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EFFICACY OF BOTANICALS AGAINST MUSTARD APHID (*LIPAPHIS ERYSIMI* KALT.) (HOMOPTERA: APHIDIDAE) ON *BRASSICA CAMPESTRIS* L.

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Abstract

Efficacy of neem leaf extract, mahogany seed dust, and neem seed kernel dust against the mustard aphid *Lipaphis erysimi* Kalt., (Homoptera: Aphididae) on the mustard plant (*Brassica campestris* L.) was investigated during November 2014 to January 2015. The trial included four treatments, namely T1: neem leaf extract, T2: mahogany seed dust, T3: neem seed kernel dust, T4: control. The treatments began 22 DAS and were repeated every 7 days. T4 had the maximum number (9500 ± 1226.3) of aphid pest population at 57 DAS, and the lowest number (3 ± 0.9) of aphid pest population was found in T4 at 29 DAS. The aphid population was found to be nil at 22 and 71 DAS in all treatments. Furthermore, in case of T2, the aphid population was zero at 29 DAS. There was no significant difference in aphid counts between the treatments, according to the ANOVA test. Only in T2, the aphid counts showed a significant difference by replicates. But the number of fruits and seed output of mustard were affected by the efficacy of botanicals against mustard aphid. T1 exhibited the highest percentage of fruits (27.7%), seeds (42.64%), and seed weight (54.9%). T1 had the highest proportion of healthy seed (75.91%), whereas T4 had the highest percentage of defective seed (45.49%). Aphid population is negatively correlated to average temperature and relative humidity in all treatments.

Introduction

Lipaphis erysimi Kalt., the mustard aphid, is the most damaging pest of rapeseed, mustard, and a major limiting factor for successful crop cultivation in this country (Biswas *et al*. 2000, Biswas and Das 2000). The pest is also a serious problem in other South-East Asian countries and the United States (Atwal and Dhaliwal 2007, Biswas 2008). This aphid species infests several economically important crops particularly under Cruciferae family. The nymphs and adults of this pest cause damage to mustard plants from early vegetative to siliqua maturity (Verma and Singh 1987), resulting the plant with stunted growth, flowers fade, and pod formation is hampered. Although an aphid is a small insect, it can destroy plants faster than larger insects and has a negative impact on market value of cruciferous crops (Sultana *et al*. 2009). Plant vitality is greatly reduced due to the pest's large population. The leaves become curly, the flowers fail to form pods, and the developing pods do not produce healthy seeds (Gazi *et al*. 2001).

In Bangladesh, the main and most significant oil seed crop is the mustard plant, *Brassica* spp. It provides most of the nation's total production of edible oil seeds (Biswas 2013). It covered approximately 0.48 million hectares of land during the 2010-2011 crop seasons, and approximately 0.53 million metric tons of seed were produced (DAE 2011). Bangladesh primarily cultivates three species: *Brassica campestris*, *B. juncea* and *B. napus* (Mamun *et al*. 2010). Of these *B. campestris* is of greatest importance in the world's oil seed trade and several varieties

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of this species such as Tori-7, Sonali Sarisha (SS-75), Kallaynia (TS-72), Sampad Agrani, BARI Sarisha-6, BARI Sarisha-9 and Sampad are mainly grown in Bangladesh. In comparison, botanical pesticides are less expensive, have low toxicity, made from naturally occurring plant materials, degrade quickly, and are safe for non - target organisms (Sultana *et al*. 2009). Because they are susceptible to degradation by light, heat, and microorganisms, botanicals are environmentally friendly than synthetic pesticides. Scientific efforts were also made to test the insecticidal abilities of various plant extracts against mustard aphid considering these findings (Srivastava and Guleria 2003). According to Ahmed (1984), 221 plant species have insecticidal activities. A subtropical tree with a native range in arid regions of Asia and Africa, neem tree (*Azadirachta indica)* is a source of several insecticidal alkaloids (Saha *et al*. 2006). The primary pesticide found in neem is azadirachtin. Products made from neem are cheaper, safer for beneficial organisms, and made from naturally occurring materials (Biswas 2013). Extensive research has been done to show the effectiveness of neem seed kernel extracts in controlling insect pests. These extracts also contain azadiractin, salanin, and meliontriol (Saxena *et al*. 1981). The seeds of the mahogony plant are very toxic to the insect pests and diseases. When necessary, the ecological perspective to pest management advises using both chemical and botanical pesticides. With the negative effects of pesticides in mind, it is important to place an emphasis on finding alternatives to pesticides that are less toxic, secure, affordable, produced locally, and environmentally friendly (Mohammad *et al*. 2010). Neem extracts are typically safe for beneficial organisms like bees, predators and parasitoids, mammals, and the environment (Tang *et al*. 2002). In order to accomplish the goals of the current research project, the present study was aimed to find out the efficacy of some botanical insecticides i.e. neem leaf extract, mahogany seed dust, and neem seed kernel dust against mustard aphid (*Lipaphis erysimi* Kalt.).

Materials and Methods

The present study was conducted on the rooftop garden of the Department of Zoology of Jagannath University (23°42′37″ N-90°24′40″E), Dhaka during November 2014 to January 2015. A Randomized Complete Block Design (RCBD) was used to set up the experiment with 4 treatments having 5 replications for each. The design of the work was adopted using the method used by Rashid *et al*. (2004). Mustard variety, type of soil, amount and component of pots needed in the experiments were Tori-7 *(Brassica campestris)*, fertile, well-drained sandy loams to loamy soils, 20 mud made pots, respectively. The treatments began 22 days after sowing (DAS) and applied with 7 days interval for controlling mustard aphid infestation.

Treatment 1 (T1): The 250 g of green neem leaves were soaked in one liter of water overnight. On the following day, wet leaves were ground into a thin paste using a pestle and mortar, and the crude extract was filtered through a fine mesh of cotton cloth. Water was added to bring the total volume to 1.5 liters. Treatment 2 (T2): 200 g of mahogany seed dust were soaked overnight in two liters of fresh, clean water. To extract the contents fully, the extract was filtered through a fine, clean cotton cloth. Treatment 3 (T3): 200 g of neem seed kernel dust were soaked in two liters of water and left over night with occasional stirring. Extracts were filtered through a fine, clean cotton cloth in the morning, and Treatment (T4): (Control) Untreated (an equal volume of water).

Urea (250 mg), phosphorus (200 mg), and potash (200 mg) fertilizer were applied in each pot to increase the fertility of soil at the interval of one month. Fertilizer was applied in a liquid form at each pot at afternoon to avoid the intensity of sunlight. Watering was done by using watering pipe placed in roof. Until fruiting, the mustard crop has a high-water requirement throughout the growing period, and watering was done regularly during dry periods of study. For good drainage

the seedbeds were raised to about 12-14 inch high. The soil was mixed with well-rotted farmyard manure and poultry droppings.

For samples of pods, stems, and leaves, the number of aphids per centimeter of plant part was measured (Prasad *et al.* 1983), aphid populations were assessed weekly after 22 Days After Sowing (DAS). Every week, the sampling began at the same time frame (8 – 10 am). Both the adult and nymph populations were measured. A magnifying glass and a manual tally counter were used to count the population.

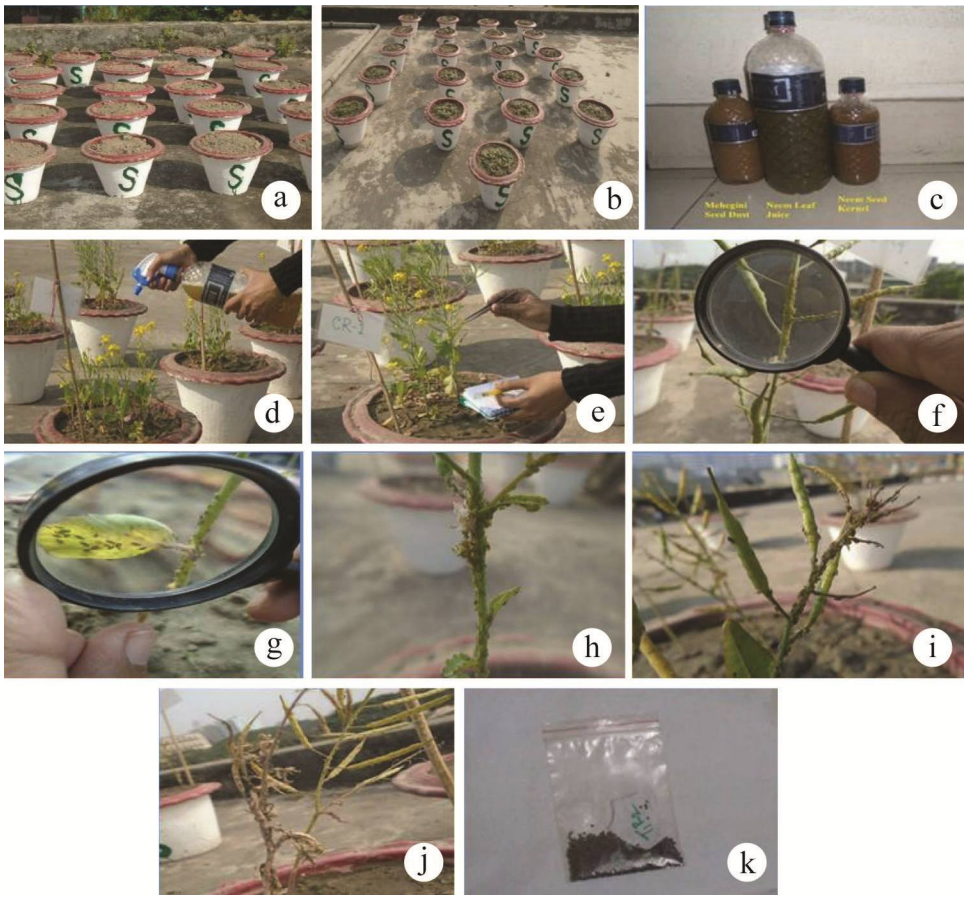

Plate 1. Different materials and stages of the present study. (a) Seed bed preparation, (b) Emerging seedling, (c) Prepared botanicals, (d) Spraying botanicals, (e) Counting of aphids, (f) Infested stem, (g) Infested leaf, (h) Severe infestation, (i) Damaged pod because of infestation, (j) Distorted plant and (k) Collection of seed.

When the pod reached maturity, seed yield was calculated. Ripened pods were manually collected into polythene bags from the two central rows in accordance with treatments and replicates. The pods were then sun dried for a week before being manually shelled. Weights were documented by weighing the dry grains with an EK-H series weighing balance (EK300H model). The yield was generalized to grams.

Data of humidity and temperature of the study area were collected from the Bangladesh Meteorological Department.

Results were analyzed by utilizing the Microsoft Office Excel programme. The collected data were summarized statistically to obtain means and standard deviations. RStudio (2022.02.3 version) was used to perform statistical analysis. Analysis of Variance (ANOVA) test was performed by using the library *"ggplot2"* and *"tidyverse"* within the*"ggplot2"* and *"tidyverse"* packages to determine statistical difference.

Results and Discussion

The number of mustard aphid infestation on mustard plants during the sampling period is presented in Fig. 1 that illustrates how minimal the infestation was up until 43 DAS. Aphid pest population at its peak number (9500 ±1226.3) was documented in T4 (Control) on 57 DAS followed by T2 on 64 DAS. Then, no mustard aphid was found on 71 DAS.

In case of T1, firstly aphids appeared on the mustard plant on 29 DAS. There were very few aphids up to 36 DAS. But after 43 DAS, it increased gradually until 57 DAS and then began to decline. The highest number of aphids (7895 ± 782.35) was recorded on 57 DAS, followed by 64 DAS, whereas the lowest number (4 ± 0.84) of aphid infestation was found on 36 DAS followed by 29 DAS.

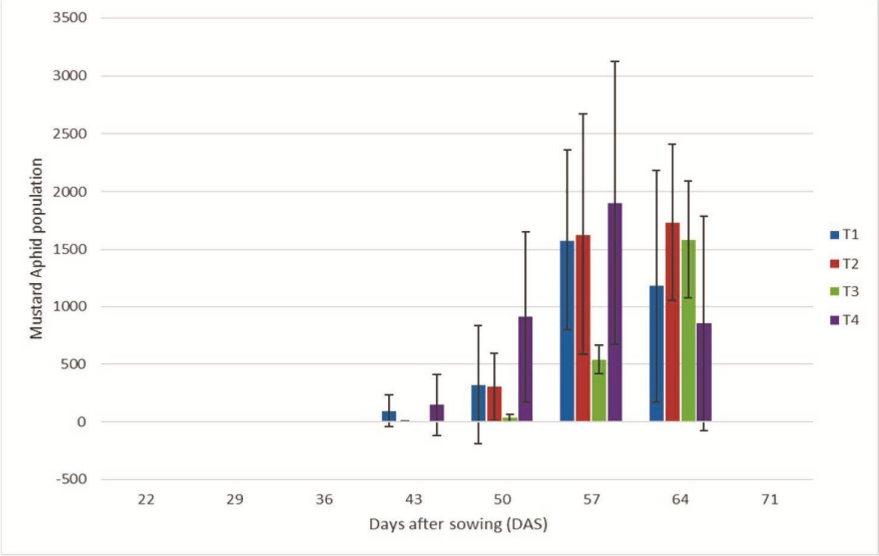

Fig. 1. Infestation of the number of aphids on mustard plants in 4 treatments during the study period.

Aphids were seen in T2 in small numbers for up to 43 DAS. However, after 43 DAS, it increased gradually until 57 DAS before gradually declining after that. On 64 DAS, most aphids (8665 ± 677.22) were noticed. On 36 DAS, the lowest aphid infestation rate (4 ± 1.30) was documented. On 22, 29, and 71 DAS, no aphid was seen. This result demonstrates that the aphid population completely decreased after the number of aphids was increased to 64 DAS.

On 29 DAS, aphids were first detected on the mustard plant for T3. The count of aphids was minimal prior to 36 DAS. However, it increased gradually from 43 DAS to 57 DAS and after that gradually decline. The highest concentration of aphids (7915 ± 507.62) was on 64 DAS, then

on 57 DAS. Twenty nine DAS had the fewest aphid infestations (5 ± 1.00), followed by 43 and 36 DAS. On 22 and 71 DAS, no aphid was seen. This result showed that the aphid population completely decreased after the number of aphids was increased to 64 DAS.

In case of T4, aphids first appeared on the mustard plant on 29 DAS. The number of aphids was zero prior to 36 DAS. But after 43 DAS, it considerably increased until 57 DAS, and then it started to decline. The maximum number of aphids (9500 ± 1226.3) was observed on 57 DAS, followed by 50, 64, and 43 DAS. However, the lowest number of aphid infestations (3 ± 0.9) was found on 36 DAS. On the first and last dates of the data count, no aphids were seen. This finding suggests that the aphid population gradually decreased after being raised to a maximum of 57 DAS.

In every treatment, the average aphid population per replication was inversely correlated with the temperature (Fig. 2). In T1, the population of mustard aphids (*Lipaphis erysimi*) was moderately correlated with the mean temperature (R^2 = 0.2148), according to Pearson's correlation coefficient. Similar to that, (R^2 = 0.2075), or moderate correlation, was seen in T4. In T2, aphid population and average temperature showed a weak correlation (R^2 = 0.1197). A very weak correlation (R^2 = 0.0021) was observed in T3 (Fig. 2).

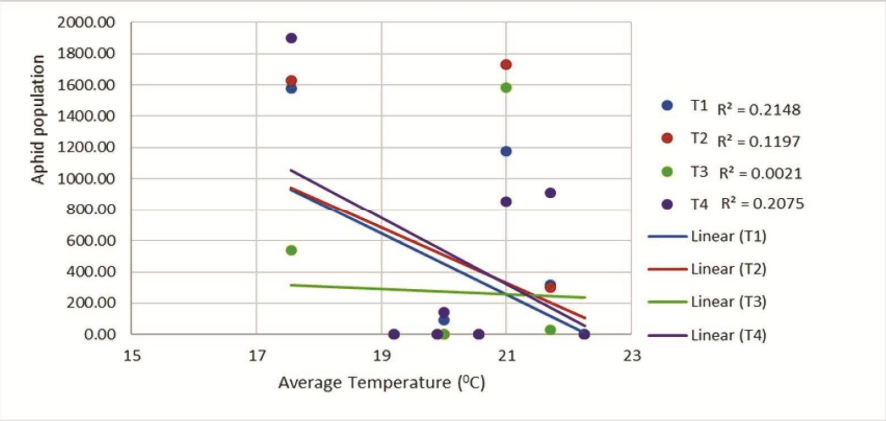

Fig. 2. Correlation of aphid population with average temperature for all treatments.

In all treatments, the average relative humidity of the weekly sampling period was negatively associated with the average aphid population per replication (Fig.3). T2 (R^2 = 0.2824) on the other hand, showed comparatively moderate correlation with average relative humidity while T4 (R^2 = 0.4573) and T1 (R^2 = 0.3454) showed relatively strong negative correlation. In the case of T3, a mediocre negative correlation (R^2=0.1405) was found (Fig. 3).

Figure 4 showed that T1 had the highest percentage (27.7%) of fruit yield and T3 had the lowest percentage (18.08%). T1 displayed the highest percentage (42.64%) while T3 showed the lowest percentage (10.31%) of seeds. T1 exhibited the maximum seed weight, followed by T2, and T4, respectively. Under T4, the highest proportion of malformed seeds was visible. The highest percentage of good seeds was observed in T1.

When comparing the aphid population count by DAS, an ANOVA test revealed a statistically significant difference ($F = 31.34$, $p < 0.001$). However, there was no statistically significant difference in aphid counts between the treatments ($F = 1.44$, $p > 0.1$). Aphid counts in all treatments were statistically significant by DAS, according to an ANOVA test for individual

treatment ($p < 0.001$). However, there were no statistically significant variations in aphid counts between replicates T1, T3, and T4 ($p > 0.1$). Only in T2, the aphid counts showed a statistically significant difference by replicates ($p < 0.05$).

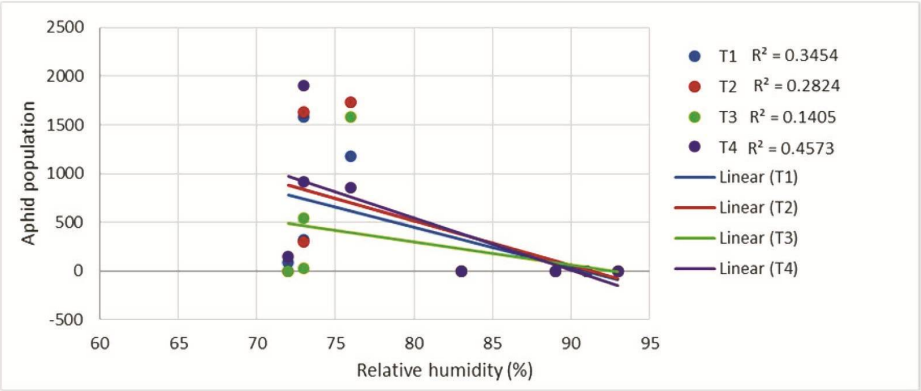

Fig. 3. Correlation of aphid population with relative humidity for all treatments.

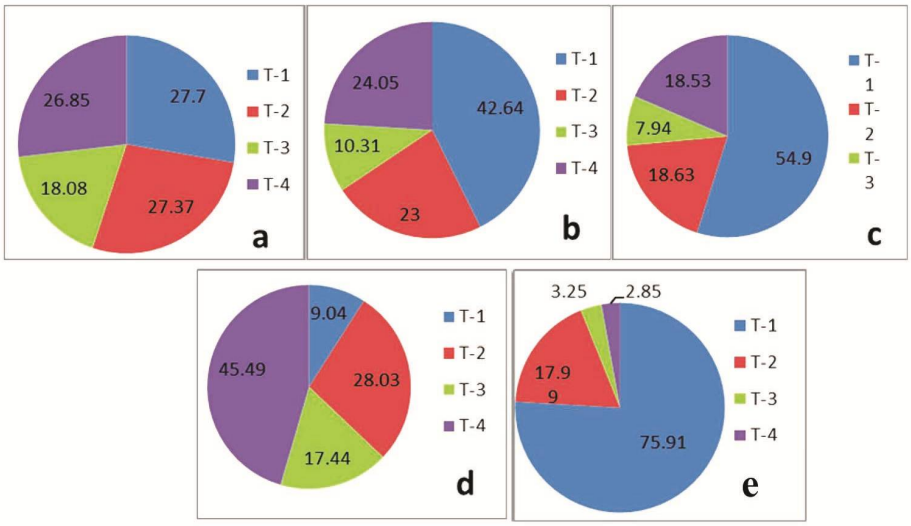

Fig. 4. Relative abundance (%) of (a) Fruits (b) Seeds by number (c) seeds by weight (d) deformed seed (e) good seed.

During the study period from November 2014 to January 2015, appearance of mustard aphid was reported from initial appearance to highest peak (Fig. 1). The highest number of aphid pest population (9500 ±1226.3) was recorded in T4 in 57 DAS, and the lowest (3 ± 0.9) was also recorded in T4 in 29 DAS (Fig. 1). A peak in aphid population was reached during blooming phase of mustard plants. The findings are more or less with the observations made by Singh and Lal (1999), Biswas and Das (2000), and Devi *et al*. (2001). This study showed insignificant number of aphid population at 29 DAS (2nd week of December), which is in line with the research conducted by Sultana *et al.* (2009) who did not find any aphid on mustard plant even up to 22nd

December 2008 (35 DAS). In that study in the first week of January, during the crop's flowering and pod-formation stage (50 DAS), the appearance of aphid was apparent on the mustard crop, and they persisted in their infestation through the third week of January, when the crop was still immature (70 DAS).

The air temperature and relative humidity during this study period were 17.55-22.25ºC and 72-93%, respectively. Under all the treatments, there was a negative correlation between the aphid population and the mean temperature. T2 and T3 exhibited weak negative correlation, while T4 and T1 exhibited moderate negative correlation (Fig. 2).

Under all treatments, there was a negative correlation between aphid population and relative humidity. Strong negative correlations were seen in T4 and T1, moderate negative correlations were seen in T2, and weak negative correlations was seen in T3 (Fig. 3). In the second week of January, when the mean temperature was 17.55^0C, highest aphid population was observed.

The present observation agrees with the observation made by El-Nagar *et al*. (1982) who mentioned that a substantial negative impact on population structure was caused by a gross increase in temperature. However, Campbell *et al.* (1974) observed positive correlations between the maximum aphid population and a medium rise in temperature.

Sahoo (2012) observed that a clear trend in the relationship of aphid population with weather factors could not be established by the correlation between aphid population and weather parameters. Singh and Lal (2012) worked on the ability of some plant leaf extracts to effectively repel mustard aphid, *Lipaphis erysimi* Kalt. on *Brassica campestris*. Neem leaf extract (T1) consistently caused the highest level of aphid mortality (77.33 and 71.76%), followed by punch phuli leaf extract (74.35 and 70.96%) and Garlic leaf extract (73.19 and 62.17%) on the seventh day following spray in both years 2009-2010 and 2010-2011. Insecticidal activity was present in all treatments using plant leaf extracts.

The ANOVA test conducted for the present study revealed that none of the treatments had a significant impact on the data. When an independent ANOVA test was conducted for each treatment with its replication, Treatment2 demonstrated significance. The data under all treatments were significantly affected by test periods (DAS), according to ANOVA. The neem leaf extract (T1) applied pots showed the greatest increase in mustard seed yield (10.93 g), followed by mahogany seed dust (T2) applied pots (3.7 g), control (T4) (3.69 g), and neem seed kernel dust (T3) (1.58 g) treated pots. The untreated pot (T4) had the second lowest seed yield (3.69 g). The highest (10.93 g) was calculated from neem leaf extract (T1). This finding demonstrated the potency of neem leaf extracts (T1) in reducing aphid populations in mustard during seed production.

Different botanicals displayed noticeable variations in the quantity, weight, and quality of mustard fruits and seed. The percentage from highest to lowest was T1 > T4 > T2 > T3 in terms of the quantity of seeds, T1 > T2 > T4 > T3 in terms of the quantity of fruits, T1 > T4 > T3 > T2 in terms of the weight of seeds, T4 > T2 > T3 > T1 in terms of deformed seeds, and T1 > T2 > T3 > T4 in terms of the quantity of good seeds. T1 displayed the highest proportion of healthy seed, whereas T4 displayed the highest proportion of damaged seed. Oparaeke *et al*. (2005) documented that leaf extract of neem and eucalyptus caused less pod damage per plant compared to untreated plants, and the yield was also higher.

Mustard aphid *Lipaphis erysimi* Kalt. is regarded as the primary pest of mustard plant. Heavy infestation reduces the vigor of the plants, show distorted and stunted leaves, reduced fruit set and sometimes plant may be killed by direct feeding. Considering the above fact, aphid sampling is used as monitoring tool for determining the need for control measures against mustard aphid. Aphid infestation gives an insight that the aphid population's peak incidence was in January 2015.

According to the results of the ANOVA test, the use of Mahogany seed dust (T2) had a significant impact on the data compared to the other treatments. The healthiest seeds were found under T1, whereas the most deformed seeds were found in T4. From the obtained results it may be concluded that further study is required on neem and mahogany based insecticides as a replacement of synthetic insecticides that will protect the beneficial species and guarantee the good health of its most prized inhabitants.

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