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SCENARIO OF INSECT PESTS, PREDATORS AND POLLINATORS ASSOCIATED WITH CROP PLANTS IN AN AGROFORESTRY IN BANGLADESH

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ABSTRACT

The abundance of insect pests, predators and pollinators and status of pest insects associated with citrus, mango and pineapple crops grown in an agroforestry in Bangladesh was studied during July 2015 to June 2016. Twenty five species of insects belonging to 19 families in 5 orders were found as pest of citrus and their relative abundance varied from 2.4 to 13.4%. Among the citrus pests, green leaf hopper was most abundant, but whitefly, mealy bug, lemon butterfly and leaf minor were found as major pests. Fifteen species of insects under 13 families in 6 orders were found as pests of mango and their relative abundance varied from 0.5 to 82.6%, and hopper and fruit fly were found as major pests. Four species of insects belonging to 4 families in 3 orders were found as pest of pineapple and their relative abundance varied from 12.2 to 44.9%, and all were found as minor pests. There were 20 species of predator insects belonging to 13 families in 6 orders and their abundance ranged from 0.8 to 2.5/ 40 sweeps. In total 19 species of insects belonging to 12 families in 4 orders were found as pollinators and their abundance varied from 1.7 to 5.1/40 sweeps. The ants and honeybees were most abundant as predators and pollinators, respectively.

Keywords: Agroforestry, Abundance, Insect Species, Citrus, Mango, Pineapple

INTRODUCTION

Bangladesh is a subtropical country having an area of 147570 km^2 with 160.2 million people. Agriculture has an overwhelming impact on the economy of the nation and has made significant progress in boosting national food production. However, a large part of the population still lacks access to sufficient, safe, and nutritious food. Arable land and forest areas in Bangladesh are reducing day by day due to demographic

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pressure, urbanization and industrialization. To accelerate crop production and conservation of nature, the concept of agrofrorestry has become popular here in the recent decades.

Agroforsetry is an agricultural system comprising diversity of plants, pests, predators and pollinators which are linked to crop productivity. Intensive agricultural system creates disturbance of the natural habitats, and affects species richness, abundance and community structure (Debinski and Holt, 2000). That is why the cultivated areas in Bangladesh are gaining interest for conserving tropical biodiversity.

The diversity of crop species in the agroforestry provides a variety of resources like shelter and food for predators and pollinators. The heterogeneity of the habitat in the agroforestry area thus alters the quality and quantity of bio-resources and regulates ecological niches of various species in the community (Bugg and Waddington, 1994). The composition of an agroforestry system influences its microclimatic factors such as temperature, relative humidity, light intensity, precipitation, wind, carbon dioxide and water vapor thereby affecting on the diversity and abundance of insect species (Dwivedi et al., 2003; Anitha et al., 2009).

Mango, pineapple and citrus are popular fruits in Bangladesh and these crops are widely grown throughout the country. In the agroforestry system, pineapple, citrus and mango are cultivated as lower, middle and upper storied crop, respectively, but there is limited information regarding insect abundance and their nature of interactions with these crops. Therefore, in the present study, the abundance of insect pests, predators and pollinators, status of insect pests associated with citrus, mango and pineapple were taken into investigation.

MATERIALS AND METHODS

Study site and condition

The study was conducted in the agroforestry field laboratory of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) at Gazipur (25°25′ North latitude and 89°5′ East longitude) in Bangladesh during July 2015 to June 2016. The study site is surrounded by sal (*Shorea robusta)* forest. The climate of this area is characterized as dry during February to May, rainy from June to September, and cold from December to January. Annual mean maximum and minimum temperatures are 36.0^{o}C and 12.7^{o}C, respectively, with 65.8% relative humidity and 237.6 cm rainfall. The agroforestry system is marked by different management intensity, grasslands, rice, fruit and vegetable crops. The area of the agroforestry is 2205 m^2, and occupied by citrus, pineapple and 45 mango trees (variety Amrapali); each 11 years old, 3-4 m high and 7m apart.

Insect collection and identification

The free-living insects on citrus, pineapple and mango plants were collected during the day using a 30 cm diameter sweep net having 1.5 mm mesh and attached with a

2.0 m long rod. Sweeping was done in between 10.00 and 11.30 hour of the day every two weeks interval and each sample consisted of 40 sweeps, encompassing an area from ground level to the top of the trees. Small and immobile insects were observed by collecting infested leaves. The collected insects and leaves were brought from the experiment field to the Entomology Laboratory of BSMRAU for counting total catch. The insects were killed by storing in a freezer for one night, then mounted on points and dried and morphotyped. During each sampling, sessile insects were observed and identified using hand lens on 40 leaves of each crop. Insects were identified by observing their morphological characteristics, compared with museum specimens and with photographs to species or genus level and also separated as pest, predator and pollinator.

Assessment of pest status

During insect collection, leaf, flower and fruit of citrus, mango and pineapple were observed for infestation (%) of different insect pests. Insects those caused less than 10% infestation were categorized as minor pest, while those with 10% or above infestation were categorized as major pests.

Calculation of relative abundance and statistical analysis

Relative abundance (%) of the pest species of citrus, mango and pineapple was calculated using the following formula.

$$\text{Abundance (\%)} = \frac{\text{Total number of individual of a species}}{\text{Total number of individual of different species}} \times 100$$

One way analysis of variance (ANOVA) followed by Tukey post hoc statistics was employed for analyzing the data of the predator and pollinator species. All the analyses were performed using IBM SPSS 21.0. (IBM SPSS statistics 21, Georgia, USA).

RESULTS AND DISCUSSION

In total 25 species of insects belonging to 19 families in 5 orders (Isoptera, Thysanoptera, Hemiptera, Lepidoptera and Diptera) were found as pest of citrus (Table 1). Their relative abundance varied from 2.4 to 13.4%, and green leaf hopper was most abundant (13.4%) followed by mealy bug (9.3%), leaf miner (8.6%), fruit fly (7.4%) and lemon butter fly (7.2%). The percent abundance of the other insects was less than 5.0%. Among the insects, white fly, mealy bug, lemon butterfly and leaf minor were found as major pest as they caused more than 10% infestation, and the other insects were found as minor pest because their infestation level was less than 10%.

Table 1. Taxonomic profile, comparative abundance and status of pest insects associated with citrus plant in the agroforestry area during July 2015 to June 2016

Name	Taxonomic profile	Abundance (%)	Status
Termite	*Odontotermes obesus* Ramber (Isoptera: Termitidae)	4.5	Minor
Thrips	*Scirtothrips citri* Moulton (Thysanoptera: Thripidae)	4.8	Minor
White fly	*Dialeurodes citri* Ashmead (Hemiptera: Aleyrodidae)	5.3	Major
Black fly	*Aleurocanthus woglumi* Ashby (Hemiptera: Aleyrodidae)	2.6	Minor
Black aphid	*Toxoptera aurantii* Boyer De Fonscolombe (Hemiptera: Aphididae)	4.3	Minor
Scale insect	*Ceroplastes destructor* Newstead (Hemiptera: Coccidae) *Aonidiella aurantii* Maskell (Hemiptera: Diaspididae) *Aonidiella citrina* Coquillett (Hemiptera: Diaspididae) *Icerya purchase* Maskell (Hemiptera: Margarodidae)	5.0 - - -	Minor
Mealy bug	*Planococcus citri* Risso (Hemiptera: Pseudococcidae) *Pseudococcus citriculus* Green (Hemiptera: Pseudococcidae) *Pseudococcus filamentosus* Cockrell (Hemiptera: Pseudococcidae)	9.3 - -	Major
Spined bug	*Biprorulus bibax* Breddin (Hemiptera: Pentatomidae)	2.6	Minor
Citrus psyllid	*Diaphorina citri* Kuwayama (Hemiptera: Psyllidae)	4. 8	Minor
Green leaf hopper	*Empoasca citrusa* Theron (Hemiptera: Cicadellidae)	13.4	Minor
Leaf-footed bug	*Leptoglossus phyllopus* Linnaeus (Hemiptera: Coreidae)	2.6	Minor
Green stink bug	*Rhynchocorris humeralis* Thunberg (Hemiptera: Pentatomidae)	4.1	Minor
Bark-eating borer	*Indrabela quadrinotata* Walker (Lepidoptera: Metarbelidae)	2.6	Minor

Name	Taxonomic profile	Abundance (%)	Status
Fruit piercing moth	*Othreis cjeta* Cramer (Lepidoptera: Noctuidae)	3.4	Minor
Lemon butterfly	*Papilio demoleus* Linnaeus (Lepidoptera: Papilionidae)	7.2	Major
Swallow tail butter fly	*Papilio polytis* Linnaeus (Lepidoptera: Papilionidae)	2.6	Minor
Leaf miner	*Phyllocnistis citrella* Stainton (Lepidoptera: Gracillaridae**)**	8.6	Major
Flower moth	*Prays citri* Milliere (Lepidoptera: Yponomeutidae)	2.4	Minor
Rrind borer	*Prays endocarpa* Meyrick (Lepidoptera: Yponomeutidae)	2.4	Minor
Fruit fly	*Bactrocera dorsalis* Hendel (Diptera: Tephritidae)	7.4	Minor

Fifteen species of insects under 13 families in 6 orders (Isoptera, Thysanoptera, Hemiptera, Coleoptera, Lepidoptera and Diptera) were found as pest of mango (Table 2). Their relative abundance varied from 0.5 to 82.6%, and mango hopper was the most abundant (82.6%) followed by fruit fly (8.0%). The mango hopper and fruit fly were found as major pest because their infestation level was more than 10%.

Table 2. Taxonomic profile, comparative abundance and status of pest insects associated with mango plant in the agroforestry area during July 2015 to June 2016

Name	Taxonomic profile	Abundance (%)	Status
Termite	*Odontotermes obesus* Ramber (Isoptera: Termitidae)	0.72	Minor
Thrips	*Thrips hawaiiensis* Morgan (Thysanoptera: Thripidae)	0.8	Minor
Hopper	*Idioscopus clypealis* Lethierry (Hemiptera: Cicadellidae)	82.6	Major
	Idioscopus niveosparus Lethierry (Hemiptera: Cicadellidae)	-	
	Amritodus atkinsoni Lethierry (Hemiptera: Cicadellidae)	-	
Mealy bug	*Rostrococcus iceryoides* Green (Hemiptera: Pseudococcidae)	1.5	Minor

Name	Taxonomic profile	Abundance (%)	Status
Scale insect	*Aulacaspis tubercularis* Newstead (Hemiptera: Coccidae)	0.5	Minor
Stem borer	*Bactocera rufomaculata* De Geer (Coleoptera: Cerambycidae)	0.8	Minor
Stone weevil	*Sternochaetus mangiferae* Fabricius (Coleoptera: Curculionidae)	0.9	Minor
Mango defoliator	*Cricula trifenestrata* Helfer (Lepidoptera: Saturniidae)	0.9	Minor
Bark eating caterpillar	*Indarbella quadrinotata* Walker (Lepidoptera: Noctuidae)	0.7	Minor
Leaf webber	*Orthaga exvinacea* Hampson (Lepidoptera: Pyralidae)	1.0	Minor
Leaf eating caterpillar	*Euthalia garuda* Moore (Lepidoptera: Nymphalidae)	1.1	Minor
Fruit fly	*Daucas dorsalis* Hendel (Diptera: Tephritidae)	8.0	Major
Leaf gall	*Procontarinia matteiana* Kieffer & Cecconi (Diptera: Cecidomyiidae)	0.5	Minor

Table 3 showed that four species of insects belonging to 4 families were found as pest of pineapple. Their relative abundance varied from 12.2 to 44.9%, and the mealy bug was most abundant followed by fruit borer, black spot beetle and midget. The infestation levels of the insect species were less than 10% and all of them were termed as minor pest.

Table 3. Taxonomic profile, comparative abundance and status of pest insects associated with pineapple plant in the agroforestry area during July 2015 to June 2016

Name	Taxonomic profile	Abundance (%)	Status
Mealy bug	*Dysmicoccus brevipes* Cockerell (Hemiptera: Pseudococcidae)	44.9	Minor
Black spot beetle	*Metamasius dimidiatipennis* Jekel (Coleoptera:Curculionidae)	18.4	Minor
Fruit borer	*Strymon basilides* Geyer (Lepidoptera: Lycaenidae)	24.5	Minor
Midget	*Elaphria nucicolora* Guenee (Lepidoptera: Noctuidae)	12.2	Minor

In the agroforestry system multistoried crop plants act as secure habitat for pest, predator and pollinator insects. In the studied agroforestry area, Hemiptoriod insects were most abundant on different crops. The results agreed with Amin et al. (2015) who studied the insect abundance and diversity in a mango based agroforestry in Bangladesh and found that the Hemiptera were most abundant (59.8%). Namni et al. (2017) observed the highest abundance of hopper compared to other insects in a mango based agroforestry.

Table 4. Taxonomic profile of predator insects and their abundance in the agroforestry area during July 2015 to June 2016

Predator insect	Taxonomic profile	Abundance
Preying mantid	*Mantis religiosa* Linnaeus (Dictyoptera: Mantidae)	0.8 c
Dragon fly	*Aeshna verticalis* Hagen (Odonata: Aeshnidae)	1.6 ab
	Stylurus notatus Rambur (Odonata:Gomphidae)	-
	Orthetrum glaucum Brauer (Odonata:Libellulidae)	-
Damsel fly	*Coenagrion sp.* Kirby (Odonata: Coenagrionidae)	1.2 ab
	Lestes vidua Hagen (Odonata:Lestidae)	-
Assassin bug	*Rhinocoris segmentarius* Germar (Hemiptera: Reduviidae)	1.0 bc
	Sinea diadema Fabricius (Hemiptera: Reduviidae)	-
Pirate bug	*Orius insidiosus* Say (Hemiptera: Anthocoridae)	0.8 c
Lady bird beetle	*Coccinella septempunctata* Linnaeus (Coleoptera: Coccinellidae)	2.2 ab
	Coccinella transversalis Fabricius (Coleoptera: Coccinellidae)	-
	Menochilus sexmaculatus Fabricius (Coleoptera: Coccinellidae)	-
Ground beetle	*Calosoma scrutator* Fabricius (Coleoptera: Carabidae)	1.2 bc
Tiger beetle	*Cicindela ocellata* Klug (Coleoptera: Carabidae)	1.3 ab
Ant	*Formica rubra* Linnaeus (Hymenoptera: Formicidae)	2.5 a
	Camponotus compressus Fabricius (Hymenoptera: Formicidae)	-
	Solenopsis geminata Fabricius (Hymenoptera: Formicidae)	-
Wasp	*Polistes dominula* Christ (Hymenoptera: Vespidae)	0.8 c
	Vespula vulgaris Linnaeus (Hymenoptera: Vespidae)	-
Green lace wing	*Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae)	1.1 bc

The findings indicated that the Hemipteroid pests were perhaps dominant on citrus, mango and pineapple during cooler and dry season. Our findings were in concurrence with Kaushik et al. (2012) and Kannan and Rao (2000) who observed significant abundance of hopper on mango plants. The plant species diversity in the agroforestry may have influenced the survival and abundance of insects by modifying the microclimate (Ram et al., 1989). Ram et al. (1989) reported that crop species sometimes create favorable conditions for pest incidence and damage.

There were 20 species of predator insects (Table 4) belonging to 13 families. Their abundance ranged from 0.8 to 2.5/40 sweeps and the results differed significantly ($p<0.01$). The ants were most abundant followed by lady bird beetle, dragon fly, tiger beetle, ground beetle, damsel fly, green lacewing and assassin bug. The preying mantid, pirate bug and wasp had statistically similar and lowest abundance. This finding agreed with Amin et al. (2015) who reported that ants had highest abundance compared to others in a mango based agroforestry in Bangladesh.

Data expressed as mean and means per insect group are taken from 40 sweeps per total collection. Means within a column followed by same letter(s) are not significantly different (DMRT, $P \leq 0.05$). Dashes indicate no information

Nineteen species of insects under 12 families in 4 orders (Coleoptera, Lepidoptera, Hymenoptera and Diptera) were found as pollinators (Table 5). Their abundance varied from 1.7 to 5.1/40 sweeps and the results differed significantly ($p<0.001$). Honey bee and horse fly showed the highest and lowest abundance, respectively. Amin et al. (2015) found 8 species of insects belonging to 7 families in 3 orders as pollinator in a mango based agroforestry area in Bangladesh. Fajardo et al. (2008) reported 21 species in five orders as insect pollinators of mango in Philippines. Sung et al. (2006) found 39 insect species as pollinators of mango in Southern Taiwan. Uddin et al. (2012) observed five species of insects in the order Diptera and Hymenoptera as pollinator of mango in Bangladesh.

Table 5. Taxonomic profile of pollinator insects along with their abundance in the agroforestry area during July 2015 to June 2016

Insect pollinator	Taxonomic profile	Abundance
Epilachna beetle	*Epilachna dodecastigma* Wied (Coleoptera: Coccinellidae)	2.6 be
	Epilachna vigintioctopunctata Fabricius (Coleoptera: Coccinellidae)	-
Red pumpkin beetle	*Aulacophora foveicollis* Lucas (Coleoptera: Galerucidae)	2.7 be
Lemon butterfly	*Papilio demoleus* Linnaeus (Lepidoptera: Papilionidae)	3.7 ad
Swallow tail	*Papilio polytis* Linnaeus (Lepidoptera: Papilionidae)	2.5 be

Insect pollinator	Taxonomic profile	Abundance
butter fly		
Four footed butter fly	*Junonia sp.* Hubner (Lepidoptera: Nymphalidae)	2.2 de
Monarch butterfly	*Danus plexippus* Linnaeus (Lepidoptera: Nymphalidae)	1.9 de
Sulphur butter fly	*Colias eurytheme* Boisduval (Lepidoptera: Pieridae)	4.1 ac
Honey bee	*Apis mellifera* Linnaeus (Hymenoptera: Apidae)	5.1 a
	Apis cerana Fabricius (Hymenoptera: Apidae)	-
	Apis dorsata Fabricius (Hymenoptera: Apidae)	-
Carpenter bee	*Xylocopa pubescens* Spinola (Hymenoptera: Apidae)	2.6 be
Wasp	*Polistes dominula* Christ (Hymenoptera: Vespidae)	1.9 de
	Vespula vulgaris Linnaeus (Hymenoptera: Vespidae)	-
House fly	*Musca domestica* Linnaeus (Diptera: Muscidae)	2.9 be
Horse fly	*Tabanus sp.* Linnaeus (Diptera: Tabanidae)	1.7 e
Blow fly	*Calliphora erythrocephala* Meigen (Diptera: Calliphoridae)	2.6 be
Syrphid fly	*Syrphid sp*. Linnaeus (Diptera: Syrphidae)	4.3 ab
Fruit fly	*Bactrocera dorsalis* Hendel (Diptera: Tephritidae)	2.3 ce

Data expressed as mean and means per insect group are taken from 40 sweeps per total collection. Means within a column followed by same letter(s) are not significantly different (DMRT, $P \leq 0.05$). Dashes indicate no information.

The variation of the insect species abundance among pest, predator and pollinator in different countries and different regions of a country is due to climatic conditions, host plants and habitat management. In the present study, relative abundance of the insect pest species on citrus, mango and pineapple showed variation, and the abundance of predator and pollinator insect species also differed significantly. The predator and pollinator insects may have got secure habitat because of the presence of different plant species in the agroforestry system and they showed adequate abundance. Expansion of agroforestry technology could provide habitat for restoration of the beneficial insects, but information on the abundance and damage threshold of the insect pest species is very important prior to expand this technology in any locality (Epila, 1988). So, plant species combinations must be on the basis of least favorable conditions for the survival and multiplication of major pest species.

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