INCIDENCE AND CONTROL OF COWPEA APHID, *Aphis craccivora* KOCH (HOMOPTERA: APHIDIDAE) ATTACKING ROOFTOP GROWN BEAN AND COWPEA PLANTS

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Abstract

A study was conducted on four bean (*Dolichos lablab*) varieties, viz. Ipsa bean, Noldoga bean, Bari bean and Shem kartica, and two cowpea (*Vigna unguiculata*) varieties, viz. Green cowpea and Red cowpea to observe the incidence of cowpea aphid, *Aphis craccivora* Koch, their correlation with environmental factors, and the effects of different treatments with water, detergents and botanicals, viz. custard apple seed dusts, for their control at a rooftop garden in two Rabi seasons (viz. November 2012-February 2013 and November 2013-January 2014). Among the 16 weeks of study period, the highest incidence of aphid (11496 ±771.13/plant) was recorded at 9th week (1st week of January 2013) in variety 5 and the lowest incidence (4.67±1.5/ plant) was at 11th week (3rd week of January 2013) in variety 3 during the 1st Rabi season (November 2012-February 2013). Incidence of pest population varied at various parts of the plant in different weeks during the two study seasons. A linear correlation of mean population with air temperature and relative humidity (RH) was estimated. *A. craccivora* populations had positive corelations with temperature in variety1 (r = 0.43), variety 2 (r=0.30), variety 3 (r = 0.44), variety 4 (r = 0.17), variety 6 (r = 0.11) and a negative corelation in variety 5 (r= − 0.30). These populations had negative corelations with RH in variety 1 (r = −0.35), variety 2 (r = −0.42), variety 3 (r = −0.21), in variety 6 (r = −0.26) and positive corelation with RH in variety 4 (r = 0.05) and variety 5 (r = 0.28). The infestation of *A. craccivora* aphid was highly controlled by treatment 2-5, where the treatment 1 (water only) showed the highest infestation at the early stage of the plants and gave a lower yield. However the treatment 5 (viz. a combination of detergent, custard apple seed dusts, and water) showed lower plant infestation and gave the highest yield.

***Key words*:** *Aphis craccivora*, *Dolichos lablab*, *Vigna unguiculata*, Treatment, Custard apple seed, Roof Garden.

INTRODUCTION

Cowpea or Hyacinth cowpea aphid, *Aphis craccivora* Koch is one of the most important polyphagous insect pests that colonize, with marked preference for legumes, cole crops and cucurbits, throughout the world. Hyacinth bean (country bean) and cowpea (Yard long bean) are very common and important vegetable crop cultivated year-around in Bangladesh and infested by *Aphis craccivora* causing damage to flowers, buds, tender shoots, and reduce seed viability and the market value (Srivastava and Singh 1986, Karim 1995). Severe infestation causes necrosis to the leaf chlorophillus tissue, suppresses flowers to bloom and reduces fruit formation (Way *et al.* 1954). As a result of its attack, considerable damage occurs every year affecting the quality and crop yield adversely. Dense population of the aphid can reduce the vigor of the host plant and making it susceptible to other pests (Yarahmadi *et al*. 2011).

The effects of various plant products including insecticidal, repellent and anti-feedant activities have been reported (Huang *et al*. 1998). Some botanical extracts, such as tobacco, neem, garlic, eucalyptus and mehogony etc. were used to control aphids in Bangladesh (Bahar *et al.* 2007). The seeds of custard apple (*Annona squamosa* L.) are known to show insecticidal and vermicidal activities. The seeds contain chemicals known as acetogenins, which are toxic to insects, but are usually safe for beneficial organisms, such as bees, insect predators, parasitoids and mammals, as well as, for the environment (Rao *et al.* 2005). The extract of the seeds reduces the population of several aphid species in many crops, causing high mortality and decreasing fecundity, as well as, inhibiting population growth (Tang *et al.* 2002).

The control measures adopted for the cowpea aphid in Bangladesh have so far been based mainly on chemical insecticides (Satar *et al*. 2005). The application of broad-spectrum insecticides for the control of this pest also have destroyed beneficial natural enemy populations and as a result, contributed to cowpea aphid outbreaks which also damaging the environment and human health (Rashid *et al.* 2004). Bayhan *et al*. (2006) reported the effect of custard apple seed's extract for the aphid control which clearly reduced adult longevity, survival rate, fecundity, and life table parameters.

Some attempts in pest management could be treated as the *'environmentally sound attempts'*. The present work is the fractional part of such an attempt. In this attempt a botanical (dust of custard apple seed) was used for practicing a device to keep the aphid population below the economic injury level- 'EIL' where the insect would show its incidence on the cowpea and bean plants.

The present investigation was also carried out to assess the incidence of cowpea aphid, *A. craccivora* on bean and cowpea plants, the impact of climatic factors (temperature and relative humidity) on the aphid incidence, and to screen the effect of the dusts of custard apple seed for the management of aphids.

MATERIAL AND METHODS

The experiment was carried out during two Rabi seasons (November 2012-February 2013 and November 2013-January 2014) at the rooftop garden of Zoology Department, Jagannath University, Dhaka. The experiment was laid out in a Randomized Complete Block Design (RCBD) with five treatments having three replications for each. The work design was made according to the procedure followed by Rashid *et al.* (2004). The experimental tubs were arranged in five rows, each of which contained fifteen bean plants (*Dolichos lablab*) of four varieties, viz. Variety 1 (Ipsa bean), Variety 2 (Noldoga bean), Variety 3 (Bari bean) and Variety 4 (Shem kartica), as well as cowpea plants (*Vigna unguiculata*) of two verities, viz. Variety 5 (Green cowpea) and Variety 6 (Red cowpea). Five different treatments (Table 1), with three replications each, were applied on the bean plants at an interval of three days and continued for six weeks (from late November 2013 to mid January 2014) used for controlling aphids infesting the bean plants. In the treatments water, dusts of custard apple seeds, and detergents in different combinations were used. For each treatment spraying was done directly on the infested plants.

Table 1. Five treatments used for controlling cowpea aphid population on the bean and cowpea plants.

Treatments	Materials
Treatment 1 (Control)	1 litter water
Treatment 2	2 g dust of custard apple seeds + 1 liter water
Treatment 3	1 g dust of custard apple seeds + 1 liter water
Treatment 4	0.5 g detergent powder + 1 liter water
Treatment 5	1 g dusts of custard apple seeds + 0.5 g detergent powder + 1 liter water

Aphid population on the infested bean and cowpea plants were monitored twice weekly between 8 am and 11 am at each sampling occasion. The number of aphids was recorded by leaf count method. The aphid infested leaves on different plants were selected randomly. The counting of the aphid number started two weeks after plantation. The average numbers of insect individuals was counted each time and was computed for each treatment. Percentage of infested leaves or fruits was done by using the following formula:

$$\text{Percentage of leaf or fruit infestation} = \frac{\text{Number of leaf or fruit infested}}{\text{Total number of leaf or fruit}} \times 100$$

Data on temperature and humidity were obtained from the meteorological department of Dhaka city. The data were analyzed using Microsoft Office Excel programme.

RESULTS AND DISCUSSION

Weekly incidence of *A. craccivora* population on different varieties of bean and cowpea plants was observed in 16 weeks from November'12 to February'13 (Fig. 1). Monthly incidence of *A. craccivora* is shown in the Table 2. In variety 1, the highest incidence was found in 16th week (1155.17±62.35/plant) and the lowest incidence was found in 11th week (49.83±11.87/plant). From 1st to 16th week aphid population was increased by 509.59%. The aphid population increased gradually from 1st to 4th week, but from 5th to 14th week it decreased gradually except the 6th, 8th and 13th weeks. In the 15th and 16th weeks it increased again. For monthly record, the highest incidence was found in February (523.92±440.35/plant) and the lowest incidence in January (94.75±44.73/plant). From November'12 to February'13, the population increased by 31.47%. The ANOVA test shows that incidence of *A. craccivora* population among different varieties of bean and cowpea plants differ insignificantly (P>0.05, F=2.361) (Table 2).

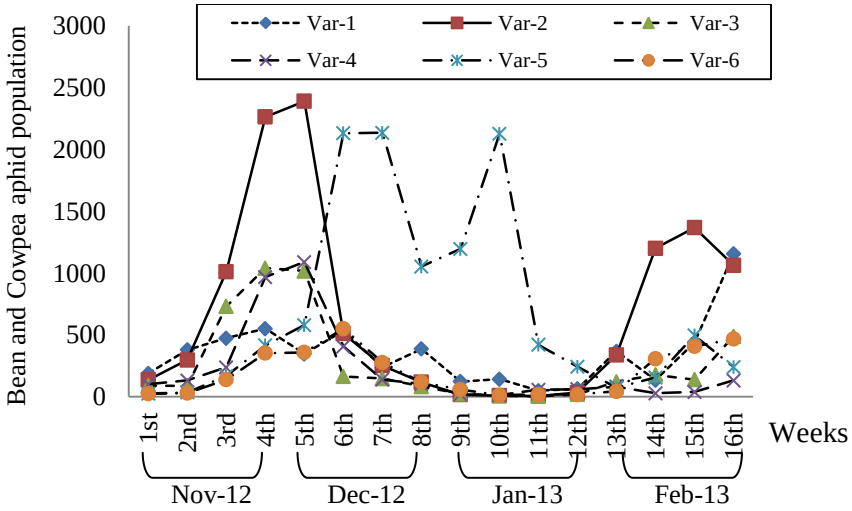

Fig. 1. Incidence of *A. craccivora* population during 16 consecutive weeks in different varieties (var) of bean and cowpea plant (First of November 2012 to last of February 2013).

Table 2. Monthly incidence of cowpea aphid *A. craccivora* on different varieties of bean and cowpea.

Months	Variety1 (Mean±SD)	Variety 2 (Mean±SD)	Variety 3 (Mean±SD)	Variety 4 (Mean±SD)	Variety 5 (Mean±SD)	Variety 6 (Mean±SD)
Nov'12	398.50±156.06	927.54±968.63	487.42±477.00	360.12±409.76	161.42±181.36	136.54±153.97
Dec'12	376.46±122.49	818.13±1060.72	353.04±444.17	434.92±457.46	3925.12±4201.15	326.33±180.13
Jan'13	94.75±44.73	16.92±11.91	13.92±9.12	37.54±25.17	3821.71±5283.67	27.00±21.28
Feb'13	523.92±440.35	992.75±454.13	254.67±192.90	70.33±47.38	241.44±183.39	306.96±187.05

ANOVA (*P-value* at 5% Probability level).

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Months	1619967	3	539988.9	0.628355	0.607844	3.287382
Verities	10148138	5	2029628	2.361765	0.090422	2.901295
Error	12890537	15	859369.2			
Total	24658642	23				

Weekly incidence of bean and cowpea aphid populations and average temperature and average relative humidity in all the varieties of bean and cowpea is shown in Fig. 2. Correlation of coefficient showed that the mean number of population per plant had a positive correlation with temperature in almost all the varieties (viz. r = 0.43 in variety1, r = 0.30 in variety 2, r = 0.44 in variety 3, r =0.17 in variety 4 and 0.11 in variety 6) except variety 5 (r = −0.30) which showed a negative correlation. The mean number of population per plant had a negative correlation with relative humidity in almost all the bean and cowpea varieties (viz. r = −0.35 in variety 1, r = −0.42 in variety 2, r = −0.21 in variety 3, and r = −0.26 in variety 6) except variety 4 (r = 0.05) and variety 5 (r = 0.28) which showed a positive correlation.

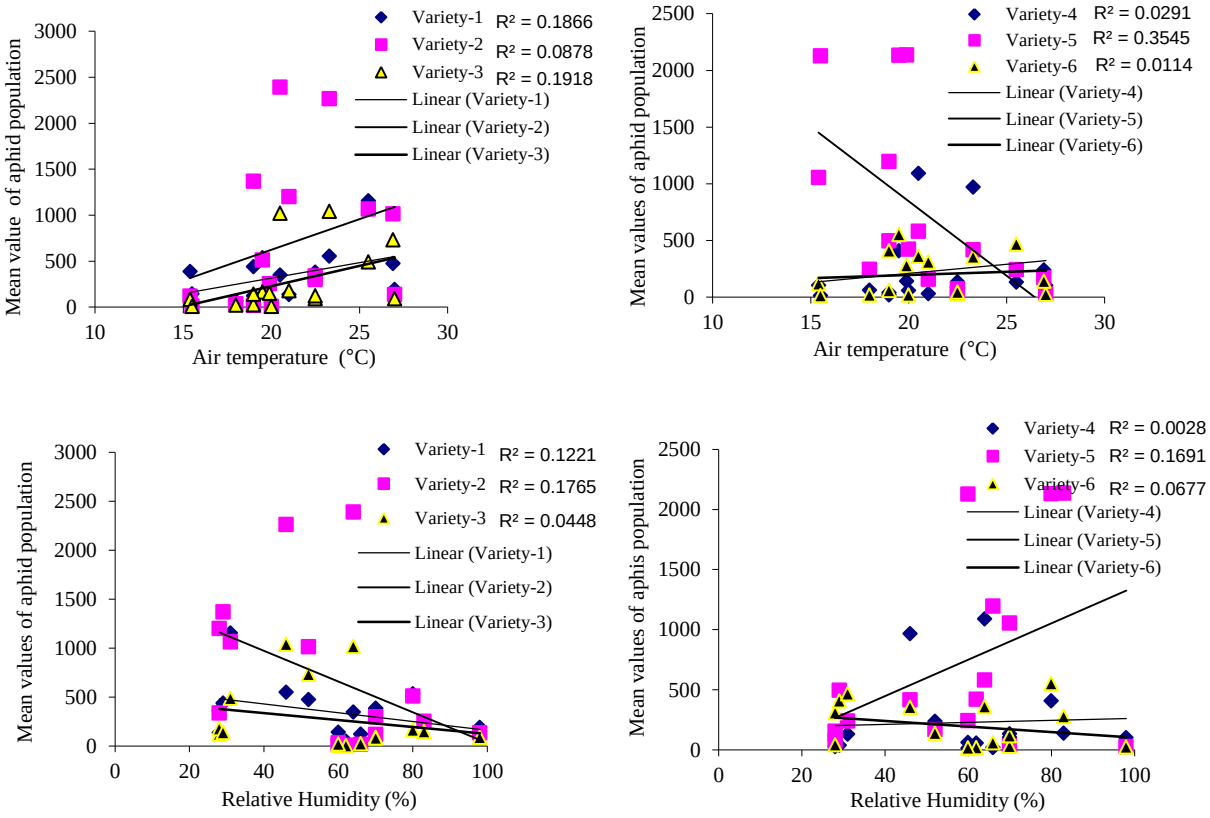

Fig. 2. Correlation of *Aphis craccivora* population with temperature and relative humidity in different varieties of bean and cowpea plants (16 weeks: First of November 2012 to last of February 2013).

The results of different treatments applied on the different bean and cowpea varieties for the control of aphids are shown in the Fig. 3. In the cases of all varities, the highest aphid incidence was seen in the Treatment 1 (water only) at the 6th week, viz. 4088±122.19/plant for variety 1, 3770±670.52/plant for variety 2, 3560.67±373.97/plant for variety 3, 3102.33±201.56/plant for variety 4, 3860.33±230.68/plant for variety 5 and 875±104.66/plant for variety 6. On the other hand, Treatment 5 (a combination of detergent, custard apple seed dusts and water) had the maximum controlling effects on different varieties of bean and cowpea resulted with lowest aphid infestation, viz. 6±1.16/plant for variety 1, 2±0.58/plant for variety 2, 1±1/plant for variety 3, 3.33±0.67/plant for variety 4.8±1/plant for variety 5 and 1.33±0.67/plant for variety 6. The results indicate that a gradual decrease of aphid population in the later weeks after Treatments 2-5, but gradual increases in Treatment 1 in all the varieties.

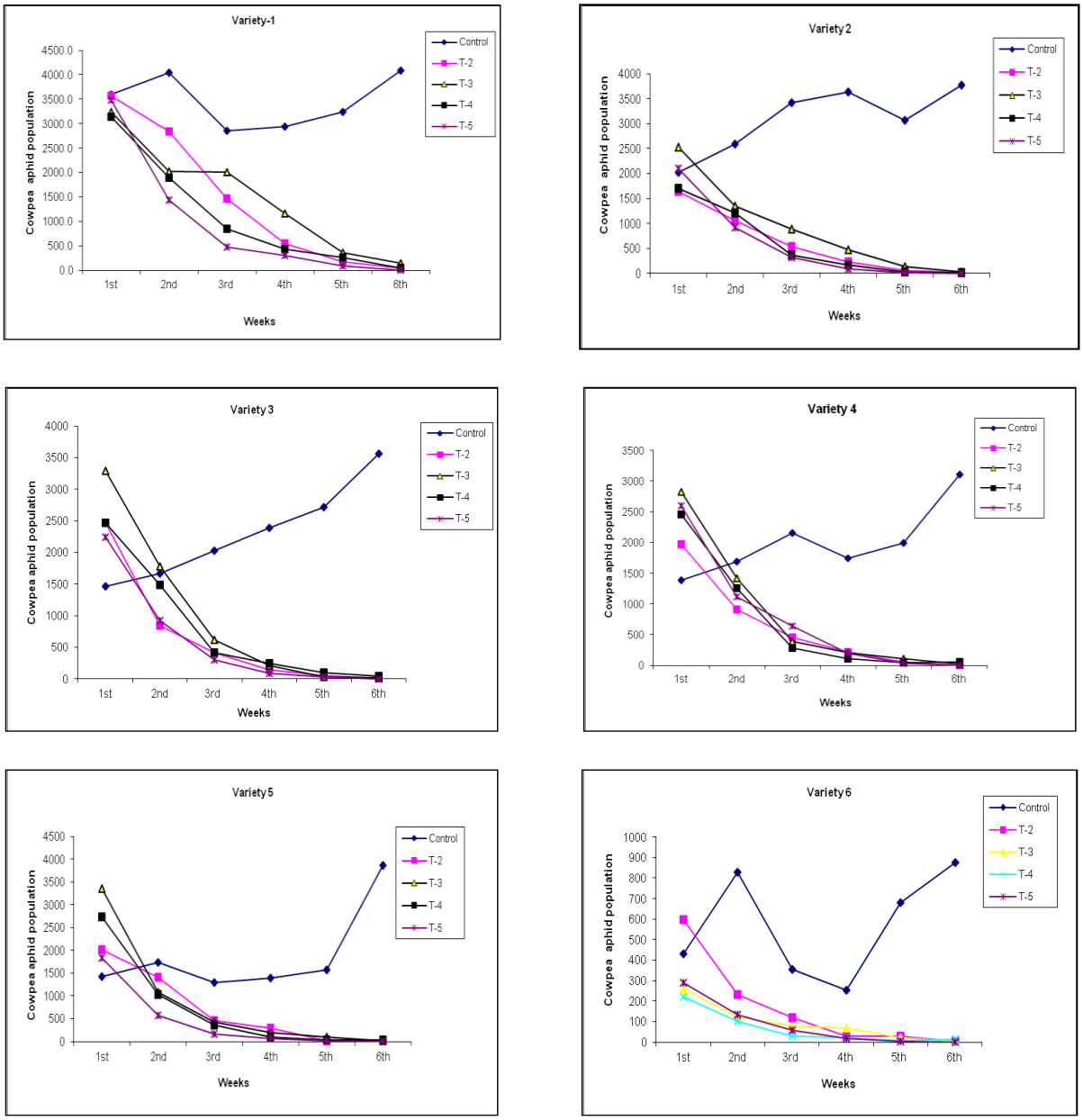

Fig. 3. Effects of different treatments (1 to 5) on cowpea aphid (from late November 2013 to mid January 2014).

The results of total fruits yielded and infested fruits are shown in Fig. 4. The results indicate that, the lowest aphid infested variety was variety 6 (4.29±2.52/plant), but its pod production rate was very low (13.50±6.25/plant). The highest yield was found on variety 4 (29.54±7.25/plant), its infested fruit number being 8.96±4.25/plant. The infested number of fruit in variety 1 (7.92±3.25/plant) and variety 3 (7.79±3.75/plant) were almost similar, but pod production rate was slightly higher in variety 3 (26.75±8.25/plant) than variety 1 (25.67±5.75/plant). The highest aphid infested variety was variety 2 (10.33±4.25/plant), but its pod production rate was 21.37/plant. Finally it was found that, variety 3 and variety 4 were economically beneficial and least infested by the cowpea aphid, *A. craccivera.*

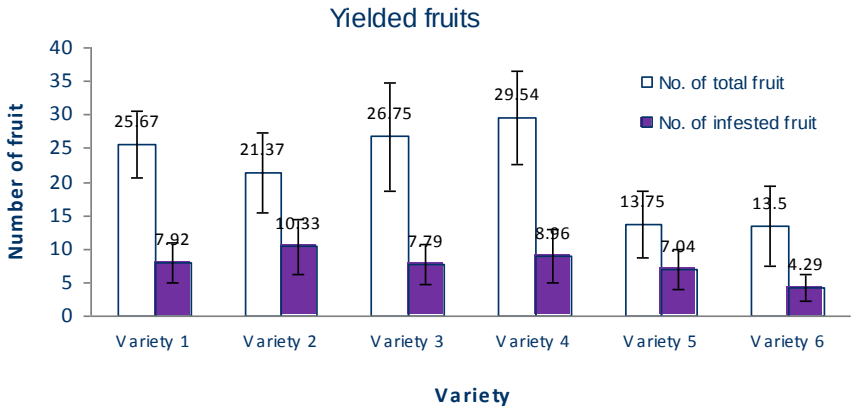

Fig. 4. Number of total and infested fruit by the cowpea aphid of six varieties of bean and cowpea.

In general, the cowpea aphid was abundant on all varieties except variety 5 (Green cowpea) in November'12 and February'13, when average temperature in Dhaka city was 24.93°C and 22°C, respectively and average relative humidity was 66.50% and 29%, respectively. Present study partially corroborates to the study of Mall *et al*. (1992) and Rondon *et al.* (2005). Mall *et al.* (1992) had noted that the survivability of the insect pest to be uppermost when temperature was between 20 and 25°C.

The present results indicate that aphid populations were positively correlated with increase in temperature. Several studies have already been conducted regarding the effects of temperature on development, survivorship and reproduction of different aphid species (Wang and Tasi 2000, Aalbersberg *et al.* 1987). Campbell *et al*. (1974) indicated that the peaks of aphid population were positively correlated with increase in temperature. The result of the present study was mostly similar to Campbell's findings. Present study also indicates that the incidence of aphid populations was negatively correlated with RH (29-74.25%) and the correlation was not strong enough. In this study aphid infestation was high in almost all the varieties during November and December. This result was consistent with the study of Karim *et al.* (2001b), who noted that the aphid population became the highest in January and gradually decreased in February. Karim *et al.* (1994) observed the maximum number of aphids during January and temperature showed negative effect on aphid population.

The major component of custard apple seed kernel, anonaine, is the chemical responsible for its antifeedant and repellent properties (Prakash and Rao 1997). The variable labels of control of aphids on bean and cowpea indicate that the host plant influences the effectiveness of custard apple treatment and mixture of custard apple with the detergent treatment (Treatment 5). Comparing the five treatments, it appears that the Treatment 5 was the most effective than other five treatments. Malathion @ 2.5ml per liter of water and Diazinon @ 0.04% were recommended by Anonymous (1992) against the bean aphid and have been found to be effective and standardized insecticides against aphid. Treatment 1 was least effective. Treatment 4 reduced aphid population significantly, but it had also negative impacts on plant, like yellowing in color. Islam (1999) observed that aphids could be successfully controlled by spraying soap-water suspension @ 25ml liquid detergent per liter of water. The present study provides evidence that botanical extracts of custard apple seeds can be used for controlling aphids. Custard apple seeds and detergent are commonly available and the extract preparation and handling are simple and safe, which is very important in the context of the socio-economic conditions of rural Bangladesh. Finally, this can be said that custard apple based insecticides could be introduced as an alternative to chemical insecticides which can reduce both leaf and fruit infestation, minimizing aphid population at a tolerable level. This procedure may also stand as environmentally sound process and device.

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