




## Management of mustard aphids using eco-friendly control approaches

Bijoya Saha<sup>1</sup>, Md Mahbubur Rahman <sup>2\*</sup>, Mohammad Mahir Uddin<sup>2</sup>, Md Shahjahan<sup>2</sup>, Banin Roy<sup>3</sup>

<sup>1</sup>Bangladesh Rice Research Institute, Gazipur 1701, Bangladesh

<sup>2</sup>Department of Entomology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

<sup>3</sup>Department of Agricultural Extension, Ministry of Agriculture, Dhaka, Bangladesh

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Gopal Das

[gopal\\_entom@bau.edu.bd](mailto:gopal_entom@bau.edu.bd)

#### \*Corresponding Author

Md Mahbubur Rahman

[rahmanmm\\_ent@bau.edu.bd](mailto:rahmanmm_ent@bau.edu.bd)



### ABSTRACT

Mustard aphid, *Lipaphis erysimi* (Aphididae: Hemiptera) is one of the major constraints for mustard production in Bangladesh. Traditionally, a variety of broad-spectrum chemical insecticides are being used to control this pest which is detrimental to beneficial insects and the environment. Hence, sustainable management was required. In the present study, as an alternative to conventional insecticides, we have tested: insecticides claimed to be least toxic to the environment (cypermethrin and carbofuran), botanicals (neem oil and mahogany oil) and two non-chemical measures (wood ash and wood ash combined with lime). Cypermethrin and neem oil followed by carbofuran were most efficient to minimize aphid infestations. Comparing to the untreated control plots, reduction of overall percent infestations of plants (74 - 79%), leaves (74 - 90%), twigs (48 - 61%) and pods (64 - 77%) were obtained through the application of cypermethrin, neem oil and carbofuran. Mahogany oil, wood ash solely and wood ash + lime were also found effective compared to the control plots. Therefore, cypermethrin and neem oil could be the first choice for the mustard growers followed by carbofuran to manage mustard aphids effectively. Mahogany oil followed by wood ash combined with lime and wood ash alone can be suggested only when aphid infestations remain at the lower level.

**Keywords:** *Lipaphis erysimi*, sustainable management, cypermethrin, carbofuran, neem oil, mahogany oil



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## 1 Introduction

Mustard aphids, *Lipaphis erysimi* Kalténbach (Aphididae: Hemiptera) is one of the major and economically damaging pests of mustard (Singh and Singh, 1983; Shylesha et al., 2006), can damage mustard plants from seedling to harvesting stages (Begum, 1995; Biswas and Das, 2000). Both the nymphs and adults suck the cell-sap from the plant parts resulting in stunted growth of the plants, withered flowers, and hindered pod formations. Besides, they may inject toxic materials while feeding into the plants which may cause chlorosis of the feeding sites, yellowing of the veins and curling of leaves (Jayappa and Lin-

gappa, 1988). They also suppress plants by indirect damages such as carrying viruses including mosaic viruses (Kennedy et al., 1962) and influencing sooty mould formation (Callan and Carris, 2004). If proper efforts are not given, they may cause up to 90% damage to the crops (Begum, 1995; Biswas and Das, 2000; Rohilla et al., 2004; Bhattacharya, 2019). A severe aphid infestation may build up within a short period because of its rapid and unique reproduction capacity (Agarwala and Datta, 1999; Bhattacharya, 2019). For example, a single aphid may produce a colony of 5.9 billion offspring in just 6 weeks duration (Dixon, 2005).

Sustainable management of mustard aphids is a big challenge because of their unusual life cycle, widespread habitats, and resistance to many pesticides (Bhattacharya, 2019). The application of synthetic insecticides is the usual way to control pests in Bangladesh. Farmers often apply pesticides without considering the efficacy and suitability against the target pests and their harmful impacts. Application in higher doses and frequencies is a common practice in aphid infestations. Inappropriate application of chemical insecticides affect beneficial insects and non-target organisms and accelerate pest resurgence, secondary pest outbreaks and pesticide resistance (Sekhon and Ahman, 1993). Above all, synthetic chemicals are a great threat to the environment and human health (Aktar et al., 2009).

Plant extracts and organic-based insecticides (for example cypermethrin, carbofuran), on the other hand, are comparatively less toxic to the non-target organisms, easily degradable and least toxic to the environment (Pickett and Bugg, 1998; Ruberson et al., 1998; Srivastava and Guleria, 2003; Isman, 2006). Many botanicals are being used traditionally for controlling pest since long before. There are a large number of plant extracts that have been proven as successful control measures for many pests in the field and laboratory experiments (Bajpai and Sehgal, 2000; Pedigo, 2002; Jahan et al., 2013; Rahman et al., 2013; Majlish et al., 2015; Rahman et al., 2016; Sultana et al., 2017). Plants like neem and mahogany can be found throughout the country and extracts can be prepared with minimum expenses and efforts (Luckman and Metclalf, 1978; Hussain, 1989; Roy et al., 2005).

Wood ash, sometimes in association with other materials like lime is applied on aphid infested crops in some areas of Bangladesh. Wood ash forms a layer on the plant surfaces and reduce exposure of feeding surfaces to the insects and make them less favourable (Elwell and Mass, 1995). Besides, wood ash provides extra nutrients to the soil as a fertilizer. However, wood ash may not be effective on the lower parts of plants and the abaxial surfaces of the leaves as they may not reach or stick on those parts. Hence, before recommending wood ash as a control option of mustard aphids, it is important to evaluate its efficacy in the field trials. In the current study, short persistent pesticides and non-chemical control options were evaluated in the field trials for efficient management of mustard aphids.

## 2 Materials and Methods

### 2.1 Experimental design and layout

The experiments were laid out in a Randomized Complete Block Design (RCBD) with 3 replications of each treatment. The experimental field (14 m × 6 m) was divided longitudinally into 3 equal blocks (14 m × 2

m). Each block was divided into 7 plots of approximately 2 m<sup>2</sup> (1.42 m × 1.42 m). A gap of 0.5 m was kept in between 2 plots for intercultural operations and data collection. Seeds of a mustard variety, BARI Sarihsa-14 (developed by the Bangladesh Agriculture Research Institute, BARI) were collected from a commercial seed dealer at Mymensingh city and sown in mid-November at the rate of 7 kg ha<sup>-1</sup> in the plots by broadcasting method followed by covering with soil and light irrigation. Plants were grown with standard agronomic practices (Azad et al., 2021).

### 2.2 Evaluation of treatments

Self-degradable, short-persistent and environment-friendly control options were selected to evaluate against mustard aphids. One contact insecticide, cypermethrin (Ustaad 10EC @ 1 mL L<sup>-1</sup> of water), one systemic insecticide, Carbofuran (Biesteren 5G @ 1.4 g m<sup>-2</sup> area), two botanicals (neem oil, *Azadirachta indica* and mahogany oil, *Swietenia mahagoni* @ 3 mL L<sup>-2</sup> of water) and two non-chemical materials (wood ash alone @ 70 g m<sup>-2</sup> area and the mixture of wood ash and lime (3:1) @ 70 g m<sup>-2</sup> area) were tested along with untreated control each replicated thrice. Treatments were applied at the flowering stage and five treatments were applied at 7 days intervals. At 7 days after each treatment application, plots were observed and the plants that have the presence of aphids were recorded as infested plants. To know the level of infestations, one infested plant was randomly selected from each plot and the number of healthy and infested leaves, twigs and pods were recorded. The plant parts that have the presence of aphids were considered as infested. The percent aphid infestations were calculated from the recorded data for the statistical analyses, presentations, and interpretations.

### 2.3 Statistical analysis

Data were compiled, organized, and presented using the Microsoft Office Excel® program (Microsoft Corporation 2016) and analysed statistically with a statistical program, MSTAT-C (MSTAT-C, 1991). One-way ANOVA (analysis of variance) followed by Least Significant Difference tests (LSD) were performed to summarise the difference among the treatments used in the experiment.

## 3 Results

### 3.1 Levels of aphid infestations

Different levels of plant infestations by mustard aphids were found in different plots treated with various treatments at 7 days after the 1st (F<sub>6,14</sub> = 32.27; P<0.001), 2nd (F<sub>6,14</sub> = 45.52; P<0.001), 3rd (F<sub>6,14</sub> = 40.98; P<0.001), 4th (F<sub>6,14</sub> = 7.99; P<0.001) and 5th

( $F_{6,14} = 61.29$ ;  $P < 0.001$ ) treatment application (Table 1). All treatments were effective to reduce percent plant infestations compared to untreated control plots at different data recording ( $P < 0.05$ ). At 7 days after the 1st spraying, cypermethrin and neem oil worked better than the sole application of wood ash ( $P < 0.05$ ). The efficacy of carbofuran, mahogany oil and the mixture of wood ash and lime were not different from the efficacy of cypermethrin, neem oil and wood ash ( $P > 0.05$ ). At 7 days after the 2nd spraying, cypermethrin and neem oil were more efficient than mahogany oil, wood ash + lime and wood ash ( $P < 0.05$ ). Carbofuran was equally effective as cypermethrin, neem oil, mahogany oil ( $P > 0.05$ ) but more effective than wood ash + lime and solely application of wood ash ( $P > 0.05$ ). However, there was no significant difference in the efficacy of mahogany oil, lime + wood ash and wood ash application ( $P > 0.05$ ). At the 3rd data recording, the lowest aphid infestations were found in cypermethrin, neem oil and carbofuran treated plots than all other treatments ( $P < 0.05$ ). No difference was found in the efficacies of mahogany oil, wood ash + lime and wood ash application ( $P > 0.05$ ) but they were effective to reduce plant infestations compared to the untreated control plots ( $P < 0.05$ ). At 7 days after the 4th and 5th spraying, a similar trend in the efficacies of treatments was observed. Cypermethrin, neem oil and carbofuran were highly effective among the treatments ( $P < 0.05$ ). At 7 days after the 4th spraying, mahogany oil and wood ash + lime were comparatively less effective, and application of wood ash was not effective compared to control plots ( $P > 0.05$ ). On the other hand, mahogany oil was equally effective as like cypermethrin, neem oil and carbofuran ( $P > 0.05$ ) and wood ash + lime and wood ash were less effective among the treatments. Considering the overall infestations in all 5 successive observations, cypermethrin, neem oil and carbofuran followed by the mahogany oil treated plots had lower aphid infestations. Wood ash + lime and wood ash treated plots had comparatively higher plant infestations but lower than control plots ( $P > 0.05$ ). Over 75 to 80% of aphid infestations were reduced over the control plots by the application of cypermethrin, neem oil and carbofuran (Table 1).

### 3.2 Leaf infestations by aphids

Different levels of leaf infestations were found on the different treatment treated and untreated plots (Table 2). All treatments were effective in reducing leaf infestations in almost all data recordings. At 7 days after first data spraying, the highest number of leaves were found to be infested in untreated control plots ( $F_{6,14} = 15.32$ ;  $P < 0.001$ ; LSD;  $P < 0.05$ ). Cypermethrin, as well as neem oil, carbofuran, mahogany oil and wood ash + lime, were found equally effective ( $P > 0.05$ ) in reducing leaf infestations among the

treatments ( $P < 0.05$ ). However, the leaf infestations in wood ash treated plots was significantly higher than in cypermethrin treated plots ( $P < 0.05$ ) but was not different from the other treatments ( $P > 0.05$ ). At 7 days after the second spraying ( $F_{6,14} = 22.75$ ;  $P < 0.001$ ), the lowest leaf infestations were found in Cypermethrin treated plots than all other treatments treated plots ( $P < 0.05$ ). Neem oil, carbofuran, mahogany oil and wood ash + lime were equally effective to reduce leaf infestations ( $P > 0.05$ ) and more effective than the sole application of wood ash ( $P < 0.05$ ). At 7 days after the 3rd spraying ( $F_{6,14} = 34.06$ ;  $P < 0.001$ ), leaf infestations were minimum in cypermethrin, carbofuran, neem oil and mahogany oil-treated plots than on wood ash + lime and wood ash treated plots ( $P < 0.05$ ). Wood ash + lime and wood ash application were found effective comparing to the untreated plots ( $P < 0.05$ ). No differences were observed in the efficacies among cypermethrin, carbofuran, neem oil and mahogany oil treatments ( $P > 0.05$ ) and in the efficacy between wood ash + lime and wood ash ( $P > 0.05$ ). At the 4th observation ( $F_{6,14} = 6.151$ ;  $P < 0.01$ ), all treatments except wood ash lowered leaf infestations significantly compared to the control plots ( $P < 0.05$ ). However, leaf infestations in wood ash treated plots were not different than the leaf infestations in the plots treated with mahogany oil and wood ash + lime ( $P > 0.05$ ).

At 7 days after the 5th spraying ( $F_{6,14} = 56.61$ ;  $P < 0.001$ ), cypermethrin and neem oil were the most efficient considering the leaf infestations among the treatments ( $P < 0.05$ ). Carbofuran was more effective than mahogany oil, wood ash + lime and wood ash application but was less effective than the cypermethrin ( $P < 0.05$ ) and worked like neem oil ( $P > 0.05$ ) to reduce leaf infestations. Considering the overall leaf infestations, cypermethrin and neem oil followed by carbofuran were found efficient than other treatments. With the application of these treatments,  $\approx 75\%$  to  $90\%$  leaf infestations were reduced over the control plots (Table 2).

### 3.3 Twig infestations by aphids

Percent twig infestations under various treatments were significantly lower than on the untreated control plots in all successive observations (Table 3). At 7 days after the 1st spraying, twig infestations by aphids were varied for different treatments ( $F_{6,14} = 25.32$ ;  $P < 0.001$ ) and minimum twig infestations found on cypermethrin, carbofuran and neem oil treated plots ( $P < 0.05$ ). Mahogany oil and wood ash + lime also worked like carbofuran and neem oil ( $P > 0.05$ ), but they were less effective than the cypermethrin ( $P < 0.05$ ). The sole application of wood ash was least effective considering among the treatments.

Cypermethrin was found as the most prominent and distinctly effective than other treatments in 2nd ( $F_{6,14} = 72.34$ ;  $P < 0.001$ ), 3rd ( $F_{6,14} = 26.52$ ;  $P < 0.001$ ),

**Table 1.** Percent plant infestations at 7 days after successive treatment applications

Treatments	Seven days after					Mean	% ↓
	1st spraying	2nd spraying	3rd spraying	4th spraying	5th spraying		
Cypermethrin	0.44c	0.22d	0.32d	0.72c	2.24c	0.79c	79.30
Carbofuran	0.50bc	0.37cd	0.89c	1.32c	2.06c	1.03c	74.81
Neem oil	0.46c	0.25d	0.74cd	1.12c	2.23c	0.96c	76.06
Mahogany oil	0.66bc	0.70bc	2.22b	2.88b	2.79c	1.85bc	54.36
Wood ash + lime	0.56bc	0.87b	2.23b	2.96b	5.12b	2.34b	40.65
Wood ash	0.72b	0.92b	2.28b	3.65ab	6.07b	2.73b	33.17
Control	1.67a	2.39a	3.06 a	5.00 a	9.04a	4.23a	
Sig. level	***	***	***	***	***	***	

%↓ = percent reduction over control; Values in a column with the same letter are not statistically different ( $P>0.05$ )

**Table 2.** Percent leaf infestations at 7 days after successive treatment applications

Treatments	Seven days after					Mean	% ↓
	1st spraying	2nd spraying	3rd spraying	4th spraying	5th spraying		
Cypermethrin	0.10c	0.20d	0.43c	0.67c	2.93d	0.87d	90.38
Carbofuran	0.63bc	2.33c	2.22c	1.57c	5.13c	2.38cd	74.55
Neem oil	0.43bc	2.17c	0.90c	1.57c	3.93cd	1.80d	78.62
Mahogany oil	0.77bc	2.25c	2.41c	2.27bc	13.33b	4.21bc	54.18
Wood ash + lime	0.78bc	2.33c	4.99b	2.22bc	4.85c	3.03cd	67.42
Wood ash	1.43 b	6.13b	5.88b	4.20ab	13.01b	6.13b	25.34
Control	3.79 a	8.26a	13.67a	6.18a	16.10a	9.60a	
Sig. level	***	***	***	**	***	***	

%↓ = percent reduction over control; Values in a column with the same letter are not statistically different ( $P>0.05$ )

**Table 3.** Percent twig infestations at 7 days after successive treatment applications

Treatments	Seven days after					Mean	% ↓
	1st spraying	2nd spraying	3rd spraying	4th spraying	5th spraying		
Cypermethrin	16.78d	17.78d	16.67d	21.22d	27.78e	20.04e	61.98
Carbofuran	21.32cd	33.67c	28.67c	32.54c	34.44d	30.13d	48.8
Neem oil	20.63cd	32.33c	28.10c	30.00cd	30.55de	28.23de	51.26
Mahogany oil	27.11c	33.78c	34.94bc	26.52cd	50.00c	34.47cd	34.71
Wood ash + lime	28.67c	36.71c	34.22bc	27.97cd	73.81b	40.28c	22.44
Wood ash	44.44b	43.52b	39.84b	45.44b	77.78b	50.21b	19.34
Control	52.95a	63.33a	50.00a	62.22a	86.67a	63.04a	
Sig. level	***	***	***	***	***	***	

%↓ = percent reduction over control; Values in a column with the same letter are not statistically different ( $P>0.05$ )

4th ( $F_{6,14} = 22.12$ ;  $P<0.001$ ) and 5th ( $F_{6,14} = 74.93$ ;  $P<0.001$ ) data collections ( $P<0.05$ ). Carbofuran, neem oil and mahogany oil were found as the second most effective in the 2nd, 3rd and 4th data collection. In most of the observations, wood ash + lime was equally effective to the carbofuran, neem oil and mahogany oil ( $P<0.05$ ). Wood ash application was

found least effective among the treatments throughout the trial. Considering the overall twig infestations ( $F_{6,98}=23.92$ ;  $P<0.001$ ), cypermethrin and neem oil followed by carbofuran, and mahogany oil had greater impacts and wood ash + lime and wood ash application had least impacted to reduce twig infestations.



**Table 4.** Percent pod infestations at 7 days after successive treatment applications

Treatments	Seven days after					Mean	% ↓
	1st spraying	2nd spraying	3rd spraying	4th spraying	5th spraying		
Cypermethrin	8.55d	7.90e	2.93d	4.81c	11.11d	7.06e	77.25
Carbofuran	16.68cd	12.99cd	17.53c	10.40c	12.44d	14.01d	64.57
Neem oil	14.80cd	12.62d	14.00c	9.687c	11.62d	12.54d	64.25
Mahogany oil	24.83bc	16.40bc	22.26b	10.73c	20.69c	18.98c	39.54
Wood ash + lime	28.64ab	17.49b	24.23b	19.27b	20.95c	22.11c	36.55
Wood ash	29.89ab	16.46bc	31.32a	20.45b	35.14b	26.65b	25.54
Sig. level	***	***	***	***	***	***	

%↓ = percent reduction over control; Values in a column with the same letter are not statistically different ( $P>0.05$ )

### 3.4 Pod infestations by aphids

Percent pod infestations were varied for different treatments in different data collections such as at 7 days after the first ( $F_{6,14} = 9.43$ ;  $P<0.001$ ), 2nd ( $F_{6,14} = 23.39$ ;  $P<0.001$ ), 3rd ( $F_{6,14} = 64.44$ ;  $P<0.001$ ), 4th ( $F_{6,14} = 28.04$ ;  $P<0.001$ ) and 5th ( $F_{6,14} = 59.13$ ;  $P<0.001$ ) spraying (Table 4). At the 1st counting, cypermethrin, carbofuran and neem oil were found most effective than other treatments used in the experiment ( $P<0.05$ ). Mahogany oil was equally effective as carbofuran and neem oil ( $P>0.05$ ) during the trial. Wood ash and wood ash+ lime were not effective to lower the pod infestations compared to untreated control plots ( $P>0.05$ ). Mahogany oil treated plots had lower pod infestations than untreated control plots ( $P<0.05$ ) but was alike to the application of wood ash and wood ash + lime treated plots ( $P>0.05$ ).

At 7 days after the second and 3rd spraying, the lowest pod infestations were found on cypermethrin treated plots ( $P<0.05$ ). Impacts of carbofuran and neem oil applications were not different to each other ( $P>0.05$ ) but less effective than cypermethrin application ( $P<0.05$ ). Mahogany oil and wood ash + lime at the 3rd counting, and mahogany oil and wood ash followed by wood ash + lime at the 2nd counting were found least effective to lower pod infestations per plant. However, wood ash was effective in the 3rd counting ( $P>0.05$ ).

At 7 days after the 4th spraying, there was no difference in the efficacies of cypermethrin, carbofuran, neem oil and mahogany oil ( $P>0.05$ ) and were distinctly efficient than the other treatments considering the percent pod infestations ( $P<0.05$ ). Unlike the 4th counting, mahogany oil was not as effective as cypermethrin, carbofuran and neem oil at 7 days after the 5th spraying ( $P<0.05$ ) but worked similarly like wood ash + lime ( $P>0.05$ ). Among the treatments, solo application of wood ash was the least efficient to lower the pod infestations ( $P<0.05$ ).

Without the temporal effect of treatments, all were effective to lower the pod infestations compared to

the control plots ( $P<0.05$ ) although various levels of pod infestations were observed for different treatments ( $F_{6,98} = 44.46$ ;  $P<0.001$ ). Application of cypermethrin followed by carbofuran and neem oil application were the most suited control measures to have minimum pod infestations ( $P<0.05$ ). The efficacies of mahogany oil and wood ash + lime were not different to each other ( $P>0.05$ ) but were better than the application of wood ash solely ( $P<0.05$ ).

## 4 Discussion

Considering all parameters cypermethrin, neem oil followed by carbofuran were found effective to reduce infestations (of plants, leaves, twigs, and pods) caused by mustard aphids, *Lipaphis erysimi* in the field trials (Tables 1 to 4). Insecticides of the cypermethrin group are fast-acting and neurotoxin in action. They are short persistent and degraded on soil and plants in few weeks (European Food Safety Authority et al., 2018). During the active period, cypermethrin is highly toxic to the target pests and provide effective control (Khalequzzaman and Nahar, 2008). Many researchers evaluated cypermethrin as the most suitable control measure of mustard aphids (Tripathi et al., 1988; Ahmad and Miah, 1989; Sharma and Kumar, 2014; Zafar et al., 2015). Moreover, cypermethrin insecticides are listed as moderate to least toxic to the environment and non-target organisms including mammals (European Food Safety Authority et al., 2018). Therefore, insecticides from the cypermethrin group can be recommended to farmers to treat mustard aphids.

Likewise, neem oil is an environment friendly and self-degradable material from neem plants having strong insecticidal properties Schmutterer (1990); Deka and Singh (2001); Rahman et al. (2013); Majlish et al. (2015). The azadirachtin and salannin along with many unidentified compounds of neem oil are the killing agents of neem oil. The mechanism of killing insects involves deterring insects from feeding and

regulating their growth. Neem oil has been reported as an effective control option of mustard aphids in the field (Ali et al., 2009) and laboratory experiments (Pandey et al., 1987). Similar to neem oil, neem extracts (from the neem plant parts) reduced mustard aphid populations (Gupta, 2005; Biswas, 2013). In addition, positive synergistic effects of neem extract in association with other control measures boosted up the efficacy of control measures of mustard aphids (Monim et al., 2010; Akter et al., 2015). Moreover, the application of neem extracts could be a cost-effective approach as the farmers can easily prepare them from locally available neem plants (Luckman and Metclalf, 1978; Hussain, 1989; Roy et al., 2005).

Carbofuran can also be recommended as a control option of mustard aphids (Tables 1 to 4). Carbofuran is an organocarbamate insecticide that works as a systemic insecticide and is widely used to kill borer and sucking insects like mustard aphids. To control mustard aphids, carbofuran has been reported as an effective option by many researchers (Bakhetia et al., 1986; Aslam and Munir, 2000). Some researchers (Sharma and Kumar, 2014) also recommended carbofuran as the best option to control mustard aphids.

Other control measures namely, mahogany oil (*Swietenia mahagoni*), wood ash + lime and wood ash alone were also found effective in reducing aphid infestations comparing to the control plots (Tables 1 to 4). Mahogany oil has repellent properties and it has been suggested to use against many pests (Satti and Elamin, 2012; Majumdar, 2013; Majlish et al., 2015; Rahman et al., 2016; Sultana et al., 2017) including aphids. Treatment like application of wood ash solely or mixed with soapy water and or with lime can cause a significant negative impact on pest populations (Ellwell and Mass, 1995). Wood ash acts as a physical barrier or poison between insects and feeding surfaces and often causes the abrasion of epicuticular waxes. It also interferes with the chemical signals emanating from the host plants thus obstructing the initial host location by pests. The treated foliage further becomes unpalatable to the pests like mustard aphids. In contrast to the chemical insecticides, wood ash and limes has no or minimum impacts on the beneficial insects and the environment. Moreover, they can supplement nutrients (eg. phosphorus) to the plants. Wood ash and lime are easily available and inexpensive and hence, they can be recommended to treat mustard aphids at lower infestation levels.

## 5 Conclusion

It can be concluded that cypermethrin and neem oil followed by carbofuran can be recommended to control mustard aphids effectively. Mahogany oil can also be recommended if there is a low level of aphid infestation to keep their population below the eco-

nomic injury level. Other control measures such as wood ash + lime and wood ash solely produced a significant difference compared to the untreated control plots. Therefore, the application of wood ash + lime and wood ash alone can be used to minimize aphid infestations, but their impacts were the least among the treatments.

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## Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

## References

- Agarwala B, Datta N. 1999. Life history response of the mustard aphid *Lipaphis erysimi* to phenological changes in its host. *Journal of Biosciences* 24:223–231. doi: 10.1007/BF02941204.
- Ahmad M, Miah RU. 1989. Screening of insecticides for the control of mustard aphid, *Lipaphis erysimi* (Kalt.). *Indian Journal of Entomology* 51:366–368.
- Aktar MW, Sengupta D, Chowdhury A. 2009. Impact of pesticides use in agriculture: their benefits and hazards. *Interdisciplinary Toxicology* 2:1–12. doi: 10.2478/v10102-009-0001-7.
- Akter A, Kabir MR, Roni MZK, Uddin AFMJ. 2015. Control of mustard aphid, *Lipaphis erysimi* (Kalt.) using different botanical insecticides. *Bangladesh Research Publication Journal* 10:298–303.
- Ali A, Rizvi PQ, Khan FR. 2009. Bio-efficacy of some plant leaf extracts against mustard aphid, *Lipaphis erysimi* (Kalt.) on indian mustard, *Brassica juncea*. *Journal of Plant Protection Research* 50:233–267. doi: 10.2478/v10045-010-0022-4.
- Aslam M, Munir A. 2000. Effectiveness of some insecticides against mustard aphid, *Lipaphis erysimi* (Kalt.) (Aphididae: Homoptera) on three different crops. *Journal of Research (Science)* 12:19–25.
- Azad AK, Miaruddin M, Wahab MA, Sheikh HR, Nag BL, Rahman HH. 2021. *Krishi Projukti Hatboi (Handbook on Agro-Technology)*, 9th edition. University of California Press.

- Bajpai NK, Sehgal VK. 2000. Efficacy of neem, Karanj and tobacco formulations against *Helicoverpa armigera* (Hubner) in chickpea crop. *Indian Journal of Entomology* 62:21–23.
- Bakhetia DKC, Brar KS, Sekon BS. 1986. Bioefficacy of some insecticides for the control of mustard aphid, *Lipaphis erysimi* (Kalt.) on rapeseed and mustard. *Indian Journal of Entomology* 48:137–143.
- Begum S. 1995. Insect pests of oilseed crops of bangladesh. *Bangladesh Journal of Zoology* 23:153–158.
- Bhattacharya S. 2019. Brassica-aphid interaction: challenges and prospects of genetic engineering for integrated aphid management. *Physiological and Molecular Plant Pathology* 108:101442. doi: 10.1016/j.pmpp.2019.101442.
- Biswas G. 2013. Comparative effectiveness of neem extracts and synthetic organic insecticide against mustard aphid. *Bangladesh Journal Agricultural Research* 38:181–187. doi: 10.3329/bjar.v38i2.15881.
- Biswas GC, Das GP. 2000. Population dynamics of the mustard aphid, *Lipaphis erysimi* (Kalt.) (Hemiptera : Aphididae) in relation to weather parameters. *Bangladesh Journal of Entomology* 19:15–22.
- Callan BE, Carris LM. 2004. 7 - fungi on living plant substrata, including fruits. Burlington: Academic Press. p. 105–126. doi: 10.1016/B978-012509551-8/50010-6.
- Deka MK, Singh SN. 2001. Neem formulation in the management of sugarcane insects and pests. *Proceedings of the 63rd Annual Convention of the Sugar Technologists' Association of India, Jaipur, India.*
- Dixon AFG. 2005. Insect herbivore-host dynamics: tree-dwelling aphids. Cambridge University Press. doi: 10.1017/CBO9780511542671.
- Elwell H, Mass A. 1995. Natural pest and disease control. *Natural Farming Network, Zimbabwe* :128p.
- European Food Safety Authority, Arena M, Auteri D, et al. 2018. Peer review of the pesticide risk assessment of the active substance cypermethrin. *EFS2 Journal* 16. doi: 10.2903/j.efsa.2018.5402.
- Gupta MP. 2005. Efficacy of neem in combination with cow urine against mustard aphid and its effect on coccinellid predators. *Natural Product Radiance* 4:102–106.
- Hussain M. 1989. Controlling rice borer under bangladesh conditions. *Pestology* 8:28–28.
- Isman MB. 2006. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. *Annual Review of Entomology* 51:45–66. doi: 10.1146/annurev.ento.51.110104.151146.
- Jahan R, Uddin MM, Rahman MM, Haque MA. 2013. Varietal Preference and Management of Bean Aphid, *Aphis Craccivora* (Koch). *Persian Gulf Crop Protection* 2:40–46.
- Jayappa BG, Lingappa S. 1988. Screening of cowpea germplasm for resistance of *Aphis craccivora* in India. *Tropical Pest Management* 34:62–64. doi: 10.1080/09670878809371209.
- Kennedy JS, Day MF, Eastop VF. 1962. A conspectus of aphids as vectors of plant viruses. London, UK: Commonwealth Institute of Entomology.
- Khalequzzaman M, Nahar J. 2008. Relative toxicity of some insecticides and azadirachtin against four crop infesting aphid species. *University Journal of Zoology Rajshahi University* 27:31–34. doi: 10.3329/ujzru.v27i0.1950.
- Luckman WH, Metclalf RL. 1978. The pest management concept: An introduction to insect pest management. John Willey and Sons, New York. :pp. 3–35.
- Majlish AK, Uddin MM, Jahan M, Rahman MM. 2015. Comparative efficacy of different botanicals and chemical insecticides for controlling rice stem borer. *Journal of Bangladesh Agricultural University* 13:183–189. doi: 10.3329/jbau.v13i2.28778.
- Majumdar MZ. 2013. Use of mahogany (*Swietenia mahogani*) seed oil as an alternative of sumithion in eradicating backswimmers (*Notonecta* sp.) from nursery pond. *Bangladesh Agricultural University, Mymensingh, Bangladesh.*
- Monim MA, Moniruzzaman KM, Mondal RK, Qudus MA, Islam ABMS. 2010. Integrated management of aphid in mustard. *Journal of Agroforestry and Environment* 4:93–95.
- MSTAT-C. 1991. A software program for the design, management and analysis of agronomic research experiments. michigan state university, east lansing. .
- Pandey ND, Singh YP, Tripathi RA. 1987. Effect of certain plant extract against *Lipaphis erysimi* (Kalt.) under lab condition. *Indian Journal of Entomology* 49:238–242.
- Pedigo LP. 2002. *Entomology and Pest Management.* Princeton and Hall Incorporation, London.

- Pickett CH, Bugg RL. 1998. Enhancing biological control: habitat management to promote natural enemies of agricultural pests. Berkeley: University of California Press.
- Rahman MA, Uddin MM, Haque MA, Rahman MM. 2016. Comparative efficacy of different tactics for the management of okra shoot and fruit borer, *Earias vittella* (fab.) Under field condition. International Journal of Applied Sciences and Biotechnology 4:74–78. doi: [10.3126/ijasbt.v4i1.14465](https://doi.org/10.3126/ijasbt.v4i1.14465).
- Rahman MM, Uddin MM, Shahjahan M. 2013. Management of okra shoot and fruit borer, *Earias Vittella* (Fabricius) using chemical and botanical insecticides for different okra varieties. International Research Journal of Applied Life Sciences 2:1–9.
- Rohilla HR, Bhatnagar P, Yadav PR. 2004. Chemical control of mustard aphid with newer and conventional insecticides. Indian Journal of Entomology 66:30–32.
- Roy B, Amin R, Uddin MN, Islam ATMS, Islam MJ, Halder BC. 2005. Leaf extracts of Shiyalmutra (*Blumea lacera* DC.) as botanical insecticides against lesser grain borer and rice weevil. Journal of Biological Sciences 5:201–204. doi: [10.3923/jbs.2005.201.204](https://doi.org/10.3923/jbs.2005.201.204).
- Ruberson J, Nemoto H, Hirose Y. 1998. Chapter 11 - Pesticides and conservation of natural enemies in pest management. San Diego: Academic Press. p. 207–220. doi: [10.1016/B978-012078147-8/50057-8](https://doi.org/10.1016/B978-012078147-8/50057-8).
- Satti AA, Elamin MM. 2012. Insecticidal activities of two meliaceous plants against *Trogoderma granarium* Everts (Coleoptera: Dermestidae). International Journal of Science and Nature 3:696–701.
- Schmutterer H. 1990. Properties and potentials of natural pesticides from the neem tree. Annual Review of Entomology 35:271–297. doi: [10.1146/annurev.en.35.010190.001415](https://doi.org/10.1146/annurev.en.35.010190.001415).
- Sekhon BS, Ahman I. 1993. Insect Resistance with Special Reference to Mustard Aphid. volume 19. Springer: Berlin, Heidelberg. doi: [10.1007/978-3-662-06166-4\\_13](https://doi.org/10.1007/978-3-662-06166-4_13).
- Sharma SD, Kumar S. 2014. Effect of different insecticidal treatments on mustard aphid *Lipaphis erysimi* (Kalt.) infestation, yield and yield contributing traits in *Brassica rapa* var Sarson crop in kullu valley of Himachal Pradesh. Agricultural Science Digest 34:299–232. doi: [10.5958/0976-0547.2014.01009.X](https://doi.org/10.5958/0976-0547.2014.01009.X).
- Shylesha AN, Azad TNS, Pathak KA, Rao KR, Saikia K, Surose S, Kodandaram NH, Kalaishekar A. 2006. Integrated management of insect pest of crops in north eastern hill region. Technical Bulletin No. 19. ICAR RC for NEH Region, Umiam :50.
- Singh H, Singh Z. 1983. New records of insect-pests of rapeseed- mustard. Indian Journal of Agricultural Sciences 53:970.
- Srivastava A, Guleria S. 2003. Evaluation of botanicals for mustard aphid, *Lipaphis erysimi* (Kalt.) control in Brassica. Himachal Journal of Agricultural Research 29:116–118.
- Sultana T, Uddin MM, Rahman MM, Shahjahan M. 2017. Host preference and eco-friendly management of cucurbit fruit fly under field condition of bangladesh. Asian-Australasian Journal of Bioscience and Biotechnology 2:55–59.
- Tripathi NLM, Sachan GC, Verma SK. 1988. Laboratory evaluation of some synthetic pyrethroids and other insecticides against *Lipaphis erysimi* (Kalt.). Indian Journal of Plant Protection 16:53–55.
- Zafar M, Khan MKA, Asmatullah M. 2015. Efficacy of cypermethrin, bifenthrin and azadirachtin against crop infesting aphid species of *Lipaphis erysimi* (Kalt.) and *Myzus persicae* (Sulzer) on cauliflower and potato plants. Punjab University Journal of Zoology 30:7–9.



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