Developmental effect of cashew nut shell extract against nymphal instar of Silver leaf Whitefly (*Bemisia tabaci* Genn.)

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Abstract. Cashew nut shell (CNS), which are one of the most still is tropical biomass waste. This study was aimed to test mortality rates of CNS extract against the first to third instar nymphs of Silverleaf Whitefly (*Bemisia tabaci* Genn.1889). The concentration of CNS extract were: 0.22 %, 0.67 %, 2.00 %, 6.00 %. The LC50 and LC90 values indicated that CNS extract at concentration of 2.00 % were the most toxic compound to the first instar stage followed by CNS extract at concentration of 0.67 %, 6.00 %, imidacloprid, and CNS at concentration of 0.22 %, respectively. The concentration of 6.00 % showed the most toxic effect to the second stage followed by CNS extract at concentration of 2.00 %, 0.67 %, imidacloprid, and CNS at concentration of 0.22 %, respectively. The lethal concentration (LC50–90) value of the CNS extract at concentration of 6.00 %, at concentration of 2.00 %, 0.67 %, imidacloprid, CNS extract at concentration of showed the toxicity against the third instar nymph. This CNS extract at concentration of 2.00 % could be used to suppress of the *B. tabaci* nymphs of different stages (first to third instar) and negative effect of phytotoxicity on the soybean leaves.

Keywords: Botanical pesticide, concentration, nymphs, mortality rate, phytotoxicity.

1. Introduction

Silverleaf Whitefly (*Bemisia tabaci* Genn. 1889, Hemiptera: Aleurodidae) is the most problematic pest during the dry seasons on soybean plants. Therefore low rainfall and temperatures high could cause significant outbreaks. On the other hand the whitefly is vector for mosaic disease. The mosaic disease incidence increased with the increases of the whitefly populations, if there was inoculum source. Utilization of traditional breeding for whitefly resistance have mostly not been successful [1].

The use of synthetic insecticide is generally not recommended against whitefly because insecticide induced resurgence of insect on farm condition. Botanical pesticides have been used as attractive alternatives to synthetic chemical. Cashew plant was found in many regions in Indonesia. It is known as jambu mete (Java), jambu mede (Sunda). Cashew nut shell liquid (CNSL) had the potential to be used as ecofriendly insecticide against *Helicoverpa armigera* (Hübner,1809) and *Spilarctia oblique* (Walker, 1855). The shell liquid of cashew nut contain a complex secondary metabolite, which affected growth and developmental of two lepidopteran insects [2]. Anacardic acid is the main constituents of natural CNSL that obtained by extraction of cashew shell [3, 4]. The high mortality of insect was caused a complex mixture of the compounds anacardic acid in the CNSL. The bioactive compound acts as antifeedant with blocking sensory cell to starve. Oils have increased risk of causing...
phytotoxicity. Although capsicin was not phytotoxicity because the plants posses a wax which have protected them [5].

These authors also observed the antifeedant active compound of CNS extract against B. tabaci. However, the the nymphal stage of B. tabaci most susceptible to CNS extract and no phytotoxic on the leaves were not performed. Therefore, concentration of 0.22 %, 0.67 %, 2.00 %, 6.00 % are used to test the efficacy of CNS extract against the soybean young nymphs (first and second instar) and old nymphs (third instar) of B. tabaci. Thus, before recommending of CNS extract based on efficacy in controlling the B. tabaci.

The objective of the results was to evaluate the activity of CNS extract for reducing phytotoxicity on soybean plant and determine the nymphal stage of B. tabaci most susceptible to CNS extract.

2. Materials and methods

Greenhouse experiments were carried out in Kedunggalar District in Ngawi City, East Java, with annual averages of 30 °C, and 90 % RH.

2.1. Rearing B. tabaci

Seedling of soybean were planted in the care cage net at 30 °C ± 1°C, RH 85 % ± 5 %. A large colony of adults B. tabaci was introduced on seedling of soybean in pot for 14 d. Thereafter, the insect were removed by the opening the net and shaking the plant. The plants covered with the cage net and the nymphal stage last for 9 d to 10 d before the adults stage. The abaxial part of the soybean leaves was checked the presence of eggs and introduce to the soybean plant until adult B. tabaci.

2.2. Cashew nut shell extraction

Shell of cashew nut were sliced and air dried to ground using blender. The powdered cashew nut shell was carried out by maceration in n-hexane and stirred for 1 h. Thereafter, the extract was incubated for 24 h and filtered until three times. The filtrate was distilled at 50 °C to separated oil and the solvent using rotary evaporator vacuum in water bath until viscous extract.

2.3. Acute toxicity (LC50 and LC90)

The lethal dose (LC50 and LC90) of CNS extract was evaluated by seedling of soybean in the rearing cage net to get specific nymphal stages of B. tabaci. The seedlings containing nymphs of each instar in blocks were sprayed on the abaxial parts of the soybean leaves with CNS extract at concentration of 0.22 %, 0.67 %, 2.00 %, 6.00 %, which based in preliminary test.

2.4. Data analysis

2.4.1. Mortality effect of cashew nut shell extract on B. tabaci. Cashew nut extract concentration was compared with Imidacloprit active compound of insecticide (Movento Energy 240 SC). Its recommended commercial dose (0.50 mL L⁻¹). Control treatment used distilled water. After 6 d application, the number of living and dead nymphs were counted using a stereo-microscope. Nymphs were considered dead when all appendages were dark brown to black colour. Two leaves per replicate per treatment were removed to record total number of dead and living nymphs at each observation.

2.4.2. Comparative toxicity of cashew nu shell extract and imidacloprit against B.tabaci. In the experiment four concentration of Cashew nut shell extract Cashew nut extract (0.22 %, 0.67 %, 2.00 %, 6.00 %) and imidacloprit active compound of insecticide (Movento Energy 240 SC) with commercial dose (0.50 mL L⁻¹) was used. LC50 and LC90 was determined on the first, second and third instar nymphs of B. tabaci. Fifty of first, second, and third instar nymph were used per concentration and placed individually in glass vials with soybean leaves in the dark, respectively. The number of dead insect was assessed after 6 d application.
2.5. Analysis statistic.
The analysis of factorial experiment (nymphal instar and CNS extract concentration) was carried out according to a completely randomized design with four replications. Regression analysis were performed to assess of the relationship between nymphal mortality and CNS extract concentration. The normality and homogeneity of variance (HOV) tests were performed using GLM procedure with Welch option in SAS [6]. Non-homogeneity, percent mortality values were transformed using arc sin \((x/100)^{0.5}\) before analysis. Data were submitted to the analysis of variance to determine the interaction effect for instar, CNS extract concentration, and day after spraying. If there is a significant interaction effect was observed between factors. One for the factor level was compared to each of the other levels by by Tukey’s test \((P < 0.05)\). CNS extract concentrations were transformed using \(\log_{10}(X)\). The probit analysis was used to determine \(LC_{50}\) and \(LC_{90}\) values with their associated 95% confidence intervals of CNS extract at different concentration against \(B. tabaci\) nymphs. The probit regression (slope) was used to determine the correlation of log concentration with probit mortality at each CNS extract concentration against \(B. tabaci\) nymphs. The efficiency of extract were determined by the following formula Abbot.

\[
P_t = \frac{P_o - P_c}{100 - P_c} \times 100\%
\]

\(Pt\) : Corrected mortality (%)
\(P_o\) : Observed mortality
\(P_c\) : Control mortality

3. Results
The CNS extract at concentration of 2.00 % there was the potential mortality of the first, second and third instar nymphs of \(B. tabaci\) was compared insecticide with imidacloprit active compound. The mortality of increased gradually with the rise concentration of CNS extract. The mortality of first nymph reached the highest at concentration of 6.00 %. However, the mortality of second nymph decreased with the rise concentration (figure 1).

![Figure 1. The mortality of the first to third instar nymphs of \(B. tabaci\) on leaves of soybean seedling after treatment with CNS extract at different concentration. **significant at 1% probability.](image-url)
Each of the CNS extract at concentration of 6.00 % caused the greatest mortality rate of the *B. tabaci* nymphs of different stages (first to third instar) with 95.6 %, 90.9 % and 87.9 % efficiency, respectively. The CNS extract at 2.00 % and 6.00 % concentrations killed not significantly different for all nymphal stages of *B. tabaci*. Likewise, the ability of imidacloprid killed the second instar nymph not significantly different with CNS extract at concentration of 0.67 %. However, the mortality of second nymph showed significantly with the CNS extract at concentration of 0.22 %,  

Table 1. Mortality of the *B. tabaci* nymphs (first to third instars) on soybean leaves after application of CNS extract.

| Compounds (%) | 1st instar mortality (%) | Efficiency (%) | 2nd instar mortality (%) | Efficiency (%) | 3rd instar mortality (%) | Efficiency (%) |
|---------------|--------------------------|----------------|--------------------------|----------------|--------------------------|----------------|
| 0.00          | 8.6 ± 3.7 d              | 0.0            | 8.1 ± 3.9 d              | 0.0            | 8.4 ± 0.9 d              | 0.0            |
| Imidacloprid  | 38.2 ± 2.9 c             | 44.3           | 50.2 ± 6.6 b             | 63.1           | 36.2 ± 1.7 c             | 42.8           |
| CNS (0.22 %)  | 31.7 ± 3.1 c             | 41.6           | 23.6 ± 1.5 c             | 32.6           | 20.3 ± 1.1 cd            | 30.6           |
| CNS (0.67 %)  | 70.2 ± 4.8 b             | 80.4           | 48.1 ± 6.2 b             | 61.0           | 43.5 ± 4.8 b             | 57.4           |
| CNS (2.00 %)  | 94.6 ± 3.6 a             | 91.2           | 91.2 ± 2.2 a             | 88.4           | 72.0 ± 2.7 a             | 82.6           |
| CNS (6.00 %)  | 99.5 ± 3.0 a             | 95.6           | 92.7 ± 2.2 a             | 90.9           | 88.5 ± 2.7 a             | 87.9           |

*For analysis, the data were transformed using arc sin (x/100)^1.  
*Means ±SE followed by different letters in the columns differ by Tukey’s test (*P < 0.05)  
*Determined after correcting the control mortality by Abbott’s formula [8].

The highest mortalities of first instar nymphs were obtained with 2.00 % and 6.00 % of CNS extract. The two different lethal concentration levels (LC50 and LC 90) of each treatment was estimated by Probit analysis (X^2; P < 0.0001) and fiducial limits values of CNS extract agains *B. tabaci* nymphs of different stages are summarized in table 2.

Table 2. Lethal concentration of CNS extract (antifeedant active compound) compared with imidaclorpid (neurotoxic insecticide) against *B. tabaci* nymphs (first to third instars).

| Compounds (%) | Stage instar | LC  | EV  | CI  | χ^2 |
|---------------|--------------|-----|-----|-----|-----|
| Imidacloprid  | 1st          | 50  | 9.82| 8.01to 12.41| 14.10|
|               | 90           | 15.23| 13.46 to 19.01| |
|               | 2nd          | 50  | 9.73| 7.62 to 12.33| 13.65|
|               | 90           | 14.25| 11.88 to 18.28| |
|               | 3rd          | 50  | 11.43 (0.26) | 9.28 (0.21) to 15.41 (0.33) | 10.22|
|               | 90           | 25.21 (0.53) | 19.08 (0.47) to 22.86 (0.49) | |
| CNS (0.22 %)  | 1st          | 50  | 25.21 (0.53) | 19.08 (0.47) to 22.86 (0.49) | 10.22|
|               | 90           | 6.75 (0.14) | 5.85 (0.11*) to 8.41 (0.16*) | 12.25|
|               | 2nd          | 50  | 11.01 (0.26) | 9.57 (0.22*) to 17.20 (0.43*) | 9.85|
|               | 90           | 6.45 (0.14) | 5.28 (0.10*) to 7.00 (0.13*) | 9.85|
|               | 3rd          | 50  | 10.98 (0.25) | 8.95 (0.17*) to 12.80 (0.27*) | 9.85|
| CNS (0.67 %)  | 1st          | 50  | 19.18 (0.47) | 19.55 (0.23*) to 16.19 (0.31) | 21.18|
|               | 90           | 30.42 (0.44) | 27.61 (0.41*) to 32.75 (0.46) | |
|               | 2nd          | 50  | 19.82 (0.48) | 18.02 (0.46*) to 23.11 (0.50) | 26.40|
|               | 90           | 21.25 (0.49*) | 14.78 (0.28*) to 19.46 (0.47*) | |
|               | 3rd          | 50  | 18.25 (0.46) | 15.75 (0.34*) to 19.42 (0.47*) | 20.01|
|               | 90           | 19.05 (0.47) | 16.86 (0.32*) to 21.07 (0.48*) | |
| CNS (2.00 %)  | 1st          | 50  | 68.95 (0.85) | 57.42 (0.74*) to 74.45 (0.89) | 33.57|
|               | 90           | 81.17 (0.92*) | 77.65 (0.90*) to 82.17 (0.93*) | |
|               | 2nd          | 50  | 66.82 (0.84*) | 55.42 (0.72*) to 68.45 (0.85*) | 33.02|
|               | 90           | 79.17 (0.91) | 75.65 (0.89*) to 78.17 (0.90) | |
|               | 3rd          | 50  | 20.15 (0.48) | 18.70 (0.46*) to 22.12 (0.49) | 29.98|
|               | 90           | 22.45 (0.49) | 19.96 (0.47*) to 21.27 (0.48) | |
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The effect of lettuce and tomato germination that was caused by bioactive compounds, viz. anacardic acid and Glycine max concentration of 6% caused phytotoxic, viz. brown spot on leaves, whirling followed by the death of cardol. Cashew nut shell liquid (CNSL) could be delayed larva and pupal periods of mortality of first instar stage than the other instars. Neem oil at concentration of 1.00% could kill plant tissues.

\[ \chi^2 \text{scale with significance level at 95\% confidence limits; C, CNS extract concentration} \]

Cashew nut shell liquid compounds can be prevented ingestion of instar nymphs. Based on the qualitative observation, at concentration of 2.00% (X^50_2 = 29.98; df = 5), at concentration of 0.67% (X^50_2 = 13.65; df = 5) showed the toxicity against the third instar nymph.

The previous studies have been carried out using neem oil at concentration of 1.00% higher mortality of first instar stage followed by CNS extract at concentration of 6.00%, 0.67%, imidacloprid, and CNS at concentration of 0.22%, respectively. The lethal concentration (LC50) value of the CNS extract at concentration of 6.00% (X^50_2 = 31.16; df = 5), at concentration of 2.00% (X^50_2 = 29.98; df = 5), at concentration of 0.67% (X^50_2 = 20.01; df = 5), imidacloprid (X^50_2 = 13.65; df = 5) showed the toxicity against the third instar nymph.

### 4. Discussion

The toxicity contained in the CNS extract will increase, if the concentrations used are the highest, so the physiological and developmental processes of the nymph are disrupted, but its reduced the number of third instar nymphs. No efficiency of mortality was recorded in the control treatment (0.00). A mortality rate of over 90% was observed for the first and second instars at concentration of 2.00 and 6.00%. Both first and second instars had higher mortality than the third instar. The third mortality percentage decreased to less than 90%. Cashew nut shell compounds can penetrate into the leaves to cause antifeedant effect of early instar after the hatching of viable eggs and toxic effect. These compounds can be prevented ingestion of instar nymphs. Based on the qualitative observation, at concentration of 6% caused phytotoxic, viz. brown spot on leaves, whirling followed by the death of plant tissues.

The previous studies have been carried out using neem oil at concentration of 1.00% higher mortality of first instar stage than the other instars. Neem oil at concentration of 1.00% could kill over 80% of the first to third instar stages without phytotoxic effect of Phaseolus vulgaris L. and Glycine max L. plants in a greenhouse [7]. Increasing cashew nut shell liquid extract had negative effect of lettuce and tomato germination that was caused bioactive compound, viz. anacardic acid and cardol. Cashew nut shell liquid (CNSL) could be delayed larva and pupal periods of Helicoverpa armigera Hübner. It has been either shown that toxic effect of CNS extract has activity as antifeedant compound of CNS extract and imidacloprit. Therefore, the lethality of CNS extract is confirmed on stage instar of B. tabaci depending on the concentration evaluated. Mortality of B. tabaci was not restricted to the first instar nymphs. Lethal effect on the second instar nymphs stage is also apparent after application with CNS extract compound at concentration of 2.00%. Here, the toxicological

### Table 2. Continued.

| Compounds (%) | Stage instar | LC50 | EV | CI | \( \chi^2 \) |
|---------------|--------------|------|----|----|------------|
| CNS (6.00 %)  | 1\textsuperscript{st} | 50   | 85.95 (0.95) | 93.80 (0.98) to 95.15 (1.75) | 33.51 |
|               | 2\textsuperscript{nd} | 90   | 91.15 (0.97) | 93.65 (0.98) to 97.28 (1.28) | 31.42 |
|               | 3\textsuperscript{rd} | 90   | 89.45 (0.96) | 91.22 (0.97) to 95.55 (1.03) | 31.16 |

\[ \text{LC}_{50} \text{ and LC}_{90} \text{ concentration of CNS extract causing 50\% and 90\% mortality, respectively; Fiducial limits based on a log scale with significance level at 95\% confidence limits; C, CNS extract concentration; } \chi^2, \text{ Chi square value for lethal concentration.} \]

The LC50 and LC90 values with their limits at 95% confidence interval indicated that CNS extract at concentration of 2.00% (X^50_2 = 33.57%; df = 5) was the most toxic compound to the first instar stage followed by CNS extract at concentration of 6.00%, 0.67%, imidacloprid, and CNS at concentration of 0.22%, respectively. The lethal concentration (LC50,90) value of CNS extract at concentration of 6.00% (X^50_2 = 31.16; df = 5), at concentration of 2.00% (X^50_2 = 29.98; df = 5), at concentration of 0.67% (X^50_2 = 20.01; df = 5), imidacloprid (X^50_2 = 13.65; df = 5), CNS extract at concentration of (X^50_2 = 9.85; df = 5) showed the toxicity against the third instar nymph.

The LC50 and LC90 values were lower than CNS compound. The lethal concentration (LC50,90) values were indicator to the level resistance of instar stages without phytotoxic effect of Phaseolus vulgaris L. and Glycine max L. plants in a screenhouse [7]. Increasing cashew nut shell liquid had negative effect of lettuce and tomato germination that was caused bioactive compound, viz. anacardic acid and cardol. Cashew nut shell liquid (CNSL) could be delayed larva and pupal periods of Helicoverpa armigera Hübner. It has been either shown that toxic effect of CNS extract has activity as antifeedant compound of CNS extract and imidacloprit. Therefore, the lethality of CNS extract is confirmed on stage instar of B. tabaci depending on the concentration evaluated. Mortality of B. tabaci was not restricted to the first instar nymphs. Lethal effect on the second instar nymphs stage is also apparent after application with CNS extract compound at concentration of 2.00%. Here, the toxicological
selectivity of CNS extract compound target are suitable as botanical insecticide for organic agriculture. It showed that CNS extract at concentration of 2.00 % could be developed as source of botanical insecticide to reduce the number of first to second instar nymphs of *B. tabaci* on soybean plant. On the other hand, CNS extract at concentration of 2.00 % as a botanical pesticide has many excellent attributes including its rapid degradation in the environment, and no phytotoxicity effect on the leaves of soybean seedlings. However, these botanical insecticides should not be considered to be the only solution. They may have toxic effects on parasitoids and predators [11].

5. Conclusion
First and second instar nymphs are more susceptible to CNS extract at concentration of 2.00 % than third instar nymphs. Cashew nut shell extract at concentration of 2.00 can reduce the population of first to second nymphal instars of *B. tabaci* by over 90 %, and no phytotoxicity effect on the leaves of soybean seedlings. The lethality of CNS extract is confirmed on stage instar of *B. tabaci* depending on the concentration. CNS extract at concentration of 2.00 % could be developed as source of botanical insecticide to reduce the number of first to second instar nymphs of *B. tabaci* on soybean plant.

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References
[1] Andayanie W R, Santosa V and Rahayu M 2017 Resistance to *Soybean mosaic virus* with high yield on F7 soybean lines *Int. J. Agric. Biol.* 19 226–32 [http://www.fspublishers.org/published_papers/97341...](http://www.fspublishers.org/published_papers/97341...)

[2] Mahapatro G K 2011 Insecticidal activity of cashew nut shell liquid against two Lepidoptera pest *Indian J. Entomol.* 73 121–24 [http://www.indianjournals.com/ijor.aspx?target=ijor:ije&volume=73&issue=2&article=007](http://www.indianjournals.com/ijor.aspx?target=ijor:ije&volume=73&issue=2&article=007)

[3] Morais S M, Silva K A, Araujo H, Vieira I G P, Alves D R, Fontenelle ROS and Silva AMS 2017 Anacardic acid constituents from cashew nut shell liquid NMR characterization and the effect of unsaturation on its biological activities *Pharmaceuticals* 10(1) 1–10 [https://www.ncbi.nlm.nih.gov/pubmed/28300791](https://www.ncbi.nlm.nih.gov/pubmed/28300791)

[4] Andayanie W R, Nuriana W and Iswati R 2019 Use tillage system and botanical herbicide of cashew nut shell extract on losses nutrient and organic matter in the sloping land *Proc. 4th Int. Symp. Appl. Chem. 2018 AIP Conf. Proc.* 2024, 020018 1–6 [https://aip.scitation.org/doi/pdf/10.1063/1.5064304](https://aip.scitation.org/doi/pdf/10.1063/1.5064304)

[5] Martinez L C, Plata R A, Zanuncio J C and Serrao J E 2015 Bioactivity of six plant extracts on adults of *Demotispa neivai* (Coleoptera: Chrysomelidae). *J. Insect Science* 15(1) 1–5 [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4535497/](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4535497/)

[6] SAS Institute Inc 2004 *SAS/STAT 9.1 User’s Guide* (Cary: SAS Institute) ch. 2, 3 pp 25–69 [https://support.sas.com/documentation/onlinedoc/91pdf/sasdoc_91/stat_ug_7313.pdf](https://support.sas.com/documentation/onlinedoc/91pdf/sasdoc_91/stat_ug_7313.pdf)

[7] Pinheiro P A, Quintela E D, Pereira de Oliveira J and Seraphin J C 2009 Toxicity of neem oil to *Bemisia tabaci* biotype B nymphs reared on dry bean *Pesq. Agropec. Bras.* 44(4) 354–60 [http://www.scielo.br/scielo.php?pid=S0100-204X2009000400004&script=sci_abstract](http://www.scielo.br/scielo.php?pid=S0100-204X2009000400004&script=sci_abstract)

[8] Matias R, Rosa C R, Oliveira A K B M, Pereira K C L, Rizzi E S and Machado A A 2017 Cashew nut shell liquid and formulation: Toxicity during the germination of lettuce, tomato seeds, and coffee senna and seedling formulation *Acta Scientiarum* 39(4) 487–95 [https://www.redalyc.org/articulo.oa?id=303055078009](https://www.redalyc.org/articulo.oa?id=303055078009)

[9] Silva G C D B, Silva M A, Vendramim J D and Dias C T D S 2012 Insecticidal and behavioral effects of secondary metabolites from Meliaceae on *Bemisia tabaci* (Hemiptera: Aleyrodidae) *Florida Entomologist* 95(3) 743–51
https://bioone.org/journals/Florida-Entomologist/volume-95/issue-3/024.095.0325/Insecticidal-and-Behavioral-Effects-of-Secondary-Metabolites-from-Meliaceae-On/10.1653/024.095.0325.full

[10] Isman M B 2006 Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world *Annu. Rev. Entomol.* **51** 45–66
https://www.ncbi.nlm.nih.gov/pubmed/16332203

[11] Tunca H, Kilincer N and Özkan C 2014 Toxicity and repellent effects of some botanical insecticides on the egg-larval parasitoid *Chelonus oculator* Panzer (Hymenoptera: Braconidae) *Sci. Res. Essays* **9**(5) 105–13
http://www.academicjournals.org/app/webroot/article/article1395664135_Tunca%20et%20al.pdf