Research article **Bangladesh Journal of Entomology**
*ISSN (Print): 1021-1004, ISSN (Online): 3007-3332, Website: www.bangladeshes.org*
*Bangladesh J. Entomol. (2025) 33(2): 107-122*

# EFFICACY OF THREE INDIGENOUS PLANT EXTRACTS AGAINST *MYZUS PERSICAE* SULZER IN LABORATORY CONDITION

**Mst. Afroza aktar[1], Mohammad Mosharof Hossain Bhuyain[1*], Md. Nizam Uddin[1], Md. Adnan Al Bachchu[1] and Md. Alamgir Hossain[1]**

[1]Department of Entomology, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur 5200, Bangladesh

**Received:** 7 October 2025; Accepted: 1 November 2025

## ABSTRACT

The experiments were conducted to study the efficacy of three indigenous plant extracts namely, ata (*Annona reticulata*), marigold (*Tagetus patula*) and chilli (*C. frutescens*) in n-hexane solvent for their residual toxicity and repellency effect against aphid, *M. persicae* in the laboratory of the Department of Entomology, Hajee Mohammad Danesh Science and Technology University, Dinajpur during the period from December 2024 to April 2025. The n-hexane solvent extracts of ata, marigold and chilli at three concentrations (1.0, 1.5 and 2.0 mg/ml) were maintained in each extract along with a control. The results showed that all tested plant extracts had toxic and repellent effects against aphid. Among the tested plant extracts, chilli extract showed the highest toxic effect (mortality, 58.98%) whereas marigold extract showed the lowest toxic effect (mortality, 44.29%). The order of the toxicity of the plant extracts were found as chilli>ata> marigold. Mortality percentage was also found directly proportional to the level of concentrations of plant extracts and to the exposure periods. Chilli extract showed the highest repellency **(**60.44%) but marigold showed the lowest repellency (43.56%).

***Keywords:*** *M. persicae*, botanical extracts, toxicity, repellency, B:C ratio.

## INTRODUCTION

Tomato (*Solanum lycopersicum*) is one of the most important vegetables in the world. It is the third most economically important vegetable crop after potato and onion. Major tomato producing countries in descending order include China, USA, India, Turkey and Egypt, respectively. Africa contributes 15% of the world's tomato production (FAOSTAT 2008). It is ranked second important vegetable crop after potato. Its fruits are eaten as raw or cooked. It is used in salad in homes and

*Corresponding author: *mosharof_ent@tch.hstu.ac.bd*

hotels. Large quantities are used to produce soup, juice, ketchup, paste and powder. The average yield of tomato was found 32.78 t/ha (Agong *et al*. 2003). It contains many compounds that play a pivotal role in the prevention of cancer, heart disease, and many other common health problems. It is a good source of vitamins A, B, and C and contains fat of 3.5%, mineral 1%, vitamin 0.5% glucose 32.1% soybean meal 29.8%.

*Myzus persicae* become a major pest of tomato and has a wide host range in beans, citrus, cucurbits, potato, tomato, sugar beet, and sugarcane in tropical and sub- tropical areas. Market price of tomato is high but the production is low due to the insect's infestation. Both nymphs and adults of *M. persicae* damage different crops from vegetative to fruiting stages and may cause yield loss up to 100% (Attia *et al.* 1986). When plants are heavily infested, leaf distortion and stunted growth commonly occur, and the end result is poor quality of fruits (York 1992). Moreover, it transmits about 20 non-persistent plant viruses (Kaiser 1979, Thottappilly and Rossel 1985).

Many preventive and effective chemical control measures have been reported to minimize the loss of fruits and vegetables due to insect attack. Among these, many researchers suggested that chemical insecticides are effective for their control. But chemical control of insects has been used with serious drawbacks. The synthetic insecticides are expensive and create many undesirable side effects such as (i) development of pesticides resistance in insect pests (ii) toxic residues in food and the environment (Rajappan *et al.* 2000) (iii) pests' resurgence and outbreak of secondary pests, (iv) destruction of natural enemies of pests and non-target organisms, (v) health hazards, (vi) environmental pollutions (Metcalf and Luckmann 1975). The development of cross and multi-resistant strains in many important insect species; resulting from the continuous use of chemical insecticides have been reported from all over the world (Dyte 1970, Dyte and Hallday 1985, Irshad and Jilani 1990, Zettler and Cuperus 1990, Zettler 1991). Botanical insecticide is an effective alternative pest management method because of its eco-friendly nature (Wang *et al.* 2012).

Plant based botanical insecticides can be effective and safe, which are locally available, cheap and less hazardous. Plants are a rich source of bioactive compounds

having insecticidal activities (Arnason *et al.* 1989). The main advantages of botanicals are that these can be easily produced by farmers, less expensive, biodegradable, safe to apply and unique in action. Most of the botanical insecticides are non-hazardous and non-toxic to human. The earlier studies by different authors also established the successful actions of different plant parts and extracts against different major insect pests of Bangladesh (Talukder and Howse 1993, 1994a, 1994b, 1995a, 1995b, Haque and Husain 1993).

In spite of the above facts, few scientific research works were conducted to explore locally available plant materials for the management of harmful insect pest in vegetables. Therefore, the present study was undertaken with the following objectives:

- To determine the efficacy of three plant extracts against *M. Persicae*.
- To evaluate the repellency of three plant extracts against *M. Persicae*.

## MATERIALS AND METHODS

The present study on the evaluation of toxicity and repellency effect of three indigenous plant extracts against aphid *Myzus persicae* was conducted in the laboratory of the Department of Entomology, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during December 2016 to April 2017. The tested plants were ata (*Annona reticulata*), marigold (*Tagetes patula*) and chilli (*Capsicum frutescens*). Both the leaves and fruits were used for this experiment. The english name, scientific name, family name and the three botanical plants which, used in the research are given in the following Table 1.

**Collection and preparation of botanical powders:** The fresh plant leaves of ata marigold were collected around the HSTU campus and fruits of chilli were collected from basherhat, Dinajpur. After collection, they were kept in the laboratory for 7 days for air drying followed by one day sun drying before making powder. After dried they were made powder separately by an electric grinder in the laboratory. Later, the powder was stored separately at room temperature in air tight plastic pot for experimental use.

**Collection and rearing of insects:** The aphid, *Myzus persicae* was collected from the infested tomato field in HSTU campus and the stock insects were built

**Table 1.** List of plants and their parts used in the bioassay

| English name | Scientific name | Family name | Plant parts used |
|---|---|---|---|
| Sweet soap | *Annona reticulata* | Annonaceae | Leaf |
| Marigold | *Tagetes patula* | Compositae | Leaf |
| Chilli | *Capsicum frutescens* | Solanaceae | Fruit |

up in the laboratory of Department of Entomology. Then, the stock insects were reared in rectangular jars, setting in a growth chamber with ventilation at ambient temperature, RH and photoperiod in the laboratory. Fresh leaves were given time to time. The jars were covered with pieces of cloth and fastened with rubber bands to prevent insect escape.

**Preparation of plant extracts:** The prepared powdered materials were extracted in n-hexane solvent. Fifty grams of each category of powder were taken in a 600 ml beaker and mixed separately with 150 ml of n-hexane. Then the mixture was stirred for 30 minutes in a magnetic stirrer (600 rpm). The mixture was then allowed to stand for 72 hours in an electric shaker. Then, the mixture was filtered through a filter paper (Whatman no. 4) and allowed to evaporate the solvents. Finally, hard different coloured extracts were obtained. Then extracts were preserved in tightly corked vials separately and stored in a refrigerator for experimental use.

**Preparation of doses:** The crude extracts were weighed by electronic balance and dissolved in n-hexane solvent for making different concentrations. Different concentrations (2.0, 1.5, and 1.0 mg/ml) of each category of plant extracts were prepared by dissolving the stock solution in the n-hexane solvent. Prior to conducting study, pilot experiments were done to obtain the appropriate dose.

**Insect bioassays:** Insect bioassay were performed in laboratory conditions with ambient temperature of 28 ± 2°C and 75 ± 5% relative humidity to determine the direct toxicity and repellent effects on aphid.

**Direct toxicity test:** Residual film method was used for toxicity test of different plant extracts against *M. persicae* (Busvine 1971). Extracts collected from the different leaf and fruit were weighed and dissolved in the n–hexane solvent according to the proportion of the concentration of 2.0, 1.5 and 1.0 mg/ml. For insect bioassay 5 cm diameter Petri dishes were used. Then 1 ml plant extract of each dose was dropped

separately on Petri dishes (5 cm) with the help of pipette, covering uniformly the whole area of the Petri dish internally. The Petri dishes were then kept open for sometimes to evaporate the solvents fully. When solvents were fully evaporated, 10 aphids (7 days old), *M. persicae* were released in each Petri dish. Three replications were made for each dose of all the 4 treatments. Only distilled water was used for the untreated control. The Petri dishes were then kept without food at 25°C ± 0.5°C in the laboratory and insect mortality were recorded at 12, 24, 36, 48, 60 and 72 hours after treatment. The percentage of mortality was corrected using Abbott's formula (Abbott 1987). P = [(P' -C)/100-C) × 100] Where, P= Corrected mortality (%); P'= Observed mortality (%); C= Mortality (%) in untreated control. The observed data then subjected to probit analysis according to Finney (1947) and (Busvine 1971) using software MSTAT-C. This data entered into a linear regression program, which first a regression linear into a probit log dose concentration graph. Mortality percentage and doses can be determined from this graph using the probit transformation table (Busvine 1980).

**Repellency test:** The repellent activities of the three indigenous plant extracts were evaluated using the filter paper impregnation method (Talukder and Howse 1993). The filter paper (Whatman no. 4) was cut into two halves, treated and untreated filter paper attached with cello tap and 1 ml solution of each concentration was applied to half of the filter paper by the help of micro pipette. The treated and untreated control papers then air dried for 20 minutes to evaporate the solvent. The treated half of the paper was attached with the untreated half one in the way that attachment did not interfere with the free movement of aphid from one half to another. After attachment, the treated and untreated control paper were placed in a Petri dish (5 cm diameter) and then 5 pairs of adult wingless aphid (7 days old) from lab culture were released at the centre of the filter paper. The Petri dish was covered with its lid and kept in undisturbed condition in the laboratory. Each treatment was replicated thrice and the number of insects on each portion was counted at hourly intervals up to the 5$^{th}$ hours. The data was expressed as percentage of repulsion (PR) using the following formula: PR= (Nc-50) × 2 where, Nc = Percentage of insects present in the untreated control half. Positive (+) values expressed repellency and negative (-) values attractancy. The average values were categorized according to the following scale (McDonald *et al.* 1970) shown in Table 2.

**Table 2.** Scale and rates of average values of repellency

| Class | Repellency (%) | Class | Repellency (%) |
|---|---|---|---|
| 0 | 0 > 0.01 to 0.1 | III | 40.1 to 60 |
| I | 0.1 to 20 | IV | 60.1 to 80 |
| II | 20.1 to 40 | V | 80.1 to 100 |

**Statistical analysis:** The data obtained from the experiments were statistically analyzed by MSTAT-C computer program and the treatment mean values were compared by New Duncans Multiple Range Test (Duncan 1951). The original insect mortality data were corrected by Abbott's formula before analysis. The observed mortality was also subjected to probit analysis. All other graphical works were done by using Microsoft Excel.

## RESULTS AND DISCUSSION

The effects of three indigenous plant extracts (ata, marigold and chilli) were evaluated against aphid, *M. persicae*. The results of various experiments were conducted during the study period are presented and discussed under the following subheadings.

**Direct toxicity effects of different plant extracts against aphid:** The results of the direct toxicity effects of ata, marigold and chilli extracts on aphid are presented in Tables 3, 4 & 5. Average mortality percentage at 24, 48 and 72 hours after treatment (HAT) indicated that chilli extract possessed the highest toxic effect (mortality, 58.98%) whereas marigold extract possessed the lowest toxic effect (mortality, 44.29%) on aphid (Table 3). Mortality percentages were directly proportional to the time after treatment. The orders of the toxicity of three plant extracts on aphid was: chilli > ata > marigold. The average mortality percentage of aphid was differed significantly ($P<0.05$) among all the plant extracts.

Mortality percentage of aphid was also differed significantly ($P<0.05$) among all the concentrations level at different time intervals (Table 4). The highest average mortality (75.34%) was observed at the highest concentration (2%) of plant extract. On the other hand, the lowest average mortality (62.9%) was found at the lower

**Table 3.** Direct toxic effect of different plant extracts against *Myzus persicae* at different hours after treatment (HATs) (Interaction of plant extracts and times)

| Plant extracts used | Insect mean mortality (%); ± SE at different time intervals | | | Average mortality (%) |
|---|---|---|---|---|
| | 24 HAT | 48 HAT | 72 HAT | |
| Ata | 45.00 ± 8.11 a | 53.33 ± 9.48 b | 65.37 ± 10.39 a | 54.37 ± 9.24 a |
| Marigold | 29.17 ± 6.13 b | 46.67 ± 8.20 c | 57.12 ± 9.33 b | 44.29 ± 7.63 b |
| Chilli | 50.83 ± 9.16 a | 60.28 ± 10.25 a | 65.83 ± 10.42 a | 58.98 ± 9.90 a |
| Control | 0.00 c | 0.00 d | 0.00 c | 0.00 c |
| LSD | 9.101 | 5.667 | 6.067 | 6.228 |
| CV (%) | 25.92 | 12.59 | 11.47 | 14.07 |
| $S\bar{x}$ | 3.118 | 1.942 | 2.079 | 2.134 |
| p-value | 0.0002 | 0.0002 | 0.0104 | 0.0002 |

Within column values followed by different letter(s) are significantly different at 5 % level of probability by DMRT.

concentration (1.0%) and it was also found that the average mortality percentage directly proportional to the level of concentration of different plant extracts.

The interaction effects of plant, dose and time is presented in Table 5. Mortality percentage of aphid treated with different plant extracts of different dose level at different hours were found statistically significant ($P<0.05$). Overall average value indicated that the highest percent mortality (84.07%) was found in chilli extract at highest dose (2.0%) whereas marigold plant extract showed the lowest mortality (53.08%) at lowest dose (1.0%), which was statistically different from all other plant extracts at different concentration level.

From the above finding it was observed that the tested three plant extracts possessed toxicity effect on aphid but chilli can be most effective against aphid and marigold plant extracts can be less effective. This might be due to the major active constituent of chilli is Capsaicin and its analogues; collectively called Capsaicinoids. The present results coincided with the findings of Das *et al.* (2008) who evaluated aphidicidal activity of hot and cold-water extracts of some indigenous plants, *Azadirachta indica*, *Calotropis procera, Polygonum hydropiper* and *Ipomoea sepiaria* were tested against the tomato aphid, *M. persicae*. Hot water extract of *Polygonum hydropiper* and *Azadirachta indica* was found to be the most effective (87.6-94.5%) and (80.47-89.6%) mortality, respectively).

**Table 4.** Direct toxic effect of different doses of plant extracts against *Myzus persicae* at different HATs (Interaction of doses and times)

| Dose (mg/ml) | Insect mean mortality (%); ± SE at different time intervals | | | Average mortality (%) |
|---|---|---|---|---|
| | 24 HAT | 48 HAT | 72 HAT | |
| 2.0 | 62.22 ± 6.40 a | 77.65 ± 3.18 a | 86.04 ± 2.25 a | 75.34 ± 3.80 a |
| 1.5 | 55.56 ± 5.29 ab | 71.97 ± 3.95 a | 82.59 ± 2.90 ab | 69.71 ± 3.75 ab |
| 1.0 | 48.89 ± 5.12 b | 62.96 ± 2.80 b | 76.91 ± 3.13 a | 62.92 ± 3.54 b |
| Control | 0.00 ± 0.00 c | 1.11 ± 1.11 c | 5.556 ± 1.75 c | 2.21 ± 0.78 c |
| LSD | 10.51 | 6.544 | 7.005 | 7.191 |
| CV (%) | 25.92 | 12.59 | 11.47 | 14.07 |
| $S\bar{x}$ | 3.600 | 2.242 | 2.400 | 2.464 |
| p-value | 0.000 | 0.000 | 0.000 | 0.000 |

Within column values followed by different letter(s) are significantly different at 5 % level of probability by DMRT.

**Table 5.** Direct toxic effect of different plant extracts of different doses against *Myzus persicae* at HATs (Interaction of plant extracts, doses and times)

| Plant extracts used | Doses (mg/ml) | Insect mean mortality (%); ± SE at different time intervals | | | Average mortality (%) |
|---|---|---|---|---|---|
| | | 24 HAT | 48 HAT | 72 HAT | |
| Ata | 2.0 | 66.67 ± 3.33 ab | 76.67 ± 3.33 abc | 89.25 ± 0.37 a | 77.65 ± 2.16 ab |
| | 1.5 | 60.00 ± 5.77 abc | 73.33 ± 3.33 bcd | 85.92± 4.07 a | 72.22 ± 2.93abc |
| | 1.0 | 53.33 ± 3.33 abcd | 63.33 ± 3.33 def | 79.63 ± 5.45 ab | 65.43 ± 3.88 bcd |
| | Control | 0.00 ± 0.000 e | 0.00 ± 0.000 g | 6.67± 3.33 c | 2.20 ± 1.10 e |
| Marigold | 2.0 | 43.33 ± 13.33 bcd | 70.00 ± 5.77 cde | 79.60 ± 5.43 ab | 64.32 ± 7.89 bcd |
| | 1.5 | 40.00 ± 10.00 cd | 60.00 ± 5.77 ef | 76.29 ± 6.29 ab | 58.65 ± 7.05 cd |
| | 1.0 | 33.33 ± 8.81 d | 56.67 ± 3.33 f | 69.26 ± 5.14 b | 53.08 ± 5.56 d |
| | Control | 0.00 ± 0.00 e | 0.000 ± 0.00 g | 3.33 ± 3.33 c | 1.10 ± 1.100 e |
| Chilli | 2.0 | 76.67 ± 3.33 a | 86.29 ± 3.16 a | 89.25±0.37 a | 84.07 ± 2.23 a |
| | 1.5 | 66.67 ± 3.33 ab | 82.59 ± 3.76 ab | 85.55 ± 3.90 a | 78.27 ± 3.11 ab |
| | 1.0 | 60.00 ± 5.77 abc | 68.89 ± 5.87 cdef | 81.85 ± 4.07 ab | 70.24 ± 5.13 bc |
| | Control | 0.000 ± 0.00 e | 3.33 ± 3.33 g | 6.67 ± 3.33 c | 3.33 ±1.93 e |
| | LSD | 21.76 | 11.33 | 12.13 | 12.46 |
| | CV (%) | 25.92 | 12.59 | 11.47 | 14.07 |
| | $S\bar{x}$ | 7.454 | 11.33 | 4.157 | 4.268 |
| | P-value | 0.0022 | 0.0036 | 0.000 | 0.000 |

Within column values followed by different letter(s) are significantly different by DMRT at 5 % level of probability.

**Probit analysis for direct toxic effect of plant extracts:** The results of the probit analysis for the estimation of $LD_{50}$ values, chi-square values and their 95% fiducial limits at 24, 48 and 72 hours after treatment (HAT) for the mortality of tomato aphid are presented in Table 6. The $LD_{50}$ values of three plant extracts showed that at 24 HAT chilli (0.67) extract was the most toxic followed by ata (0.86) and marigold (2.86) extracts. The $LD_{50}$ values of ata (0.54 mg), marigold (0.75 mg) and chilli (0.57 mg) at 48 HAT indicated that ata extract showed the highest toxic effect. Among the three indigenous plant extracts chilli plant extract also performed the highest toxicity as compared by $LD_{50}$ values at 24, 48 and 72 HAT. The chi-square values were insignificant at 5% level of probability of different plant extracts at different HAT and mortality data did not show any heterogeneity.

From the above probit results it is clear that all the tested three plants extract would be more or less effective for controlling aphid but chilli and ata was found the most effective. These results are comparable with the findings of Das *et al.* (2008) who evaluated aphidicidal activity of hot and cold-water extracts of some indigenous plants i.e., *Azadirachta indica, Calotropi procera* (Aiton), W.T. Aiton (akanda), *Polygonum hydropiper* L. (biskatali) and *Ipomoea sepiaria* J. koenig ex Roxb. (bankalmi) were tested against aphid. Hot water extract of *P. hydroper* and *A. indica* was found to be the most effective (87.6-94.5 and 80.5-89.6% mortality, respectively, $P<0.01$) among all the extracts. Other hot and cold water extracts also appeared to be useful (59.5-87.5% mortality) as pesticides against aphid. Finally, from the above result it is concluded that chilli would be effective for controlling the tomato aphid, *M. persicae.*

**Probit regression lines:** The probit regression lines for the bioefficacy of three indigenous plant extracts (ata, marigold and chilli) against *M. persicae* at 24, 48 and 72 HAT are presented in Fig. 1 (A, B, C). The calculated probit regression equation lines for the Bioefficacy of different plant extracts on tomato aphid at 24 HAT were $Y= 0.18x + 5.616$, $Y= 0.13x + 4.97$, $Y= 0.245x + 5.966$ for ata, marigold and chilli plant extracts, respectively (Fig. 1A). Among the three lines, the regression line for chilli extract showed the highest probit mortality but marigold extract showed the lowest probit mortality. The probit regression lines for three plant extracts on aphid at 48 HAT are given in Fig. 1B. From the probit analysis, the regression equations were $Y= 0.205x + 6.013$, $Y= 0.17x + 5.656$, $Y=0.305x + 6.476$ for ata, marigold and

**Table 6.** Relative toxicity (by probit analysis) of different plant extracts treated against *Myzus persicae* after 24, 48 and 72 hours after treatment

| Extracts used | No. of insect used | $LD_{50}$ mg/cm$^2$ | 95% fiducial limits | | $\chi^2$ values with 1 df |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| | | 24 HAT | | | |
| Ata | 90 | 0.86 | 0.30 | 2.46 | 2.67 |
| Marigold | 90 | 2.86 | 0.58 | 14.27 | 7.27 |
| Chilli | 90 | 0.67 | 0.20 | 2.27 | 0.19 |
| | | 48 HAT | | | |
| Ata | 90 | 0.54 | 0.18 | 2.73 | 0.39 |
| Marigold | 90 | 0.76 | 0.19 | 2.95 | 0.20 |
| Chilli | 90 | 0.57 | 0.20 | 1.58 | 0.12 |
| | | 72 HAT | | | |
| Ata | 90 | 0.41 | 6.97 | 2.36 | 5.23 |
| Marigold | 90 | 0.32 | 1.15 | 9.41 | 3.41 |
| Chilli | 90 | 0.005 | 8.78 | 3623.26 | 0.01 |

Values were based on three concentrations, three replications of 10 insects each. $\chi^2$ = Goodness of fit, the tabulated value of $\chi^2$ is 3.84 (d.f = 1 at 5% level)

chilli plant extracts, respectively. Comparing among the three plant extracts at 48 HAT for probit mortality, chilli extract showed the highest probit mortality whereas marigold extract showed the lowest. Chilli was also maintained its highest probit mortality when the probit regression lines were compared at 72 HAT (Fig. 1C). The insect mortality rate showed positive correlation with the doses in all treatments. The probit regression lines of three plant extracts showed a clear linear relationship between probit mortality and their log doses and the regression lines become sleeper as doses increased, because the adult insects were treated with more toxins for the same period at higher doses.

**The repellent effect:** The repellency rate of three plant extracts at different HAT are presented in Table 7. Ata, marigold and chilli plant extracts showed different repellent effect against tomato aphid. Among the three plant extracts tested, chilli extract showed the highest **(**60.44**)** mean repellent effect followed by ata (50.44%) and marigold (43.56%). On the basis of mean repellency rate, it was found that ata and marigold plant extracts were in the same repellency class i.e., class III and other plant extracts chilli were in class IV.

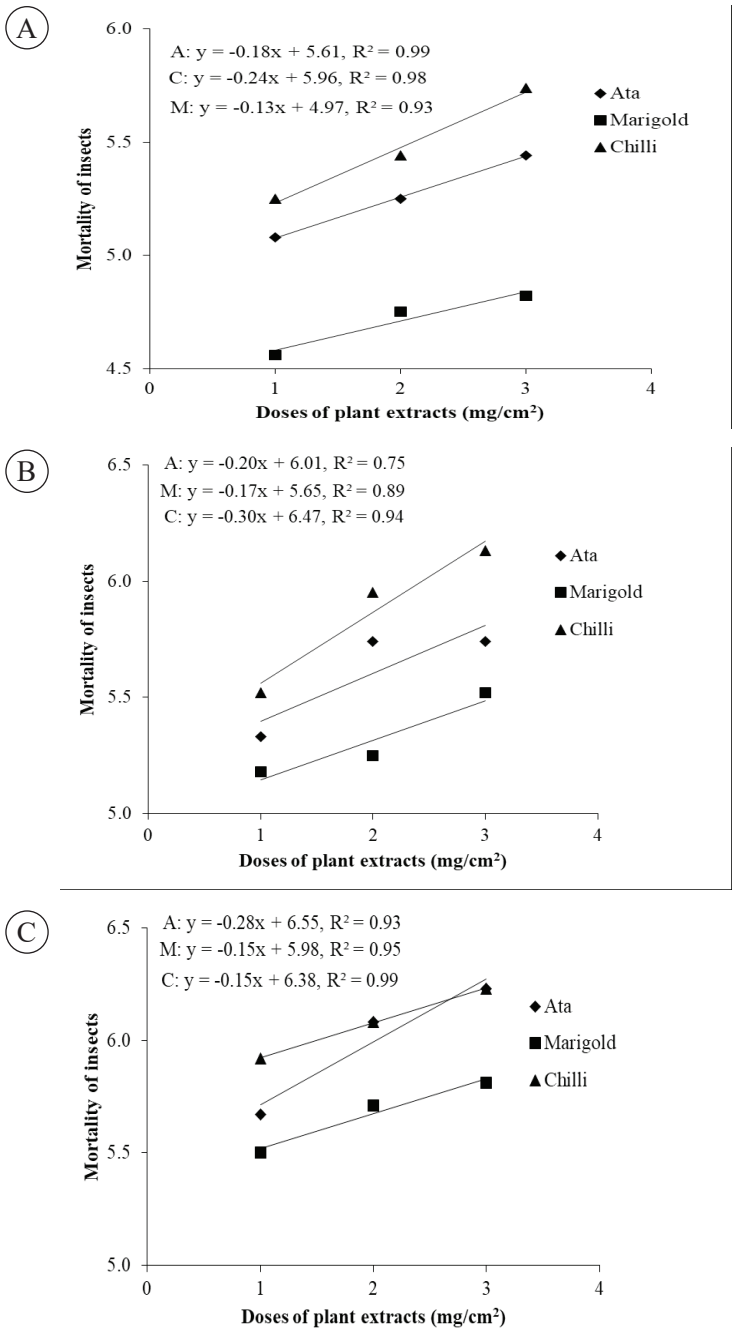


**Fig. 1.** Relationship between probit mortality and log doses of different plant extracts against *Myzus persicae* at 24 HAT (A), 48 HAT (B) and 72 HAT (C).

**Table 7.** Repellent effect of different plant extracts against *Myzus persicae* using treated filter paper at different HAT (Interactions of plant extracts and times)

| Extracts used | Repellency rate (%); mean ± SE | | | | | Mean repellency (%) | Repellency classes |
|---|---|---|---|---|---|---|---|
| | 1 HAT | 2 HAT | 3 HAT | 4 HAT | 5 HAT | | |
| Ata | 52.22 ± 7.41 a | 75.56 ± 6.47 a | 62.22 ± 7.77 | 68.89 ± 5.87a | 60.00 ± 8.16 | 63.78 ± 3.86 | IV |
| Marigold | 43.33 ± 6.23 a | 46.67 ± 8.81 b | 51.11 ± 9.49 | 53.33 ± 11.05 a | 46.67 ± 9.42 | 48.22 ± 5.85 | III |
| Chilli | 40.00 ± 6.66 a | 41.11 ± 10.06 b | 46.67 ± 6.66 | 40.00 ± 12.90 a | 44.44 ± 10.42 | 42.44 ± 5.11 | III |
| LSD | 15.48 | 22.79 | 26.95 | 29.77 | 29.28 | 14.49 | |
| CV (%) | 34.60 | 42.27 | 51.03 | 55.59 | 58.69 | 28.42 | |
| $S\bar{x}$ | 5.212 | 7.671 | 9.072 | 10.02 | 9.855 | 4.877 | |
| p-value | 0.256 | 0.011 | NS | 0.153 | NS | 0.017 | |

Mean followed by the same letter(s) are not significantly different at 5% level by DMRT.

The repellency effect of different plant extracts in different doses level against tomato aphid are presented in Table 8. The repellency rates of insects were influenced by the concentration of extracts. The highest mean repellency (63.78%) was found in 2% level of concentration and its bear repellency class IV and the lowest repellency (42.44%) was found in 1% level of concentration and its bear repellency class III.

Table 9 shows the interaction repellent effect of plant, dose and time. The repellent effect influenced by different level of concentrations at different HAT and had significant difference. Among different plant extracts chilli extract showed the highest mean repellency rate (73.33%) in highest concentration level. The repellency class of different plant extracts at different concentration level varied between I to IV. Chilli is the most toxic and also serves as a repellent against *M. persicae*. From the above result it was found that chilli extract showed strong repellent effect against tomato aphid than other plant extracts.

**Table 8.** Repellent effect of different plant extracts against *Myzus persicae* using treated filter paper at different HAT (Interactions of doses and times)

| Dose (mg/ml) | Repellency rate (%); mean ± SE | | | | | Mean repellency (%) | Repellency classes |
|---|---|---|---|---|---|---|---|
| | 1 HAT | 2 HAT | 3 HAT | 4 HAT | 5 HAT | | |
| 2.0 | 30.00 ± 5.27 b | 45.56 ± 13.65 a | 48.89 ± 8.24 | 51.11 ±12.95 | 42.22 ± 8.46 a | 43.56 ± 5.46 | III |
| 1.5 | 43.33 ± 6.23 b | 53.33 ± 8.16 a | 55.56 ± 8.01 | 53.33 ± 7.45 | 46.67 ± 9.42 a | 50.44 ± 5.96 | III |
| 1.0 | 62.22 ± 4.00 a | 64.44 ± 5.55 a | 55.56 ± 8.67 | 57.78 ± 222 | 62.22 ± 9.68 a | 60.44 ± 4.73 | IV |
| LSD | 15.48 | 22.79 | 26.95 | 29.77 | 29.28 | 14.49 | |
| CV (%) | 34.60 | 42.27 | 51.03 | 55.59 | 58.69 | 28.42 | |
| $S\bar{x}$ | 5.212 | 7.671 | 9.072 | 10.02 | 9.855 | 4.877 | |
| p-value | 0.001 | 0.243 | NS | NS | 0.343 | 0.073 | |

Mean followed by the same letter(s) are not significantly different at 5% level by DMRT.

**Table 9.** Repellent effect of different plant extracts against *Myzus persicae* using treated filter paper at different HAT (Interactions of plant extracts, doses and times)

| Extracts used | Doses (mg/ml) | Repellency rate (%); mean ± SE | | | | | Mean repellency (%). | Repellency classes |
|---|---|---|---|---|---|---|---|---|
| | | 1 HAT | 2 HAT | 3 HAT | 4 HAT | 5 HAT | | |
| Ata | 2.0 | 46.67 ± 13.33abc | 80.00 ± 11.54 a | 66.67 ± 6.66 | 66.67 ± 6.66 a | 60.00 ± 11.54 | 64.00 ± 4.61 ab | IV |
| | 1.5 | 50.00 ± 5.77 ab | 40.00 ±0.00 a | 53.33 ± 17.63 | 66.67 ± 6.66 a | 40.00 ± 20.00 | 50.00 ± 7.02 ab | III |
| | 1.0 | 33.33 ± 13.33bc | 40.00 ± 11.54 a | 46.67 ± 17.63 | 26.67 ± 6.66 a | 40.00 ± 20.00 | 37.33 ± 13.33 b | II |
| Marigold | 2.0 | 36.67 ± 8.81bc | 73.33 ± 17.63 a | 60.00 ± 11.54 | 60.00 ± 11.54 a | 40.00 ± 11.54 | 54.00 ± 3.05 ab | III |
| | 1.5 | 20.00 ± 0.00c | 53.33 ± 29.05 a | 40.00 ± 23.09 | 26.67 ± 17.63 a | 40.00 ± 11.54 | 36.00 ± 14.42 b | II |
| | 1.0 | 33.33 ± 13.33bc | 10.00 ± 5.77 b | 46.67 ± 6.66 | 66.67 ± 33.33 a | 46.67 ± 24.03 | 40.67 ± 7.33 b | III |
| Chilli | 2.0 | 73.33 ± 6.66a | 73.33 ± 6.66 a | 60.00 ± 23.09 | 80.00 ± 11.54 a | 80.00 ± 11.54 | 73.33 ± 7.42 a | IV |
| | 1.5 | 60.00 ± 0.000ab | 46.67 ± 6.66 a | 60.00 ± 11.54 | 66.67 ± 24.03 a | 60.00 ± 20.00 | 58.67 ± 4.80 ab | III |
| | 1.0 | 53.33 ± 6.66ab | 73.33 ± 6.66 a | 46.67 ± 13.33 | 26.67 ± 17.63 a | 46.67 ± 17.63 | 49.33 ± 6.66 ab | III |
| LSD | | 26.82 | 39.48 | 46.69 | 51.57 | 50.72 | 25.10 | |
| CV (%) | | 34.60 | 42.27 | 51.03 | 55.59 | 58.69 | 28.42 | |
| $S\bar{x}$ | | 9.027 | 13.29 | 15.71 | 17.36 | 17.07 | 8.447 | |
| p-value | | 0.000 | 0.104 | 0.000 | 0.156 | 0.000 | 0.000 | |

Means followed by the same letter(s) are not significantly different by DMRT at 5% level of probability.

## REFERENCES

ABBOTT, W. S. 1987. A method of computing the effectiveness of an insecticide. *J. Am. Mosq. Control Assoc.* **3**: 302-303.

AGONG, S.G., KINGETSU, M., YOSHIDA, Y., YAZAW, S. & MASUDA, M. 2003. Response of tomato genotypes to induced salt stress. *Afr. Crop Sci. J.* **11**(2): 133-142.

ARNASON, J. T., PHILOGENC, B. J. R. & MORAND, P. 1989. Insecticides of plant organ. ACS *Symptoms Service.* 62. Washington, D.C. p. 387.

ATTIA, A. A., EL-HENEIDY, A. H. & EL-KADY, E. A. 1986. Studies on the aphid, *M. persicae* (Homoptera: Aphididae) in Egypt. *Bull. Egypt. Soc. Physiol. Sci.* **66**: 319-324.

BUSVINE, J. R. 1971. A critical review of the techniques for testing insecticides, Commonwealth Agricultural Bureau (CAB), London, UK, pp. 263-288.

BUSVINE, J. R. 1980. Insects and Hygiene. Chapman and Hall. London, England.

DAS, B. C., SARKER, P. K. & RAHAMAN, M. M. 2008. Aphidicidal activity of some indigenous plant extracts against aphid *M. persicae* (Homoptera: Aphididae). *J. Pest. Sci.* **81**(3): 153-159.

Duncan, D. B. 1951. A significance test for differences between ranked treatments in an analysis of variance. *Va. J. Sci.* **2**(3): 171-189.

DYTE, C. E. 1970. Insecticide resistance in stored products insects with special reference to *Tribolium castaneum. Trop. Stored Prod. Inf.* **20**: 13-15.

Dyte, C.E. & Hallday, D. 1985. Problems of development of resistance of phosphoric by insect pests of stored grains. Organization Europeans Mediterranean pour La protection des plants. **15**: 5 1-57.

FAOSTAT. 2008. "FAO Statistics, Food & Agriculture Organization of the United Nations, Rome, 2012" http://faostat.fao.org/

IRSHAD, M. & JILANI, W. A. 1990. Resistance in *Tribolium castaneum* Herbst. (Coleoptera: Tenebrionidae) against malathion. *Pak. J. Zool*. **22** (3): 257-262.

KAISER, W. J. 1979. Natural infection of cowpea and moong bean by alfalfa mosaic virus in Iran. *Plant Dis. Rep.* **63**: 414-4 18.

MCDONALD, L. L., GUY, R. H. & SPEIRS, R. D. 1970. Preliminary evaluation of new candidate materials as toxicants repellents and attractants against stored product insects. Marketing Research Report No. 882. Agricultural Research Service. U.S. Department of Agriculture. Washington. 8p.

METCALF, R. L. & LUCKMANN, W. H. 1975. Introduction to insect pest management. John Wiley and Sons. New York, Toronto, London, Sydney. pp. 235-273.

RAJAPPAN, K., USHA MALINI, C., SUBRAMAMIAN, N., NARASIMHAN, V. & ABDUL KAREEM, A. 2000. Effect of botanicals on the population dynamics of *Nephotettix virescens*. rice tungro disease incidence and yield of rice. *Phytoparasitica*. **28**: 10-20.

RAJASEKARAN, B. & KUMARASWAMI, T. 1985. Control of storage insects with seed protectants of plant origin. The paper presented in the conference theme, *Behavioral and physiological approaches in pest management*. pp 15-17.

SAIM, N. & MELOAN, C. E. 1986. Compounds from leaves of bay *(Laurus nobilis* L.) as repellents for *Tribolium castaneum* (Herbst) when added to wheat flour. *J. Stored Prod. Res*. **22**: 141-144.

SHARABY, A. 1988. Evaluation of some Myrtaceae plant leaves as protectants against the infestation by *Sitophilus oryzae* L. & *Sitophilus granaries* L. *Insect Sci.* **9**: 465-468.

SHARMA, Y. 1985. Effect of aak flower extract on different larval stages of the lesser grain borer, *Rhizopertha dominica* Fab. *J. Adv. Zool*. **6** (1): 8-12.

SINCHAISRI, N., ROONGSOOK, D. & CHUNGSAMARNYART, N. 1991. Insecticidal activity of plant crude extracts on diamondback moth larvae, *Nat. Sci. Res.* **25**: 106-110.

TALUKDER, F. A. & HOWSE, P. E. 1993. Deterrent & insecticidal effects of extracts of pithraj, *Aphanamixis polystachya* (Meliaceae) against *Tribolium castaneum*. *J. Chem. Ecol.* **19**: 2463-2471.

TALUKDER, F. A. & HOWSE, P. E. 1994a. Laboratory evaluation of toxic &repellent properties of the pithraj tree, *Aphanamixis polystachya* Wall & Parker against *Sitophilus oryzae* L. *Int'l J. Pest Manage.* **41**(3): 274-279.

TALUKDER, F. A. & HOWSE, P. E. 1995a. Evaluation of *Aphanamixis polystachya* as repellents, antifeedants, toxicants &protectants in storage against *Tribolium castaneum*. Herbst. *J. Stored Prod. Res.* **31**(1): 55-61.

TALUKDER, F. A. & HOWSE, P. E. 1995b. Efficacy of pithraj, *Aphanamixis polystachya* seed extracts against stored product pests. Proc. 6th Int. Working Conference Stored Product Protect Canberra, Australia, April, 1994.

TALUKDER. F. A. & HOWSC, P. E. 1994b. Repellent, toxic &food protectant effects of Pithraj, *Aphanamixis polystachya* (Meliaceae) against pulse beetle, *Callosobruchus chinensis* L. in storage. *J. Chem Ecol.* **20**(4): 899-908.

TANZUBIL, P. B. 1987. The use of neem products in controlling the cowpea weevil. *Callosobruchus maculatus* Fab. *Nyankpala Agricultural Experimental Station & Crop Research Institute, Tamale, Ghana.* pp. 517-523.

THOTTAPPILLY, G. & ROSSEL, H.W. 1985. Worldwide occurrence & distribution of virus diseases. In: Sing, S.R., Rachie, K.O. (eds.) Cowpea research production & utilization. Wiley. New York. pp. 155-171.

WANG, M., LING, J., CAO, X., BAO, S. & ZHANG, M. 2012. Toxicity evaluation of botanical insecticides &their mixture against the *Aleurodicus dispersus*. South China University, China. *J. Biosaf.* pp. 1787-2095.

YORK. A. 1992. Pests of cucurbits crop, marrow, pumpkin, squash, melon &cucumber. In: Mckinlay RG (eds) Vegetable crop pests. Macmillan Press, Houndrmills, Basingstoke. pp. 137-167.

ZETTLER. J. L. 1991. Pesticide resistance in *Tribolium castaneum* & *Tribolium confusum* (Coleoptera: Tenebrionidae) from flour mills in the United Sates. *J. Econ. Entomol*. **84**: 763-767.

ZETTLER. J. L. & CUPERUS, G. W. 1990. Pesticide resistance in *Tribolium castaneum* (Coleoptera: Tenebrionidae) & *Rhizopertha dominica* (Coleoptera: Bostrichidae) in wheat. *J. Econ. Entomol*. **83**: 1677-1681.