

Full Length Research Paper

# Efficacy of imidacloprid, a nicotinoid group of insecticide against the infestation of chilli aphid, *Myzus persicae* (Hemiptera: Aphididae)

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Accepted 14 October, 2013

An experiment was carried out during October, 2012 to January, 2013 in the farmer field, under Boyra union, Mymensingh Sadar Thana, to evaluate the efficacy of imidacloprid (Rally, 20 SL) against chilli aphid, *Myzus persicae*. Three doses of Rally 20 SL (imidacloprid) namely: 1, 2 and 3 ml/L were evaluated against the nymphs and adults infestation at the flowering and fruiting stage of chilli. Data were collected at 1, 3, 7 and 10 day after insecticides spray. The highest mortality was observed from 3 ml/L both in the leaf as well as in twigs which was followed by 2 and 1 ml/L concentration in comparison with that in the water treated control. Imidacloprid had good knock down effect on aphid's populations; those were significantly reduced just 1 day after insecticide spray although the highest mortality was recorded from day 3 after insecticide spray. Once sprayed, the action of imidacloprid clearly persisted at least up to the 10th day. In untreated plant, >70% of leaves were found distorted or in a somewhat twisted condition. Following imidacloprid spray, majority of the distorted leaves were backed to normal condition within 10 days after spray (DAS), but no significant changes were observed on 1-7 days after spray although aphid populations were significantly reduced immediately after imidacloprid spray (>80% reduction was observed after the 1st day). The aphid populations were mostly confined on the ventral surface of the leaf than the upper surface. For controlling chilli aphid, Rally 20 SL would be an excellent neonicotinoid insecticide with the dose of 2 ml/L considering the mortality level.

**Key words:** Chilli, aphid, *Myzus persicae*, imidacloprid, efficacy, mortality.

## INTRODUCTION

Chilli (*Capsicum frutescens*) is a valuable spice under the family solanaceae and also an important cash crop in Bangladesh. About 170,041 ha of land of Bangladesh is under chilli cultivation in both rabi and kharif seasons and the production is about 137,000 M ton (BBS, 2004). Though the area and production have been raised, per unit yield of chilli is very low. Both green and dry chillies are used as spices for the preparation of various curries. Dry chilli is an ingredient of curry powder, sauces and pickles. However, the production is affected by several insect pests in the field including: aphid (also known as green peach aphid), white flies, capsid bugs, thrips, cutworm, gram caterpillar, etc. Among these insects, aphid or green peach aphid is one of the most important constraints of chilli production in Bangladesh as well as in other chilli producing countries. The infestation of aphids usually starts from seedling stage although the severe

infestation appears in the vegetative stage as well as in the flowering and fruiting stages. The chilli fruits not directly affected by aphids but indirect loss severely occur as leaves are mostly affected by nymphs and adults. Aphid populations are mostly confined in the ventral surface of the leaf in comparison with that in the upper surface. Both nymphs and adults suck the cell sap mostly from the ventral surface of the leaf and as a result the infested leaf loses its vitality and vigor and finally the leaf become curled or twisted. Along with leaf, both nymphs and adults suck the cell-sap from the twigs and stem and ultimately the affected twigs are curled or distorted due to loss of vitality. Indirect damage also occurs by photosynthetic reduction as the formation of sooty mold fungus on honey dew is secreted by aphids.

One recent study reported that severely infested chilli plant almost failed to produce any fruits or produced very

minimum number of deformed fruits (Shi et al., 2011). It was also reported that *Myzus persicae* became the most destructive insect pests of chilli in India and did a huge economic damage. Under favorable conditions, chilli aphid reproduces at a faster rate and may cause damage to 15-30% of total chilli production (Reddy et al., 2009). Therefore, a regular monitoring of chilli crop during favorable environmental conditions of aphid breeding is essential. Various non-chemical approaches are currently applying to reduce the infestation level of aphid while these approaches are not enough during severe condition. In case of severe infestation, different systemic insecticides, for example, malathion, phosphamidon and dimecron are injudiciously used against sap-sucking insects like aphids but their efficacy is really questionable. Imidacloprid, a new class of neonicotinoid insecticides, is potently replaced with different toxic and hazardous insecticides due to their unique mode of action (nicotinic acetylcholine receptor agonist or acetylcholine mimic) and comparatively less toxicity to human and environment. Some recent studies show that imidacloprid gives an outstanding result against sucking insects (Elbert et al., 1991; Kencharaddai and Balikai, 2012; Joshi and Sharma, 2009; Dewar et al., 1992). Imidacloprid is a type of insecticide that works immediately after application even with low concentrations. When insecticidal molecules enter into the central nervous system through the sucked sap, they bind with the nicotinic receptor agonists and eventually produce excess amount of acetylcholine, a potent neurotransmitter in the insects' central nervous system which continuously produce signalling through synapse, and ultimately the affected insects die due to the convulsion, tremor and paralysis. Therefore, the present investigations were carried out to evaluate the potency of imidacloprid (Rally 20 SL) against chilli aphid (*M. persicae*) in the field condition.

## MATERIALS AND METHODS

### Raising of seedlings

Seeds were collected from local market and then soaked in water overnight as the coat of seed is comparatively hard. After that the seedlings were raised in 1.5 × 1.5 m size tray. Twenty days old seedlings were then transplanted in the main experimental plot. The variety Bangla Lanka-1 was used in this study to evaluate the efficacy of imidacloprid (Rally 20 SL) against the infestation of chilli aphids in the field condition.

### Transplantation of seedlings and management

The experimental plots were prepared by ploughing and cross-ploughing followed by laddering. All plots were prepared with proper proportions of manures and fertilizers. Twenty days old seedlings were then

transplanted in the plots. The unit plot size was 1.5 × 1.5 m being 40 × 40 cm plant distance. The Randomized Complete Block Design (RCBD) was followed with 3 replications. All agronomic practices were started after seedlings transplantation and continued up to maturity stage of chilli.

### Specifications of insecticides

The aim of this experiment is to evaluate the effect of imidacloprid (Rally 20 SL, Runner Agro Products Ltd.) against chilli aphid. Imidacloprid is a new class of neonicotinoid insecticide and its mode of action is acetylcholine mimic or nicotinic acetylcholine receptor agonists. The insecticide was collected from the local market. Some recent study from India and China (Kencharaddai and Balikari, 2012; Joshi and Sharma, 2009; Patil et al., 2009) has reported that the action of imidacloprid was excellent against sap-sucking insect and for that reason it was selected as a new insecticide against chilli aphid. Three doses namely: 1, 2, and 3 ml/L water were selected to evaluate the efficacy of imidacloprid (Rally 20 SL) against chilli aphid, *M. persicae*, in the field condition.

### Data collection

Data were collected based on: (i) the effect of imidacloprid on the mortality of aphids on leaf, (ii) mortality of aphids on twigs, (iii) recovery of deformed leaf into fresh leaf following imidacloprid spray, and (iv) abundance of aphids' populations upper versus ventral surface of leaf. Control measures were not taken for untreated plant and plants were allowed for higher aphid infestation. For control, data were collected just 1 day before insecticides spray and in case of treated condition data were collected at 1, 3, 7 and 10 days following insecticide spray.

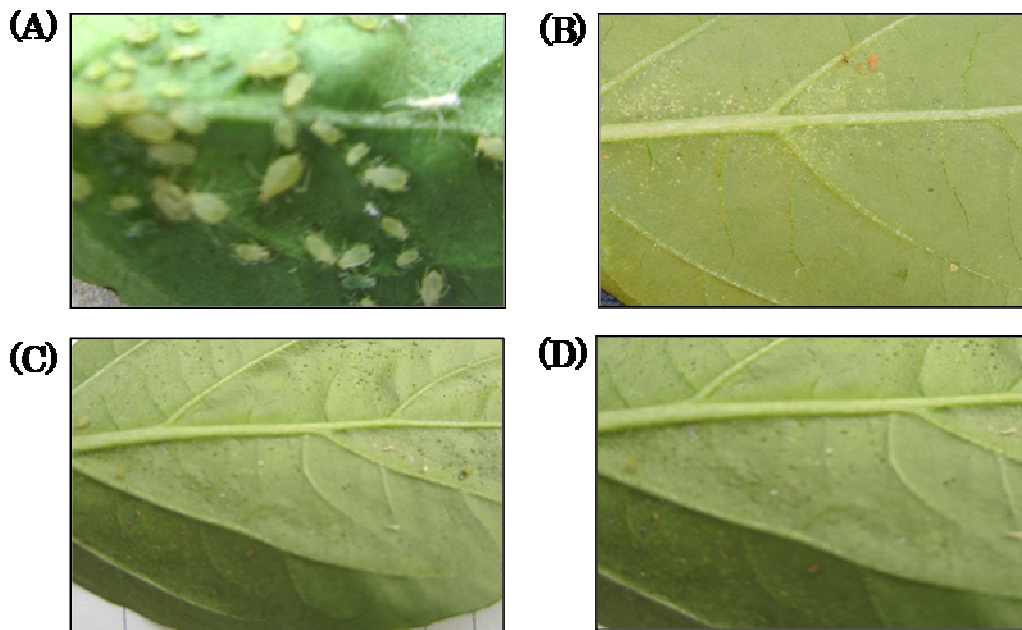
### Statistical analyses

Data were collected from 5 random plants per experimental or untreated plot and then an average was made. After that, data were analyzed statistically with MSTAT programme and the means were separated by LSD test.

## RESULTS

### Effect of imidacloprid (Rally 20 SL) on the mortality of aphids on leaf

In the control or untreated plant, aphid populations were counted just 1 day before insecticide application. In control condition, nymph's populations were higher than adults in either the leaf or twigs. The potency of imidacloprid was evaluated using 3 doses (for example, 1,



**Figure 1.** Chilli leaves (A-D) showing the presence of aphids in control or untreated leaf (A) and imidacloprid treated leaf at 1 (B), 3 (C) and 7 (D) days following spray @ 3 ml/L concentration. Severe infestation occurred when the plants were kept without any treatment or treated with only water (A) while aphid populations were markedly reduced (B-D) when the chilli plants were treated with imidacloprid (Rally 20 SL) at the dose of 3 ml/L. Noted that Rally 20 SL worked immediately after spray (B) against aphid and this effect was continued up to at least 7 days after spray.

2 and 3 ml/L) and the data were collected at 1, 3, 7 and 10 days following insecticide spray. Both nymphal and adult populations were potently reduced by different doses of imidacloprid although nymphal mortality was slightly higher than adult mortality (Figures 1 and 2). The mortality was clearly dose dependent. In all days (1, 3, 7 and 10 days), the highest mortality for both adults and nymphs (>96%) was found when the plant was treated with 3 ml/L which was followed by 2 (87%) and 1 ml/L (60%) respectively. It is also notable that the action of imidacloprid against aphids was comparatively rapid, that is, the mortality level was found at significant level just 1 day after spray which was peaked by 3 DAS and persisted at least for 10 days. It was found that the aphid populations were mostly confined in the ventral surface of the leaf in comparison with that in the upper surface.

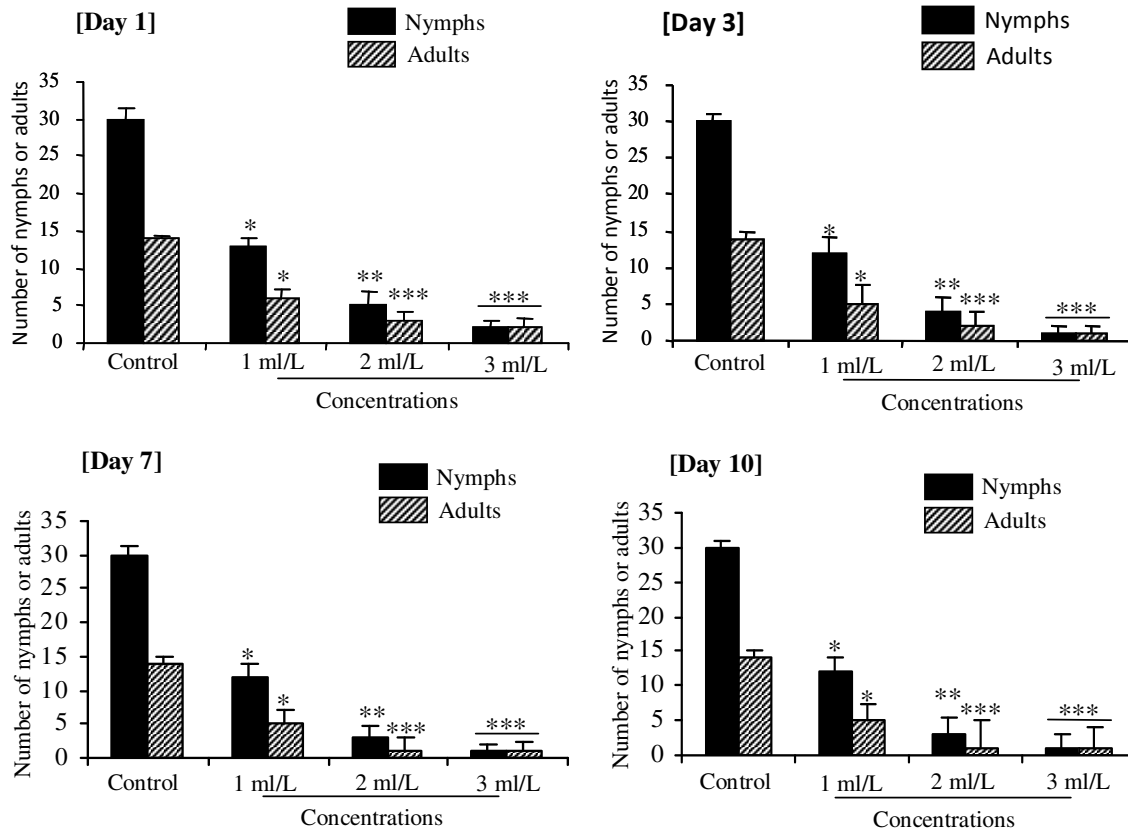
#### **Effect of imidacloprid (Rally 20 SL) on the mortality of aphids in twigs**

The pattern of mortality of aphids by imidacloprid in the twig is same as that of leaf. It is noted that aphids' populations were 4-5 times higher in the twig than in the leaf. Similar to leaf, nymphal populations were greater in the untreated twigs in comparison with adult aphids. In untreated conditions, about 150-200 aphid populations were found in the twig and they were located in both the surface of the tender leaves as well as in the very soft

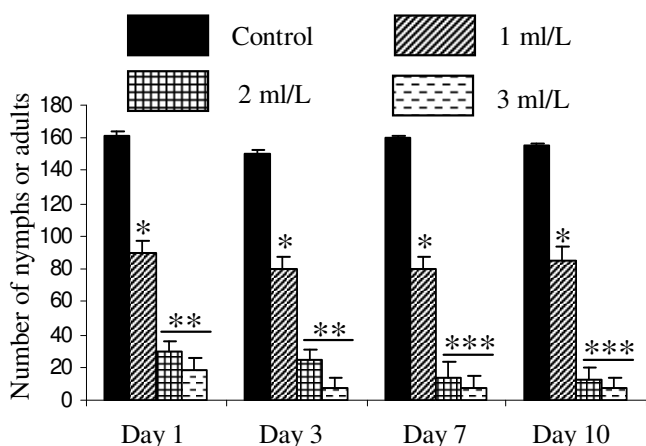
stem. A day after imidacloprid spray, the aphid populations were significantly reduced when the plants were treated with 1 ml/L ( $p < 0.05$ ) as compared to the untreated control. Although the highest mortality was counted from 3 ml/L ( $P < 0.001$ ) which was followed by 2 ml/L (Figure 3,  $P < 0.001$ ), among all counted days (1, 3, 7 and 10 days), the excellent result was found on day 3 after spray where about 96% of the aphid populations were killed by Rally 20 SL using 3 ml/L concentration. It was also found that the imidacloprid action significantly persisted at least up to day 10 after the insecticide was sprayed in the field.

#### **Recovery of deformed leaf to normal leaf following imidacloprid spray**

It was found that aphid populations were mostly confined in the upper portion of the plant and the lower portion of the plant was less affected. About 50% of the leaves were affected by aphid infestation while the tender leaves and twigs were targeted mainly. As the habit of aphid feeding, they suck the cell sap from the leaf and tender twig, resulting to the loss of vigor and vitality, and the affected leaves are finally curled or deformed. Figure 4 clearly shows that the curled or deformed leaf gradually went back to its normal form following imidacloprid application. No significant changes were found on leaf deformation from day 1 to 7 even after imidacloprid spray,



**Figure 2.** Graphs are showing the mortality level of aphids (Both nymphs and adults) in leaf following imidacloprid (Rally 20 SL) spray with different concentrations in comparison with that in the control or untreated condition. The action of imidacloprid was clearly dose dependent, the highest mortality was found from 3 ml/L which was followed by 2 and 1 ml/L respectively. The mortality was also gradually increased with increasing time. P\*\*\*<0.001 vs control, P\*\*<0.01 vs. control, P\*<0.05 vs. control.

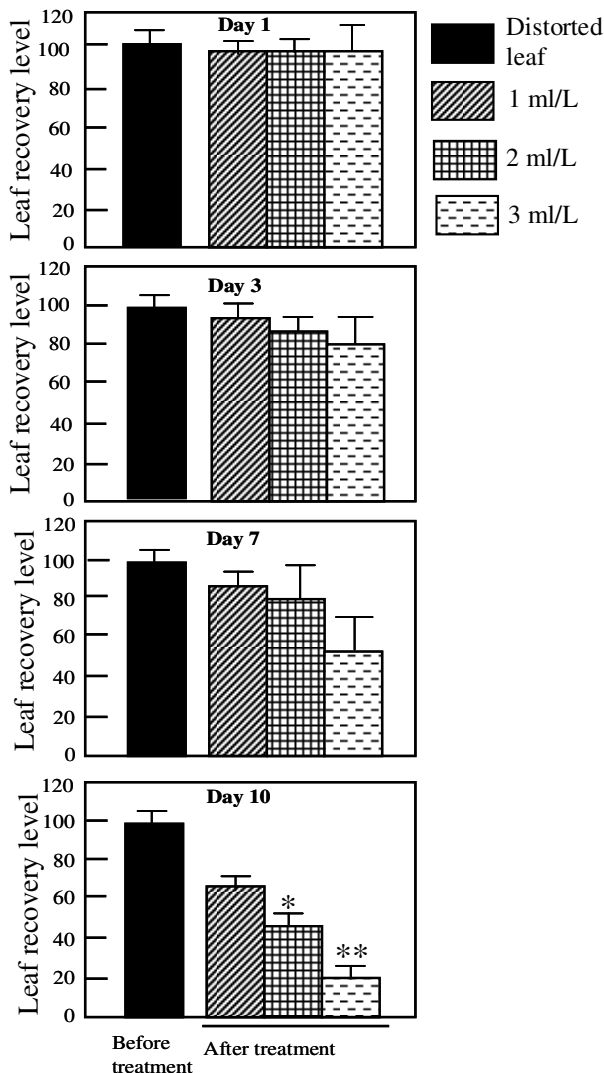


**Figure 3.** Mortality of chilli aphid in twigs following different doses of imidacloprid application at different days after spray. The highest mortality was counted from 3 ml/L concentration which was followed by 2 and 1 ml/L respectively. Imidacloprid significantly worked just 1 day after spray, the maximum effect was observed on day 3 following spray and the effect was significantly persisted at least up to day 10. \*P<0.05, \*\*P< 0.01, \*\*\*P< 0.001 versus control.

while almost 45 and 80% of the deformed or curled leaves went back to its previous or normal condition at 10 DAS with the concentration of 2 ml/L (p<0.05) and 3 ml/L (p<0.01) respectively. In brief, once infested chilli plants were treated with imidacloprid insecticides, then the infested plants gradually recovered their normal vigor and vitality which is comparable with uninfested leaf. It was also mentioned that the lowest concentration (1 ml/L) had no significant effect on leaf deformation or leaf twisting; however, increasing of time duration did not cause any change at 10 days after spraying.

**Abundance of aphid populations in the lower leaf of chilli plant**

It was noticed that the aphid populations were mostly confined in the ventral surface of the medium to tender leaves in comparison with that in the upper surface. Studies showed that about 90% of the aphid populations were located in the ventral surface (data not shown). On the other hand, in very fresh leaves, the aphid populations were uniformly observed in both sides of the leaf surface.



**Figure 4.** Recovery of distorted or twisted leaf to normal leaf following imidacloprid (Rally 20 SL) spray over time. No significant changes were seen up to day 7 following spray but significant changes were seen on day 10 with higher concentrations. Data clearly showed that approximately 45% and 80% of the distorted leaves were recovered to normal leaf at 10 days after spray with the doses of 2 and 3 ml/L respectively. It is also noted that the lower dose had no significant effect on leaf distortion in comparison with that in the control. After two weeks of imidacloprid spray, all most all the distorted leaf was recovered to normal leaf (data not shown). \* $P < 0.05$ , \*\* $P < 0.01$  versus control.

## DISCUSSION

The imidacloprid (Rally 20 SL) worked as an excellent systemic insecticide against aphids on chilli, that is, approximately 96% of the nymphs as well as adults were killed by 3 ml/L concentration which was followed by comparatively lower doses (for example, about 87 and

60% were killed by 2 and 1 ml/L concentrations respectively). Green or fresh chili is a popular spice in Bangladesh and people usually eat green chili immediately after harvesting from the field, therefore the selection of insecticidal doses might be considered carefully.

In the present experiment, three doses were selected for the evaluation of the potentiality of Rally 20 SL against the infestation of chilli aphids and also to identify the proper dose among the three doses regarding the mortality level, recurrence of aphid populations, as well as toxic effect on human and environments. The current findings clearly suggested that the level of mortality was clearly dose dependent, in that the highest mortality (>96%) was recorded from 3 ml/L, followed by 2 ml/L concentration (about 87%) and the lowest mortality (about 56%) was found from 1 ml/L. Considering the mortality level as well as level of toxicity, 2 ml/L would be the best choice for controlling aphids populations on chilli. The dose of 1 ml/L may not be wise for the potential and long term control of aphids as there is high possibility of recurrence of aphids in the same field or same plant. After imidacloprid spray, the mortality data were collected on days 1, 3, 7 and 10 following spray. It was observed that significant mortality (>90%) was recorded just 1 day after spray with the dose of 3 ml/L although the highest mortality was found at 3 days after spray (>96%) and the action of imidacloprid significantly persisted at least up to day 10 with a slight decrease of the mortality level. This finding clearly suggested that the neonicotinoid insecticides like imidacloprid takes slightly longer time (>24 h) for its maximum effect against sap-sucking insect like aphids. Once applied, the insecticide enters into the plant system by translaminar action, after which it enters into the insect body by feeding and finally killing the aphid by binding it with nicotinic acetylcholine receptor. The whole process takes a little longer time and as a result the highest mortality was found at day 3 after spray. On the other hand, the action of imidacloprid persisted at least up to day 10 which raises the possibility that once it enters into the plant system, the imidacloprid remains comparatively for a longer period of time which has also been supported previously (Hernandez et al., 1999; Shah et al., 2007; Robson et al., 2007; Shi et al., 2011).

It was interestingly observed that the aphids were mostly confined in the lower surface of leaf than on the upper surface. The cause is not known exactly but it possible that the aphids are light sensitive or they prefer the lower surface for their sucking due to some special morphological characters of the lower surface. Aphid infestations were mostly found in tender as well as semi-mature leaf than in the mature leaf which suggested that the amount of sap in the leaf is possibly responsible for higher infestation of aphids. Moreover, twigs were mostly susceptible for aphid infestation and approximately 150-160 aphids were counted per twig in comparison with that in the leaf where about 30-35 aphids were found. Another

important finding of this study is the recovery of deformed or curled leaf to normal fresh leaf following imidacloprid spray.

It was observed that no recovery of leaf was seen immediately after spray but about 70-80% of the affected leaves were recovered to normal fresh leaf following 10 days of imidacloprid spray with the highest concentrations which clearly suggested that once aphid populations reduced or disappeared, the affected leaf got back its previous physiological and biochemical contents and hence flowering and fruiting capacity increased.

Chilli is an economical crop in Bangladesh and highly popular to all classes of people especially to poor or marginal people. This crop is affected by different kinds of insect pests while aphid is one of the most important culprits. In Bangladesh, various systemic insecticides are currently used for controlling sap-sucking insects like aphid and their efficacy and safety to environment is contradictory. Imidacloprid is a new class of insecticide and its potency against sucking insect is well reported in different countries of the world (Kerns et al., 1998; Hegde and Nidagundi, 2009; Patil et al., 2009). It is comparatively safer than other conventional insecticides and once it is applied, the action continued for a longer period. Among the three doses, dose 3 ml/L treatment was found to be most effective against chilli aphid which was closely followed by 2 ml/L concentration. Therefore, considering the mortality level (>87%), toxicity to beneficial organisms, and health and environmental safety, the dose 2 ml/L concentration would be the most effective chemical approach in controlling aphids for chilli growers. However, it needs further investigations in the field as well as in the laboratory conditions.

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