*Available online at* www.pelagiaresearchlibrary.com

Pelagia Research Library

European Journal of Experimental Biology, 2014, 4(5):76-81

ISSN: 2248 –9215
CODEN (USA): EJEBAU

# Codling moth damage assessment in apple fruit and its management using insecticide bioassays

**Muhammad Shahnawaz[1], Mukhtar Ahmed[1], Muhammad Arshad[1*], Maqsood Hussain[2] and Sadat Sher Khan[1]**

[1]*Department of Agriculture and Food Technology, Karakoram International University, Gilgit, Pakistan*
[2]*Integrated Mountain Area Research Center (IMARC), Karakoram International University, Gilgit, Pakistan*

---

**ABSTRACT**

*Codling moth Cydia pomonella (Lepidoptera: Tortricidae) damage assessment and evaluation of its insecticidal control is important to reduce loss of fruit to sustain primary source of income of apple farmers. The study is the combination of field survey and laboratory experiments. The survey was carried out to quantify the percent apple fruit damage by the codling moth in seven different orchards at four different dates. The experiments were conducted on different concentrations of active ingredients of seven insecticides i.e. Lamda Cylhal (0.40 & 0.80 mL), Cypermethrin (0.25 & 0.50 mL), Cosset 40 (0.25, 0.50 & 0.75 mL), Talstar (0.06 & 0.12 mL), Advantage (0.09 & 0.18 mL), Ematac (0.40 & 0.80 mL), and Novastar (0.25 & 0.50 mL) to evaluate the most effective chemicals as control measure for the insect. It has been observed that the insect infestation on the fruit significantly varied among the sampling dates and among the orchards. The insecticides tested significantly increased ($p \leq 0.05$) the mortality of the insect compared to the control. Application of Talstar, Ematac and Novastar at concentrations of 0.12, 0.80 and 0.50 mL per 250 mL $H_2O$, respectively, provided the 100% mortality of the insect. However, maximum 90% mortality was observed through the use of Lamda Cylhal, Cypermethrin, Cosset 40, Advantage, and Novastar at concentrations of 0.32, 0.20, 0.20, 0.072, and 0.1%, respectively.*

**Keywords:** *Cydia pomonella*, Infestation, Mortality, Chemical control, Orchards

---

## INTRODUCTION

Codling moth (*Cydia pomonella*) is the serious insect pest of apple fruit in different parts of the world. A remarkable damage (80%) of the fruit has been observed due to the insect in temperate parts of all major continents [1, 2]. While being an economically important pest of the apple worldwide, the growers have a low tolerance (<1%) for its injury [3, 4]. This has necessitated the adoption of different control strategies especially frequent applications of broad-spectrum insecticides throughout the fruiting period. Most of the apple orchards are sprayed with a few insecticides about three times a year and also the same chemicals are used to clean up the soil prior to planting against the pest [5]. The intensive and extensive utilization of the chemicals with inappropriate concentrations or doses not only leads to environmental pollution but also increases the cost of the fruit production and fresh fruit quality issues. The situation may further be aggravated due to the farmer's intension towards cheaper compared to the expensive chemicals resulting greater unfriendly repercussions for the environment, human and animals [6].

Moreover, the increased application of the chemicals for sprays on fruit trees results into spray drift that can directly or indirectly affect non-target species especially the beneficial insects.

Codling moth is acclimated to a wide range of climatic conditions and geographical locations. It can complete one to five generations in a year owing to having multi-volatile species and facultative diapauses it can complete one to five generations in a year. But its life cycle greatly depends on latitudes and elevation. In Gilgit-Baltistan, the life cycle of the insect has well synchronized with the prevailing conditions of the area. The larvae of insect are over-wintered in a dense and silken cocoon that is usually located under the bark or in debris of the trees. The larvae pupate in spring and start to emerge during the bloom or petal-fall stages during the apple fruit development period. The eggs of the insect are laid primarily on leaf surfaces nearby the location of the fruit and after one to three weeks start hatching upon the commencement of the favorable air temperature ranging from one to three weeks. The newly-hatched larvae try to enter the fruit through its calyx or sides, and start feeding on flesh and seeds of the fruits. The larvae bore and feed inside the apple fruit leading to an unsightly hole and promote internal rotting of the tissues. At its full growth, the larvae burrow out of the fruit and form silken cocoons to pupate. The insect undergoes two to three generations each year under the normal weather conditions.

Chemical pesticides are of the great importance in the agriculture sector for the improvement of the quality and quantity of fruits in field and storage. The chemicals are being used in many countries and have played a significant role in plant protection. However, extensive and inappropriate application of the chemicals as plant protection measure has accelerated a number of biological hazards especially the accumulation in the food chain with associated poisoning effects [7]. Additionally, insecticide resistance in insects due to increasing frequencies of application have been reported [8, 9, 10, 11, 12, 13, 14, 15]. In apple growing areas where codling moth is absent and insecticides are not used, farmers are at remarkable advantage due to marketing of high quality fruit with low insecticide contamination [16].

In preview of increasing deterioration of apple fruit quality due to codling moth attack and absence of appropriate insecticidal control measure for the insect, it is highly enviable to have research on damage assessment of the insect and its control measure. This research was conducted to assess the apple fruit damage by the codling moth in the Astore valley in Gilgit-Baltistan region of Pakistan followed by laboratory experiments to evaluate insecticidal control measure for the insect.

## MATERIALS AND METHODS

### Study area and site

Study area for the codling moth infestation was district Astore in Gilgit-Baltistan region while insecticide management experiments were conducted in the Food Technology Laboratory of Karakoram International University of Pakistan. The potential study area is characterized with an altitude of 5700 ft (msl) and average rainfall of 150 mm. The major agricultural activities include the orchard farming, field crop production and livestock rearing which serve as important sources of income for the local people.

### Infested fruit sampling and insecticide treatments

The study comprises the field survey of codling moth infestation in the seven apple orchards and at four different dates i.e. 17.08.2012, 30.08.2012, 30.09.2012, and 30.10.2012, followed by four laboratory experiments for the target insect pest management using different concentrations of active ingredient of seven insecticides i.e. Lamda Cylhal (0.40 & 0.80 mL), Cypermethrin (0.25 & 0.50 mL), Cosset 40 (0.25, 0.50 & 0.75 mL), Talstar (0.06 & 0.12 mL), Advantage (0.09 & 0.18 mL), Ematac (0.40 & 0.80 mL), and Novastar (0.25 & 0.50 mL). For field survey a random sampling technique was adopted for the selection of apple growers or orchards from the study area. Similarly, a random sampling procedure was adopted for the selection of three apple trees from each orchard followed by random sampling of 30 fruits per tree as described by Fitzgibbon and Morris [17]. For the assessment of codling moth infestation, fruits infested with the insect were counted and per tree percent infestation was computed. The samples were stored at room temperature in plastic bottles for few days. After few days the larvae of codling moths were collected from the damage and infected apples for further experimentation.

### Insecticide bioassays assessment

For the assessment of insecticides, bioassays were prepared using the defined concentrations of the chemicals with 250 mL of water. In the laboratory, four experiments were managed for already infested apple fruits together with a

control treatment without the application of insecticide. For the insecticide treatments, apple fruits of red delicious variety were cut into circular pieces. The apple slices were taken in petri dishes and thereby sprayed with aforementioned insecticide bioassays. Live larvae of the pest were collected from infested apple fruits and put five larvae into each petri dish and loosely closed with lids to let the insect feed on the fruit tissues. After three days, dead and live larvae were counted and percent mortality of the insect was computed. For control a petri dish was maintained with the same material except the application of the insecticide.

**Statistical Analysis**

Codling moth percent infestation data of apple fruits and mortality data of laboratory experiments obtained were statistically analyzed using SAS program for ANOVA followed by Duncan's Multiple Range Test (DMRT) as mean separation procedure. The results obtained were presented in tables and graphs.

## RESULTS

**Codling moth infestation of apple fruit**

Samples of thirty fruits per tree were collected from seven different farmers of Astore valley at four different dates during the harvesting season were examined for codling moth infestation on apple and results are presented in the Table1. It has been observed that the infestation (%) significantly ($p \leq 0.05$) varied within both the sampling dates and the farmers. There was gradual increase in the percent infestation (6-11%) starting from the midst of August till the first week of October. A significant increase of the infestation was observed within the first fortnight period from 6 to 9%. However, after that the increase was not significant but it persisted thereof. Similarly, percent infestation of apple fruit by the codling moth was in the range of 6 to 14%. Among the seven orchards of the farmers one had significantly the highest infestation (14.4%) compared to the rest which had not significantly different level of infestation.

**Table 1 Spatio-temporal dynamics of codling moth infestation of apple fruit in Astore Valley of Gilgit-Baltistan**

| Farmer | % Infestation on different dates | | | | Mean |
|---|---|---|---|---|---|
| | Aug 17, 2012 | Aug 30, 2012 | Sep 09, 2012 | Oct 02, 2012 | |
| **1** | 06.68±3.32 | 10.00±3.30 | 11.13±5.09 | 12.23±5.08 | 10.01±4.25$^{b}$ |
| **2** | 05.56 ±1.96 | 07.80±1.90 | 07.80±1.90 | 10.00±3.30 | 07.79±2.58 $^{bc}$ |
| **3** | 06.66±3.35 | 10.00±3.30 | 13.33±3.35 | 11.13±5.09 | 10.28±4.13$^{b}$ |
| **4** | 10.00 ±3.30 | 13.33±3.35 | 15.53±6.92 | 18.90±6.96 | 14.44±5.74$^{a}$ |
| **5** | 04.46±3.86 | 07.80±1.90 | 06.66±3.35 | 07.76±5.08 | 06.67±3.48$^{c}$ |
| **6** | 03.33±3.35 | 06.66±3.35 | 07.80±1.90 | 06.66±3.35 | 06.11±3.13$^{c}$ |
| **7** | 06.66±3.35 | 08.86±5.09 | 08.86±5.09 | 11.13±5.09 | 08.88±4.35$^{bc}$ |
| **Mean** | 06.19±3.38$^{b}$ | 09.20±3.47$^{a}$ | 10.16±4.76$^{a}$ | 11.11±5.6$^{a}$ | |

*Note: Values with same alphabets in the column and row for mean are not significantly different from each other and vice versa.*

**Insecticidal Management of Codling Moth Infestation in Apple Fruit**

**Lamda Cylhal and Cypermethrin:** Effect of bioassays prepared using water with different concentrations of active ingredients namely Lamda Cylhal and and Cypermethrin compared to the control treatment for codling moth management in apple fruit was studied (Fig.1). Significantly higher ($p \leq 0.05$) rate of mortality of the insect in the fruit was observed due the application of each of the insecticides compared to the control. However, within the concentrations of each insecticide tested, the higher concentration showed a greater mortality of the insect, although the increase was not statistically significant ($p \geq 0.05$). Although none of the concentrations of Lamda Cyhal and Cypermethrin provided 100% mortality of the insect, however, 90% mortality would be achieved by the application of either 0.8 ml of the former or 0.5 ml of the later insecticide.

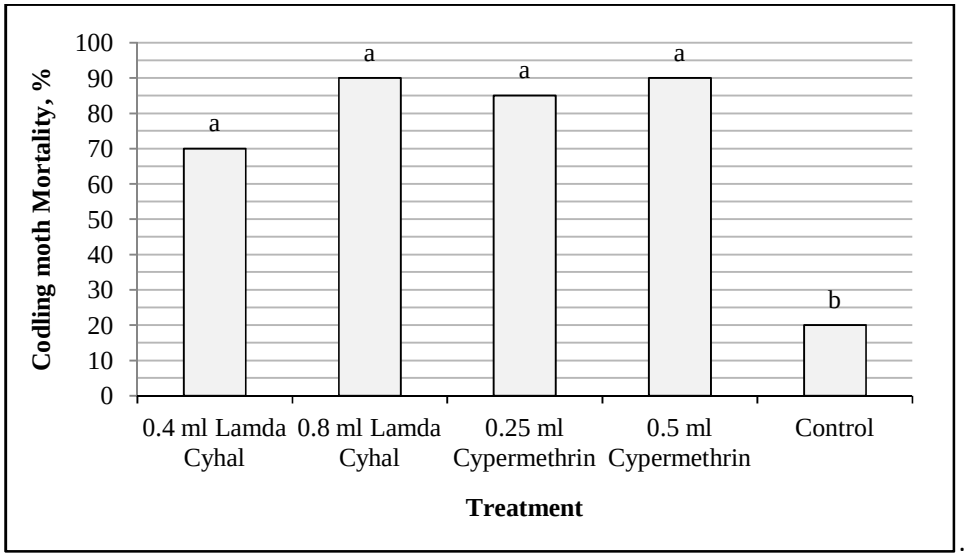


**Figure 1 Effect of Bioassay of Lamda Cyhal and Cypermethrin on mortality of codling moth infestation of apple fruit**

**Cosset 40:** Effect of application of four bioassays prepared using 250 ml water with different concentrations of an active ingredient namely Cosset 40 on mortality rate of codling moth infestation in apple fruit was studied and results are presented in Fig. 2. Each of the concentrations of Cosset 40 showed a significantly higher ($p \leq 0.05$) mortality of the insect compared to the control. Among the concentrations of active ingredient tested, there was no significant difference of mortality and none of these could give 100% control; however, 90% mortality of the insect could be seen due to the application of either 0.5 ml or 0.75 ml of the active ingredient.

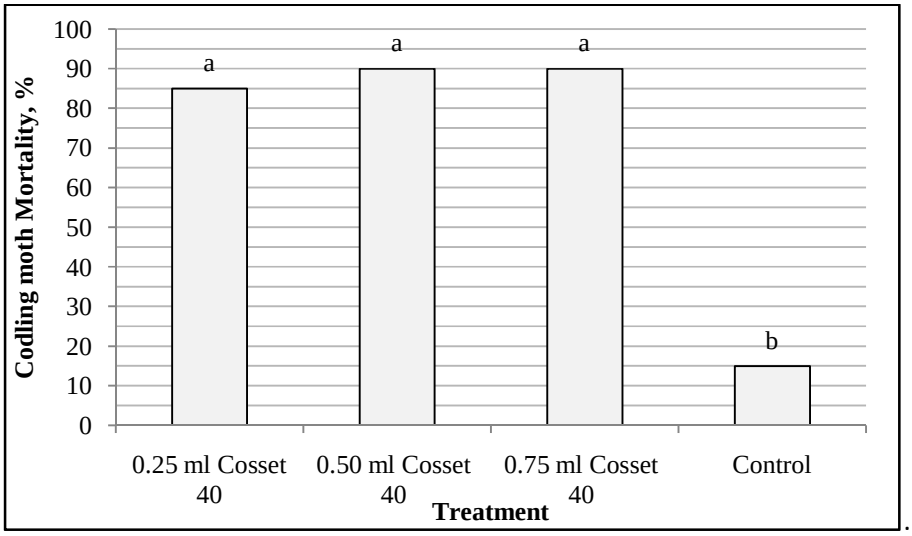


**Figure 2 Effect of bioassays of Cosset 40 on mortality of codling moth infestation of apple fruit**

**Talstar and Advantage:** Four bioassays prepared using 250 ml of water with two concentrations of each Talstar and Advantage were applied to codling moth infested apple fruits for control. Significant mortality ($p \leq 0.05$) was observed in all the insecticide applications compared to the control (Fig. 3). Within the concentrations of each insecticide, there was no significant difference for Talstar concentrations but mortality rate of codling moth varied significantly ($p \leq 0.05$) between the concentrations of Advantage. Resultantly, the highest mortality of the insect pest was observed due to the applications of 0.12 ml of Talstar (100%) followed by 0.18 ml of Advantage (95%).

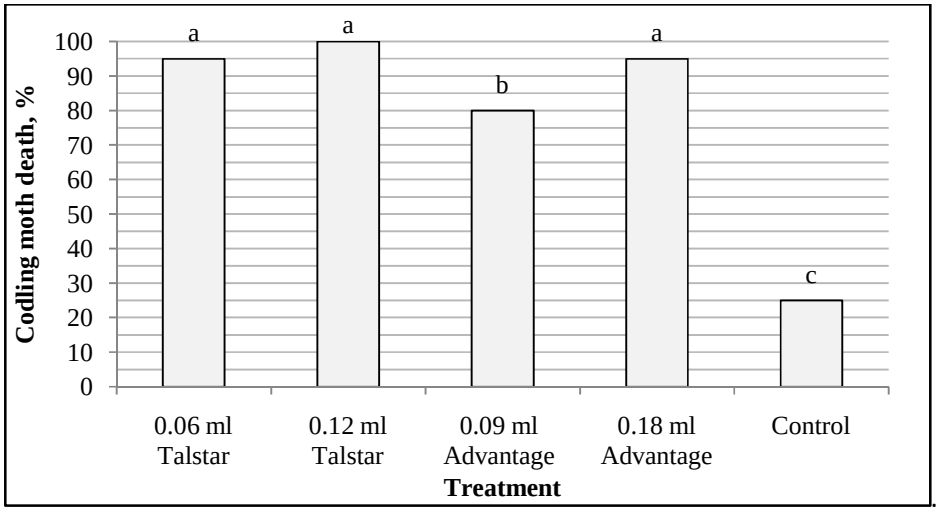


**Figure 3 Effect of bioassay of Talstar and Advantage on mortality of codling moth infestation of apple fruit**

**Ematac and Novastar:** Two concentrations of each of Ematac and Novastar were tested to control codling moth infestation in apple fruit. There was a significantly higher mortality of the insect pest due to all the insecticide applications compared to the control treatment (Fig. 4). Within the concentrations of each of the insecticide, codling moth mortality is significantly varied ($p \leq 0.05$) for Ematac but not for Novastar. The highest mortality (100%) of the insect pest was observed for the concentrations of 0.8 ml of Ematac and 0.5 ml of Novastar.

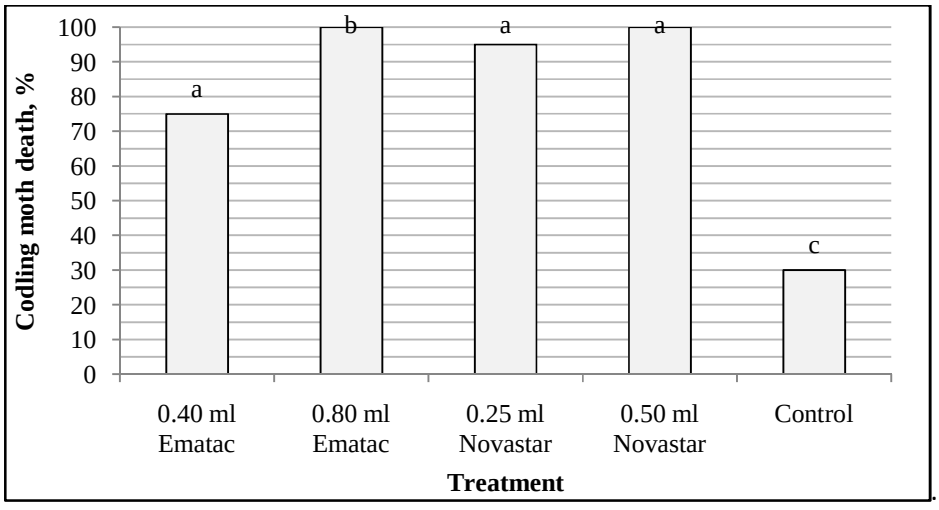


**Figure 4 Effect of bioassay of Ematac and Novastar on mortality of codling moth infestation of apple fruit**

## DISCUSSION

Codling moth infestation varied within the sampling dates due to the dynamics of the ecological behavior, environment and traditional insect pest management practices. The study area is located at high altitude that

experiences weather differences time and again thereby affecting the ecological conditions for the insects [18, 19, 20, 21]. Further, following the codling moth infestation appearance on apple fruits, the growers start applying insecticides without appropriate doses. This can limit the insect pest population to increase further but higher dosage of the chemicals left residual affects against human health in the fruits [6]. Differences of infestation by the codling moth among the farmers could be partially due to the variations in the levels of insect pest management practices and partially owing to specific locations of the orchards with respect to elevation. During the fruiting period there is gradual increase in maturity of the apple fruits that may invite greater number of pests to sting on.

The high levels of mortality of over wintering stages of codling moth in the laboratory experiments indicated the ability of the insecticides to manage this important insect pest. The bioassays can be applied to knock down the population of the pest and resultantly lower pressure may yield higher advantages for the farmers interlinked with reduced chemical insecticide inputs and high fruit quality. Insecticidal control of the pest is fast compared to other cultural and biological measures. Due to low pest pressure of the insect as experienced in the UK, cardboard traps placed around tree trunks would not work. In addition to the biological and cultural methods of codling moth control, application of pesticides is still has its importance as a final control measure. However, such application should be opted appropriately with recommended doses to produce fresh produce with minimal hazardous effects.

## CONCLUSION

Field survey of apple orchards indicated that codling moth infestation increases with time during the fruiting period and varied considerably with the farmers. This could possibly be owing to spatiotemporal variation in weather parameters, fruiting maturity and management practices. In light of the research work carried out a few insecticides can be applied as prompt control measure to achieve 100% mortality of the pest. In this respect minimal quantities of Talstar (0.048%), Ematac (0.325%) and Novastar (0.200%) can be recommended for full control of codling moth attack in apple orchards.

**Acknowledgements**
We authors acknowledge the financial support of Department of Agriculture and Food Technology, Karakoram International University, Pakistan. We also appreciate the technical guidance of each Dr. Khalique Ahmad and Dr. M.S. Awan during the field survey and laboratory experiments.

## REFERENCES

[1] Wood WS. *Monsanto Chemical Company*. **1965**.
[2] Barnes MM, Van der Geest L.P.S., Evenhuis H.H.. *World Crop Pests*., **1991**, 5, 313-227.
[3] Dorn S, Schumacher P, Abivardi C, Meyhöfer R. *Agric. Ecosyst. Environm*, **1999**, 1422, 1-8.
[4] Chen MH, Dorn S. *Bulletin of Entomological Research*, 2010. 100, 75–85.
[5] GOP (Government of Pakistan), *IUCN*. IUCN Pakistan, Karachi. **2003**, pp. 301.
[6] Driver P. *Aga Khan Rural Support Programme*. L.G. Mouchel and Partners Ltd. UK. **1994**, 32 pp.
[7] Aktar MW, Sengupta D, Chowdhury A. *Interdisc Toxicol*., **2009**, 2, 1–12.
[8] Hough WS. *J Econ Entomol*. **1928**, 21, 325–329.
[9] Thwaite WG, Williams DG, Hately A.M.. *Pest Cont Sustain Agric*., **1993**, 93, 166–168.
[10] Rield H, Zelger R. *Obstbau-Weinbau*, **1994**, 94, 107–109.
[11] Sauphanor B, Benoit M, Bouvier JC, Perron G, Fremond JC. *Phytoma*, **1994**, 458, 46–49.
[12] Charmillot PJ, Pasquier D, Sauphanor B, Bouvier JC, Olivier R. *Rev Suisse Vitic Arboric Hortic*., **1999**, 31, 129–132.
[13] Sauphanor B, Avilla J, Charmillot PJ, Ioriatti C, Michele S, Matias C. *Czech Republic*, **1998**, 747 pp.
[14] Reuveny H, Cohen E. *J Appl Entomol*. **2004**, 128, 645–651.
[15] Reyes M, Bouvier JC, Boivin T, Sauphanor B, Fuentes-Contreras E. *Agricultura Técnica*. **2004**, 64, 229–237.
[16] Woods W, Hardie D. **1997**. http://www.agric.wa.gov.au:7000/ento/ codling.htm
[17] Fitzgibbon CT, Morris LL. *How to Design a Program Evaluation*. Newbury Park, CA: Sage **1987**.
[18] Kuhrt U, Samietz J, Dorn S. *Entomol. Exp. Appl*. **2006a**, 118, 245–259.
[19] Kuhrt U, Samietz J, Dorn S. *Physiol. Entomol*. **2006b**, 31, 80–88.
[20] Saethre MG, Hofsvang T. *Environ. Entomol*., **2002**, 31, 804–815.
[21] Hagley EAC. *Environ. Entomol*. **1976**, 5, 967–625.