International Journal of Fauna and Biological Studies
Available online at www.faunajournal.com

International Journal of Fauna And Biological Studies

E-ISSN 2347-2677
P-ISSN 2394-0522
https://www.faunajournal.com
IJFBS 2023; 10(5): 09-15
Received: 16-05-2023
Accepted: 18-06-2023

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Management of Bihar hairy caterpillars, *Spilosoma obliqua* Walker (Lepidoptera: Arctiidae) considering usage of different indigenous naturally occurring botanical insecticides on brassicaceae agroecosystems

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Abstract
A field experiment was conducted to evaluate comparative bio efficy of four naturally occurring indigenous plant extracts against destruction of Bihar hairy caterpillars, *Spilosoma obliqua* Walker (Lepidoptera: Arctiidae) under mustard agroecosystem. The Unripe fruits of custard apple, *Annona squamosa* Linn. (71.78 per cent), Karanj, *l*eaves of *Pongamia glabra* Vent. (Fabaceae), arial parts of ariappl, *Lantana camara* Linn. (46.27 per cent), leaves of Black Pepper, *Piper nigrum* Linn (Piperaceae) were collected in the vicinity of Kanpur, shade dried and make them powder farm and extracted them with the help of soxhlet apparatus using alcohol, acetone Petroleum either as solvent. From stolk solution we make different concentrations (0.5, 1.0 and 2.0 per cent) and each different concentration of each plant extract. In field study there are three treatments were used and each treatment with three concentration were introduced. It is obvious from results that Unripe fruits of custard apple, *Annona squamosa* Linn. showed maximum larval mortality 71.78 per cent and placed at top followed by, Karanj, *l*eaves of *Pongamia glabra* Vent.(62.63 per cent), leaves of Black Pepper, *Piper nigrum* Linn (55.52 per cent) whereas arial parts of ariapple, *Lantana camara* Linn. Gave only 46.27 per centlarval mortalty to the Bihar hairy caterpillars, *Spilosoma obliqua* Walker under mustard agroecosystem.

Keywords: Agroecosystem, *Spilosoma obliqua, Annona squamosa, Pongamia glabra*

1. Introduction
The Bihar hairy caterpillar *Diacrisia* (*Spilosoma* or *Spilarctia*) *obliqua* Walk. (Lepidoptera: Arctiidae) is significant destructive insect-pest of Papaiya, castor and mustard crops Ahmed and Bhattacharya 1991) [1]. Bihar hairy caterpillar, *Spilosoma obliqua* Walker is a polyphagous pest of sporadic nature has been in regular occurrence, causing considerable damage to cruciferous vegetables and crop (Chandel *et al*. 2004) [2]. Major hosts include cruciferous, oilseeds, vegetables, groundnut, castor, Papaiya, sunflower, cashew, castor, cucurbits, mulberry, pigeonpea, beans, jute, sweet potato and millets crop in abroad (Tandon *et al*. 2004) [3]. The caterpillars of *Spilosoma obliqua* feeds on the leaves of the plant and cause considerable damage to cruciferous crops and vegetables in our country they occurs all parts of mustard and vegetables growing agroecosystem. The caterpillar's feeds on the leaves of the plant and cause considerable damage to mustard crop (Dubey *et al*. 2004) [4].
The insect-pests destroy more than one-third of the world's crop production and this heavy crop losses at both the International and National level can be successfully dealt with only through the intensive use of the pesticides (Butani and Verma 1976, Butani *et al*.`977, [5, 6]. If pesticides are not used, the graph of the crop losses may rise to 50.0 per cent and even more in the developing countries (Golob and Webley 1980,) [7]. In India, in inflicts huge losses to early and late sown cauliflower and mustard. The pest is distractive in its larval stage (Chen and Chang, 1996) [8].
The synthetic insecticides are employed in the management of insect-pest on crops bearing direct hazardous adverse effects on humans, wildlife, aquatic life and the environment at large. However, there are concerns about the use of pesticides, because of their negative effects on the environment and human health (Yuan *et al.*, 2014) [9]. These pesticides are also expensive and out of reach to the poor farmer. Therefore, there is a need to develop alternative methods of pest management (Chowdhury. 2009) [10]. To solve this problem many synthetic pesticides were used.

These chemicals have the ability to kill the target insect pest and non-target organism such as ~ 21 ~ International Journal of Fauna and Biological Studies http://www.faunajournal.com beneficial insects. Many synthetic chemical insecticides can cause significant health problems and they can be harmful to the environment. They contaminated in soil and water resources and also they accumulate in food and many human systems and cause cancer (Guyton *et al.*, 2015) [11]. The exposure to these synthetic chemicals may cause many symptoms like dizziness, headache, nausea, vomiting, eye irritation, fatigue, muscular twitching, unconsciousness, brain and nervous disorders and immune systems failures (Mohapatra, 2001) [12] Botanical plant materials are currently recognized as biodegradable, systemic, eco-friendly and nontoxic to mammals and are thus considered as safe alternatives (Chandel 2017, Ali *et al*.1983, Pascual *et al*.1990, Sarup, and Srivastava 2001) [13, 14, 15]. Indeed, Secoy and Smith (1983) reported that pyrethrins, isolated from the dried flowers of *C. cinerariifolium* Vis. possess insecticidal properties [16]. Insecticidal activities of certain neem, Azadirachta indica A. Juss extractives, products and derivatives on larvae of *E. vittella* was reported (Sharma *et al.*1980, Raghuraman and Singh 1999, El and El, 2000,) [18, 30, 20, 29]. Oil extracted from various materials was used in the tropics as a dressing for livestock to control blowfly. Biopotency of plant extracts were reported by Gahukar, 2000 [29]. Its high level of activity makes possible its commercialization as a mosquito larvicide (Lowery and Smirle 2000) [22]. To the best of our knowledge, there are no data available on use of such indigenous plant extractives and essential oils. Because of the significant difference in smell of the aerial parts of both plants, we have focused this study to use of certain indigenous plant extractives which are responsible for the insecticidal activities. However, in his study, plant extracts taken for study were not tested against third instars larvae of S. obliqua. Hence, the present studies were undertaken in the laboratory trials to study, the relative insecticidal efficacy of six plant extracts against third instar larvae of Bihar hairy caterpillar, *Spilosoma obliqua* Walker in mustard agroecosystem.

2. Materials and Methods

2.1 Mass culturing of Bihar hairy caterpillar

Bihar hairy caterpillar, *Spilosoma obliqua* Walker were obtained from the mustard experimental farmers' fields of ekghra village, Kanpur Nagar and maintained in the laboratory on natural diets. The collected larvae were kept for at least 2 days in the laboratory to check, whether or not, there are any other infections before using them for experiments. *Spilosoma obliqua* required for the study were mass reared on cruciferous leaves in the laboratory. The mass culturing was initiated by confining 10 larvae of *Spilosoma obliqua* in the plastic containers of 59x21x18 cm having green mustard leaves which were covered with muslin cloth and secured tightly with rubber band. Mass culturing of *D. obliqua* larvae was done at 28±2 ºC temperature in the plastic container and observed daily.

2.2 Collection of Natural Plant Materials

The natural plant materials used in the present investigation were collected mainly from cultivated fields of the farmers, wasteland and wild areas in the vicinity of Kanpur region laboratory for further processing at the Zoology-Entomology laboratory of D.B.S. College campus affiliated to C.S.J.M. University, Kanpur,. The collected four materials *viz*;. The Unripe fruits of custard apple, *Annona squamosa* Linn. (Annonaceae), Karanj, *l*eaves of *Pongamia glabra* Vent. (Fabaceae), arial parts of ariappl, *Lantana camara* Linn. (Verbanaceae), leaves of Black Pepper, *Piper nigrum* Linn (Piperaceae) were collected in the vicinity of Kanpur, shade dried and shade dried.

2.3 Powder Preparation and Extraction

Fresh collected plant materials were washed with tap water and kept in the laboratory for 5 days for shadow air drying before making powder. Electric grinder was used to have coarse powder then these were passed through a 60-mesh sieve to get fine powder. Powders were kept in polythene bags at room temperature and properly sealed to prevent quality loss. For the extraction, Soxhlet Apparatus was used; about 20 g powder of each category was extracted with 300ml of alcohol/acetone/PE and distilled water). Extractions of each category of powder were done in about 12 hrs. After soxhlet extraction, the material was run on rotary evaporator. The extracts were concentrated on rotary evaporator by removing the excess solvent under vacuum. After evaporation of solvent the remaining extracted material was kept on water bath for removing remaining solvent from the extracts. The extracts were stored at 4 °C prior to application. 2.4 Preparation of Stock Solution and

2.4. Insecticidal Formulations

50ml. extract in each case was taken into reagent bottles and 50ml. benzene was added in it to dissolve the constituents of the selected plant materials. The mouth of the bottles were stopper with airtight corks after which, these bottles containing the solutions were kept in refrigerator. The alcoholic extracts of Aforementioned were tested under laboratory against third instar larvae of *D. obliqua*, which is noxious insect pest of okra vegetables and crop. Three concentrations of plant extractives (0.5, 1.0, and 2.0 percent) were used for experiments on insecticidal tests in the field conditions. The different concentrations of the herbal extracts were prepared from the stock solution using benzene as solvent and Triton X-100 as emulsifier. The level of solvent and emulsifier were kept constant. 2.5 Apparatus used for experiment: More than one hundred glass petridishes (15cm diameter) were used for the experiment, One hand compression poly sprayer and muslin cloth was required for covering the petri-dishes and ridges of plots either going or coming the larvae in the cruciferous leaves in the petridishes.

3. Experimental Protocol

Field experiment was conducted to the insecticidal effect of six extractives *viz*; Unripe fruits of custard apple, *Annona squamosa* Linn.(Annonaceae), Karanj, *l*eaves of *Pongamia glabra* Vent.(Fabaceae), arial parts of ariappl, *Lantana camara* Linn. (Verbanaceae), leaves of Black Pepper, *Piper nigrum* Linn (Piperaceae) against third instars larvae of *Spilosoma obliqua*, which are noxious insect pest of mustard vegetables and crop. For testing the insecticidal effect the mustard leaves were used as food against the third instar larvae of *Spilosoma obliqua* treated with different concentrations of four selected extractives insecticides. The treated foods per plants were covered with muslin cloths. Then third instar, 24 hours starved larvae of *Spilosoma* *obliqua* were released in each set of extract and one control was introduced under field conditions. For control set the leaves and fruits were sprayed with Benzene + emulsified water only. After 24 hrs, 48 hrs and 72 hrs. hours of the release of larvae the data was collected on the number of larvae dead at each treated food set. Three replication of treatment were made. The insecticidal effect of each the plant extractives was judged by counting the mortality of larvae after 24, 48 and 72 hours and the larval mortality percentage were adjudged over control. All the values were calculated as per Abbott formula (Abbott 1925) [23].

Table 1: List of selected botanicals for experimentation under field trials

Custard apple	*Annona squamosa* Linn.	Unripe fruits	Annonaceae
Ariapple	*Lantana camara* Linn.	Arial parts	Verbanaceae
Karanj	*Pongamia glabra* Vent.	Leaves	Fabaceae
Black Pepper	*Piper nigrum* Linn.	Unripe fruits	Piperaceae

Table 2: Mean mortality % of Bihar hairy caterpillar, *Spilarctia obliqua* using botanicals

Treatment	**Con.**	**Lab.**	**Mean**	**Mortality**	**%**	**After**	
		24	**Hrs.**	**48**	**Hrs.**	**72**	**Hrs.**
(Plant extracts)	(%)	T_1	T.B.V.$_1$	T_2	T.B.V.$_2$	T_3	T.B.V.$_3$
A. squamosa Linn.	0.5	45.00	50.0	46.92	53.4	52.78	63.4
A. squamosa Linn.	1.0	52.78	63.4	54.78	66.7	61.22	76.8
A. squamosa Linn.	2.0	77.71	95.5	83.85	98.9	90.00	100.0
L. *camara* Linn.	0.5	30.99	26.5	39.23	40.0	43.08	46.6
L. camara Linn	1.0	43.08	46.6	46.92	53.4	48.85	56.7
L. camara *Linn*	2.0	52.78	63.4	54.78	66.7	56.79	70.0
P. glabra Vent.	0.5	45.00	50.0	48.85	56.7	52.78	63.4
P. glabra Vent.	1.0	50.77	60.0	57.00	70.4	63.93	80.7
P. glabra Vent.	2.0	71.56	90.0	83.85	98.9	90.00	100.0
P. nigrum Linn.	0.5	43.08	46.6	45.00	50.0	48.85	56.7
P. nigrum Linn.	1.0	52.78	63.4	54.78	66.7	56.79	70.0
P. nigrum Linn.	2.0	63.44	80.0	66.15	83.6	68.85	87.0
S. nigrum Linn.	0.5	35.22	33.3	37.22	36.6	43.08	46.6
Control	0.00	0.00	18.44	10.00	18.44	10.00	12.26

(T_1, T_2, T_3 = Treatments and TBV.1, TBV.2, TBV.3= Transformed Back Values)
C.D. for the treatment combination means = 0.175

The analysis of variance in table 1 shows that the main effect of insecticide, concentrations and periods as well as "Control versus treated" in first order and periods, concentrations in second order interaction are more highly significant except the first order interaction "insecticide x concentration" and the Second order interaction" period x insecticide x concentration which is non-significant. The effect of control VS treatment is also significant, at 0.5ercent level of significance.

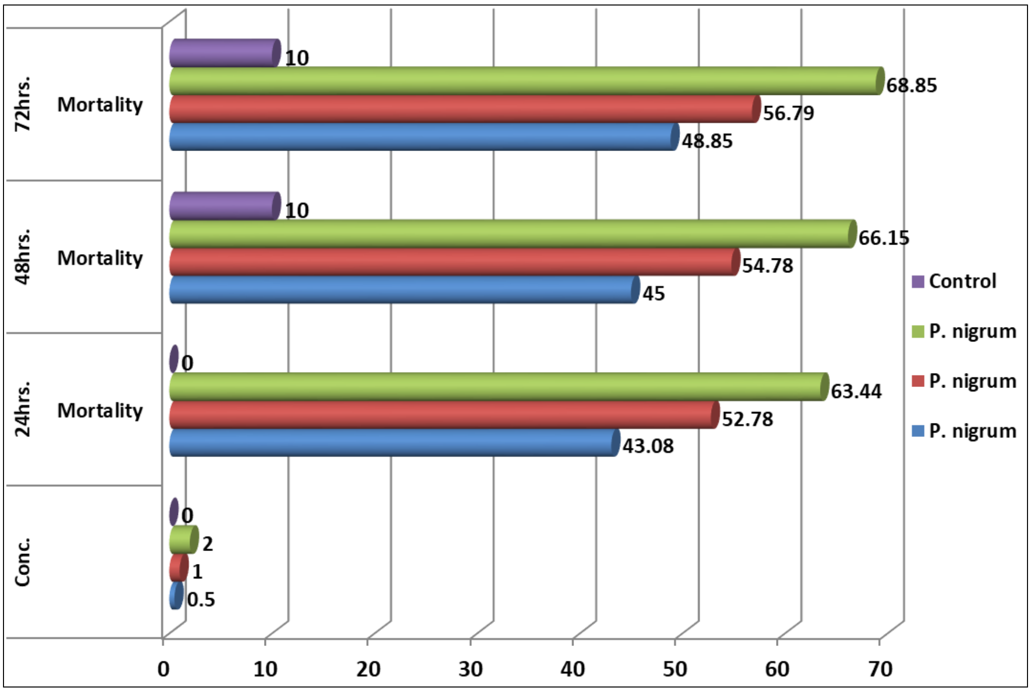

Fig 1: Mean mortality % of Bihar hairy caterpillar, *Spilarctia obliqua* using *A. squamosa* cc

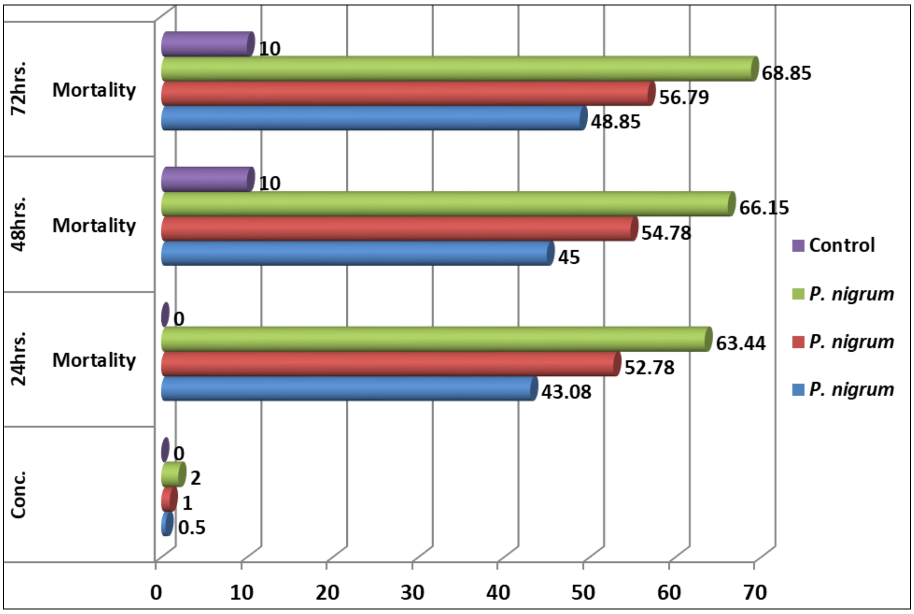

Fig 2: Mean mortality % of Bihar hairy caterpillar, *Spilarctia obliqua* using L. camara

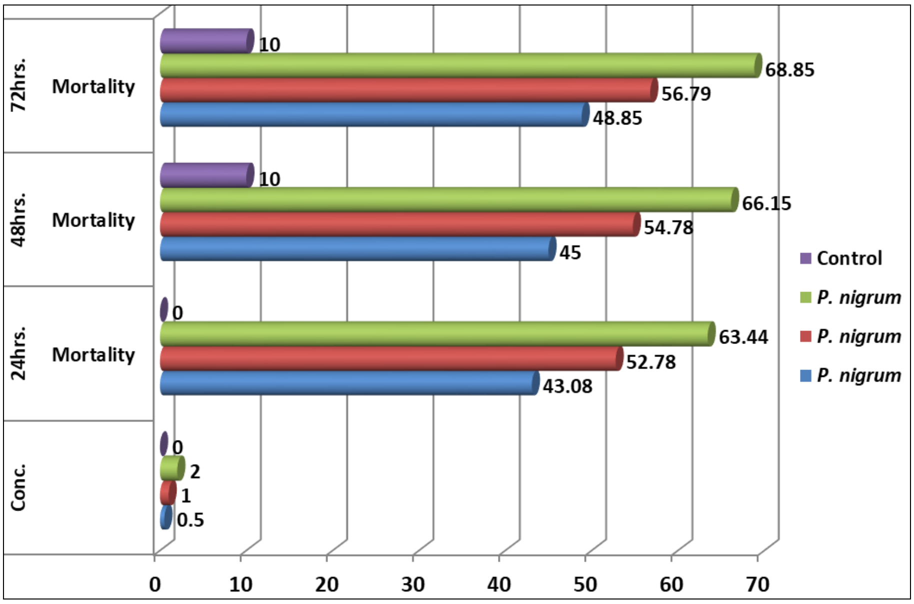

Fig 3: Mean mortality % of Bihar hairy caterpillar, *Spilarctia obliqua* using *P. glabra*

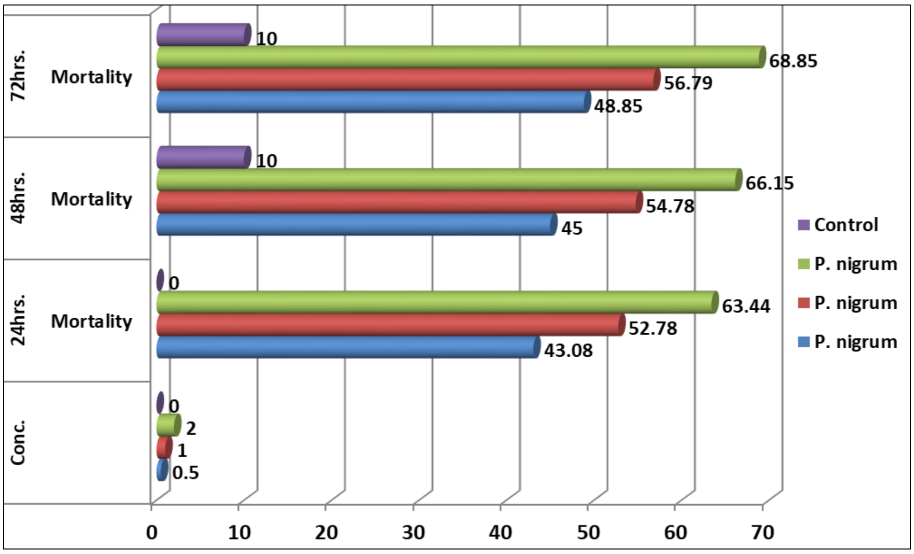

Fig 4: Mean mortality % of Bihar hairy caterpillar, *Spilarctia obliqua* using *P. nigrum*

Table 3: Mean mortality % of *S. obliqua* in exposure periods irrespective of concentration

Treatment	**Lab.**	**Mean**	**Mortality**	**%**	**after**		**Mean**	**mortality**
	6	**Hrs.**	**12**	**Hrs.**	**24**	**Hrs.**	**%**	
Botanicals	T_1	TBV_1	T_2	TBV_2	T_3	TBV_3	G.T.	TBV
A. squamosa	85.49	99.3	61.85	77.8	68.00	85.9	71.78	79.1
L. *camara*.	42.28	45.2	46.97	53.4	49.57	57.9	46.27	53.2
P. glabra	55.77	68.3	63.23	79.7	68.90	87.0	62.63	78.9
P. nigrum	53.09	63.9	55.31	67.6	58.16	72.2	55.52	67.2
Control	0.00	0.00	18.44	10.00	18.44	10.00	12.26	4.25

(T_1, T_2, T_3 = Treatments and TBV.1, TBV.2, TBV.3= Transformed Back Values) C.D. for the treatment combination means = 0.147

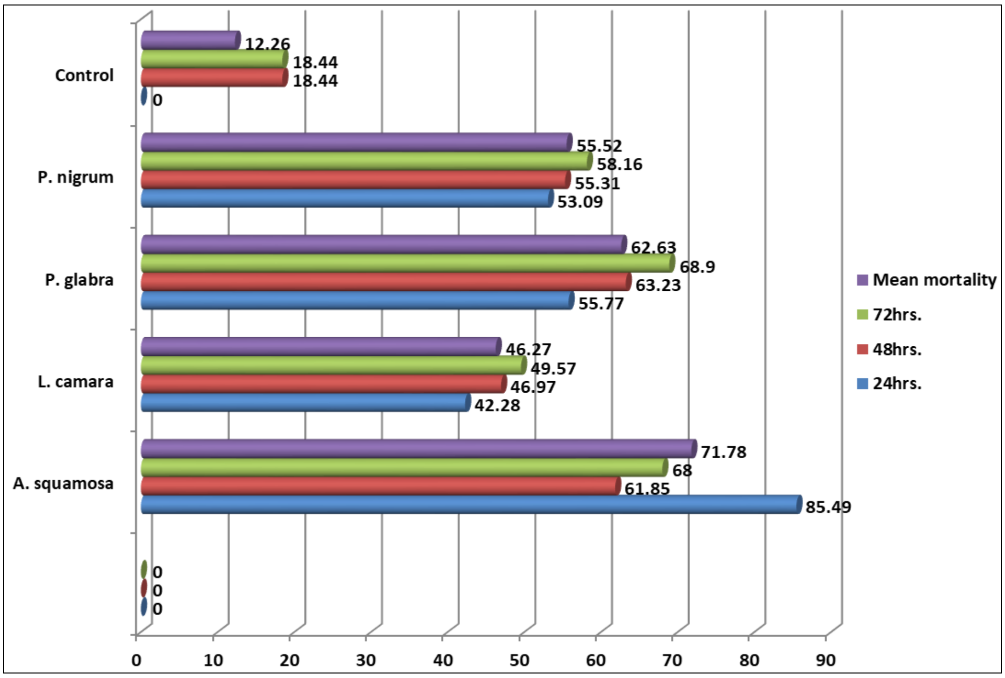

Fig 5: Mean mortality % of *S. obliqua* in exposure periods irrespective of concentration

Table 3 indicated that unripe fruits of custard apple, *Annona squamosa* Linn., Karanj, leaves of *Pongamia glabra* Vent., arial parts of ariappl, *Lantana camara* Linn and leaves of Black Pepper, *Piper nigrum* Linn extract and their different concentrations (0.5,1.0 and 2.0 per cent) tested under field conditions. The data depicted from results that the extract of custard apple, *Annona squamosa* Linn showed maximum larval mortality 71.78 per cent and placed at top followed by Karanj, leaves extract of *Pongamia glabra* Vent. (62.63 per cent), leaves of black Pepper, *Piper nigrum* Linn (55.52 per cent) larval mortality, whereas ariapple, *Lantana camara* Linn. Gave only 46.27 per cent larval mortalty to the Bihar hairy caterpillars, *Spilosoma obliqua* Walker under mustard agro- ecosystem. Based on the transfarm back values the difference in percentage larval mortality of hairy caterpillar, *Spilosoma obliqua* Walk in 24 hours (84.6 per cent) and 12 hours (83.39per cent) is greater than the difference in percentage mortality in the period of 12 hours (78.7 percent) and 6 hours (59.81 percent). Similarly, all the three concentration differed significantly to one another. The concentration 2.0 per cent is superior to concentration 1.0 and 0.5 per cent. It is observe that the difference in the percentage larvae of hairy caterpillar, *Spilosoma obliqua* Walker kill in concentration 2.0 per cent and 1.0 per cent is greater than the difference in concentration to kill the larvae in 1.0 per cent and 0.5 per cent in all the three periods.

Many plants can protect themselves against insects by producing their own chemical defences that are insecticidal. The consideration for the use of extracts of plants origin is that they are easily biodegradable, effective on some pests and considered safe in pest control operations as they minimize pesticide residues, ensure safety of the consumers of the treated grains and the environment. Further, the production of organic extracts of plant origin for pest control may be easier and less expensive than the synthesis of some complex chemical. They possess many of the attributes of an ideal biological control agent, including broad host range, high virulence, host seeking capability, ease of mass production, recycling ability, non- hazardous to environment, etc. (Thangapandian *et al*. 2011) [24]. Neem Pesticide is a natural product, absolutely non-toxic, 100% biodegradable and environmentally friendly in nature (Attri, 1975) [25]. If required, it can be mixed with other synthetic pesticides. Gradually, the ratio of Neem content in the mixture can be increased and synthetics reduced till you reach a stage where synthetics become redundant. Neem consists of several compounds hence development of resistance is impossible. Neem does not destroy natural enemies of pests thereby allowing these natural enemies to keep a check on the pest population (Joshi *et al*. 1984) [26]. Neem has a broad spectrum of action active on many species of pests.

Our findings are in conformity with the findings of Chitra *et al*. (1993) evaluated insecticidal efficacy of certain plant products against *H. Vigintioctopunctata*. Petroleum ether leaves extract of *Argemone mexicana* gave (76.18 per cent) mortality followed by *A. indica* leaves extract 0.1 per cent showed 71.75 per cent mortality, respectively [27]. Pandey and Raju, (2003) tested different eco-friendly insecticides against *Plutella xylostella* larvae among them NSKE 2.00 per cent gave considerable mortality to the second instar larvae of *Plutella xylostella* [28].

5. Conclusion

Conclusively, the present investigation revealed that the data depicted from results that the extract of custard apple, *Annona squamosa* Linn showed maximum larval mortality 71.78 per cent and placed at top followed by Karanj, leaves extract of *Pongamia glabra* Vent. (62.63 per cent), leaves of black Pepper, *Piper nigrum* Linn (55.52 per cent) larval mortality, whereas ariapple, *Lantana camara* Linn. Gave only 46.27 per cent larval mortalty to the Bihar hairy caterpillars, *Spilosoma obliqua* Walker under mustard agro- ecosystem

6. Acknowledgement

The authors are thankful to Principal, D.B.S. College, and Kanpur for providing the necessary facilities. Prof. N.D. Pandey, farmer Head, Division of Entomology, C S Azad University of Agriculture and Technology, Kanpur for rendering their support and help for the completion of this work.

7. References

1. Ahmed SR, Bhattacharya AK. Growth inhibitory effect of some plants for *Spilosoma obliqua* Walker. Indian J Ent. 1991;53(3):453-474.
2. Chandel BS, Srivastava SC, Dwivedi ND, Shukla S, Dubey A. Bioefficacy of certain asteraceous plants on growth, development, nutrition and reproduction of *Spilosoma obliqua* Walker. Nat J Life Science. 2004;1(2):4577-4460.
3. Tandon S, Mittal AK, Kasana, Pant AK. Effect of essential oil of Elsholtzia densal. On growth and reproduction of *Spilosoma obliqua* (Walker) Indian Journal of Entomology. 2004;66(3):206-208.
4. Dubey A, Gupta Rishu, Chandel BS. Efficacy of *Acorus calamus*, Vitex negundo and Ageratum conyzoides against tobacco caterpillar *Spilosoma obliqua* Walk. Indian Journal of Entomology. 2004;66(3):238-240.
5. Butani DK, Verma S. Insect pests of vegetables and their control. Pesticides. 1976;10(7):31-37.
6. Butani DK, Jotwani MG, Verma S. Insect pest of vegetables and their control: Cole Crops. Pesticides. 1977;11(5):19-24.
7. Golob P, Webley DJ. The use of plants and minerals as traditional protectants of stored products. Tropical Products Institute G. 1980;138:1-32.
8. Chen CC, Chang SJ. Deterrent effective of the chinaberry extract on oviposition of the diamondback moth, *Plutella xylostella* Linn. (Lepodoptera: ~ 26 ~ International Journal of Fauna and Biological Studies Jour. Applied Entomol. 1996;120(3):165-169.
9. Yuan Y, Chen C, Zheng C, Wang X, Yang G, Wang Q, *et al*. Residue of chlorpyrifos and cypermethrin in vegetables and probabilistic exposure assessment for consumers in Zhejiang Province, China. Food Control. 2014;36:63-68.
10. Chowdhury M. Incidence of saw fly, *Athalia lugens proxima* Klug as influenced by level of irrigation and fertilizers on mustard. J Plant Prot Sci. 2009;1:80-82.
11. Guyton K, Loomis D, Grosse Y, El Ghissassi F, Brenbrahim-Tallaa L, Guha N, *et al*. Carcinogenicity of tetrachlorvinphos, parathion, malathion, diazinon, and glyphosate. Lancet Oncology. 2015;2045(15):70134-8
12. Mohapatra LN. Efficacy of some synthetic insecticides and neem products against cashew leaf beetle, *Monolepta longitarsus*. Indian J Ent. 2001; 63(1):11-13.
13. Chandel BS. Biopotency of *Acorus calamus*, *Wthania somnifera* and *Azadirachta indica* in suppressing oviposition and adult emergence, caused by of *Callosobruchus chinensis* (L) infesting stored chickpea seeds in U.P. International Journal of Zoology Studies. 2017;2(6):161-166.
14. Ali SI, Singh OP, Misra US. Effectiveness of plant oils against pulse beetle, *Callosobruchus chinensis* Linn. Indian J Entomol. 1983;45:6-9.
15. Pascual N, Marco MP, Belles X. Azadirachtin induced imaginal moult deficiencies in *Tenebrio molitor* L. (Coleoptera: Tenebrionidae). J Stored Prod. Res. 1990;26:53-57.
16. Sarup P, Srivastava VS. Observations on the damage of neem (*Azadirachta indica* A. Juss) seed kernel in storage by various pest and efficacy of the damaged kernel as an antifeedant against the desert locust, *Schistocerca gregaria* F. Indian J Entomol. 1971;33:228-230.
17. Secoy DM, Smith AE. Use of plants in control of agricultural and domestic pests. Economic Botany. 1983;37(1):28-57.
18. Sharma GK, Czoppett C, Rembold H. Further evidence of insect growth disruption by neam, *Azadirachta indica* seed fractions. Z. Angew. Ent. 1980;90(5):439-444.
19. Ullah S, Ullah R, Shakir L, Ullah R. Cheek list of ethno botanical plants of tehsil colony, Samarbagh, District Dir lower, Khyber Pakhtunkhwa Pakistan. Int. J Agric. Nutr. 2021;3(1):41-49. DOI: 10.33545/26646064.2021.v3.i1a.63
20. El SMM, El Sed. Toxicity of neem, *Azadirachta indica* insecticides to certain aquatic organisms. Jour. Egypt. Soc. Parasitology. 2000;30(1):221-231.
21. Hossain ABMS, Al-Saif AM, Taha RM. Fruit growth, TSS and pH content development of water apple as affected by N-2-chloro-4-pyridyl-N- phenylurea (CPPU). Int. J Biol. Sci. 2021;3(2):06-11. DOI: 10.33545/26649926.2021.v3.i2a.29
22. Lowery DT, Smirle MJ. Toxicity of insecticides to oblique banded leafroller, *Choristoneura rosaceana*, larvae and adults exposed previously to neem seed oil. Entomol. Exp. Appl. 2000;95:201-207
23. Abbott WS. A method of computing the effectiveness of an insecticide. Jour. Econ. Ent. 1925;18:265-267.
24. 24.Thangapandian K, Muthusamy M, Vimal P. Efficacy of the plant products *Acorus calamus*, *Piper longum*, and *Econeem* against the Larvae of Tobacco caterpillar, *Spodoptera litura* Fab. (Lepidoptera: Noctuidae). Journal of Research in Biology. 2011;7:490-493.
25. Attri BS. Studies on utility of neem oil extractive as feeding deterrent on locust. Indian J Ent. 1975;37(4):17-419.
26. Joshi BG, Ramaprasad G, Nageswara Rao S. Neem seed kernel suspension as an antifeedant for *Spodoptera Litura* in a planted flue-cured Virginia tobacco crop.

Phytoparasitica. 1984;12(1):3-12.
27. Chitra KC, Rao S, Janardhan Rao P, Kameswara, Magaioh K. Field evaluation of certain plant products in the control of brinjal pest complex. Indian J Ent. 1993;55(3):237-240.
28. Pandey R, Raju SVS. Log dose probit studies of different eco-friendly insecticides against *Plutella xylostella* larvae. Indian J Ent. 2003;65(1):141-143.
29. Gahukar RT. Use of neem products/pesticides in cotton pest management. International J Pest Management. 2000;46(2):149-160.
30. Raghuraman S, Singh RP. Biological effects of neem, *Azadirachta indica* seed oil on an egg parasitoid, *Trichogramma chilonis*. Jour. Econ. Ent. 1999;92(6):1274-1280.