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STUDIES ON EFFECT OF ANTIBIOTIC ON BIOLOGICAL PARAMETERS OF DIAMONDBACK MOTH, *Plutella xylostella* (Linnaeus)

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ABSTRACT

Diamondback moth larvae were reared on natural diet (cabbage) with three concentrations of Streptomycin sulphate (0.05, 0.1 and 0.2%) and without antibiotic (control). Mean larval developmental period was prolonged to 10.00, 11.00 and 12.00 days at 0.05, 0.1 and 0.2 per cent antibiotic respectively, compared to untreated natural diet (9.00 days). Among the concentrations of antibiotic tested, a dose of 0.2 per cent resulted in reduced pupal recovery (67.40%) with shortest pupal duration (4.23 days). Emergence of adults was drastically decreased from 85.80 per cent (control) with a higher number of females (1.5 f/m) to 57.80 per cent (0.2per cent antibiotic) with higher number of males (0.8 f/m). Females laid a greater number of eggs on untreated diet (151.70 eggs/female), with highest percent egg hatchability (82.16%), while a marked reduction was observed at 0.2 per cent antibiotic with 95.38 eggs/female and 58.25 per cent egg hatchability. Biological parameters of *Plutella xylostella* were negatively affected at all the three concentrations of Streptomycin sulphate and it was more obvious at 0.2 per cent antibiotic dose.

KEYWORDS: Diamondback moth, Streptomycin sulphate, Natural diet, biological parameter.

INTRODUCTION

Diamondback moth (DBM), *Plutella xylostella* (Linnaeus) (Lepidoptera: Plutellidae) is considered as the most universally distributed insect of all Lepidopteran insects and is a major pest of cruciferous vegetables (Paudel *et al*., 2022). It is a native of Mediterranean region or South Africa and then it had spread to Europe (Kfir*,* 1998). It is a cosmopolitan insect species found in most places wherever crucifers such as mustard, cabbage, cauliflower, radish, broccoli, turnip, rapeseed, brussels, knol-khol and kale are being grown (Badenes *et al.,* 2020). The change in the population of any insect pest depends on the nutritional status of their host plants, which influences growth, development and reproduction of insect population (Dumas *et al*., 2015). Antibiotic feeding to insects can negatively affect the biological parameters of insects. Among the antibiotics, rifampicin and aureomycin were the most commonly used antibiotics to treat aphids (Lal, 1971; Adams *et al*., 1996) and penicillin to *Spodoptera exigua* (Hubner) (Jung and Kim 2006). Raymond *et al*. (2009) reared *P. xylostella* on artificial diet with rifampicin for clearing gut bacteria. In this view, the present study was undertaken to study the effect of antibiotic on biological parameters of Diamondback moth.

MATERIAL AND METHODS

The studies on the effect of antibiotic on biological parameters of Diamondback moth, *Plutella xylostella,* were conducted during 2023-24 at Insectary, Department of Entomology, S. V. Agricultural College, Tirupati.

Rearing and maintenance of DBM on natural diet (Cabbage)

Egg mass and early instars of DBM were collected from the farmer's field and S.V. Agricultural College farm and brought to the insectary for the rearing and maintenance on cabbage.

Cabbage crop was grown at Insectary, Department of Entomology, S.V. Agricultural College, Tirupati by following Dr. YSRHU, package of practices except plant protection measures. The fresh leaves of cabbage were washed with distilled water, shade dried and cut into discs of uniform size and placed in petri plates. Neonates of Diamondback moth were transferred to Petri plates containing cabbage leaves. The fresh leaves were provided as feed for developing larvae at regular interval and left out material along with excreta were removed daily. The final instar larvae were separated and placed in separate rearing containers for pupation. Pupae were collected and placed in adult rearing cage (30×30×30 cm) for emergence of adult moths. After adult emergence the cages were provided with 10per cent honey solution on

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cotton swabs as adult food and 4-5 leaf stage mustard seedlings as ovipositional substrate

Testing of antibiotic using natural diet (Cabbage) through leaf disc method

An antibiotic (Streptomycin sulphate) was tested at three different concentrations of 0.05 per cent, 0.1 per cent and 0.2 per cent using cabbage as natural diet through leaf disc method. Leaf discs of cabbage leaves were surface sterilized with 75 per cent alcohol for 2 min, and then washed through distilled water to remove the external contamination. Disinfected leaf discs were picked with a needle and then dipped in antibiotic solutions of three different concentrations for 2 h. Antibiotic treated leaf discs were shade dried and were placed in petri dishes. Freshly hatched larvae of DBM were accessed to feed on treated leaf discs of cabbage separately. For each treatment, 30 larvae were released in three replications. Treated leaf discs were provided until pupation. Leaf discs without antibiotic treatment was also tested as control.

RESULTS AND DISCUSSION

The significant differences in biological parameters of *P. xylostella* were recorded among different treatments of natural diet (cabbage) are presented in the Table 1 (Fig. 1 and 2).

Significant differences were found in total larval period among different treatments of natural diet (cabbage), varied from 9.00 days (control) to 12.00 days (0.2% Streptomycin sulphate). At 0.05 per cent (NDS1) and 0.1 per cent (NDS2) of Streptomycin sulphate, the duration of larva was 10.00 and 11.00 days respectively, which were statistically on par with each other (Table 1).

The percentage of pupae resulted from larvae reared on natural diet (cabbage) treated with and without antibiotic was ranged from 67.40 (NDS3) to 81.47 per cent (NDC). Pupal recovery was significantly higher in control, which was on par with natural diet treated with 0.05 per cent antibiotic (76.66%). Percentage of pupal recovery on NDS2 and NDS3 were 72.22 per cent and 67.40 per cent at 0.1 per cent and 0.2 per cent antibiotic respectively (Table 1).

Pupal duration was shortest (4.23 days) on diet treated with 0.2 per cent antibiotic (NDS2) and on par with NDS1 (5.10 days). Whereas on diets; NDC (control) and NDS1 (0.05 per cent), pupal duration was relatively longer with 5.70-6.43 days, which is similar to the pupal duration of 5-7 days under natural conditions (Table 1).

The percentage of adult emergence from pupae resulted from different treatments of natural diet (cabbage) ranged between 57.81 per cent (0.2% antibiotic) to 85.80 per cent (control), which were significantly different from each other. Highest percentage of adult emergence (85.80%) was recorded on natural diet without antibiotic (NDC), whereas at 0.05 per cent and 0.1 per cent antibiotic, it was 76.56 per cent (NDS1) and 69.45 per cent (NDS2) respectively. Least percentage of adult emergence (57.81%) was recorded from the diet treated with 0.2 per cent antibiotic (NDS3) (Table 1).

There was a significant differences in sex ratio (females to males) among treatments of natural diet (cabbage) ranging from 0.8 to 1.5. It was observed that number of females were more than males when fed on natural diet without antibiotic (1.5), followed by 0.05 per cent antibiotic (1.16) and 0.1 per cent antibiotic (1.06). In contrast high proportion of males were produced at 0.2 per cent antibiotic with sex ratio of 0.8. Adult males from natural diet (cabbage) without antibiotic were lived up to 8.73 days, followed by 8.23 days on NDS1 (0.05% antibiotic). Duration from the diets treated with 0.1- 0.2 per cent antibiotic was 5.90-6.53 days (Table 1).

Adult males from natural diet (cabbage) without antibiotic were lived up to 8.73 days, followed by 8.23 days on NDS1 (0.05% antibiotic). Duration from the diets treated with 0.1- 0.2 per cent antibiotic was 5.90-6.53 days. The similar trend was observed in female adult longevity, in which longevity of adult female on natural diet without antibiotic (control) was longest with 10.70 days, and was found on par with NDS1 (0.05% antibiotic) with 9.60 days. Duration of adult female at 0.1 per cent antibiotic was 8.63 days. Longevity was shortest at 0.2 per cent antibiotic (NDS3) with 7.10 days, which were significantly different from control. It indicates that as the concentration of Streptomycin sulphate was increased in the diet, longevity of both male and female adults were decreased to 5.90 and 7.10 days respectively, at 0.2 per cent (NDS3) (Table 1).

Statistically significant differences were observed in egg production among different diets. The fecundity was highest (151.70 eggs/female) on natural diet without antibiotic (NDC). Fecundity at 0.05 per cent (NDS1) and 0.1 per cent antibiotic (NDS2) were 132.76 and 107.37 eggs/female, which are significantly different from control diet. Lowest fecundity was observed (95.38 eggs/female) in the diet treated with 0.2 per cent antibiotic (NDS3) (Table 1). An inverse relationship was observed between fecundity and concentration of antibiotic (Table 1).

Table 1. Biological Parameters of *Plutella xylostella* reared on natural diet (cabbage) with and without antibiotic

Parameter	Diet treatments				ANOVA
	NDS1	NDS2	NDS3	NDC	
Larval period (days)*	10.00^{ab} (1.00 ± 0.00)	11.00^{ab} (1.04 ± 0.57)	12.00^{b} (1.08 ± 0.57)	9.00^{a} (0.95 ± 0.00)	F = 10.00, df = (3, 8) P<0.01
Pupal recovery (%)**	76.66^{bc} (61.11 ± 0.64)	72.22^{ab} (58.19 ± 0.64)	67.40^{a} (55.18 ± 0.97)	81.47^{c} (64.50 ± 1.48)	F = 36.53, df = (3, 8) P<0.01
Pupal period (days)*	5.70^{bc} (0.76 ± 0.15)	5.10^{ab} (0.71 ± 0.05)	4.23^{a} (0.63 ± 0.14)	6.43^{c} (0.81 ± 0.23)	F = 33.97, df = (3, 8) P<0.01
Adult emergence (%)**	76.56^{c} (61.04 ± 0.38)	69.45^{b} (56.44 ± 0.58)	57.81^{a} (49.49 ± 1.32)	85.80^{d} (67.86 ± 1.04)	F = 167.00, df = (3, 8) P<0.01
Sex ratio (female/male)**	1.16^{b} (6.18 ± 0.03)	1.06^{ab} (5.90 ± 0.03)	0.8^{a} (5.13 ± 0.05)	1.5^{c} (7.03 ± 0.05)	F = 37.66, df = (3, 8) P<0.01
Adult male longevity (days)*	8.23^{bc} (0.92 ± 0.14)	6.53^{ab} (0.81 ± 0.08)	5.90^{a} (0.77 ± 0.05)	8.73^{c} (0.94 ± 0.12)	F = 156.09, df = (3, 8) P<0.01
Adult female longevity (days)*	9.60^{bc} (0.98 ± 0.05)	8.63^{b} (0.94 ± 0.08)	7.10^{a} (0.85 ± 0.05)	10.70^{c} (1.03 ± 0.47)	F = 39.22, df = (3, 8) P<0.01
Fecundity (eggs/female)*	132.76^{c} (2.12 ± 1.39)	107.37^{b} (2.03 ± 1.46)	95.38^{a} (1.98 ± 1.99)	151.7^{d} (2.18 ± 2.39)	F = 38.95, df = (3, 8) P<0.01
Egg hatch (%)**	75.65^{bc} (60.43 ± 1.40)	67.06^{b} (54.97 ± 0.97)	58.25^{a} (49.74 ± 1.72)	82.61^{c} (65.35 ± 1.45)	F = 55.61, df = (3, 8) P<0.01

With in a row, means followed by the same letter are not significantly different (α=0.05), (Tukey test; SPSS-25). Figures in the parenthesis are transformed values ± standard errors. *Log transformation, **Arc sine transformation. Where NDS1= Natural diet (Cabbage) with Streptomycin Sulphate @ 0.05 per cent; NDS2= Natural diet (Cabbage) with Streptomycin Sulphate @ 0.1 per cent; NDS3= Natural diet (Cabbage) with Streptomycin Sulphate @ 0.2 per cent; NDC= Natural diet (Cabbage) without antibiotic

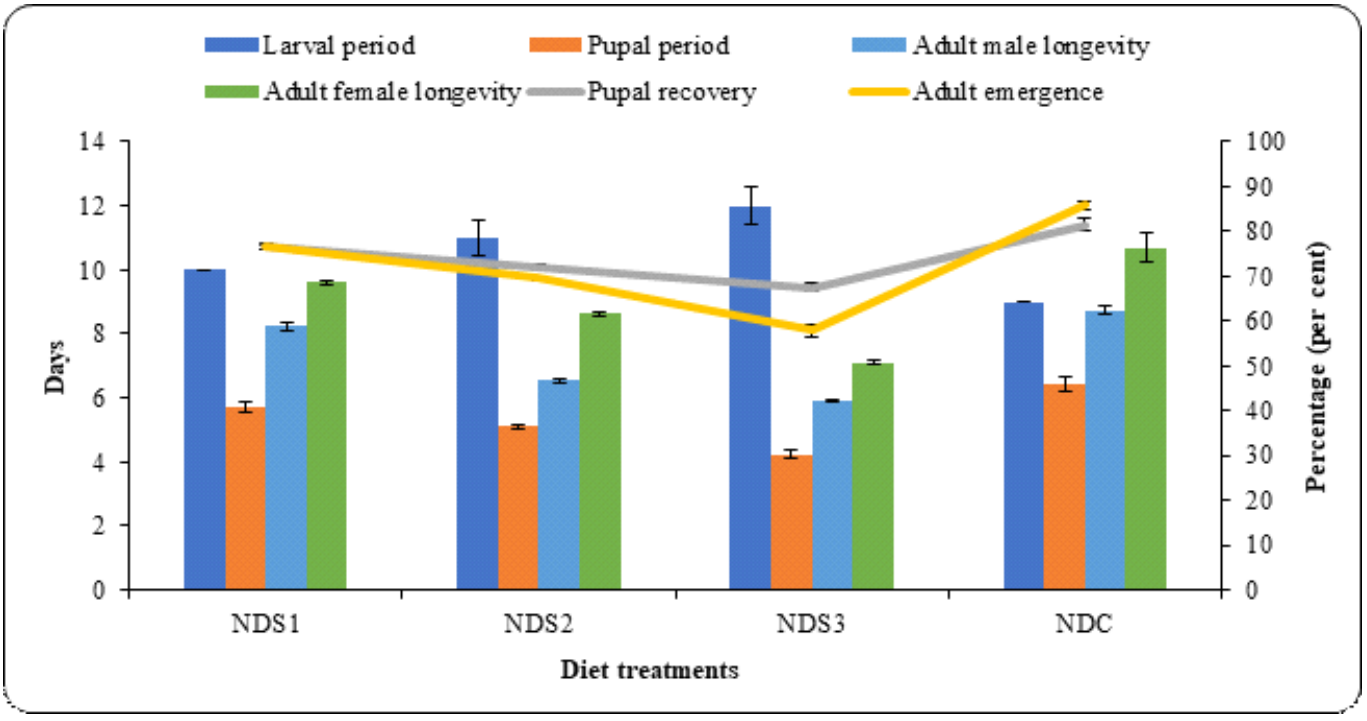

Fig. 1. Biological Parameters of *Plutella xylostella* reared on Natural diet (cabbage) with and without antibiotic.

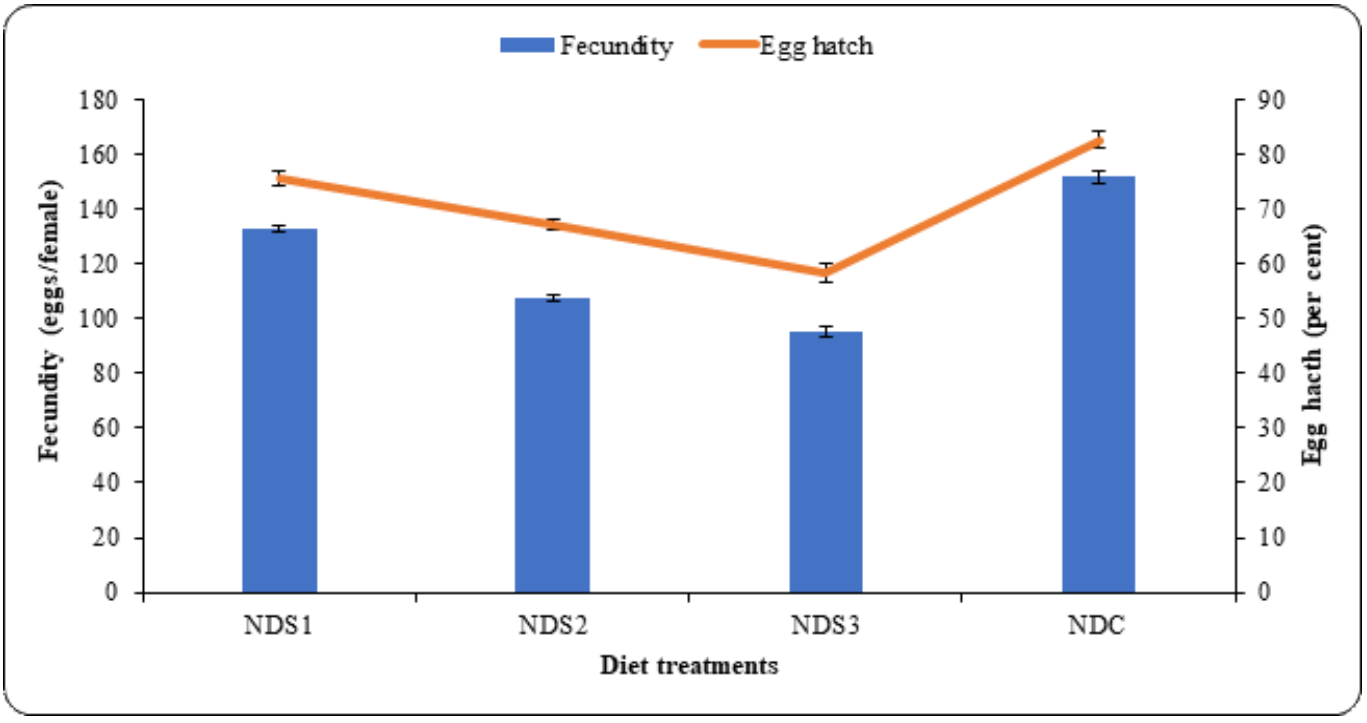

Fig. 2. Fecundity and fertility of *Plutella xylostella* reared on natural diet (cabbage) with and without antibiotic.

Percentage of egg hatch was highest (82.61%), on natural diet without antibiotic (NDC) followed in diet treated with 0.05 per cent antibiotic (75.65%). Whereas at 0.1 per cent antibiotic it was 67.06 per cent. Lowest percentage of egg hatch was observed at 0.2 per cent antibiotic (NDS3) with 58.25 per cent, which was significantly different from remaining diets (Table 1). Antibiotic treatment had showed detrimental effect on hatchability of eggs laid by females from diets treated at higher concentration of antibiotic (Table 1).

Mean larval period of DBM reared on natural diet (cabbage) treated with Streptomycin sulphate at three concentrations of 0.05, 0.1 and 0.2 per cent resulted in significant increase in larval duration from 9.00 (control) to 12.00 days (0.2 per cent antibiotic). The similar findings reported by Zhu *et al*. (2023), who found that the developmental duration of larvae fed on natural diet (radish) treated with 0.2 per cent of tetracycline, prolonged to 16.55 days, compared to 7.43 days on control. The highest pupal recovery was recorded on natural diet (cabbage) without antibiotic (81.47 per cent) and decreased to 67.40 per cent as the concentration of Streptomycin sulphate was increased to 0.2 per cent in natural diet, which were corroborated with Shen *et al*. (2018), who reported that larvae of *P. xylostella* fed on natural diet (radish) treated with antibiotic has declined pupation rates. Pupal period was reduced to 4.23 days in natural diet treated with 0.2 per cent of Streptomycin sulphate, when compared to 6.43 days in diet without antibiotic. Proportion of number of females were high in natural diet without antibiotic (1.5 f/m), whereas the number of females were reduced with slight increase in concentration of Streptomycin sulphate. It indicates that diets without antibiotic were suitable diets in favour of female sex ratio, which is an attribute of standard diet for insect rearing (Alam *et al*., 2024). Adult emergence was highest in natural diet without antibiotic (85.80%), while the emergence rate was decline to <60 per cent at 0.2 per cent Streptomycin sulphate. These results are in line with Thakur *et al*. (2016), who also reported that adult emergence of *Spodoptera litura* was decreased with increased concentrations of Streptomycin sulphate at 0.03 per cent, 0.07 per cent and 0.15 per cent, which resulted in poor emergence to <65.00 per cent compared to 85.00 per cent in control. Longevity of adult males and females of *P. xylostella* on natural diet without Streptomycin sulphate were lived up to 8.73 and 10.70 days respectively. Longevity of adult male were reduced from 8.23 to 5.90 days with increased concentration of Streptomycin sulphate from 0.05 to 0.2 per cent, similarly for adult females from 9.60 (0.05%) to 7.10 days (0.2%). Longevity of both male and female adults were slightly affected at 0.05 and 0.1 per cent, but at 0.2 per cent longevity was drastically affected. The present findings on adult longevity are in agreement with Zhang *et al*. (2022), who reported that larval feeding with ciprofloxacin shortened adult longevity of oriental fruit moth, *Grapholita molesta* (16.68 days) with slight increase in concentration of antibiotic by 0.0001 per cent, compared 17.86 days in control diet. Adult females of *P. xylostella* from natural diet without antibiotic laid highest number of eggs (151.70 eggs/female) with egg hatchability of 82.61 per cent, whereas from the diet treated with 0.2 per cent antibiotic; fecundity (95.38 eggs/female) and fertility (58.25%) were hugely affected. Zhang *et al*. (2022) also reported that larval feeding with a minimum concentration of ciprofloxacin (0.0001%), significantly affected larval growth, development and reproduction in *Grapholita molesta* which resulted in decreased fecundity (87.54 eggs/female) and egg hatchability (58.24%), compared to larval feeding without antibiotic, which resulted fecundity of 122.13 eggs/female and egg hatchability of 80.20 per cent.

Our results demonstrated that larvae of DBM reared on natural diet (cabbage) treated with Streptomycin sulphate at three concentrations significantly affected larval growth, development and reproduction, resulting in prolonged larval period, reduced pupal recovery with shortened pupal duration, decreased adult longevity with a greater number of males, and reduced fecundity and egg hatchability. Biological parameters of DBM were more negatively correlated with increasing concentration of Streptomycin sulphate.

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LITERATURE CITED

Adams, D., Wilkinson, T.L and Douglas, A.E. 1996. The aphid-bacterial symbiosis: a comparison between pea aphids and black bean aphids. *Entomologia Experimentalis et Applicata.* 80: 275–278.

Alam, A., Abbas, S., Ali, J., Liangzhu, W., Shakeel, M., Ullah, F., Xiao, F., Weibo, Q., Haichao, W., Jiali, L and Abbas, A. 2024. Diet suitability through biological parameters in *Ostrinia furnacalis* (Lepidoptera: Crambidae) clades. *Entomological Research*. 54(7): 12751.

Badenes, F.R., Gershenzon, J and Heckel, D.G. 2020. Plant glucosinolate content increases susceptibility to Diamondback moth (Lepidoptera: Plutellidae) regardless of its diet. *Journal of Pest Science*. 93(1): 491-506.

Dumas, P., Legeai, F., Lemaitre, C., Scaon, E., Orsucci, M., Labadie, K., Gimenez, S., Clamens, A.L., Henri, H., Vavre, F and Aury, J.M. 2015. *Spodoptera frugiperda* (Lepidoptera: Noctuidae) host-plant variants: two host strains or two distinct species. *Genetica*. 143: 305-316.

Jung, S and Kim, Y. 2006 Synergistic effect of *Xenorhabdus nematophila* K1 and *Bacillus thuringiensis subsp. aizawai* against *Spodoptera exigua* (Lepidoptera, Noctuidae). *Biological Control*. 39: 201–209.

Kfir, R. 1998. Origin of the diamondback moth (Lepidoptera: Plutellidae). *Annals of the Entomological Society of America*, 91(2): 164-167.

Lal, O.P. 1971. A New Approach to fight aphids with low concentrations of insecticides in combination with antibiotic and surfactant. *Entomologie*. 68: 314–321.

Paudel, A., Yadav, P.K and Karna, P. 2022. Diamondback Moth *Plutella xylostella* (Linnaeus, 1758) (Lepidoptera: Plutellidae); A Real Menace to Crucifers and Its Integrated Management Tactics. *Turkish Journal of Agriculture-Food Science and Technology*. 10(12): 2504-2515.

Raymond, B., Paul, R.J., Denis, J.W., Richard, J.E., Crickmore, N and Michael, B.B. 2009. A mid-gut microbiota is not required for the pathogenicity of *Bacillus thuringiensis* to Diamondback moth larvae. *Environmental Entomology*. 11: 2556–2563.

Shen, J., Wang, Q., Xia, X and You, M. 2018. Effect of antibiotics and gut bacteria on fitness of Diamondback moth *Plutella xylostella* (L.). *Acta Microbiologica Sinica*. (6): 1025-1035.

Thakur, A., Dhammi, P., Saini, H.S and Kaur, S. 2016. Effect of antibiotic on survival and development of *Spodoptera litura* (Lepidoptera: Noctuidae) and its gut microbial diversity. *Bulletin of Entomological Research*. 106(3): 387-394.

Zhang, X., Wang, X., Guo, Z., Liu, X., Wang, P., Yuan, X and Li, Y. 2022. Antibiotic treatment reduced the gut microbiota diversity, prolonged the larval development period and lessened adult fecundity of *Grapholita molesta* (Lepidoptera: Tortricidae). *Insects*. 13(9): 838.

Zhu, X., Zhang, L., Li, J., He, A., You, M and You, S. 2023. Effects of Antibiotic Treatment on the Development and Bacterial Community of the Wolbachia-Infected Diamondback Moth. *Evolutionary Bioinformatics*. 19(3): 69.