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Influence of weather parameters on seasonal abundance of arthropods in a floricultural ecosystem

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Abstract
The present investigation was carried out to explore the weather correlation with the abundance of arthropods in floricultural ecosystem *viz.*, rose, and cock's comb and jasmine fields. The present study was conducted at Agricultural College and Research Institute, Tamil Nadu Agricultural University and Kasthurinay kumpalayam in Coimbatore district during 2011-2012. Correlation analysis showed that the arthropod population was positively correlated with relative humidity (0.4987) and evening sunshine hours (0.1358), but negative correlation was observed in maximum temperature (-0.5012) and rainfall (-0.2013). Among the spiders, order Araneae had a negative correlation with maximum temperature (-0.4232) and positively correlated with sunshine hours (0.4422) but this was negatively correlated with rainfall (-0.4588). In case of insects, a positive correlation with high humidity (0.5247) and sunshine hours (0.1026), but a significant negative correlation with rainfall (-0.1657) and maximum temperature (-0.3871) was observed. The insects belonging to the orders Coleoptera, Hemiptera and Hymenopetra were also subjected to correlation analysis with the weather parameters.

Keywords: weather parameters, floricultural, investigation

1. Introduction

The fact that life is characterized by its diversity (amongst other things) is a notion as old as biology itself and that is what biologists of all persuasions are working on [1]. In the last decade, biodiversity concerns have been in the forefront of conservation efforts worldwide. It was stated that biodiversity can be represented as an interlocked hierarchy of elements on several levels of biological organization [2]. Arthropods are frequently used as ecological indicators because they represent more than 80 per cent of the global species richness. The class Insecta have always been regarded as the most speciose class in the Animal kingdom [3, 4, 5]. This class also constitute a substantial proportion of terrestrial species richness and biomass, and play a significant role in ecosystem functioning [6]. Spiders are among the most abundant invertebrate predators in terrestrial ecosystems [7, 8]. It was also revealed that after the five largest insect orders, the order Araneae ranks seventh in global diversity of animals among arachnids [9].

Seasonal conditions are considered to be the major factors in determining spatial and temporal distribution of organisms [10]. Despite the adaptation of insects and plants to combinations of these factors through evolutionary time, phytophagous insects with periodic outbreaks occurred, usually preceded by favourable environmental conditions [11, 12]. Irruptions of insect populations are associated with increase in food quality, reduced natural enemy pressure, or an extended period of favourable weather [10]. It was revealed that weather factors influenced food availability, natural enemy and herbivorous populations and, therefore, could be important determinants of fluctuation of insect-pest populations [13]. Food availability in particular, was influenced by weather factors and, in perennial systems, could be influenced by plant age. Meteorological factors affect insect population dynamics *via* faster developmental rates with increasing temperature, and lower survival with heavy rain, extreme temperatures and low moisture [14, 15, 16], and by negatively affecting individual reproductive behaviours [17, 18]. Similarly, meteorological factors might directly and indirectly influence the mortality ratios caused by insect natural enemies [17, 19, 20]. Meteorological factors might affect insect pest populations directly, through influences on reproductive and mortality ratios, and indirectly, through influences on their natural enemies [21]. Seasonal variation in weather variables, such as rainfall and temperature maxima and minima, might be the most important causes of dramatic changes in insect abundance, especially in temperate ecosystems. Although the climate of tropical forest ecosystems is moderately constant (e.g., minimal variation in monthly average temperatures), marked local variation in temperature and precipitation might occur due to changes in topography, and such variation might affect insect population dynamics [15]. Understanding the impacts of local weather variables on insect population dynamics is important for managing pests generally, including pests of tropical crops [22].

So we took up this study to determine the effect of climatic parameters on the seasonal abundance of arthropods in a floricultural ecosystem of rose, jasmine and cocks comb.

2. Materials and Methods

2.1 Experimental sites

The present experiment was conducted at the farmers' field for rose and cock's comb and also in the University Botanical Garden for *Jasminum sambac* L from August 2011 and was continued upto April 2012.

2.2 Sampling methods

For carrying out arthropod collection, the plot was divided into 100 quadrats (10 m × 10 m). Five such quadrats were chosen each at random and the entire plot was covered during the sampling period. To develop a package of methods for quantitative sampling of arthropod communities, collections were made using four different methods *viz*., active searching, net sweeping, pitfall trap and rubbish trap.

2.2.1. Active searching

Active searching was done in the early morning or evening hours. Each quadrat was selected at random and they were actively searched for arthropods. Each site was searched for a total of two hours. Spiders were collected by walking diagonally in the fields and care was taken to capture them without injuring and transferred to polythene bags for further studies. Specimens from a single quadrat at each habitat type were pooled for analysis.

2.2.2 Net sweeping

Sweeping is very effective for the collection of flying and jumping arthropods at the ground level and under storey vegetation. The nets used in systematic sweeping of the ground level were made of thick cotton cloth with a diameter of 30 cm at the mouth and a bag length of 60 cm.

Out of the 100 quadrats to which the entire plot was divided, five quadrats representing the field were chosen at random and the entire ground level vegetation in the chosen quadrat was covered during the sweeping. Net sweeps were always done between 10 am and 12 noon. The sweeps were made at ground vegetation above one metre height from the ground for collecting insects from shrubs. The arthropods collected from each quadrat were transferred into polythene bags containing cotton dipped in chloroform. They were sorted on the same day. Spiders and other arthropods were separated from the vegetation. Soft bodied insects and spiders were later separated from the bag and preserved in vials containing 70 per cent alcohol.

2.2.3 Pitfall traps

This method was adopted to collect ground dwelling and nocturnal arthropods. Pitfall traps were set out using a plastic container (15 cm height and 10 cm width) buried into the soil to a depth of 20 cm. Five pitfall traps were placed in each of five randomly chosen quadrats. The traps were set up between 6 am and 5 pm and specimens were collected the next morning. In order to stop the receptacle from filling with water or leaf litter and to deter some larger predators like mice, the trap was covered with a flat stone supported by four smaller stones. Teepol (2-3 drops) in water was kept in the traps as trapping fluid. The traps were placed at the rate of 25 per plot.

The trapping fluid was changed every week. Observations were recorded daily on the number and type of arthropods trapped in each container.

2.2.4 Rubbish traps

These traps were constructed using chicken wire mesh, stuffed with leaf litter

(45 cm length and 15 cm width). Five rubbish traps were placed in each of five randomly chosen quadrats. The traps were placed in the field allowing a week for arthropods to take up residence. Every seven days, these traps were removed and brought to the laboratory and arthropods found inside were collected.

2.3 Identification of arthropods

The collection of arthropods was carried out in rose, cock's comb and jasmine fields at different stages of the crop growth. The collected arthropods were sorted out based on taxon. Soft bodied insects and spider species were preserved in 70 per cent ethyl alcohol in glass vials. Other arthropods were card mounted or pinned. The preserved specimens were photographed and identified based on the taxonomic characters.

All arthropod species were identified to the lowest possible taxon. Insects were identified following literature [23, 24, 25, 26, 27] and also by comparing with the specimens in the Department of Agricultural Entomology, Tamil Nadu Agricultural University. Spiders were identified with the help of Dr. M. Ganesh Kumar, Professor of Entomology and Dr. Manju Siliwal, Research Associate, Zoo Outreach Organization, Coimbatore.

3. Results and Discussion

Abundance of arthropods in various ecosystems showed a significant relationship with climatic variables. From Table 1, it could be seen that there was a strong direct correlation between relative humidity and arthropod population. It could be seen that maximum population of arthropods was found at high humidity (morning). Similarly arthropod population was positively correlated with sunshine hours (Table 1). However, arthropod population was negatively correlated with maximum temperature. Among the spiders, order Araneae had a negative correlation with maximum temperature and positively correlated with sunshine hours but this was negatively correlated with rainfall (Table 2). In case of class Insecta, there was a positive correlation with high humidity and sunshine hours, but a significant negative correlation with rainfall and maximum temperature was observed (Table 3). In addition, the seasonal abundance of important families of class insect, *viz*., Coleoptera, Hemiptera and Hymenoptera was also correlated with weather parameters. It was found that the seasonal abundance of Hemiptera was positively correlated with relative humidity and sunshine hours, but negatively correlated with temperature and rainfall (Table 4). The same trend was followed in the case of Hymenoptera also (Table 5). But the order Coleoptera exhibited a different trend since their abundance was negatively correlated with sunshine and rainfall. Positive correlation was observed between the parameters like temperature and humidity and the abundance of beetles in the floricultural ecosystem (Table 6).

Earlier studies [13] suggest that weather factors influenced food availability, natural enemy and herbivore populations and, therefore, could be important determinants of fluctuation of insect-pest populations. In the present investigation, correlation analysis showed that arthropods *viz*., spiders and insects were positively correlated with relative humidity and sunshine hours but negatively correlated with temperature and rainfall. High temperatures have been shown to have a negative impact on spiders because thermal stress suppresses the spider activity [8, 28]. The thermal environment also limits foraging activities to certain periods of the day [29]. However, the temperature influences different species in different ways and some spiders actually select warmer areas in order to enhance egg development [8]. It was found [30] that the relative humidity less than 45 percent could cause stress to early instars of *Cheiracanthium inclusum* (Hentz).

In the present study, it was observed that the total rainfall exhibited a negative influence on mites, thrips and aphid populations. The present findings are in conformity with an earlier study in which the same trend was observed in *Aphis gossypii* in Brinjal [31]. The present finding showed that Coleopterans were positively correlated with temperature and relative humidity but negatively correlated with rainfall and sunshine hours. It was earlier reported [32] that sunshine showed negative impact while maximum, minimum and average relative humidity had positive impact on blister beetle (*Mylabris pustulata*) population infesting pigeon-pea crop. In case of order Hymenoptera, the results showed a positive correlation with relative humidity and sunshine hours but were negatively correlated with temperature and rainfall. This is in conformity with the earlier studies [33] where it was found that the population of ants increased with increased sunshine hours.

Table 1: Influence of weather parameters on seasonal abundance of total arthropods (Correlation analysis)

Correlation analysis of arthropods							
Variables	**Arthropods (Numbers)**	**Maximum temperature (^{0}C)**	**Minimum temperature (^{0}C)**	**RH at 0722 hrs (%)**	**RH at 1422 hrs (%)**	**Rainfall (mm)**	**Sunshine (hrs)**
Arthropods (Numbers)	1	*	*	*	*	*	*
Maximum temperature (^{0}C)	-0.5012	1	*	*	*	*	*
Minimum temperature (^{0}C)	-0.4355	0.433435	1	*	*	*	*
RH at 0722 hrs (%)	0.4987	-0.54213	0.117738	1	*	*	*
RH at 1422 hrs (%)	0.1001	-0.60831	0.331667	0.720556	1	*	*
Sunshine (hrs)	0.1358	0.397174	-0.32423	-0.50201	-0.7111	1	*
Rainfall (mm)	-0.2013	-0.1699	0.244403	0.466552	0.526489	-0.48732	1

Table 2: Influence of weather parameters on seasonal abundance of order Araneae (Correlation analysis)

Correlation analysis of Araneae							
Variables	**Araneae (Numbers)**	**Maximum temperature (^{0}C)**	**Minimum temperature (^{0}C)**	**RH at 0722 hrs (%)**	**RH at 1422 hrs (%)**	**Rainfall (mm)**	**Sunshine (hrs)**
Araneae (Numbers)	1	*	*	*	*	*	*
Maximum temperature (^{0}C)	-0.4232	1	*	*	*	*	*
Minimum temperature (^{0}C)	-0.6521	0.433435	1	*	*	*	*
RH at 0722 hrs (%)	0.2412	-0.54213	0.117738	1	*	*	*
RH at 1422 hrs (%)	0.0124	-0.60831	0.331667	0.720556	1	*	*
Sunshine (hrs)	0.4422	0.397174	-0.32423	-0.50201	-0.7111	1	*
Rainfall (mm)	-0.4588	-0.1699	0.244403	0.466552	0.526489	-0.48732	1

Table 3: Influence of weather parameters on seasonal abundance of class Insecta (Correlation analysis)

Correlation analysis of Insecta							
Variables	**Insecta (Numbers)**	**Maximum temperature (^{0}C)**	**Minimum temperature (^{0}C)**	**RH at 0722 hrs (%)**	**RH at 1422 hrs (%)**	**Rainfall (mm)**	**Sunshine (hrs)**
Insecta (Numbers)	1	*	*	*	*	*	*
Maximum temperature (^{0}C)	-0.3871	1	*	*	*	*	*
Minimum temperature (^{0}C)	-0.4234	0.433435	1	*	*	*	*
RH at 0722 hrs (%)	0.5247	-0.54213	0.117738	1	*	*	*
RH at 1422 hrs (%)	0.0748	-0.60831	0.331667	0.720556	1	*	*
Sunshine (hrs)	0.1026	0.397174	-0.32423	-0.50201	-0.7111	1	*
Rainfall (mm)	-0.1657	-0.1699	0.244403	0.466552	0.526489	-0.48732	1

Table 4: Influence of weather parameters on seasonal abundance of order Hemiptera (Correlation analysis)

Correlation analysis of Hemiptera							
Variables	**Hemiptera (Numbers)**	**Maximum temperature (^{0}C)**	**Minimum temperature (^{0}C)**	**RH at 0722 hrs (%)**	**RH at 1422 hrs (%)**	**Rainfall (mm)**	**Sunshine (hrs)**
Hemiptera (Numbers)	1	*	*	*	*	*	*
Maximum temperature (^{0}C)	-0.5428	1	*	*	*	*	*
Minimum temperature (^{0}C)	-0.1237	0.433435	1	*	*	*	*
RH at 0722 hrs (%)	0.4789	-0.54213	0.117738	1	*	*	*
RH at 1422 hrs (%)	0.1452	-0.60831	0.331667	0.720556	1	*	*
Sunshine (hrs)	0.3214	0.397174	-0.32423	-0.50201	-0.7111	1	*
Rainfall (mm)	-0.1231	-0.1699	0.244403	0.466552	0.526489	-0.48732	1

Table 5: Influence of weather parameters on seasonal abundance of order Hymenoptera (Correlation analysis)

Correlation analysis of Hymenoptera							
Variables	**Hymenoptera (Numbers)**	**Maximum temperature (^{0}C)**	**Minimum temperature (^{0}C)**	**RH at 0722 hrs (%)**	**RH at 1422 hrs (%)**	**Rainfall (mm)**	**Sunshine (hrs)**
Hymenoptera (Numbers)	1	*	*	*	*	*	*
Maximum temperature (^{0}C)	-0.1472	1	*	*	*	*	*
Minimum temperature (^{0}C)	-0.2158	0.433435	1	*	*	*	*
RH at 0722 hrs (%)	0.3217	-0.54213	0.117738	1	*	*	*
RH at 1422 hrs (%)	0.1121	-0.60831	0.331667	0.720556	1	*	*
Sunshine (hrs)	0.1489	0.397174	-0.32423	-0.50201	-0.7111	1	*
Rainfall (mm)	-0.1722	-0.1699	0.244403	0.466552	0.526489	- 0.48732	1

Table 6: Influence of weather parameters on seasonal abundance of order Coleoptera (Correlation analysis)

Correlation analysis of Coleoptera							
Variables	**Coleoptera (Numbers)**	**Maximum temperature (^{0}C)**	**Minimum temperature (^{0}C)**	**RH at 0722 hrs (%)**	**RH at 1422 hrs (%)**	**Rainfall (mm)**	**Sunshine (hrs)**
Coleoptera (Numbers)	1	*	*	*	*	*	*
Maximum temperature (^{0}C)	0.1458	1	*	*	*	*	*
Minimum temperature (^{0}C)	0.1327	0.433435	1	*	*	*	*
RH at 0722 hrs (%)	0.2758	-0.54213	0.117738	1	*	*	*
RH at 1422 hrs (%)	0.2214	-0.60831	0.331667	0.720556	1	*	*
Sunshine (hrs)	-0.4144	0.397174	-0.32423	-0.50201	-0.7111	1	*
Rainfall (mm)	-0.1127	-0.1699	0.244403	0.466552	0.526489	-0.48732	1

4. Conclusion

Correlation analysis showed that the arthropod population was positively correlated with relative humidity and sunshine hours but negatively correlated with maximum temperature and rainfall. Araneid population was negatively correlated with maximum temperature, minimum temperature and rainfall. Similarly, class Insecta showed negative correlation with maximum temperature and rainfall.

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