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Biodiversity of insect pests of cole crops in mid hills of Meghalaya

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Abstract
The North eastern region of India is one of the mega biodiversity hotspots in the World. The climatic conditions of the region are highly conducive for reproduction and multiplication of insects. The efforts were undertaken to study the biodiversity of major insect pests of cole crops in mid hills of Meghalaya. Limited information is available on insect pests in cole crops ecosystem in mid –hills of Meghalaya. A total of 12 insect pests belonging to four insect orders viz., Lepidoptera (6), Coleoptera (2), Diptera (2), Hemiptera (2) were documented during the year 2014-2015. The large white cabbage butterfly (*P. brassicae*) green peach aphid (*Myzus persicae*) and tobacco caterpillar (*Spodoptera litura*) were found to be the most serious pest of cole crops in this region. Besides, diamondback moth (*Plutella xylostella*) was also found to be the one of the major pest of late planted cole crops. Striped flea beetle (*Phyllotreta striolata*), leaf beetle (*Monolepta quadriguttata*), cabbage looper (*Thysanoplusia orichalcea*), cabbage stink bug (*Eurydema dominolus*), small white cabbage butterfly (*P. canidia*), fruit fly (*Bactrocera tau*), dipteran fly (*Allactoneura* sp) and cabbage heart caterpillar (*Crocidolomia pavonana*) appeared to be a minor pest. The collected species were identified by established taxonomic keys and by taxonomists. The comprehensive data generated from present study would be useful in further understanding of the biodiversity of arthropod fauna associated with cole crops in other regions of the country and this study would certainly have implications for pest management, taxonomy, quarantine and trade and for development of diagnostic guide.

Keywords: Biodiversity, major insect pests, ecosystem

Introduction
Cole crops, one of the most abundantly consumed vegetables in the world belonging to the family Brassicaceae comprises about 380 genera and over 3000 species of cultivated and wild plants that have almost similar insect pest complex (Heywood, 1993) [11]. Family Brassicaceae consists of 380 genera and over 3000 species of cultivated and wild plants that have almost similar insect pest complex (Heywood, 1993) [11]. Throughout the world, a total of 51 insect pests species (Maison, 1965) [16] and a total of 37 insect pest species from India have been reported to feed on cruciferous crops (Lal, 1975) [15]. Although horticultural brassicaceous plants are excellent sources of fiber, vitamins and minerals, the majority of the research has concentrated on the content of secondary metabolites, primarily glucosinolates .The enormous yield and economic losses in *Brassica* crop production every year caused by insects is a threat to global agriculture. Sometimes the yield loss by insects reaches as high as 60-70% and a report has been made that Indian agriculture is currently suffering an annual loss of about ₹ 86.39 million due to insect pests (Dhaliwal *et al*., 2007) [4]. On an average 25-30% yield loss in vegetables worldwide is caused by insect pests (Reddy and Zehr, 2004) [22].
With the increase in the production and the productivity of agricultural crops, by intervention of high yielding varieties, agro-chemicals, irrigation, monoculture *etc*., there have been tremendous changes in the pest scenario of the crops (Dhaliwal and Arora, 2001; Atwal and Singh, 1990). Eventhough pathogens and nematodes cause constrain in the production of vegetable brassica, the major challenge with Brassicaceae production is the damage caused by insect pest complex right from germination till harvesting stage (Dhaliwal and Arora, 2001) [3]. Out of the 800,000 - 1,000,000 species of insects that have been described so far, not more than 1,000 (about 1/10 of 1%) can be regarded as serious pests, and less than 10,000 (about 1%) are occasional or sporadic pests (Meyer, 2009). A total of 51 insect pests species damaging cruciferous crops have been reported from throughout the world (Maison, 1965) [16]. In India a total of 37 insect pest species have been reported to feed on cruciferous crops (Lal,

1975) [15]. Amongst all, diamondback moth (DBM) (Plutella xylostella L.), head caterpillar (*Croccidolomia binotalis Zeller)*, webworm (*Hellula undalis Fab.)*, cabbage butterflies *(Pieris brassicae, P. canidia and P. rapae* L.), aphids (Lipaphis erysimi Kaltenbanch and *Brevicoryne brassicae **Linn.)*** **and** flea beetle (*Phyllotreta brassicae Goeze*) are most common insect pests on vegetable brassicas in India (Srinivasan and Murthy, 1991). Insect pests cause enormous yield and economic losses in Brassica crop production every year, and are a threat to global agriculture. Sometimes the yield loss by insects reaches as high as 60-70% and it is reported that Indian agriculture is currently suffering an annual loss of about ₹ 86.39 million due to insect pests (Dhaliwal *et al*., 2007) [4]. Insect pests, on an average, cause 25-30% yield loss in vegetables worldwide (Reddy and Zehr, 2004) [22].

North east India is considered as one of the mega biodiversity hot spots (Mayer *et al*., 2000) [17]. North east India comprises of eight states, viz., Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. This region comprises of 7.7% of India's total geographical area supporting 50% of the flora (ca.8000 species) (Rao, 1994), of which 31.58% (ca.2526 species) is endemic (Khosoo, 1998). North east India has a predominantly humid sub-tropical climate with hot, humid summers, severe monsoons and mild winters. Meghalaya is a part of North Eastern Himalayas and it is a land-locked territory with a geographical area of 22 429 km2, lying between 25° 47' and 26° 10' N latitude, and 89° 45' and 92° 47' E longitude. Meghalaya state is exceptionally rich in biodiversity of insect pests and their natural enemies. About 50% species of Indian flora is confined to north eastern region of the country (Rao and Hajra, 1986) [21].

The vertical distribution of important pests of cole crops in Meghalaya was found to be influenced by the environmental factors as the climatic conditions of North east India are highly conducive for reproduction and development of insect species (Sachan and Gangwar, 1980) [23]. Moreover, North east India shares international borders with five different countries, therefore trans-boundary insect migration is also inevitable. Although some studies have been done, till date no comprehensive information is available, especially of major insect pests of cole crop ecosystem of India or Meghalaya. Many more unidentified insect species might have been harboring under cole crop ecosystem in this region. Accurate identification of already identified species is also is an issue as evidenced in different species of cabbage white butterfly *(Pieris brassicae, P. napae, P. rapae and P. canidia)* (Pachuau *et al*., 2012) [19]. Therefore, major aim of this study is to study and develop data of major insect pests of cole crops in mid hills of Meghalaya. The details of major insect pests of cole crop ecosystem would be very useful and could be shared with other research community and quarantine agencies across the globe.

Materials and Methods

Location and Site

Studies on "Biodiversity of Insect pests of cole crops in mid hills of Meghalaya" was carried out during 2014-15 in the IPM laboratories of Entomology section of Crop Protection Division, ICAR Research Complex for North Eastern Hill (NEH) Region, Umiam, Meghalaya. The institute is situated at Umiam (Barapani), 25º41'-21" North latitude and 91º55'-25" East longitude having an elevation of 1010 m above the msl. The climatic condition in this area is of mid tropical zone, with an average annual rainfall of 2810 mm with maximum temperature range of 20.90C to 27.40C and minimum temperature from 6.70C to 18.10C. The biodiversity of natural enemies of cole crops in this area was observed during the experimental period.

Sample collection

Specimens (Maximum 10 each) were collected from two multiple experimental plots of cole crops at two different locations viz., Entomology experimental farms of Entomology Section and Horticulture Division of ICAR Research Complex for North East Hill Region, Umiam (Barapani), Meghalaya during October 2014 to March 2015 (Table 1). Various collection methods were practiced for collection of samples from cole crops. Larvae (of butterfly and moths), several bugs and beetles were collected by hand picking. Medium sized flying insects were collected with the help of Insect net by sweeping small flies and aphids were collected by aspirator. In case of larvae, the specimens were reared to adulthood on their natural host in laboratory and adult was used for identification. A maximum ten specimens were collected for each species. Information on host plant, location, collection date and stage collected were recorded for all the individual species.

Species identification

Preliminary identification of the collected samples was done based on established taxonomic key or by matching the characters with identified species in Insect Museum of Entomology section of Crop Protection Division, ICAR Research Complex for NEH Region, Umiam, Meghalaya. For further confirmation of the identified species, specimens were also sent to IARI (Indian Agricultural Research Institute), New Delhi and ICAR-NBAIR (National Bureau of Agricultural Insect Resources), Bengaluru. Some samples which were not identified by established taxonomic keys were also sent to IARI and NBAIR.

Preservation

The multiple specimens of species which were identified using established taxonomic keys and later by taxonomist were preserved in 100% ethanol. All the tubes were labelled with name of species and other collections details. The voucher specimens of all the identified species were maintained at Insect Museum, Division of Crop Protection of ICAR Research Complex for NEH Region, Umiam, Meghalaya. The dry specimen of insects were spread and pinned and kept in insect box for display with proper information about each species. A clear and close up photo of various specimens was also maintained separately.

Results & Discussion

Biodiversity of major insect pests of cole crops ecosystem of Meghalaya

The North-Eastern Himalayan region of India is exceptionally rich in terms of flora and fauna and is also considered to be one of the mega biodiversity hotspot in the World (Mayer *et al*., 2000) [17]. Bio-diversity of arthropod fauna is varied in between crops, regions and habitat. Therefore, the more knowledge on this aspect is crucial for formulating proper insect pest management techniques and especially in case of implementation of biological control programmes where each tropic level have significant impact on other organism. In present investigation a total of 12 insect species were

observed and documented (Table 2). It is well known fact that, the species complex within the same crop ecosystem varied from region to region due to climatic condtions and other factors. A total of 51 insect pests species infesting the cole crops across the World have been reported and documented (Maison, 1965) [16]. Another study carried out by Pajmon in 1965 observed about 38 insect pest species in cole crop ecosystem. In India, a total of 37 insect species infesting cole crops across different parts of the country have also been reported (Lal, 1975) [15]. The study which was specifically conducted in North-eastern Himalaya reported and documented similar insect pest species on cole crops (Azad *et al*., 2012) [1]. Cabbage butterflies *(P. brassicae and P. canidia),* aphids *(B. brassicae and L.erysimi),* diamondback moth *(P. xylostella),* cabbage head borer *(H. undalis),* semilooper *(P. orichalcea),* cabbage semilooper (P. orichalcea, Trichoplusia ni), cutworm *(Agrotis flammatra),* flea beetle *(Phyllotreta cruciferae),* painted bug *(Bagrada cruciferarum),* leaf webber *(Crosidolomia binotalis),* cutworm *(Agrotis ipsilon)* and saw fly *(Athalialugens proxima)* are common insect pests recorded from North-eastern himalaya.In present investigation, Large white cabbage butterfly *(P. brassicae),* tobacco caterpillar (Spodoptera litura), Diamond back moth (P. xylostella) and Green peach aphid (M. persicae) were found to be the important major pests which were found infesting both cabbage and cauliflower crops in 2014-15 (Table 2, Plate 1-4). Firake *et al*. (2012) also reported and documented 15 insect pests in the cruciferous ecosystem of Meghalaya where the large white cabbage butterfly *(P. brassicae)* and mustard aphid (L. erysimi) were the most serious pest of vegetable brassica *(cole crops).* In present investigation, P. xylostella was observed to be the late season pest of cole crops in the cole crop ecosystem of Meghalaya (Table 2, Plate 3). Irrespective of season cabbage butterflies, *(P. brassicae and P. canidia),* aphids *(M. persicae and L. erysimi)* and sometime S. litura have been reported to be the major pests in cole crop ecosystem of Meghalaya.

Different species of cabbage butterflies, passes the winter in the plains and migrates to hilly regions during summer in India. These pest species causes extensive damage in almost all parts of India including north-eastern region during seedling, vegetative and flowering stages of cole crops (Sachan and Gangwar, 1980) [23]. Moreover, Talekar and Shelton (1993) [24] reported that diamondback moth, Plutella xylostella is another most severe pest of crucifers worldwide. In present investigation, P. xylostella was observed to be the major pest of late season/planted cole crops in mid altitudes of Meghalaya. The caterpillars of this pest are defoliator that hampers the successful cultivation of cabbage in the world. Previous report shows that, in India, it was first recorded (Fletcher, 1914) [10] on cruciferous vegetables. Now P. xylostella has been noticed all over India on all the crops belonging to the family Brassicaceae (Devi *et al*., 2004) [2].

Sharma and Bisht (2008) reported cauliflower and cabbage as a major host plant of S. litura in India. S. litura has also been reported as the most destructive pest of cabbage and cauliflower crops in Tamil Nadu (Kumar and Rangupathy, 2001) reported. S. litura was also considered to be the most harmful pest of turnip crops, larvae of this pest remains in the crop upto maturity and causes maximum damage during the vegetative phase of the plant (Fatah *et al*., 1977) [7]. In India S. litura causes economic losses to host crops in the range of 25.8 to 100% based on crop stage and its infestation level in the field *(Dhir et al., 1992)* [6]. The cabbage aphid (B. brassicae) and the green peach aphid *(M. persicae)* are important sucking pests of cole crops across the World. The cabbage aphid feeds only on plants in the Cruciferae family (cole crops, mustard, etc.), M. persicae is a serious winter greenhouse pest (Hines and Hutchinson, 2011).

In present investigation, striped flea beetle *(Phyllotreta striolata),* leaf beetle *(Monolepta quadriguttata),* cabbage looper *(Thysanoplusia orichalcea),* cabbage stink bug *(Eurydema dominolus),* small white cabbage butterfly (P. canidia), fruit fly (Bactrocera tau), dipteran fly (Allactoneura sp) and cabbage heart caterpillar *(Crociolomia pavonana)* appeared to be a minor pests of cole crops (Table 2, Plate 5-12). Among these minor pests, P. striolata was reported first time from north east India (Table 2, Plate 5). This pest has not been reported on cole crops from north east India. Similarly and as per the existing literature scan, the Bactrocera tau (Table 2, Plate 11) has also not been reported as a pest of cole crops from India. B. tau was found to be the minor pests of knol-khol in mid altitudes of Meghalaya.

Conclusions

In this study, we have analysed and documented only 12 insect pests of cole crops, but there may be more species harboured in this region of India. Therefore, additional studies have to be undertaken to get a clear picture of insect pests diversity and the pest status in the region. The comprehensive data generated from present study would be useful in further understanding of the biodiversity of arthropod fauna associated with cole crops in other regions of the country and this study would certainly have implications for pest management, taxonomy, quarantine and trade and for development of diagnostic guide.

Disclosure statement-

No potential conflict of interest was reported by the authors.

Table 1: Collection details of specimen during experimental season (2014-15)

Sl. no	Name of insect species	Order	Family	Date of collection	Host	Location
1	*Pieris brassicae*	Lepidoptera	Pieridae	Nov. 2014	Cabbage	Ento.Field
2	*Pieris canidia*	Lepidoptera	Pieridae	Nov. 2014	Cabbage	Ento.Field
3	*Plutella xylostella*	Lepidoptera	Plutellidae	Nov. 2014	Cabbage	Ento.Field
4	*Spodoptera litura*	Lepidoptera	Noctuidae	Nov. 2014	Cabbage	Ento Field
5	*Monolepta quadriguttata*	Coleoptera	Chrysomelidae	Nov. 2014	Knol-khol	Ento.Field
6	*Thysanoplusia orichalcea*	Lepidoptera	Noctuidae	Nov. 2014	Cabbage	Horti Field
7	*Bactrocera tau*	Diptera	Tephritidae	Nov. 2014	Knol-khol	Horti Field
8	*Crocidolomia pavonana*	Lepidoptera	Crambidae	Nov. 2014	Cauliflower	Ento. Field
9	*Phyllotreta striolata*	Coleoptera	Chrysomelidae	Feb. 2015	Radish	Ento. Field
10	*Eurydema dominulus*	Hemiptera	Pentatomidae	Feb. 2015	Cabbage	Ento. Field
11	*Allactoneura sp*	Diptera	Mycetophilie	Feb. 2015	Radish	Horti Field
12	*Myzus persicae*	Hemiptera	Aphididae	Feb. 2015	Cauliflower	Ento. Field

Table 2: Image and Biodiversity of insect pests of cole crops ecosystems in mid altitude of Meghalaya.

Sl. no	Common name	Scientific name	Pest status	Plate no.
1.	Large white cabbage butterfly	*Pieris brassicae*	Major pest	1
2.	Tobacco caterpillar	*Spodoptera litura*	Major pest	2
3.	Diamondback moth	*Plutella xylostella*	Major pest	3
4.	Green peach aphid	*Myzus persicae*	Major pest	4
5.	Striped flea beetle	*Phyllotreta striolata*	Minor pest	5
6.	Dipteran fly	*Allactoneura sp*	Minor pest	6
7.	Leaf beetle	*Monolepta quadriguttata*	Minor pest	7
8.	Cabbage stink bug	*Eurydema dominulus*	Minor pest	8
9.	Cabbage heart caterpillar	*Crocidolomia pavonana*	Minor pest	9
10.	Small white cabbage butterfly	*Pieris canidia*	Minor pest	10
11.	Fruit fly	*Bactrocera tau*	Minor pest	11
12	Cabbage semilooper	*Thysanoplusia orichalcea*	Minor pest	12

Plate No. 1

Plate No. 2

Plate No. 3

Plate No. 4

Plate No. 5

Plate No. 6

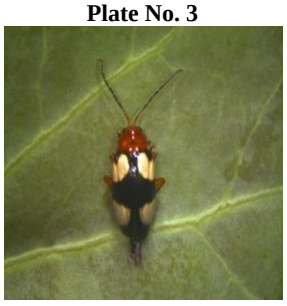

Plate No. 7

Plate No. 8

Plate No. 9

Plate No. 10

Plate No. 11

Plate No. 12

Fig 1: (Plate 1-12) - Biodiversity of insect pests of cole crops in mid hills of Meghalaya

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