Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 547 - 557
Received 05 March 2021; Accepted 01 April 2021.

Effect of Hot Pepper Plant Extracts on Resistance to Aphids on Okra

Subreen Mohsen Hasan, Mahmood T. Al-Jayashi[1]
Muthanna Agriculture Directorate, Ministry of Agriculture, Iraq.
[1]Agriculture College, Al-Muthanna University, Iraq

Abstract
In order to compared the effect of varieties of hot pepper plant extracts on the population buildup of sucking complex in okra crop at experimental field Al Essa district, Swed, Iraq. The following concentrations of hot pepper extracts in water were prepared (concentrations (%): 1, 3, 5, 7 and 9) and sprayed on the crop. The observations were recorded on population of aphid before and after spraying. The results showed that the efficacy of different hot pepper aqueous extracts against aphids at different treatments for two weeks starting from mid of July 2019. Average reduction in the population of avid were achieved using the highest concentration (9%). The best mortality rates were achieved after the first spray since the average mortality rate was 1.76, in comparison with 0.24 and 0.22, the averages for the second and third spray respectively. Furthermore, there is relationship between the concentration of the hot pepper extract with the total wet shoots, since sig.(2-tailed) p value was less than 0.05.

Keywords: Okra, Aqueous extracts, Population buildup, Sucking complex, Aphid.

1. Introduction

Aphid, *Aphis gossypii* are the major sucking insect pests of okra (Chandio *et al.*, 2017). The Taxonomy of Avid is as follows: Kingdom: Animalia (Animals), Phylum: Arthropoda (Arthropods), Subphylum: Hexapoda (Hexapods), Class: Insecta (Insects), Order: Hemiptera (True Bugs, Cicadas, Hoppers, Aphids and Allies), Suborder: Sternorrhyncha (Plant-parasitic Hemipterans), Superfamily: Aphidoidea, Family: Aphididae (Aphids) (Iowa State University, 2021).

Aphid, *Aphis gossypii*, is found mostly temperate zone of the Northern Hemisphere. It remains active in optimum temperature. Aphid is a polyphagous insect and found on upper and lower surface of leaves near the base of the plant (Dutta, 2018). Aphids are the vehicle of viruses especially on cucurbit crops.

This notorious insect pest that attach okra, not only reduces the growth of okra but also transmits diseases (Shabozoi *et al.*, 2011). The Extensive loss of cell fluid results not only in short life period but also inhibits plant growth. Furthermore, the sucking insect pests cause a damage by sucking the plant sap. Insect pests may cause from 40-70% crop yield losses.

During the last 50 years a continuous increase in pesticide application was observed, but pest attacks have not been successfully controlled and crops losses continue (Muhammad *et al.*,

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 547 - 557
Received 05 March 2021; Accepted 01 April 2021.

2018). Also synthetic pesticides have serious effects on human health, it cause various disorders like breast cancer, the suppression of immune system, disorder of nervous system, respiratory disorder, hormonal damages, disruption of male reproductive hormones, low sperm count in men and birth defects in babies (Sushma *et al.*, 2015).

An alternative management approach for pest control for plants could be the plants extract pesticides (bio-pesticides) which are safe to the environment, risk free to crop damage and no harmful effects on people and animal health (Regnault-Roger, Vincent and Arnason, 2012). Application of bio-pesticides showed aptitude for pest management in different crops overseas and brought significant reduction in yield losses in various crops (Rattan, 2010). Several plant extracts of plant species such as; Neem - Azadirachta indica A. Juss., tobacco - Nicotiana tabacum L., garlic - Allium sativum L. and ginger - Zingiber zerumbet have shown to be promising bio-pesticides for controlling insect pests and diseases in agriculture (Khater, 2012; Showler, 2017). The present study was conducted to evaluate the extract hot pepper for pesticidal activities against aphids in okra to provide an easy and cost effective way for the control of aphid attack on okra in Iraq.

2. Material and Methods

2. 1. Experimental site

Field trials were conducted mid of July 2019 for two weeks period at the Al Essa district, Swed, Iraq. Okra was grown in plots in a field with a size of 1 km^2. The experimental field was consisted of 18 plants. Normal agronomic practices like soil preparation, irrigation and fertilization were done.

2.2. Preparation of plant extracts

Hot pepper plant was purchased from the local market, air dried and ground using with electrical blender. To prepare the dried residue of the hot pepper, Mansour method (AlMansour, 1995) was adopted with some modifications, in which 100 g of the ground pepper powder was placed in 1000 ml conical flask, 500 ml distilled cold water was added, the solution was stirred with a magnetic stirrer for 15 minutes, left overnight, covered to avoid the impurities, then filtered using filter paper, the solution was evaporated to dryness using the rotary evaporated at 50ºC, the residue was transferred to crucible and kept in a vacuum oven (50ºC) for overnight. To prepare the stock solution 10 g of the dried residue was dissolved in 100 ml distilled water to have concentration 10%, a series of diluted concentration was prepared using distilled water to get the following concentrations (%): 1, 3, 5, 7 and 9.

The experiment was laid out in a randomized complete block design with 5 treatments (five concentrations) and 3 replicates. and five leaves were observed from each plant from top, middle and bottom. The crop was sprayed with the following treatments.

2.3. Treatments

The treatments with the five concentrations of the hot pepper extract were applied in the morning to prevent photodecomposition of the extracts. The application of treatments commenced at 15/7/2020 and was repeated weekly for over two weeks.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 547 - 557
Received 05 March 2021; Accepted 01 April 2021.

2.4. Data collection and Data Analysis

Data were collected on diversity and population of insect pest and the plant growth parametrs such as: leaf area, the wet and dry shoots were recorded.

Data collected were subjected to analysis of variance (ANOVA) using SPSS software ver. 24.

3. Results and Discussion

The plants were sprayed three time in two weeks starting from 15/7/2020, three okra plants were used for each concentration as shown below in **Table 1**.

Table 1: The number of aphid insects at the begging of the experiment before spraying.

Trial Number	Concentration %	Number of aphids on each plant Three replicates
1	**1**	**6 – 5 – 4**
2	**3**	**7 – 5 – 4**
3	**5**	**5 – 5 - 4**
4	**7**	**7 – 6– 5**
5	**9**	**5 – 6 -6**
6	**control**	**7 – 6 – 6**

After spraying for the first time, at 15/7/2020, the following data were obtained, **Table 2**.

Table 2: The number of aphid insects after the first spraying with the extract.

Trial Number	Concentration %	Number of aphids on each plant Three replicates
1	**1**	**5 – 4 – 3**
2	**3**	**7 – 6 – 1**
3	**5**	**3 – 2 – 5**
4	**7**	**5 – 2 – 5**
5	**9**	**1 – 1 – 4**
6	**control**	**7 – 7 – 6**

After a week, 22/7/2020, the aphid insects were counted, **Table 3**, before the second spraying with the extract.

Table 3: The number of aphid insects before spraying the second spraying with the extract.

Trial Number	Concentration %	Number of aphids on each plant Three replicates
1	**1**	**9 – 1 – 8**
2	**3**	**13 – 13 – 10**
3	**5**	**10 – 10 – 8**

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 547 - 557
Received 05 March 2021; Accepted 01 April 2021.

4	**7**	**15 – 14 – 13**
5	**9**	**10 – 7 – 7**
6	**control**	**11 – 13 - 14**

After spraying for the second time, at 22/7/2020, the following data were obtained, **Table 4**.

Table 4: The number of aphid insects after the second spraying with the extract.

Trial Number	**Concentration %**	**Number of aphids on each plant Three replicates**
1	**1**	**10 – 10 – 7**
2	**3**	**12 – 14 – 6**
3	**5**	**7 – 7 – 10**
4	**7**	**12 – 10 – 10**
5	**9**	**6 – 5 – 4**
6	**control**	**12 – 15 - 16**

After a two week, 31/7/2020, the aphid insects were counted, **Table 5**, before the third spraying with the extract.

Table 5: The number of aphid insects before spraying the third spraying with the extract.

Trial Number	**Concentration %**	**Number of aphids on each plant Three replicates**
1	**1**	**7 – 8 – 7**
2	**3**	**10 – 7 – 10**
3	**5**	**7 – 7 – 6**
4	**7**	**10 – 10 – 9**
5	**9**	**6 – 5 – 4**
6	**control**	**9 – 7 – 8**

After spraying for the third time, at 31/7/2020, the following data were obtained, **Table 6**.

Table 6: The number of aphid insects after the third spraying with the extract.

Trial Number	**Concentration %**	**Number of aphids on each plant Three replicates**
1	**1**	**7 – 6 – 5**
2	**3**	**9 – 10 – 2**
3	**5**	**5 – 7 – 5**
4	**7**	**9 – 4 – 6**
5	**9**	**3 – 2 – 1**
6	**control**	**9 – 7 – 9**

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 547 - 557
Received 05 March 2021; Accepted 01 April 2021.

In order to investigate the relationship between the time period of spraying (the repetition of the spraying process, after a week and after two weeks) and the number of insects on each plant (3 replicates for each concentration), the standard deviations of aphids numbers before and after spraying and the average death rate were calculated (Table 7).

Table 7: The arithmetic averages and standard deviations of aphids numbers before and after spraying and the average death rate.

variables	MEAN	Std. Deviation
TNABS1	16.5000	1.87083
TNABS2	44.5000	27.50818
TNABS3	22.8333	5.03653
TNAFS1	12.3333	4.63321
TNAFS2	28.8333	9.36839
TNAFS3	18.1667	7.13909
AVPMR1	1.7650	3.69134
AVPMR2	0.2437	0.28939
AVPMR3	0.2212	0.25231

Where: The total number of aphids before spraying is TNABS1, TNABS2, TNABS3, the total number of aphids after spraying: TNAFS1, TNAFS2, TNAFS3, Average percentage mortality rate: AVPMR1, AVPMR2, AVPMR3.

It is evident from Table (7) that the arithmetic mean of aphids numbers before spraying in the first experiment on 15/7 was equal to (16.5000) and that the arithmetic mean of the number of aphids after spraying equals (12.3333), which indicates that the number of aphids after spraying decreased. In the second experiment on 22/7, the average number of aphids before spraying was equal to (44.5000), and the arithmetic average for the number of aphids after spraying was equal to (28.8333), which indicates that the number of aphids after spraying decreased. At 31/7 the arithmetic mean of the number of aphids before spraying was equal to (22.8333), and the arithmetic mean after spraying was equal to (18.1667), meaning that the number of insects decreased. Similar results were obtained by Muhammad *et al.*, (2018) using Neem (Azadirachta indica) seed and Turmeric (Curcuma longa) rhizome extracts extracts to control aphid populations in okra. Also, Shabozoi *et al.*, (2011) found that different preparations of cured tobacco leaves and stems significantly reduced insect pest infestation in okra. The botanical pesticides, that usually contains; essential oils, flavonoids, alkaloids, glycosides, esters and fatty acids, have numerous chemical properties and modes of action and can influence insects in different ways namely; repellents, feeding deterrents, antifeedants, toxicants, growth retardants, and chemosterilants (Hikal *et al.*, 2017; Rajashekar and Shivanandappa, 2017; Cheng *et al.*, 2019; Pocrnić *et al.*, 2020).

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 547 - 557
Received 05 March 2021; Accepted 01 April 2021.

The arithmetic mean of the average of the percentage mortality rate was the highest in the spraying process in the first experiment by a percentage (1.765), then it is followed by the second experiment with a percentage of (0.2437), then followed by the third experiment with a percentage of (0.2212), which indicates that the length of the spraying period leads to a decrease in the average mortality rate for a death insect. Similar results accrued by Magsi *et al.*, (2017) by using tobacco extracts on the population buildup of sucking complex in okra crop, the post treatment count was made after 24, 48, 96, 120 hours and one week intervals. Moreover, Shabozoi *et al.*, (2011) in their experiment using tobacco extract, on weekly basis for 5 weeks, noticed a steady increase in the first 3 weeks, then accompanied by a decrease in the fourth week, followed by another increase in the final treatment. Furthermore, Muhammad *et al.*, (2018) reported that there was a reduction in aphids attacks on okra plants by using Turmeric extract, but the reduction was statistically not significant as compared to the control, but the Neem extract caused a significant reduction in aphids attacks as compared to the control. The repeated spray increased the mortality rate of aphids from 45% up to 80 % by in Neem and Turmeric treated plots.

The correlations relationship between the concentration of the plant extract that used as a natural insecticide and the number of insects on each plant (**Table 8**, using the three replicates) was tested using Pearson Correlation**,** It can be seen from Table (2) that there is a strong correlation between the concentration of hot pepper extract as a natural pesticide on the number of aphids after spraying, as the strongest correlation coefficient was (0.821) in the first experiment on 15/7, then the correlation coefficient in the third experiment on 31/7 (0.813), then it is followed by the second experiment on 22/7 with a correlation coefficient equal to (0.727). The Sig (2-Tailed) value in the first and the third experiments was less than or equal to 0.05, so there are some statistically significant correlations between the two variables.

Table 8: The relationship of correlation between the concentration of hot pepper extract as a natural pesticide on the number of aphids.

Concentration	**TNAFS1 15/7/2020**	**TNAFS2 22/7/2020**	**TNAFS3 31/7/2020**
Pearson Correlation, N=6	**0.821**	**0.727**	**0.813**
Sig 2 tailed	**0.045**	**0.101**	**0.049**

Nearly all the reported botanical insecticides reported, up to our knowledge, in the literature were done using only one concentration. In our experiment, the best aphid mortality was achieved using the highest concentration (the 9%).

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 547 - 557
Received 05 March 2021; Accepted 01 April 2021.

Determination of plant growth and yield parameters

Determination of leaf area

Three leaves per plant were collected from 3 plants in each concentration. The leaf area (cm^2) was calculated from the length and width of a leaf, **Table 9**.

Table 9: Total leaf area

Trial Number	Concentration %	Total leaf area cm^2 Three replicates
1	**1**	**57 – 64 – 57**
2	**3**	**60 – 70 – 64**
3	**5**	**80 – 84 – 81**
4	**7**	**104 – 108 – 104**
5	**9**	**126 – 130 – 127**
6	**Control**	**56 – 57 - 56**

It obvious that the 5^{th} concentration, the 9 %, where the best comparing to the other concentrations.

Determination of total wet and dry shoots

For the three plants for each concentration, the wet and dry were measure using analytical balance (g), **Table 10**.

Table 10: Measurements of the sum of three wet and dry plants shoots

Trial Number	Concentration %	Total wet shoots of three replicates (g)	Total dry shoots of three replicates (g)
1	**1**	**314**	**214**
2	**3**	**331**	**233**
3	**5**	**361**	**262**
4	**7**	**413**	**291**
5	**9**	**502**	**333**
6	**control**	**264**	**152**

It was clear from the data in **Table 10**, that the total wet shoots and the total dry shoots increased steadily, through the use of the hot pepper extract, the best values were obtained at the highest concentrations. Nevertheless, Muhammad *et al.*, (2018) in their research to evaluate whether the application of Neem and Turmeric extracts for pest control using okra, shown to cause a slight but statistically significant increase in the leaf area of okra, hence this effect will cause also slight effect on both the total wet and dry shoots. Khan *et al.*, (2019) conducted a research using Peskil and Neem seed water, better total dry and wet shoots were recorded.

In order to test the relationship between the concentration of the hot pepper extract with the total wet shoots, **Table 11**, and the total dry shoots, **Table 12**, analysis of variance (ANOVA b) was applied to measure the significance of differences among different treatments and the control.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 547 - 557
Received 05 March 2021; Accepted 01 April 2021.

Table 11: Statistical treatment the concentration of the hot pepper extract with the total wet shoots

Model	Sum of Squares	df	Mean Square	F	Sig.(2-tailed)
Regression	32998.631	1	32998.631	64.570	0.01a
Residual	2044.203	4	511.051		
Total	35042.833	5			

Table 12: Statistical treatment the concentration of the hot pepper extract with the total dry shoots

Model	Sum of Squares	df	Mean Square	F	Sig.(2-tailed)
Regression	5.157	1	5.157	0.01	0.976a
Residual	19860.343	4	4965.086		
Total	19865.500	5			

Table 11 revealed that there is relationship between the concentration of the hot pepper extract with the total wet shoots, since sig.(2-tailed) p value was less than 0.05. No similar relation was observed for the total dry shoots. Also it is clear from **Figure 1**, that the data for the variables follow a normal distribution.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 547 - 557
Received 05 March 2021; Accepted 01 April 2021.

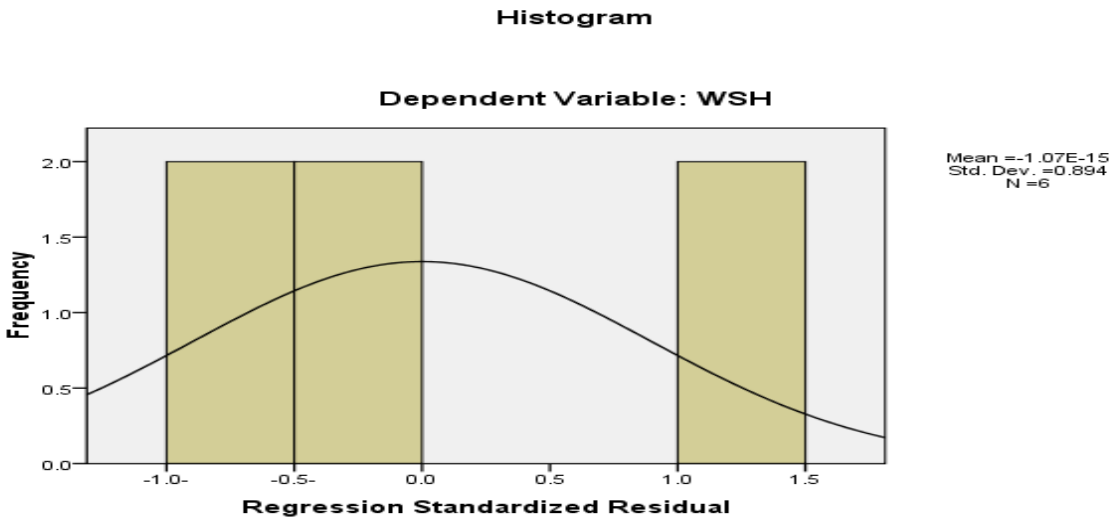

Figure 1: The relationship between concentration of the hot pepper extract with the total wet shoots.

Murovhi, and his coworkers, (2020) evaluated the eficacy of five plant materials (bio pesticides): pawpaw (Carica papaya L.), Mexican marigold (Tagetes minuta L.), serrano pepper (Capsicum annuum L.), common lantana (Lantana camara L.) and tobacco (Nicotiana tabacum L.) on Aphis population in okra production. There was a strong positive correlation between aphid abundance and leaf damage (r = 0.86).

4. Conclusions

Botanical insecticides are natural chemicals extracted from plants with insecticidal properties and used as an excellent alternative to synthetic or chemical pesticides for crop protection to avoid negative or side effects of synthetic insecticides. The extracts of the hot pepper plant in different concentrations were used to control the population reduction of aphids.

Spray against aphid pests using varieties hot pepper extracts was useful for reduction of the maximum population of these insects. The maximum reduction in the population of aphids was recorded by using the maximum concentration of the hot pepper extracts. This study proved that insect pests can be managed better in field with lower concentrations of the bio-pesticides. The best mortality rates were achieved after the first spray since the average mortality rate was 1.76, in comparison with 0.24 and 0.22, the averages for the second and third spray respectively, using the highest concentration of the hot pepper extract, namely 9%. Furthermore, understanding the phenomena of hot pepper extracts perspective precise of controlling such harmful insect pests and taking advantage of their implementation by farmers. Moreover, this eco-friendly approaches of pest control with minimum disturbance to natural beneficial insects and non-target organisms should be highly encouraged.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 547 - 557
Received 05 March 2021; Accepted 01 April 2021.

5. Acknowledgment

We are thankful to ……of our department who helped us on each and every step of this research.

6. References

[1]. AlMansour, N. A. A. (1995) *Effest of Various extracts of the vine horn on lutea(Staph.)Van Eslet(Martyniacea)*. Basra University.

[2]. Chandio, M. A. *et al.* (2017) 'Varietal Resistance of Okra Against Cotton Jassid, Amrasca biguttula biguttula', *Journal of Entomology and Zoology Studies*, 5(3), pp. 1647–1650.

[3]. Cheng, J. Q. *et al.* (2019) 'Analysis of 27 β-blockers and metabolites in milk powder by high performance liquid chromatography coupled to quadrupole Orbitrap high-resolution mass spectrometry', *Molecules*, 24(4). doi: 10.3390/molecules24040820.

[4]. Dutta, S. K. (2018) 'Susceptibility of okra to major insect pests under open field conditions', 6(January), pp. 1156–1159.

[5]. Hikal, W. M. *et al.* (2017) 'Botanical insecticide as simple extractives for pest control', *Cogent Biology*. Cogent, 3(1), p. 1404274. doi: 10.1080/23312025.2017.1404274.

[6]. Iowa State University, (Department of Entomology) (2021) *Bug Guide*. Available at: https://bugguide.net/node/view/147 (Accessed: 2 January 2021).

[7]. Khan, Z. *et al.* (2019) 'Efficacy of Aqueous Plant Extracts and Pesticide Against Okra Fruit Borer in Commercial Okra Cultivars', *Acta Scientific Agriculture*, 3(12), pp. 81–84. doi: 10.31080/asag.2019.03.0728.

[8]. Khater Hanem (2012) 'Prospects of botanical biopesticides in insect pest management', *Journal of Applied Pharmaceutical Science*, (May 2012). doi: 10.7324/japs.2012.2546.

[9]. Magsi, F. H. *et al.* (2017) 'Effect of different tobacco extracts on the population buildup of sucking complex in okra crop', *120 ~ International Journal of Fauna and Biological Studies*, 4(2), pp. 120–123.

[10]. Muhammad, U. *et al.* (2018) 'Effects of Neem (Azadirachta indica) seed and Turmeric (Curcuma longa) rhizome extracts on aphids control, plant growth and yield in okra', *Journal of Applied Botany and Food Quality*, 91, pp. 194–201. doi: 10.5073/JABFQ.2018.091.026.

[11]. Murovhi, J., Phophi, M. M. and Mafongoya, P. (2020) 'E ffi cacy of Plant Materials in Controlling Aphids on Okra (Abelmoschus esculentus L . Moench) in Limpopo Province of South Africa', *Agronomy 2020*, 10(December), p. 1968. doi: 10.3390/agronomy10121968.

[12]. Pocrnić, M. *et al.* (2020) 'Chiral separation of beta-blockers by high-performance liquid chromatography and determination of bisoprolol enantiomers in surface waters', *Arhiv za Higijenu Rada i Toksikologiju*, 71(1), pp. 56–62. doi: 10.2478/aiht-2020-71-3318.

[13]. Rajashekar, Y. and Shivanandappa, T. (2017) 'Mode of action of the natural insecticide, decaleside involves sodium pump inhibition', *PLoS ONE*, 12(1), pp. 1–15. doi: 10.1371/journal.pone.0170836.

[14]. Rattan, R. S. (2010) 'Mechanism of action of insecticidal secondary metabolites of plant origin', *Crop Protection*, 29(9), pp. 913–920. doi: 10.1016/j.cropro.2010.05.008.

[15]. Regnault-Roger, C., Vincent, C. and Arnason, J. T. (2012) 'Essential oils in insect control: Low-risk products in a high-stakes world', *Annual Review of Entomology*, 57(March 2015), pp. 405–424. doi: 10.1146/annurev-ento-120710-100554.
[16]. Shabozoi, N. U. K. *et al.* (2011) 'Economic appraisal of pest management options in Okra', *Pakistan Journal of Zoology*, 43(5), pp. 869–878.
[17]. Showler, A. T. (2017) 'Botanically Based Repellent and Insecticidal Effects Against Horn Flies and Stable Flies (Diptera: Muscidae)', *Journal of Integrated Pest Management*, 8(1). doi: 10.1093/jipm/pmx010.
[18]. Sushma, D. *et al.* (2015) 'A Review on Status of Pesticides Use in Nepal', *Research Journal of Agriculture and Forestry Sciences Res. J. Agriculture and Forestry Sci*, 3(3), pp. 2320–6063.