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ARTHROPOD FAUNA AND THEIR RELATIVE ABUNDANCE IN TOMATO INTERCROPPING SYSTEM

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Abstract

The study was carried out during September 2016 to August 2017 at Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur to investigate the community composition of arthropods and their relative abundance in additive row intercropping system of tomato with brinjal, lettuce, onion and garlic. In total of 2512 arthropods were collected from the intercropping system which belonged to 8 taxonomic Orders while Hemiptera occupied 50.8% of the total abundant. The collected arthropods were categorized as insect pests, arthropod predators and insect pollinators. The insect pests belonged to 5 taxonomic orders and they showed the highest abundant in Hemiptera (76.0%). The arthropod predators were under 5 taxonomic orders and Acari revealed the highest abundance (31.4%) followed by Hymenoptera (24.6%), Coleoptera (17.4%), Diptera (15.0%), and Neuroptera (11.5%). The pollinator insects were found in two taxonomic orders namely Hymenoptera (74.0%) and Lepidoptera (26.0%). In total 13 species of insects belonged to nine families were found as pest and their relative abundance varied from 2.9 to 29.4%. Eight species of predatory arthropods were found which belonged to seven families and their relative abundance ranged from 5.3 to 21.9%. Among the predatory arthropods garden spider was most abundant (21.9%). The prevailed insect pollinators of the intercropping system were in 12 species and their relative abundance varied from 1.8 to 42.0%. The findings suggest that the tomato intercropping system is a habitat for abundance and diversity of arthropod community.

Keywords: Community composition, *Lycopersicon esculentum,* insect, spider, mite.

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is an important vegetable all over the world and its production in Bangladesh is 413.6 thousand metric tons per year (BBS, 2015). The average yield in Bangladesh is 7.4 t/ha which is very low compared to other tropical countries in the world (Degri *et al*., 2014). Yield varies greatly on pollination and health of the crop, climate and whether the crop is for fresh harvest or processing. Arthropod fauna, mainly insects, spiders and mites are very common in tomato field and they are found as pest, predator, parasitoid and pollinator.

Tomato plants are attacked from seedling to harvesting by various arthropods such as insects and mites. The frequently abundant insect pests are whitefly, aphid, jassid, thrips, fruit borer*,* flea beetle*,* serpentine leaf miner etc. Amin *et al*. (2016) observed 3.6 to 22.2% fruit infestation by fruit borer (*Helicoverpa armigera*) in different varieties of tomato released by Bangladesh Agricultural Research Institute. *H. armigera* causes infestation on

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tomato up to 46.8% in Bangladesh and 35% in India (Bhatt and Patel, 2001; Dhandapani *et al.,* 2003; Alam *et al*., 2007).

Pollinating insects contribute to the reproduction of plants and common insect pollinators include bees, wasps, ants, flies, butterflies, moths and beetles (Ollerton *et al*., 2011). Predatory arthropods feed on all host stages of insect pests such as egg, nymph or larva, pupa and adult. A parasitoid is an organism that lives on or in a host organism and ultimately kills the host. So, pest, predator, pollinator and parasitoid species in an agro-ecosystem interact with each other and effect directly or indirectly on crop yield and quality.

Intercropping affects the microclimate of the agroecosystem and ultimately produces unfavorable environment for pests. It enhances insect predator and pollinator populations through their contribution to habitat diversification (Mensah, 1999; Parajulee and Slosser, 1999; Prasifka *et al*., 1999). Intercropping system enhances the yield of crop compared to monoculture system (El-Gaid and Al-Dokeshy*,* 2014). In Bangladesh, many farmers cultivate tomato following intercropping, as it is a cultural as well as traditional method of pest management. But there is no update information on arthropod species regarding tomato intercropping system. Therefore, the present study was conducted to find out the arthropod species associated with tomato intercropping system citing their taxonomic profile and relative abundance.

Materials and Methods

Study site and climatic conditions

The study was conducted in the field and laboratory of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh during September 2016 to August, 2017. The study site is located at 25°25′ North latitude and 89°5′ East longitude, which is in the middle of Bangladesh. The study area has a sub-tropical climate having dry season, rainy season and short winter. Annual mean maximum and minimum temperatures, relative humidity and rainfall are 36.0°C and 12.7°C, 65.8% and 149.6cm, respectively.

Cultivation of tomato

Tomato (BARI tomato-2), brinjal (BARI begun-4), lettuce (BARI lettuce-1), local onion and garlic were used in the intercropping system. The tomato seedlings having 3-5 leaves were transplanted in 12 × 9 m^2 plot. Fertilizers were applied according to fertilizer recommendation guide (FRG, 2012) (N- 60 kg, P- 45 kg and K- 45 kg per hectare). Plants were arranged according to an additive row intercrop design, where one row of tomato was placed between every two rows of onion or garlic or lettuce or brinjal.

Collection and identification of arthropods

The arthropod species were collected using sweeping net having 30 cm diameter ring and 1.5 mm mesh, and attached with a 2 m long rod. A vacuum suction sampler (aspirator) was also used to capture very small insects. The collected arthropods were brought from the experimental field to the Entomology Laboratory of BSMRAU for counting total abundance. The arthropods were killed by storing in a freezer at 4^{o}C for overnight then mounted on points, dried and morphotyped. Arthropods viz., insects, spiders and mites were identified to species or genus level and also separated as pest, predator, pollinator and other category. For identification, the collected arthropods were compared with the specimens of the labeled collection in the museum and compared with pictures or descriptions.

Statistical analysis

Chi statistic was applied to find out significant difference in percentage of insects among different orders. All the analyses were performed using IBM SPSS 21.0. (IBM SPSS statistics 21, Georgia, USA).

Results and Discussion

The arthropod community composition in tomato intercropping systems comprised of insects and spiders. They belongs to eight different taxonomic orders and their abundance in the orders varied from 1.6 to 50.8% (Fig. 1) and the results differed significantly ($\chi^2 = 144.8$, df = 7, $p < 0.001$). Among the orders, Hemiptera and Neuroptera showed the highest (50.8%) and lowest (1.6%) abundance, respectively. Arthropod species and their relative abundance differed with variations in geographical locations, climatic conditions and host species. Willey (2005) reported a total of 22 insect and 3 spider species under 5 taxonomic orders in a tomato–eggplant intercropping system in Vietnam.

Fig. 2 showed that a total of 1581 insects were found as pest and they belongs to 5 different taxonomic orders. Their relative abundance differed significantly ($\chi^2 = 84.3$, df = 4, $p < 0.001$) and Hemiptera occupied the highest abundance (76.0%), followed by Lepidoptera (9.1%), Diptera (7.2%), Coleoptera (4.3%) and Thysanoptera (3.3%). Emuh*et al*. (2006) collected 351 insects from okra with tomato based intercropping system in a vegetable field in Vietnam. They observed that the insects were under six orders and Hemiptera occupied the most abundant, followed by Diptera, Lepidoptera and Coleoptera.

In the present study, the number of predator insect and spiderswere 256 and 117, respectively and they belonged to 5 orders. Their relative abundance in different taxonomic orders ranged from 11.5 to 31.4%, and the results differed significantly ($\chi^2 = 82.7$, df = 3, $p < 0.001$; Fig. 3). Among the taxonomic orders Acari and Neuroptera showed the highest and lowest abundance, respectively. The abundance of predators greatly varies

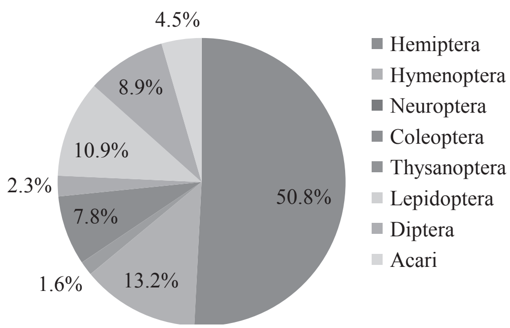

Fig. 1. Percentage of arthropods belongs to different taxonomic orders found in tomato intercropping system during December 2016 to February 2017.

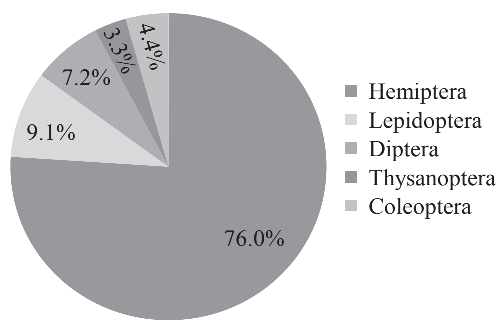

Fig. 2. Percentage of insect pests belongs to different taxonomic orders found in tomato intercropping system during December 2016 to February 2017.

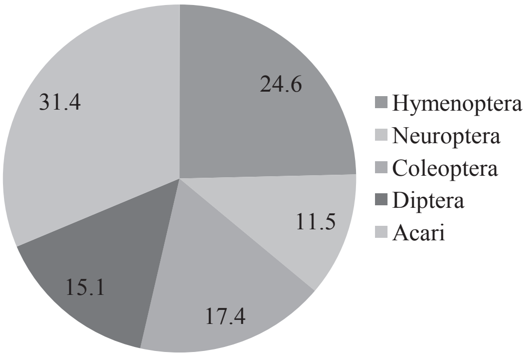

Fig. 3. Percentage of arthropod predators belongs to different taxonomic orders found in tomato intercropping system during December 2016 to February 2017.

with their habitats, prey source and abiotic components of the environment. (Blaser *et al*., 2007) observed a total of 47 insect species and 8 mite species in commercial orchards of Miranda in Venezuela of which 10 were predators.

A total of 558 pollinator insects were collected from the tomato intercropping systems, which belonged to 2 taxonomic orders (Fig. 4) namely Hymenoptera and Lepidoptera. The abundances of Hymenoptera and Lepidoptera were 74.0% and 26.0%, respectively and the results varied significantly (χ^2 = 23.0, df = 1,

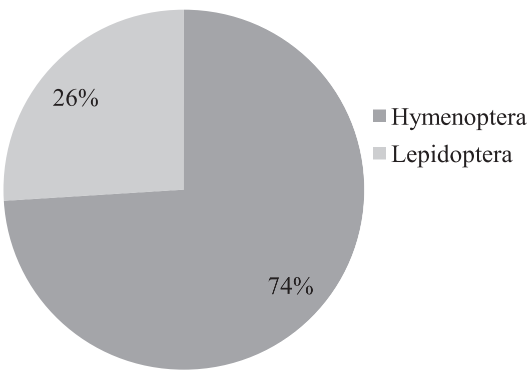

Fig. 4. Percentage of pollinator insects belongs to different taxonomic orders found in tomato intercropping system during December 2016 to February 2017.

$p < 0.001$). You and Xu (2015) collected in total of 452 pollinator insects from cruciferous field which belonged to 23 species in nine families and six orders and the percentages of the pollinators in different taxonomic orders differed significantly.

In total 13 species of insects belongs to nine families were found as pest of tomato (Table 1). Their abundance ranged from 2.9 to 29.4% and the white fly revealed the highest abundance followed by aphid (28.4%), jassid (12.5%), fruit borer (7.5%) and lowest abundance was found in case of thrips. Ramphall and Gill (2000) found 27 species of insects in 13 families under 8 orders as the pest of tomato in India and they reported that the whitefly was the most abundant.

Table 2 showed that eight species of arthropods belonged to seven families in six orders were found as predators. Their relative abundance ranged from 6.1 to 25.3% and the garden spider showed the highest abundance. Elmore and Jackobs (2004) studied the predators in brinjal-lettuce intercropping field in Mali and found that 25 species of insects belongs to 10 families and four orders were as predators. Munyuli *et al.* (2008) reported higher abundance of arthropod predators and their diversity in cowpea and green gram intercropping system compared to their monoculture system.

Table 3 showed that 12 species of insects belongs to five families in two orders were found as pollinator and their relative abundance varied from 1.8 to 42.0%. Among the pollinators ant and sulphur butterfly revealed the highest and lowest abundance, respectively. Kunjwal *et al*. (2014) studied the flower-visiting insect pollinators in brown

Table 1. Taxonomic profile and relative abundance of insect pests associated with tomato plant and found in tomato intercropping system during December 2016 to February 2017

Insects	Taxonomic profile	Abundance (%)
Aphid	*Aphis gossypii* (Hemiptera: Aphididae)	28.4
	Myzus persicae (Hemiptera: Aphididae)	-
	Macrosiphum euphorbiae (Hemiptera: Aphididae)	-
Jassid	*Amrasca devastans* (Hemiptera: Cicadellidae)	12.5
Whitefly	*Aleurodicus disperses* (Hemiptera: Aleurodidae)	29.4
	Trialeurodes vaporariorum (Hemiptera: Aleurodidae)	-
	Bemisia tabaci (Hemiptera: Aleurodidae)	-
Fruit borer	*Helicoverpa armigera* (Lepidoptera: Noctuidae)	7.5
Serpentine leaf miner	*Liriomyza trifolii* (Diptera: Agromyzidae)	3.6
Thrips	*Thrips tabaci* (Thysanoptera: Thripidae)	2.9
Cutworm	*Spodoptera litura* (Lepidoptera : Noctuidae)	5.5
Flea beetle	*Phyllotreta vitulla* (Coleoptera: Chrysomelidae)	5.5
Stem borer	*Phthorimaea operculella* (Lepidoptera: Pyralidae)	4.5

Table 2. Taxonomic profile of arthropod predators along with their relative abundance found in different tomato intercropping system during December 2016 to February 2017

Predators	Taxonomic profile	Abundance (%)
Paper wasp	*Polistes* spp. (Hymenoptera: Vespidae)	14.1
Pirate bug	*Orius* spp. (Hemiptera: Anthocoridae)	6.1
Green lace wing	*Chrysoperla carnea* (Neuroptera: Chrysopidae)	17.2
Lady bird beetle	*Coccinella septempunctata* (Coleoptera: Coccinellidae)	15.2
	Coccinella transversalis (Coleoptera: Coccinellidae)	-
Robber fly	*Alcimus* spp (Diptera: Asilidae)	16.2
Wolf spider	*Pardosa amentata* (Araneae: Lycosidae)	6.1
Garden spider	*Argiope aurantia* (Araneae: Araneidae)	25.3

Table 3. Taxonomic profile of pollinator insects along with their relative abundance found in tomato intercropping system during December 2016 to February 2017

Pollinators	Taxonomic profile	Abundance (%)
Honey bee	*Apis cerana* (Hymenoptera: Apidae)	16.8
	Apis mellifera (Hymenoptera: Apidae)	-
	Apis dorsata (Hymenoptera: Apidae)	-
Carpenter bee	*Xylocopa sonorina* (Hymenoptera: Apidae)	15.2
Lemon butterfly	*Papilio demoleus* (Lepidoptera: Papilionidae)	10.8
Swallow tailed butterfly	*Papilio cresphontes* (Lepidoptera: Papilionidae)	7.6
	Papilio troilus (Lepidoptera: Papilionidae)	-
	Papilio machaon (Lepidoptera: Papilionidae)	-
Four footed butterfly	*Phystis simois* (Lepidoptera: Nymphalidae)	5.8
Sulphur butterfly	*Phoebis sennae* (Lepidoptera: Pieridae)	1.8
Black ant	*Lasius niger* (Hymenoptera: Formicidae)	42.0
Red ant	*Formica rufa* (Hymenoptera: Formicidae)	-

mustard field at Patnagar in India and found 30 species of insects belonged to 10 families in 4 orders as pollinator. Lucia *et al*. (2015) reported that the abundance of pollinators to tomato flowers was higher in the intercropped plots than the single-cropping plots in USA.

Conclusion

This study investigated the abundance of insects and spiders in tomato intercropping system and found that the intercropping system was eco-friendly crop cultivation practice, which provided good shelter for arthropods along with predator and pollinator species.

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