Research paper Bangladesh Journal of Ecology

ABUNDANCE AND DIVERSITY OF ARTHROPODS IN MUSTARD

E Mandal[1], MR Amin[1*], H Rahman[1] and AM Akanda[2]

[1]Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh, [2]Department of Plant Pathology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh

Correspondence: Md. Ruhul Amin, Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur-1706, E-mail: mramin.bsmrau@gmail.com, Cell: 01714-260959

Received: 12 July 2019, Revised: 21 July 2019, Accepted: 23 July 2019

ABSTRACT

The experiment was carried out with mustard *Brassica juncea* variety BARI Shorisha-11 to know the abundance, richness and diversity of foraging arthropods in the mustard field during September 2016 to March 2017 at Gazipur in Bangladesh. In this study, mobile arthropods were collected with sweep net and sweeping was done at weekly interval from seedling stage of the plant to maturity of the siliqua. A total of 311 arthropods were collected from the field which belonged to 19 species of 19 different families and 7 Orders. Among the arthropods, 5 species were found as insect pests which belonged to 4 families of 3 Orders. There were 5 species of predators of 3 families under 2 Orders. The pollinators were statistically higher in abundance and richness compared to pests, predators and other categories of arthropods but the pests prevailed with higher diversity. Cabbage white fly and flea beetle showed the highest and lowest abundance of insect pest species, respectively. All the predator insects belonged to the Order Odonata and Coleoptera, and the abundance of the predator insects did not differ significantly.

Keywords: Abundance, *Brassica juncea,* diversity, insects, spiders

Introduction

Mustard *Brassica juncea* belongs to the family Brassicaceae (or Cruciferae) is an important oil crop, which ranks the first in Bangladesh and play a vital role in human nutrition. Mustard has been explored for its biodiesel potential (Jham *et al.* 2009). Various types of arthropods such as insect and spider species are found in the mustard field as they get shelter, food and oviposition site. Many of the insects and spiders have profound effect as pest, predator or pollinator and some of them just prevail in the field. The insect pests damage the crop by feeding on leaves, stems, flowers, and fruits. Pollinators aid in pollination as well as fruit setting. Beneficial insects like predators, parasitoids and other arthropods maintain an ecological equilibrium.

Insect pests pose a great challenge to *Brassica* crop production worldwide. So many insect pests attack *Brassica* species as preferred host plants (Sibanda *et al*. 2000). Among them aphid, flea beetle, sawfly and leaf eating caterpillar are highly destructive. Aphid is the most severe one (Das 2002) and flea beetles are also serious and widespread pests of mustard (Aslam and Gok 2006). The insect pests are the major factor for plant growth and yield of mustard and their importance varies in different geographical location (Kanrar *et al*. 2002).

Arthropod species visit in different parts of mustard plant but most of them have a common attraction for flowers. It is indicated that most of the insect species has specific intention for nectar collection which lead to efficient pollination. But some species are casual visitors or occasional pollinators which can be found at different locations of mustard plants (Sima *et al*. 2014, Rajkumari *et al*. 2014).

Categorization of the arthropods of any crop field is important for knowing their biology, behavior and seasonal population dynamics. These characteristics are prerequisites for development of integrated pest management program. Therefore, this study was undertaken to find out the harmful and beneficial species of arthropods prevailed in the mustard field, and their abundance, richness and diversity.

Materials and Methods

The study was conducted during September 2016 to March 2017 in the Field and Laboratory of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh.

The mustard *Brassica juncea,* variety BARI shorisha-11 seed was collected from Oil Seed Research Center, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. Mustard seeds were sown on 30 October 2016 in rows. The distance from row to row was 45 cm. Intercultural operations such as irrigation and weeding etc were done whenever necessary but no pest management practices were done in the field. Fertilizers were applied according to Fertilizer Recommendation Guide by BARI (N- 40kg, P- 12kg, K- 30kg, S- 9 kg ha^{-1}).

Observation, collection and identification of free living arthropods: Free-living insects were collected from seedling to siliqua maturation stages using a 30 cm diameter sweep net having 1.5 mm mesh, and attached with a 1.5 m long rod. Every week sweeping was done in between 09.00 to 11.00 h of the day, and each sample was consisted of 30 sweeps encompassing an area from ground level to the top of the plants. The collected insects were brought to the Entomology Laboratory of BSMRAU for identification and counting. They were killed by storing in a freezer for a few hours, mounted on points, dried and morphotyped. Insects were identified up to species or genus level and also separated as pest, predator, pollinator and unknown categories.

One way analysis of variance (ANOVA) followed by Tukey HSD posthoc test was used for analyzing abundance (total number of individuals), richness (total number of species), diversity (Simpson's Diversity Index), and abundance of pests and predators. Diversity was calculated following the formula of Simpson (1949). All the analyses were performed using IBM SPSS 21.1 software.

Results and Discussion

In this study, a total of 311 arthropods were collected from the mustard field which belonged to 19 species of 19 different families and 7 orders. Figure 1 showed that the percentages of arthropods belonged to 7 taxonomic Orders varied significantly ($\chi^2 = 138.5$, df = 6, $p < 0.001$). The highest percentage of arthropods was observed in the Order Diptera (44.1 %), followed by Hymenoptera (36.3 %), Hemiptera (9.97 %), Acari (4.2 %), Coleoptera (3.2 %), Lepidoptera (1.3 %) and other (unable to identify 1 %) (Figure 1).

Abundance of arthropod species varied with geographical location, season, host plant and management practices of the crop. Roy *et al.* (2016) reported that 29 insect

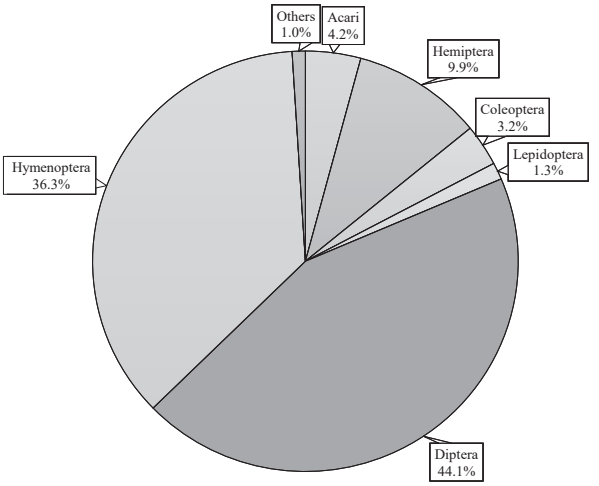

Figure 1. Abundant of arthropods in mustard field presented by different taxonomic Orders.

species belonging to 16 families under 7 orders as visitors of *Brassica juncea*. As a whole, Lepidoptera had the highest number of species followed by Coleoptera and Hymenoptera. Amin *et al.* (2015) studied the insect abundance in a mango based agroforestry system in Bangladesh and reported that they collected 1751 insects which belonged to 53 species of 38 families under 11 orders and the percent insects in different taxonomic Orders varied significantly. They also reported that the insects of the Order Hemiptera were most abundant, followed by Diptera, Hymenoptera, Lepidoptera, Coleoptera and others. Agroforestry is a multistoried i.e. poly cropping system and the insect abundance in agroforestry differed from the present mono-cropping system.

Table 1 showed that the abundance, richness and diversity of pest, predator, pollinator and other category of insects varied from 1.0 ± 0.4 to 29.1 ± 7.4, 0.6 ± 0.3 to 5.3 ± 1.0 and 0.3 ± 0.2 to 0.8 ± 0.1 per 30 sweeps, respectively and the results differed significantly (abundance: $F_{3, 28}=11.82$, $P < 0.001$; richness: $F_{3, 28}=13.72$, $P < 0.001$; diversity: $F_{3, 28} = 3.6$, $P < 0.05$). The richness and abundance of pollinators were significantly higher compared to pests, predators and other category. The pests revealed the highest diversity compared to predators, pollinators and other category.

In mustard field, most of the arthropods forage during blooming stage which varies from 20 days to 22 days depending on many environmental factors (Roy *et al.* 2014). However, many insect species start to visit at the full grown stage of mustard and then decrees gradually. Similarly, many species occur at the post blooming phase (after 8 to 9 days of blooming) and remain till harvest.

Table 1. Average richness, abundance and diversity of mobile arthropods in mustard field of BSMRAU experimental farm

	Pests	Predators	Pollinators	Others
Abundance	6.0 ± 1.8 b	1.0 ± 0.4 b	29.1 ± 7.4 a	2.5 ± 0.2 b
Richness	1.6 ± 0.42 b	0.6 ± 0.3 b	5.3 ± 1.0a	1.8 ± 0.2 b
Diversity	0.8 ± 0.1 a	0.3 ± 0.2 b	0.4 ± 0.1 ab	0.4 ± 0.1 ab

Data expressed as mean ± SE. Means per insect group are taken from 30 sweeps per total collection. Means within a row followed by same letter(s) are not significantly different by Tukey HSD posthoc statistic at < 0.05. BSMRAU: Bangabandhu Sheikh Mujibur Rahman Agricultural University.

There are also some species which were found irregularly throughout the blooming session and there was no specific interaction with other co-taxa (Roy *et al*. 2016). So, arthropod species abundance, richness and diversity may vary with the categories of pest, predator, pollinator and others. The present study showed similarity to that of Amin *et al.* (2015) who studied the pest, predator, pollinator and other category insect abundance, richness and diversity in an agroforestry system in Bangladesh and found significant variations among them.

In total, 5 species of insects belonged to 4 families in 3 orders (Hemiptera, Coleoptera and Hymenoptera) were found as mobile insect pest (Table 2). Their abundance varied from 3.0 ± 1.2 to 0.13 ± 0.1 per 30 sweeps and the results differed significantly ($F_{3, 28} = 3.03$, $p < 0.05$). Among the pests, cabbage white fly showed the highest abundant while the flea beetle was the lowest in abundance. In the present study, two species of flea beetle were found in the mustard field. Metspalu *et al*. (2014) stated that flea beetles are important insect pests of cruciferous oilseed crops in northern Europe, and they reported that adults of six species of flea beetles were found on the *B. juncea.*

Five species of insects belonged to 3 families under 2 orders (Coleoptera and Odonata) were found as predator (Table 3). Their abundance varied from 0.8 ± 0.4 to 0.13 ± 0.1 per 30 sweeps and the results did not differ significantly ($F_{2, 21} = 2.37$, $p = 0.12$). Aphid colonization in the mustard field invited natural enemies before the time that the crop become susceptible to pest damage. It has been reported that mustard crop is colonized by aphid and they are found primarily on the growing points of the host plants, including tips, flowers and developing pods and cover the whole plant at high density (Nelson and Rosenheim 2006). However, the abundance of insect pest species is related to climatic factors and crop growth stages but they show correlation with predators.

Amin *et al.* (2015) identified 13 insect species belonged to 8 families under 6 orders (Coleoptera, Hymenoptera, Hemiptera, Odonata, Dictyoptera and Neuroptera) as predator in a mango-based agroforestry in Bangladesh of which ants were significantly higher abundant. The present study showed dissimilarity with the findings of Amin *et al.* (2015) as they studied in an agroforestry system which

Table 2. Mobile insect pests along with their abundance in mustard field of BSMRAU experimental farm

Pests	Taxonomic profile	Abundance
Cabbage white fly	*Aleyrodes proletella* (Hemiptera: Aleyrodidae)	3.0 ± 1.2a
Leaf hopper	*Macrosteles quadrilineatus* (Hemiptera: Cicadellidae)	0.9 ± 0.6ab
Flea beetle	*Phyllotreta cruciferae* (Coleoptera: Chrysomelidae)	0.13 ± 0.1b
	Monalepta signata (Coleoptera: Chrysomelidae)	-
Saw fly	*Athalia lugens* (Hymenoptera: Tenthredinidae)	2.0 ± 0.5ab

Data expressed as mean ± SE. Mean of each pest was taken from 30 sweeps per total collection. Means in the column followed by same letter(s) are not significantly different by Tukey HSD posthoc statistic at < 0.05. BSMRAU: Bangabandhu Sheikh Mujibur Rahman Agricultural University.

Table 3. Insect predators along with their abundance in mustard field of BSMRAU experimental farm

Predators	Taxonomic profile	Abundance
Lady bird beetle	*Coccinella septempunctata* (Coleoptera: Coccinellidae)	0.8 ± 0.4a
	Coccinella transversalis (Coleoptera: Coccinellidae)	-
	Menochilus sexmaculatus (Coleoptera: Coccinellidae)	-
Ground beetle	*Calosoma scrutator* (Coleoptera: Carabidae)	0.13 ± 0.1a
Dragon fly	*Aeshna verticalis* (Odonata: Aeshnidae)	0.13 ± 0.1a

Data expressed as mean ± SE. Mean of each pest was taken from 30 sweeps per total collection. Means in the column followed by same letter(s) are not significantly different by Tukey HSD posthoc statistic at < 0.05. BSMRAU: Bangabandhu Sheikh Mujibur Rahman Agricultural University.

had one tree species and two crop species, but the present study was done with only mustard crop.

In the present study only mobile pests were considered because the sessile pests require different counting methods. The findings showed that different categories of arthropods including pests, predators and pollinators have their access to the mustard field. Among them, pollinators were the most abundant as the field provided a good niche for pollination. The possible causes for lower diversity and abundance in the surrounding field may be due to the fragmented land and non-judicious application of agrochemicals.

References

Amin MR, Namni S, Miah MRU, Miah MG, Zakaria M, Suh, SJ and Kwon YJ. 2015. Insect inventories in a mango-based agroforestry area in Bangladesh: foraging behavior and performance of pollinators on fruit set. Entomological Research*, 45*: 217-224.

Aslan EG and Gok A. 2006. Host-plant relationship of 65 flea beetles species from Turkey, with new associations (Coleoptera: Chrysomelidae: Alticinae). Entomological News, *117:* 297-308.

Das BC. 2002. Ecology and diversity of agricultural crop infesting aphids (Homoptera: Aphididae). Bangladesh Journal of Aphidology*, 16:* 51-57.

Jham GN, Moser BR, Holser SRA, Dhingra OD, Vaughan SF, Berhow MA, Winkler-Moser JK, Isbell TA and Holloway RK. 2009. Wild Brazilian mustard (*Brassica juncea* L.) seed oil methyl esters as biodiesel fuel. Journal of American Chemical Society*, 86:* 917- 926.

Kanrar S, Venkateswari J, Kirti PB and Chopra VL. 2002. Transgenic Indian mustard (*Brassica juncea*) with resistance to the mustard aphid (*Lipaphis erysimi* Kalt.). Plant Cell Report*, 20:* 976-981.

Metspalu L, Kruus E, Ploomi A, Williams IH, Hiiesaar A, Jogar K, Veromman E and Mand M. 2014. Flea beetle (Chrysomelidae: Alticinae) species composition and abundance in different cruciferous oilseed crops and the potential for a trap crop system. Acta Agricultura*, 64:* 572-582.

Nelson EH and Rosenheim JA. 2006. Encounters between aphids and their predators: the relative frequencies of disturbance and consumption. *Entomologia Experimentalis et Applicata, 118:* 211-219.

Rajkumari P, Sharmah D, Rahman A and Patgiri P. 2014. Diversity and distribution pattern of Hymenopteran insects in Jorhat District, Assam, India. *International Journal of Scientific Research, 3:* 1938-1941.

Roy S, Bhaumik S, Imam I, Chatterjee T, Roy K and Mitra B. 2016. A preliminary study on the succession of insect visitors and their symbiotic interaction for effective pollination in *Brassica juncea* (L.) of southern West Bengal. *International Journal of Advanced Research, 4:* 1762-1768.

Roy S, Gayen AK, Mitra B and Dutta GA. 2014. Diversity, foraging activities of the insect visitors of mustard (*Brassica juncea* L,) and their role in pollination in West Bengal. *Journal of Zoology Study, 1:* 7-12.

Sibanda T, Dobson HM, Cooper JF, Manyangarirwa W and Chiimba W. 2000. Pest management challenges for small holder vegetable farmers in Zimbabwe. Crop Protection, *19:* 807-815.

Sima, Bhati D and Srivastava M. 2014. Floral visitors of different crops as recorded from an agro-ecosystem near Jhunjhunu, Rajasthan (India). International Journal of Scientific Research, *3:* 1732-1738.

Simpson EH. 1949. Measurement of diversity. Nature, *163***:** 688.