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Research Article

Toxicity of Insecticides against Diamond Back Moth, *Plutella xylostella* in Laboratory and Field Conditions

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ABSTRACT

The diamondback moth, Plutella xylostella L., belongs to the family Plutellidae and the order Lepidoptera, which is a destructive pest all over the world and causes great problems in many countries and has great economic importance and its control costs approximately one billion dollars annually. The current experiment was performed on this pest to check the toxicity of Dimethoate, Emamectin, and Lufenuron insecticides on larvae of P. xylostella. The results showed that emamectin was the most toxic insecticide, followed by lufenuron and dimethoate in both laboratory and field conditions. The mortality rate of pests was low in field conditions as compared to laboratory conditions. The mortality percentage increased with the increase in the application time of insecticides. All the treatments were also observed to be significantly superior to the control.

Keywords: *Plutella xylostella; Cabbage; Cauliflower; Insecticides; Mortality; Pakistan.*

INTRODUCTION

The Crusader family of vegetables, which includes cabbage and cauliflower, are among the most significant winter crops grown primarily in tropical and temperate regions of the world and are susceptible to various insect pests. In addition to being a significant source of nutrients like fat, protein, vitamins A and C, and minerals, cabbage and cauliflower also contain *Plutella xylostella*, which causes irregular spots on the underside of the host plant's leaves and renders them unfit for no Depreciation (Akbar et al., 2014; Zhang et al., 2016; & Ahmad et al., 2019).

Although a valuable crop economically, cabbage is severely harmed by attacks from cabbage aphids (*Brevicornye brassicas*), *P. xylostella*, and armyworms (*Spodoptera litura*) (Ramzan et al., 2020).

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These pests, especially the Diamondback moth (*P. xylostella*) (Lepidoptera: Plutellidae), are regarded as one of the main pests in Iran. India, Pakistan, and all regions where cabbage is grown globally and do great harm. One of the most destructive insect pests, the diamondback moth, *P. xylostella*, is the main barrier to the successful cultivation of cruciferous crops, which negatively impacts quality and output globally (Ramzan et al., 2019b). *P. xylostella* has national importance on cabbage as it causes a 50-80% annual loss in the marketable yield. *P. xylostella* was discovered on cruciferous vegetables for the first time in 1914 on the Indo-Pakistani subcontinent. Cruciferous vegetables in several parts of Pakistan suffered significant damage by *P. xylostella* (Abro et al., 2013; Zalucki et al., 2012; Yadav & Malik, 2014; & Sharma et al., 2017).

As a result, farmers must use chemical insecticides to cultivate lucratively because traditional and cultural practices alone are insufficient to provide adequate control over the pest threat. Pesticides, high-yielding crop varieties, and fertilizers have significantly increased agricultural productivity for Pakistani farmers. Hence the present investigation was undertaken with a view to studying the toxicity of different insecticides on the diamondback moths.

MATERIALS AND METHODS

Insect collection

Adults were collected from different unsprayed fields of cabbage and brought to the laboratory for the purpose of rearing and further bioassay study. The rearing of insects was done under controlled conditions by using the rearing methods of early researchers who conducted the study on this pest (Ramzan et al., 2019a). The 2nd generation larvae were used for bioassay study. Before watering, the leaves of the softened plant were removed from the field, cleaned with water, dried, and then submerged briefly in insecticide solutions at the specified concentrations for each pesticide individually. The treated leaves were then allowed to air dry for two hours at room temperature. In order to determine the percentage of mortality after 24, 48, and 72 hours of treatment, the number of dead larvae was calculated. The leaves were placed in sterile Petri dishes in the form of tablets containing filter paper moistened with water, and due to the presence of larvae of different larval ages, 10 larvae were added randomly to each dish. The dishes were then kept at a temperature of 25 2°C and 60-65% relative humidity. The laboratory tests were conducted as two-factor experiments using a thorough randomization design. When the larva infestation reaches a count of 6 per plant leaf, the plants undergo insecticide spraying. This is done with three replications, where each replication represents an entire plant.

The recommended concentration of the insecticide is used, and each pesticide is applied separately using a 1-litre handheld sprinkler. In the control treatment, the plants are sprayed with water instead. Before the spraying process, the distillate determines the number of larvae present in three replicates, with each replicate consisting of three vegetable leaves. The number of live larvae is calculated after 24, 48, and 72 hours of treatment. The Orell and Schneider equation, as stated in Shaban and Al-Mallah's work from 1993, is utilized according to the following equation. The field experiments were conducted using the random sector design as a *factor experiment. The averages obtained were compared using the RLSD method with a* significance level of 0.01 and 0.05. The statistical analysis was performed using the SPSS program.

RESULTS AND DISCUSSION

Multiple factors contribute to the lower productivity of cabbage compared to its potential, with insect pests being one of the primary constraints. One of the major and most destructive pests affecting cabbage crops is the diamondback moth, scientifically known as *Plutella xylostella*. It, commonly known as the diamondback moth, is a herbivorous insect that feeds on cruciferous crops. It is recognized as one of the top 10 insect pests globally (Wang et al., 2021). Adult diamondback moths possess the ability to be carried by winds, allowing them to cover long distances and migrate to different regions, countries, and even continents. Recent studies have indicated that South America serves as the origin of *P. xylostella* (Gao et al., 2018; Xia et al., 2018; & Steinbach et al., 2015). However, this pest has now spread to all areas where cruciferous hosts are cultivated and is considered the most widely distributed moth species. The feeding behaviour of *P. xylostella* on the leaves of vegetable crops and the siliques of grape seeds leads to reduced crop yields and compromised product quality (Li et al., 2016). Consequently, the global cost of *P. xylostella* damage and its management is estimated to reach as high as $5 billion annually (Furlong et al., 2013; Shen et al., 2023; & Zhang et al., 2016).

This pest significantly limits the successful cultivation of cruciferous crops. In Pakistan, the diamondback moth (*P. xylostella*) holds national importance as it causes an annual loss of 50-80% in marketable cabbage yield. Consequently, farmers are compelled to resort to the use of chemical insecticides to ensure profitable cultivation, as traditional and cultural practices alone fail to provide satisfactory control over this pest menace. However, the frequent and excessive use of chemical insecticides leads to the decline of natural enemies and the development of insecticide resistance in *P. xylostella* against a wide range of insecticides in various parts of the world (Meena et al., 2011; & Akmal et al., 2013).

In the current study, emamectin benzoate was most toxic as compared to other tested insecticides. The toxicity of emamectin was recorded highest, followed by lufenuron and dimethoate. The toxicity of all insecticides increased with the increased time duration of application, as shown in Figure 1. Various researchers have recorded such findings in the globes against various insect pests (Akbar et al., 2014; Al-Baridi et al., 2011; & Teja et al., 2019). The efficacy or toxicity of chemicals always increases with the increase in dose rate and time duration of chemicals application. The mortality percentage of larvae was 44, 59, 67, 71 and 77%, respectively, at 24, 48, 72, 96 and 120 hours of emamectin benzoate applications. The average effect of abamectin, dimethoate, and lufenuron was recorded at 63.60, 27.00 and 37.20%, respectively, as given in Table 1.

Table1. Mortality percentage of *P. xylostella* larvae in the field

Insecticides	Time duration (hours)					Effect average of insecticides
	24	48	72	96	120	
Emamectin benzoate	44	59	67	71	77	63.60
Dimethoate	10	23	29	32	41	27.00
Lufenuron	18	27	39	47	55	37.20

The comparative efficacy of insecticides in laboratory and field conditions is shown in Figure 2. The insecticides showed maximum toxicity against larvae in controlled conditions as compared to field conditions. This may be due to various factors such as environmental factors, larval instars, and many other factors. Senguttuvan et al. (2014) have reported emamectin, the best chemical pesticide against larvae of *P. xylostella*, and the least toxic was recorded dimethoate with 47.65% mortality.

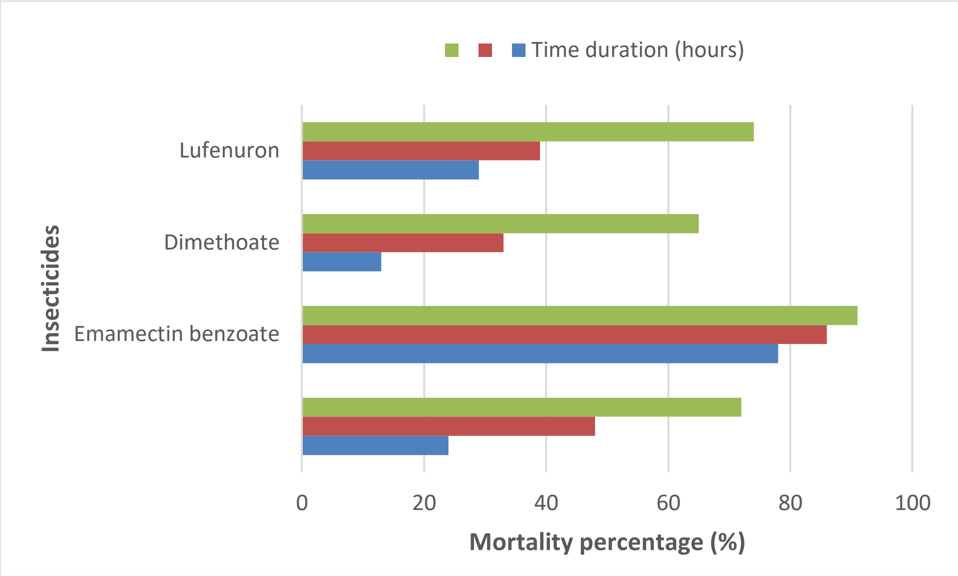

Figure1. Insecticides toxicity against larvae of *P. xylostella* in laboratory conditions

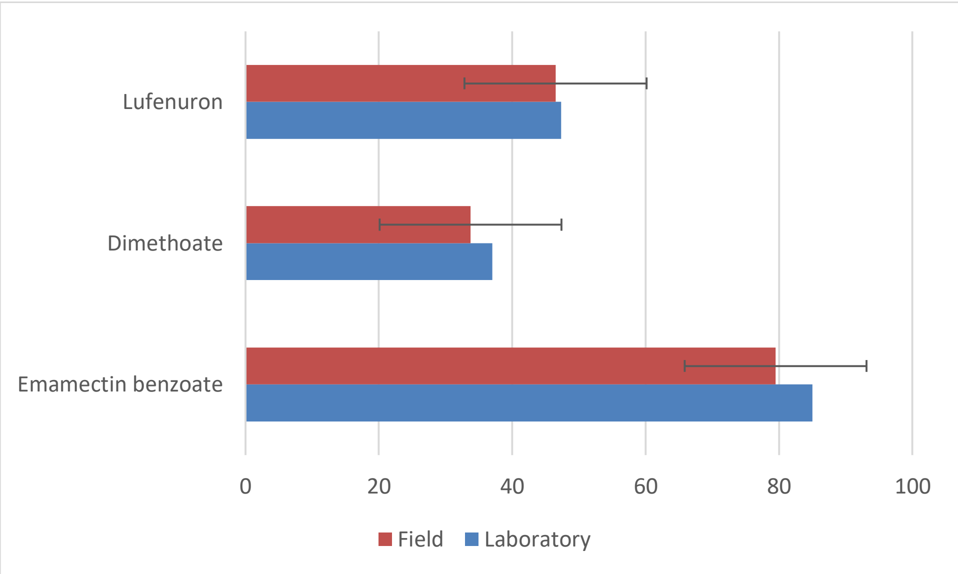

Figure2. Comparative toxicity of insecticides against laboratory and field conditions

CONCLUSION

Emamectin was the most toxic insecticide among all tested insecticides. The least toxic insecticide was dimethoate in both laboratory and field conditions. The mortality percentage of larvae was low in field conditions compared to laboratory conditions with all insecticides. The mortality percentage increased with the increase in the application time of insecticides. All the treatments were also observed to be significantly superior to the control.

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Conflict of interest:
The authors declare no conflict of interest.

Author's contribution:
Each author plays an equal role in performing this study.

REFERENCES

Akbar, I., Sttar, S., Khurshid, I., & Akbarm, A. (2014). Comparative efficacy of synthetic insecticides and botanical extracts against diamondback moth (*Plutella xylostella*) (Lepidoptera :

Plutellidae) in Cauliflower. *European Acad. Res. 2*(5), 6051-6066.

AL-Baridi, M. M., AL-Fuhaid, M. S., AL-Hassoun, E. A., & AL-Tubaishi, A. A. (2011). Directory of agricultural pesticides in the Kingdom of Saudi Arabia, Ministry of Agriculture.78-79 pp (in Arabic).

Abro, G. H., Syed, T. S., Kalhoro, A. N., Sheikh, G. H., Awan, M. S., Jessar, R. D., & Shelton, A. M. (2013). Insecticides for control of the diamondback moth, *Plutella xylostella* (L.)(Lepidoptera: Plutellidae) in Pakistan and factors that affect their toxicity. *Crop Protection*, *52*, 91-96.

Ahmad, B., Mehmood, N., Sohail, K., Saljoqi, A. U. R., Khan, A., Rab, A., & Hussain, S. (2019). In vitro management of diamondback moth (*Plutella xylostella* L.) using different concentrations of parthenium and neem extracts. *Journal of Agricultural Science and Technology*, *21*(3), 659-669.

Akmal, M., Freed, S., Malik, M. N., & Gul, H. T. (2013). Efficacy of *Beauveria bassiana* (Deuteromycotina Hypomycetes) against different aphid species under laboratory conditions. *Pakistan Journal of Zoology*. *45*(1), 71-78.

Akbar, I. L. Y. A. S., Sattar, S. H. A. H. I. D., Khurshid, I. S. M. A., & Akbar, A. N. E. E. L. A. (2014). Comparative efficacy of synthetic insecticides and botanical extracts against diamondback moth (*Plutella xylostella*)(Lepidoptera: Plutellidae) in cauliflower. *Euro. Acad. Res*, *2*, 6051-6066.

Furlong, M. J., Wright, D. J., & Dosdall, L. M. (2013). Diamondback moth ecology and management: problems, progress, and prospects. *Annual review of entomology*, *58*, 517-541.

Gao, Y., Kim, K., Kwon, D. H., Jeong, I. H., Clark, J. M., & Lee, S. H. (2018). Transcriptome-based identification and characterization of genes commonly responding to five different insecticides in the diamondback moth, *Plutella xylostella*. *Pesticide biochemistry and physiology*, *144*, 1-9.

Li, Z., Feng, X., Liu, S. S., You, M., & Furlong, M. J. (2016). Biology, ecology, and management of the diamondback moth in China. *Annual review of entomology*, *61*, 277-296.

Meena, R. K., Ram, J., & Lal, O. P. (2011). Bio-efficacy of some commercially available Neem formulations on Diamondback moth, *Plutella xylostella* (L.) on cabbage. *Journal of Progressive Agriculture. 2*(2), 55-56.

Ramzan, M., Ullah, U. N., Hanif, M., Nadeem, M., Qayyum, M. A., & Javaid, M. (2019a). Biology of diamondback moth, *Plutella xylostella* (Lepidoptera: Plutellidae) of cauliflower under laboratory conditions. *Journal of Innovation Sciences*, *5*(2), 89-94.

Ramzan, M., Murtaza, G., Javaid, M., Iqbal, N., Raza, T., Arshad, A., & Awais, M. (2019b). Comparative efficacy of newer insecticides against *Plutella xylostella* and *Spodoptera litura* on cauliflower under laboratory conditions. *Indian Journal of Pure Applied Biosciences*, *7*(5), 1-7.

Ramzan, M., Sultan, Y., Sabir, M. W., Shafiq, M., Murtaza, G., Shahid, M., & Asif, H. M. (2020). Effect of host plants on the biology of *Spodoptera litura* (F.). *Indian Journal of Entomology*, *82*(3), 408-411.

Senguttuvan, K., Kuttalam, S., & Gunasekaran, K. (2014). Baseline toxicity of Lufenuron 5.4 EC against diamondback moth, *Plutella xylostella* L.for Resistance Monitoring. *Trends in Biosciences 7*(13), 1440-1443.

Sharma, P., Kumawat, K. C., Khinchi, S. K., Kumar, V., & Prasad, B. (2017). Bioefficacy of different insecticides against diamondback moth. *International Journal of Chemical Studies*, *5*(3), 891-893.

Shaban, A., & AL-Mallah, N. M. (1993). The pesticides. Ministry of Higher Education and Scientific Research. University of AL Mosul 520 pp (in Arabic).

Shen, X. J., Cao, L. J., Chen, J. C., Ma, L. J., Wang, J. X., Hoffmann, A. A., & Wei, S. J. (2023). A comprehensive assessment of insecticide resistance mutations in source and immigrant populations of the diamondback moth *Plutella xylostella* (L.). *Pest Management Science*, *79*(2), 569-583.

Steinbach, D., Gutbrod, O., Lümmen, P., Matthiesen, S., Schorn, C., & Nauen, R. (2015). Geographic spread, genetics and functional characteristics of ryanodine receptor based target-site resistance to diamide insecticides in diamondback moth, *Plutella xylostella*. *Insect Biochemistry and Molecular Biology*, *63*, 14-22.

Teja, N., Sunitha, V., RameshBabu, V., & Satyanarayana, J. (2019). Evaluation of novel insecticides and their persistency against diamondback moth, *Plutella xylostella Linn. J. Entomol. Zool. Studies 7*(3), 338-341.

Wang, J., Zheng, X., Yuan, J., Wang, S., Xu, B., Wang, S., & Wu, Q. (2021). Insecticide resistance monitoring of the Diamondback moth (Lepidoptera: Plutellidae) populations in China. *Journal of Economic Entomology*, *114*(3), 1282-1290.

Xia, X., Sun, B., Gurr, G. M., Vasseur, L., Xue, M., & You, M. (2018). Gut microbiota mediate insecticide resistance in the diamondback moth, *Plutella xylostella* (L.). *Frontiers in microbiology*, *9*, 25.

Yadav, N. K., & Malik, Y. P. (2014). Efficacy of some new insecticides against diamondback moth (*Plutella xylostella* L.) of cauliflower and cabbage. *Trends in Biosciences*, *7*(12), 1180-1183.

Zalucki, M. P., Shabbir, A., Silva, R., Adamson, D., Shu-Sheng, L., & Furlong, M. J. (2012). Estimating the economic cost of one of the worlds major insect pests, *Plutella xylostella* (Lepidoptera : Plutellidae). *J. Econ. Entomol. 105*, 1115-1129.

Zhang, S., Zhang, X., Shen, J., Mao, K., You, H., & Li, J. (2016). Susceptibility of field populations of the diamondback moth, *Plutella xylostella*, to a selection of insecticides in Central China. *Pesticide biochemistry and physiology*, *132*, 38-46.

Zhang, S., Zhang, X., Shen, J., Mao, K., You, H., & Li, J. (2016). Susceptibility of field populations of the diamondback moth, *Plutella xylostella*, to a selection of insecticides in Central China. *Pesticide biochemistry and physiology*, *132*, 38-46.