Effect of a botanical oil (citral) against the cottony camellia scale, Pulvinaria floccifera Westwood (Hemiptera: Coccidae)

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ABSTRACT

Toxic substances used for pest control can cause serious problem such as toxicity in humans, animals and environmental pollution. Therefore development of safer compounds is essential to reduce pesticides hazard. In this research, the efficacy of botanical oil, citral (orange peel extract) was compared with chlorpyrifos (organophosphate insecticide) for control of the cottony camellia scale, Pulvinaria floccifera Westwood (Hemiptera: Coccidae). The experiment was performed with 3 replications and 4 treatments including chlorpyrifos, citral, chlorpyrifos+ citral and water (control). Each compound was applied at the maximum recommended field concentration: chlorpyrifos 2 ml/1Lit and citral 10 ml/1Lit against 1-day-old 2nd instars nymphs of P. floccifera. Spraying was done by a hand sprayer on leaves of Euonymus sp. infested with P. floccifera. The number of live nymphs of P. floccifera was counted after randomly selecting 30 leaves for each treatment after 3, 7, 14 and 21 days post-treatment. Corrected mortality and mean comparison was determined by using the Henderson-Tilton formula and Tukey test at 0.01% probability level, respectively. Based on the results a single application of citral in control of P. floccifera population was more effective than a single application of chlorpyrifos. Insecticidal activity of chlorpyrifos increased in combination with citral oil. So, chlorpyrifos+citral treatment found to be effective than two other treatments in reducing of P. floccifera population. The highest mean mortality percent of P. floccifera nymphs (73.7%) caused by chlorpyrifos+citral all days after treatments. However, no significant differences were obtained 7, 14 and 21 days after spray among treatments. This shows that citral can be effective alternative to harmful synthetic insecticide, chlorpyrifos for control of P. floccifera.

Key words: botanical oil, the cottony camellia scale, Euonymus, chlorpyrifos, citral

1. INTRODUCTION

The genus *Pulvinaria* (Coccidae) contains more than 100 described species of which 25 species have been recorded from the New World [1]. *Pulvinaria* has also a variety of hosts including ornamental plants such as *Euonymus* sp. [2]. Nymphs and adult females feed on leaves and twigs and result in production of large amounts of honeydew and the growth of black sooty mold. It causes the weakness of the host plant, leaf loss and slow dieback of twigs and branches [3]. Chlorpyrifos (Organophosphate insecticide) is the commonly used insecticide to control *Pulvinaria* in Iran [4]. The extensive and repeated use of insecticides against the pest [5] can cause serious problem such as possible toxicity in humans and animals and also environmental pollution. Therefore, it is necessary to find alternative compounds to control pests in the shade of integrated pest management (IPM) concept. According to Kim *et al*. [6], oils can control a range of pests and can replace synthetic pesticides. The aim of this study was to evaluate the efficacy of botanical oil, citral (orange peel extract) against *P. floccifera* compared with chemical insecticide, chlorpyrifos to find a new approach decreasing environmentally hazardous compounds.

2. Material and methods

This study was carried out outdoor on *Euonymus* plants approximately 10 years old planted in the pots infested with 1-day-old 2nd instars nymphs of *P. floccifera*. Chlorpyrifos (40.8% EC) and the botanical oil, citral (80% EC) were prepared at the maximum recommended field concentrations: chlorpyrifos 2 ml/1Lit and citral 10 ml/1Lit. Test was performed with complete randomized blocks with 3 replications (2 pots for each replication) and 4 treatments including chlorpyrifos, citral, chlorpyrifos+ citral and water (control). Each one sprayed on both sides of leaves by a hand sprayer until run-off. The sampling was carried out a day before test and 3, 7, 14 and 21 days post-treatment. For sampling of each treatment, 30 leaves were randomly picked (ten leaves for each replication). The numbers of live nymphs of *P. floccifera* on lower side of each leaf were counted in the laboratory under a stereomicroscope and recorded. The mortality rate was obtained and data was corrected by Henderson-Tilton formula [7].

The analysis of data was performed using SAS software and the comparison of means by Tukey's test ($P \leq 0.01$). For normalization the data obtained from the number of live nymphs of *P. floccifera* and percentage data were transformed by sqrt and Arc sine √percentage, respectively. One-way analysis of variance was applied to analyze the percentage data.

3. RESULTS

The results showed that the tested insecticides decrease the number of *P. floccifera* nymphs at days post-treatment compared with the control (Table 1). There were significant differences among treatments 3 ($F = 50.78$, df =3,8, $p = 0 < 0001$), 7 ($F = 29.59$, df =3,8, $p = 0.001$) and 14 ($F = 14.41$, df =3,8, $p = 0.001$) days post-treatment. While 21 days after treatment, no significant differences was observed among treatments ($F = 6.24$, df =3,8, $p = 0.017$). It found that citral is more successful than chlorpyrifos against *P. floccifera* population. The mean numbers of nymphs treated by citral were less than the mean numbers of nymphs treated by chlorpyrifos. Chlorpyrifos+citral treatment was found to be effective than two other treatments in reducing of *P. floccifera* population.

Table 1. *Mean number of Pulvinaria floccifera nymphs one day before test and 3, 7, 14 and 21 days post-treatment by chlorpyrifos, citral and chlorpyrifos+ citral*

Treatments	Concentration (ppm)	1 DBT	3 DAT	7 DAT	14 DAT	21 DAT
Control	-	37±3.7	41±2.08 a	44.6±2.4 a	29.3±2.9 a	31.3±4.9 a
Chlorpyrifos	2000	36±3.05	28.3±2.1 b	27.5±2.8 b	14. 3±2.3 b	22.3±3.1 a
Citral	10000	31.24±2.4	16±1.15 c	13±2.3 b	12±1.5 b	15±1.7 a
Chlorpyrifos+ Citral	2000+10000	41.24±2.08	15±1.1 c	13.8±0.31 b	11.3±1.8 b	16±2.5 a

DBT: Day before treatment
DAT: Day after treatment
Note: Means ± SX in columns followed by different letters differ significantly ($P \leq 0.01$).

The corrected mean percentage of mortality of *P. floccifera* nymphs, which were subjected to chlorpyrifos, citral and chlorpyrifos+citral, is shown in Figure 1. The highest mortality percent of *P. floccifera* nymphs treated by chlorpyrifos (42.2%) was obtained 14 days after treatment. Citral and chlorpyrifos+citral treatments caused the highest mortality 7 days after treatment 64.6% and 73.7% respectively. As shown in figure 1 the means of mortality of *P. floccifera* nymphs treated by citral were higher than the means of mortality caused by chlorpyrifos. But insecticidal activity of chlorpyrifos increased in combination with citral. So, among treatments the highest mean mortality of *P. floccifera* nymphs caused by chlorpyrifos+citral at days after treatments. A comparison of mean percentages of mortality showed that in the 3 days post-treatment sampling, there were significant differences among treatments ($F = 48.76$, df =2,6, $p = 0.0002$). While no significant differences were obtained 7 ($F = 4.63$, df=2,6, $p = 0.06$), 14 ($F = 1.81$, df =2,6, $p = 0.24$) and 21 ($F = 2.11$, df =2,6, $p = 0.2$) days after treatment.

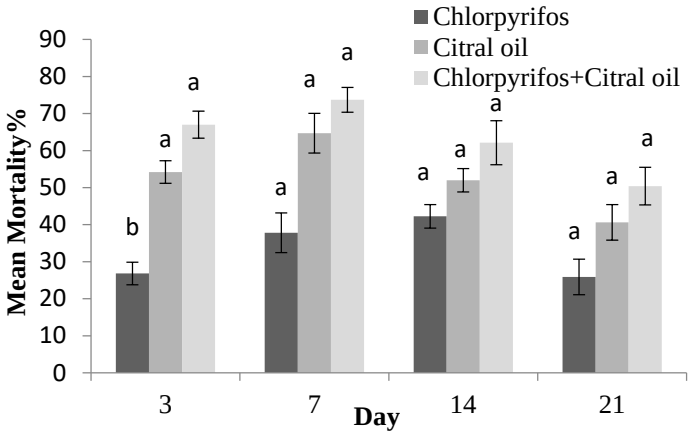

Fig. 1. *Means (±SX) percentage of mortalities of Pulvinaria floccifera nymphs at different times post-treatment (3, 7, 14 and 21 days)*
Note: Means ± SX in each day with the same letter are not significantly different (P ≤ 0.01)

4. DISCUSSION

In this study, a single application of citral in control of *P. floccifera* population was more effective than a single application of chlorpyrifos. Similar to the results, oil showed a considerable reduction (99.2%) when used on the soft scale *P. psidii* Maskell [8]. Citral is orange peel extract in vegetable oil and recommend to control of some insects including scales. Insecticidal activity of orange peel oil reported by some researchers [9; 10]. Oils gave excellent results against insects and mites [11]. The compounds found to be effective for controlling scale insects [12]. The successful control of two scale insects; *Lepidosaphes beckii* Newman and *Parlatoria ziziphus* Lucas occurred by oil usage [13]. Mineral oil gave 89.5%, 90.2% and 90% reduction in the population of nymphal stages of the nigra soft scale, *Parasaissetia nigra* Nietner, after the 1st week, 2nd week and 3rd week of application, respectively. Also, the compound caused 87.7%, 86.6% and 93.3% reduction in the population of nymphal stages of the camellia soft scale, *P. floccifera* Westwood after the 1st week, 2nd week and 3rd week of application, respectively [14].
The results of the present study showed that insecticidal activity of chlorpyrifos increased in combination with citral. El-Kifl *et al.* [15] indicated that organophosphorus insecticides when added to mineral oil gave better results in controlling the Latania scale, *Hemiberlesia latania* Signort. Malathion caused a reduction of 85.1% against Egyptian fluted mealybug, *Icerya aegyptiaca* Douglas. The insecticide mixture with oil increased mortality up to 90% [16]. The insecticides parathion, methidathion, fenoxycarb and imidacloprid when combined with mineral oil increased the toxicity on the mulberry scale *Pseudaulacaspis pentagona* Targioni-Tozzetti [17].
In this study when oil spray and synthetic insecticide were compared, there were not differences in their abilities to suppress the *P. floccifera* infestation. It demonstrated that citral alone can be effective to control *P. aurantii*. A similar result was obtained by Damavandian [18] when the efficacy of mineral oil (1L/100L) against *P. aurantii* was compared with conventional insecticides. In other study, the efficacy of mineral oil spray to control the citrus leafminer, *Phyllocnistis citrella* Stainton was compared with the insecticides, imidacloprid and chlorpyrifos. Mineral oil spraying provided adequate control and it was reported that oil can replace the synthetic pesticides that are applied in the citrus orchards [19].
In fact, chemical compounds are unsafe in controlling pests as they are one of the major reasons in the environmental pollution and cause a chronic diseases for humans and harmful for most of the living organisms [20]. Chlorpyrifos is an organophosphate insecticide used to control of many scale insects including *P. floccifera* in Iran. It is reported that the insecticide had low selectivity to natural enemies [21; 22]. In contrast plant-based compounds can control pests effectively and are less harmful for the environment, people and non-

target organisms [23]. Insecticidal activity has been demonstrated in many plants [24]. Many botanical extracts have been reported to be a powerful pesticide against pests. A 3000 ppm dose of tondexir (Hot red pepper extract in edible oil) and palizin (Coconut soap 65%) caused 90.6% and 89.1 % mortality on the citrus mealybug *P. citri*, respectively [25]. Manjri [26] indicated that azadirachtin (2ml/L) was effective against *P. citri*.

Citral as a plant-based compound showed effectiveness in control of *P. floccifera* without symptoms of phytotoxicity. In agreement with the result no phytotoxicity reported on the treated plants when mineral oil used in controlling soft scale insect [8]. Also, oils found to be less disruptive to natural enemies including parasitoids and predators than broad spectrum insecticides [27]. Liu and Stansly [28] stated that mineral oils have low toxicity to parasitoids and predators of whiteflies.

5. CONCLUSION

According to the finding plant-based compound, citral can be effective alternative to synthetic insecticide, chlorpyrifos for control of *P. floccifera*. Therefore, this extract, as botanical pesticide, can be an important and promising tool in integrated pest management program of *P. floccifera.* However it recommends doing more tests to evaluate the effects of citral on natural enemies of *P. floccifera*.

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