of the disease.

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