Association of soil mesofauna with litter decomposition

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Abstract

Soil fauna are considered as soil bioengineers because they feed on plant debris, reduce its mass and expose broken litter surfaces to increased rate of nutrient release and improve soil fertility. Therefore, the association of soil mesofauna with decomposition of crop debris (*Vigna radiata*- stem, V. *radiata*- root, *Cuminum cyminum*- stem, C. *cyminum*- root) has been investigated. The litters were buried in nylon mesh at 5 and 10 cm depth. The density of soil mesofauna associated with decomposing litter bags was analyzed. The population of Acari and other soil arthropods recovered from litter bags was highest with V. *radiata*- stem litter type and lowest with C. *cyminum*- root. These groups of soil fauna showed highest population ratio in V. *radiata*- stem decomposing in soil in comparison to V. *radiata*- root, C. *cyminum*- stem and C. *cyminum*- root at both depths. The population ratios of acarines were highest, however, that of other soil arthropods were lowest in all decomposing litters of roots and stems. The participation of oribatids in litter decomposition was highest in comparison to other soil arthropods. The present investigations clearly demonstrated the association of soil mesofauna with decomposing crop litters. Therefore, soil mesofauna may be used for management of organic waste resources in desert.

Additional keywords: crop litter; oribatids.

Resumo

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A fauna do solo é considerada bioconstrutora, porque se alimenta de restos de plantas, reduz sua massa e expõe a superfície quebrada da palha a níveis maiores de nutrientes liberados, melhorando a fertilidade do solo. Portanto, foi pesquisada a associação da mesofauna do solo com a decomposição de restos de culturas (*Vigna* radiata- caules, V. *radiata*- raízes, *Cuminum cyminum*- caules, C. *cyminum*- raízes). Os restos vegetais foram enterrados em malha de náilon a 5 e 10 cm de profundidade. Analisou-se a densidade da mesofauna do solo associada com os sacos contendo restos vegetais em decomposição. A população de Acari e de outros artrópodos do solo, recuperados dos sacos, foi maior com restos de V. *radiata*- caules e menor com C. *cyminum*- raízes. Esses grupos de fauna do solo apresentaram a maior proporção de população em restos de V. *radiata*- caules, em comparação com V. *radiata*- raízes, C. *cyminum*- caules e C. *cyminum*- raízes, em ambas as profundidades. A proporção de população de ácaros foi maior, mas a de outros artrópodos do solo foi menor em todos os restos de raízes e caules em decomposição. A participação de oribatídeos nos restos em decomposição foi maior que a de outros artrópodos do solo. Os presentes estudos demonstraram, claramente, a associação da mesofauna do solo com restos vegetais em decomposição. Portanto, a mesofauna do solo pode ser usada para manejo de restos orgânicos em desertos.

Palavras-chave adicionais: restos de cultura; oribatídeos.

Introduction

McBRAYER & REICHLE (1971) pointed out that the soil invertebrates constitute a vertical continuum by which organic matter is incorporated into mineral soil in the form of faeces, exuviae and the carcasses. REDDY & ALFRED (1978) found microarthropods playing an effective role in decomposition of pine litter under natural conditions. EDWARDS et al. (1970) discussed that the C/N ratio of the litter progressively decreases from 3:1 to 10:1 during decomposition. Most of the sugars and starches are transformed to carbon dioxide and water, and the proteins to carbon dioxide, water and ammonia. Mineral elements also disappear from decomposing litter. COLEMAN et al. (1977) suggested that a wide range of organisms participate in saprophytic dissimilation of organic matter, but the principal ones are the microflora and micro- and mesofauna with some assistance from macrofauna. Studies pertaining to interactions between soil food web components and their implications for decomposition, nutrient mineralization and plant growth have been reviewed (SCHEU et al., 1999).

The arthropod fauna associated with the decomposition of herbage of various species on the surface of the soil was studied by CURRY (1973). There were quantitative and qualitative differences between the microarthropod communities associated with the various litters. HARDING & STUTTARD (1974) have stressed that large numbers of microarthropods are dependent on decomposition of plant materials but it is difficult to assess the extent to which decomposition

is dependent on such fauna in terms of bioecological maintenance, organic matter metabolism and chemical decomposition of litter.

Some microarthropods feed on decomposing litter, reducing its mass and exposing broken surfaces to increased rates of nutrient release (LUSSENHOP, 1992). Others feed on fungal hyphae, even scrap hyphae from root surfaces, or on soil bacteria increasing nutrient cycling and affecting soil aggregation. It has been show that excluding microarthropods reduces rates of forest litter decomposition (SEASTEDT & CROSSLEY, 1983; BLAIR et al., 1992). KNOEPP et al. (2000) studied the biological indices of soil quality and found soil microarthropods as important one. Soil organism, in close interaction with each other and their environment, are responsible for decomposition of organic matter in ecosystems.

Crop debris is usually a principal amendment applied to the soil system and plays an important role in maintaining soil fertility, affecting both physical and chemical properties of soil. Returning large amounts of crop residue to the soil can maintain organic matter at levels high enough to support good yields. But no information is available on fauna associated with the decomposition of litters in dry region. Therefore, an experiment was planned to study the association of soil mesofauna with decomposition of different crop litters in an arid environment.

Materials and methods

The study was carried out in barren land of Barmer district of Rajasthan. This study area situated at the latitude of 26o49' north and a longitude of 72o1' east with an altitude of 128.96 meters from sea levels in the western part of India. This area is arid and the soil is sandy. The climate of the study area is dry tropical type characterized by extremes of temperature (2–50ºC), fitful and uncertain rainfall (34–204 mm), strong winds (16–75 km/h) and high potential evaporation. The debris of different crops (*Vigna radiata*-stem, *V. radiata*-root, *Cuminum cyminum*- stem, *C. cyminum*- root) were dried, washed, chopped and bagged into nylon mesh (20.3 x 20.3 cm). There was 100 g debris (crop litter) in each bag. The bags were buried in soil at a depth of 5 and 10 cm. Three replications of each group of crop litter were taken. Thus a total of 24 bags were buried and examined after a span of one year for association of soil faunal population with litter decomposition. Litter bags were taken out after one year and brought to the laboratory for faunal extraction by Tullgren funnel. The decomposing litter bags contained individuals of Oribatida, Isopoda, Diplopoda, larvae of Diptera etc. because litter residue was available due to slow degradation in arid climate. The fauna extracted from each bag were counted. Analysis of variance (ANOVA) was done and P value was set at 0.05.

Results and discussion

Populations of different mesofaunal groups collected from one year old decaying crop litter bags of V. *radiata*- root, *V. radiata*- stem, *C. cyminum*- root and *C. cyminum*- stem buried at two different depths (5 cm and 10 cm) are given in Figure 1. It is clear that the population of Acari was higher in comparison to other soil arthropods in all litter types at both depths. At the depth of 5 cm, Acari showed higher population in *V. radiata*- stem in comparison of *C. cyminum*- root, *V. radiata*- root and *C. cyminum*- stem. Other soil arthropods exhibited higher population in *V. radiata*- stem in comparison of *C. cyminum*- stem, *C. cyminum*- root and *V. radiata*- root. At the depth of 10 cm, Acari and other soil arthropods showed higher population in *V.* radiata- stem in comparison of *C. cyminum*- stem, *V. radiata*- root and *C. cyminum*- root. The decomposition process was higher at 10 cm depths in comparison to 5 cm depth. Figure 2 shows the population ratios of different mesofaunal groups collected from decaying crop litter bags of *V. radiata*- root, *V. radiata*- stem, *C. cyminum*- root and *C. cyminum*- stem buried at 5 cm and 10 cm depths. These systems showed highest population ratios of Acari (oribatids) in comparison to other soil arthropods. Likewise, changes have also been reported in the relative abundance of various arthropod groups and species during the course of decomposition in different litters (CURRY, 1973).

Acari (oribatids) population in litter bags was higher in comparison to other soil arthropods. Soil fauna showed higher population in *V.* radiata- stem decomposing in soil. The different litter types showed highest population ratios of Acari and lowest of other soil arthropods. The present investigations clearly demonstrated the association of soil mesofauna with decomposing crop litters. Large amount of nutrients are locked up in fresh organic matter and are not available to the plants until chopped, ingested and mineralized by soil organisms. REDDY (1995) has also documented the association of soil fauna in litter decomposition in tropical region. Similarly, soil fauna have been reported to increase the humus content of soil which enhances soil fertility (KUMAR et al., 1999). Therefore, soil mesofauna may be used for management of organic waste resources in desert.

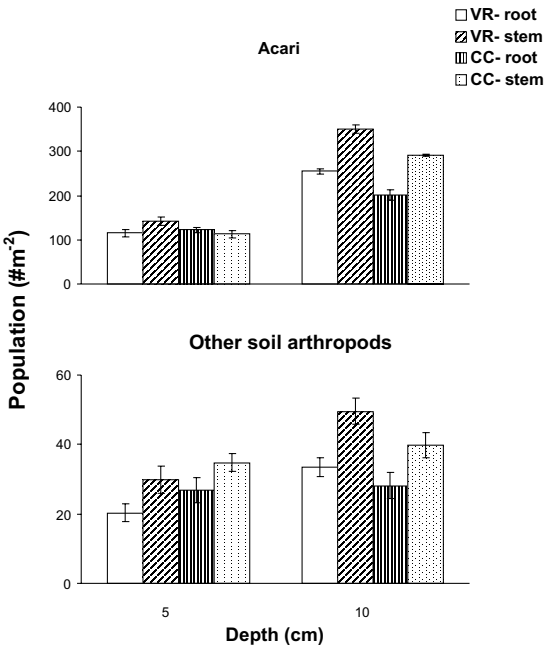

FIGURE 1 - Populations of Acari (oribatids) and other soil arthropods collected from one year old decaying litter bags of VR- root, VR- stem, CC- root and CC- stem burried at two different depths. VR: *Vigna radiata*; CC: *Cuminum cyminum*. Data between 5cm and 10cm depth differed significantly for a particular type of plant debris.

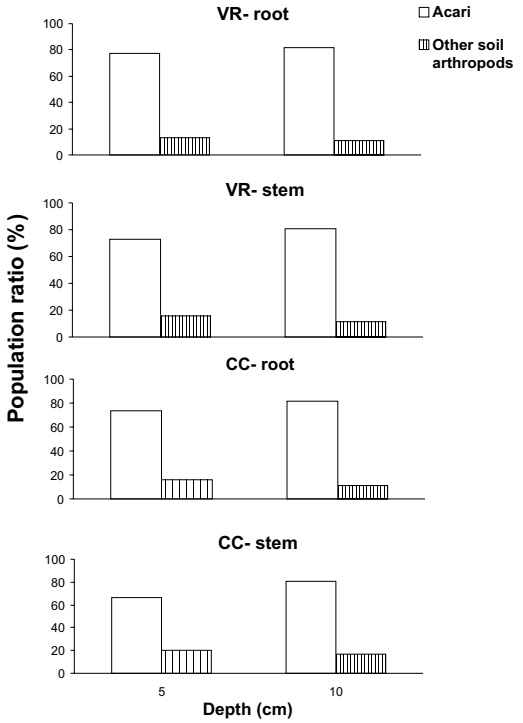

FIGURE 2 - Ratio of different groups of soil fauna (Acari-orbatids and other soil arthropods) collected from litter bags of VR- root, VR- stem, CC- root and CC- stem burried at two different depths. VR: *Vigna radiata*; CC: *Cuminum cyminum*.

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