Effectiveness of caffeine as a snail repellent.

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Abstract

Caffeine is a crystalline alkaloid belongs to chemical family of Xanthenes. It is an effective biological treatment against some common pests, fungus and bacteria. Snails are troublesome pests in agriculture as they adversely affect to the yield and yield quality. This study was conducted to assess the effectiveness of caffeine as a snail repellent as well as to evaluate the impact for the feeding behavior of snails. When snails put into a tray with caffeine-soaked cotton balls, they moved away from the cotton balls. Snails were put into a tray placed with water soaked and 5% caffeine-soaked iceberg lettuce in opposite areas and after 24 hours, 82.45% and 5.26% weight reduction in lettuce was observed in control and 2% caffeine treatments respectively. Moreover, when the same experiment was done by using 0.5% and 2% caffeine, they have eaten more in control and then 0.5% caffeine treated lettuce. In addition, a smaller number of snails were active in caffeine treatments and all the snails were active in control. The mortality rate was high in 2% caffeine treatment which is 46.6%, however, 0.5% caffeine and control treatments didn't show any mortality in snails. Therefore, caffeine is an effective biological alternative for controlling snails to protect food crops in agriculture.

Keywords: Caffeine, snails, pest repellent, feeding behavior

1. Introduction

Caffeine is a naturally occurring purine alkaloid (1,3,7 - trimethyllxanthine). In general, alkaloids are nitrogen-containing compounds of small molecular mass that can be easily identified in more than 20% of flowering plants. Caffeine belongs to the chemical family of xanthine and has the chemical formula $C_8H_{10}N_4O_2$. Several plant species such as coffee (Coffea arabica), tea (Camellia sinensis), cocoa (Theobroma cacao) naturally produce caffeine within the plant itself and it is well established that caffeine has many health benefits for humans as well as for plants (Kim, Choi & Sano, 2010; Sledz et al., 2015). Exogenous application of certain caffeine concentrations is beneficial for repelling some plant pests and pathogenic microbes as well as improving stress tolerance of plants. Furthermore, Moreover, exogenously applied caffeine has the pest repellent ability and pest control ability by interrupting their reproductive ability (Kim, Choi & Sano, 2010). Relatively high concentrations of caffeine can be lethal or effectively retardate the growth of pests and pathogenic microbes. For instance, 0.01 – 2% caffeine treated cabbage leaves were less affected by slugs and 0.1 – 2% caffeine treatments were lethal for mature orchid snails

(Hollingsworth, Armstrong & Campbell, 2002). Caffeine treatments can inhibit the growth of some microbial pathogens such as Pseudomonas syrinage, Aspergillus ochraceus, Monacrosporium ambrosium and Crinipellis perniciosa (Kim, Choi & Sano, 2010).

Snails are considered as troublesome pests in agriculture and it is a widespread issue across the globe. Snails feed on fresh leaves, seedlings, and some ripening fruits such as strawberries and thereby affect to the crop productivity as well as quality (Horgan, 2018). There are different commercial products available to control snails in the market and most of them contain metaldehyde or methiocarb as the active ingredient. The problem is that the residues of these chemicals are remain in the fruit crops and those are not allowed to be in food crops in most countries. Therefore, it is an ongoing requirement to develop an alternative product to control snails and simultaneously minimize the chemical residues in final crop products (Hollingsworth, Armstrong & Campbell, 2002). The aim of this study is to evaluate the effectiveness of synthetic caffeine powder as a snail repellent. There were two experiments were conducted separately to assess the effectiveness of caffeine as a snail repellent as well as to interrupt their feeding behavior.

2. Objectives

The specific objectives of this study were to:

- Study the effectiveness of caffeine as a pest repellent
- Assess the impact of caffeine for the feeding behaviour of snails
- Study the impact of caffeine for the activeness and mortality of snails

3. Methodology

The experiment was conducted in a greenhouse in Robinvale. First experiment was conducted by using 50 snails to evaluate the effectiveness of caffeine powder as a snail repellent and the second study was conducted by using 45 snails to assess the influence of caffeine for the feeding behavior of snails. For the first experiment, cotton balls were soaked in 20% caffeine solution and then placed the corner of a plastic tray. 50 snails were then added to that trat tray and covered with a plastic net. It was observed after 2 hours to see the movements of snails. For the second experiment, two samples of iceberg lettuce were weighed and then one sample was soaked in 5% caffeine and the other was soaked in water for 5 minutes. Two samples were then placed inside a plastic tray in opposite direction and then put 50 snails inside the tray. After 24 hours, remaining weight of the iceberg lettuce was recorded. At the same time, three containers were prepared and put same amount of iceberg lettuce inside the contains. Iceberg lettuce samples were soaked in 0.5%, 2% caffeine solution and water for 5 minutes. 15 snails were then put into each container and covered with a plastic net. After 24 hours, the remaining weight of lettuce was recorded and the activeness of snails was observed.

4. Results

(a)

(b)

Figure 1: Effect of caffeine on repellent of snails. (a) Keeping cotton balls soaked with 20% caffeine and snails inside the plastic tray. (b) Effect of caffeine on behavior/ movements of the snails after 24 hours.

(a)

(b)

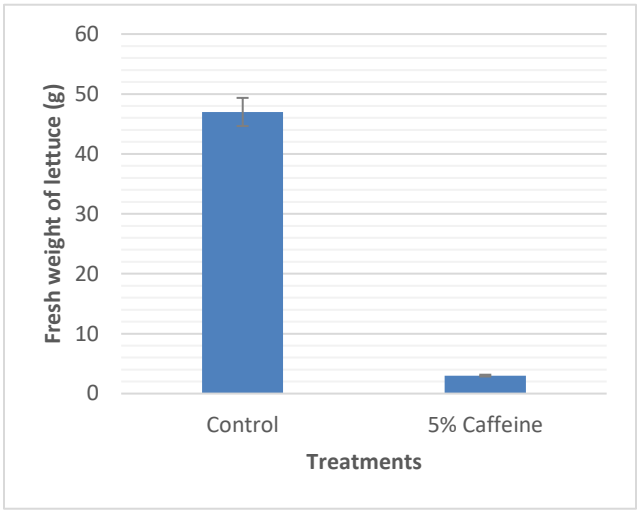

Figure 2: Effect of caffeine on feeding behavior of snails. **(a)** Feeding behavior of snails after 24 hours. **(b)** Amount of iceberg lettuce eaten by snails in each treatment after 24 hours.

(a)

(b)

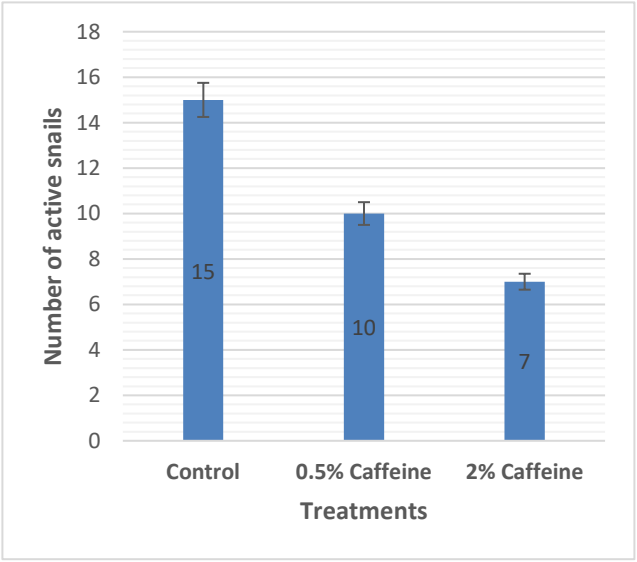

Figure 3: Effect of caffeine on feeding behavior of snails. **(a)** Feeding behavior of snails after 24 hours. **(b)** Amount of iceberg lettuce eaten by snails in each treatment after 24 hours.

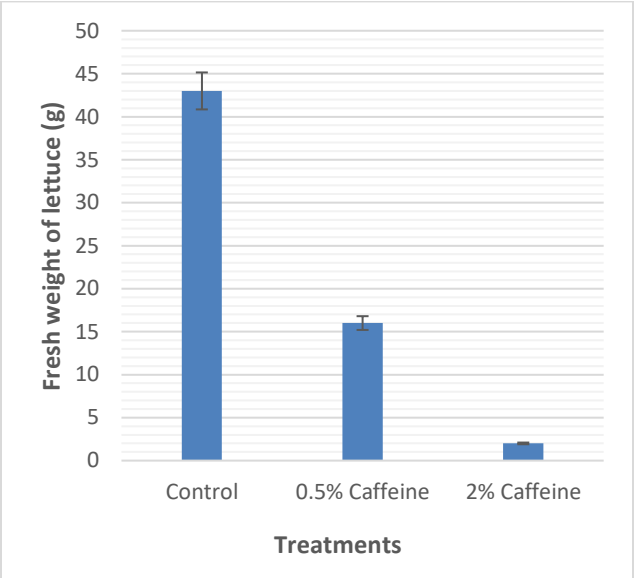

Figure 4: Effect of caffeine on activeness of snails.

5. Discussion

Pest repellent capability of caffeine has been well documented by several authors (Hollingsworth, Armstrong & Campbell, 2002, Kim, Choi & Sano, 2010). In this study, we conducted the first experiment to assess the effectiveness of caffeine to work as a snail repellent. After 24 hours putting snails into the tray, it is observed that snails were moved out from the caffeine-soaked cotton balls (Figure 1). The movement of the snails were further observed until another 12 hours, but the snails did not reach to the area that the cotton ball placed.

The second experiment was conducted to assess the impact of caffeine on feeding behavior and activeness of snails. Once putting 50 snails into the tray with 5% caffeine-soaked iceberg lettuce, first they achieved to towards both leaves. After 24 hours, lettuce soaked with water was eaten more compared to the lettuce

soaked with caffeine solution. There was a significant difference between the amount eaten by snails in control and caffeine treated lettuce (Figure 2). In addition, few snails have eaten caffeine treated lettuce and they were less active compared to other snails. Similar to these results, Hollingsworth et al. (2002) found that caffeine treated foliage had a less feeding pressure by slugs. In this study, the percentage of weight reduction in lettuce was calculated and it was 82.45% and 5.26% in control and caffeine treated lettuce respectively. Therefore, it is clear that feeding pressure is significantly low in caffeine treated lettuce compared to control.

When snails were put into separate containers with caffeine treated lettuce and water treated lettuce, they tended to eat more in control lettuce compared to caffeine treated lettuce. Among two caffeine concentrations, snails have eaten more in 0.5% treated lettuce compared to 2% caffeine treated ones (Figure 3). In addition, activeness of the snails was also recorded in this experiment. All the snails were active in control treatment where 10 and 7 active snails were in 0.5% and 2% caffeine treatments respectively (Figure 4). Furthermore, mortality rates of the snails were observed and after 30 hours, 46.6% mortality rate showed in 2% caffeine treatment. It is well documented that snails and slugs are more inclined to contact poisoning from caffeine (Hollingsworth, Armstrong & Campbell, 2002).

6. Conclusion

In conclusion, caffeine is an effective treatment against snails as it works as a snail repellent. Caffeine treated foliar has less feeding pressure by snails and even 0.5% of caffeine is effective to significantly reduce the snails' feeding. Similarly, the weight reduction of caffeine treated lettuce was 5.26% while 82.45% in control or water treated lettuce. In addition, a smaller number of snails were active in caffeine treatments and all the snails were active in control. Finally, the mortality rate was high in 2% caffeine treatment which is 46.6%, however, 0.5% caffeine and control treatments didn't show any mortality in snails.

7. References

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