I J T A
© Serials Publications
National Academy of Agricultural Science (NAAS) Rating : 3.03

Diversity of Insect fauna associated with citrus ecosystem at Pantnagar

Deepika Chauhan[1*] and Poonam Srivastava[2]

ABSTRACT: *24 species of insect-pests, 11 species of natural enemies and 9 species of pollinators were recorded at various stages of the citrus. The diversity of insect fauna indicates eight orders having 30 families infesting various parts of citrus. The insect pests of major significance were Papilio demoleus L., P. polytes L., Diaphorina citri Kuwayana, Phyllocnistis citrella Stnt., Aleurocanthus wogulmi Ashby, Dialeurodes citri Ashmead. The remaining pests were of minor importance. Four sps. of coccinellid viz., Coccinella septempunctata, C. transveralis, Cheilomenes sexmaculata , Scymnus sp., were found during present study. Among the pollinators viz., Syrphus corollae Fab., Episyrphus balteatus De Geer and Melanostoma spp. L. (dipterans) and Apis dorsata, Apis mellifera and Tetragonula sp. (hymenopteran) were noticed as most abundant insect visitors on citrus flowers.*

Key words: *Citrus, diversity, insect-pests, pollinators.*

INTRODUCTION

The citrus family is the most cherished and highly prized fruit throughout the world. In India it is the third important fruit crop after Mango and Banana and have numerous therapeutic properties like anticancer, anti-tumor and anti-inflammatory. Citrus fruit are recognized as important components in human healthy life. Vitamin C, Beta-carotene, flavonoid, limonoid, folic acid and dietary fiber are important bioactive components found in these species and they certainly prevent (Sanofer, 2014) and cure vitamin C deficiency-the cause of scurvy (Aronson, 2001).

India ranks sixth in the production of citrus fruit in the world. In India citrus crop occupies a prominent place covering an area of about 10.78 L ha with an annual production of 111.47 L tonnes. (NHB, 2014).

The productivity and quality of citrus is severely affected by several factors; insect pests being one of them. Great diversity of soils and agro ecosystems in which citrus is grown in Asia are rich sources of insect fauna, In India 250 species of insects have been reported on various citrus species (Fletcher, 1921; Prut and Mani, 1945; Wadhi and Batra, 1964). A number of insect pests attack citrus plants both in the nurseries as well as in the orchards inflicting heavy economic losses. Majority of the insect pests occur at the new flush stage and damage the new growth thereby hampering the plant development. Some of the most serious pests of citrus includes: citrus caterpillars [*Papilio demoleus* Linnaeus and *Papilio polytes* Linnaeus (Lepidoptera: Papilionidae)], citrus psylla [*Diaphorina citri* Kuwayama (Hemiptera: Psyllidae)], citrus leaf miner [*Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae)], citrus whitefly [*Dialeurodex citri* Ashmnead (Hemiptera: Aleyrodidae)] and citrus red scale [*Aonidiella aurantii* Maskell (Homoptera: Diaspididae)] (Atwal, 1976).

Information on insect-pest complex in a particular agro climatic condition is a prerequisite for designing a successful pest management strategy. Likewise in order to enhance the productivity of the crop through pollinators activity, knowledge of insects that contribute in pollination of flowers is essential for their augmentation and conservation. Keeping in view, the present study has aimed to understand the various insect fauna associated with citrus ecosystem in Tarai region of UK. In turn this study would be helpful for developing the ideal and suitable management strategies.

MATERIALS AND METHODS

The experiment was conducted at Horticulture Research Centre, Patharchatta, G.B.Pant University of Agriculture and Technology, Pantnagar, during

* Department of Entomology, G.B. Pant University of Agriculture and Technology, Pantnagar- 263145.

July 2013 to July 2015. Pantnagar is situated at the foothills of Himalayas at an altitude of 243.84 meters above the mean sea level (MSL), 29^0N latitude and 79.3^0E longitude. Regular systemic surveys and surveillance were carried out at weekly interval to record and identify the insect-pest fauna in *Citrus* sp. The Collected insects were arranged systematically for identification.

RESULT AND DISCUSSION

44 species of insect-pests were recorded in the various cultivars of citrus. Of which 9 insect species belong to the order Lepidoptera, Hemiptera and Coleoptera, 7 species of Hymenoptera, 5 species of Diptera, and one species of Thysanoptera, Neuroptera and Dictyoptera were assessed during investigation. Among these 11 species of natural enemies and 9 species of pollinators were occurred in citrus ecosystem. A total of 25 insect-pest species were observed attacking the leaves, stem, flower and fruit of citrus. The collected insects-pests were categorized as major and minor according to their incidence and the extent of damage they cause.

The insect pests fauna observed in citrus ecosystem (presented in table 1) included psylla, *Diaphorina citri* Kuwayama (Hemiptera : Psyllidae), citrus butterfly, *Papilio demoleus* Linn. and *Papilio polytes* (Lepidoptera : Papilionidae), citrus leaf miner, *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillaridae), citrus black fly, *Aleurocanthus wogulmi* Ashby (Hemiptera: Gracillaridae), citrus aphid, *Toxoptera* spp. Kirkaldy, *Aphis gossipii* Glover (Hemiptera: Aphididae), citrus white fly , *Dialeurodes citri* Ashmead (Hemiptera: Aleurodidae), scale insect/ coccids, *Anoidiella aurantii,* citrus mealy bug (*Planococcus citri)*. The results showed that *D. citri*, *P. demoleus* and *P. polytes*, *P. citrella* were the major pests.

Citrus psylla, *D. citri* is one of the most destructive and consequently the most important of all the insect pests of citrus. Buds and soft young shoots are attacked by the pest, leaves become distorted and curled; honeydew production leads to sooty mould infestation. Badly damaged leaves die and fall and defoliation of branches can occur. It is thought that the saliva of the pest is probably toxic to produce such distortion (Dennis, 1983). Although there is a visible difference in the rise and fall of citrus psylla population in various seasons, yet the ill effects of its damage are so long-lasting that the trees may look sickly even when the pest population is not high. Thus sooty and sickly plants seen in the winter are the victims of this insect, which had caused damage during the previous summer (Atwal, 1976).

The high population of *D.citri* was observed during the study in the months of April, May, June and moderate during July, August, September, October, November, March and while no population was found during December, January, February during the year 2013-2015. During the period of study the grubs and adults of lady bird beetle *Coccinella septumpunctata* L. were also found to predate on the nymphs and adults of psylla. Hoy (2000) also reported that *C. septempunctata* is an efficient predator of citrus psylla. In the present investigation, *Tamarixia radiata*, a species specific ectoparasitoid of *Diaphorina citri* is also reported. *T. radiata* a eulophid parasitiod preferred to parasitized nymphs from the late (3rd, 4th and 5th instar nymphs) nymphal instars of citrus psylla. Adult of *T.radiata* emerges by chewing a circular exit hole in the integument of the thoracic region. Female *T. radiata* are reported to attack *D. citri* during the psyllids 3^{rd}, 4^{th} or 5^{th} instars nymphal development (Skelley and Hoy, 2004), by ovipositing particularly underneath the fourth and fifth instar nymph.

Papilio demoleus L., the citrus butterfly and *Papilio polytes* L. the common mormon butterfly are the major pest of citrus. The larva feed voraciously on the leaves of citrus and cause extensive damage to the fresh growth particularly in citrus nurseries and young saplings. Severe infestation causes entire defoliation of the tree. Infestation of lemon butterfly on citrus plants is always synchronized with the flush of new foliage. Lemon butterflies were active throughout the year but in present study it was found severe during the months of May, June, July and October, moderate during March, April, August, September, November however no activity found during December, January, and February. *P. demoleus* incidence was high in the month of August, September in Bundelkhand region of Uttar Pradesh (Pal *et al.,* 2000) and Alturi *et al.,* (2002) observed *P.demoleus* activity during June to October in *Citrus limon* in India.

Roberts (2001) reported that *P. polytes* is commonly seen during and after monsoon. The pest attacks mandarin and acid lime plantations almost throughout the year but serious during July-August (NHB, 2012). Yadav *et al.,* (1995) reported peak activity of *P.polytes* during February to June in Uttar Pradesh.

Citrus leaf miner (*P. citrella*) is an important pest attacking citrus. It was recorded as major pest of citrus as it attacked the new flush of citrus. The pest activity coincides with the new flushes The larva made

Table 1
Diversity of Insect pest fauna associated with citrus ecosystem

S.No.	Common name	Scientific name	Order	Family	Plant Parts/Crop Stage Damaged	Status/Intensity	Active Period/Peak Activity
1.	Citrus psylla	*Diaphorina citri* Kuwayama	Hemiptera	Psyllidae	Leaves, young shoots and buds	Major	March-Sept
2.	Lemon butterfly	*Papilio demoleus* L.*P. polytes* L.	Lepidoptera	Papilionidae	Tender leaves	Major	May-Oct
3.	Citrus leaf miner	*Phyllocnistis citrella* Stnt.	Lepidoptera	Phyllocnistidae	leaves	Major	Sept.-Dec.
4.	Citrus mealy bug	*Planococcus citri*	Hemiptera	Pseudococcidae	Leaves and tender twigs	Minor	February-March
5.	Fruit borer	*Helicoverpa armigera*	Lepidoptera	Pyralidae	Leaves, buds, fruits	Minor / Low to moderate	March-May
6.	Tobacco caterpillar	*Spodoptera litura*	Lepidoptera	Pyralidae	leaves	Minor	April
7.	Hadda beetle	*Epilachna vigintioctopunctata Fabricius*	Coleoptera	Coccinellidae	leaves	Minor	June
8.	Citrus looper	*Ascotis* sp.	Lepidoptera	Geometridae	Foliage	Minor	April
9.	Ash weevil	*Myllocerus* sp.	Coleoptera	Curculionidae	Root and Leaves	Minor	May-June
10.	Citrus black fly	*Aleurocanthus wogulmi* Ashby	Hemiptera	Aleurodidae	leaves	Major	Sep-April
11.	Citrus white fly	*Dialeurodes citri* Ashmead	Hemiptera	Aleurodidae	leaves	Major	March-April
12.	Fruit sucking bugs	*Chrysocoris grandis* Thunberg	Hemiptera	Pentatomidae	Buds and fruits	Minor	March-April
13.	Citrus aphid	*Toxoptera* spp. Kirkaldy *Aphis gossipii* Glover	Hemiptera	Aphididae	Leaves and twigs	Minor	February-March
14.	Citrus Scale insect/coccids	*Anoidiella aurantii* Maskell	Hemiptera	Diaspididae	Leaves	Minor	Sep.- October
15.	Four spotted beetle	*Monolepta signata*	Coleoptera	Galerucidae	Leaves	Minor	
16.	Cabbage semilooper	*Tircihoplusia ni*	Lepidoptera	Noctuidae	Leaves	Minor	September
17.	Citrus leaf roller	*Psorosticha zizyphi*	Lepidoptera)	Oecophoridae	Leaves	Minor	Sep- October
18.	Flea beetle	*Phyllotreta sp.*	Coleoptera	Chrysomellidae	Leaves and buds	Minor	April
19	Thrips	*Scirtothrips aurantii* Faure	Thysanoptera	Thripidae	Buds and young leaves	Minor	March
20.	Green stink bug	*Nezara viridula*	Hemiptera	Pentatomidae	Leaves and shoots	March	April
21	Ants	*Formica sp.*	Hymenoptera	Formicidae	Leaves and flowers	Minor	Feb.-April
22.	Bark eating caterpillar		*Indarbela quardinotata* Walker	Coleoptera	Metarbelidae	Bark	MinorApril
23.	Crane fly	*Tipula* sp	Diptera	Tipulidae	leaves	Minor	April

Table 2
Diversity of natural enemies associated with citrus ecosystem

S.No.	Natural Enemies	Order	Family	Host	
1.	Coccinellids	*Coccinella septempunctata* *Coccinella transveralis* *Cheilomenes sexmaculata* *Scymnus* sp.,	Coleoptera	Coccinelidae	Citrus aphid, citrus black fly, citrus white flyCitru psylla, thrips, mealy bug, scales
2.	Praying mantis	*Mantis* sp.	Dictyoptera	Mantidae	Leaf miner and many insect
3.	Psylla parasitiod	Tamarixia radiata (Waterston)	Hymenoptera	Eulophidae	Psylla nymph
4.	Citrus leaf miner parasitiod	*Citrostichus phyllocnistoides*	Hymenoptera	Eulophidae	Leaf miner
5.	Braconid parasitiod	Unidentified sp.	Hymenoptera	Braconidae	Citrus butterfly
6.	Spider	*Marpissa* sp, *Plexippus* sp.	Araneae	Salticidae	Thrips, flies
7.	Lace wing	*Chrysoperla* sp.	Neuroptera	Chrysopidae	Citrus aphid, citrus black fly, Citrus psylla, scales, thrips

Table 3
Diversity of Pollinators associated with citrus ecosystem

S.No.	Common name	Scientific Name	Order	Family	Subfamily
1.	Syrphid fly	*Syrphus corollae* Fab.	Diptera	Syrphidae	Syrphinae
2.	Syrphid fly	*Episyrphus balteatus* De Geer	Diptera	Syrphidae	Syrphinae
3.	Syrphid fly	*Melanostoma* sp. L.	Diptera	Syrphidae	Syrphinae
4.	Giant honey bee	*Apis dorsata* Fab.	Hymenoptera	Apidae	Apinae
5.	Italian honey bee	*Apis mellifera* Fab.	Hymenoptera	Apidae	Apinae
6.	Stinglees bee	*Tetragonula* sp.	Hymenoptera	Apidae	Melliponinae
7.	Cabbage butterfly	*Pieris brassicae* L.	Lepidoptera	Pieridae	Pierinae
8.	Painted lady butterfly	*Vanessa sp*	Lepidoptera	Nymphalidae	Nymphalini
9.	Housefly	*Musca domestica* L.	Diptera	Muscidae	Muscinae

serpentine mines in the leaves feeding on epidermal cells of the leaf and leave behind the remaining leaf tissues quite intact. The pest was seen throughout the year except during severe cold (January and February). Jadhav (1999) in Maharastra found that the leaf miner activity was peak during February – March, June – July and October – November. *Citrostichus phyllocnistoides* is reported as parasitiod of citrus leaf miner during present investigation. Wang *et al*. (2006) also reported that the third instar larvae of citrus leaf miner were the most preferred stage for parasitism by *C. phyllocnistoides*.

The citrus black fly (*A. wogulmi*) was observed on the leaves of citrus throughout the investigation period, severe during September and April. Citrus white fly (*D. citri*) was observed on the young leaves of citrus during the month of March and April. Various species of coccids were recorded feeding on various parts of citrus trees including branches, leaves, flowers and fruits. Among them *Anoidiella aurantii* was very common on citrus leaves during the months of September-October. Citrus mealy bugs (*Planococcus sp.*) were also seen during the months of February and March. Avidov (1970) also reported that scale insects were among the most injurious pests of citrus.

The present findings on the diversity and abundance of insect-pest associated with citrus ecosystem were in close conformity with the report of Ohgushi (1962). Who observed *Phyllocanthus citrella*, *Papilio* spp as the major pest of citrus in Omura city, Nagasaki, Japan.

The occurance of natural enemies of different insect pests of citrus comprising nine species of predator and three parasitiod is presented in table 2. Unidentified species of praying mantids are reported as predators of the citrus butterfly *Papilio demoleus* L. (Singh and Singh, 1998). Mani and Krishnamoorthy (2000) reported *Distatrix papilionis* is a potential braconid larval parasitoid of citrus butterflies causing up to 73% parasitism in India. *Tamarixia radiata*, a species specific ectoparasitoid of *Diaphorina citri* and *Citrostichus phyllocnistoides* is reported as parasitiod of citrus leaf miner during present investigation. Four sps. of coccinellid *viz*., *Coccinella septempunctata, Coccinella transveralis, Cheilomenes sexmaculata, Scymnus* sp., were found during present study.

A total of 9 insect visitors species were collected on citrus flowers. Of which 3 insect species belong to the order Hymenoptera and 4 of Diptera and 2 species of Lepidoptera. Syrphids and hymenopterans were noticed as most abundant insect visitors on citrus flowers during the present study. *Syrphus corollae* Fab., *Episyrphus balteatus* De Geer and *Melanostoma* spp. L. (dipterans) and *Apis dorsata*, *Apis mellifera* and *Tetragonula* sp. (hymenopterans) were recorded during present study. Besides these, other insect visitors such as *Musca domestica* L. *Pieris brassicae* L. and painted lady butterfly were also found on the citrus flowers during investigation.. In earlier studies also, the honey bees (*Apis* sp.), non apis bees, syrphid flies, ants, and wasps (Das and Chodhury, 1968) and the *Tetragonula sp.* (Chacoff and Aizen, 2006) were reported to visit citrus flowers and many of these were important pollinators of citrus crop.

The survey will help in yielding the seasonal incidence and population dynamics of major pests with which suitable management practices can be recommended and timely control measure can be adopted. As most of the major pests *viz*., citrus butterfly, leaf miner, psylla and thrips attack the tender leaves, a prophylactic spray at the new flush stage of the crop will protect from the pests. The continuous survey and surveillance will help in timely protection of the crop by preventing the pests from reaching the economic injury levels (Sreedevi, 2010).

REFERENCES

Ahmad, M.M., Rehman, Z.S.U., Anjum, F.M.I and Sultan, J.I. (2006), Genetic Variability to Essential Oil Composition in Four Citrus Fruit Species", *Pak. J. Bot.*, 38(2): 319-324.

Alturi, J.B., Ramana, S.P.V. and Reddi, C.S. (2002), Life history of Princeps demoleus (Lepidoptera: Rhopalocera: Papilionidae) from India. *J Natl Taiwan Mus*. 55: 27–32.

Aronson, J.K., (2001), Nature Publishing Group. Retrieved from: *http://medicine.nature.com*

Atwal, A.S. (1976), Agricultural Pests of India and South-East Asia. Kalyani Publishers Ludhiana., Delhi. pp. 195-213.

Avidov, Z. (1970), Biology of natural enemies of citrus scale insects and the development of methods for their mass production. [8] + 247 pp. 107.

Chacoff, N.P and M.A. Aizen (2007), Pollination requirements of pigmented grapefruit (*Citrus paradisi* Macf.) from northwestern Argentina. *Crop Sci.* 47: 1143-1150.

Das, C. S., and Choudhury, R. (1958), Floral biology of litchi *(Litchi chinensis* sonn.). *Indian Hort.* 6(1): 17-22.

Fletcher, T. B. (1921), Life histories of Indian insects. Microlepidoptera. Mem. Dept. Agric. India 6:1-217, 68 p. Foliage and Fruit. In 2005 Florida Pest Management Guide. [Available at *http://edis.ifas.ufl.edu/CG004*]

Mani, M; and Kirshnamoorthy, A. (2000), Safety of plant products and conventional pesticides to *Distatrix papilions* (Vireck) (Hymenoptera; Braconidae), a parasitoid of citrus butterfly.*Indian Journal of Plant Protection. 28*: 1, 19 – 24; 20 ref.

National Horticulture Mission, (2012), Ministry of Agriculture, Department of Agriculture & Cooperation Krishi Bhawan, New Delhi, IPM Schedule for Citrus Pests, Extension Bulletin No. 4 , PP. 19-20.

Ohgushi, R. (1962), Ecological studies on the injurious insects attacking the young branches and forages of citrus orchard, a preliminary report. *Japanese J. Eco.*, 14: (6), 241-247.

Pruthi HS, Mani MS. (1945), Our knowledge of the insect and mine pests of the citrus in India and their control. *Imperial Council Agricultural Research Sciences Monograph* 16: 1-42.

Ram, P., Pal, R.K. and Singh, J. (2000), Incidence of lemon butterfly, Papilio demoleus on citrus. *Ann Plant Prot Sci.* 8(2): 245-246.

Sanofer. A. A. (2014), Role of Citrus Fruits in Health. *J. Pharm. Sci. & Res.* 6(2): 121-123.

Shah, N. C. (2015), Citrus fruits in India Part II. *The Scitech Journal*, 2(1): 33-39.

Singh, S.B. and Singh, H.M. (1998), Natural Enemies associated with insect pests of lemon, *Citrus limon Birm. Shashpa*. 1998, 5: 1, 109-110.

Skelley, L.H. and M.A. Hoy, (2004), A synchronous rearing method for asian citrus psyllid and its parasitoid in quarantine. *Bio. Cont.*, 29: 14–23.

Sreedevi, K. (2010), Survey and Surveillance of insect pests and their natural enemies in Acid lime ecosystems of south coastal Andhra Pradesh. 2010. *Pest Management in Horticultural Ecosystems,* Vol. 16, No. 2 pp 131-135.

Wadhi, S.R. and Batra, H. N. (1964), Pests of tropical and sub-tropical fruit trees. In: Entomology in India 1938-1963. Silver Jubilee Number of the *Indian J. Ento.,* 247.

Wang, L., Bisseleua, D.H.B., M. You., J. Huang and Liu, B. (2006), Population dynamics and functional response of *Citrostichus phyllocnistoides* (Narayanan) (Hymenoptera.: Eulophidae) on citrus leafminer, *Phyllocnistis citrella* (Stainton) (Lepidoptera: Phyllocnistidae) in Fuzhou region of south-east China. *Journal of Applied Entomology*, 130 (2): 96-102.

Yadav, L. B. and Rizvi, S. M. A. (1995), Studies on the insect pests of lime, Citrus aurentifolia Swing. In eastern Uttar Pradesh. *Ann Plant Prot Sci.* 3(1): 34-37.