SEASONAL ABUNDANCE AND DIVERSITY OF ARTHROPODS IN BT COTTON OF KALABURAGI, KARNATAKA, INDIA

***Original Research Article***

# ABSTRACT

Present study was conducted at Bt-cotton fields of selected study area of Kalaburagi. The results shows that a total 21 arthropods were recorded, among them 13 insects were categorized as pests and 8 were natural enemies; apart from that, 3 species of predatory spiders were recorded. In Bt cotton agro-ecosystem, leafhoppers, whiteflies, aphids, thrips, mites, and red cotton bugs were abundant during 35th, 36th, 40th, 38th, 39th and 46th SMW. On the other hand, natural enemies, viz, spiders, lady bird beetles, lace wings, hover flies, and ants were found predominantly during period of 34th to 36th SMW. A correlation studies shows that rainfall had a negative correlation with semilooper, whitefly, leafhopper, and hover fly and green lacewing population. Significantly positive correlation was observed between maximum temperature and mealy bug, green stink bug, pink bollworm and green lacewing, hover fly, white flies, and chafer beetle and spider population. Diversity of arthropod fauna was moderate to rich in Bt cotton agro-ecosystem of the selected study area (H'=2.09) with higher abundance of aphids followed by whiteflies, leaf hoppers, mites, thrips, and red cotton bugs.

**Keywords:** Bt-cotton; diversity; arthropods; ecosystem; pests; natural enemies.

# INTRODUCTION

Cotton, *Gossypium hirsutum* L*.,* is utmost important fiber crop of global importance, having high commercial value, and it is grown for trading purpose in the temperate and tropical zones of more than 70 countries of world, including India. Cotton is one of

the important and leading prime cash crops in Indian economy [1]. India is the only country which cultivates all the four species of cotton, viz., *Gossypium herbaceum, G. arboreum, G. hirsutum, G.barbadense* [2]. India as a major producer of cotton and it provides raw material to cotton textile industry. In Karnataka the cotton is grown in 4.64 lakh hectares

and annual production is 21 lakh bales [3]. Major Bt cotton growing districts of Karnataka includes Yadgir, Raichur, Kalaburgi, Bidar, Bellary, Koppal, Bagalkot, and Davanagere.

Transgenic Bt cotton is favourable and helpful in the management of the bollworm population, but sucking pest complex will damage the cotton crop with regular occurrence at different growth stages, reducing the yield of crop [4,5]. Cultivation of genetically modified Bt cotton resulted in increase of yield, and adoption of Bt cotton has decreased the use of chemical pesticides, which are much hazardous for the environment and human health [6]. Arthropods are most abundant creatures in nature; they may be found in air, aquatic medium also on and below the soil. They are dominant and most vital component in soil ecosystem. About 162 species of insects occurs in cotton at different stages of growth, out of which 15 are key pests which causes loss in yield [7]. Cotton ecosystem is shelter for many pests and predatory arthropod communities. Cotton pests can be primarily divided into foliage feeders and sucking pests.

The transgenic cotton showed great resistance to key pests, i.e., *Helicoverpa armigera (Hub.) Pectinophora gossypiella* (Saund.*), Earias insulana* (Biosd.), and *E. vittella* (Fab.) both in field and laboratory conditions [8]. Bt toxins can effectively control specific Lepidopterous species, and shows lack of resistance against sucking insect pests [9]. The key pests of cotton includes American bollworm and pink bollworm whereas sucking pests includes leafhopper, thrips, white fly, and aphids. The practice of Bt cotton has been decreased the usage of insecticides, but which may lead to increase population of sucking pests [10]. The commonly occurring predators in cotton, like chrysopa, spiders, and coccinellid spp. which prey upon the sucking pests of cotton and play an major role in the regulation of their population [11].

Ants are always having a positive impact in agriculture by consuming number of pest insects and increasing soil nutrients [12]. Now a day’s, heavy application of insecticides shows negative impact on the abundance of predatory arthropod species in cotton. At present, minimal information is available in the selected study area about pests and predators of cotton. Accordingly, the present study was undertaken to survey the abundance and diversity of arthropod pests and predatory fauna in the selected area, *i.e.,* Kodla village of Kalaburagi district. The conservation of natural enemies in agro ecosystems has to be recognized as a practice, and that must be implemented for effective Integrated Pest Management (IPM).

# MATERIALS AND METHODS

## Study Area

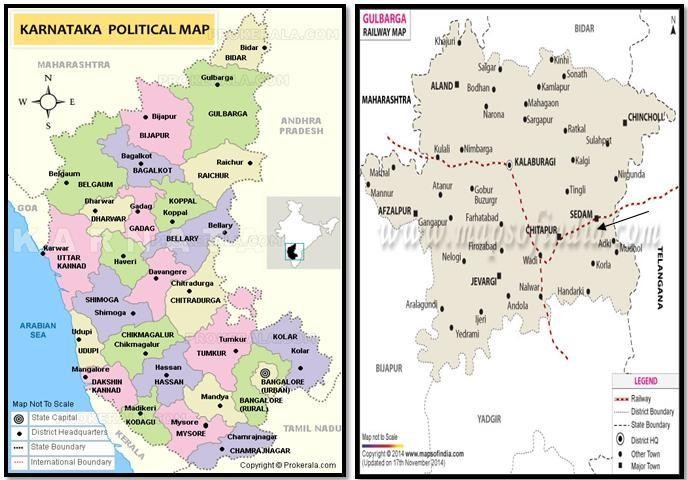
Kalaburagi district is one of the 30 districts of Karnataka State. Kalaburagi is the administrative headquarters of the District. It is situated in Deccan Plateau, located at 17°**-**33" North and 76°**-**83" East and area of 10,951 sq.km. The district is one among the major cotton growing areas in Karnataka. The present study was undertaken at selected Bt cotton fields of Kodla village, Sedam taluka, Kalaburagi. The hybrids of Bt cotton, namely Jadoo and Ajit, are practiced in selected study area. The present study was undertaken during July 2019 to December 2019.

During the study period, 10 rows in cotton field were randomly selected and 10 plants were selected at the centre of each row, which form square shaped study plot. On each plot, the arthropod samples were collected weekly for the sampling months. The study we also involved group discussion or individual interview with farmers on the type of pesticides and insecticides used for control of cotton pest such as Imidacloprid[1-(6-chloro-3- pyridylmethyl)-N- nitroimidazolidin-2-ylideneamine)], Cypermethrin (2- dimethyl cyclopropane carboxylate), Ampligo [Chlorantraniliprole (10%) + Lambdacyhalothrin (5%)] and Super killer (Cypermethrin 10%) etc.

## Methodology

Insects are usually less active in early morning and early evening hours. Hence, most of the collection was undertaken during morning hours and evening hours after sunset. Various sampling techniques were used to collect arthropod samples, namely, sweep net technique, pit-fall technique, and light-trap technique.

* + 1. **Sweep net technique:** This method is mostly used for flying arthropod species by using two types of nets. The sweeps were done during morning hours and also early evening. This method suits much for ground layer vegetation and helps to collect flying arthropods.
    2. **Pit-fall technique:** This method is used for the soil dwelling arthropods by using the 500 ml plastic jars buried so that the mouth was level with the soil surface, and rotten meat/fruits were kept in jar to attract arthropods. Detergent water is added to this jar to trap arthropods later; they were preserved in 70% alcohol or pinning method.
    3. **Light-trap technique:** Sometimes, in the late evening after sunset, we used light trap to attract flying arthropods, and they were collected.



**Map 1. Kalaburagi**

Sampling was carried out weekly for each plot. During the field visit wherever, adult stage arthropod specimens collected by all above methods were preserved by pinning or preserved in 70% alcohol for identification in the laboratory. The collected fauna were sent for identification Department of Entomology, College of Agriculture, Bheemaryangudi, University of Agriculture Sciences, Raichur, Karnataka.

## Environmental (weather) Factors in the Study Area of Kalaburagi

The temperature and rainfall during the study period of 2019 is recorded (Table 1). Maximum temperature of 43℃ was recorded in the month of May, and

minimum temperature of 15℃ recorded was recorded in the month of November during study period. The highest rainfall was recorded in the month of 10.4 mm in the month of May 2019. The same is represented in Fig. 1 and Fig. 2.

## Correlation between Weather (Abiotic) Parameters and Pests/Natural Enemies at Kalaburagi

The population of pests and natural enemies were correlated with many weather parameters. For correlation studies, data of weather parameters of preceding week were considered by the population of pests and natural enemies (predators) of current standard meteorological week (SMW).

**Table 1. Temperature and rainfall during the study year 2019**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Months** | **Temperature Maximum** | **Temperature Minimum** | **Rainfall Maximum** | **Rainfall Minimum** |
| January | 34℃ | 15℃ | 0 mm | 0 mm |
| February | 36℃ | 17℃ | 0 mm | 0 mm |
| March | 40℃ | 20℃ | 5.6 mm | 0 mm |
| April | 42℃ | 23℃ | 5.4 mm | 1 mm |
| May | 43℃ | 25℃ | 12.6 mm | 10.4 mm |
| June | 38℃ | 22℃ | 39.2 mm | 1.7 mm |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Months** | **Temperature Maximum** | **Temperature Minimum** | **Rainfall Maximum** | **Rainfall Minimum** |
| July | 35℃ | 22℃ | 18.5 mm | 1.3 mm |
| August | 37℃ | 22℃ | 18.8 mm | 1.6 mm |
| September | 38℃ | 21℃ | 36 mm | 1.2 mm |
| October | 36℃ | 21℃ | 54.4 mm | 1 mm |
| November | 35℃ | 16℃ | 0 mm | 0 mm |
| December | 35℃ | 17℃ | 8.6 mm | 0 mm |

**Fig. 1. Temperature during the study year 2019**

50

45

40

35

30

25

20

15

10

5

0

Temperature Max.

Temperature Min.

**Months**

60

50

40

30

20

Rainfall Max.

Rainfall Min.

10

0

**Months**

**Rainfall (mm)**

JAN

FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

**Fig. 2. Rainfall data during the study year 2019**

JAN

FEB MAR APR MAY JUN JUL AUG SEP OCT NOV

DEC

## Shannon Biodiversity Index

**Temperature (℃)**

Considering the occurrence of various types of species of pests and natural enemies in Bt cotton agro--

ecosystems of selected study area of Kalaburagi, the same data was used to estimate the diversity index for generic level/ species level by following Shannon diversity index using following formula.

s

H' = - ∑ (Pi ln Pi) i=1

Pi= ni/N

ni = number of individuals of species “i”

N = total number of individuals of all species pi

S = total number of species H’ = Shannon Diversity Index

pi = relative abundance of species “i”

# RESULTS AND DISCUSSION

## Arthropod Fauna Recorded in Bt Cotton Ecosystem of Study Area in Kalaburagi

During the Present study period, total of 21 arthropods were recorded in the selected Bt cotton Plot of study area in Kodla of Kalaburagi district (Table 2). The collected arthropods were differentiated in to thirteen pests and eight arthropod natural enemies (Predators). Out of thirteen pests, six were sap sucking pests such as whitefly, leaf hoppers, aphids, thrips, mealy bugs, and mites. Other important pests include green stink bugs, chaffer beetles, grasshoppers, tobacco cutworms, semiloopers, red cotton bugs, and one bollworm, i.e., pink bollworm, were recorded during the study period. Among nine natural enemies lady bird beetles, predatory spiders, hover fly, green lacewings, ants, mirid bugs, mantids

, and dragonflies were recorded. Other than these insects in selected Bt cotton agro-ecosystem, three predatory spiders were recorded, namely *Oxyopes* spp., *Theridion* spp., *Pardosa* spp.

Many researchers reported about these important sucking pests and their seasonal incidence [13,14] in Karnataka and Maharashtra. Some other authors have also reported about various types of arthropod pests and natural enemies from different parts of India [15]. Some also have reported about major predators and their role in controlling pests of cotton ecosystem [16]. These predators, such as lady bird beetles, mantids, hover fly and green lacewings, play an important role in Bt cotton agro-ecosystem. They further reported that the sucking pests like aphids, jassids, and thrips were effectively checked by these predators, but the insecticide usage and Bt toxins are affecting negatively on non target predatory arthropods in Bt-cotton [17]. Most of the insect-pests, including mite were observed to be commonly recorded pests in this locality. However, among the predators mired bug was found active in Bt cotton ecosystem besides other common predators. Spiders also acts as predators and prey on different pests. total 3 predatory spiders were recorded in Bt-cotton agro-ecosystem of study area in Kalaburagi district, namely, *Oxyopes* sp., *Theridion* sp. and *Pardosa* sp., and the same species were also recorded previous reports.

**Table 2. Arthropod pests and natural enemies recorded in bt cotton agro-ecosystem during study period**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl. No** | **Common Name of Arthropods** | **Species** | **Family** | **Order** | **Pests / Natural Enemies** |
| 1 | Whitefly | *Bemisia tabaci*  (Genn.) | Aleyrodoidae | Hemiptera | Pest |
| 2 | Leafhopper | *Amrasca biguttula*  *biguttula* (Ishida) | Cicadellidae | Hemiptera | Pest |
| 3 | Aphid | *Aphis gossypii*  (Glover) | Aphididae | Hemiptera | Pest |
| 4 | Tobacco cutworm | *Spodoptera litura*  (Fabricius) | Noctuidae | Lepidoptera | Pest |
| 5 | Pink  Boll worm (PBW) | *Pectinophora gossypiella*  (Saunders) | Gelechiidae | Lepidoptera | Pest |
| 6 | Thrips | *Thrips tabaci*  (Lindeman) | Thripidae | Thysanoptera | Pest |
| 7 | Grasshopper | *Hieroglyphus nigrorepletus*  (Bolivar) | Acrididae | Orthoptera | Pest |
| 8 | Semilooper | *Anomis flava*  (Fabricius) | Erebidae | Lepidoptera | Pest |
| 9 | Mites | *Tetranychus* sp. | Tetranichidae | Trombidiformes | Pest |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl. No** | **Common Name of Arthropods** | **Species** | **Family** | **Order** | **Pests /**  **Natural Enemies** |
| 10 | Mealy bug | *Phenacoccus solenopsis*  (Tinsley) | Pseudococcidae | Hemiptera | Pest |
| 11 | Green stink bug | *Nezara*  *viridula* (Linnaeus) | Pentatomidae | Hemiptera | Pest |
| 12 | Red  Cotton Bug (RCB) | *Dysdercus cingulatus*  (Fabricius) | Pyrrhocoridae | Hemiptera | Pest |
| 13 | Chafer beetle | *Oxycetonia versicolor*  (Fabricius) | Scarabeidae | Coleoptera | Pest |
| 14 | Ladybird Beetle | *Cheilomenes sexmaculata*  (Fabricius) | Coccinellidae | Coleoptera | Natural enemies |
| 15 | Mirid bug | *Creontiades biseratense*  (Distant) | Miridae | Hemiptera | Natural enemies |
| 16 | Hover fly | *Ischiodon scutellaris*  (Fabricius) | Syrphidae | Diptera | Natural enemies |
| 17 | Spiders | *Oxyopes* sp.  *Theridion* sp.  *Pardosa* sp. | Oxyopidae, Theridiidae, | Araneae | Natural enemies |
| 18 | Green lacewings | *Chrysoperla*  *zastrowi* (Sensu lato*)* | Chrysopidae | Neuroptera | Natural enemies |
| 19 | Ants | *-* | Formicidae | Hymenoptera | Natural  enemies |
| 20 | Mantid | *Mantis* sp. | Mantidae | Mantodea | Natural  enemies |
| 21 | Dragonfly | *-* | Aeshnidae | Odonata | Natural  enemies |

## Seasonal Abundance of pests in Bt Cotton Agro-Ecosystem

During the present study period thirteen pest species were recorded which includes, Whitefly (*Bemisia tabaci*), Leafhopper (*Amrasca biguttula biguttula)*, Aphids (*Aphis gossypii*)*,* Tobacco cutworm (*Spodoptera litura*), Pink Bollworm (*Pectinophora gossypiella*)*,* Grasshopper (*Hieroglyphus nigrorepletus*)*,* Semilooper (*Anomis flava*)*,* Mites (*Tetranychus* spp.), Mealy bug *(Phenacoccus solenopsis*), Green stink bug (*Nezara viridula*), Red Cotton Bug *(Dysdercus cingulatus*), Chafer beetle (*Oxycetonia versicolor*) which are divided into sucking pests and foliage feeding pests (Fig. 1 and Fig. 2) in the Bt-cotton plot of selected study area.

The whiteflies were noticed from 28th standard meteorological week (SMW), and Peak abundance was recorded in 36th SMW; later, they decreased in

number. The leafhoppers were noticed from 27th SMW to 48th SMW, and peak abundance was recorded in 38th SMW. The Aphids incidence was noticed from 28th SMW to 50th SMW, and abundance of aphids gradually increased, and peak level was recorded in 40th SMW. Incidence of thrips was noticed from 29th SMW to 50th SMW; their number increased moderately, and peak abundance was recorded in 38th SMW. Tobacco cut worm was recorded from 28th SMW to 32nd SMW. The Semiloopers were noticed from 30th SMW to 33rd SMW, but their population was scanty. The mite incidence was noticed from 35th SMW to 42nd SMW, but the peak abundance was recorded in the time of 39th SMW. The melay bugs were noticed from 36th SMW, and peak abundance was recorded in 38th SMW. The grasshopper incidence was from 37th SMW to 47th SMW, but peak abundance was recorded during 41st SMW. The green stink bugs were noticed from 36th SMW to 44th SMW. The incidence of red cotton bug was from 40th SMW

**Fig. 3. Seasonal abundance of sucking arthropod pests in Bt-cotton of study area during study period**

25

20

15

10

5

Leafhopper Whitefly Aphids Thrips Mites

Melaybugs

0

25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 51

**SMW**

5

4.5

4

3.5

3

2.5

2

1.5

1

0.5

0

Grasshoppers Green stink bugs Pink boll worm semiloopers Tobacco cut worm Chafer beetles

Red cotton bug

25 27 29 31 33 35 37 39 41 43 45 47 49 51

**Months**

**Population**

**Fig. 4. Seasonal abundance of foliage feeding arthropod pests in Bt-cotton of study area during study period**

51st SMW and their population gradually increased, and peak abundance observed at the time of 47th SMW. Chafer Beetles are noticed from 40th SMW, and they were abundant during 43rd SMW, but it was negligible. The pink boll worm incidence was noticed during formation of cotton bolls from 43rd SMW, and peak abundance bollworm larvae recorded at time of 46th SMW.

**Population**

## Seasonal Abundance of Natural Enemies (Predators) in Bt-Cotton Agro-Ecosystem

During the present study, a total of eight natural enemies (predatory arthropods) were recorded, namely, lady bird beetle (*Cheilomenes sexmaculata*)*,* Mirid bug (*Creontiades biseratense*)*,* Hover fly (*Ischiodon scutellaris*)*,* green lacewings (*Chrysoperla*

*zastrowi),* spiders (*Oxyopes* sp., *Theridion* sp., and *Pardosa* sp.), ants, mantis (*Mantis sp.*), and Dragon fly recorded in Bt cotton fields of the selected study area.

The incidence of lady bird beetles was noticed from 31st SMW to 48th SMW with gradual increase in the population, and peak abundance is recorded during 36th SMW. Hover flies were noticed from 31st SMW to 42nd SMW, and the abundance moderately increased during the period of 34th and 35th SMW. The incidence of spiders was observed from 32nd to 51st SMW, and gradually population increased and shown peak abundance during 36th SMW. Green lace wings were noticed from 32nd to 42nd SMW, and peak abundance was recorded in 35th SMW. Incidence of mired bug was noticed from 37th SMW to 50th SMW, but peak abundance was recorded in 45th SMW. The mantid populations were recorded from 33rd SMW to 48th SMW. The dragon flies were abundant during 38th SMW.

## Correlation between the Arthropod Population and Weather Parameters (Abiotic Factors) in Bt Cotton Agro- Ecosystem of Selected Study Area

A simple correlation was recorded and shows a relationship between the arthropod populations and the weather parameters in Bt cotton agro-ecosystem of selected study area of Kalaburagi (Table 3). The minimum temperature had a negative significant correlation with aphids compared to maximum

temperature, and they showed no significant correlation with rainfall. Maximum temperature (r= 0.897) shows positive significant correlation with semilooper population where as the minimum rainfall (r= -0.980) shows negative significant correlation with semiloopers. Minimum temperature (r= -0.659) shows negative significant correlation with mites population. The maximum (r

=0.491) temperature and minimum (r=0.501) temperature both shows positive correlation with population of melay bugs. Green stink bugs shows a positive correlation with maximum temperature (r=0.609) and shows negative correlation with minimum temperature(r=-0.471). The lady bird beetles shows significant positive correlation with minimum temperature(r=0.667) and are negatively correlated with maximum temperature. The hover flies population shows negative correlation with rainfall (r=-0.536). The spiders, which predator in nature, shows positive correlation with minimum temperature(r=-0.672). Green lacewings shows significant positive correlation with maximum temperature (r=0.762) and they shows a negative correlation with minimum temperature(r=-0.820) and rainfall(r=-0.496). Rain fall(r=-0.543) and minimum temperature(r=0.617) shows positive correlation with ant’s population. White fly and leafhoppers have no significant correlation with temperature. Maximum temperature (r=0.873) and minimum temperature (r=0.536) showed a significant correlation with pink bollworm population.

**Table 3. Correlation between arthropod population and weather factors in Bt cotton agro-ecosystem of Kalaburagi**

|  |  |  |  |
| --- | --- | --- | --- |
| **Insect** | **Temp. Max** | **Temp. Min** | **Rain fall** |
| Leafhopper | 0.023 | 0.393\* | -0.272 |
| Whitefly | 0.170 | 0.323 | -0.244 |
| Aphid | -0.070 | -0.728\*\* | -0.357 |
| Thrips | 0.218 | 0.139 | -0.311 |
| Semilooper | 0.914\*\* | -0.331 | -0.980\*\* |
| Mite | 0.273 | -0.659\*\* | -0.133 |
| Mealy bug | 0.491\*\* | 0.501\*\* | -0.089 |
| Grasshopper | 0.041 | 0.334 | 0.080 |
| Green stink bug | 0.609\*\* | -0.471\* | -0.177 |
| Red cotton bug | 0.128 | -0.468\* | -0.402\* |
| Chaffer beetle | 0.911\*\* | -0.733\*\* | -0.849\*\* |
| Pink boll worm | -0.873\*\* | -0.536\*\* | - |
| Lady bird beetle | -0.055 | 0.667\*\* | -0.038 |
| Hover fly | 0.119 | 0.407\* | -0.536\*\* |
| Spider | 0.261 | 0.672\*\* | 0.378\* |
| Green lacewing | 0.762\*\* | -0.820\*\* | -0.496\*\* |
| Ant | 0.199 | 0.617\*\* | 0.543\*\* |
| Dragonfly | -0.483\*\* | 0.269 | 0.862\*\* |
| Miridbug | 0.437\* | 0.114 | -0.176 |

*Significant correlation at 0.5% (r = 0.376), \*\* Significant correlation at 1% (r = 0.482)*

**Table 4. Shannon biodiversity index of arthropod fauna in Bt-Cotton agro-ecosystem in the study area of Kalaburagi during 2019**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name of Species** | **Av.No. of insect recorded** | **Percent abundance** | **Pi** | **ln Pi** | **Pi ln Pi** |
| Leafhopper | 64.35 | 13.77 | 0.137 | -1.985 | -0.273 |
| Whitefly | 41.54 | 8.88 | 0.087 | -2.447 | -0.212 |
| Aphid | 178.3 | 38.16 | 0.378 | -0.973 | -0.368 |
| Tobacco cut worm | 0.8 | 0.171 | 0.002 | -6.403 | -0.011 |
| Thrips | 29.87 | 6.38 | 0.07 | -2.665 | -0.186 |
| Semilooper | 1.98 | 0.43 | 0.003 | -5.71 | -0.019 |
| Mite | 38 | 8.11 | 0.083 | -2.491 | -0.206 |
| Mealybug | 3.78 | 0.8 | 0.009 | -4.733 | -0.042 |
| Grasshopper | 3 | 0.645 | 0.007 | -4.899 | -0.037 |
| Green stinkbug | 15.1 | 3.23 | 0.003 | -5.844 | -0.017 |
| Red cotton bug | 19.56 | 4.17 | 0.042 | -3.174 | -0.133 |
| Chafer beetle | 1.3 | 0.25 | 0.003 | -5.71 | -0.019 |
| Pink bollworm | 1.9 | 0.4 | 0.005 | -5.305 | -0.026 |
| Lady bird beetle | 12.2 | 2.61 | 0.028 | -3.57 | -0.101 |
| Hover fly | 4.8 | 1.02 | 0.012 | -4.457 | -0.052 |
| Spiders | 7.6 | 1.51 | 0.015 | -4.179 | -0.064 |
| Lacewing | 5.7 | 1.22 | 0.014 | -4.293 | -0.059 |
| Ant | 11.9 | 2.55 | 0.026 | -3.662 | -0.094 |
| Dragonfly | 1.6 | 0.37 | 0.004 | -5.592 | -0.021 |
| Miridbug | 23.2 | 4.96 | 0.05 | -2.994 | -0.15 |
| Total | 467 | 99.636 |  | H' = | 2.09 |

## Shannons Biodiversity Index of Arthropods in Selected Study Area

Shannon diversity index (Table 4) shows that the percentage abundance of sucking pests, *viz*, cotton aphids *Aphis gossypii* was 38.8 percent, followed by leafhopper (13.77%), whiteflies (8.8%), mite (8.1%), and thrips (6.3%) in descending order. Thus, the sucking pest complex shared more than 75 percent population of arthropod fauna. Red cotton bug shared (4.17 percent). Population of the pink boll worm was meager (0.44percent). Among the predators, mirid bug showed 5.01 percent, Lady bird beetles (2.62%), ant (2.54%), hover fly (1.02%), lacewings (1.37%), and Spider shared (1.51%) abundance and had more species diversity. A rich Shannon diversity index (H'

= 2.09) was recorded in *Bt* cotton ecosystem of selected study area, comprising twenty one different arthropods fauna.

# CONCLUSION

In the Bt-cotton agro ecosystem of selected study area, the abundance of natural enemies is less compared to pests. Heavy pesticide practicing is one among the reason for decrease in population of beneficial predatory (natural enemies) arthropod fauna. Abiotic factors also play an important role on the activities of arthropod fauna. Role of predatory spiders, Ladybird

beetle, Ants, and lace wings are noteworthy but their population is declined due to heavy pesticide application. Hence, the conservation of natural enemies has to be done by practicing integrated pest management with reduction in the use of harmful chemical pesticides, and instead of them, we should promote use of organic pesticides so that to achieve biological pest control and save the ecosystem.

# COMPETING INTERESTS

Authors have declared that no competing interests exist.

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