Biolife
AN INTERNATIONAL QUARTERLY JOURNAL OF BIOLOGY & LIFE SCIENCES
4(1):164-171

ISSN (online): 2320-4257
www.biolifejournals.com

BIOLIFE RESEARCH ARTICLE

Effects of soil management practices on the composition of soil-inhabiting micro arthropods

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ABSTRACT

Microarthropods play a significant role in accelerating plant residue decomposition through their interactions with the microflora. During the present investigation, attempts were made to investigate the effects of 15 different soil management practices on soil microarthropods across rainy, postrainy, and dry seasons in Alfisol maize agroecosystems. The present experiment was carried out in the field designated RM19B on the research farm at the ICRISAT Asia Center. Population densitites of soil inhabiting microarthropods in each experimental plot across the treatments were sampled using 10 cm core device of 4.5 cm diameter, whose interior widened slightly to relieve compression of soil. Acarina was dominant among the microarthropods, the mean percentage composition ranging between 40.6 and 70 % across the treatments. Composition ranged from 13 to 42.5 % across the 15 treatments. The soil-inhabiting arthropods collected across the 15 soil management treatments such as different tillage and organic amendments with annual crop and perennial ley treatments belonged to 29 different arthropod taxa.

Key Words: Microarthropods, population densities, Acarina, soil management practices.

INTRODUCTION

Soil environment provides shelter for all forms of life, including micro, meso and macro arthropods. The soil arthropods, depending on their body size, are divided into different groups such as mesofauna (2-10 mn), including all micro arthropods and macrofauna (>10 mm), which include larger arthropods and earthworms. Microarthropods are usually the most obvious of the measofauna which live in soil pores and interstices. Many of them are small and microscopic while some of the soil microarthropods spend a portion of their lives feeding in the soil. Some many spend much of their life above the soil; for instance, certain beetles which prey on aphids. Other soil arthropods spend their entire lives in the soil ecosystem. Since the soil is a highly specialized environment, it acts like a filter and only small animals which can cope with its peculiar conditions are able to survive in it (Kuhnelt, 1955 and Ghilarov, 1959). The soil floor has several layers which can be a habitat for even the smallest arthropods. However, research on the ecology of soil microarthropods is difficult due to their habitat, their delicate and small body size, sampling and taxonomic difficulties and experimental set–ups.

Microarthropods play a significant role in accelerating plant residue decomposition through their interactions with the microflora (Seastedt, 1984; Norton, 1985; Moore and Walter, 1988). The flow of energy and nutrients through the soil may be accelerated by microarthropods grazing on microflora, causing, and increased rates of microbial biomass turnovers. It is often felt the soil microarthropods are important to the process of decomposition (Macfadyen, 1963; Wallwork,

How to Site This Article:
Venu N, Srinvivas Reddy, V and Vikram Reddy M. (2016). Effects of soil management practices on the composition of soil-inhabiting micro arthropods. *Biolife*, 4(1), pp 164-171.

DOI:https://dx.doi.org/10.5281/zenodo.7313206
Received: 9 January 2016;
Accepted; 27 February 2016;
Available online : 6 March 2016

1976), because they comminute organic matter, making it more readily available for breakdown by smaller organisms. They also serve as a reservoir of nutrients which become available to plants when they die. They stimulate fungal growth by grazing, and disperse their spores.

Although considerable research has been done on the effects of various soil management practices on soil arthrorpods in temperature agroecosystems, very little is known on these aspects in tropical and sub–tropical agroecosystems, particularly in India. Reddy et al (1992) reprted on soil management and seasonal community structure of soil microarthropods in semi – arid tropical Alfisls. During the present investigation, attempts were made to investigate the effects of 15 different soil management practices on soil microarthropods across rainy, postrainy, and dry seasons in Alfisol maize agroecosystems.

Materials and Methods

Study site:

The present experiment was carried out in the field designated RM19B on the research farm at the ICRISAT Asia Center (Long : 78^0,17'^{0}'E,Lat.17^0 28'58'N", altitude Ca 547 m.s.l.), at Patancheru, 26 km northwest of Hyderabad, In Medak district of Telangana, India (Fig.2). The slope on the land surface is in the range of 1.5-2.0 %.

Soil type:

The soil of the study area belonged to the Patancheru series which is a member of the clayey-skeletal, mixed, Isohyperthermic family of Udic Rhodustalfs (Murthy et al., 1982). Analytical data of this soil type are given in El Swaify et al (1987). The soil is locally regarded as a crusting, and profile hardening soil, The textural profile consisted of a sandy loam merging to sandy clay loam or light clay at 10-15 cm and then to gravelly sandy loam overlying murrum (parent material) rich in quartz gravel at depths ranging from 30 to 70 cm. It was formed on weathrered granite –gneiss.

Experimental Design:

Population densitites of soil inhabiting microarthropods in each experimental plot across the treatments were sampled using 10 cm core device of 4.5 cm diameter, whose interior widened slightly to relieve compression of soil. Three random soil cores representing the top, middle, and bottom position of each plot were taken on each sampling date in the morning between 07.30 to 09.30 hrs when the ambient temperature was conductive. Sample sites were selected in the central part of each plot to avoid possible edge effects. The soil cores of each plot were placed in plastic bags separately, labeled, taking as much care as possible to prevent spillage, and brought to the laboratory. The soil cores were processed for extraction of microarthropods through Berlese – Tullgren funnel (Macfadyen, 1955). The heat and light source for each funnel was a 60- watt light bulb connected to a rheostat. Low settings were used so that the microarthropods would not be trapped inside the soil core due to rapid drying of soil. The extraction was continued for a minimum of 3 days. However, the period of extraction depended upon the soil water content and varied from 3-5 days, particularly during the rainy months. The arthropods were moved downward and finally out of the soil into a collecting phial containing 80 % ethanol + 1 % glycerol. These microarthropods were identified, grouped into various taxa and were enumerated with the help of stereoscopic binocular microscope (Wild Heerbrug) at 60 magnification. Their numbers were converted into the number per metre square. The data of population densites of microarthropods across the treatments and seasons were processed by ANOVA using GENSTAT.

Results & Discussion

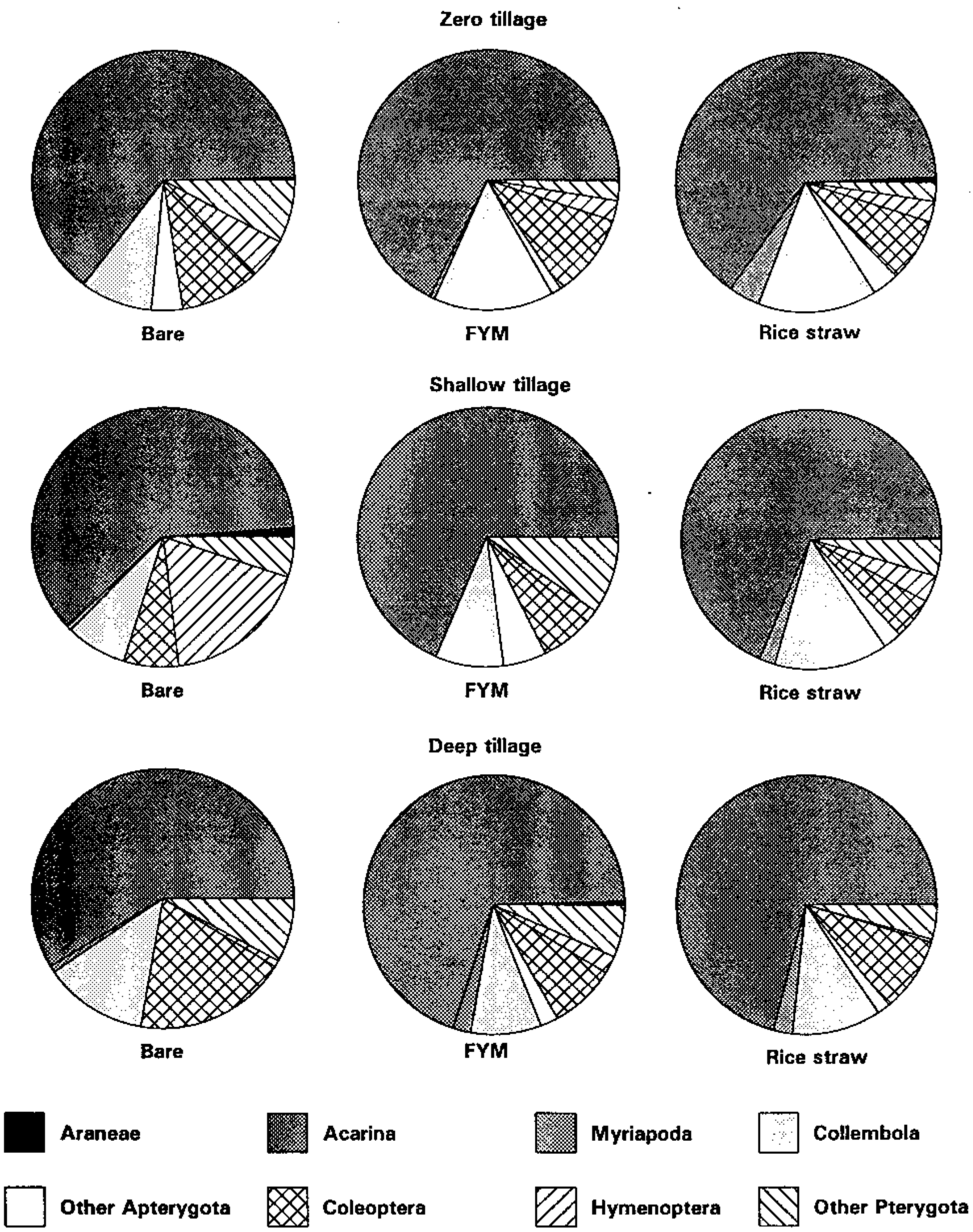
Qualitative composition

The soil–inhabiting arthropods collected across the 15 soil management treatments such as different tillage and organic amendments with annual crop and perennial ley treatments belonged to 29 different arthropod taxa such as Araneae, Pseudoscorpions and Acarina–Prostigmata, Cryptostigmata, Mesostigmata and Astigmata ; Diplopoda, Chilopoda and Symphyla, Protura, Thysanura, Diplura ; Collembola – Entomobryidae , Isotomidae, Sminthuridae and Poduriade; Coleoptera–Carabidae, Staphylinidae, Tenebrionidae, *Megalodicne* Sp. And Coleoptera larvae; Hymenoptera, Isoptera, Thysanoptera, Hemiptera, Homoptera, Diptera and Lepidoptera larvae. The mean perecentage compsotion of their taxa under the management treatments are presented in Figs. 1a and b.

Acarina;

Acarina was dominant among the microarthropods, the mean perencetage composition ranging between 40.6 and 70 % across the treatments. In Zero–and shallow – tillage treatments, their mean perecentage compsotion ranged from 63.5 and 60 % n bare amendment to 66 and 68.3 % in farmyard manure amendment. In deep–tillage treatments, their mean percentage composition ranged between 58.5 % in bare amendemtn and 70 % in rice- straw amendment. In perennial ley treatments, their percentage composition ranged from 41.5 % in pigeon pea + S. *hamata* treatment to 49.1 % in pigeon pea + S. *hamata* + C. *ciliaris* amendment. Prostigmata being the dominant taxa among the Acarina, its mean percentage

Figure-1. Perentage composition of different soil – inhabiting micro – arthropods across tillage and organic amendment treatments.

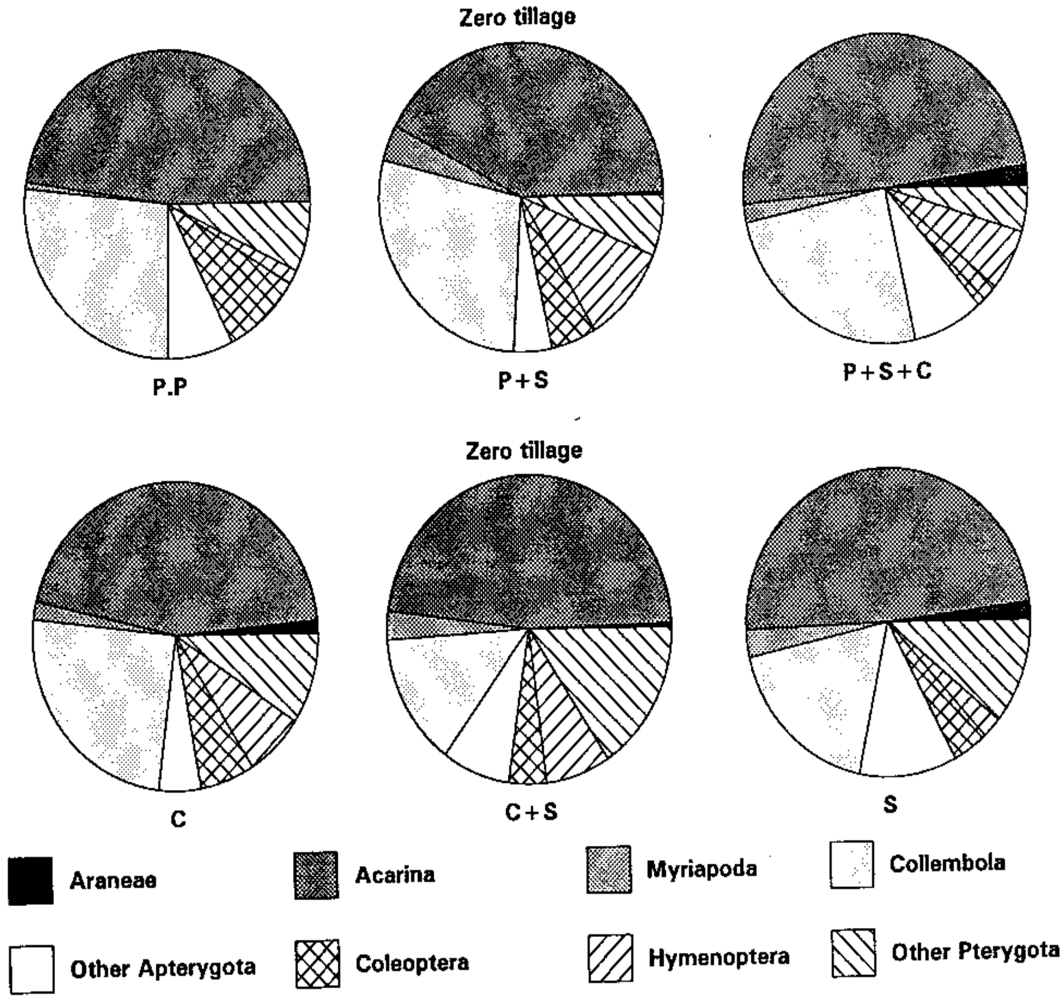


Composition ranged from 13 to 42.5 % across the 15 treatments. In zero –tillage treatments, its percentage composition ranged from 34 % in bare amendment to 42.4 % in rice- straw amendment. In shallow- tillage treatments, its percentage composition ranged from 28.2% in bare amendment to 39.2 % in farmyard manure amendment. In deep–tillage treatments, its percentage composition ranged from 20.3 % in farmyard manure amendment to 40.3% in bare amendment. In perennial ley treatments, its percentage composition ranged from 1 % in *S. hamata* treatment to 20 % in pigeon pea treatment.

Astigmata:

Its percentage composition ranged from 8.0 to 31.3 % across the 15 treatments. In zero – tillage treatments, its percentage compsoiton ranged from 8.1 in bare

Figure-2. Percentage composition of different soil- inhabiting micro arthropods across perennial ley crop treatments.



amendment to 16.8 % in farmyard manure amendment. In shallow–tillage treatments, its percentage compsotion ranged from 14.9 % in bare and farmyard manure amendments to 16% in rice–straw amendment. In deep – tillage treatments, its percentage composition ranged from 11.9 % in bare amendment to 31.5 % in farmyard manure amendment. In perennial ley. Treatments, its percentage composition ranged from 14.3 % in pigeon pea + S. *hamta* treatment to 25.5 % in C. *ciliaris* +S. *hamata* treatment.

Cryptostigmata:

Its mean percentage composition ranged from 4.6 to 19 % across the 15 treatments. In zero–tillage treatments, its percentage composition ranged from 9.4 % in rice- straw amendment to 18.5 % in bare amendment. In shallow–tillage treatments, its percentage composition ranged from 14.3 in farmyard manure amendment to 19 % in rice–straw amendemtn. In deep– tillage treatments, its percentage composition ranged from 5.6 % in bare amendment to 18.3 % in rice–straw amendment. In perennial ley treatments, its percentage composition ranged from 4.7 % in *C. ciliaris* + *S. hamata* to 12.1 % in pigeon pea + S. *hamata* + C. *ciliaris* treatments. Mesostigmata: Its mean percentage composition from < 1 to 2.5 % across the 15 treatments. In zero– tillage treatments, its percentage composition ranged from 1 % in rice–straw amendment to 2.5 % in bare amendment. In shallow–and deep–tillage treatments, it was recorded only in rice- straw amendment and comprised < 1 % (0.5 and 0.7 %) and was not recorded in other treatments. In perennial ley treatments also it comprised of < 1 % (0.7).

Collembola:

It was the second dominant taxa among the microarthropods and the percentage composition ranged from 7.4 to 27.1 % across the 15 treatments. In zero–tillage treatments, their percentage composition ranged from 8.8 % in bare amendment to 14.9 % in farmyard manure amendment. In shallow- tillage treatments, the percentage composition ranged from

7.5 % in bare amendment to 14.1 % in rice–straw amendment. In deep tillage treatments, the percentage composition ranged from 8.6 % in farmyard manure amendment to 12.5 % in bare amendment. In perennial ley treatments, the percentage composition ranged from 13.8% in C. *ciliaris* + S. *hamata* treatment to 28.1 % in pigeonpea + S. *hamata* treatment. Isotomidae being the dominant taxa among the Collembola, its percentage compsotion ranged from < 1 to 17.2 % across the 15 treatments. In zero–tillage treatments, its percentage composition ranged from 14. 3 in bare amendment to 8.9 % in rice- straw amendment. In shallow- tillage treatments, its percentage composition ranged from 1.1 % in farmyard manure amendment to 8.3 in rice–straw amendment. In deep – tillage treatments, its percentage composition ranged from < 1 % in bare amendment to 5.1 % in rice- straw amendment. In perennial ley treatments, its percentage composition ranged from 5.4 % in S. hamata treatments to 17.2 % in pigeonpea + S. *hamata* + C. *ciliaris* treatment.

Poduridae:

Its percentage composition ranged from < 1 to 13 .6 % across the 15 treatments. In zero – and shallow- tillage treatments, its percentage composition showed very little variation, ranging from 1 to 3.7 % across the amendments. In deep – tillage treatments, its percentage composition ranged from < 1 % in farmyard manure amendment to 7.1 % in bare amendment. In perennial ley treatments, its percentage composition ranged from 3.9 % in C. *ciliaris* + S. *hamata* treatment to 13.4 % in pigeonpea + S. *hamata* treatment. ***Sminthuridae***: Its percentage composition ranged from 3.1 % in farmyard manure amendment to 5.3 % in bare amendment. In shallow-tillage treatments. Its percentage to 5.3 % in bare amendment. In shallow–Tillage treatments, its percentage compsotion ranged from 2.5 % in rice- straw amendment to 3.1 % in bare amendment. In deep – tillage treatments its percentage composition ranged from 2.3 % in bare amendment to 4. 3% in farmyard manure amendment. In perennial ley treatments, its percentage composition ranged from < 1 % in C. *ciliaris* + S. *hamata* treatment to 3.7 % in C. *ciliaris* treatment.

Entomobryidae:

Its percentage composition ranged from 0.3 to 2. 5 across the 15 treatments. In zero tillage treatments, its percentage composition ranged from < 1 % in rice-straw amendment to 1.1 % in farmyard manure amendment. In deep – tillage treatments, its percentage compsotion ranged from 2.4 in bare amendment to 2.7 % in farmyard manure and rice – straw amendments. In perennial ley treatments, its percentage composition ranged from < 1 % in pigeon pea + S. *hamata* + C. *ciliaris* treatment to 2.3 % in C. *ciliaris* treatment.

Other Apterygota:

The percentage composition of other Apterygota, comprising Protura, Thysanura, and Diplura, ranged fom 1.1 to 10.1 % across the 15 treatments. In zero–tillage treatments, their percentage composition ranged from 1.2 % in farmyard manure amendment to 3.9 % in bare amendment. In shallow- and deep–tillage treatments, their percentage composition ranged from 2.3 and 1.6 % in rice–straw amendment to 5.3 and 2.2 % in farmyard manure amendment, respectively. In perennial ley treatments, their percentage composition ranged from 4.3 % in pigeon pea + S. *hamata* treatment to 11.1 % in S. *hamata* treatment. Among the other Apterygota, Protura being the dominant taxa, its percentage composition ranged from < 1 to 9.4 % across the 15 treatments. In zero–tillage treatments, its percentage composition ranged from < 1 % in rice-straw amendment to 1 1.1 % in bare amendment. It was not recorded in shallow- tillage treatments. In deep-tillage treatments, it was recorded only in rice-straw amendment, and its percentage composition was < 1 (0.8 %) and was not recorded in other treatments. in perennial ley treatments, its percentage composition ranged from < 1 % in pigeon pea + S. *hamata* + C. *ciliaris* treatment to 9.4 % in S. *hamata* treatment.

Thysanura:

Its percentage composition ranged from <1 to 5.2 % across the 15 treatments. In zero–tillage treatments, its percentage composition ranged from < 1 % in farmyard manure amendment to 1.6 % in rice-straw amendment. In shallow – and deep–tillage treatments, its percentage composition ranged from 2.2 and 0.4 % in rice–straw amendmet to 5.3 and 2.1 % in farmyard manure amendment respectively. In perennial ley treatments, its percentage composition ranged from 0.3 % in S. *hamata* treatment to 3 % in C. *ciliaris* + S. *hamata* treatment.

Diplura:

Its percentage composition ranged from 0.3 to 6.0 % across the 15 treatments. In zero–tillage treatments, its percentage composition ranged from 1.3 % in rice–straw amendment to 2.1 % in bare amendment .It was not recorded in shallow–tillage treatments. In deep–tillage treatments, it was recorded in rice straw amendment, and was 0.4 % and not recorded in the other two amendments. In perennial ley treatments, its percentage composition ranged from 1.3 % in C. *ciliaris* + S. *hamata* and S. *hamata* treatments to 6.1 % in pigeon pea + S. *hamata* + C. *ciliaris* treatment.

Myriapoda:

The percentage composition of Myriapoda, which comprised Symphyla, Diplopoda, and Chilopoda ranged from 0.5 to 3.8 % across the 15 treatments, In zero–tillage treatments, their percentage composition ranged from 0.6 % in farmyard manure amendment to 3.7 % in rice- straw amendment.in shallow and deep–tillage treatments, their percentage composition ranged from 0.5 and 0.7 % in bare amendmet to 2 and 2.3 % in rice–straw amendment respectively. In perennial ley treatments, their percentage composition ranged from <

1% in pigeon pea treatment to 3.7 % in pigeon pea + S. *hamata* amendment. Symphyla being the dominant taxa among the Myriapoda, its percentage composition ranged from 0.5 to 3.4 % across the 15 treatments. In zero–tillage treatments, it was recorded only in rice–straw amendment, and was 3.5 % in shallow-tillage treatments, its percentage composition ranged from < 1 % in bare amendment to 1 % in rice–straw amendment. In deep tillage treatments, its percentage composition ranged from 1.2 % in rice – straw amendment to 1.5 % in farmyard manure amendment. In perennial ley treatments, its percentage composition ranged from 0.4 % in C. *ciliaris* treatment to 3.2 % in pigeon pea + S.*hamata* treatment.

Diplopoda:

Its percentage composition ranged from < 1 to 1.3 % across the 15 treatments. In zero–tillage treatments, its percentage composition was < 1 %. In shallow–tillage treatments, it was recorded only in rice–straw amendment, and was 1 % in deep–tillage treatments, its percentage composition ranged from 0.4 % in farmyard manure amendment and 1.2 % in rice–straw amendment. In perennial ley treatments, its percentage composition ranged from < 1 % in pigeon pea + S. *hamata* treatments to 1.3 % in C. *ciliaris* treatment.

Chilopoda:

Its percentage composition was too low to show any distinct variation among the 15 different soil management treatments.

Coleoptera:

The percentage composition of Coleoptera, comprising Megalodicne Sp, Staphylinidae, Tenebrionidae, Carabidae, and Coleoptera larvae, ranged from 2.5 to 17 % across the 15 treatments. In zero–tillage treatments, their percentage composition ranged from 7.8 % in rice–straw amendment to 9.6 % in farmyard manure amendment. In shallow–tillage treatments, their percentage composition ranged from 4.2 % in rice-straw amendmet to 6.6% in bar amendment. In deep–tillage treatments, their percentage composition ranged from 8.2 % in farmyard manure amendment to 18 % in bare amendment. In perennial ley treatments, their percentage composition ranged from 2.5 % in pigeon pea + S. *hamata* + C. *Ciliaris* treatment to 8.8 % in Pigeon pea treatment. Carabidae being the dominant taxa among the Coleoptera, its percentage composition ranged from < 1 to 8.6 % across the 15 treatments. In zero-tillage treatments, its percentage composition ranged from 4.3 % in rice–straw amendment to 84 % in farmyard manure amendment. In shallow - tillage treatments, its percentage composition ranged from 1.6 % in farmyard manure amendment to 3.0 % in bare amendment. In deep–tillage treatments, its percentage composition ranged from 6.2 % in rice straw amendment to 7.7 % in bare amendment. In perennial ley treatments, its percentage composition ranged from < 1 % in C. *ciliaris* + S. *hamata* treatments to 7.3 % in pigeon pea treatments.

Coleoptera larvae:

Their percentage composition ranged from <1 to 3.5% across the 15 treatments. In zero–tillage treatments, the percentage composition was < 1 % in shallow–tillage treatments, its percentage composition ranged from 2 % in rice–straw amendment to 3.2 % in farmyard manure amendment. In deep – tillage treatments, its percentage composition ranged from < 1 % in farmyard manure amendment to 2.3 % in bare amendment. In perennial ley treatments, its percentage composition ranged from 1.3 % in pigeon pea + S. *hamata* + C. *ciliaris* and S. *hamata* treatments to 3.5 % in pigeon pea + S. *hamata* treatment. *Staphylinidae*: It percentage composition ranged from < 1 to 6.2 % across the 15 treatments. In zero tillage treatments, its percentage composition ranged from 1.2 % in farmyard manure amendment to 2.7 % in bare amendment. In shallow- tillage treatments, its percentage composition ranged from < 1 % in bare amendment to 1% in rice-straw amendment. In deep–tillage treatments, its percentage composition ranged from < 1% in rice–straw amendment to 6.1 % in bare amendment. In perennial ley treatments, its percentage composition ranged from < 1 % in C. *ciliaris* + S. *hamata* treatments to 2.3 % in C. *ciliaris* treatment. The percentage composition of Megalodicne Sp. And Tenebrionidae was too low to show any distinct variation in their percentage composition among the 15 treatments.

Hymenoptera:

Their percentage composition ranged from < 1 to 17 % across the 15 treatments. In zero and shallow–tillage treatments, its percentage composition ranged from 2.4 and 1. 6 % in farmyard manure amendment to 4.9 and 17 % in bare amendment respectively. In deep–tillage treatments, its percentage composition ranged from < 1 % in rice – straw amendment to 2.2 % in farmyard manure amendment. In perennial ley treatments, its percentage composition ranged from 1.5 % in pigeon pea treatment to 10 .2 % in pigeon pea + S. *hamata* treatment.

Other pterygota:

The percentage composition of other pterygota, which included psoptera,Isoptera, Thysanoptera, Hemiptera, Homoptera, Diptera, and Lepidoptera larvae ranged from 2.2 to 14.7% across the 15 treatments. In zero tillage treatments, their percentage composition ranged from 2.3% in rice-straw amendment to 7.6% in bare amendment. In shallow-tillage treatments, their percentage composition ranged from 4.5% in rice-straw amendment to 9.4% in farmyard manure amendment to 7.7% in bare amendment. In perennial ley treatments, their percentage composition ranged from 4.7% in pigeonpea +S.*hamata*+C.*ciliaris* treatment to 14.6% in C.*ciliaris* +S.*hamata* treatment. Psocoptera being the dominant taxa among the other pterygota, its percentage composition ranged from <1 to 9.1% across the 15 treatments.It was not recorded in zero-tillage treatments.In shallow-and deep-tillage treatments,its percentage composition ranged from 2.2 and 1.2% in farmyard manure amendment to 2.4 and 2.3% in bare amendment respectively.In perennial ley treatments ,its percentage composition ranged from<1% in pigeonpea + S.*hamata* +C.*ciliaris* to 9.1% in S.*hamata* treatment.

Isoptera:

Its percentage composition ranged from<1 to 6.7 % across the 15 treatmetns. In zero –tillage treatments ,its percentage composition was 4.7% in bare amendment and not recorded in other two amendments,as also shallow-tillage treatments.In deep tillage treatments,its percentage composition was<1 across the organic amendments.In perennial ley treatments, its percentage composition ranged from <1% in pigeonpea treatment to 6.7% in C.ciliaris+ S.*hamata* treatment.

Thysanoptera:

Its percentage composition ranged from 0.3 to 5.2 % across the 15 treatmetns. In zero–tillage treatments, its percentage composition ranged from < 1 % in farmyard manure amendment to 1.6 % in rice–straw amendment. In shallow–and deep-tillage treatments, its percentage composition ranged from 2.9 and < 1 % in rice – straw amendment to 5.3 and 2.2 % in farmyard manure amendment respectively. In perennial ley treatments, its percentage composition ranged from < 1 % in S. *hamata* treatment to 3.2 % in C. *ciliaris* treatment.

Hemiptera:

Its percentage composition ranged from < 1 to 1.7 % across the 15 treatments. In zero–tillage treatments, its percentage composition ranged from < 1 in bare amendment to 1.7 % in farmyard manure amendment. In shallow– tillage treatments, it was recorded only in bare amendment, and was 1.7 % in each of the other treatments. In deep–tillage treatments, its percentage composition showed very little variation, ranging from < 1 (0.8 %) in bare and rice–straw amendments to 1.1 % in farmyard manure amendment. In perennial ley treatments, its, percentage composition also showed very little variation ranging from 1 < % in pigeon pea + S. *hamata* and Pigeon pea + S. *hamata* + c. *ciliaris* treatments to 1% in C. *ciliaris* treatment. The percentage compsotion of Homoptera, Diptera, and Lepidoptera larvae were too low to show any distinict variation among the 15 different soil management treatments.

Araneae:

The percentage composition of Araneae, which included *Thanatus* Sp., and Pseudoscorpions ranged from < 1to 2.2 % across the 15 treatments. In zero tillage treatments, their percentage composition was < 1 % among the organic amendment treatments. In shallow–tillage treatments, their percentage composition showed very little variation, ranging from < 1 % in rice–straw amendment to 1.2 % in bare amendment. In deep– tillage treatments, they were recorded in farmyard manure amendment, comprising < 1 %. In perennial ley treatments, their percentage composition ranged from 0.3 % in pigeon pea + S. *hamata* treatment to 2.2 % in pigeon pea + S. *hamata* + C *ciliaris*. Treatment. Thanatus Sp., *hamata* being the dominant taxa among the araneae its percentage composition ranged from < 1 to 1.5 % across the 15 treatments. It was not recorded in zero–tillage treatments. In shallow–and deep–tillage treatments, its percentage composition showed very little variation ranging from < 1 % in C. *ciliaris* treatment to 1.5 % in pigeon pea + S. *hamata* + C. *ciliaris*, and S. *hamata* treatments.

Pseudoscorpions:

Its percentage composition ranged from < 1 to 1 % across the 15 treatments. In zero, shallow and–tillage treatments, its percentage composition were < 1 %. In perennial ley treatments, it percentage composition showed very little variation ranging from < 1% in pigeon pea + S. *hamata* and *s. hamata* treatments to 1 % in C. *ciliaris* treatment.

Conflict of Interests

Authors declare that there is no conflict of interests regarding the publication of this paper.

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