STUDY ON MITE FAUNA ASSOCIATED WITH PULSE CROPS WITH SPECIAL REFERENCE TO LIFE TABLE STUDY OF *Oligonychus biharensis*

A thesis
submitted to the
Bidhan Chandra Krishi Viswavidyalaya
in partial fulfilment of the requirements for the award of the Degree of Master of Science (Agriculture)

In

Entomology

By

ARNAB SINGHA
Registration No.: 07A08P2223

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY
FACULTY OF AGRICULTURE
Bidhan Chandra Krishi Viswavidyalaya
Mohanpur, Nadia-741252, West Bengal

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2024

DEDICATED

TO

MY BELOVED PARENTS

APPROVAL OF EXAMINERS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (AGRICULTURE) IN ENTOMOLOGY

We, the undersigned, having been satisfied with the performance of **Mr. ARNAB SINGHA**, in the viva-voce examination, conducted today, the ……… …21st August…………2024, and recommend that the thesis be accepted for the award of the Degree of **Master of Science (Agriculture) in Entomology** of Bidhan Chandra Krishi Viswavidyalaya.

NAME	DESIGNATION	SIGNATURE
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2. Prof. Suprakash Pal	**External Examiner**	[signature] 21.08.24
3. Prof. Krishna Karmakar	**Member** (Advisory Committee)	[signature] 21/08/2024
4.Dr. Pranab Debnath	**Member** (Advisory Committee)	Pranab Debnath 21.08.24
5.Dr. Md. Nasim Ali	**Member** (Advisory Committee)	[signature] 21.08.24
6 . Prof. Aniruddha Pramanik	**Head** (Department of Agricultural Entomology)	[signature] 21.08.24.

T-6623

Bidhan Chandra Krishi Viswavidyalaya
ALL INDIA NETWORK PROJECT ON AGRICULTURAL ACAROLOGY
Directorate of Research,
Mohanpur, 741252, Nadia, West Bengal

Dr. Suvash Ch. Bala
Assistant Professor in
Agricultural Entomology and
Ex- officer In-charge of AINP
on Agricultural Acarology.

P.O. Kalyani, Dist. Nadia
West Bengal, PIN 7412 35
Mob: 09432871959
E-mail: bala.suvash@ bckv.edu.in

Ref. No. Date:

Certificate

This is to certify that the work recorded in the thesis entitled "**Study on mite fauna associated with pulse crops with special reference to life table study of *Oligonychus biharensis***" submitted by **Arnab Singha** in partial fulfillment of the requirements for the award of the degree of Master of Science (Agriculture) in Entomology, Faculty of **Agriculture,** Bidhan Chandra Krishi Viswavidyalaya, is the faithful and bonafide research work carried out under my supervision and guidance. The results of the investigation reported in thesis have not so far been submitted for any other Degree or Diploma. The content of the thesis has been checked for plagiarism and the similarity level is within the permissible limit (10%) as per the university rules. The soft copy of the thesis which has been checked for similarity and the hard copy of the thesis which has been submitted for the degree are identical. The assistance/ help received during the course of investigations have been duly acknowledge.

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Registration No: 07A08P2223

Contact No: 8116284310

E-mail: toarnabsingha@gmail.com

Arnab Singha
Signature of the student

Date: 16th **August, 2024**

Place: B.C.K.V., Mohanpur, Nadia

T-6623

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Date: 16th August, 2024

Place: B.C.K.V., Mohanpur, Nadia
West Bengal

Arnab Singha

(Arnab Singha)

ABSTRACT

Pulses are called as Poor man's meat because they have high content of proteins, minerals like iron, zinc, Ca, Mg and vitamins. Major pulses grown and consumed in West Bengal are Bengal gram, Pigeon pea, Green bean, Chick pea, Lentils etc. Among the various factors responsible for lower productivity of black gram in west Bengal, mite infestation is one of the major concerns. Besides other mite species *Oligonychus biharensis* is a important mite species in West Bengal that affects pulse crops. Moreover, there is a growing global demand for agtricultural products with minimal or zero usage of chemicals, leading farmers to seek alternatives. This work aims to improve our knowledge of *O. biharensis* and other mite specieses associated with pulse crops. This will help in effective management of mite pests and especially in biological control of phytophagous mites by the predatory mites.

The present study was undertaken with two objectives: 1. To study the diversity of mite fauna associated with pulse crops in West Bengal and 2. To study the life-table of *Oligonychus biharensis* (Hirst). on pigeon pea leaves.

In light of these considerations, a survey was conducted in six districts of West Bengal. Altogether1501 mite specimens were collected from different pulse crops . They were preserved and identified in the Acarology laboratory of Department of Agricultural Entomology at Bidhan Chandra Krishi Viswavidyalaya. On the other hand, For the life table study of *Oligonychus biharensis*,a study was conducted in Januaray-March, 2024. Population of *Oligonychus bihatensis* were reared in a plastic tray on mature pigeonpea leaves and studied. Mites develop through various phases, including egg, larva, protonymph, deutonymph and adult. The duration of all the phases were documented. The number of eggs laid by gravid females was recorded daily. The duration of different life stages of

Oligonychus biharensis was recorded seperately at different temperatures. The number of specimens for each species was counted to reflect the species richness and the diversity and species dominance were calculated using the formulas supplied by Shannon-Weiner (1963), and Simpson (1949).Life-fecundity tables were constructed by using different parameters, pivotal age in days (x), survival data of gravid female individuals in each pivotal age (lx), female offspring produced per female in each age class (mx), net reproductive rate (Ro), mean generation time (t_G),intrinsic rate of increase (r_m), finite rate of increase m (λ) and doubling time (Dt).

A total of 1501 specimens were collected from natural and cultivated pulse vegetation from 6 districts of West Bengal Among them 16 predatory and 5 phytophagous mite species were found. From the Mesostigmata order 11 species of predatory mites of Phytoseiidae family were found. viz., *Amblyseius largoensis*, *Euseius alstoniae*, *Euseius ovalis*, *Paraphytoseius orientalis*, *Typhlodromips syzygii*, *Scapulaseius asiaticus*, *Scapulaseius moraes*, *Phytoseius kapuri*, *Neoseiulus pranadae*, *Typhlodromus sp*. On the other hand, 5 predatory mites were found from different families (Ascidae, Bdellidae, Cunaxidae, Cheyletidae and Stigmaeidae) of Prostigmata order. All the 5 species of phytophagous mite were of Tetranychidae family, Prostigmata order. Mostly abundant phytoseiid mite is *Neoseiulus pranadae* followed by *Typhlodromips syzygii*. *Cunaxa sp*. is the most abundant predatory prostigmatid mite .The most abundant phytophagous mite is *Tetranychus urticae*. The study revealed the highest diversity of predatory phytoseiid mite. It reflects that the ecosystem of West Bengal is congenial for survival of few species of predatory mite. So the database generated on mite fauna will be helpful in natural suppression of harmful phytophagous mites. The population of *Oligonychus biharensis* increases severely when the atmospheric temperature is high and so the infestation and yield loss due to them also increases .

Therefore, it is comprehended that *Oligonychus biharensis* prefer hot climatic condition for better growth and development. So, during this period appropriate management measures against this mite should be taken to control yield loss due to infestation by this mite.

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ABBREVIATION AND SYMBOLS USED

%	Percentage
and	And
cm	Centimeter
***et al*.**	Other authors/and other
etc.	etcetera (and other things)
mm	Millimeter
ml	Milliliter
°C	Degree Celsius
H'	Shannon's Diversity
D	Species Dominance
R_o	Net Reproduction Rate
t_G	Mean Generation Time
Rm	Intrinsic Rate of Natural Increase
λ	Finite rate of increase
Dt	Doubling time
Jan	January
Feb	February
-	To
°	Degree

INTRODUCTION

1. INTRODUCTION

Pulse crops are important to global agriculture and food security as they are grown mainly for their edible seeds. Pulses are an important source of dietary protein and key nutrients in India, where they have a substantial impact on national agricultural productivity and rural livelihoods. Pulses are often referred to as 'climate change smart crops' and sometimes as the 'poor man's meat' due to their rich content of proteins, vitamins, minerals, and other essential nutrients (Darai *et al*., 2021). They are highly valued by vegetarians and individuals with diabetes for their nutritional benefits. Pulses are a significant source of dietary fiber, containing approximately 8-27.5% fiber (Guillon, 2002), and are considered a superior protein source, containing 21-25% proteins and 60-65% carbohydrates (Singh, 2017). In West Bengal, pulse production reached 384 thousand metric tonnes in 2019, with major cultivation districts including Malda, Murshidabad, Nadia, Birbhum, Midnapore, South 24 Parganas, and North 24 Parganas (Ray *et al*., 2013). The eastern Indian state of West Bengal is well-known for its wide range of agricultural techniques and different agroclimatic conditions that are ideal for the production of pulse crops.

However, pulse cultivation faces various challenges in West Bengal, including diseases, pests, and weeds. *Oligonychus biharensis* is an important mite species in West Bengal that affects pulse crops because of its economic impact and prevalence on crops like mung beans, chickpeas, and pigeon peas. This pest is particularly damaging due to its broad host range, high fecundity, migratory behavior, and adaptability to diverse agro-climatic conditions, making it a national concern. Additionally, other pests such as thrips, whitefly, leafhopper, black aphid, bihar hairy caterpillar, and stem fly contribute to significant yield losses, amounting to approximately Rs. 6000 crores annually (Dhar and Ahmad, 2004). Insect pests and diseases collectively cause annual yield losses estimated at 18-20% and 8-10%, respectively. The present thesis intends to give a complete study on the mite fauna associated with pulse crops in West Bengal, with a specific focus on *Oligonychus biharensis*. This work aims to improve our knowledge of *O. biharensis* and other mite specieses associated with pulse crops and provide important insights into its management and control by investigating its life history parameters in detail using a life table study.

This thesis delves deeper into the population dynamics and ecological interactions in pulse crop ecosystems than it does in simply identifying and counting the species of mites. The research aims to clarify the factors influencing *O. biharensis* population growth and dynamics throughout different seasons and cropping cycles by examining its life table parameters under varying environmental conditions. These parameters include developmental rates, survival rates, fecundity, and longevity.

The results of this study have important ramifications for researchers, policymakers, and agricultural practitioners who work with pulse crops and manage pests in West Bengal and other regions. Through an in-depth description of the mite fauna linked to pulse crops, the thesis lays the groundwork for the creation of sustainable pest management strategies that are customized to the unique agro-ecological circumstances of the region.

Furthermore, it is anticipated that the *O. biharensis* life table study will add significant information to the body of knowledge already available on mite population dynamics, enhancing our comprehension of pest ecology and evolution. This information can help with the creation of prediction models and decision-support systems that minimize the negative effects of pest control methods on the environment and mitigate crop losses caused by mites.

The thesis work on "Study on mite fauna associated with pulse crops with special reference to life table study of *Oligonychus biharensis*" was undertaken with the following objectives:

1. To study the diversity of mite fauna associated with pulse crops in West Bengal

2. To study the life-table of *Oligonychus biharensis* (Hirst). on pigeon pea leaves.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The use of life tables in population ecology was first introduced by Birch (1948), who emphasized the significance of these data for comprehending the intrinsic rate of rise (r) and other critical metrics.

Pulses are among the many crops that *Oligonychus biharensis*, a pest of the Tetranychidae family, is known to attack. This species is well-known for its ability to severely harm host plants and for reproducing quickly (Jeppson *et al*., 1975).

Oligonychus biharensis, a species in the Tetranychidae family is a serious pest that harms a range of crops, including pulses. These mites are well-known for multiplying quickly and eating on their host plants to inflict significant harm such as chlorosis, decreased photosynthesis, and decreased overall plant vigor (Jeppson *et al*., 1975).

Successful pest management strategies requires an understanding of *O. biharensis* population dynamics. Key demographic factors, like the net reproductive rate (R0), generation time (T), and intrinsic rate of growth (r), can only be computed with the help of a life table analysis. These parameters are essential for forecasting pest outbreaks and scheduling management actions (Southwood, 1978).

Oligonychus biharensis is a mite pest that requires integrated management combined of chemical, cultural, and biological control approaches. The use of predatory mites and other natural enemies in managing spider mite populations was discovered by Helle and Sabelis (1985).

Phytophagous mites like *Tetranychus urticae* and *Polyphagotarsonemus latus* (broad mite) are known to be seriously harmful to pulse crops. Their feeding on plant tissues results defoliation, chlorosis, and decreased photosynthetic capability (Helle and Sabelis, 1985).

Sustainable agriculture relies heavily on Integrated Pest Management (IPM) strategies, which combine chemical, cultural, and biological ways to reduce pest populations with the least amount of negative environmental impact. IPM for mite control was covered by Helle and Sabelis (1985), who emphasized the need of biological control agents, monitoring, and the targeted use of acaricides.

The significance of life tables for forecasting population growth and evaluating the effects of control measures was highlighted by Chi and Getz (1988).

Chi and Getz (1988) showed how life table analysis may be applied to evaluate the effects of pesticides and biological control agents on pest populations. These investigations can help determine the best time and method for applying acaricides to *O. biharensis* as well as when to introduce natural predators.

Studies have shown that *O. biharensis* has the potential to drastically reduce pulse crop yield and quality. This mite species causes chlorosis, decreased photosynthetic activity, and stunted plant growth, according to Rahman and Ghosh (1991). These outcomes highlight how much crucial the management of *O. biharensis* population is incase of pulse crops.

Rahman and Ghosh (1991) have drawn attention to the detrimental effects of these pests on the West Bengal economy, emphasizing the need for efficient management techniques and production losses.

Regional studies conducted by Rahman and Ghosh (1991) have demonstrated the impact of mite infestations on crop production in India, where *O. biharensis* is a serious pest of pulse crops. These studies highlight the necessity of conducting localized life table assessments in order to create management plans.

Predatory mites from the families Stigmaeidae and Phytoseiidae are important in the natural regulation of phytophagous mite populations. Research conducted by Sabelis (1992) has shown that predatory mites can effectively manage pest populations in a range of crops.

A survey on fruit plants (temperate fruits, tropical and subtropical fruits, specific fruit vegetables, fatty oil plants, etc.) was carried out in Uttar Pradesh by Mukherjee and Singh (1993). They identified 48 acari species belonging to 11 distinct families.

Studies of life tables are essential for comprehending the dynamics of pest species populations. For the purpose of creating efficient pest management plans, they offer comprehensive data on rates of survival, development, and reproduction (Carey, 1993).

In Entomology and Acarology, life table studies are essential for comprehending the demographic features of pest populations. For the purpose of forecasting population increase and assessing control measures, they offer comprehensive data on survival rates, fertility, and the length of development of various life stages (Carey, 1993).

In eight different vegetable crops i.e. brine, okra, ribbed gourd, dolichos bean, cauliflower, chilli, pea, and clustered bean , 11 phytophagous mites and 9 predatory mites were discovered by Mathur *et al*. (1994) in Haryana.

Compared to other Tetranychid mites, in-depth studies have been conducted on the biology and ecology of *O. biharensis*. Nonetheless, a thorough explanation of the anatomy, life cycle, and feeding habits of *O. biharensis* was given by Gupta and Gupta (1994). They observed that the insect prefers warm, dry weather, which promotes quick population expansion.

The morphology, life cycle, and feeding habits of *O. biharensis* have been thoroughly studied by Gupta and Gupta (1994), laying the groundwork for future studies on its management.

According to Bonato *et al*. (1995), an adult female *O. gossypii* (Zacher) lived an average of 10.8 days at 26 °C when fed cassava. In 8.3 days, an adult female laid 36.3 eggs on various cassava leaves at 26 °C., *O. gossypii* (Zacher) had a net productive rate (Ro) of 20.7 and an intrinsic rate of natural increase (r_m) of 0.185 on cassava.

In 1999, Chinnaiah and Mohanasundaram conducted research on predatory mites in the Shevroy range of Tamil Nadu's Eastern Ghats Biosphere. Within the phytoseiidae family, they discovered three new species of phytoseiidae family ,on the other hand in the cunaxidae family only new species was discovered.

Because of their high nutritional content and capacity to fix nitrogen in the soil, which improves soil fertility and sustainability, pulse crops like lentils, chickpeas, and other beans are essential to the world's food systems (Graham and Vance, 2003).

Numerous investigations have been conducted on life tables of different species of *Oligonychus* (Gotoh *et al*.'s ,2004). Study of *Oligonychus sacchari*'s life table parameters on sugarcane provided important new information about the species' population growth and development in various environmental settings.

Gotoh *et al*. (2004) investigated the life table characteristics of *Oligonychus sacchari* on sugarcane, offering information on the dynamics of the population and the possibility of an epidemic. *Tetranychus urticae* is another important pest in the *Tetranychidae family*.

The biology of *O. biharensis* (Hirst) was investigated by Chen *et al*. (2005) on a variety of litchi cultivars. They discovered that the average development time from egg to adult was 17 to 21 days at 24 °C. The average lifespan of adult females was 19.7–27.0 days, and at 24 °C, an adult female lay 34.0–68.7 eggs on various cultivars of litchi in 16.6–23.8 days. At 24 °C, *O. biharensis* (Hirst) showed a net productive rate (R_0) of 79.3-473.5 and an intrinsic rate of natural increase (r_m) of 0.1349-0.2143 on various cultivars of litchi.

Thakur and Dinabandhoo conducted a survey in Himachal Pradesh between 1999 and 2001 (2005). Along with phytophagous mites, ten predatory mite species were found. Example : *Tyrophagus putrescentiae, Neoseiulus longispinosus, Phytoseius crinitus, Phytoseius intermedius, Typhlodromus homalii, Agistemus sp., Tydeus sp., Biscirus sp.*, and *Tyrophagus sp.*

According to Prasad (2006), only four species of plant-feeding mites (tetranychids, tenuipalpids, tarsonemids, and eriophyids) were found on various vegetable crops in Hazaribagh , Jharkhand between 2002 and 2004.

Numerous investigations have provided informations about the mite fauna associated with pulse crops. For example, Karmakar *et al*. (2007) found that pulse crops were infested by a variety of mite species after conducting thorough inspections throughout India. Their research demonstrated the widespread presence of both beneficial and dangerous mites, underscoring the necessity of integrated pest management strategies.

Small arachnids called mites have the potential to seriously harm agricultural crops. The mite species associated with pulse crops have been identified by numerous investigations. For example, Karmakar *et al*. (2007) found several phytophagous mites in Indian pulse crops and noted how they affected crop health and yield. Additional studies have examined the variety and seasonal abundance of mite species, emphasizing the necessity of continuing observation and control (Gerson, 2008).

Gerson (2008) conducted a review on the effects of mite infestations on leguminous crops and emphasized the significance of comprehending the interactions between mites and plants.

Tetranychid mites are distinguished by their unique body form, which is usually round and small size (less than 0.5 mm). In particular, *O. biharensis* has a reddish-brown hue with different levels of mottling, which helps it blend in with plant surfaces (Smith, 2009).

In Himachal Pradesh, Thakur *et al*. (2010) carried out a survey, where eleven phytophagous mite species and eight predatory mite species were found. The most common in this region are *Amblyseius finlandicus* and *Panonychus ulmi*.

A description of the variety of phytophagous and predatory mites found on aromatic and medicinal plants in India was given by Gupta and Karmakar (2011). From these plants, 267 mite species from 93 genera and 18 families were found or were previously known to exist.

According to Abou-Awad*et al*. (2011), an adult female *O. mangiferus* (Rahman and Sapra) on mango leaves hatched 21.6 eggs in 25.8 days at 23 °C. The mean lifespan of an adult female was 59.1 days. At 23 °C, the intrinsic rate of natural increase (r_m) and net productive rate (R_0) of *O. mangiferus* (Rahman and Sapra) on mango leaf were 0.07 and 13.1, respectively.

In order to study the diverse predatory mite fauna from different agri-horticultural crops and weeds in the Gangetic plains of West Bengal, Karmakar and Gupta (2011) carried out a survey in 2008 and 2009. It was discovered that Predatory mites comprised of 31 species in all, divided into 9 genera and 7 families.

In the laboratory conditions at 30 + 2°C and 70 + 5% RH, Kaimal and Ramani (2011) reported that the pre-oviposition period, oviposition period, and post-oviposition period of *Oligonychus biharensis* (Hirst) on cassava were, respectively, 1 day, 10.9 + 0.75 days, and 0.8 + 0.22 days. The species' ovipositional rate was determined to be 44.6 + 4.2 eggs for mated females and 30.6 + 1.6 eggs for unmated females, respectively, at 30 + 2 °C and 70 + 5% RH. At 30 + 2 °C and 70 + 5% RH, the total time for sexual and parthenogenetic development was found to be 7.75 + 0.09 days and 7.0 + 0.06 days, respectively. Male to female ratio was 1-2: 10.

According to Das *et al*. (2012), *O. coffeae* (Nietner) took 12.1–12.2 days at 25 °C to develop from egg to adult on various tea clones. An mature female laid 102.0 to 120.7 eggs on various tea leaves at 25 °C in 19.5–23.9 days, with a mean lifespan of 22.1–27.3 days.

For millions of individuals, especially in underdeveloped nations, they supply vital proteins and micronutrients (Singh *et al*., 2013). However, a number of pests, including mites are a threat to these crops' yield, which calls for in-depth research on pest control.

Research on *O. pratensis* (Khanamani *et al*., 2013) has provided important informations about effective control methods. These results emphasize the importance of species-specific life table for efficient pest control.

Random surveys were conducted in the Thrissur district of Kerala by Bhaskar *et al*. (2013) between February 2011 and January 2012 to examine the effects of weather variables on the population dynamics of *Tetranychus urticae* and *Polyphagotarsonemus latus*, which infest bitter gourd, cowpea, amaranthus, bitter gourd, and chillies.

Ghosh *et al*. (2013) examined IPM techniques for pulse crops in the West Bengal environment, emphasizing the value of utilizing regional ecological knowledge and customs.

The eastern Indian state of West Bengal is well-known for its varied farming methods and substantial output of pulse crops, including mung beans, lentils, and chickpeas. Due to its ability to fix nitrogen and provide vital nutrients, pulse crops are extremely important to the region's agrarian economy (Singh *et al*., 2013). However, biotic stressors such as pest infestations frequently limit the production of these crops.

According to Kaimal (2013), *Oligonychus biharensis* (Hirst) on cowpea leaves underwent immature development for an average of 6.2 days at 30 °C. According to his research, the average lifespan of an adult female was 11.5 days, and at 30°C, she deposited 40.2 ± 1.4 eggs on cowpea leaves. The adult female's oviposition duration on cowpea leaves at 30°C was determined to be 11.5 ± 0.7 days.

Khanamani *et al*. (2013) investigated the life table of this pest under various environmental settings, emphasizing the variation in life history features depending on environmental factors.

Lin (2013) noted that on mango leaves at 25 °C, *O. mangiferus* (Rahman and Sapra) finished developing from egg to adult in 14.6 to 14.8 days. On mango leaves at 25 °C, *O. mangiferus* (Rahman and Sapra) had a net productive rate (R0) of 14.2 and an intrinsic rate of natural increase (rm) of 0.12.

In three constant temperature and relative humidity combinations—35+2°C and 60+5%RH, 30+2°C and 70+5%RH, and 25+2°C and 80+5%RH—Kaimal and Ramani (2014) investigated the effects of temperature and relative humidity on the oviposition and fecundity of the spider mite, *Oligonychus biharensis* (Hirst), on cassava. The pre-oviposition period measured 0.5+0.12 days at 35 + 2°C and 60 + 5% RH was the shortest, and 1.9+0.07 days at 25 + 2°C and 80 + 5% RH was the longest. 35 + 2°C and 60 + 5% RH had the highest fecundity (75.6+0.9 eggs per female), while 25 + 2°C and 80 + 5% RH had the lowest (26.7+0.6 eggs per female). Increased humidity had a detrimental effect on the ability to lay eggs. Lower temperatures and greater humidity led to a shorter oviposition period. *O. biharensis* (Hirst) on cassava was shown to thrive and develop best at a combination of 35+2°C and 60+5%RH out of all the temperature-humidity variables that were examined.

In nine districts of South Bengal , Karmakar *et al*. (2015) looked into the mite population on 25 distinct species of ornamental and floricultural plants. There are 33 species of phytophagous and predatory mites in total from five families and nine genera.

Numerous research about the mite fauna in agriculture have been conducted specifically in West Bengal. Surveys carried out in several agroclimatic zones of West Bengal by Sarkar *et al*. (2015) revealed the presence of multiple mite species infesting pulse crops. They discovered both predatory and phytophagous mites, including *Tetranychus urticae*, or the two-spotted spider mite.

Sarkar and Mukhopadhyay (2016) investigated the effectiveness of native predatory mites in controlling mite pests in pulse crops in West Bengal that showed promising results.

Supplementary releases of these natural enemies can help maintain pest populations below economic thresholds. Predatory mites, like *Neoseiulus californicus*, have shown promise in suppressing *O. biharensis* populations by preying on eggs and nymphs (Kumar and Sharma, 2016). Biological control methods provide sustainable alternatives to chemical treatments.

O. biharensis is a common pest in temperate to subtropical regions of India. It infests a variety of commercially significant crops, including cotton, tea, and mangoes (Sharma, 2017).

Key characteristics of *O. biharensis*, including the quantity and arrangement of setae on the body, the form and structure of the genitalia in males and females, and the existence of distinctive morphological structures such the gnathosoma, must be examined under a microscope in order to be identified (Kumar *et al*., 2018). For precise taxonomy and species classification within the Tetranychidae family, these characteristics are essential.

Reduction of mite infestations can be achieved by cultural methods such crop rotation and sustaining plant vigor with proper nutrition and watering (Patil and Deshmukh, 2018). When combined with other management techniques, mechanical control techniques such as the application of high-pressure water sprays to remove mites from plant surface salso proved to be efficacious.

Synthetic acaricides are a common part of traditional *O. biharensis* control; nevertheless, resistance development is progressively compromising their effectiveness (Patel and Patel, 2019). To reduce their negative effects on the ecosystem, integrated pest management (IPM) techniques are helpful using biopesticides and rotating acaricides with several modes of action.

According to Yao *et al*. (2019), *O. litchii* Lo and Ho took 10.6 to 14.6 days on several litchi cultivars at 25 °C to finish developing from egg to adult. The average lifespan of adult females was determined to be 26.0–32.7 days, and they deposited 14.8–64.8 eggs on various litchi cultivars at 25 °C in 9.8–19.7 days. On various litchi cultivars at 25 °C, the net productive rate (R_0) and intrinsic rate of natural increase (r_m) of O. litchi Lo and Ho were found to be 1.8–22.9 and 0.04–0.15, respectively.

According to Quan *et al.* (2019), adult female *O. litchii* Lo and Ho laid 77.2 eggs on various eucalyptus leaves at 25 °C in 19 days. At 25 °C, O. litchi Lo and Ho had net productive rates (R_0) of 37.0 and intrinsic rates of natural increase (r_m) of 0.17 on litchi leaves, respectively.

O. biharensis and other tetranychid mites are found across the world, though their frequency varies according to climate and host availability. Research by Patel *et al.* (2020) shows that *O. biharensis* is found on several continents, demonstrating its resilience to a range of environmental circumstances.

The mean duration *of O. biharensis* (Hirst) immature development was found to be 12.4 days on cowpea and 10.9 days on lablab bean at 25 °C, according to Roknuzzaman*et al.* (2020). He stated that at 25 °C, the female adult longevity of *O. biharensis* (Hirst) was 17.06 days on lablab bean leaves and 14.92 days on cowpea leaves. The *O. biharensis* (Hirst) species was found to have an oviposition time of 9.06 days, during which it laid 8.53 eggs on cowpea leaves and 8.53 days, laying 10.92 eggs on lablab bean leaves at 25 °C. On lablab beans, *O. biharensis* (Hirst) had the following values: net productive rate (R_0), intrinsic rate of natural increase (r_m), mean generation time (t_G), and finite rate of rise (λ): 12.30, 0.155, 16.18, and 1.167, respectively. The pre-oviposition, oviposition, and post-oviposition periods of *Oligonychus biharensis* (Hirst) were found to be 4.26, 9.06, and 3.74 days for lablab beans and 3.8, 8.53, and 2.54 days for cowpea at a temperature of 25 °C, respectively.

O. punicae (Hirst) took 10.9 to 12.3 days at 25 °C to develop from egg to adult on various eucalyptus leaves, according to Ferraz*et al*. (2020). The average lifespan of an adult female was 8.3–18.5 days, and at 25 °C, she laid 5.4–44.8 eggs on various eucalyptus leaves in 4.2–15.3 days. At 25 °C, O. punicae (Hirst) showed a net productive rate (R_0) of 5.1–44.9 and an intrinsic rate of natural increase (r_m) of 0.09–0.19 on various eucalyptus leaves.

Temperature, humidity, and agricultural methods all have an impact on the geographic distribution of mite populations and infestation levels throughout India (Singh and Gupta, 2021).

Bala (2021) investigated the population fluctuations of the red spider mite (*Tetranychus urticae* Koch) on roses in West Bengal, as well as the mite fauna linked to the rose ecology. The five families Tetranychidae, *Tetranychus urticae* (Koch), *Eutetranychus orientalis* (Klein), *Schizotetranychus andropogoni* (Hirst.), *Oligonychus coffeae*, *Panonychus sp*., and Tenuipalpidae, Brevipalpus phoenicis (Geisk), were found to be the primary mite pests of roses. A total of eight species of predatory mites were identified.

In order to assess the host adaptability of several solanaceous and cucurbitaceous vegetable crops, Draz*et al*. (2021) examined the development, survival, fecundity, and life-table aspects of *Tetranychus urticae* Koch. The survival rates of the considered hosts varied greatly, ranging from 100% on watermelon to 42.86 on pepper. Host plants had a major impact on the duration of larval, deutonymphal, and total immature stages' development. On pepper, the longest timings were recorded. The cucurbitaceous plants had the longest female life span (13.2-13.9 days) and oviposition period (11.5-12.3 days) of any plant. Watermelon had the highest values for finite rate of growth (λ) (7.82 individuals/day), net productive rate (Ro) (72.95) and intrinsic rate of natural increase (r_m) (2.055 offspring/female/day).

Bala (2022) conducted research on the variety of phytophagous and predatory mites in chilli crops in order to identify acceptable cultivars from an indigenous gene pool that are resistant to yellow mites and to establish a more effective and environmentally sound mite pest management strategy. Twelve different species of predatory mites from five families were found in chilli crop.

In Bihar, India, Bala and Karmakar (2022) investigated the diversity of mite fauna on several agro-horticultural crops. Twenty predatory mite species from thirteen genera, including Amblyseius, Euseius, Typhlodromips, Scapulaseius, Neoseiulus, Phytoseius, Phlodromus, Lasioseius, and Agistemus, were identified. Six major phytophagous mite species, including *Tetranychus urticae, Eutetranychus orientalis, Oligonychus litchi, Oligonychus mangiferous,* and *Schizotetranychus baltazari* from the Tetranychidae family and *Polyphagotarsonemus latus* from the Tarsonemidae family, were identified and classified as important mite pests.

In West Bengal, the diversity of mite fauna found in agro-horticultural crops was investigated by Bala and Karmakar (2022). The genera Amblyseius, Euseius, Paraphytoseius, Typhlodromips, Scapulaseius, Neoseiulus, Protoseius, Asperoseius,

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MATERIALS AND METHODS

3. MATERIALS AND METHODS

To begin an experiment ,proper methodology is needed apart from objectives. The materials and methodology used during this investigation are stated below.

3.1. Mite fauna associated with pulse crops :

3.1.1. Study area

The current study was carried out in six districts of West Bengal (Malda, North Dinajpur, South Dinajpur, Nadia, North 24 Prganas and Murshidabad) and the Acarology Laboratory of the Department of Agricultural Entomology in Bidhan Chandra Krishi Viswavidyalaya in Mohanpur, West Bengal, between 2022 and 2024.

3.1.2. Materials

The materials used in this study project included plastic vials, sterilized cotton wool, petri dishes, mounting media, glass slides, cover slips, camel hair brushes (size 000), needles, and stereo-zoom binocular and phase contrast microscopes. These were made available at the Bidhan Chandra Krishi Viswavidyalaya in Mohanpur, West Bengal, in the Acarology Laboratory of the Department of Entomology.

3.1.3. Collection of Specimen:

The first step was extraction of mites from the leaves of various pulse plants. Samples were collected in the early morning and late afternoon from six districts of West Bengal. The mites were collected using the leaf beating method in this method, using a stick, plant materials were pounded over a board covered in black art paper. Then the handpicking process was done using a fine, steady, triple zero hair brush soaked with 70% ethyl alcohol, the mites were kept in a plastic vial (5 Ml capacity) filled with 70% ethyl alcohol. Vials were

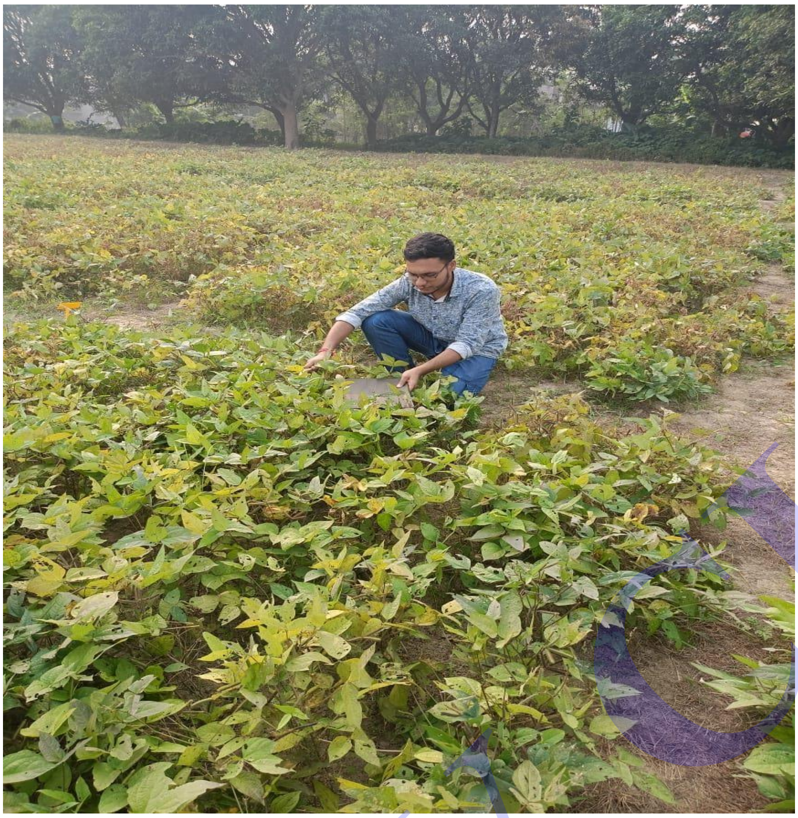

Plate 1 : Mite collection from infested field

appropriately labeled with the location, the date of collection, name of the crop etc. Leaves collected from the field were placed in polythene zipper bags and labeled. At last, all the collected samples were transported to the laboratory**.**

3.1.4. Preparation of Permanent slides

In the laboratory, collected mite specimens were transferred into a cavity block. Then, a drop of mounting material was placed in the centre of a clean glass slide. The specimen was then kept on the drop and covered with a cover slip. After that, the slides were labeled with details such as the name of hosts, the location and date of the collection, the collector's identity etc. The prepared slides were then placed in a slide heater for fifteen to twenty days. Transparent nail polish was used to seal the edges of the cover slips, minimizing the possibility of the specimen being harmed by excessive drying or dampness. Finally, a slide box was used to store the slides .The slides prepared using this procedure can be kept for a long time at 25°C and 35–45% relative humidity, which will avoid fungal infections.

3.1.5. Mounting media

Hoyer's Medium (Baker and Wharton, 1952) and Modified Berlese Medium (Amrine and Manson, 1996) were the two types of medium used for mounting and slide preparation. The two media were prepared using the following methodology:

<u>Hoyer's Medium (Baker and Wharton ,1952)</u>

The following substances were combined in the proper amounts to create Hoyer's medium, which was then let to stand at room temperature. Following preparation, muslin cloth was used to filter the medium. The substances are :

Distilled Water- 50 ml

Gum Arabic Crystals- 30 g

Chloral Hydrate- 200 g

Glycerine- 20 ml

Modified Berlese Medium (Amrine and Manson, 1996)

Modified Berlese Medium was prepared using the following:

Sorbitol- 5 g

Glycerine- 5 ml

Distilled Water- 8 ml

3, 3, 4, 4- Benzophenone tetracarboxylic di anhydride- 3 g

Acetic Acid- 3 g

Chloral Hydrate- 70 g

3.1.6. Identificatrion

The prepared slides were properly inspected and studied using an Olympus BX-41 Phase Contrast microscope. The Chant and McMurtry (2007) categorization approach was applied for the taxonomic identification of Phytoseiidae mites.

3.1.7 Identifying characters of *Oligonychus biharensis*

The spider mite species *Oligonychus biharensis* is a member of the Tetranychidae family, which also comprises a number of pest species that are significant to the economy. These mites are important agricultural and horticultural pests since they are known to infest a broad variety of host plants, such as ornamentals, fruits, and vegetables.

Size and Color:

Adult *Oligonychus biharensis* are quite little, with a length of only 0.2 to 0.3 mm. Even though they are little in size, they have the ability to seriously harm plants because of their feeding habits. *O. biharensis* has different colors depending on the stage of development and the surroundings. Their colors typically range from light yellowish-green to greenish-brown, with their habitat and food having a significant impact on color intensity.

Body Structure and Shape:

Like many other spider mite species, *O. biharensis* has an oval-shaped body that is somewhat flattened dorsoventrally. They can move between plant tissues because to their morphology, especially on the undersides of leaves where they usually feed. Under magnification, the mites' comparatively smooth cuticle appears glossy. Their anatomy is designed to move and feed on plant sap efficiently.

Legs and Appendages:

O. biharensis has four pairs of legs total, making eight legs, just as all other members of the Tetranychidae family. Their ability to move on plant surfaces is facilitated by their long, thin legs. Claws at the tips of each leg enable them to hold onto plant structures and hairs for support as they are moving or feeding. Setae, or hairs, are arranged in a unique way on the legs and body, which helps them stick to plant surfaces and provides sensory information.

Morphological Features:

Upon microscopic inspection, a number of essential morphological characteristics set *O. biharensis* apart from other species of spider mites. Their appendages and body are covered in distinctive setae that change in length and form based on their position. These setae are simple or branched, and taxonomic identification can be based on how they are arranged. *O. biharensis* can be identified under high magnification thanks to the presence of tiny spines or tubercles on their dorsal surface in addition to setae.

Behavior and life cycle:

In ideal circumstances, *Oligonychus biharensis* has a quick lifecycle, maturing from an egg to an adult in a matter of weeks. Through a process called parthenogenesis, females are able to generate viable eggs even in the absence of mate. Their capacity to proliferate quickly is facilitated by this reproductive method, particularly in situations where the humidity and temperature are ideal for their growth.

Damage and Economic Impact:

O. biharensis is a phytophagous pest that feeds on plant sap by puncturing cells with its mouthparts and sucking out the contents. This feeding activity may cause the leaves to become mottled or stippled, which lowers the plant's overall vigor and photosynthetic efficiency. In severe circumstances, severe infestations can result in premature leaf loss, lower-quality fruit, and even plant mortality. *O. biharensis* infestations cause large financial losses in horticulture and agriculture, which is why integrated pest management techniques are used to regulate their populations.

Plate 2 : Preparation of permanent slides

Plate 3 : Rearing of mites

3.2. Rearing of mites and Life table study

The study was conducted in January – March ,2024.To begin the culture, adult gravid females and males of *O. biharensis* were taken and reared in a laboratory setting. A 10x8 inchesplastic tray was used, with a foam pad added. Water was supplied to maintain moisture levels. Mature pigeonpea leaves were collected from the field, rinsed with water, and wiped with a cloth and kept in the tray.Then mites were allowed to colonize on the leaves. After 6 hours, adults were transferred to a new tray, and eggs were collected. Mites develop through various phases, including egg, larva, protonymph, deutonymph and adult. Food was changed every 2-3 days.The number of eggs laid by gravid females and other stages were recorded. The duration of different life stages of *Oligonychus biharensis* was recorded seperately at different temperatures.

3.3. Statistical analysis

The number of specimens for each species was counted to reflect the species richness and the diversity and species dominance were calculated using the formulas supplied by Shannon-Weiner (1963), and Simpson (1949) in order to comprehend the diversity and community structure of various phytoseiid mite as well as phytophagous mite in different locations.

Life-fecundity tables were constructed by using different parameters, pivotal age in days (x), survival data of gravid female individuals in each pivotal age (lx), female offspring produced per female in each age class (mx), net reproductive rate (Ro), mean generation time

(t_G),intrinsic rate of increase (r_m), finite rate of increase m (λ) and doubling time (Dt). All the above mentioned parameters were calculated following Birch (1948).

- **Life-fecundity parameters included in the present study are:**

- **Age-specific survival rates (l_x)**

Age-specific survival rate(l_x)= (fraction of females surviving at age x) × (rate of egg hatchability) × (rate of survival of immature stages)

where x is female age in days

- **Age-specific fecundity (m_x)**

Age-specific fecundity (m_x) is expected number of female offspring produced per female alive at age x.

m_x= (age-specific oviposition) × (proportion of females in the population)

It is expressed as female offspring/ female/ day.

- **Net reproduction rate/ Net maternity(R_o)**

Net reproduction rate (R_0) is the mean number of female offspring can be produced by an individual during its life span. It is taken as the summation of age-specific maternity($l_x.m_x$).

$$R_o = \Sigma\, l_x.m_x$$

It is expressed in female offspring/ female.

Mean generation time (t_G)

Mean generation time (t_G) is the amount of time that a population requires to increase its size R_0 fold as time approaches infinity and the population settles to a stable age-stage distribution.

$$t_G = \Sigma x.l_x.m_x / R_o$$

It is expressed in days.

Intrinsic rate of natural increase (r_m)

It was calculated as:

$$r_m = \ln R_0 / t_G$$

It is expressed in female offspring/ day.

Finite rate of increase (λ)

Finite rate of increase is defined as multiplication factor of the original population at each time . The finite rate of increase was calculated as follows:

$$\lambda = e^{rm}$$

It is expressed as female offspring/ day.

Doubling time(Dt)

It was calculated as ln (2) / rm. It is expressed in days.

RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSION

4.1. Mite fauna associated with pulse crops

A survey was done in 2022-24 to detect predatory and phytophagous mites associated with pulse crops in West Bengal. Samples of phytophagous and predatory mites were collected from six districts in West Bengal: Nadia, Malda, Murshidabad, North 24 Parganas, North Dinajpur and South Dinajpur. Major pulse crops in West Bengal, including green gram, lentil, black gram, pegionpea, lathyrus, mung bean, and Bengal gram, were examined. A total of 1501 mite specimens were collected from various pulse crops, including eleven species of phytoseiid mites: *Amblyseius largoensis* (Muma, 1955), *Euseius alstoniae* (Gupta, 1975), *Euseius ovalis* (Evans, 1953), *Paraphytoseius orientalis* (Narayanan, Kaur andGhai), *Typhlodromips syzygii* (Gupta, 1975), *Scapulaseius asiaticus*,*Scapulaseius moraesi*,*Phytoseius kapuri* (Gupta, 1969), *Neoseiulus pranadae*,*Neoseiulus longispinosus, Typhlodromus (Anthoseius) sp*. were identified in several pulse crops . *Neoseiulus pranadae* accounts for 45.84% of the phytoseiid predatory mite population, followed by *Typhlodromips syzygii*, *Amblyseius largoensis, Typhlodromus (Anthoseius) sp., Euseius ovalis, Neoseiulus longispinosus, Paraphytoseius orientalis, Scapulaseius moraesi, Scapulaseius asiaticus* .*Neoseiulus pranadae* was the most common predatory mite found on pulse crops, followed by *Typhlodromips syzygii*. During the examination, predatory mites from the Tydeidae, Bdellidae, Ascidae, Stigmaeidae, Cunaxidae, and Cheyletidae families of the Prostigmata order were observed. Cunaxa dominated the prostigmatid mite population, with Bdelloides accounting for 37.69 and 21.92 percent, respectively . *Tetranychus urticae* (Koch.) is the most common phytophagous mite found on pulse crops, accounting for 60.49 % of the population . *Eutetranychus orientalis* (Klein) and *Schizotetranychus baltazari* (Hirst) account for 17.81 % and 12.69%, respectively. The study revealed the highest diversity of predatory phytoseiid mite in terms of Shannon's diversity= 2.0937 and highest dominance of 0.4584.

Table 1 : Predatory mite fauna from Mesostigmata order

Order: Mesostigmata Family: Phytoseiidae	Host plants	Distribution in West Bengal	Latitude	Longitude
Amblyseius largoensis (Muma)	Mungbean, Dolichos bean, Pigeon pea, Blackgram	Nadia	22°58'34.6"N	88°25'09.8"E
		Malda	25° 23' 29.4" N	88°34.2" E
Euseius ovalis (Evans,1953)	Dolichos bean, Chickpea, Lathyrus, Black gram	North Dinajpur	25° 27' 9" N	88° 10' 25.68" E
		Murshidabad	24°24'55.5"N	88°15'43.6"E
		Nadia	22° 33' 47.52" N	88° 18' 18.36" E
Typhlodromips syzygii (Gupta,1975)	Greengram, Lathyrus, Blackgram, Lentil	Nadia	22°59'15.3"N	88°25'30.9"E
		Murshidabad	24°24'55.5"N	88°15'43.6"E
		Nadia	22° 59' 10.32" N	88° 26' 47.04" E
Paraphytoseius orientalis (Narayanan,Kaur andGhai)	Dolichos bean, pigeon pea	Nadia	22°59'15.3"N	88°25'30.9"E
		Nadia	22°58'13.6"N	88°29'34.5"E
Euseius alstoniae (Gupta,1975)	Blackgram	Nadia	22°59'15.3"N	88°25'30.9"E
Scapulaseius moraesi (Karmakar andBhowmik,2018)	Blackgram	Malda	25° 24' 24.48" N	88° 52' 0.84" E
Scapulaseius asiaticus (Evans)	Blackgram	Nadia	22°59'15.3"N	88°25'30.9"E
Phytoseius kapuri (Gupta,1969)	Blackgram	Nadia	22°59'15.3"N	88°25'30.9"E

Order: Mesostigmata **Family: Phytoseiidae**	**Host plants**	**Distribution in West Bengal**	**Latitude**	**Longitude**
Neoseiulus pranadae (Karmakarand Gupta, 2014)	Green gram, Black gram, Lathyrus, Chickpea, Pigeonpea, Lentil	Nadia	22°59'15.3"N	88°25'30.9"E
		Malda	25° 24' 24.48"N	88° 52' 0.84" E
		North 24 Parganas	22° 53' 22.2" N	88° 25' 19.2" E
		North 24 Parganas	22° 49' 53.4" N	88° 23' 51.72" E
Neosiulus longispinosus	Black gram	Malda	25° 24' 24.48" N	88° 52' 0.84" E
Typhlodromus (Anthoseius)sp.	Mung bean, Black gram	Nadia	22°59'15.3"N	88°25'30.9"E

Table 2: Predatory mite fauna from Prostigmata order

Order : Prostigmata	Host plants	Distribution	Latitude	Longitude
Family: Ascidae *Lasioseiuspar berlesei*	Blackgram	Nadia	22°59'15.3"N	88°25'30.9"E
		Malda	25.4068°N	88.8669°E
Family: Bdellidae *Bdelloides* sp.	Black gram, Pigeon pea	Nadia	22°59'15.3"N	88°25'30.9"E
		North 24 Parganas	22.7248°N	88.4789°E
Family: Cunaxidae *Cunaxa* sp.	Garden pea, Pigeon pea, chickpea, lentil, blackgram	Nadia	22°56'46.4"N	88°32'11.5"E
		Nadia	22°59'15.3"N	88°25'30.9"E
Family:Cheyletidae *Cheyletus* sp.	Lentil, green gram, Pigeonpea	Nadia	22°59'15.3"N	88°25'30.9"E
		Murshidabad	24°24'55.5"N	88°15'43.6"E
Family: Stigmaeidae *Agistemus industani*	Chickpea, Lathyrus Pigeon pea	Malda	25° 24' 24.48" N	88° 52' 0.84"E
		Nadia	22°59'15.3"N	88°25'30.9"E

Table 3: Phytophagous mite fauna associated with pulse crops

Order: Prostigmata, Family: Tetranychidae	Host plants	Distribution in West Bengal	Latitude	Longitude
Tetranychus urticae(Koch)	Black gram, Green gram, Cowpea, Mungbean, Lentil, Pigeonpea, Chickpea, Pigeonpea	South Dinajpur	25° 19' 0.12" N	87° 45' 0" E
		Murshidabad	22°09'29.4"N	88°26'07.7"E
		Murshidabad	24°24'55.5"N	88°15'43.6"E
		Malda	24°57'07.0"N	87°59'33.9"E
		Malda	25° 23' 29.4" N	88°34.2" E
		Nadia	22°59'15.3"N	88°25'30.9"E
		Nadia	22°56'46.4"N	88°32'11.5"E
Eutetranychus orientalis(Klein)	Pigeonpea,	Nadia	22°59'15.3"N	88°25'30.9"E
		Nadia	22°56'46.4"N	88°32'11.5"E
Schizotetranychus cajani	Pigeonpea	Nadia	22°59'15.3"N	88°25'30.9"E
		Nadia	22°56'46.4"N	88°32'11.5"E
Schizotetranychus baltazari	Pigeonpea	Nadia	22°59'15.3"N	88°25'30.9"E
		Nadia	22°56'46.4"N	88°32'11.5"E
Oligonychus biharensis	Cowpea, Pigeonpea	Nadia	22°56'46.4"N	88°32'11.5"E

Table 4 : Relative Abundance of phytoseiid predatory mites

Species	Number	Relative abundance(%)
A.largoensis	99	14.68
N.longispinosus	16	2.37
E.alstoniae	10	1.48
E.ovalis	18	2.67
P.orientalis	11	1.63
T.syzygii	160	23.73
S.asiaticus	6	0.89
S.moraesi	15	2.23
P.kapuri	13	1.92
N.pranadae	309	45.84
Typhlodromus(Anthoseius)sp.	17	2.52
Total	674	

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Shannon's Diversity(H') =2.0937

Species Dominance(D)= 0.4584

Chart 1 : Relative abundance of Phytoseiid predatory mites associated with pulse crops in West Bengal

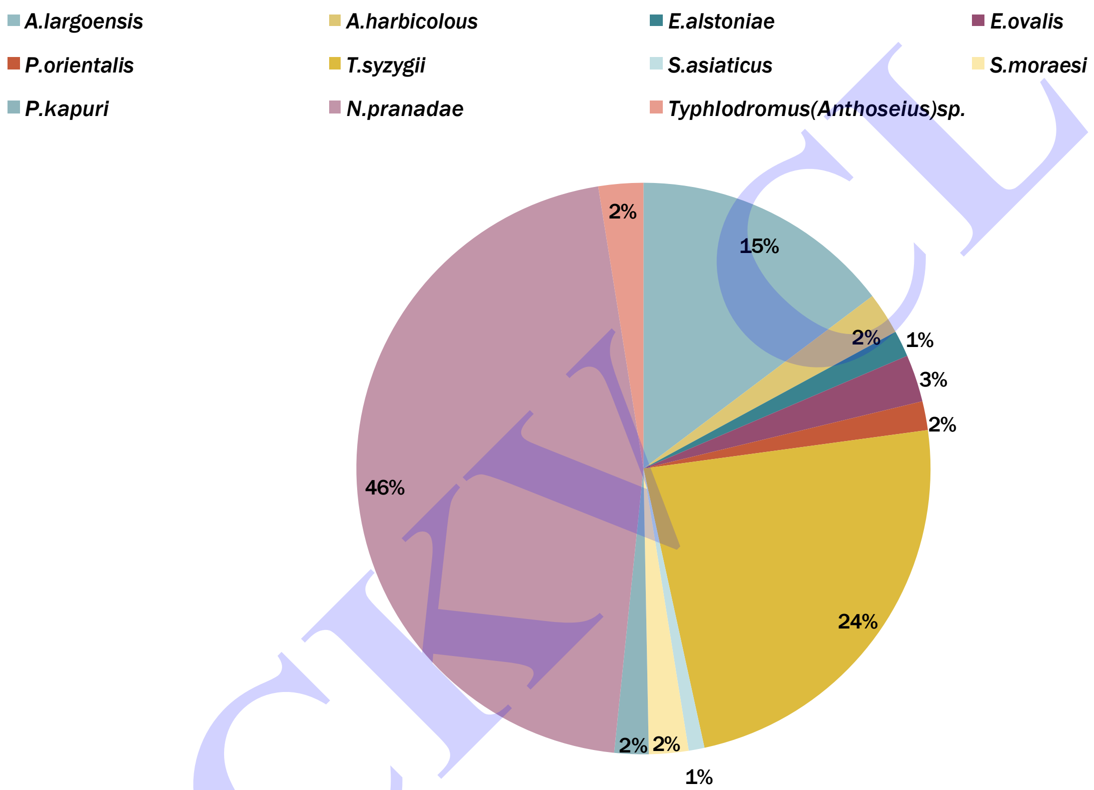

Table 5: Relative Abundance of Prostigmatid predatory mites

Species	**Number**	**Relative abundance(%)**
Bdelloides sp.	57	21.92
Lasioseiusparberlese	11	4.23
Agistemusindustani	49	18.84
Cunaxa sp.	98	**37.69**
Cheyletus sp.	45	17.30
Total	**260**	

Shannon's Diversity (H') = 1.558

Species Dominance (D) = 0.377

Chart 2 : Relative abundance of Prostigmatid predatory mites associated with pulse crops of West Bengal

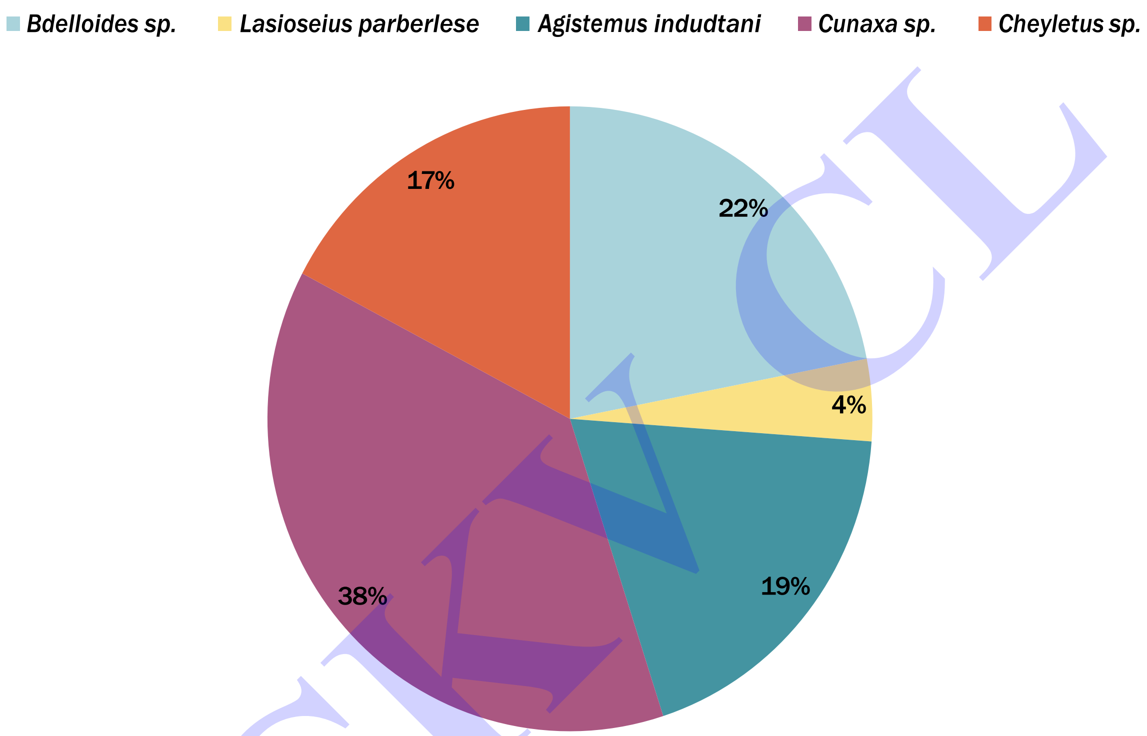

Table 6: Relative Abundance of Phytophagous mites

Species	Number	Relative abundance(%)
T.urticae	343	60.49
E.orientalis	101	17.81
S.baltazari	72	12.69
O.biharensis	51	8.99
Total	567	

Shannon's Diversity (H') = 1.228

Species Dominance (D) = 0.605

Chart 3: Relative abundance of phytophagous mite associated with pulse crops of West Bengal

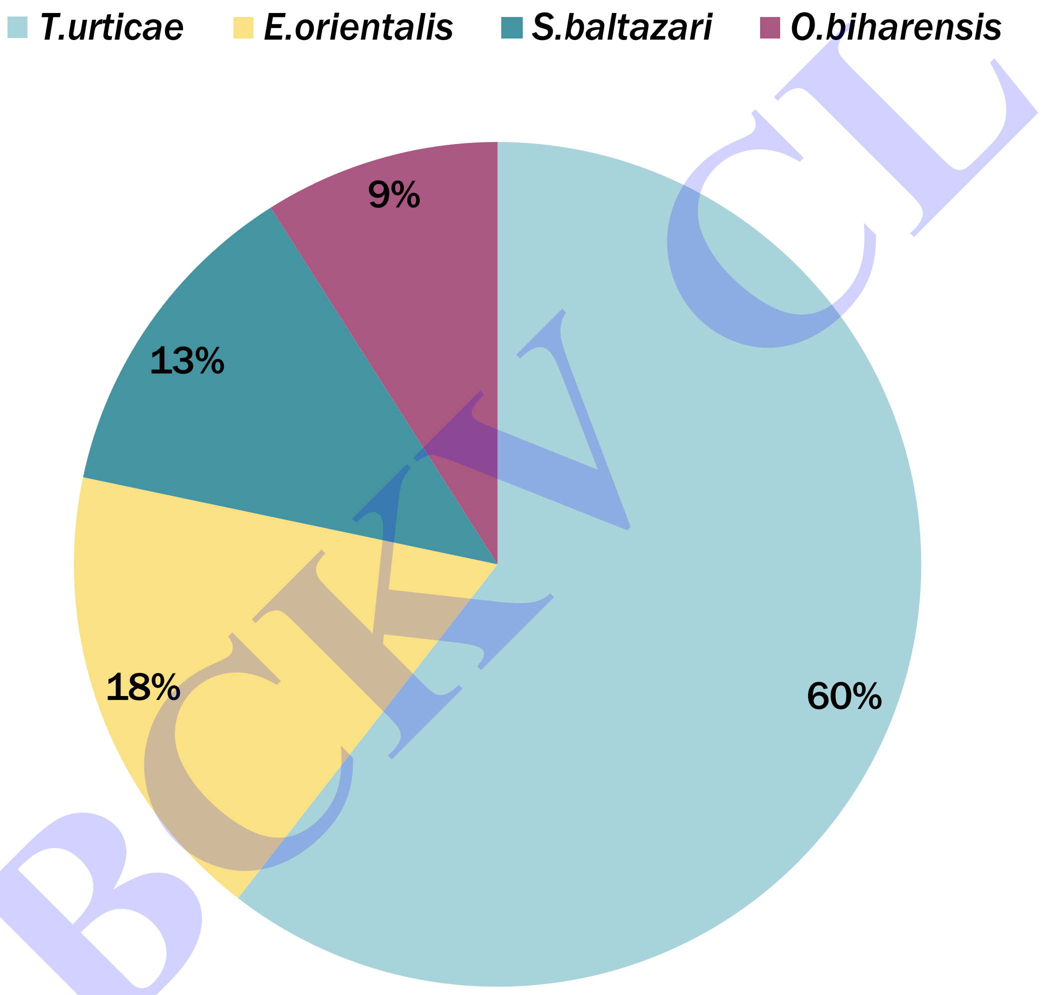

Plate 4 : *Amblyseius largoensis*

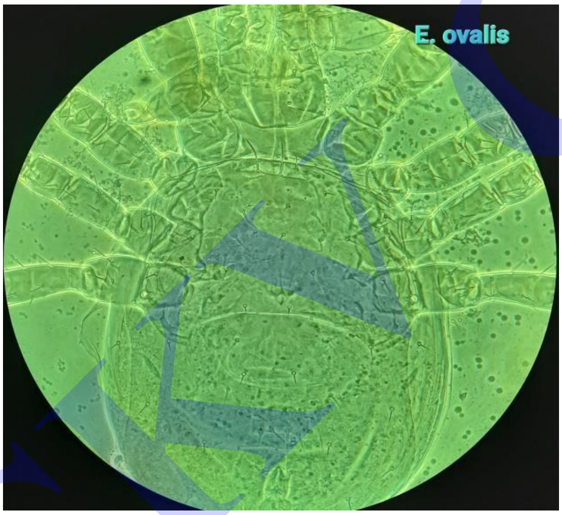

Plate 5: *Euseius ovalis*

Plate 6 : *Typhlodromips syzgii*

Plate 7 : Neoseiulus pranadae

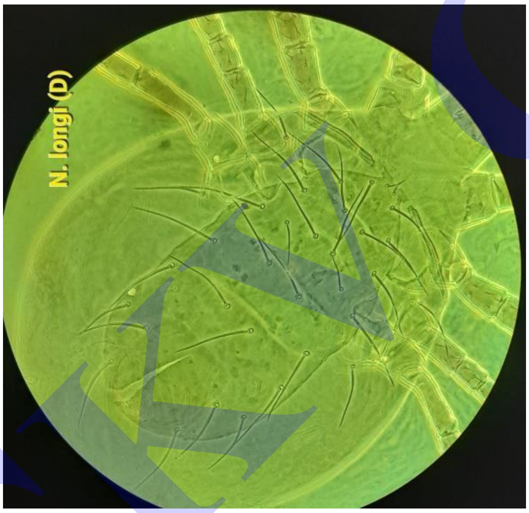

Plate 8: *Neoseiulus longispinosus (Dorsal)*

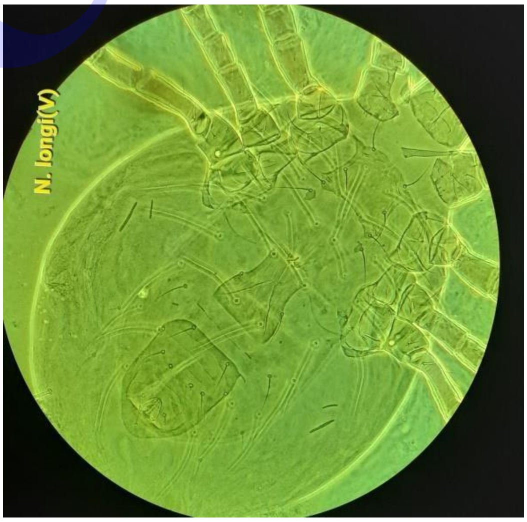

Plate 9: *Neoseiulus longispinosus (Ventral)*

Plate 10: Cunaxid mite

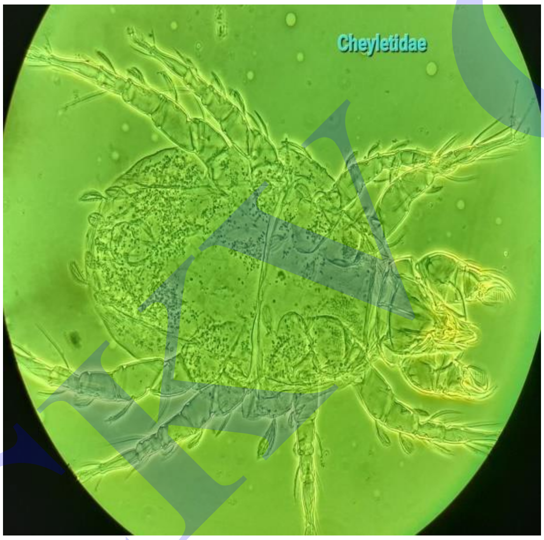

Plate 11: Chelytid mite

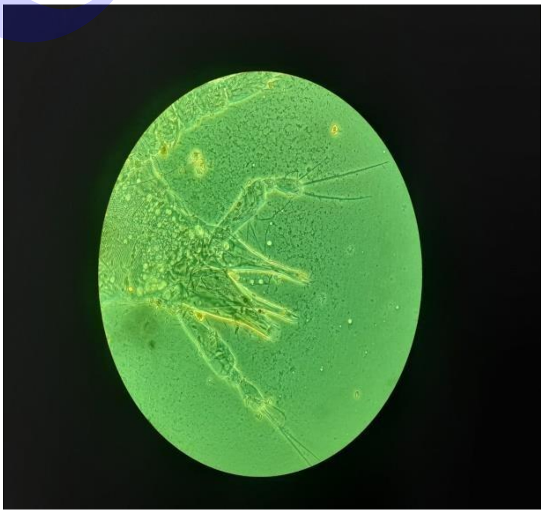

Plate 12: Bdellid mite

4.2. Life table study of *Oligonychus biharensis*

From the life fecundity parameters taken on January-February we can get the following results : Net Reproduction Rate(R_o)=2.96,Mean Gerneration Time (t_G) =16.41 days ,Intrinsic Rate of Natural Increase (Rm)=0.066,Finite rate of increase (λ) =1.06,Doubling time(Dt)=10.50 days . Life fecundity parameters taken on February –March give us the following results : Net Reproduction Rate(R_o)=5.65,Mean Gerneration Time(t_G) =16.93 days, Intrinsic Rate of Natural Increase (Rm)=0.102,Finite rate of increase (λ) =1.107,Doubling time(Dt)=6.79 days .

The durations of all the life stages were recorded in several temperatures in winter and starting of summer . Mean temperature of winter is 16.5 ° C and mean temperature of starting of summer is 32.5° C. The mites goes through different stages from egg to larva,protonymph,deutonymph and finally adult. In the mean temperature of 16.5 ° C the egg period is of 12.78±0.38 hours,larval period is of 5.68±0.24 hours,protonymph and deutonymph periods are 5.26±0.24 hours and 4.73 ±0.16 hours respectively. In the mean temperature of 32.5 ° C the egg period is of 4.81±.24 hours,larval period is of 2.37±0.20 hours,protonymphal and deutonymphal periods are 2.31±0.16 hours and 2.25 ±0.12 hours respectively. In 16.5° C the total development was completed in 28.45±1.02 hours and in 32.5 °C the total development was completed in 11.74±0.72 hours.

Table 7: Life fecundity parameters of *Oligonychus biharensis(Jan-Feb)*

Age in days (x)	No. of females surviving at age x (N)	Fraction of female surviving at age x, $a=N/N_0$	Egg hatchibility (b)	Survival rate of immature (c)	Age-specific survival rate, l_x=a.b.c	Egg laid by single female at age x (d)	Proportion of female in the population (e)	Age-specific fecundity, m_x=d.e	$l_x.m_x$	$x.l_x.m_x$
14	5(N_0)	1	12/20 =0.6	7/12= 0.58	0.35	2	4/7=0.57	1.14	0.39	5.46
15	5	1			0.35	3.2		1.82	0.64	9.6
16	4	0.8			0.28	4.5		2.56	0.71	11.36
17	3	0.6			0.2	4		2.28	0.45	7.65
18	3	0.6			0.2	3		1.71	0.34	6.12
19	2	0.4			0.14	2.5		1.42	0.19	3.61
20	2	0.4			0.14	3		1.71	0.24	4.8
									$\sum l_x.m_x$=2.96	$\sum x.l_x.m_x$ =48.6

- **Net Reproduction Rate(R_o)=2.96**
- **Mean Gerneration Time (t_G) =16.41 days**
- **Intrinsic Rate of Natural Increase (R_m)=0.066**
- **Finite rate of increase (λ) =1.06**
- **Doubling time(D_t)=10.50 days**

Table 8: Life fecundity parameters of *Oligonychus biharensis (Feb-March)*

Age in days (x)	No. of femals survivig at age x (N)	Fraction of female surviving at age x, $a=N/N_0$	Egg hatchability (b)	Survival rate of immature (c)	Age-specific survival rate, $l_x=a.b.c$	Total no. of eggs laid by N females at age x	Egg laid by single female at age x (d)	Proportion of female in the population (e)	Age-specific fecundity, $m_x=d.e$	$l_x.m_x$	$x.l_x.m_x$
14	7(N_0)	1	15/22=0.68	12/15=0.8	0.54	6	0.85	7/12=0.58	0.49	0.26	3.64
15	7	1			0.54	15	2.14		1.24	0.66	9.9
16	7	1			0.54	29	4.14		2.40	1.29	20.64
17	6	0.857			0.47	34	5.6		3.24	1.52	25.84
18	6	0.857			0.47	25	4.16		2.41	1.13	20.34
19	4	0.57			0.31	12	3		1.74	0.53	10.07
20	3	0.42			0.23	6	2		1.16	0.26	5.2
										$\sum l_x.m_x$ =5.65	$\sum x.l_x.m_x$=95.63

- ❑ **Net Reproduction Rate(R_o)=5.65**
- ❑ **Mean Gerneration Time(t_G) =16.93 days**
- ❑ **Intrinsic Rate of Natural Increase (R_m)=0.102**
- ❑ **Finite rate of increase (λ) =1.107**
- ❑ **Doubling time(D_t)=6.79 days**

Table 9: Duration of developmental phases of *Oligopnychus biharensis*

	Duration of Development (hrs.)				
	Egg	Larva	Protonymph	Deutonymph	Total Development
Lab temp. (16.5° C)	12.78±0.38	5.68±0.24	5.26±0.24	4.73±0.16	28.45±1.02
32.5° C	4.81±0.24	2.37±0.20	2.31±0.16	2.25±0.12	11.74±0.72

The analysis of the data showed that *Oligonychus biharensis* developed most rapidly during the hot condition. In contrast, development slowed due to lower temperatures. These findings align with previous research, which indicates that higher temperatures promote faster development. Specifically, this study have shown that this condition significantly shorten the developmental stages of important agricultural mite genera Oligonychus.

SUMMARY AND CONCLUSION

5. SUMMARY AND CONCLUSION

A total of 1501 specimens were collected from natural and cultivated pulse vegetation from 6 districts of West Bengal . Among them 16 predatory and 5 phytophagous mite species were found.The predatory mites are from 2 orders – Prostigmata and Mesostigmata.From the Mesostigmata order , 11 species of predatory mites of Phytoseiidae family were found.On the other hand, 5 predatory mites were found from different families (Ascidae,Bdellidae,Cunaxidae,Cheyletidae and Stigmaeidae) of Prostigmata order. All the 5 species of phytophagous mite from Prostigmatid order were of Tetranychidae family.Mostly abundant predatory phytoseiid mite *is Neoseiulus pranadae* Followed by *Typhlodromips Syzgii*. *Cunaxa sp.* is the most abundant predatory prostigmatid mite .The most abundant phytophagous mite is *Tetranychus urticae* .

The study revealed the highest diversity of predatory phytoseiid mite in terms of Shannon's diversity= 2.0937 and highest dominance of 0.4584. It reflects that the ecosystem of West Bengal is congenial for survival of few species of predatory mite.The predatory mites feed upon the phytophagous mites. So the database generated on mite fauna will be helpful in natural suppression of harmful phytophagous mites.

The total time for development of *Oligonychus biharensis decreases* with increase in temperature .The population of *Oligonychus biharensis* increases severely when the atmospheric temperature is high and so the infestation and yield loss due to them also inceasrs .In case of *Oligonychus biharensis,* the persual data showed that the net reproductive rate and finite rate of increase ,increased with increase in temperature . On the

other hand mean generation time and doubling time declined with increase in temperature.

Therefore, it is comprehended that *Oligonychus biharensis* prefers hot climatic condition for better growth and development.So,during this period appropriate management measures against this mite should be taken to control yield loss due to infestation by this mite.

FUTURE SCOPE OF RESEARCH

6. FUTURE SCOPE OF RESEARCH

Some future scopes of this study are as follows :

- **Expansion of Mite Fauna Studies**: Future research can expand beyond *Oligonychus biharensis* to include a broader spectrum of mite species associated with pulse crops. By documenting the diversity of mite fauna and their respective ecological roles, researchers can develop a more holistic understanding of mite communities and their impact on pulse crop health.
- **Longitudinal Studies on Population Dynamics**: Conducting longitudinal studies to monitor the population dynamics of *Oligonychus biharensis* over multiple growing seasons will provide insights into the long-term trends and fluctuations of mite populations. This can reveal patterns related to climate variability, cropping systems, and pest resistance, offering critical data for forecasting and managing mite outbreaks.
- **Development of Integrated Pest Management (IPM) Strategies**: The life table data on *Oligonychus biharensis* can be integrated into the development of targeted IPM strategies. Future research can focus on identifying natural predators and parasitoids of *Oligonychus biharensis*, evaluating their efficacy in controlling mite populations, and exploring biological control methods. Additionally, integrating cultural practices, such as crop rotation and resistant pulse varieties, can enhance the sustainability of pest management programs.
- **Genetic and Molecular Studies**: Investigating the genetic and molecular basis of resistance in *Oligonychus biharensis* to various control measures can provide valuable information for developing resistant crop varieties. Future studies can

employ molecular tools to understand the genetic diversity and adaptation mechanisms of *Oligonychus biharensis*, leading to the development of more effective and precise control strategies.

- **Impact Assessment on Crop Yield and Quality**: Assessing the direct and indirect impacts of *Oligonychus biharensis* on pulse crop yield and quality is crucial for understanding the economic implications of mite infestations. Future research can quantify yield losses and quality degradation associated with different mite population densities and evaluate the cost-effectiveness of various management practices.
- **Climate Change Implications**: With the ongoing impact of climate change on agricultural systems, future studies can explore how changing environmental conditions affect the life cycle, behavior, and distribution of *Oligonychus biharensis*. This research can inform adaptive management strategies to mitigate the effects of climate variability on mite populations and pulse crop production.
- **Educational and Extension Activities**: Translating research findings into practical recommendations for farmers is essential. Future work can include developing educational materials and extension programs to raise awareness about mite management practices among pulse crop growers. Workshops, training sessions, and outreach activities could help disseminate knowledge and promote best practices in pest management.
- **Biological control :**There is a growing global demand for agtricultural products with minimal or zero usage of chemicals,leading farmers to seek alternatives. The predatory mites feed upon the phytophagous mites. So the database generated on mite fauna will be helpful in natural suppression of harmful phytophagous mites.

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