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Dynamics of *Aleurocanthus woglumi* Ashby (Hemiptera: Aleyrodidae) in Tahiti acid lime (*Citrus latifolia*) orchards under different fertilizer applications

Alirya Magda Santos do Vale Gomes[1], Raimunda Nonata Santos de Lemos*[2], Gislane da Silva Lopes[2], Cristina Silva Carvalho[1], Fabrício de Oliveira Reis[2], José Ribamar Gusmão Araujo[2], Janaina Marques Mondego[1], Ester Azevedo do Amaral[2], Adriano Soares Rêgo[1]

[1]Graduate Program in Agroecology, State University of Maranhão. São Luís, Maranhão, Brazil
[2]State University of Maranhão. São Luís, Maranhão, Brazil

***Corresponding author: rlemos@cca.uema.br**

Abstract

Citrus black fly *Aleurocanthus woglumi* Asbhy is an important citrus pest because it causes significant losses in production. The objective of this study was to evaluate the incidence and distribution of *A. woglumi* egg laying, eggs and nymphs on *Citrus latifolia* (Tahiti acid lime) plants grown under different fertilizer applications. The experiment was carried out in a citrus orchard in the municipality of Paço do Lumiar, MA, Brazil. A randomized block design in a 3×5×3 factorial arrangement (three evaluation times, five treatments, and three plant strata) was used with 4 replications. The experimental unit consisted of three plants and treatments with different fertilizations were applied to the soil: T1: control (no fertilizer application); T2: organic fertilizer (bovine manure); T3: organic fertilizer + potassium silicate (K_2O_3Si); T4: NPK; T5: NPK + K_2O_3Si. The number of egg laying, eggs and nymphs of *A. woglumi* was evaluated in the basal, mid and apical strata of *C. latifolia* plants at 30, 60 and 90 days after fertilizer application. Reductions in the number of eggs and nymphs were observed in treatments with organic fertilization + K_2O_3Si and NPK + K_2O_3Si. *Citrus latifolia* plants treated with K_2O_3Si were less susceptible to *A. woglumi* and plants fertilized with NPK present higher susceptibility ($p<0.05$). There was a higher incidence of egg laying, eggs and 1st instar nymphs in the apical stratum and 2nd, 3rd and 4th instar nymphs in the basal and mid strata in *C. latifolia* ($p<0.05$). The addition of K_2O_3Si to organic and mineral fertilization is recommended as a viable alternative to reduce the population level of *A. woglumi* in citrus plants.

Keywords: Citrus black fly; Citrus plants; NPK; Organic fertilizer; Potassium silicate.
Abbreviations: *A. woglumi*_*Aleurocanthus woglumi*; *C. latifolia*_ *Citrus latifolia*; K_2O_3Si_ Potassium silicate; MA_ Maranhão; NPK_ Nitrogen, Phosphor e Potassium; p_value of probability.

Introduction

Citriculture is one of the most important agricultural activities in the world. The citrus production in Brazil is highlighted in the international market. It is the greatest citrus producing country worldwide, responding for approximately 34% of world's total production, followed by China and the European Union (Usda, 2022). Brazil is the fifth largest producer of Tahiti acid lime (*Citrus latifolia* Tanaka) in the world, with growth of 53% in a decade (Hortifruti Brasil, 2020). This acid lime is among the most produced citrus species and one of the most economically important citrus fruit in Brazil due to the good acceptance by the national and international markets (Oliva et al., 2017).

Aleurocanthus woglumi Ashby 1915 (Hemiptera: Aleyrodidae), commonly known as citrus black fly, has become a phytosanitary problem of great importance in the production chain of *Citrus* spp. in Brazil (Vilela and Zucchi, 2015). Citrus plants are the preferred and suitable hosts for populations of *A. woglumi* (Eppo, 2020), which cause direct and indirect damage, impairing their development and fruit quality for commercialization (Carvalho and Fancelli, 2021).

Aleurocanthus woglumi present a versatile adaptation to different climatic conditions and hosts (Mendonça et al., 2015). Adult immature insects can be found in the abaxial surface of leaves (Castilhos et al., 2019) where they develop and damage citrus plants by sucking leaf nutrients, which weakens the plants. Furthermore, they excrete sugar substances (honeydew) that favor the emergence of sooty mold, covering leaves and fruits (Carvalho and Fancelli, 2021) and severely harming the leaf respiration and photosynthesis (Nguyen et al., 2019).

As a control measure for *A. woglumi*, pesticides and soluble mineral fertilizers have been applied excessively to cultivated plants, causing interference in proteosynthesis (Huber et al., 2012). These products cause deregulation in the production of free amino acids and concentration of soluble sugars, which leads to changes in plant development and increases the incidence of insect pests (Zanuncio Junior et al., 2018). Therefore, citrus producers should prioritize the use of control strategies established by ecological pest managements, combined with monitoring practices of *A.*

woglumi population (Mendonça et al., 2015) to avoid the use of pesticides and their impacts to the environment.

In this context, positive effects of using organic or mineral soil fertilizer applications to control different pests has been highlighted, since a balanced soil fertilizer application provides nutrients to plants making them more tolerant to pest attacks (Bianchini et al., 2015). Considering the challenge of managing insect-pests that are well adapted to citrus crops and the lack of efficient control techniques that are not aggressive to the environment, the supplying of nutrients through soil fertilizer application is an easy measure for producers, which increases the plant defense against injuries caused by insects.

Since organic and mineral fertilizers provide essential elements to cultivated plants, the basic knowledge of plant nutritional management is important. A balance nutrition usually provides physiological and metabolic balance, in addition to improving their conditioning in the face of abiotic stresses (Abdul Rahman et al., 2021). Thus, this work aimed to evaluate the incidence and distribution of *A. woglumi* eggs and nymphs in *Citrus latifolia* plants grown under different fertilizer applications.

Results

Evaluation of the number of egg laying, eggs and nymphs of Aleurocanthus woglumi

The analysis of variance of the studied parameters showed no interaction (p<0.05) between the treatments and collection times for the variables number of egg laying events, abundance of 1st instar and 2nd instar nymphs (Fig. 1). The effect of the treatments were evaluated only for these developmental stages.

The treatments organic fertilizer + K_2O_3Si and NPK + K_2O_3Si negatively affected the number of egg laying events (Fig. 1A) and abundance of 1st instar (Fig. 1B) and 2nd instar (Fig. 1C) nymphs of *A. woglumi* on *C. latifolia* plants, resulting in the lowest means when compared to the other treatments.

The plants with the highest incidences of *A. woglumi* were those treated with NPK, which presented mean number of egg laying events of 22.28 (Fig. 1A), number of 1st instar nymphs of 64.22 (Fig. 1B) and number of 2nd instar nymphs of 39.86 (Fig. 1C).

The analysis of variance showed significant interaction between treatments and evaluation times for number of eggs and abundance of 3rd and 4th instar nymphs (p<0.05) (Fig. 2).

The lowest number of eggs (Fig. 2A) and abundance of 3rd instar (Fig. 2B) and 4th instar (Fig. 2C) nymphs of *A. woglumi* were found in the treatments organic fertilizer + K_2O_3Si and NPK + K_2O_3Si, which were not different from the control in all evaluations. The highest number of eggs were found on plants in NPK, which presented 295.06, 306.45, and 396.81 eggs at 30, 60, and 90 days after the application, respectively (Fig. 2A). This treatment also had the highest incidences of 3rd instar (Fig. 2B) and 4th instar (Fig. 2C) nymphs during the three evaluation times.

The comparison of the evaluation times showed that NPK had the highest number of eggs (396.81 eggs) (Fig. 2A) and abundance of 3rd instar nymphs (33.06) (Fig. 2B) at 90 days, and abundance of 4th instar nymphs at 60 and 90 days (Fig. 2C), presenting 17.03 and 18.20 nymphs, respectively.

Distribution of Aleurocanthus woglumi in Citrus latifolia strata

The interaction between treatments and basal, median and apical strata of *C. latifolia* plants were significant for number of egg laying events and eggs, and abundance of 2nd instar, 3rd instar, and 4th instar nymphs. This interaction was not significant for abundance of 1st instar nymphs. The effect of plant strata was evaluated only for this developmental stage of the pest (p<0.05) (Fig. 3).

The lowest mean number of eggs of *A. woglumi* (Fig. 3A) was found in the treatments with K_2O_3Si, which were not different from the control in the plant strata studied. Similar results were found for number of egg laying events (Fig. 3B), which varied from 2.61 to 6.06; and for abundance of 2nd instar (Fig. 3D), 3rd instar (Fig. 3E), and 4th instar (Fig. 3F) nymphs of *A. woglumi* in all plant strata.

The highest number of eggs (Fig. 3A), number of egg laying events (Fig. 3B), 2nd instar (Fig. 3D), 3rd instar (Fig. 3E), and 4th instar (Fig. 3F) nymphs were found in the treatment NPK in the plant basal, mid, and apical strata, with significant difference from the other treatments.

Regarding the *C. latifolia* plant strata infested with *A. woglumi*, the plant apical stratum presented the highest numbers of eggs (435.46 eggs) (Fig. 3A) and egg laying events of *A. woglumi* (28.96) (Fig. 3B) in the treatments NPK (T4). Higher abundance of 1st instar nymphs was found for the apical stratum of *C. latifolia*, significantly differing from the plant mid and basal strata (Fig. 3C).

The highest mean abundance of 2nd instar (Fig. 3D), 3rd instar (Fig. 3E), and 4th instar (Fig. 3F) nymphs in the plant basal and mid strata were found in the treatment NPK.

Citrus latifolia fertilized with NPK + K_2O_3Si and organic fertilizer + K_2O_3Si had a lower number of egg laying events, 1st and 2nd instar nymphs (Fig. 1), as well as number of eggs, and an abundance of 3rd and 4th instar nymphs (Fig. 2), whereas plants treated only with NPK showed the greatest intensification of *A. woglumi* development stages (Fig. 1 and Fig. 2). The apical stratum stood out with higher incidences for the number of eggs, postures and 1st instar nymphs (Fig. 3); and the highest incidences of 2nd, 3rd and 4th instar nymphs were found in the basal and median strata in *C. latifolia* (Fig. 3).

Discussion

The *C. latifolia* plants infested with *A. woglumi* and subjected to different fertilizer applications presented the best results for numbers of egg laying events (Fig. 1A) and 1st instar (Fig. 1B) and 2nd instar (Fig. 1C) nymphs in the treatments NPK + K_2O_3Si and organic fertilizer + K_2O_3Si. In these treatments, the *A. woglumi* populational density decreased, probably due to structural changes in the plants caused by the addition of potassium silicate, and anatomical (thicker epidermal cells and higher lignification) and biochemical (increase in the synthesis of toxins) changes (Camargo et al., 2011). These changes may affect the insects' feeding behavior and biology, since the females differentiate suitable, non-suitable, and non-host plants before the oviposition. This discrimination process is based on morphological, physical, and chemical characteristics of the plants (Raga et al., 2016).

Pinto et al. (2014) evaluated potassium silicate applications in cocoa orchards and found decreases in the incidence and damage level caused by *Toxoptera aurantii* (Fonscolombe

1841) (Hemiptera: Aphididae). Different results were found by Ferreira et al. (2011), who found no effect of silicon on the oviposition and mean number of nymphs of *Bemisia tabaci* Gennadius 1889 (Hemiptera: Aleyrodidae) in soybean crops.

Plants treated with NPK presented the highest incidences of egg laying events (Fig. 1A), and 1st instar (Fig. 1B) and 2nd instar (Fig. 1C) nymphs. This was probably due to the amino acid concentrations in leaves of plants treated with NPK, which makes the plant more vulnerable. This high amino acid concentrations caused by a fast nutrient assimilation due to N fertilizer application favors the incidence of pests (Wackers et al., 2017). This was also found by Soares et al. (2013), who evaluated the dynamics of *B. tabaci* in tomato plants and found higher incidences of eggs and nymphs in the treatment with N fertilizer application.

The lowest numbers of eggs (Fig. 2A), and abundance of 3rd instar (Fig. 2B) and 4th instar (Fig. 2C) nymphs were found in the treatments organic fertilizer + K_2O_3Si and NPK + K_2O_3Si. This may be due to the addition of potassium silicate, which increases the leaf tissue resistance, promoting a mechanical barrier against insect-pests. This decreases damages caused by these arthropods and their feeding activity (Ferreira et al., 2011) by increasing the resistance of plant tissues to penetration by their mouth apparatus. Therefore, adult *A. woglumi* found difficulties for egg laying and, consequently, for the maintenance of immature insects due to the protection generated by the application of potassium silicate. According to Camargo et al. (2011), application of potassium silicate can change chemical responses of plants, generating increases in synthesis of toxins that are inhibitor and repellent of insects.

Correa et al. (2005) evaluated the incidence of white fly in cucumber plants and found decreases in the population of *B. tabaci* (biotype B) in plants treated with silicon during the whole crop cycle. In addition, Dalastra et al. (2011) found decreases in number of nymphs and adults of thrips *Enneothrips flavens* Moulton 1941 (Thysanoptera: Thripidae) in peanut crops treated with potassium silicate. This denotes that the production of compounds due to silicon applications induces the plant resistance to herbivory.

The highest incidences of eggs and *A. woglumi* insects found in the treatment NPK (Fig. 2) was probably due to the faster nutrient assimilation, which favors soluble nitrogen accumulation (amino acids and soluble sugars) by the *C. latifolia* plants and results in a higher number of egg laying events, eggs, and nymphs of *A. woglumi*. Huber et al. (2012) reported that disturbances in the protein synthesis process and carbon hydrates metabolism are caused by soil mineral imbalances, mainly by using mineral fertilizers with high solubility (e.g., NPK, urea, KCl, superphosphate), especially nitrogen fertilizers, and use of synthetic organic compounds, which affect the plant physiology by decreasing protein synthesis and increase the accumulation of free amino acids and reducing sugars.

Silva et al. (2011) evaluated the dynamics of *A. woglumi* and found that the infestation level varies according to the crop system and management adopted, since the occurrence of many annual generations of *A. woglumi* is favored by its large reproductive potential and nutrient availability. Chaboussou (2006) reported that phytophagous insects (aphid, mealybug, sharpshooter leafhopper, and thrips species) depend on soluble substances, such as amino acids and reducing sugars for their survival. Thus, many constituents of plants changed by N (e.g., amino acids, protein, acids nucleic) are correlated with resistance or susceptibility to insect-pests.

Considering the evaluation times, the number of *C. latifolia* plants with presence of eggs and 3rd and 4th instar nymphs (Fig. 2) was higher in the treatments with application of NPK at 90 days after the last soil fertilizer application. This denotes that the NPK application favored the occurrence and establishment of the pest throughout the experiment. This is explained by the higher metabolic activity at 90 days after the last soil fertilizer application, with higher absorption of N due to the chemical fertilizer application, which results in higher availability of N in amino acid forms. According to Boaretto et al. (2007), during the growth period of citrus plants, N accumulation from fertilizers and its availability tend to increase.

According to Raga et al. (2012) the behavior of these Aleyrodidae species can be maintained or modified depending on management conditions. In the present study, female *A. woglumi* insects preferred to oviposit on plants in the treatment NPK. This treatment resulted in emergences of young and succulent leaves that enabled a better development of *A. woglumi* at different developmental stages.

Plants treated with potassium silicate (Fig. 3) had lower infestations in all evaluated plant parts. This was probably due to the protection provided by the silicon, which can be expressed as lignification of the cell wall, formation of papillae or induction of defense proteins (Costa et al., 2011), since the result was the same for the plant basal, mid, and apical parts. This issue requires further studies, since the application of potassium silicate and its use by plants has been a potential strategy in integrated pest managements, and has determined the resistance or tolerance of plants species to insect-pests (Ferreira et al., 2011).

The *A. woglumi* dynamics in the plant parts showed higher number of eggs (Fig. 3A), number of egg laying events (Fig. 3B), 1st instar (Fig. 3C), 2nd instar (Fig. 3D), 3rd instar (Fig. 3E) and 4th instar (Fig. 3F) nymphs in the treatment NPK in all evaluation times. The *A. woglumi* insects presented a probably dependency on the plant for shelter, reproduction location, and feeding, and their consumption choice for plant parts is probably dependent on the nutritional contents and palatability of the plant stratum (Del-Claro and Torezan-Silingardi, 2012).

The treatment with NPK showed the highest numbers of eggs (Fig. 3A) and egg laying events (Fig. 3B) in the plant apical stratum. This preference for younger plant parts was also found by Huber et al. (2012), who pointed out that young leaves have fine and soft cuticles, higher quantity of water, and present higher quantities of nutrients (amino acids), which can be readily available for these organisms. These characteristics favors the oviposition process and ensure a higher survival of immature insects.

First instar nymphs are mobile. Aafter the hatching, they select an ideal place in the hosts plants to fix (Nguyen et al., 2019). In addition to preference of oviposition of adult insects for younger leaves of the apical stratum of *C. latifolia* plants, there was higher survival of 1st instar nymphs (Fig. 3C) in this plant part, probably due to the leaf characteristics.

The results found in the present study confirm those of Soares et al. (2013), who state that adult insects of the Aleyrodidae family prefer to oviposit on the apical stratum of the host plants, where they find more tender leaves for feeding, and that younger nymphs (1st and 2nd instar) remain

Table 1. Chemical analysis of the soil before of the application of the treatments. Maranhão, Brazil, 2016.

OM	pH	P	K	Ca	Mg	SB	H+Al	CEC	BS	K/CEC	Mg/CEC
g dm^{-3}		mg dm^{-3}	mmolc dm^{-3}						%	%	%
13	6.0	20	2.6	18	15	35.6	12	47.6	75	5.5	31.5

OM = organic matter; SB = sum of bases; CEC = cation exchange capacity; BS = base saturation.

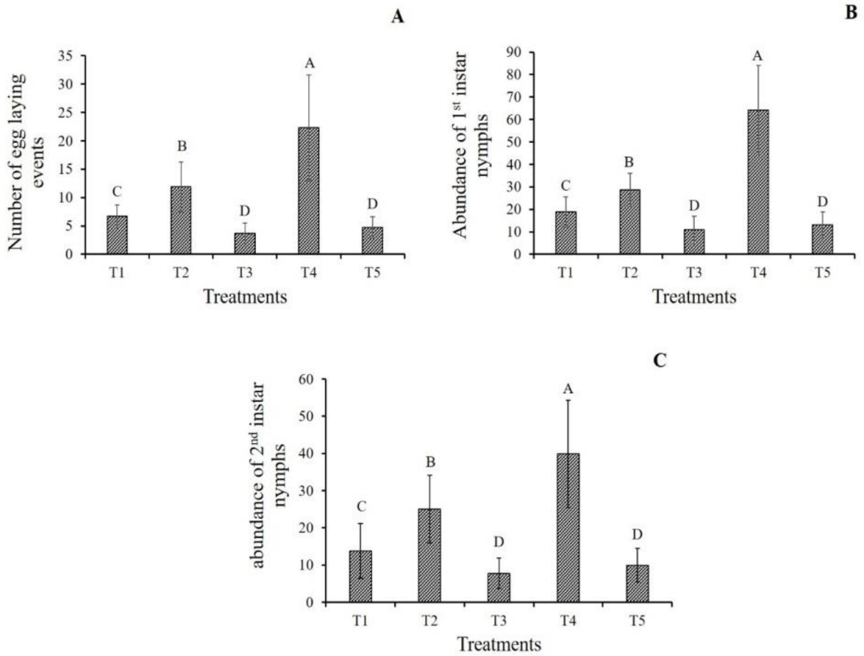

Fig 1. Mean number of egg laying events per plot (A), abundance of 1st instar nymphs per plot (B), and abundance of 2nd instar nymphs per plot (C) in *Citrus latifolia* plants infested with *Aleurocanthus woglumi* under soil organic and mineral fertilizer applications. Maranhão, Brazil, 2019. Means followed by the same letter in the treatments are not different by the Tukey's test at 5% probability level. Vertical lines indicate the standard deviation. (T1 = Control; T2 = organic fertilizer; T3 = organic fertilizer + K_2O_3Si; T4 = NPK; T5 = NPK + K_2O_3Si).

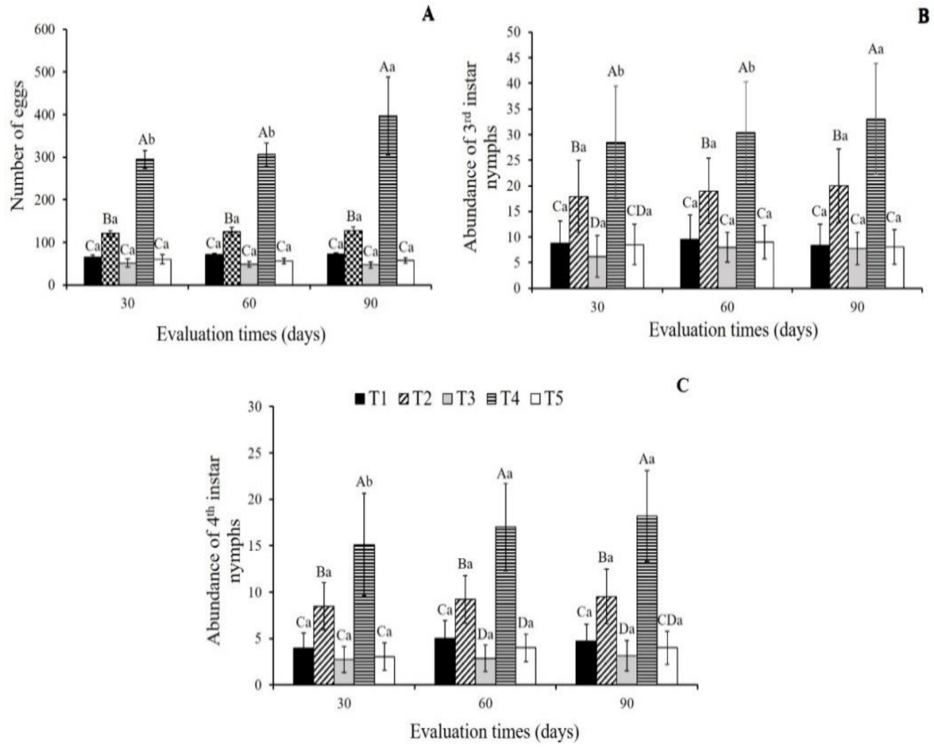

Fig 2. Mean number of eggs per plot (A), abundance of 3rd instar nymphs per plot (B), and abundance of 4th instar nymphs per plot (C) in *Citrus latifolia* plants infested with *Aleurocanthus woglumi* under soil organic and mineral fertilizer applications. Maranhão, Brazil, 2019. Means followed by the same uppercase letter in the treatments, or lowercase letter in the evaluation times, are not different by the Tukey's test at 5% probability level. Vertical lines indicate the standard deviation. (T1 = Control; T2 = organic fertilizer; T3 = organic fertilizer + K_2O_3Si; T4 = NPK; T5 = NPK + K_2O_3Si).

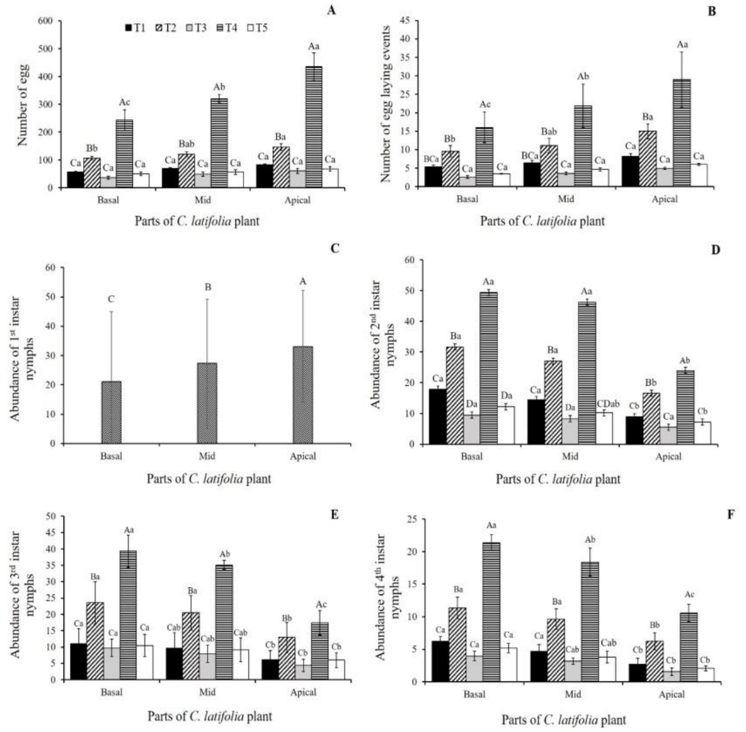

Fig 3. Mean number of eggs per plot (A), number of egg laying events per plot (B), abundance of 1st instar nymphs per plot (C), abundance of 2nd instar nymphs per plot (D), abundance of 3rd instar nymphs per plot (E), and abundance of 4th instar nymphs per plot (F) on *Citrus latifolia* infested with *Aleurocanthus woglumi* under soil organic and mineral fertilizer applications. Maranhão, Brazil, 2019. Means followed by the same uppercase letter in the treatments, or lowercase letter in the leaf parts, are not different by the Tukey's test at 5% probability level. Vertical lines indicate the standard deviation. (T1 = Control; T2 = organic fertilizer; T3 = organic fertilizer + K_2O_3Si; T4 = NPK; T5 = NPK + K_2O_3Si).

mainly in the mid stratum of the plant. Lopes et al. (2013) evaluated the oviposition preference and life cycle of *A. woglumi* in fruit tree species and found feeding preference more tender leaves, and high incidences in Rubi orange, Tahiti acid lime, and Ponkan tangerine trees. Moreover, Silva et al. (2009) evaluated 1st instar nymphs of *B. tabaci* and found higher infestations in the apical part of vegetable plants, such as okra, common bean, and sweet pepper. Thus, the preference of Aleyrodidae species for younger leaves for feeding and oviposition is found in different crops.

Higher infestations of 2nd instar (Fig. 3D), 3rd instar (Fig. 3E), and 4th instar (Fig. 3F) nymphs in the plant basal and mid strata was also found in tomato crops by Soares et al. (2013), who reported higher abundance of white fly nymphs in the plant basal and mid strata. This behavior was also found in melon plants by Azevedo and Bleicher (2003), who reported higher density of 2nd instar, 3rd instar, and 4th instar nymphs in leaves in the lower third of the plants. These authors explained that sessile stage of 2nd instar, 3rd instar, and 4th instar nymphs is correlated with the vertical growth of host plants, which explains the vertical distribution of these stages in the lower plant parts.

After the 2nd instar, *A. woglumi* nymphs are sessile. Thus, the location of the infested leaf and the physiological development period of the host plant present a linear distribution, with a defined standard of distribution in the plant. According to Azevedo and Bleicher (2003), all apical strata become mid and basal over time due to the plant development. Therefore, the preference of adults and nymphs of *A. woglumi* for the plant apical stratum causes a higher occurrence of 2nd instar, 3rd instar, and 4th instar nymphs in the other plant strata. Thus, leaves in the plant mid and basal strata can provide higher exposure time of Aleyrodidae insects in these developmental stages and probably can be used to establish sampling plans.

Material and methods

The study was conducted from March 2016 to August 2019, at the São Judas Tadeu citrus orchard (2°30'4.9''S, 44°04'22.8''W, and altitude of 4 m), in the municipality of Paço do Lumiar, state of Maranhão (MA), Brazil, and at the Laboratory of Entomology of the Center for Agricultural Sciences of the State University of Maranhão (UEMA).

The Paço do Lumiar region presents an Aw, tropical climate, according to the Köppen classification, with mean annual temperature of 28 °C and mean annual rainfall depth of 2,361.75 mm (Labmet-Nugeo, 2019). The predominant soil of the area was classified as a Typic Hapludult (Argissolo Vermelho Amarelo) (Embrapa, 2018) of sandy-loam texture. The results of soil analysis carried out in the Soil Chemistry Laboratory of the Center for Rural Technology of Engineering of the UEMA is presented in Table 1.

Experimental design

Sixty 6-year-old Tahiti acid lime (*Citrus latifolia* Tanaka) plants under field conditions, naturally infested with *A. woglumi*, were randomly selected for the study. A randomized block design was used, in a 3×5×3 factorial arrangement (three evaluation times, five treatments, and three plant strata), with 4 replications. The experimental unit consisted of three plants and treatments with different fertilizations were applied to the soil: T1: control (no fertilizer application); T2: organic fertilizer (bovine manure); T3: organic fertilizer + potassium silicate (K_2O_3Si); T4: NPK; T5: NPK + K_2O_3Si.

Conducting the experiment

The treatments with organic and mineral fertilizer were applied at 30 days after lime (total neutralizing power of 70%) application to the soil of the experimental area (3.6 kg plant^{-1}) (Iac, 1997). The organic fertilizer (manure bovine) rate was based on the literature (Iac, 1997); a rate of 5 L plant^{-1} were applied around the plants in May 2017.

The soil mineral fertilizer (NPK) was applied in the canopy projection area, considering the soil analysis, using the formulation 16-5-10 (N-P_2O_5-K_2O) (Table 1). Nitrogen was applied using 888.85 g plant^{-1} of urea, split into three applications of 296.29 g plant^{-1} (May, July, and October 2017). Phosphoros was applied in a single application of triple superphosphate at the rate of 260.4 g plant^{-1} (May, 2017). Potassium was applied using 500 g plant^{-1} of potassium chloride, split into three applications of 165.84 g plant^{-1} (May, July, and October 2017). Three leaf applications with 30-day intervals were carried out with potassium silicate (Fertisílicio; Plant-Defender, Limeira, Brazil) at the concentration of 5 mL SiK_2O L^{-1} of water. Usual cultural practices for citrus orchards (weeding, pruning, and irrigation by micro sprinklers) were carried out during the experiment.

The evaluations were carried out at 30 (December 2017), 60 (January 2018), and 90 (February 2018) days after the last soil fertilizer application. The *A. woglumi* populational dynamics were evaluated by collecting six randomly chosen leaves of each plant (two from the basal, two from the mid, and two from the apical strata of the plant), totaling 360 leaves per collection. The leaves were then stored in labeled plastic bags, placed in expanded polystyrene boxes, and taken to the Laboratory of Entomology of the Center for Agricultural Sciences of the UEMA for counting of number of egg laying events, eggs and nymphs of *A. woglumi*, using a stereomicroscope.

The variables evaluated were: number of eggs, egg laying events, and abundance of 1st, 2nd, 3rd, and 4th instar nymphs as a function of the treatments (T1, T2, T3, T4, and T5), evaluation times (30, 60 and 90 days), and plant strata (basal, mid, and apical).

Statistical analysis

The data obtained were subjected to exploratory analysis, normality tests, and analysis of variance (ANOVA). The means of the treatments were compared by the Tukey's test at 5% probability level, using the Sisvar® program (Ferreira, 2000).

Conclusion

Citrus latifolia plants fertilized with NPK + K_2O_3Si and soil organic fertilizer + K_2O_3Si are less susceptible to attack of *A. woglumi* by affecting the number of egg laying events and biological cycle of this insect-pest. The addition of potassium silicate to NPK and organic fertilizers decrease the incidence of *A. woglumi* insects on *C. latifolia* plants. *C. latifolia* plants fertilized with NPK present higher susceptibility to *A. woglumi* at 30, 60 and 90 days after application. Higher incidences of egg laying events, eggs, and 1st instar nymphs are found in the apical stratum of *C. latifolia* plants, and higher incidences of 2nd instar, 3rd instar and 4th instar nymphs are found in the plant basal and mid strata.

Conflicts of interest

The authors declare that no conflicts of interest.

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Author contributions

Lemos RNS, Gomes AMSV, Araujo JRG and Mondego JM conceived and designed the research. Gomes AMSV, Amaral EA conducted the experiment. Carvalho CS and Rêgo AS performed statistical analysis. Gomes AMSV, Reis FO, Lemos RNS and Lopes GS wrote and revised the manuscript.

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