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The insecticidal potential of neem extracts (*Azadirachta indica* JUUS) against whiteflies (*B. tabaci*) in tomato crops

Abstract

The tomato (*Solanum lycopersicum*) is one of the main vegetables grown in Sinaloa. This crop is affected by pest insects, such as the white fly (*Bemisia tabaci*). The objective was to evaluate the effect of different doses of neem-based biorational insecticide on the population density of whiteflies. A completely randomized design was established to evaluate the population density of whitefly adults. The treatments evaluated were different doses of neem leaf extracts (NLE): (T1) control, (T2) 200 g NLE•L^{-1}, (T3) 300 g NLE•L^{-1}, (T4) 400 g NLE•L^{-1} and (T5) 500 g NLE•L^{-1}. An analysis of covariance was applied to the data obtained and the difference between the means was evaluated using the Tukey test with an $\alpha=0.05$. Neem extracts had an effect on population density ($p\leq0.05$), by reducing the population as the concentration of the extracts increased. T5 presented the highest reduction with 43.56%±1.6, while T4 presented a reduction of 39.27%±1.7, compared to the control. However, the application of T5 causes damage to the plant, so it can be considered that T4 is more suitable for its application. Therefore, neem extracts had an effect in controlling the whitefly population.

Keywords: bioinsecticide, aqueous extract, vegetable, insects, pest

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Introduction

The whitefly (*Bemisia tabaci*) is an insect that perforates the leaf tissue with its mouthparts and feeds on the phloem. This weakens the plant and creates early wilting, reducing the growth rate and yield of the plant. It is considered one of the most important tomato pests in the tropical and subtropical zone, where it causes great losses in the crop due to direct feeding and transmits geminiviruses.[1] To mitigate loss due to infestation, many farmers use synthetic chemical insecticides. However, chemical whitefly control is expensive and not always effective.[2] Furthermore, control of whiteflies with chemical pesticides is often difficult due to the widespread emergence of resistance in whiteflies to these pesticides, in addition to the negative effect of pesticides on the natural enemies of the whitefly. In addition to the above, the use of these leaves residues in food and water, generating harmful consequences for health.[3] Neem has a lethal effect on insects that suck plant sap and those that chew plant parts. Its active ingredient is azadirachtin, which acts as a growth regulator and deterrent to feeding and oviposition.[4] Also, as a growth regulator by reducing the level of ecdysone, a hormone that interrupts the molting process of insects and therefore prevents larvae from becoming adults.[5] Azadirachtin is a mixture of seven isometric compounds ranging from Azadirachtin-A to -G, with Azadirachtin-A as the dominant and Azadirachtin-E as the most effective growth regulator.[6] Due to the above, the objective of this research was to evaluate the effect of neem plant extract on whitefly population density in tomato crops under open field conditions in Guasave, Sinaloa.

Materials and methods

Location of the study and collection of neem leaves

The study was carried out in the experimental field of the Tecnológico Nacional de México campus Guasave, which is located in the state of Sinaloa in the municipality of Guasave. The city of Guasave is the head of the municipality, which is located in the Northwest of the state of Sinaloa between meridians 108º10'00" and 109º06'50" West longitude of Greenwich and parallels 25º10'03" to 25º46'19" North latitude. It limits to the North with the municipalities of Ahome, El Fuerte and Sinaloa; to the East with Salvador Alvarado and Angostura; to the South and to the West with the Gulf of California and to the Northwest with the municipality of Ahome.

The material for the elaboration of the extracts consisted of neem leaves, where the leaflets were separated from the rachis of the leaf manually. Once separated, they were washed and disinfected with 50 ppm chlorinated water for subsequent drying. Drying took place in a tunnel-type solar dehydrator for two days, until reaching an approximate humidity of 13%. Once the leaves were dried, they were subjected to a grinding process in an Estrella Blanca forage mill.®#8, to reduce the particle size and increase the contact surface when making the extracts.

Establishment of tomato cultivation

For this study, seedlings of the Sweet Hearts hybrid from the SAKATA group, obtained from a local producer, were used. The seedlings were transferred to the designated rows for each treatment, with a distance between plants of 0.4 m in the open field. Prior to transplanting, an antifungal solution was applied by immersion to the root ball of the plant. Subsequently, traditional cultural practices were carried out for the cultivation of tomatoes in the open field. Natural midge infestation was allowed until day 30 after transplantation and the treatments were subsequently applied. Once the treatments were applied, a period of three days was expected to count the dead adults. All treatments were performed in triplicate sample.

Evaluated variables

The variables evaluated in the experiment were the number of live adults in different parts of the plant such as the stem, in basal leaves and in apical leaves, as well as the percentage of reduction. The reduction percentage (%R) was calculated using the equation proposed by Henderson and Tilton's[7]:

$$\%R = (1 - \frac{Ta \times Cb}{Tb \times Ca}) \times 100$$

Where: Tb is the number of insects recorded before treatment, Ta is the number of insects recorded after treatment, Cb is the number of insects recorded in the control before treatment, and Ca is the number of insects recorded in the control after treatment. treatment.

Preparation of the extracts

The preparation of extracts was carried out using a solid-liquid extraction method, maintaining a different weight/volume ratio for each treatment. T1 consisted of the application of a commercial insecticide (Gorplus®), T2 = 200 g•L^{-1}, T3 = 300 g•L^{-1}, T4 = 400 g•L^{-1} and T5 = 500 g•L^{-1} of dehydrated ground leaf and distilled water. The water was placed in a container and kept on a heating plate until it reached a temperature of 95 oC and then the neem leaves were immersed for a period of 5 min. The extract was filtered through Whatman number 1 filter paper, then it was deposited in an amber bottle and stored refrigerated until use.

Comparison of extracts against registered brands

Finally, a comparison was made between the extract that was most effective in combating the whitefly of the previous experiment (400 g NLE•L^{-1}) and two commercial products used to combat the same pest. The procedure for planting the tomato crop, applying the treatments and counting adults for this stage was carried out in the same way as described above. And the treatments were applied as follows: T1 = control, where only water was applied, T2 = extract (400 g NLE•L^{-1}), T3 = shampoo and T4 = Gorplus®.

Experimental design

The data generated were analyzed by means of an analysis of covariance, taking as covariate the initial count of adults before applying the treatments. The differences between the average values were established using the Tukey test with aα=0.05, in a statistical package Minitab®17. Additionally, a regression analysis was performed between the variables.

Results and discussion

population density

Figure 1 shows the behavior of the different neem extracts on the population density of whiteflies. Significant difference was detected ($p \leq 0.05$) between treatments. In T1 the highest count was obtained than the other treatments with an average of 38±3 live adults/plant, which was different from all other treatments. The two most effective extracts to counteract the plague were T4 and T5. At T4 there was a count of 25±2 live adults/plant, while T5 averaged 21±2 live adults/plant. In general, as the concentration of NLE in treatments, increases the capacity of the extracts to combat whitefly. These results agree with what was reported by Muños-Reyes et al.,[8] who tested different concentrations of azadirachtin (1, 0.5, 0.2 mg/mL), on the percentage of repellency against adult whiteflies. The results showed that as the concentration of the extracts increases, the repellency percentage is higher. In addition, the results showed that this percentage decreases as the application time of the treatments increases.

In Table 1 the percentages of reduction of the extracts with respect to the control are observed. All the extracts presented a significant difference ($p \leq 0.05$). Regarding T1 (13.73%±1.5) and T2 (12.13%±1.8), presented a difference with respect to the control, however, among them the reduction percentages did not present a significant difference ($p \geq 0.05$). The extracts that presented the highest %R were those of T4 and T5 with an average of 39.27%.±1.7 and 43.56%±1.6 regarding Control. The results show the same behavior as in the aforementioned variable, since there is an inverse relationship between the concentration of the extract and the number of live adults per plant (R2=0.84), as well as a direct linear correlation with the reduction percentage (R2 =0.864).

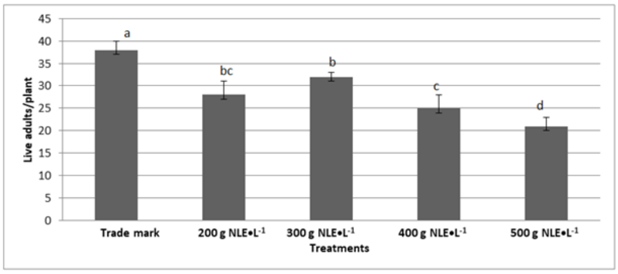

Figure 1 Effect of neem extracts on whitefly population density in open field tomato crops.

[abcd]Literal difference within each bar indicates significant difference ($p \leq 0.05$) between treatments.

Table 1 Effect of neem extracts on the percentage reduction in the population density of *B. tabaci* in tomato crops

Control	48±two	38±3	0d
200g•L^{-1}	41±3	28±1	13.73±1.5c
300g•L^{-1}	46±4	32±two	12.13±1.8c
400g•L^{-1}	52±3	25±two	39.27±1.7b
500g•L^{-1}	47±two	twenty-one±two	43.56±1.6th

[abcd]Different literal within the column, indicates significant difference ($p \leq 0.05$) between treatments.

Figure 2 shows the comparison of the effectiveness of the 40% m/v extract, which presented the best characteristics to reduce the whitefly population in the first experiment against different commercial brands of insecticides used to reduce the plague. There was a significant difference between the treatments($p \leq 0.05$) and the tested extract had the lowest count (7±1live adults/plant), while the other treatments Shampoo (12±2 live adults/plant) and Gorplus (17±2 live adults/plant) presented higher values. The results presented above indicate the effectiveness of aqueous extracts of neem leaves to combat whitefly in tomato crops.

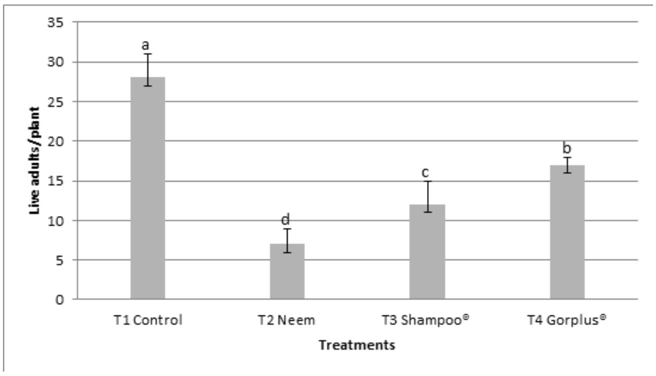

Figure 2 Comparison of the effectiveness of neem extract (40% m/v) against different commercial brands of insecticides.

[abcd]Literal difference within each bar indicates significant difference ($p \leq 0.05$) between treatments.

Conclusion

Neem extracts were effective in combating whitefly (*B. tabaci*) in open-field tomato crops. In the first experiment, extracts T4 (40%

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m/v) and T5 (50% m/v) were the most effective to combat the pest, since they presented the lowest number of live adults per plant and the highest percentages of reduction. In the second experiment, the selected extract (40% m/v) presented the lowest number of live adults per plant compared to the commercial brands tested. Because they reduce population density, they can be used successfully as an alternative to integrated pest management.

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Conflicts of interest

All authors made significant contributions to the document. Therefore, they agree with its publication, likewise, we state that there are no conflicts of interest in this study.

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