

Criterion - 7

Institutional Values and Best Practices

NAAC- SSR (2nd Cycle)



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HIMACHAL PRADESH

7.3.1(6)

Insect pests, associated diseases and their management



ETERNAL UNIVERSITY

BARU SAHIB, SIRMOUR-173101
HIMACHAL PRADESH

REVIEW ARTICLE

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Endosymbiotic microbes from entomopathogenic nematode (EPNs) and their applications as biocontrol agents for agro-environmental sustainability

Preety Tomar¹, Neelam Thakur^{1*} and Ajar Nath Yadav²

Abstract

Background: The biological diversity on planet earth is declining day by day, due to different factors such as excessive applications of pesticides. The utilization of chemical pesticides affected environment as well as microorganisms. The awareness among the peoples towards the hazards by the residual toxicity of chemical pesticides should be developed for agro-environmental sustainability.

Main body: Entomopathogenic nematodes (EPNs) are the bacto-helminth parasites which show classical mutualism with the genera *Xenorhabdus* and *Photorhabdus*. The nematodes along with its endosymbiotic bacteria have a bio-control potential which could be used to reduce chemical pesticides. Applications of bioagents have been reported and resulted in considerable reduction in pathogens. Furthermore, these bioagents are biodegradable, eco-friendly and easy to apply for protection of crops against diverse pathogenic organism. The nematode-bacterium complexes are effective against huge range of bacteria, fungi, nematodes and insects that are harmful to the crops. Along with biocontrol potential, the endosymbionts produce diverse secondary metabolic compounds, exoenzymes and toxic compounds that show antibiotic, antimycotic, nematicidal, miticidal and anticancerous properties.

Conclusion: The present review deals with the diversity of endosymbiotic microbes from EPNs and their role in bio-control for the agro-environmental sustainability.

Keywords: Agricultural sustainability, Biocontrol, Diversity, Entomopathogenic nematode, *Photorhabdus*, *Xenorhabdus*

Background

Entomopathogenic nematodes (EPNs) are microscopic roundworms that belong to the families Heterorhabdidae and Steinernematidae of phylum Nematoda. EPNs are beneficial nematodes that exhibit a holoparasitic mode of survival (Bhat et al. 2020). The EPNs have been reported to survive in most of environmental conditions

except psychrophilic conditions of Antarctica (Hominick 2002). The EPNs from genus *Steinernema* and *Heterorhabditis* were considered deadly fatal for a number of agricultural insects (Liu et al. 2020). Globally, 17 species of genus *Heterorhabditis* and 100 species of genus *Steinernema* have been reported that are found to be lethal for insect pests (Bhat et al. 2020). These nematodes showed mutualistic associations with endosymbiotic bacterial species that live inside the nematode. A major role has been played by these bacterial endosymbionts in nutritional physiology (Feldhaar 2011). The endosymbionts *Xenorhabdus* and *Photorhabdus* reside in symbiotic

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RESEARCH

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Synergistic effect of entomopathogens against *Spodoptera litura* (Fabricius) under laboratory and greenhouse conditions

Neelam Thakur¹, Preety Tomar¹, Sakshi Sharma¹, Simranjeet Kaur¹, Sushma Sharma², Ajar Nath Yadav³ and Abd El-Latif Hesham^{4*}

Abstract

Background: Entomopathogens such as nematodes, bacteria and fungi are well recognized for their biocontrol potential. This study was carried out to examine the insecticidal properties of the *Heterorhabditis bacteriophora* Poinar, *Beauveria bassiana* Balsamo-Crivelli, *Bacillus thuringiensis* Berliner, individually and in combination against 3rd instar larvae of *Spodoptera litura* Fabricius (Noctuidae: Lepidoptera) under controlled laboratory and greenhouse conditions at Eternal University, Baru Sahib, Sirmaur, Himachal Pradesh.

Results: The results demonstrated that the combined applications of the tested entomopathogens resulted in 100% insect mortality under the laboratory conditions. Among the individual concentrations, applications of 200 IJs/ml were noticed highly virulent with (98%) mortality, followed by *B. thuringiensis* (96%) and then by *B. bassiana* (92%). However, single treatments were also evaluated that further showed a highest mortality in the target pest by *H. bacteriophora*, followed by *B. thuringiensis*. Among the combined treatments by *H. bacteriophora* plus *B. thuringiensis* (200 IJs + 1×10^{12} CFU/cm²) more effective caused (100%) mortality were noticed in the laboratory and (28%) under the greenhouse conditions than *H. bacteriophora* plus *B. bassiana* (200 IJs + 1×10^{10} conidia/cm²) that caused (100%) mortality and (34%) damage under both, laboratory and greenhouse conditions.

Conclusion: Laboratory bioassay and greenhouse evaluation tests demonstrated that the combined sprayed treatments showed reliable and fast synergism. This study could be recommended to the farmers to control the pest.

Keywords: *Bacillus thuringiensis*, *Beauveria bassiana*, Bio-efficacy, *Heterorhabditis bacteriophora*, *Spodoptera litura*

Background

Spodoptera litura (Fabricius, 1755) (Lepidoptera: Noctuidae), known as tobacco caterpillar, beet armyworm, lesser armyworm, small mottled willow, cutworm and pigweed caterpillar, is the most serious insect pest in the countries like Japan, China, India, Pakistan (Ghaffar et al. 2002) and South Asia (Qin et al. 2004). It is a very destructive and polyphagous insect pest that causes damage to various crops such as potato, cotton, capsicum, tomato, soybean,

okra, clover and onion (Saleem et al. 2016). The larvae feed on leaves of the cultivated plants that lead to complete defoliation in the early stage causing severe crop damage in India (Firake and Behere 2020). Commercially important vegetable Capsicum (*Capsicum annum* Linnaeus) (Solanales: Solanaceae) grown worldwide is highly infested by *S. litura* (Baikar and Naik 2016). Constant use of pesticides leads to environmental contamination and pesticide residues in all foodstuffs all over the world (WHO 2017). This leads to develop safer, novel, biodegradable biopesticides as insecticidal alternatives (Chaudhary et al. 2017).

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RESEARCH ARTICLE

Indigenous entomopathogenic nematode as biocontrol agents for insect pest management in hilly regions

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Abstract

The present investigation emphasized on the development and use of entomopathogenic nematodes (EPNs) as a bio-insecticide. The success in controlling insect pests in the soil environments increased the production and use of the adapted indigenous EPNs species for insect management in the fields. EPNs as biocontrol agents were capable for high virulence, easy for application, safe for non-target animals and eco-friendly in nature. These nematodes have ubiquitous nature. These occur in low population in their natural habitat which was mass multiplied in the laboratory. In the present investigation, 5 concentrations (30, 60, 90, 120 and 150 IJs) of *Heterorhabditis bacteriophora* strain S₁₅ were applied against the 3rd and 4th instar larvae of four major agricultural insect pests, namely *Helicoverpa armigera* (Hubner), *Spodoptera litura* (Fabricus), *Agrotis segetum* (Denis and Schiff-ermüller) and *Mythimna separata* (Walker) under laboratory conditions at different time exposure (24, 48, 72 and 96 h). It was observed that the 3rd and 4th larval instars of all 4 insects (*H. armigera*, *S. litura*, *A. segetum* and *M. separata*) were highly susceptible for the pathogenesis caused by *H. bacteriophora* strain S₁₅. Amongst all insects, both the larval instars of *M. separata* are highly susceptible for EPNs infection with highest 96% and 98% mortality in highest dose @150 IJs. In 3rd instar larvae of other insects such as *H. armigera*, *S. litura* and *A. segetum* larval mortality ranges from 84%, 92% and 94% respectively. Among 4th instar larvae of *H. armigera*, *S. litura* and *A. segetum* the pathogenicity varies from 88%, 94% and 96%, respectively. The recorded median lethal concentration (LC₅₀) in 3rd instar larvae of *H. armigera*, *S. litura*, *A. segetum* and *M. separata* varies from 36.15, 30.05, 30.97 and 23.81 IJs/larva. Similarly in 4th instar larvae of *H. armigera*, *S. litura*, *A. segetum* and *M. separata*, LC₅₀ ranged from 31.41, 28.64, 26.92 and 20.64 IJs/larva respectively. Statistically significant variations were observed in the data recorded on the mortality, in all the treatments. EPNs are the best weapon to overcome insect resistance problems and must be employed to manage insect population.

Keywords

Agrotis segetum, Biocontrol, *Helicoverpa armigera*, *Mythimna separata*, *Spodoptera litura*

Introduction


Over the next few decades, the world's population predicted to be reached about 10 billion (1). Most of the people in India depend upon agriculture to fulfil their every day needs. The main concern of the agricultural industry is

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Eco-friendly management of *Spodoptera litura* (Lepidoptera: Noctuidae) in tomato under polyhouse and field conditions using *Heterorhabditis bacteriophora* Poinar, their associated bacteria (*Photorhabdus luminescens*), and *Bacillus thuringiensis* var. *kurstaki*

Neelam Thakur¹, Preety Tomar^{1*} , Jaspreet Kaur¹, Simranjeet Kaur¹, Anuja Sharma¹, Samiksha Jhamta¹, Ajar Nath Yadav², Harcharan Singh Dhaliwal², Rajesh Thakur³ and Seema Thakur³

Abstract

Background Insect pests cause substantial agriculture losses annually, and their regulation through chemical pesticides instigates a prolonged detrimental impact on the environment and human health. The upsurge in difficulties such as pesticide residue, soil degradation and pest resistance acted as the pacesetter for research on biological control with a prime focus on entomopathogens. To aid in knowing the biocontrol potential of these creatures, the present work deals with the applications of entomopathogenic nematode *Heterorhabditis bacteriophora* EUPT-SD, and entomopathogenic bacteria (EPBs) *Photorhabdus luminescens* and *Bacillus thuringiensis* var. *kurstaki* against the 4th larval instar of *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) in the laboratory experiment, polyhouse as well as field condition.

Results The results demonstrated that EPB, *P. luminescens*, caused the highest 100% larval mortality at the highest concentration of 5×10^2 CFU/ml after 96 h of infection, followed by *B. thuringiensis* var. *kurstaki* which resulted in 98% at a concentration of 5×10^2 CFU/ml and 92% mortality at the treatment with *H. bacteriophora* EUPT-SD (140IUs/ml) under laboratory bioassay study. In the polyhouse and field evaluation tests, again the *P. luminescens* was recorded as the most effective, followed by *B. thuringiensis* and *H. bacteriophora*, respectively. It was found that the treated plots experienced lesser damage when compared to non-treated plots.

Conclusion Applications of these pathogens are nature friendly and are a proficient alternative to synthetic chemical insecticides. It is suggested from the present investigation that the use of *P. luminescens* was the best biocontrol agent to overcome the local pest problems of this region because it is safe for animals, humans, non-target insect pests, plants, as well as for the environment.

Keywords *Spodoptera litura*, Bioassay, Entomopathogens, Management, Tomato

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RESEARCH

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Biocidal potential of indigenous isolates of Entomopathogenic Nematodes (EPNs) against tobacco cutworm, *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae)

Preety Tomar and Neelam Thakur*

Abstract

Background: Entomopathogenic nematodes (EPNs) have been regarded as the most convenient strategy for insect pest management. The native strains of EPNs: *Heterorhabditis bacteriophora* EUPT-SD, *H. bacteriophora* EUPT-R, *H. bacteriophora* EUPT-KN, *H. bacteriophora* EUPT-K and *H. bacteriophora* EUPT-H isolated from mid-Himalayan region of Himachal Pradesh were tested in laboratory for their multiplication and virulence against 3rd and 4th larval instars of the tobacco cutworm, *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae), the serious polyphagous pest affecting a wide range of agricultural crops worldwide.

Results: All the EPN strains were effective against 3rd and 4th larval instars of *S. litura*. Insect mortality reached 90–96% after 96 h at nematode concentrations of 150 infective juveniles (IJs)/ml. The insect mortality was also recorded at low concentrations of IJs, but the most exposure period was required. High virulence was shown by *H. bacteriophora* EUPT-SD 96 and 94%, followed by *H. bacteriophora* EUPT-R 92 and 90%, *H. bacteriophora* EUPT-KN 92 and 90%, *H. bacteriophora* EUPT-K 92 and 90% and *H. bacteriophora* EUPT-H 92 and 90%, respectively, against 3rd and 4th larval instars in terms of reproductive potential and killing. All the insects were alive in the absolute control.

Conclusion: Utilization of EPNs for the management of *S. litura* may be the best method to overcome the insect resistance problems and to manage the population of this insect pest. It may be an effective method and may be a partial substitute of synthetic insecticides, thus minimizing the excessive use of synthetic chemicals. The results demonstrated the potential of indigenous EPNs isolates against *S. litura*, but before further recommendation, multiplication field trials need to be conducted to confirm their efficacy at farm level.

Keywords: Entomopathogenic Nematodes, *Heterorhabditis bacteriophora*, *Spodoptera litura*, Virulence, Reproductive potential

Background

The tobacco cutworm, *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae), is a serious insect pest that feeds upon a wide variety of crops having very high fecundity with elevated reproduction rates and

migratory behaviour. Young larvae feed on leaves, and 4th and 5th larval instars cause maximum damage by completely skeletonized the leaves, which declined the photosynthesis ability of infected plants (Yadav et al. 2017). In Himachal Pradesh, the control strategies applied to manage the population of these insect pests are generally chemicals based which are hazardous to living beings and costly. Applications of chemical-based synthetic insecticides are the solution only for shorter duration that ultimately resulted in negative impacts over

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RESEARCH

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Eco-friendly management of *Spodoptera litura* (Lepidoptera: Noctuidae) in tomato under polyhouse and field conditions using *Heterorhabditis bacteriophora* Poinar, their associated bacteria (*Photorhabdus luminescens*), and *Bacillus thuringiensis* var. *kurstaki*

Neelam Thakur¹, Preety Tomar^{1*} , Jaspreet Kaur¹, Simranjeet Kaur¹, Anuja Sharma¹, Samiksha Jhamta¹, Ajar Nath Yadav², Harcharan Singh Dhaliwal², Rajesh Thakur³ and Seema Thakur³

Abstract

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Keywords *Spodoptera litura*, Bioassay, Entomopathogens, Management, Tomato

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Filing Date	:NA	4)SHEIKH DR IMRAN
(87) International Publication No	: NA	5)TYAGI DR VIKRANT
(61) Patent of Addition to Application Number	:NA	6)TOMAR PREETY
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(57) Abstract :

Present invention discloses a bio pesticide which consists of a standardized aqueous extract of fresh bio waste of Bt crops and its method of preparation. The concentration of CRY protein in the standardized extract ranges from 1-5 mg/Liter, optimally 2.5 mg/L. Preparation method involves fresh bio waste collection, cold maceration using water, preferably alkaline with optimal pH 8.5; at 4-6 times, optimally 5 times the weight of fresh bio waste; filtration, characterization, sterilization and packaging.. For use in the field, same is diluted in 1000 liters of water for spraying in 1 hectare (10,000 square meters) to protect plants from pest attack. Multiple sprays can be given. Being free of chemical compounds, the bio-pesticide is suitable for use in organic farming, safe and eco-friendly, inexpensive and prevents development of pest resistance owing to presence of several phytochemicals and phytochemicals rather than a single chemical entity.

No. of Pages : 25 No. of Claims : 2

Research Activities in the Department of Zoology

Ongoing research activities in the Department of Zoology

S. No	Name of the Student	Registration no.	Research title	Mentor	Degree awarded	Year of Award
1.	Ms. Preety	BS18PSZ001	An inventory of entomopathogenic nematodes and their bacterial symbionts based on molecular characterization in Himachal Pradesh	Dr. Neelam Thakur	Yes	2023
2.	Ms. Simranjeet Kaur	BS19PSZ001	Characterization of indigenous entomopathogenic nematodes and microbes and their use as biocontrol agents against major insect pests of tomato	Dr. Neelam Thakur	No	-
3.	Ms. Anuja Sharma	BS19PSZ002	Identification and characterization of genus <i>Spodoptera</i> Guenée, 1852 and its management in Himachal Pradesh	Dr. Neelam Thakur	No	-
4.	Ms. Samiksha	BS19PSZ003	Identification and characterization of root knot Nematodes (<i>Meloidogyne</i> spp.) Of tomato (<i>Solanum lycopersicum</i> L.) and their management using the biological and breeding strategy	Dr. Neelam Thakur	No	-
5.	Jaspreet Kaur Brar	BS20PSZ001	Taxonomic and molecular studies of family Erebidae (Lepidoptera) in mid hills of Himachal Pradesh	Dr. Neelam Thakur	No	-
6.	Taniya Chauhan	BS20PSZ002	Taxonomic and molecular studies of superfamilies Drepanoidea, Lasiocampoidea and Bombycoidea (Lepidoptera) in mid hills of Himachal Pradesh	Dr. Neelam Thakur	No	-

Research activities in the Department by M.Sc students

M.Sc. Zoology 2016 batch						
S. No	Name of the students	Registration no.	Research title	Mentor	Degree awarded	Year of Award
1	Ms. Aparna kaistha	BS16MSZ001	Morphological and molecular characterization of root-knot nematodes (<i>Meloidogyne</i> spp.) infesting tomato crop in Himachal Pradesh	Dr. Neelam Thakur	Yes	2019
2	Ms. Avantika Panwar	BS16MSZ002	Eco-friendly management of fruit fly and fruit borer complex in tomato	Dr. Ramesh Arora	Yes	2019
3	Ms. Karamveer Kaur	BS16MSZ003	Biological control of plant parasitic nematodes associated with capsicum (<i>Capsicum annuum</i> L.) in Himachal Pradesh	Dr. Neelam Thakur	Yes	2019
4	Ms. Nidhi Verma	BS16MSZ004	Studies on selected diets for mass rearing of <i>Zygogramma bicolorata</i> a natural enemy of <i>Parthenium hysterophorus</i>	Dr. Ramesh Arora	Yes	2019
5	Ms. Pooja Devi Gautum	BS16MSZ005	Studies on prevalence of gastrointestinal helminth parasites in domesticated small ruminants inhabiting rural areas of Sirmaur, Himachal Pradesh.	Dr. Nasib Singh	Yes	2019
6	Ms. Preety	BS16MSZ006	Bionomics and management of fruit fly, <i>Bactrocera</i> spp. in cucumber	Dr. Priyanka Thakur	Yes	2019
7	Ms. Puja Kumari Chauhan	BS16MSZ007	Studies on prevalence of gastrointestinal helminth parasites in domesticated large ruminants inhabiting rural areas of Sirmaur, Himachal Pradesh	Dr. Nasib Singh	Yes	2019

8	Ms. Reena Devi	BS16MSZ008	Biology and biological control of tomato fruit borer (<i>Helicoverpa armigera</i> Hubner)	Dr. Priyanka Thakur	Yes	2019
9	Ms. Shivani	BS16MSZ009	Evaluation of polythene degrading capacity of wax moth, <i>G. mellonella</i> L.	Dr. Priyanka Thakur	Yes	2019
10	Ms. Shweta Sharma	BS16MSZ010	Eco-friendly management of pod borer complex (<i>H. armigera</i> and <i>M. vitrata</i>) in French bean	Mrs. Indira Arora	Yes	2019
11	Ms. Simranjeet Kaur	BS16MSZ011	Isolation and Characterization of Entomopathogenic Nematodes from Various Fruit Orchards of Himachal Pradesh	Dr. Neelam Thakur	Yes	2019

2017 Batch

S. No	Name of the students	Registration no.	Research title	Mentor	Degree awarded	Year of Award
1.	Ms. Anuja Sharma	BS17MSZ001	Intestinal nematodes and protozoan parasites of domesticated herbivorous animals of Sirmour, Himachal Pradesh	Dr. Nasib Singh	Yes	2020
2.	Ms. Dhara Sarswati	BS17MSZ002	Studies on fish diversity in the Giri river of Himachal Pradesh	Dr. Neelam Thakur	Yes	2020
3.	Ms. Diksha Negi	BS17MSZ003	Insect pest complex of <i>Pisum sativum</i> in Sirmour district and its management	Dr. Priyanka Thakur	Yes	2020
4.	Ms. Isha Jamwal	BS17MSZ004	Plant associated arthropod biodiversity in Baru Sahib Himachal Pradesh	Mr. Balbinder Singh	Yes	2020
5.	Ms. Poonam Kumari	BS17MSZ005	Bio-efficacy of Entomopathogenic nematodes against Lepidopteran insect pests of tomato	Dr. Neelam Thakur	Yes	2020
6.	Ms. Samiksha	BS17MSZ006	Biocontrol of Lepidopteran insect pests by using Bioinsecticides	Dr. Priyanka Thakur	Yes	2020

2018 Batch

S. No	Name of the students	Registration no.	Research title	Mentor	Degree awarded	Year of Award
1.	Ms. Jaspreet Kaur	BS18MSZ001	Isolation and characterization of bacteria associated with native strains of entomopathogenic nematodes in Himachal Pradesh	Dr. Neelam Thakur	Yes	2021
2.	Ms. Manisha	BS18MSZ002	Morphological and molecular identification of muscid flies (Diptera: Muscidae) on large ruminants in Himachal Pradesh	Dr. Priyanka Thakur	Yes	2021
3.	Ms. Rashi Rattan	BS18MSZ003	Studies on aquatic insect diversity in the Giri river of Himachal Pradesh	Mr. Balbinder Singh	Yes	2021
4.	Ms. Sakshi Sharma	BS18MSZ004	Efficacy of Entomopathogenic nematodes and microbes against <i>Helicoverpa armigera</i>	Dr. Neelam Thakur	Yes	2021
5.	Ms. Taniya Chauhan	BS18MSZ005	Efficacy of nanoparticles against insect pests associated with tomato in Himachal Pradesh	Dr. Priyanka Thakur	Yes	2021

2019 Batch

S. No	Name of the students	Registration no.	Research title	Mentor	Degree awarded	Year of Award
1.	Ms. Monika Kaushal	BS19MSZ003	Population status and feeding ecology of Rhesus Macaque around Baru Sahib Himachal Pradesh	Dr. Priyanka Negi	Yes	2022
2.	Ms. PriyankaGazta	BS19MSZ006	Polulation abundance and genetic structure of white crested Kalij pheasant in Himachal Pradesh	Dr. Priyanka Negi	Yes	2022
3.	Ms. Surbhi Dhanotia	BS19MSZ010	Crop raiding pattern of Rhesus macaque: A case study of Baru Sahib and around the area in Sirmaur, Himachal Pradesh	Dr. Priyanka Negi	Yes	2022
4.	Ms. Surbhi Sharma	BS19MSZ011	Species diversity and relative abundance of avifuana of Baru	Dr. Priyanka Negi	Yes	2022

			Sahib Himachal Pradesh			
5.	Ms. Anjali Sharma	BS19MSZ001	Diversity of Orthoptera fauna of District Sirmaur, H.P	Mr. Balbinder Singh	Yes	2022
6.	Ms. Kumari Anju	BS19MSZ002	Studies on food and feeding habits of minor carps inhabiting river Giri of distt. Sirmaur, H.P	Mr. Balbinder Singh	Yes	2022
7.	Ms. Nitika Sharma	BS19MSZ006	Studies on diversity of coleopteran fauna of distt. Sirmaur, H.P	Mr. Balbinder Singh	Yes	2022
8.	Ms. Monika Sharma	BS19MSZ004	Identification and characterization of some species of Nymphalidae (Lepidoptera) from Shimla District of Himachal Pradesh	Dr. Priyanka Thakur	Yes	2022
9.	Ms. Shabnam Samra	BS19MSZ008	Diversity of aphids (Aphididae: Hemiptera) in Sirmour District of Himachal Pradesh	Dr. Priyanka Thakur	Yes	2022
10	Ms. Nisha Devi	BS19MSZ005	Effect of Synthetic Insecticides on Behaviour and Development of Syrphid Fly, <i>Episyrphus Balteatus</i> (De Geer)	Dr. Yogeeta Thakur	Yes	2023
11	Ms. Shivani	BS19MSZ009	Effect of Synthetic Insecticides on the Behaviour and Development of Ladybird Beetle (<i>Coccinella Septempunctata L.</i>) Coccinellidae, Coleoptera	Dr. Yogeeta Thakur	Yes	2022
2020 Batch						
S. No	Name of the students	Registration no.	Research title	Mentor	Degree awarded	Year of Award
1.	Ms. Gitanjali	BS20MSZ001	Studies on the predatory wasps of honey bee (<i>Apis mellifera</i>) and their management	Dr. Neelam Thakur	Yes	2023
2.	Ms. Kritika	BS20MSZ002	Genotoxic potential of Zinc oxide (ZnO) nanoparticles using mosquito as a test model	Dr. Kanwaljit Kaur Ahluwalia	Yes	2023

3.	Ms. Shivani	BS20MSZ003	Studies on age and growth characteristics of <i>Barilius bendilisis</i> from river Giri of district Sirmour, H.P.	Mr. Balbinder Singh	Yes	2023
4.	Ms. Pallvi	BS20MSZ004	Studies on efficacy of insecticide loaded metal oxide nanoparticle on <i>Spodoptera litura</i>	Dr. Priyanka Thakur	Yes	2023
2021 Batch						
S. No	Name of the students	Registration no.	Research title	Mentor	Degree awarded	Year of Award
1.	Ms. Jyotika Thakur	BS21MSZ001	Diversity and species abundance of noctid moths of Baru Sahib and adjoining areas	Dr. Gagan Preet Kour Bali	No	
2.	Ms. Mamta Chauhan	BS21MSZ002	Diversity of fish fauna from Giri river of district Sirmour	Mr. Balbinder Singh	No	