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Efficacy of neem oil and turmeric powder against *Sitobion avenae* and *Rhopalosiphum padi*

S. Bushra[1*], M. Tariq[1], M. Naeem[1], M. Ashfaq[2]

[1]*Department of Entomology, Pir Mehr Ali Shah, Arid Agriculture University, Rawalpindi, Pakistan*

[2]*Department of Plant Pathology, Pir Mehr Ali Shah, Arid Agriculture University, Rawalpindi, Pakistan*

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Abstract

Aphids are considered to be serious pests of arable crops. They remove photoassimilates from crop plants. They are responsible for viral diseases in crops by transmission of a number of plant viruses. The present study was carried out to observe the efficacy of neem and turmeric extracts against two aphid pest species, i.e. *Sitobion avenae* (F.) and *Rhopalosiphum padi*. Wheat (*Triticum aestivum*) of variety (Fareed-06) were grown in pots in glasshouse. Both aphid species were allowed to infest wheat plants separately. Twenty aphids per plant were released on 6-week plants and whole pots were covered with polythene sheets. Two weeks later neem and turmeric extract were applied separately at different concentrations (0, 1, 2, 2.5 and 3 %). Twenty four hrs later, mortality data was recorded. It was found that mortality of *S. avenae* was maximum (77.56%) at 3% concentration of neem oil after 24hrs which was statistically similar to mortality of *R. padi* (77.88%) at 3% concentration of neem oil after 24hrs. Similar results were found after 48 hrs of application of plant extracts, where both aphid species had highest mortality at 3% concentration of neem oil. Mortality of *S. avenae* was maximum (90.58%) 3% concentration of turmeric powder after 24hrs which was statistically similar to mortality of *R. padi* (90.38%) at 3% concentration of turmeric powder after 24hrs. Similarly, mortality of *S. avenae* and *R. padi* at 3% turmeric powder concentration was maximum (92.94%) (93.38%) after 48hrs. The results revealed that neem oil and turmeric powder at 3% concentration can be used for efficient aphid control in wheat plants.

* **Corresponding Author:** S. Bushra ✉ bushraentomologist@gmail.com

Introduction

English grain aphid, *Sitobion avenae* (Hemiptera: Aphididae) is a serious pest of wheat crop. It is considered as most dominant aphid specie of wheat crop. *S. avenae* infests the mature leaves and spikes of wheat plants (Tradan and Mileroj, 1999). It was found that aphid cause yield loss upto 20-80% (Akhtar *et al.,* 2010). Voss Todd *et al.* (1997) reported that *R. padi* cause 19-31% yield losses at boot stage and 15-20% at flowering stage respectively. The bird cherry-oat aphid, *Rhopalosiphum padi* (Hemiptera: Aphididae) is one of the major devastating pests in cereal crops (Qureshi and Michaud, 2005; Bailey, 2007). *R. padi* is responsible for leaf deformation, nutrient and grain loss and transmittion of Barley yellow dwarf virus in wheat (Fabre *et al.,* 2006; Borer *et al.,* 2009).

Turmeric, *Curcuma longa* (Zingiberales: Zingiberaceae) has pesticidal properties against insects and parasitic fungi (Damalas, 2011). *Azadirachta indica* (Sapindales: Meliaceae) A. Juss. (L.) is a potential bio-insecticide (El Shafie and Basedow, 2003). All parts of *A. indica* tree, i.e. bark, leaves and fruit are toxic to insect pests (Dimetry, 2012; Amadioha, 2000; Montes-Molinaa *et al.,* 2008). Schmutterer and Singh (2002) reported that about 540 insect pest species of agricultural crops are susceptible to *A. indica*. Digilio *et al.* (2008) and Sampson *et al.* (2005) reported the toxic effects of plant essential oils of *A. indica, Eucalyptus camaldulensis* and *Laurus nobilis* on different aphid species. Kraiss and Eileen (2008) reported that application of neem products i.e. essential oil and seed oil is responsible for significant mortality rate in *Aphis glycines*.

Use of synthetic insecticides for aphid control is unsuitable in wheat due to the presence of pesticide residues, development of insecticide resistance and environmental pollution (Ambethar, 2009). Previous research indicated the successful use of plant materials such as plant powders, spices, oils and extracts for pest control (Akinneye *et al.,* 2006). Use of botanical insecticides has low persistency in environment and little mammalian toxicity as compared to synthetic insecticides (Nerio *et al.,* 2009). These materials are toxic to insect pests and inhibit their reproduction (Emeasor *et al.,* 2005; Mahdi and Rahman, 2008).

Under the umbrella of above mentioned points, this experiment was conducted to examine the effect of plant extracts, neem and turmeric on aphid species, i.e. *Sitobion avenae* and *Rhopalosiphum padi* in wheat plants. This study will encourage the production of neem and turmeric based bio-pesticide under integrated pest management programs.

Materials And methods

This experiment was carried out in Pir Mehar Ali Shah Arid Agriculture University, Rawalpindi, Pakistan. All the experiments were performed in Oct 2013-Feb 2014.

Cultivar Selection

Two wheat cultivars were selected for this experiment. One of them was tolerant (Fareed-06) to aphid pests and other was susceptible (Uqab-2000) (Hussain *et al.,* 2010). These both cultivars were collected from NARC, Islamabad.

Study Species

Two aphid species, i.e. *Sitobion avenae* and *Rhopalosiphum padi* were used as study species in this experiment. All the experiments were performed in glasshouse situated in experimental field area.

Experimental Layout

Susceptible wheat variety (Uqab-2000) seeds were sown in 50 pots. These pots were placed outside the glasshouse to allow the natural environmental conditions. Aphid species, *S. avenae* and *R. padi* were collected from naturally infested cereal field crops grown in Pir Mehr Ali Shah, Arid Agriculture University, NARC field area and Koont Research Farm. Aphids were collected in glass vials gently with camel hair brush. Aphid cultures were maintained on (Uqab-2000). These aphid cultures were used in the main experiment described further.

Wheat seeds of variety (Fareed-06) were sown in 10 pots having 10 cm diameter. The experiment was conducted following CRD, comprising 5 treatments and 5 replications. About 50 seeds per plant were sown. All the experiments were carried out under controlled conditions (25 ± 2 °C) and 65% RH under an LD 16:8 h. Seeds were germinated after 4-6 days. After 6 weeks of germination the wheat plants were attained the average height of 50cm.

Twenty aphids per plant were released in 6-week old (Fareed-06) plants. Out of hundred pots, fifty pots were subjected to *S. avenae* infestation while rest of fifty pots were subjected to *R. Padi* infestation. Aphid infested wheat plants were enclosed with ventilated polythene sheets (18×6 cm). These polythene sheets help to avoid accidental aphid infestation and their escape. Two weeks later, the aphid population was maintained 100 per plant, rest of aphids were removed by using camel hair brush. At this stage, neem and turmeric extracts were applied at different concentrations (Table 1,2).

2.4 Extraction Of Neem Oil

Neem oil was obtained by crushing neem seeds in a single-screw vegetable oil expeller with a three-phase motor (Musabyimana *et al.*, 2001).

Preparation of Different Concentrations of Neem Extract

Emulsions of neem oil of five concentrations (0, 1, 2, 2.5 and 3 %) were prepared by method prescribed by (Musabyimana *et al.,* 2001). Neem extract was prepared from the stock solution by addition of calculated amount of distilled water (vol:vol) and 1% of a liquid detergent was added to it.

Application of Neem Extract

Hundred aphids per plant were left behind on 8-week (Fareed-06) wheat plants. After removing the extra aphids from wheat plants, these plants were sprayed with prepared neem extract separately. All emulsions were sprayed via spray bottle. Wheat plants were allowed to be air dried for 30 minutes after the application of above mentioned treatments.

Preparation of Different Concentrations of Turmeric Extract

Turmeric extracts at different concentrations were prepared by the method prescribed by (Musabyimana *et al.,* 2001). Turmeric extract were prepared in such a way that the known quantities of turmeric powder were soaked in a beaker containing distilled water and stirred overnight by using a magnetic stirrer. The suspensions were strained through fine and clean cheesecloth. Five treatments of turmeric powder with different concentrations (0, 1, 2, 2.5 and 3 %) were prepared from the stock solution by adding calculated amount of distilled water.

Application of Turmeric Extract

Hundred aphids per plant were left behind on 6 week (Fareed-06) wheat plants. After removing the extra aphids from wheat plants, these plants were sprayed with prepared turmeric extract separately. All emulsions were sprayed via spray bottle. Wheat plants were allowed to be air dried for 30 minutes after the application of above mentioned treatments.

Mortality and Repellency Data Collection

Mortality and repellency data of *S. avenae* and *R. padi* were collected after 24 hours of application of both plant extracts (Table 1,2). This data was further subjected to statistical analysis.

Percent corrected mortality was calculated by formula described by Abbott (1925).

% corrected mortality =

$$\frac{\text{Observed Mortality - control Mortality}}{\text{100 - \%control Mortality}} \times 100$$

Statistical Analysis

The data regarding to aphid mortality subjected to statistical analysis. Statistical programme R 2.15.2 (R Development Core Team, 2013) was used to determine ANOVA. The data obtained was subjected to HSD test at 5% level of significance to compare the difference among the means.

Results

From (Table 1), an interaction was found among two

aphid species, plant extracts and concentrations dipicted a significant effect on aphid mortality in 24 hrs (F=2.93, df=4, P<0.05). A highly significant difference was found among both aphid species and concentrations after 24 hrs (F=5.07, df=4, P<0.001). This means that aphid mortality increases with increase in plant extract concentration (Fig 1,2). There was no significant difference in mortality of *R. padi* and *S. avenae* in control (Fig 1,2). A significant difference was found among treatments of both plant extracts and control after 24 hrs of application (Fig 1,2).

Table 1. ANOVA of *Sitobion avenae* and *Rhopalosiphum padi* mortality in 24 and 48 hrs after neem and turmeric application.

Source of Variation	*Df*	F-value	
		Aphid mortality in 24 hrs	Aphid mortality in 48 hrs
Aphid Species (A)	1	3.18·	4.761*
Plant extracts (B)	1	563.17***	1589.611***
Concentrations (C)	4	18331.36***	29522.068***
A × B	1	2.47	0.019
A × C	4	5.07***	5.82***
B × C	4	106.309***	76.280***
A × B × C	4	2.93*	0.22
Residuals	980		

*** P<0.001, ** P<0.01, * P<0.05, · P< 0.1 and P<1.

From (Table 1), an interaction was found among two aphid species, plant extracts and concentrations dipicted a significant effect on aphid mortality in 48 hrs (F=0.22, df=4, P<1). A highly significant difference was found among both aphid species and concentrations after 48 hrs (F=5.82, df=4, P<0.001). This means that aphid mortality increases with increase in plant extract concentration (Fig 3,4).

Table 2. Showing the mean and mean corrected mortality of *Sitobion avenae* and *Rhopalosiphum padi* after different concentrations of neem within 24 and 48 hrs of application.

Neem oil	*Sitobion avenae*		Mean % corrected mortality		*Rhopalosiphum padi*		Mean % corrected mortality	
	24 hrs	48 hrs	24 hrs	48 hrs	24 hrs	48 hrs	24 hrs	48 hrs
Control	4.86 ± 0.14i	10.0 ± 0.18i	-	-	4.24 ± 0.17i	10.58 ± 0.19i	-	
1	22.04 ± 0.31h	33.58 ± 0.20h	19.01	29.43	22.38 ± 0.33h	33.2 ± 0.24h	19.82	28.67
2	42.48 ± 0.26f	48.6 ± 0.19f	41.67	48.25	42.24 ± 0.52f	48.66 ± 0.18f	41.52	48.20
2.5	57.60 ± 0.29d	63.48 ± 0.10d	58.41	66.87	58.12 ± 0.25d	63.7 ± 0.16d	58.87	65.24
3	77.56 ± 0.29b	84.52 ± 0.21b	80.52	93.20	77.88 ± 0.27b	84.5 ± 0.19b	80.46	93.81

Treatment means sharing a letter are not significantly different from each other (Tukey's at $P < 0.05$).

Aphid Mortality after neem application

The present study was conducted to study the impact of various concentrations of two plant extracts on two wheat aphid species in two observations. It was found that *Sitobion avenae* exhibited minimum mean mortality (4.86%) and (10.0%) in untreated control in 1st and 2nd observation respectively. The mean mortality of *S. avenae* was found (22.04%) and (33.58%) after 24 and 48 hrs of neem application at 1% concentration respectively. It was found that mean mortality of *S. avenae* was increased to (42.48%) and (48.6%) at 2% neem concentration in 1st and 2nd observation respectively. The *S. avenae* exhibited mean mortality (57.60%) and (63.48%) at 2.5%

concentration after 24 and 48 hrs of neem application. The maximum mean mortality of *S. avenae* was observed at 3% neem concentration. The mean mortality of *S. avenae* was (77.56%) and (84.52%) after 24 and 48hrs of 3% neem oil concentration respectively. The overall mean mortality of *S. avenae* was ranged from (4.86%) to (77.56%) after 1st observation. While, the overall mean mortality of *S. avenae* was ranged from (10.0%) to (84.52%) after 2nd observation (Table 2).

Table 3. Showing the mean and mean corrected mortality of *Sitobion avenae* and *Rhopalosiphum padi* after different concentrations of turmeric within 24 and 48 hrs of application.

Turmeric powder	*Sitobion avenae*		Mean % corrected mortality		*Rhopalosiphum padi*		Mean % corrected mortality	
	24 hrs	48 hrs	24 hrs	48 hrs	24 hrs	48 hrs	24 hrs	48 hrs
Control	4.48 ± 0.14i	10.94 ± 0.22i	-	-	4.1 ± 0.13i	11.6 ± 0.25i	-	
1	33.60 ± 0.32g	44.52 ± 0.21g	31.98	49.64	33.82 ± 0.32g	44.48 ± 0.17g	32.36	42.81
2	52.18 ± 0.28e	58.64 ± 0.17e	52.39	61.07	52.50 ± 0.28e	58.58 ± 0.16e	52.72	61.15
2.5	73.12 ± 0.24c	78.62 ± 0.10c	75.41	65.38	73.14 ± 0.24c	78.46 ± 0.19c	75.21	65.60
3	90.58 ± 0.19a	92.94 ± 0.10a	94.50	105.04	90.38 ± 0.21a	93.28 ± 0.19a	93.90	106.26

Treatment means sharing a letter are not significantly different from each other (Tukey's at $P < 0.05$).

It was found that *Rhopalosiphum padi* exhibited minimum mean mortality (4.24%) and (10.58%) in untreated control in 1st and 2nd observation respectively. The mean mortality of *R. padi* was found (22.38%) and (33.2%) after 24 and 48 hrs of neem application at 1% concentration respectively. It was found that mean mortality of *R. padi* was increased to (42.24%) and (48.66%) at 2% neem concentration in 1st and 2nd observation respectively. The *R. padi* exhibited mean mortality (58.12%) and (63.7%) at 2.5% concentration after 24 and 48 hrs of neem application. The maximum mean mortality of *R. padi* was observed at 3% neem concentration. The mean mortality of *R. padi* was (77.88%) and (84.5%) after 24 and 48hrs of 3% neem oil concentration respectively. The overall mean mortality of *R. padi* was ranged from (4.24 %) to (77.88%) after 1st observation. While, the overall mean mortality of *R. padi* was ranged from (10.58%) to (84.5%) after 2nd observation (Table 2).

Aphid Mortality after turmeric application

It was found that *Sitobion avenae* exhibited minimum mean mortality (4.48%) and (10.94%) in untreated control in 1st and 2nd observation respectively. The mean mortality of *S. avenae* was found (33.60%) and (44.52%) after 24 and 48 hrs of turmeric application at 1% concentration respectively. It was found that mean mortality of *S. avenae* was increased to (52.18%) and (58.64%) at 2% turmeric concentration in 1st and 2nd observation respectively. The *S. avenae* exhibited mean mortality (73.12%) and (78.62%) at 2.5% concentration after 24 and 48 hrs of turmeric application. The maximum mean mortality of *S. avenae* was observed at 3% turmeric concentration. The mean mortality of *S. avenae* was (90.58%) and (92.94%) after 24 and 48hrs of 3% turmeric concentration respectively. The overall mean mortality of *S. avenae* was ranged from (4.48%) to (90.58%) after 1st observation. While, the overall mean mortality of *S. avenae* was ranged from (10.94%) to (92.94%) after 2nd observation (Table 3).

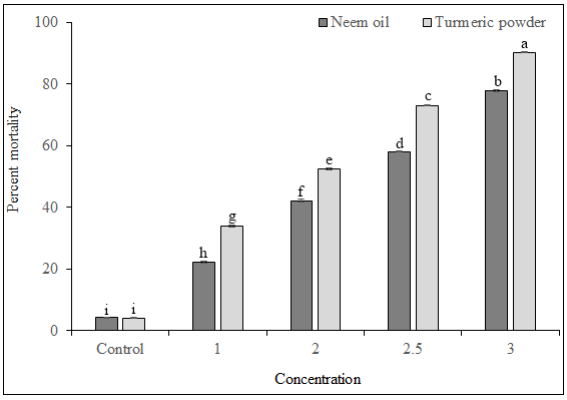

Fig. 1. Mortality of *Rhopalosiphum padi* after 24 hrs of neem oil and turmeric powder concentration.

It was found that *Rhopalosiphum padi* exhibited

minimum mean mortality (4.1%) and (11.6%) in untreated control in 1st and 2nd observation respectively. The mean mortality of *R. padi* was found (33.82%) and (44.48%) after 24 and 48 hrs of neem application at 1% concentration respectively. It was found that mean mortality of *R. padi* was increased to (52.50%) and (58.58%) at 2% neem concentration in 1st and 2nd observation respectively. The *R. padi* exhibited mean mortality (73.14%) and (78.46%) at 2.5% concentration after 24 and 48 hrs of neem application. The maximum mean mortality of *R. padi* was observed at 3% neem concentration. The mean mortality of *R. padi* was (90.38%) and (93.28%) after 24 and 48hrs of 3% neem oil concentration respectively. The overall mean mortality of *R. padi* was ranged from (4.1%) to (90.38%) after 1st observation. While, the overall mean mortality of *R. padi* was ranged from (11.6%) to (93.28%) after 2nd observation (Table 3).

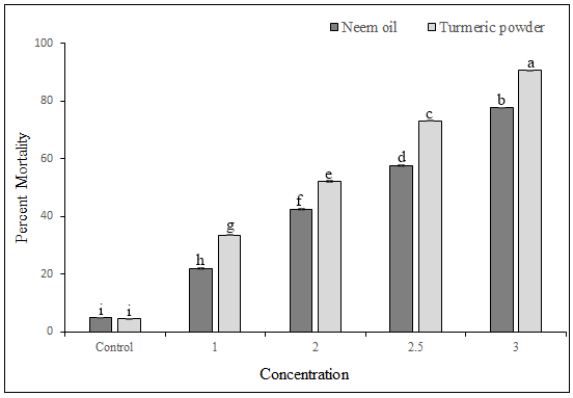

Fig. 2. Mortality of *Sitobion avenae* after 24 hrs of neem oil and turmeric powder concentration.

Discussion

Tripathi *et al.* (2001) and Khanikor and Bora (2011) found that the essential oils exhibit contact toxicity on various pest species. Abramson *et al.* (2006) found 81 and 95% mortality in fennel aphid when two plant essential oils i.e., Citronella and Alfazema were applied at 10,000 ppm concentration. Singh and Sachan (1999) found that *Lipaphis erysimi* can be controlled by only one spray of *A. indica* seed kernel extract at 5% concentration. Singh and Arya (2004) found that neem extracts in petroleum ether at 4% concentration exhibited 100% mortality in *L. erysimi*. Biswas (2013) found that aqueous solution of 50g neem seed/1L H_2O and 75g neem seed/1L H_2O exhibited 81% and 80% mortality in *Lipaphis erysimi* in treated plots.

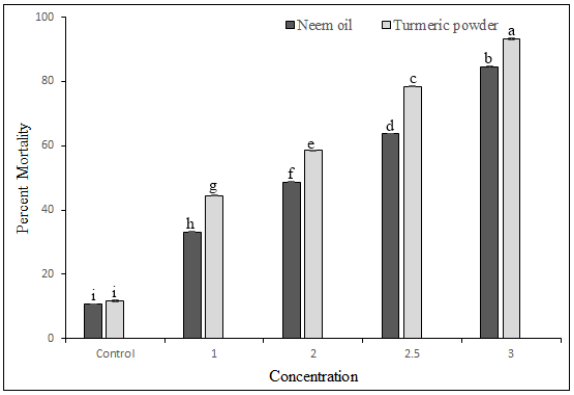

Fig. 3. Mortality of *Rhopalosiphum padi* after 48 hrs of neem oil and turmeric powder concentration.

Sampson *et al.* (2005) reported that mortality rate of turnip aphid, *Lipaphis pseudobrassicae* increases by the application of different essential oils. Lowery *et al.* (1993) found that commercial formulation of neem (Neem seed oil) is high toxic towards nine aphid species. Reddy *et al.* (2001) found that *Macrosiphum rosaeiformis* can be easily managed by application of neem oil at 2% and neem seed kernel extract at 5% concentration. Pavela *et al.* (2005) reported the toxic effects of *A. indica* essential oil towards *Brevicoryne brassicae*. Dimetry and Schmidt (1992) also found that *A. indica* has repellent and deterrent effects on aphids.

Kumari and Yadav (2002) tested the effectiveness of neem seed kernel (5%), neem cake (5%), neem oil (3%) and neem leaf extract (5%) in coriander aphid, *Hyadaphis coriandari*. Mortality in *H. coriandari* was found 27.2–73.5, 16–65.1, 22–72.8 and 12–52.1% respectively.

Stark and Rangus (1994) sprayed *A. pisum* infested plants with neem based botanical insecticide (Margosan-O) and found that *A. pisum* nymphs become more susceptible than adults and their longevity was significantly reduced as compared to controls. Ebrahimi *et al.* (2013) found that the essential oil of *A. indica* was most effective against *A. gossypii* among three tested plant essential oils. The *A. indica* 10,000 ppm concentration exhibited 100% aphid mortality after 24 h of application. Santos *et al.*

(2004) found that mortality of *A. gossypii* in nymphal stage at 410.0, 1410.0 mg/100 ml concentration was of 60.0% and 100.0%, respectively. Stark and Walter (1995) reported that neem seed oil exhibited 62% nymphal mortality in *Acyrthosiphon pisum* on treated plants. Biswas (2013) found that mortality in *Lipaphis erysimi* was 63.16-72.55% with neem leaf extracts while 73-81% with seed extracts.

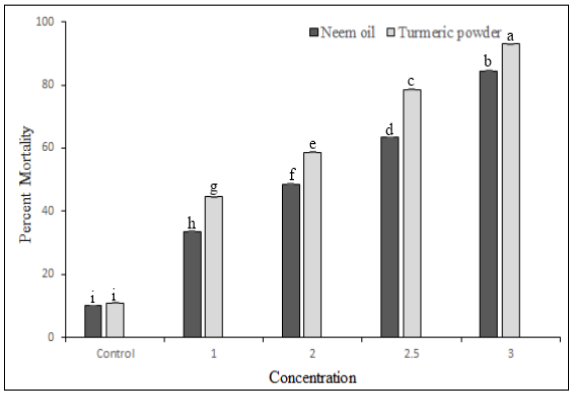

Fig. 4. Mortality of *Sitobion avenae* after 48 hrs of neem oil and turmeric powder concentration.

Our results depicted that mortality of *Sitobion avenae* was maximum (77.56%) at 3% concentration of neem oil after 1st observation which was statistically similar to mortality of *Rhopalosiphum padi* (77.88%) at 3% concentration of neem oil after 1st observation. Similarly, mortality of *S. avenae* was maximum (84.52 %) at 3% concentration of neem oil after 2nd observation which was statistically at par with mortality of *R. padi* (84.5%) at 3% concentration of neem oil after 2nd observation. This shows that there is similar effect of neem oil in both aphid species in 24 and 48 hrs of application. Similarly, mortality of *S. avenae* was maximum (90.58%) at 3% concentration of turmeric powder after 1st observation which was statistically similar to mortality of *R. padi* (90.38%) at 3% concentration of turmeric powder after 1st observation. Similarly, mortality of *S. avenae* and *R. padi* at 3% turmeric powder concentration was maximum (92.94%) (93.38%) after 2nd observation. The results revealed that neem oil and turmeric powder at 3% concentration can be used for efficient aphid control in wheat plants.

Conclusion

It was found that neem based formulations can efficiently control the aphid population in laboratory and field experiments (Lowery *et al.* 1993). Tang *et al.* (2002) found that although high concentrations of neem can cause high mortality in aphids, but neem products are not economically viable. Therefore, intermediate concentrations of neem products must be recommended. Biswas (2013) found that neem extracts cannot minimize aphid population like chemical insecticides but it is an eco-friendly, cheap and safe for aphid natural enemies and environment. Moreover, plant extracts can be used as integrated tool in biological control.

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