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Interaction between Microbial Flora and Acarine Fauna of Jatropha Plantation in Tripura

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Abstract: ***Seasonal population dynamics of acarine fauna and fungal flora was studied on soil of Jatropha plantation during February 2018 to January 2019. Study indicated highest acarine fauna (7.65±0.11nos./m^2x100^2) during September, 2018 and lowest was recorded (1.0±0.2nos./m^2x100^2) during March, 2018. On the other hand, peak fungal population was recorded in September (13.5±0.72 fungal colony/gm. soil in 10^{-3} dilution) and the less nos. was recorded during February (4.6±0.12 Fungal colony/ gm. soil in 10^{-3} dilution). Also out of 11 different genera, 13 species of acarine fauna, Archegozetes sp. was found to be more dominant (17.55%) followed by Lamellobates sp. (13.76%). Whereas, out of 10 genera of fungal flora, the dominant species was Trichoderma harzianum (21.87%) followed by Cladosporium cladosporidae (11.46%). Multiple regression analysis revealed significant influence by all the abiotic factors (F=15.96: p<0.001). But acarine fauna showed positively correlated with the fungal flora(r=0.809; p<0.001).***

Key words: Population dynamics, Acarines, Fungal flora, Tripura

1. Literature Survey

Series of works have been carried to investigate the ecology of microarthropod with special reference to soil to acarina in different ecosystems. Muller [1] was the first who recognise that soil arthropods play an important in development of soil. Diem [2] perhaps initiated the work on soil fauna from certain Swiss Alpine soils. Kevan [3] commented that moisture content of the soil is the vital to soil fauna. Seasonal variation of soil arthropod population and its correlation with different edaphic factors at Varanashi has been reported by Mukherjii and Singh [4]. A significant positive correlation with abiotic factor and total microarthropod population was reported by Bhattacharya [5]. Pal et al., [6] studied on collembolan and fungal flora in relation to different soil factors in forest site at Burdwan. Works on microarthropods were reported from cultivated, uncultivated and mixed vegetation in Cachar district of Assam [7],[8]. Bandyopadhyay et al., [9] isolated gut fungi and observed feeding behaviour of some selected soil microarthropods of Wastelands of Burdwan district.

2. Introduction

Jatropha curcus (VanaErand) grows almost everywhere, belonging to Euphorbiaceae family, 175 species, 18 are found in India. Jatropha curcus is the best in respect of excellent adaptability to various habitat, large fruits, and seeds, high oil yielding, soil conservation capabilities etc. In Tripura, Jatropha can be grown in waste land with minimum care. The Jatropha plants start yielding from the second year of planting; as a result it is more profitable which will create a great deal to the economic development of Tripura. Cultivation of this species is totally eco-friendly, easy to produce raw material, easy oil extraction and transesterification. To meet the challenges excessive import, we have to strengthen our oilseed sector and lay emphasis on amassing the existing and augmenting future potential source of Green Fuel and considered as a wild oilseed plant of the tropics and subtropics. This potential biodiesel crop can be about major economic activity providing income and employment opportunities to the rural communities in Tripura.

It is well known that Fungi play a significant role in soil fertility and primary production through their activities in organic matter decomposition and nutrient cycling as root pathogens and as participants in symbiotic association with plant roots [10]. Soil arthropods are very abundant in many soils and may influence fungal communities indirectly via communication, channelling, mixing, directly through grazing and dispersal of spores [11].

Microbial communities particularly bacteria, fungi constitute an essential component of biological characteristics in soil ecosystem [12].

The acarine fauna feeds on these fungi and the filamentous fungi are the major contributors to the soil biomass in the soil ecosystem [13]. Works on acarine or collembolan and their interactions with fungal flora are very scanty in India in general and North East India in particular except Banerjee and Roy,Pal et al., Hazra et al.,Mandal et al. [14],[15],[16],[17].

In the present paper, an attempt has been made to know the impact of microbial flora on acarine fauna in relation to soil of Jatropha curcus plantation in west district of Tripura.

3. Material and Methods

Tripura is situated in the North Eastern Region of India, surrounded by Bangladesh on the West, South and North. Its north eastern and eastern boundary is demarcated by the states of Assam and Mizoram, respectively. The state lies between $22^0$56′ and $24^0$32′ N and $90^0$10′and $92^0$21′E with an average altitude of 12.8amsl. The study was carried out at Gokulpur 15 Kms. away from Agartala, capital of Tripura.

Soil sample was collected from each plot at monthly interval over a period of one year (February 2018- January 2019). Soil sampler as described by was used for collecting soil samples at a depth of 10cm [9]. Soil samples were collected

from five different plots marked randomly in each site. Extraction of micro arthropods was done by modified Tullgren Funnel type extractor [18]. The extraction was continued for 24 hours and the microarthropods was collected in the vials containing 72% alcohol added with 5% glycerine. After extraction, collected soil fauna was sorted out by Stereoscopic binocular microscope (10x X 40x) to isolate acarine fauna and sent to Zoological Survey of India, Kolkata for identification. Edaphic properties were analysed following standard methods as for moisture content (Wet and Dry method),pH (1:20 ratio, Systronics digital pH meter) and organic carbon (Black and Walkley rapid titration method),total nitrogen(semi Kjeldahl method by Allen *et al*.,1974),available phosphorus (molybdenum blue method by Olsen and Sommers 1982),exchangeable potassium(flame photometer by Allen *et al*.,1974) [19],[20],[21].

Isolation of fungi from soil samples

Preparation of medium

For the isolation and culture of fungal tissues, Potato-Dextrose Agar (PDA) medium was prepared and sterilized properly by autoclaving. One percent (1.0%) Streptomycin was added to it to avoid bacterial contamination. The sterilized media were poured aseptically to the sterilized Petri dishes (10cm. diameter) in Laminar Air Flow.

Isolation of fungi

Isolation of Fungi from the collected soil samples were done by Soil dilution plate method [22]. 1gm.soil sample was suspended separately in 10 ml. of double distilled water to make the microbial suspensions (10^{-1} to 10^{-4}).Dilution of 10^{-3} were used to isolate the fungi. 1 ml. of microbial suspension were added aseptically to the sterile petri dishes and were incubated at 28 ± 2^0C in dark condition. The fungal growth was observed everyday for seven days.

Identification of the fungi

For the morphological study and microphotography, slides were prepared by taking fungal material from the colonies found in the petri dishes and stained properly with Lacto phenol and Cotton Blue. Isolated fungal tissue was inoculated in sterilised PDA slants and the fungal specimens were identified by Agharkar Research Institute, Pune. The percentage of relative abundance of fungi was calculated as follows:

Number of colonies of particular species / Total number of colonies of all species X 100

4. Results and Discussion

4.1 Seasonal population fluctuation

Acarine fauna and fungal flora obtained from the soil of the Jatropha plantation exhibited an irregular trend of fluctuation. During the period of study the highest mean number of flora and fauna showed maximum population recorded in July 2018and minimum in January 2018.The population of both the groups exhibited a tendency of gradual increase from June, 2018 reaching their peaks in July, 2018 to September, 2018 after which both the groups underwent a gradual decline and reached the minimum level during dry season. (December, 2018 to March, 2019).The combination of all the climatic factors showed significant influences on the population of total Acari ($F=21.89$, $p< 0.001$) but rainfall did not show any significant influences on the population ($t= -0.15$ and $p= 0.79$). Other factors like relative humidity ("$t= 3.19$ and $p= 0.004$) and air temperature ($t= 3.11$, $p=0.005$) were found to be significant and positively correlated with the population. Population of cryptostigmatid also showed similar trend where combine effect of all the climatic factors was noticed ($F=20.20$, $p<0.001$) but in partial correlation except rainfall ($t= -0.66$, $p= 0.54$), positive and significant influence of relative humidity ($t= 0.36$, $p=0.731$) and air temperature ($t= 2.49$, $p=0.019$) was observed. (Table 3).

4.2 Density of acarine population

The density of Acarine population was highest during the month of September 2018 ($(7.65\pm0.11$ nos./m^2x100^2). Acarine fauna extracted from this site belonged to 13 species under 11 genera viz. Archegozetes sp., Lamellobates sp., Scheloribates striatus, Galumna sp., Oppia sp., Xylobates sp., Haplozetes laysanensis, Lamellobates pallustris, Phyllocarabode sp., Mesoplophora crassisetosa., Malacoangelia similis, Cosmochthonius lanatus diversiseta Vepracarus cornutus. The genus Archegozetes sp. was most dominant being present in all samples and comprising 17.55% out of total population followed by Lamellobates sp. representing 13.76%. Total cryptostigmatid population was maximum in August, 2018(5.5nos./m^2x100^2) and minimum was recorded during February,2018(0.3nos./m^2x100^2). (Fig.1)

Floral make up

During the investigation period, a total no. of 12 fungal sp. under 10 genera were isolated and recorded (Table 1). The most dominant fungal species was Trichoderma harzianum (21.87%) followed by Cladosporium cladosporidae (14.46%). The order of abundance was sterile hyphae (12.93%)>Fusarium sp.(9.11%)> Trichoderma parceramosum (7.25%)> Aspergillus niger(6.25%) > Curvularia sp. (6.25%)>Penicillium sp.(5.21%)> Paecilomyces variotii (5.21%)>Aspergilus flevus(4.68%)> Mucor sp.(3.65%) >Alternaria alternata(3.13%).(Table 1). Higher incidence of Aspergilus flaves, Aspergilus niger; Cladosporium sp., Trichoderma harzianum and sterile hyphae were observed from the rhizospheric region of Accacia auriculoformis and Bambusa balcoaa in Tripura by Das *et.al* [23]which is more or less similar with the present findings. This type of inter relationship of fungal diversity and faunal component has also been reported byGaddeyyal et al., [24].Fungal diversity of any soil depends at a large extent with factors of soil, such as pH, organic carbon and moisture content [25]. In the present study, the rubber plantation site supported a diverse fauna of acarina (12 genera) as well as fungal flora (10 genera).Both the groups indicated more or less similar trend of fluctuation. This suggests the possibility of a strong correlation between acarine fauna and fungal flora (Table 2).

Edaphic factors

Throughout the period of study, the soil temperature was maximum during June, 2018(32.4^0C) and minimum in January, 2019(17.0^0C).Hydrogen ion concentration(pH) was

found to be higher in the month of December, 2018(5.65), whereas it was minimum during Sepetember,2018(5.45). In case of pH, almost same result was found throughout the observation months (February 2018 to January, 2019). Peak value of moisture content, organic carbon, total nitrogen, available Phosphorus content and exchangeable potassium was obtained during September, 2018 as 19.59%, 1.74%, 0.16%, 1.75(mg $100g^{-1}$), 0.33(me $100g^{-1}$) respectively. The minimum value was observed in different months for different edaphic factors such as moisture content was minimum in January, 2019 (8.0%); in case of available phosphorus least(1.0 mg $100g^{-1}$)) was recorded from December,2018 as well as in January ,2019 also. In April, 2018, minimum value of total nitrogen(0.19 me $100g^{-1}$) was observed, whereas exchangeable potassium was found in lower limit(0.078) during both December 2018 and January, 2019 (Figure 2).The level of moisture content was declined during dry period might be due to low rainfall and excessive evaporation of soil water.

Correlation of acarine fauna with fungal flora and edaphic factors. Correlation-coefficient of environment and edaphic factors was employed with the acarine and mycoflora population. Both the populations showed positive co-relationship with the moisture, organic carbon, total nitrogen, available phosphorus content and exchangeable potassium whereas temperature and pH exhibited negative relationship with acarine fauna and mycoflora. Fungal flora showed a strong correlation with acarine population ($r=0.809$ $p<0.001$). (Table 3).

In this study, the population of flora and fauna reached their peak in August- September when the factors like moisture, organic carbons, total nitrogen, available phosphorus and exchangeable potassium were fairly high. During summer season, concentration of all these factors were low and consequently a lean population was observed and the present findings corroborates the findings of Hazra, Pal et al.,[26],[6]. The fungal population showed numerical variation with the change of season and diversity of species was also varied with the season. During monsoon number of variety of fungal species was maximum and minimum during winter and summer seasons. But Behera and Dash and Behera and Mukharjee observed the maximum population in winter and minimum in May [27],[28]. Pal et al., [6] observed a minor winter peak which might be due to population spurt of some forms in winter, but Choudhury and Banerjii, Hazra, and Pal et al.,[29],[26],[6] observed a direct proportional interdependence between collembolan, acarina and fungal population in forest litter. Interrelationship between fungal diversity and faunal content is also reported by Gaddeyya et al., Hazra [24], [15] reported a positive significant relationship with the microfauna. Presence of Penicillium sp., Trichoderma sp., sterile hyphae which were found from the soil of rubber plantation corroborates the findings of Das et al., [23]. Filamentous yeast population was the major part of the total fungal population isolated from the Rubber plantation. Aspergillus sp. producing different kinds of aflatoxin and achrotoxin etc. which prevent the growth of other fungal species (Gaddeyya et al.,[24] .Again studies of earlier workers have convincingly established that some components of microarthropods (particularly collembolan and acarines) are known to depend solely on fungal flora as the constant source of food. Therefore, it is obvious that increased availability of food may lead to a parallel increase in acarine community Choudhury and Banerjee,Pal et al., [29], [6].

Peak fungal population was recorded in September, 2018 (19±0.72no. of fungal colony./gm.soil in 10^{-3} dilution) and the less nos. was recorded during February, 2018(4.6±0.12) no.of fungal colony/gm.soil in 10^{-3} dilution) (Figure 2). Due to sufficient amount of rainfall, the moisture content of soil in monsoon months (July-September) increased sufficiently which in turn induced an intense growth of fungal population. In addition there was an increase in the concentration of organic carbon, total nitrogen, available phosphorus, exchangeable potassium etc. during monsoon months thereby creating a favourable condition for existence of flora and acarine fauna. During winter and summer season low precipitation coupled with high rate of evaporation of moisture from soil and low concentration of organic carbon, total nitrogen, available phosphorus content, and exchangeable potassium created an unfavourable condition for the existence of an acarines. Yu.c. et al., [30] reported that soil pH, organic carbon, soil moisture are the main factors affecting the fungal population and diversity of fungi. Thus it may conclude that faunal-floral component and their probable relationship might be due to cumulative influences of varieties of abiotic and biotic factors rather than any single factor.

5. Conclusion

From the study it can be assumed that the interrelationship between acarine fauna and microbial flora might be due to cumulative impact of varieties of abiotic and biotic factors rather than the influence of any single factor.

6. Future Scope

Soil fauna-microbial flora interaction is aconceptual framework for research to understand the links between biodiversity and ecosystem.

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Table 1: Percentage occurrence of different species of Acarina and fungus found in Soil of Jatropha plantation

Name of Species	% of Acarine Fauna		Name of Fungus	% of Fungal flora
Archegozetes sp.	17.55		Curvularia sp.	6.25
Scheloribates sp.	6.85		Trichoderma harzianum	21.87
Lamellobates sp	13.76		Aspergillus niger*	6.25
Galumna sp.	9.56		Fusarium sp.	9.91
Oppia sp.	6.33		Paecilomyces variotii	5.21
Xylobates sp.	5.30		Trichoderma parceramosum	7.25
Haplozetes laysanensis	6.02		Mucor sp.	3.65
Lamellobates pallustris	4.81		Penicillium sp.	5.21
Phyllocarabodes sp.	5.5		Alternatia alternata	3.13
Mesoplophora crassisetosa	4.19		Aspergillus flaves	4.68
Malacoangelia similis	3.85		Cladosporium cladosporidae	14.46
Cosmochthonius lanatus diversiseta	2.25		Sterile hyphae	12.93
Vepracarus cornutus	2.55			

*identified by Agharkar Research Institute, Pune

Table 2: Relationship between fungal flora and other edaphic factors with Acarine population

Edaphic Factors	Parametres	
	r-value	Regression equation Y=a+bx
Temperature	-0.581	-0.922x+28.20
pH	-0.398	-0.023x+1.350
Organic Carbon	0.849***	-0.020x+1.532

Moisture content	0.796***	1.239x+8.755
Available Phosphorus	0.750*	0.337x1.176
Exchangeable Nitrate	0.757*	0.003x+0.084
Exchangeable potassium	0.648*	0.014x0.199
Fungal Flora	0.809***	0.014x0.199

Note: ***p<0.001*p<0.5

Table 3: Showing the result of multiple regression between microarthropod population and climatic variables in Jatropha

Population	F Value	t value		
		RF	RH	AT
Total Acari	15.96***	-0.15 P=0.79	3.19 P=0.004	3.11 P=0.005
Cryptostigmatid	20.20***	-0.66 p=0.54	0.36 p=0.731	2.49 p=0.019

(RF=Rainfall, RH=Relative humidity, AT=Air temperature)

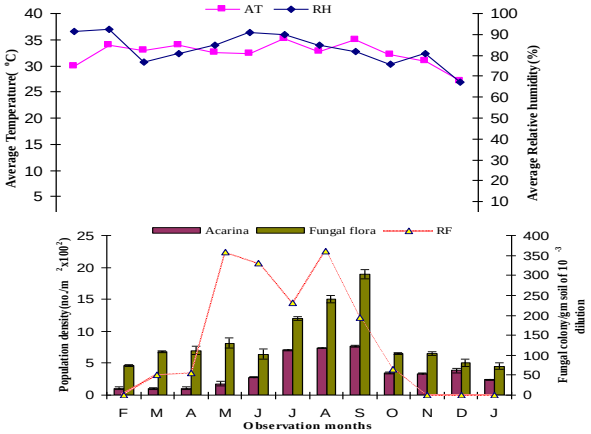
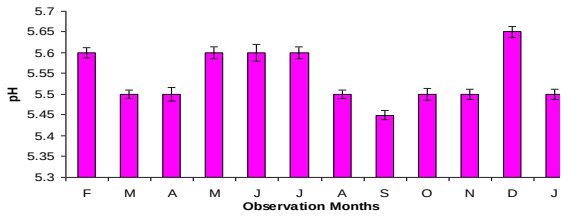


Fig.1.Showing the dynamics of Acarina fauna and Fungal flora in soil of rubber plantation in relation to climatic factors(Air Temperature, Rainfall and Relatives humidity) (February 2018 to January 2019).



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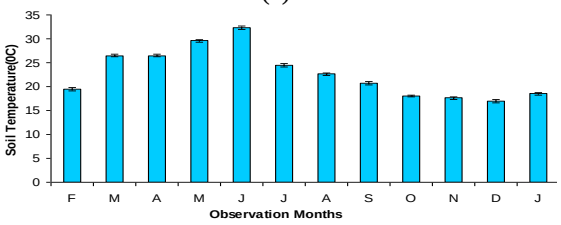

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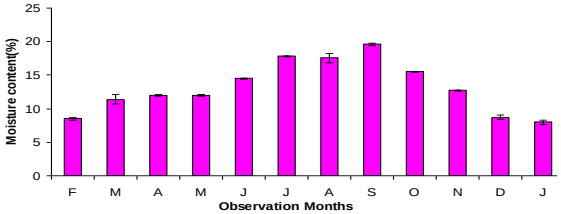

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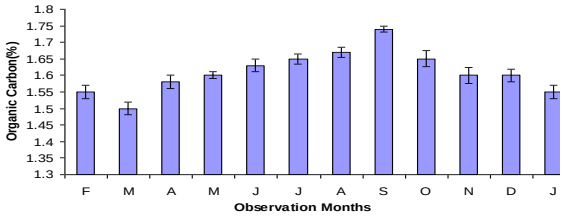

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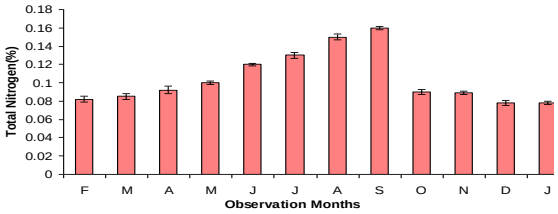

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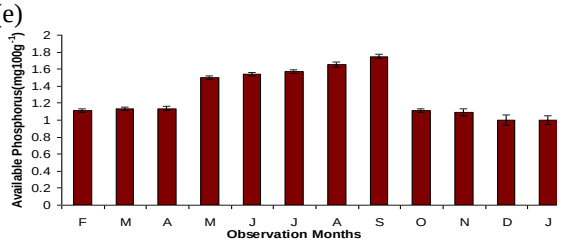

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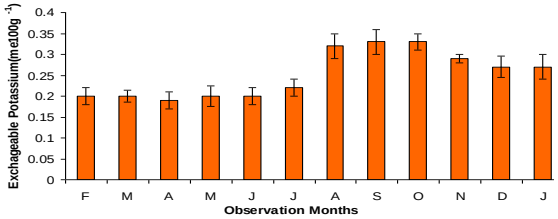

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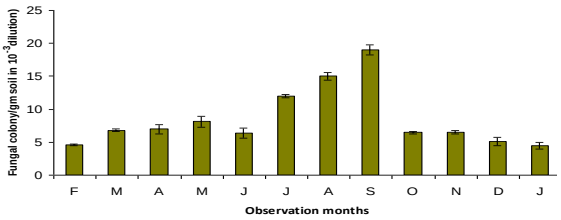

(h)

Figure 2: Showing the monthly variation of (a) pH (b) Soil Temperature(c) Moisture content (d) Organiccarbon(e)Total nitrogen (f) Available Phosphorus (g) Exchangeable soil potassium, and (h) Fungal colony investigation period (February 2018 to January 2019).

Author Profile

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