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Research Article

SOIL PHYSICO-CHEMISTRY IN RELATION TO MICROARTHROPOD DIVERSITY IN WATTLE PLANTATIONS OF THE NILGIRIS

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ABSTRACT
Microarthropods components like mites and springtails participate in the degradation of organic materials there by gains immense significance in nutrient cycling of the ecosystem. The two main wattle species; *Acacia* and *Pinus* are planted for the protection against the soil erosion in the hill district of the Nilgiris. The comparison of their soil physical and chemical parameters was assessed in this present study along with the micrarthropod diversity. Berlese Tullgren light trap method was followed for the extraction of soil meso faunal components. The result indicates that the soil microarthropod components are rich in the *Acacia* plantation soil than the of *Pinus* plantation soil. The physico-chemical parameters of the both soil show no significant difference except potassium and phosphorus. As, both these wattles do not support the indigenous soil micro fauna, the plantations of wattle are suggested to bring impact to the ecosystem.

Keywords: *Micro-arthropods, Soil Physico-chemical Properties, Wattles, Nilgiris*

INTRODUCTION
The Nilgiri district is the part of Nilgiri Biosphere Reserve which is considered as the World Heritage Site by UNESCO. This biodiversity hot spot including the hill district of the Nilgiris harbors rich natural resources in terms of fauna and flora. During the British period, a vast area of natural forest was destroyed and exotics like *Eucalyptus*, *Acacia* and *Pinus* were planted in marshy swamps or shola. Much of the natural grass lands and shola forests have been disturbed or destroyed by extensive tea plantations and non-native plantations like *Eucalyptus*, *Acacia* and *Pinus (*Nazia and Sanil, 2015). The *Eucalyptus* plantation as it sucks the underground water results in the depletion of ground water. It was reported that the secretion of the wattle species leaf produces change in the physicochemical properties of the soil (Singh, 2006; Venkataramanan, 1983). The needle like leaves of pine covers the ground completely and appears as a golden carpet and this litter remains as such without decomposition for a long period. The resin of the leaves penetrates into the ground thereby produce changes in the texture and composition of the soil. In this condition no other plants grip their roots in the area. In the case of *Acacia* plants, the seeds spread through the air all over the area and which restricts the growth of other plants. The wattle, *Acacia* produces a number of organic compounds which defend them from pests and grazing animals. These *Acacia* trees contain cyanogenic glycosides which release hydrogen cyanide from the fallen leaves that may cause harm to the livestock and even to micro-organisms which feed on it.

Soil organisms are classified as micro fauna such as protozoa; meso fauna such as Acari, and collembolanss; macro fauna such as earthworms, millipedes, woodlice, slugs and snails according to their size (Brussaard and Juma, 1995; Swift *et al.*, 1979). Macro fauna are defined as animals larger than 2 mm in size while, meso fauna are 0.1 to 2 mm in size and are the abundant group in the soil. Meso fauna feed on bacteria, fungi, algae and also scavenge on degraded organic matter. These organisms help in the breakdown of organic matter, stimulation of microorganisms and deposition of faeces which increase soil fertility (Nazia and Sanil, 2015). This present study targeted to analyse the the physico-chemical parameters in *Acacia* and *Pinus* plantation soil of the Nilgiris and to assess the meso-faunal (micro-arthropod) diversity in relation to the physicochemical properties.

MATERIALS AND METHODS

The study was conducted in the selected *Pinus* and *Acacia* plantations in selected areas of the Nilgiri District (Dodabetta- 11°24 N, 76°44 E, 2,637 MSL; Coonoor- 11°35N, 76°82E, 1850 MSL; Kotagiri- 11°26 N, 76°53 E, 1,793 MSL; Kodanad- 11°51 N, 76°90 E, 1, 8 41 MSL; Gudalur- 11°50 N, 76°50 E, 1, 072 MSL). Sample was collected up to 15 cm depth along with humus in a soil sampler of diameter 16 cm. From each site 20 samples were collected in a polythene bag and brought back to the laboratory within 3 hours for analysis. The samples were collected from both the *Pinus* and *Acacia* plantations in the summer season to get an accurate estimate. The soil samples were analyzed for the physical properties like bulk density (g/cm^3), specific gravity, electrical conductivity, soil pH and chemical parameters like moisture content (%), water holding capacity (%), organic content (%), phosphorus (mg/dL), potassium (mg/dL) according to the standard protocols (Saxena, 1990).

Half of the collected fresh sample was used for the separation of meso arthropods in Berlese Tullgren separating funnel and the organisms were fixed in ethyl alcohol. The separation of the faunal components was done for 96 hours in order to achieve complete extraction. The number and the type of the species in each separation unit was counted and estimated as the number of species/cm^3 of the soil (Helle and Sabelis, 1985). The identification of soil faunal components was done as per the classification described by Scott and Stojanovich (1962), Vanderhamman (1972), Mari Mutt (1976), Zhang and Norbakhsh (1995), Bellinger, *et al.*, (1996-2010), Jansenns (1997), Traser and Kontschan (2004).

RESULTS AND DISCUSSION

Results

The physicochemical properties of the soil samples collected from the *Acacia* and *Pinus* plantations are given in table 1. The comparison of various parameters like electrical conductivity, pH, bulk density, specific gravity, moisture content, water holding capacity and organic components indicates these do not differ significantly in both plantations. However, the phosphorous observed to be comparatively high in the *Pinus* plantations and the potassium observed to be high in the *Acacia* plantations.

Table 1: Soil Physicochemical Parameters of *Acacia* and Pine Plantations

S. No.	Parameters	*Acacia*	*Pinus*	't' Test
1	Electrical conductivity	00.07 ± 0.02	00.04 ± 00.01	Non-significant
2	pH	03.70 ± 0.27	04.10 ± 00.10	Non-significant
3	Bulk density (g/cm^3)	00.62 ± 0.01	00.67 ± 00.01	Non-significant
4	Specific gravity	00.66 ± 0.02	00.73 ± 00.02	Non-significant
5	Moisture content (%)	04.69 ± 0.62	05.29 ± 00.66	Non-significant
6	Water holding capacity (%)	48.04 ± 1.05	40.67 ± 01.25	Non-significant
7	Organic Component (%)	03.44 ± 0.21	03.65 ± 00.07	Non-significant
8	Phosphorus (P) (mg/dL)	12.25 ± 2.50	16.33 ± 05.51	P<0.05
9	Potassium (K) (mg/dL)	52.00 ± 8.66	38.50 ± 12.02	P<0.05

Table 2 shows the abundance of the various micro-arthropods (given as meso fauna due to the inclusion of nematodes) in the *Acacia* and *Pinus* plantation soil. When considering the overall diversity it is noted that the density and diversity of the micro-arthropods are very less in the *Pinus* planted soil on comparison to the *Acacia* planted soils. The groups of the micro-arthropods observed were the mites, collembola., Symphyla and Dipteran larvae However, the *Acacia* soil is diverse and the density of collembola and mites are comparatively high. The other groups of microarthropods observed in the soil were the coleoptera and thysanoptera. The non arthropods observed in the soil were the nematodes in the *Acacia* soil. The t test analysis indicates that the Symphyla and Diptera (Larva) did not significantly vary between the two plantation soil types and are rare occurrences.

Table 2: Soil micro-arthropod diversity of *Acacia* and *Pinus* plantations

S. No.	Meso-fauna	*Acacia* (Individuals/cm^3)	*Pinus* (Individuals/cm^3)	't' Test
1	Collembola	27.00±22.72	03.00±1.83	P<0.05
2	Mites	24.67±18.66	03.50±1.00	P<0.05
3	Symphyla	01.15±00.67	01.50±0.50	Non significant
4	Diptera (Larvae)	01.73±01.00	00.50±0.25	Non significant
5	Coleoptera	03.67±05.51	-	Not estimated
6	Thysanoptera	00.83±00.58	-	Not estimated
7	Nematodes	00.83±00.58	-	Not estimated

Table 3 shows the correlation between the soil properties and collembolan diversity in *Acacia* and *Pinus* soil. The four families of collembolan observed in wattle soil were Isotomidae, Entomobryidae, Onychiuridae and Sminthuridae. All the families show negative correlation to the soil moisture content of *Acacia*. Onychiuridae shows positive relation to the organic component of *Pinus* and potassium of *Acacia*. While, the Entomobryidae shows no positive relation to any of the parameters studied, but exhibits a strong negative correlation to the moisture content (r= -0634) and organic content (r= -088) of *Acacia*. In case of Isotomidae there is a considerable negative correlation (r= -0.531) with the phosphorous content. The general negative correlation may be suggestive of the avoidance of the wattle soil habitat by these very important soil organisms. However, it should be noted that most of these do not falls in the significant range of correlation and it is hard to make a general conclusion.

Table 3: Correlation between Collembolan Diversity and Soil Properties of Acacia and Pine Plantation Soil

Collembolan Diversity	Moisture Content (%)		Organic Component (%)		Phosphorus (P) (mg/1)		Potassium (K) (mg/1)	
	Acacia	Pine	Acacia	Pine	Acacia	Pine	Acacia	Pine
Isotomidae	-0.133	+0.121	-0.21	-0.399	-0.531	+0.06	+0.105	+0.06
Entomobryidae	-0.634	-0.154	-0.88	-0.417	+0.139	-0.25	0	-0.25
Onychiuridae	-0.078	-0.185	0	+0.393	-0.655	-0.12	+0.207	-0.12
Sminthuridae	-0.095	-0.228	+0.11	-0.283	-0.424	+0.51	-0.447	+0.52

Discussion

Acacia and *Pinus* are two exotic plantations commonly share their habitat for their growth. These trees are mostly seen in the temperate regions and the leaves are made for withstanding the cold of such regions. The soils of these plantations are rich in the moisture content and hence rich in their organic content. When the physicochemical parameters are compared between the *Acacia* and *Pinus* plantations, it is evident that both the plantations bear very similar soil properties. Physico-chemical parameters like moisture content, water holding capacity and bulk density are greatly dependent on the organic content of the soil.

The normal value of bulk density is 1.0 to 1.6 g/cm^3. But the value observed to be decreased than the normal values in this study can be attributed to the high rate of rainfall. The important physical property of the soil, the pH is also affected by the rainfall (Saxena, 1990). The soil becomes acidic in nature where high rainfall is present. The specific gravity of a soil is mostly depends upon the soil particle size and its texture.

Phosphorus is very much essential for the plant growth (Lowell, 2002). Phosphorus and organic content are correlated and when phosphorus increases, the soil becomes polluted. The pine soil has high phosphorous content when compared to the Acacia and can be accounted to the accumulated organic content. Likewise, the potassium is also an important factor that involves in the metabolism of meso-organisms (Saxena, 1990). The rate of Potassium (K) in the Acacia soil is high may due to the dense meso-faunal diversity it is also observed that the Sminthuridare have a correlation value of +44. Nazia & Sanil (2015) observed more collembolans in the *Eucalyptus* leaf littered soil than the soil without leaf litter, indicating the direct relation of collembola to the organic content. Springett (1976) observed that the microfauna is unable to decompose the *Pinus* leaf litters. This seems to be correlated to the present study as evident from the lesser abundance of the microarthropods in the present study. Based on the study on *Acacia* plants Adejuyigbe (1999) observed that the microarthropod population is comparatively correlated to the lignin contents, supports the presence of high number of microarthropods in *Acacia* soil in the present study. In conclusion, the diversity of the microarthropods is comparatively lesser in both the wattle planted soils. The diversity is very less in the *Pinus* planted soil indicating the plantations of *Pinus* is not good for the indegenous soil micro fauna as they do not prefer the *Pinus* litter.

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