Species abundance of soil arthropods in pigeon pea ecosystem under Nagaland conditions

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ABSTRACT

A field experiment was conducted at SASRD, Nagaland University, Nagaland from June 2017 to January 2018 on pigeon pea to find out the species abundance of arthropods fauna by means of pitfall trap for soil surface dwellers. Soil surface dwellers were recorded with a total mean of 16.60 belonging to 23 families and 13 orders comprising Hymenoptera (38.10%), Orthoptera (17.44%), Dermaptera (0.11%), Isoptera (2.05%), Dictyoptera (1.40%), Hemiptera (0.97%), Coleoptera (16.26%), Diplopoda (4.63%), Chilopoda (1.51%), Acarina (3.34%), Araneida (11.84%), Lepidoptera (0.97%) and Diptera (0.86%). Formicidae (Hymenoptera) was the most dominant group. Correlation with the abiotic factors indicated that maximum and minimum temperature, minimum relative humidity and rainfall were found positively correlated with Hymenoptera, Orthoptera, Coleoptera and Araneida but maximum relative humidity was found to be negatively correlated with Hymenoptera, Coleoptera and Araneida but non-significantly with Orthoptera. The population of arthropods was found to be increased when temperature was high but reached lowest when temperature started to decline in the month of Dec-Jan 2018.

Keywords: Arthropods; pigeon pea; soil surface dwellers; abiotic factors

INTRODUCTION

Arthropods are invertebrates which constitute an integral part of all ecosystems and are important components of natural diversity that to be identified (May 1986). The terrestrial arthropods represent a very large group of organisms in the ecosystem. Insects of class Insecta of phylum Arthropoda are known to be the most successful and diverse animals on earth. They are considerably estimated to comprise more than 75 per cent of the known species of animals and approximately 0.9 million species of insects have been described throughout the world (Alfred et al 1998). The importance of insects is being their destructive nature on crops, animals, harvested commodities and as a carrier of many diseases on plants and animals.

Pigeon pea (*Cajanus cajan* Linn), commonly known as red gram or tur belongs to the family Fabaceae and is one of the most common tropical and sub-tropical legumes cultivated for its edible seeds. Pigeon pea is fast growing, hardy, widely adaptable and drought resistant (Bekele-Tessema 2007).

Because of its drought resistance, it can be considered of utmost importance for food security in regions where rainfall is unreliable and droughts are prone to occur.

Over 300 species of insects have been reported damaging the pigeon pea crop (Lal 1998). There are several reports indicating that pigeon pea is attacked by different insect pests from different parts of the country and other countries as well (Rao et al 2002, Kumar and Nath 2003). Diverse groups of arthropods are associated as pests but are beneficial with pigeon pea ecosystem. For an efficient and sound pest management, identification of key pests is most important. In addition, the information on soil arthropods in pigeon pea is very scanty and practically no research work has been conducted in Nagaland. The insect fauna has not yet been studied comprehensively and still

thousands of available species remain unknown. Considering the importance of arthropod fauna particularly in pigeon pea as pests, the present investigations were conducted at School of Agricultural Sciences and Rural Development, Nagaland University, Nagaland from June 2017 to January 2018 to find out the abundance of insect pests and their relation with abiotic factors.

MATERIAL and METHODS

The experimental site was located at Medziphema, Dimapur district of Nagaland which has an elevation of 310 meters amsl with the topography of 10-15 per cent slopes and sub-tropical climate, predominantly humid and moderate temperature with medium to high rainfall. The condition of soil was sandy loam, well drained with mean pH of 4.4. The population of the insects associated with pigeon pea was studied at 07:00 hours by recording the number of insects from all the plots at an interval of 15 days.

Twenty pitfalls traps were installed randomly with replications at a depth of 12 cm. Each pitfall unit consisted of a wide-mouthed transparent bottle 12 cm in length and 4 cm in diameter. Each trap was supplied with 100 ml of 10 per cent formalin solution for killing, preserving specimens and repelling vertebrate predators. The mouth of each trap was covered with a flat stone placed 2 cm above from the mouth of the trap to protect from rain water and other unwanted particles falling into it. The specimens were removed and stored into vials containing 70 per cent alcohol or dried preserved in insect boxes for identification. The identification was done with the help of a stereo-binocular microscope with a magnification of 10X to 30X. The relative abundance of different taxa and species of arthropods and the natural enemies present in pigeon pea ecosystem were statistically worked out by the method as suggested by Singh and Rai (2000). Arthropod diversity was calculated by Shannon-Wiener diversity index (Kikkawa 1996).

RESULTS and DISCUSSION

The relative abundance of soil surface dwelling arthropods in pigeon pea ecosystem was recorded as 16.60 (Table 1) by employing pitfall traps. The pitfall traps were the most commonly used and were superior to many trapping devices available for studying the soil surface dwelling arthropods (Thiele 1977) and can indicate the location of species within various habitats too (Huffman and Harding 1980). The arthropods in pigeon pea ecosystem were represented by 14 orders with 23 families comprising Hymenoptera (38.10%), Orthoptera (17.44%), Dermaptera (0.11%), Isoptera (2.05%), Dictyoptera (1.40%), Hemiptera (0.97%), Coleoptera (16.26%), Diplopoda (4.63%), Chilopoda (1.51%), Acarina (3.34%), Araneida (11.84%), Lepidoptera (0.97%) and Diptera (0.86%). Eight arthropods were identified up to generic and species level from this site. Ants of family Formicidae (Hymenoptera) were the most dominant species with relative abundance of (37.67%) followed by *Achaeta* spp (Gryllidae) (15.28%) while the least was found to be *Chlaenius hamifer* Chaudoir followed by *Atrax* spp with 0.11 per cent for both. Coleoptera was represented by family Scarabeidae and Elateridae with a relative abundance of 5.60 and 6.78 per cent respectively. Other species included *Cicindella* spp with 2.80 per cent, *Coccinella septempunctata* with 0.97 per cent and *Claenius hamifer* (0.11%). Coleoptera is one of the most important soil surface dwelling arthropods, many of them particularly their larval stage being pests of many economically important plants. Other taxa were presented by *Macrotermes* spp (Isoptera) with 2.05 per cent, earwig (Dermaptera) with 0.11 per cent, Blattidae (Dictyoptera) with 1.40 per cent, assassin bug (Hemiptera) with 0.97 per cent, Lepidopteran larvae (0.97%), millipedes (4.63%), centipedes (1.51%), while Acarina ant spider (Araneida) were all recorded in negligible number.

The highest soil arthropods population was found during the end of August when the mean maximum and minimum temperature, maximum and minimum relative humidity and rainfall were 33.8 and 24.8°C, 95.1 and 70.6 per cent and 183.5 mm respectively. The high population could be due to new flush growth of pigeon pea as well as conducive environmental conditions as also reported by Reddy and Ao (1995) that most of the soil surface dwelling arthropods were abundant during the rainy season. However Kalariya et al (1997) studied the soil surface dwelling arthropods at 12 and 30 weeks after sowing which is contrary to the present study.

The correlation between dominant soil arthropods orders with maximum and minimum temperature, maximum and minimum relative humidity and rainfall showed that the maximum and minimum temperature, minimum relative humidity and rainfall had positive significant correlation with dominant soil

Table 1. Abundance of soil surface dwelling arthropods in pigeon pea ecosystem during June 2017 – January 2018 (mean values of 4 pitfall traps)

Order/family/species	Jun	Jul	Jul	Mean	Aug	Aug	Mean	Sep	Sep	Mean
Hymenoptera										
Formicidae (ants)	7.25	8.75	9.50	9.13	10.00	10.50	10.25	10.50	7.25	8.88
	(39.19)	(38.89)	(36.54)	(37.63)	(25.81)	(33.07)	(31.78)	(46.67)	(50.00)	(47.97)
Ropalidia spp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Orthoptera										
Achaeta spp	2.75	1.75	3.25	2.50	4.00	3.25	3.63	3.25	2.75	3.00
	(14.86)	(7.78)	(12.50)	(10.31)	(10.32)	(10.24)	(11.24)	(14.44)	(18.97)	(16.22)
Conocephalus longipennis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.25
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(3.45)	(1.35)
Gryllus sp	0.00	0.00	0.25	0.13	0.75	0.00	0.38	0.00	0.00	0.00
	(0.00)	(0.00)	(0.96)	(0.52)	(1.94)	(0.00)	(1.16)	(0.00)	(0.00)	(0.00)
Acrididae	0.00	0.00	0.00	0.00	0.25	0.25	0.25	0.25	0.25	0.25
	(0.00)	(0.00)	(0.00)	(0.00)	(0.65)	(0.79)	(0.78)	(1.11)	(1.72)	(1.35)
Dermaptera										
Earwig	0.25	0.25	0.75	0.50	0.00	0.00	0.00	0.25	0.00	0.13
	(0.25)	(0.25)	(0.75)	(0.50)	(0.00)	(0.00)	(0.00)	(0.25)	(0.00)	(0.13)
Isoptera										
Macrotemes spp	0.25	0.75	1.00	0.88	1.00	1.50	1.25	0.00	0.00	0.00
	(1.35)	(3.33)	(3.85)	(3.61)	(2.58)	(4.72)	(3.88)	(0.00)	(0.00)	(0.00)
Dictyoptera										
Blattidae	0.75	0.25	0.25	0.25	0.75	1.00	0.88	0.00	0.00	0.00
	(4.05)	(1.11)	(0.96)	(1.03)	(1.94)	(3.15)	(2.71)	(0.00)	(0.00)	(0.00)
Hemiptera										
Assasin bug	0.00	0.00	0.00	0.00	0.00	0.25	0.13	0.75	0.25	0.50
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.79)	(0.39)	(3.33)	(1.72)	(2.70)
Coleoptera										
Scarabaeidae	1.25	2.75	3.25	3.00	3.75	1.25	2.50	0.50	0.25	0.38
	(6.76)	(12.22)	(12.50)	(12.37)	(9.68)	(3.94)	(7.75)	(2.22)	(1.72)	(2.03)
Cicindela spp	0.00	0.00	1.75	0.88	2.00	1.75	1.88	0.25	0.25	0.25
	(0.00)	(0.00)	(6.73)	(3.61)	(5.16)	(5.51)	(5.81)	(1.11)	(1.72)	(1.35)
Elateridae	1.75	2.25	1.00	1.63	3.25	2.75	3.00	2.50	0.75	1.63
	(9.46)	(10.00)	(3.85)	(6.70)	(8.39)	(8.66)	(9.30)	(11.11)	(5.17)	(8.78)
Coccinella septempunctata	0.00	0.00	0.00	0.00	0.75	1.00	0.88	0.00	0.25	0.13
	(0.00)	(0.00)	(0.00)	(0.00)	(1.94)	(3.15)	(2.71)	(0.00)	(1.72)	(0.68)
Chlaenius hamifer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Diplopoda										
Millipedes	0.50	1.00	0.00	0.50	4.75	2.25	3.50	2.00	0.00	1.00
	(2.70)	(4.44)	(0.00)	(2.06)	(12.26)	(7.09)	(10.85)	(8.89)	(0.00)	(5.41)
Chilopoda										
Centipedes	0.75	0.25	0.00	0.13	1.00	1.25	1.13	0.25	0.00	0.13
	(4.05)	(1.11)	(0.00)	(0.52)	(2.58)	(3.94)	(3.49)	(1.11)	(0.00)	(0.68)
Acarina										
Cryptostigmata	0.50	0.50	1.00	0.75	1.50	0.75	1.13	0.25	0.00	0.13
	(2.70)	(2.22)	(3.85)	(3.09)	(3.87)	(2.36)	(3.49)	(1.11)	(0.00)	(0.68)
Mesostigmata	0.50	0.50	0.75	0.63	0.25	0.50	0.38	0.25	0.25	0.25
	(2.70)	(2.22)	(2.88)	(2.58)	(0.65)	(1.57)	(1.16)	(1.11)	(1.72)	(1.35)
Araneida										
Lycosa spp	1.75	3.00	3.25	3.13	3.75	2.25	3.00	1.50	1.75	1.63
	(9.46)	(13.33)	(12.50)	(12.89)	(9.68)	(7.09)	(9.30)	(6.67)	(12.07)	(8.78)
Pardosa sp	0.00	0.25	0.00	0.13	0.25	0.00	0.13	0.00	0.00	0.00
	(0.00)	(1.11)	(0.00)	(0.52)	(0.65)	(0.00)	(0.39)	(0.00)	(0.00)	(0.00)
Atrax sp	0.00	0.00	0.00	0.00	0.00	0.25	0.13	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.79)	(0.39)	(0.00)	(0.00)	(0.00)
Lepidoptera										
Larvae	0.25	0.25	0.00	0.13	0.50	0.75	0.63	0.00	0.00	0.00
	(1.35)	(1.11)	(0.00)	(0.52)	(1.29)	(2.36)	(1.94)	(0.00)	(0.00)	(0.00)

Diptera										
Mosquitoes	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.25 (0.65)	0.25 (0.79)	0.25 (0.78)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Count of species	**13**	**14**	**12**		**18**	**19**		**13**	**11**	
Shannon Wiener H'	**24.52**	**25.62**	**26.60**		**31.22**	**30.51**		**25.07**	**22.59**	

Table 1. Contd…..

Order/family/ species	Oct	Oct	Mean	Nov	Nov	Mean	Dec	Dec	Mean	Jan	Total mean
Hymenoptera											
Formicidae (ants)	5.75 (47.92)	2.75 (28.95)	4.25 (39.53)	3.00 (40.00)	2.25 (31.03)	2.63 (35.57)	3.25 (44.83)	2.25 (42.86)	2.75 (44.00)	1.25 (33.33)	6.25 (37.67)
Ropalidia spp	0.50 (4.17)	0.50 (5.26)	0.50 (4.65)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.07 (0.43)
Orthoptera											
Achaeta spp	2.25 (18.75)	2.25 (23.68)	2.25 (20.93)	1.75 (23.33)	2.25 (31.03)	2.00 (27.10)	1.75 (24.14)	1.50 (28.57)	1.63 (26.00)	1.50 (40.00)	2.54 (15.28)
Conocephalus longipennis	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.04 (0.22)
Gryllus sp	0.25 (2.08)	0.75 (7.89)	0.50 (4.65)	0.25 (3.33)	0.25 (3.45)	0.25 (3.39)	0.25 (3.45)	0.00 (0.00)	0.13 (2.00)	0.00 (0.00)	0.23 (1.40)
Acrididae	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.09 (0.54)
Dermaptera											
Earwig	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.11 (0.11)
Isoptera											
Macrotemes spp	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.25 (3.45)	0.00 (0.00)	0.13 (2.00)	0.00 (0.00)	0.34 (2.05)
Dictyoptera											
Blattidae	0.25 (2.08)	0.00 (0.00)	0.13 (1.16)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.23 (1.40)
Hemiptera											
Assasin bug	0.75 (6.25)	0.25 (2.63)	0.50 (4.65)	0.00 (0.00)	0.00 (0.00)	0.00 (0.79)	0.00 (0.39)	0.00 (3.33)	0.00 (1.72)	0.00 (2.70)	0.16 (0.97)
Coleoptera											
Scarabaeidae	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.93 (5.60)
Cicindela spp	0.50 (4.17)	0.00 (0.00)	0.25 (2.33)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.46 (2.80)
Elateridae	0.75 (6.25)	0.75 (7.89)	0.75 (6.98)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.13 (6.78)
Coccinella septempunctata	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.25 (3.45)	0.13 (1.69)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.16 (0.97)
Chlaenius hamifer	0.00 (0.00)	0.25 (2.63)	0.13 (1.16)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.02 (0.11)
Diplopoda											
Millipedes	0.00 (0.00)	0.25 (2.63)	0.13 (1.16)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.77 (4.63)
Chilopoda											
Centipedes	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.25 (1.51)
Acarina											
Cryptostigmata	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.32 (1.94)
Mesostigmata	0.25 (2.08)	0.00 (0.00)	0.13 (1.16)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.23 (1.40)
Araneida											
Lycosa spp	0.75 (6.25)	1.75 (18.42)	1.25 (11.63)	2.00 (26.67)	1.00 (13.79)	1.50 (20.33)	1.00 (13.79)	1.25 (23.81)	1.13 (18.00)	1.00 (26.67)	1.86 (11.19)

Pardosa sp	0.00	0.00	0.00	0.00	0.25	0.13	0.25	0.25	0.25	0.00	0.09
	(0.00)	(0.00)	(0.00)	(0.00)	(3.45)	(1.69)	(3.45)	(4.67)	(4.00)	(0.00)	(0.54)
Atrax sp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.11)
Lepidoptera											
Larvae	0.00	0.00	0.00	0.25	0.25	0.25	0.00	0.00	0.00	0.00	0.16
	(0.00)	(0.00)	(0.00)	(3.33)	(3.45)	(3.39)	(0.00)	(0.00)	(0.00)	(0.00)	(0.97)
Diptera											
Mosquitoes	0.00	0.00	0.00	0.25	0.75	0.50	0.50	0.00	0.25	0.00	0.14
	(0.00)	(0.00)	(0.00)	(3.33)	(10.34)	(6.78)	(6.90)	(0.00)	(4.00)	(0.00)	(0.86)
Count of species	**10**	**9**		**6**	**8**		**7**	**4**		**3**	
Shannon Wiener H'	**24.52**	**25.62**		**20.28**	**20.44**		**20.28**	**19.40**		**18.81**	

Figures in the parentheses are per cent conversions

Table 2. Correlation coefficient values (r) of dominant soil arthropod orders with abiotic factors in pigeon pea ecosystem

Order	Temperature (°C)		Relative humidity (%)		Rainfall (mm)
	Maximum	Minimum	Maximum	Minimum	
Hymenoptera	0.859**	0.874**	-0.664*	0.829**	0.838**
Orthoptera	0.680**	0.666**	-0.292^{NS}	0.633*	0.719**
Coleoptera	0.713**	0.747**	-0.673**	0.752**	0.806**
Araneida	0.576*	0.610*	-0.630*	0.596*	0.620*

df= (14-2)=12; $r_{0.05}$= 0.532, $r_{0.01}$=0.0661; *Significant at 5% LoS, **Significant at 1% LoS;
NS= Non-significant at 5% LoS

arthropods (Table 2). These findings are similar to the observations made by several workers who were of the opinion that increase in temperature and food served as a threshold for ant population fluctuation and the increase in ant activity was correlated with rainfall (Majer 1981).

Edwards et al (1975) reported that temperature is one of the most important factors in dealing with the activities of arthropods. They also reported that the arthropods activity depends upon weather conditions especially temperature and soil moisture and the general habitat surrounding the trap. Hymenoptera exhibited a positive and highly significant correlation with temperature (r= 0.859) and rainfall (r= 0.838) at 1 per cent level of significance but showed negative and significant correlation with relative humidity (r= - 0.664) at 5 per cent level. Orthoptera was positively correlated with temperature (r= 0.680) and rainfall (r= 0.719) at 1 per cent level but was negatively non-significant with relative humidity (r= -0.292).

These findings are similar to the findings of Majer and Koch (1982) who noted that the Orthoptera showed positive correlation with temperature and negative correlation with relative humidity. A highly positive significant relationship was revealed by the Coleopterans with mean temperature (r= 0.713) and rainfall (r= 0.806) at 1 per cent level but with relative humidity (r= -0.673) it was negative and significant at 1 per cent level. Araneida also showed positive and significant correlation with both temperature (r= 0.576) and rainfall (r= 0.620) at 5 per cent level but with relative humidity, it was negative and significant (r= -0.630) at 5 per cent level.

CONCLUSION

A mean total number of 16.60 belonging to 23 families and 13 orders were recorded. Results on the seasonal abundance of the dominant arthropods and their correlation with abiotic factors play an important role in predicting the most active period of these major pests. Hence suitable management practices can be applied at the right time. However comprehensive scientific research and study are required on the insect fauna of pigeon pea for higher profit to the farmers especially in the foothills of Nagaland.

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